North Hudson Sewerage Authority

Long Term Control Plan

Selection and Implementation of Alternatives

New Jersey Pollutant Discharge Elimination System Permit No.: NJ0025321

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Executive Summary

Under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit for the River Road Wastewater Treatment Plant (WWTP), as part of the Long Term Control Plan (LTCP), the North Hudson Sewerage Authority (the Authority) must develop a full plan of control technologies to reduce combined sewer overflows (CSOs) within the River Road WWTP service area and its outfalls. This report presents the selected control technologies for the River Road service area that will comprise the LTCP. These control technologies were selected by testing combinations of the controls in the River Road WWTP Service Area InfoWorks Integrated Catchment Modeling hydraulic collection system model (model), developing a total cost for the program, determining the affordability, and presenting an implementation schedule.

Background and Objectives of the Long Term Control Plan

In October 2015, the New Jersey Department of Environmental Protection (NJDEP) issued individual permits to municipalities and authorities that own and operate segments of the combined sewer systems (CSSs). The NJPDES permits addressed requirements for overall water quality improvements, routine reporting, and development of a CSO LTCP that parallels the CSO LTCP Guidance presented by the U.S. Environmental Protection Agency (EPA). The permit requires the permittee to develop a feasible CSO control plan that will meet water quality standards using either the Presumption Approach or the Demonstration Approach. After review of both approaches, the Authority chose to move forward with the Presumption Approach to achieve permit compliance with the LTCP because this approach is more cost-effective and methods to measure compliance are more feasible.

Under the Presumption Approach, the permittee must demonstrate one of the following:

- No more than an average of 4 overflow events per year
- The elimination or capture for treatment of no less than 85 percent (%) by volume of the combined sewage collected system-wide on an annual average basis
- The elimination or removal of no less than the mass of pollutants identified as causing water quality impairment

When conducting the Development and Evaluation of Alternatives for the service area, the Authority analyzed the requirements to reduce overflows to 4 overflows per year at each outfall, which would satisfy the Presumption Approach. At the conclusion of the evaluation, the requirements to achieve 4 overflows per year system-wide were very costly and in some cases required extensive construction of satellite facilities which may contribute to community disruptions. Eliminating the mass of pollutants identified as impairing water quality and measuring compliance would also prove difficult. For these reasons, the Authority chose to move forward with achieving a minimum of 85% capture by volume of combined sewage on an annual basis.

Consistent with the description in the permit, results from the model show the existing percent capture of combined sewage on an annual average basis within the River Road WWTP system is 60%. This percentage served as the basis for developing a full plan to increase the percent capture to 85% on an annual average basis. In addition to satisfying the permit, the goals of the Authority are to select a feasible, reasonable plan that will reduce CSOs while also supporting the community.

Current Program Status

The Authority and other cities currently have ongoing tasks and projects that will supplement the overall LTCP. These plans and their current status are described in this section.

River Road Service Area Leak Detection Program

To minimize effects of inflow and infiltration, the Authority has utilized flow monitoring and closed-circuit television inspections to identify infiltration into the collection system originating from water main leaks. This can in turn decrease volume that may infiltrate into the collection system and allow for more CSO flow to the WWTP. As part of this process, the Authority has conducted quarterly meetings with Suez Water to isolate and repair these leaks and as a result, the program reduced influent rates to the River Road WWTP from 11 mgd to under 8 mgd.

Sewer Cleaning and Linings

As part of the Authority's Operation and Maintenance Plan, efforts have been ongoing towards cleaning and repairing sewers when necessary. In addition to the regularly scheduled cleaning, the Authority has a $1 million budget set aside per year exclusively for sewer cleanings and linings. Based on known information and as conditions change, sewers are cleaned and lined according to priority as described in the Asset Management Plant. This will continue throughout implementation of the LTCP to supplement the larger projects planned. These efforts are all in addition to the regularly scheduled cleanings conducted on an ongoing basis.

Green Infrastructure

Currently there are multiple green infrastructure projects in different phases throughout the River Road service area. These projects are in response to help manage the increasing intensity and frequency of severe weather which contributes to CSOs. The strategies include increasing the service areas infiltration, detention and retention of stormwater before entering the CSS to avoid potentially overloading the system leading to flooding. Current green infrastructure elements that are either in planning or are already constructed are green infrastructure practices at schools in Union City, practices within the confines of the West New York Parking Authority, and bioswales along Park Avenue. These elements will work in parallel with the LTCP to further control CSOs.

Sewer Connection Stormwater Management Requirement

Since 2001, the Authority has required all new sewer connection approval applications to include Stormwater Management. In most cases this resulted in a small stormwater detention system that reduces peak flows into the Authority's combined sewer system during wet weather events. Since the requirement was put into place, there have been over 45 stormwater detention systems installed of various sizes, resulting in over half a million gallons of stormwater storage throughout the system. Since most of these systems were installed before the system characterization was completed, these systems are already accounted for in the baseline characterization. Therefore, they do not count toward the overall CSO reduction discussed in this plan. However, the requirement is still in place, and all new stormwater management systems will further increase the CSO capture throughout the system over time.

Long Term Control Plan

Nine Requirements

From the permit, there are nine requirements the permittee must satisfy upon submission of the LTCP. The Authority's actions to satisfy each requirement are summarized in this section.

Characterization, Monitoring, and Modeling of the Combined Sewer System

In July 2018, the Authority submitted the System Characterization Report for the River Road WWTP service area. The purpose of this characterization was to conduct a comprehensive characterization of the CSS through records review, monitoring, and modeling to establish baseline conditions upon which the LTCP would be based. The report includes a summary of existing assets within the service area, describes the current capacity of the system including the WWTP, and summarizes baseline conditions for both water quality and CSO volumes that were referenced and applied during the final selection of the LTCP. The final report was approved by NJDEP on July 23, 2019.

Public Participation

In July 2018, the Authority submitted a Public Participation Plan to outline the elements of public participation that would be implemented throughout development of the LTCP. The objectives of the Public Participation program are to communicate key program information to the general public and stakeholders, to enable stakeholders to provide feedback from the Authority, and to fulfill all public information and notification requirements of the NJPDES permit. Communication tactics to engage the public, inform them of the current program status, and update them on milestones included conducting periodic public meetings, distributing bulk mailings, establishing an online presence, and working with the Community Advisory Board to engage active community groups in development of the LTCP. Updates on actions in public participation have been outlined in the periodic progress reports. A summary of all public participation actions will be presented in Section 5 of this Selection and Implementation of Alternatives report.

Consideration of Sensitive Areas

The portion of the Hudson River that is tributary to the service area is classified as SE2(C2), or saline estuarine category 2 water, by New Jersey Surface Water Quality Standards. Under the CSO guidance outlined by the EPA, a permittee's long-term CSO control plan must give the highest priority to controlling overflows to sensitive areas. In June 2018 as part of the New Jersey CSO group, the Authority contributed to the Passaic Valley Sewerage Commission's Identification of Sensitive Areas Report to ensure that these areas, if any were identified, were considered throughout the development of the LTCP. This included identifying any endangered species, areas of primary contact recreation, and potential Outstanding Natural Resource Waters through information in online databases, direct observations, and correspondence with regulatory agencies and local environmental organizations. While the Authority will continue to ensure the area is meeting the requirements laid out in the Clean Water Act, it was determined that there are no sensitive areas within the portion of the Hudson River that is tributary to the River Road WWTP system. Additional information can be found in the final Identification of Sensitive Areas Report submitted on March 29, 2019.

Evaluation of Alternatives

In July 2019, the Authority submitted the Development and Evaluation of Alternatives Report summarizing the identification and evaluation of reasonable CSO control alternatives that will meet the water quality-based requirements of the Clean Water Act using the Presumption Approach criteria. The report identifies a list of possible control alternatives for each CSO and the River Road WWTP that were simulated in the approved model for the River Road WWTP service area. The practical and technical feasibility are identified as well as the potential level of control. The various controls analyzed included green infrastructure, increased storage capacity in the collection system, storage and expansion of capacity at the WWTP, inflow and infiltration reduction, sewer separation, treatment of CSO discharge, and bypass of secondary treatment at the WWTP. For each control, the expected results are presented as well as estimated costs. These alternatives served as the basis for the final selection of controls for the LTCP. Additional information can be found in the final Development and Evaluation of Alternatives Report accepted by NJDEP on February 24, 2020.

Cost/Performance Consideration

As part of the Development and Evaluation of Alternatives, cost estimates were developed for each alternative. For the selected alternatives, these cost estimates were applied to the complete program to determine the affordability of the program. The costs were also used to determine when funding would be available and what sources it would be provided from. The cost of the full program is shown in this Selection and Implementation of Alternatives Report.

Operational Plan

Upon approval of this final LTCP and through implementation of the approved LTCP, the Authority will modify the Operation and Maintenance Program and Manual to reflect the updated LTCP. The plan will include details on how existing and future infrastructure will be maintained and operated by the Authority. The plan will be updated throughout the implementation of the LTCP to ensure that all facilities are being operated and maintained appropriately. Further detail is provided in this Selection and Implementation of Alternatives report (Section 4).

Maximizing Treatment at the Existing WWTP

During the Selection of Alternatives, the Authority focused on maximizing treatment and storage at the treatment plant because this would be crucial to achieving the target capture goal while minimizing disruptive construction elsewhere in the service area. Feasible solutions included implementing blending of treated primary effluent with final plant effluent during wet weather events and installing a storage tank to collect flow beyond the maximum capacity of the plant during wet weather events. The selected controls at the WWTP are detailed in this Selection and Implementation of Alternatives report.

Implementation Schedule

An implementation schedule was developed to detail the phasing of construction and financing for the LTCP. When developing the schedule, the Authority considered the overall phasing by ensuring there would be adequate capacity downstream in the system prior to increasing capacity upstream, availability of funding for the projects, and the overall financial capability not only for construction but also operation and maintenance for added infrastructure. The Authority will continue to monitor the overall schedule throughout the LTCP, exploring opportunities to expedite the schedule, should they arise. The full schedule is provided in this Selection and Implementation of Alternatives Report (Section 7).

Compliance Monitoring Program

To measure overall CSO reduction as a result of the LTCP, a compliance-monitoring program has been outlined to be conducted during and after LTCP implementation. As part of the System Characterization, the Authority conducted water quality monitoring and flow monitoring to develop baseline conditions that these compliance monitoring results would be compared with to demonstrate the effectiveness of the implemented controls. Details of the compliance-monitoring program are provided in this Selection and Implementation of Alternatives Report (Section 6).

Implementation Schedule

Table ES-1 shows the Authority's proposed LTCP implementation schedule for both the Adams Street and River Road service areas, including the estimated construction cost.

Table ES-1. North Hudson Sewerage Authority Long Term Control Plan Implementation Schedule

Drainage Basin	Project	Construction Cost	Projected Start Date
H6/H7	Integration of 1-MG Resiliency Park Storage Tank into NHSA Conveyance System	$17,300,000	2020
WNY1	Land Purchase for Storage Tank	$4,000,000	2021
H6/H7	Integration of 1-MG Resiliency Park Storage Tank into NHSA Conveyance System – Phase 2	$4,000,000	2024
River Road WWTP	Increase Capacity to 35 MGD Through Blending and Plant Upgrade	$13,000,000	2025
H6/H7	Integration of 1-MG Resiliency Park Storage Tank into NHSA Conveyance System – Phase 3	$16,000,000	2026
Adams Street WWTP	Construct New Adams Street WWTP Outfall	$5,000,000	2027
JOSO	Raise JOSO Weirs	$2,000,000	2029
Adams Street WWTP	Increase Capacity at Adams Street WWTP by 20 MGD through Side Stream Treatment	$13,000,000	2030
W1234	Parallel 48-inch Park Avenue Siphon	$28,000,000	2033
H1/H3/H4/HSI	Increase Capacity of 5th Street Pump Station, Construct Force Main and Construct Parallel 11th Street Siphon	$30,000,000	2036
H5	Increase Capacity of 11th Street Pump Station	$13,000,000	2039
Adams Street WWTP	Construct 2-MG Storage Tank	$17,000,000	2042
WNY1	Construct 8-MG Storage Tank	$77,000,000	2045
Adams Street WWTP	Construct 8-MG Storage Tank	$68,000,000	2048
	TOTAL	**$307,300,000**	

JOSO = joint overflow sewer outlet
MGD = million gallons per day
NHSA = North Hudson Sewerage Authority
WNY = West New York

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Acronyms and Abbreviations

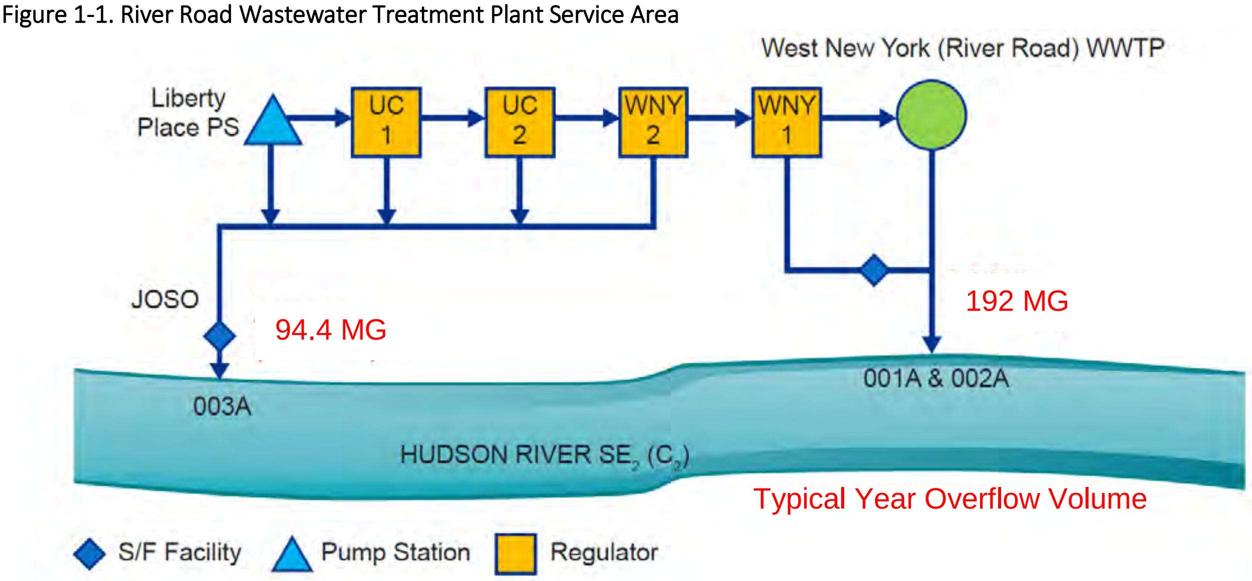
%	percent
Authority	North Hudson Sewerage Authority
CAB	Community Advisory Board
CPH	cost per household
CSO	combined sewer overflow
CSS	combined sewer system
EPA	U.S. Environmental Protection Agency
FCA	Financial Capability Assessment
FY	fiscal year
GIS	geographic information system
HLSS	high-level sewer system
JOSO	joint overflow sewer outlet
LTCP	Long Term Control Plan
MG	million gallons
MGD	million gallons per day
MHI	median household income
NHSA	North Hudson Sewerage Authority
NJDEP	New Jersey Department of Environmental Protection
NJIB	New Jersey Infrastructure Bank
NJPDES	New Jersey Pollutant Discharge Elimination System
O&M	operations and maintenance
PS	pump station
Q&A	question and answer
S/F	solids/floatables
SCADA	supervisory control and data acquisition
WNY	West New York
WWTP	wastewater treatment plant

SECTION 1

Introduction

This report presents the selected control alternatives for the Long Term Control Plan (LTCP) for the North Hudson Sewerage Authority's (NHSA or the Authority) River Road Wastewater Treatment Plant (WWTP) system. This plan includes estimated costs, affordability, and a proposed implementation schedule. Figure 1-1 depicts the system block diagrams of the River Road WWTP outfalls. This figure provides an understanding of the relative locations and configuration of the Authority's infrastructure along the Hudson River based on the WWTP service area, as well as volume of the overflow in the Typical Year from the model that was used to determine the total percent capture.

Figure 1-1. River Road Wastewater Treatment Plant Service Area



1.1 Background

The Authority owns two wastewater treatment plants (WWTPs) and the combined sewer system (CSS) tributary to these facilities. The Adams Street and River Road WWTPs are regulated by the New Jersey Department of Environmental Protection (NJDEP) under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit program.

1.2 Regulatory Requirements

In October 2015, the NJDEP issued individual permits to municipalities and authorities that own and operate segments of the CSSs. The NJPDES permits addressed requirements for overall water quality improvements, routine reporting, and development of a Combined Sewer Overflow (CSO) LTCP.

Pursuant to NJPDES Permit NJ0025321 (River Road WWTP), Part IV, Combined Sewer Management Section, Section D.3.b.i., a System Characterization Work Plan for the LTCPs was submitted to NJDEP on December 31, 2015. Additionally, pursuant to Part IV, Combined Sewer Management, Section D.3.b.v., a Development and Evaluation of Alternatives Report was submitted to NJDEP on June 26, 2019. This document fulfills the requirement in Part IV, Combined Sewer Management, Section D.3.b.iv to submit a Selection and Implementation of Alternatives Report by June 1, 2020. Information generated from the

System Characterization Work Plan and Development and Evaluation of Alternatives comprises this LTCP, including:

- Public participation process
- Operational plan
- Maximizing treatment at the existing sewage treatment plant
- Implementation schedule
- Compliance monitoring

1.3 Purpose and Scope

The purpose of this report is to fulfill NJDEP Permit requirements to develop a comprehensive long-term plan expected to accomplish the requirements of the Clean Water Act within the River Road WWTP service area. The plan includes the recommended controls, estimated costs, and expected implementation schedule. In its evaluation of each potential control scenario, the approved hydrologic, hydraulic, and water quality models were used to simulate the conditions as they are expected to exist after construction and operation of the chosen alternative scenario. The practical and technical feasibility of the proposed CSO control scenario include:

- WWTP expansion and storage at the plant, including an evaluation of the capacity of the unit processes must be conducted at the WWTP resulting in a determination of whether there is any additional treatment and conveyance capacity within the WWTP

- Increased conveyance to the WWTP

- CSO-related bypass of the secondary treatment portion of the WWTP in accordance with N.J.A.C. 7:14A-11.12 Appendix C, II C.7.

The anticipated conceptual layouts, anticipated results of implementing the alternatives using the model in the River Road WWTP service area, and planning level costs are described in the following sections.

SECTION 2

Methodology

To measure the success of the LTCP, the baseline conditions in the System Characterization (Appendix A) will be compared with conditions measured after CSO controls are implemented to verify improvements in water quality. The permit requires the permittee to measure these improvements using either the Presumption Approach or the Demonstration Approach. After review of both approaches, the Authority chose to move forward with the Presumption Approach to achieve permit compliance with the LTCP because this approach is more cost-effective and the methods of measuring compliance are more feasible. The Presumption Approach and baseline conditions are described in this section.

2.1 Presumption Approach

Since the CSO Policy was issued in 1994 and then adopted under the Clean Water Act in 2001, the Presumption Approach has been a popular strategy for CSO communities to meet the requirements under their individual CSO permits. This is because the approach provides a "reliable target for utilities negotiating consent decrees and implementing resulting requirements" (Spitzig and Vassar 2017). Under the Presumption Approach a community must satisfy one of the three criteria outlined in the CSO Control Policy (below). The criteria are indirect performance measures for water quality and, when achieved, are presumed to provide the appropriate level of water quality improvement and protection.

- Criteria 1: "No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year" (CSO Control Policy, 1995a)
- Criteria 2: "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" (CSO Control Policy, 1994)
- Criteria 3: "The elimination or removal of no less than the mass of the pollutants, identified as causing water quality impairment through the sewer system characterization, monitoring, and modeling effort, for the volumes that would be eliminated or captured for treatment under [Criteria 2] above" (CSO Control Policy, 1994)

As part of the Alternatives Analysis, the Authority analyzed alternatives that would result in 4 overflows per year at each outfall. At the conclusion of the analysis, it was determined that while the alternatives proposed could reach 4 overflows per year, construction efforts for the majority of the alternatives would be very expensive and disruptive to the community. During the selection of alternatives, the Authority analyzed combinations of alternatives to instead satisfy Criteria 2 in which 85 percent (%) of combined sewage produced in a year is captured in the system. These combinations as a whole were effective in reaching compliance and they were more cost-effective than those to reach Criteria 1. Because of this, the Authority moved forward with reaching the presumption approach and satisfying Criteria 2.

2.2 Existing Percent Capture

Percent capture within the existing system was calculated at 57% in the System Characterization. This calculation accounted only for wet weather. Reviewing the permit, percent capture is defined as, follows:

"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" (emphasis added; EPA 1995a).

The statement of combined sewage implies sanitary flow is also included in the calculation and not only wet weather flow. Applying the updated method from the permit and updated model results, the existing percent capture increases when sanitary flow during wet weather is accounted for. The following equation applies this methodology.

$$\textbf{\textit{Percent Capture}} = 1 - \frac{\textit{Overflow Volume}}{\textit{Total Volume in System during Wet Weather}}$$

As described in the Development and Evaluation of Alternatives Report, the model was updated with additional data after the System Characterization including verification of flows at the W5 outfall, finalizing the modeling of the stormwater system in H6/H7, closing the flushing chambers, and the future buildout in Hoboken. This affected the overall CSO volume generated within the system. The total CSO volume generated by each drainage basin in the typical year is shown in Table 2-1.

Table 2-1. Combined Sewer Overflow Volume by Drainage Basin in the Typical Year

Drainage Basin	CSO Volume Typical Year, MG
JOSO	94.4
WNY1	192

JOSO = Joint overflow sewer outlet
MG = million gallons
WNY = West New York

Volumes that are captured at the WWTP in the typical year are presented in Table 2-2.

Table 2-2-Wet Weather Volume at the River Road Wastewater Treatment Plant in the Typical Year

WWTP Flow	Volume Typical Year, MG
Sanitary Flow at WWTP in Dry Weather	236.9
Wet Weather Flow at WWTP	187.9
Total Wet Weather Capture Volume	424.8

Applying the updated volumes to the updated percent capture calculation, the existing percent capture within the River Road service area is 60%. This value was referenced as the baseline condition for percent capture calculations when developing combinations of controls for the LTCP.

Selected Alternatives

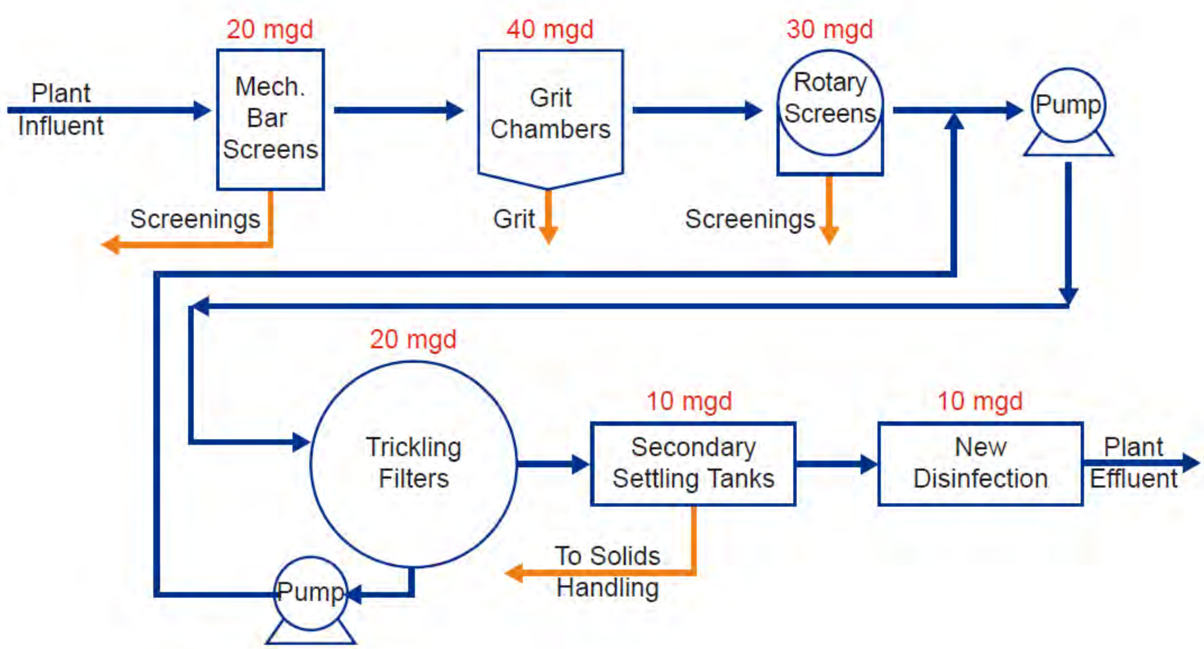
3.1 Alternatives Selection Approach

There are two outfalls within the River Road WWTP service area. Because the elevation of the JOSO outfall is approximately 100 feet below the interceptor where the flow would need to be conveyed to the WWTP, efforts focused on achieving the target percent capture by conducting the majority of work at the WNY1 outfall. Based on public input and the desire to avoid high costs and disruptive construction of satellite facilities, efforts focused on maximizing capacity at the WWTP and maximizing the conveyance to the WWTP with existing facilities.

3.1.1 Maximizing Capacity at the WWTP

The permitting discharge of the WWTP as it currently stands is 10 million gallons per day (MGD). The plant can see flows of 20 MGD during wet weather events. Figure 3-1 shows the treatment processes and the associated capacities.

Figure 3-1. River Road Wastewater Treatment Plant Service Area



The treatment bottlenecks at the River Road WWTP are the capacities of the rotary screens, the secondary clarifiers and the chlorine contact chamber. In order to identify improvements at these points in the treatment train, available space was evaluated through the plant. The WWTP is also where the least disruptive construction would occur. For these reasons, maximizing capacity at the WWTP was the major focus of the Alternatives Analysis selection process. The selected alternatives are described below.

3.1.1.1 Increase Capacity of River Road WWTP to 35 MGD through Blending and High-Rate Treatment

To investigate possible solutions to increase capacity at the River Road WWTP, a site visit was conducted on January 18, 2019 to obtain additional details on space availability and treatment flexibility. Details of this site visit can be found in Appendix B, Development and Evaluation of Alternatives. There is an existing bypass at the plant that allows flow to be directed from the vortex grit chambers to the trickling filters, bypassing the rotary screens. This location was identified to be retrofitted to send additional wet weather flow from the grit chambers directly to the secondary settling tank area. This would allow bypassing of the Rotary Screens and the Trickling Filters, to allow for blending of the wet weather flow later in the process.

During dry weather, up to 20 MGD would continue to be conveyed through the rotary screens and trickling filters. The secondary clarifiers will be decommissioned and replaced with a new higher capacity treatment unit located in the existing footprint. During wet weather, the modified bypass would convey additional wet weather flows up to 15 MGD from the vortex grit chambers directly to the new higher capacity treatment unit located in the footprint of the decommissioned secondary clarifiers. Flows from the trickling filters and the bypass from the vortex grit chamber would be blended and conveyed to an upsized chlorine contact tank. The proposed modification to the process flow schematic in order to increase plant capacity is shown on Figure 3-2 and the location of the proposed bypass is shown on Figure 3-3. It is noted that this configuration provides an additional 15 MGD of wet weather treatment capacity at the plant increasing the wet weather capacity of the plant to 35 MGD.

Figure 3-2. Proposed Modifications to Existing Plant Flow

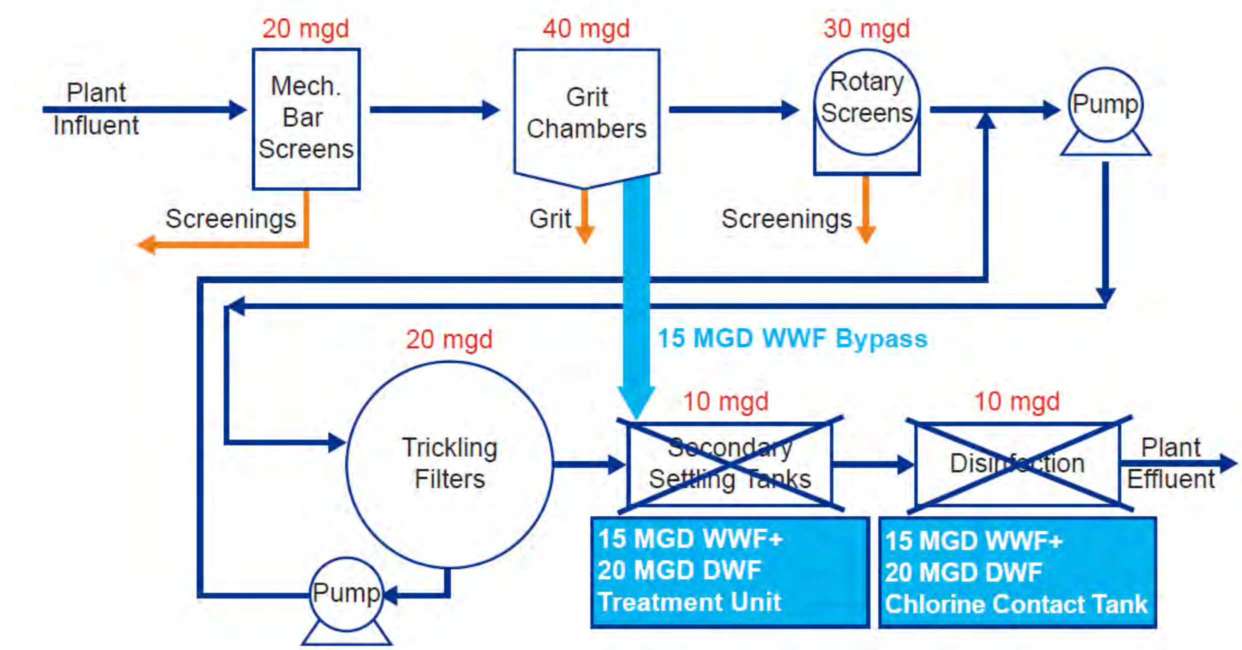
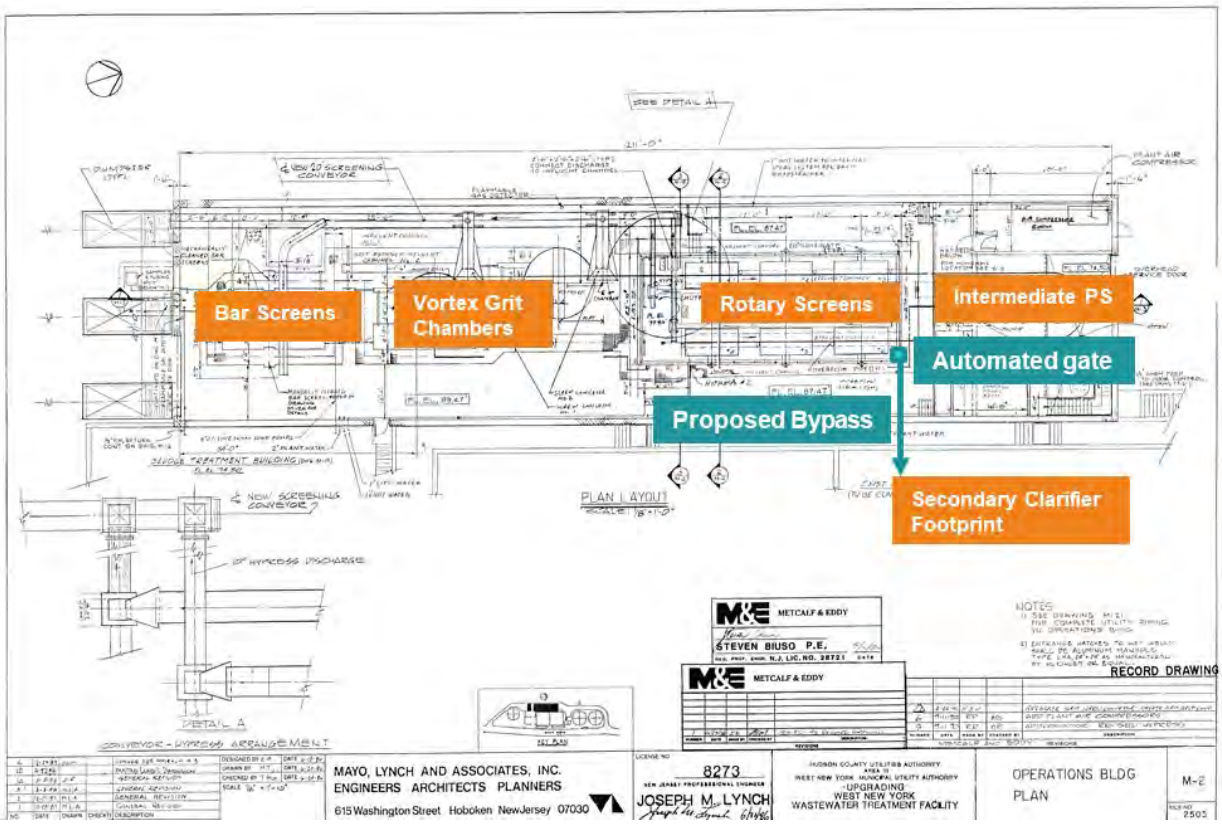


Figure 3-3. Proposed Bypass Location



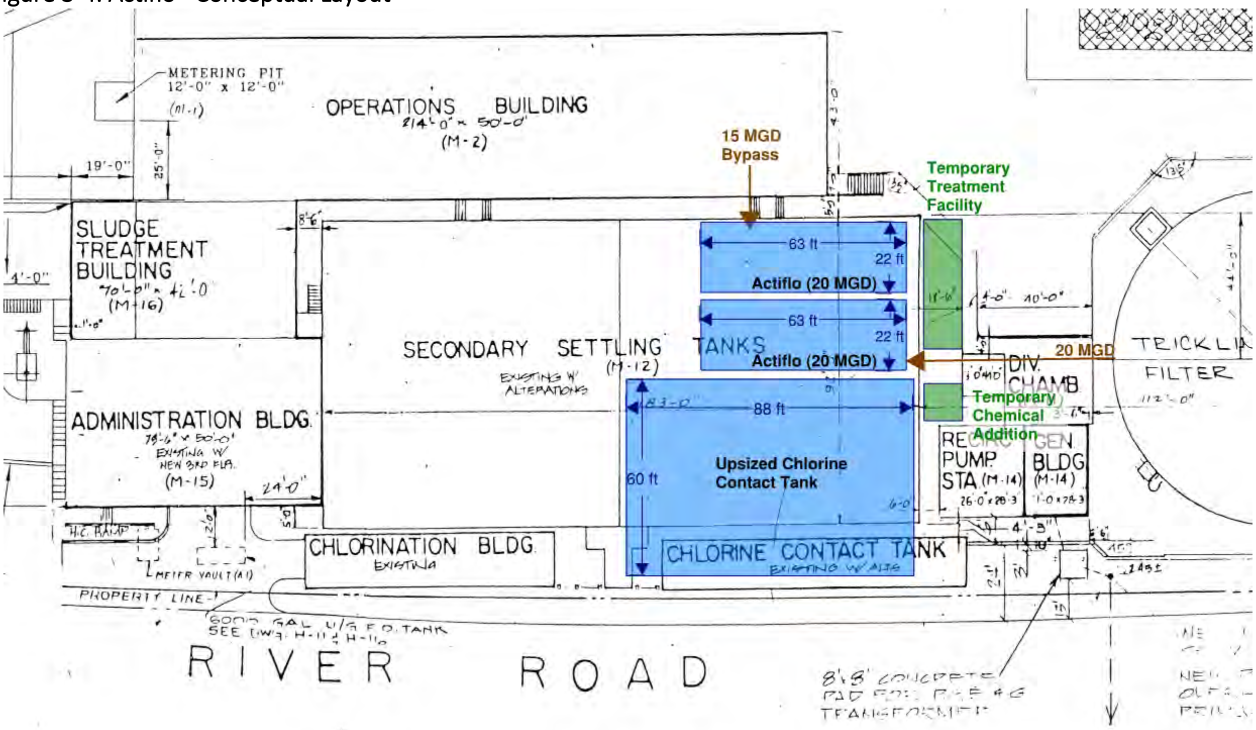
The following construction sequence is proposed for upgrades to the secondary clarification system. The construction sequence will be the same, regardless of the treatment alternative that is selected.

1. Retrofit a bypass in the preliminary treatment building so wet weather flow (up to 15 MGD) bypasses rotary screens to flow from vortex grit chamber toward secondary clarifier. Up to 20 MGD still goes through rotary screens and trickling filters to the secondary clarifiers.
2. Implement chemical dosing of southern secondary clarifier to allow for increased sludge settling and clarifier capacity.
3. If required, install temporary secondary treatment unit to supplement chemical dosing.
4. Decommission northern secondary clarifier tank, and replace it with a new treatment unit.
5. Replace the chorine contact tank with an and upsized 9-foot-deep chlorine contact tank in the same footprint.
6. If required, decommission southern secondary clarifier tank and replace with treatment unit.

This strategy is contingent upon the assumption that temporary chemical dosing of the clarifier will provide adequate secondary treatment. Alternatively, approval will be sought from NJDEP to allow an intermediary treatment approach until construction has been completed.

The current proposed technology for high rate treatment to replace the secondary clarification system is the use of Actiflo®. Actiflo® is an established ballasted flocculation technology for CSO and wet weather treatment and is known to provide total suspended solids removal rates of 80 to 95%. It is very effective in removing pollutants, particularly because the addition of coagulant and polymer which helps to remove smaller particles. As noted in the construction sequence, existing equipment would need to be relocated and reconfigured to accommodate the addition of the Actiflo® system. It is anticipated that the system may also require coarse as well as fine screening upstream to ensure that larger debris does not impact the functionality of the system. The Actiflo® system also requires space for support systems such as a coagulant, polymer, and sand storage systems. In order to achieve a total treatment capacity of at least 35 MGD, two 20-MGD units are proposed, which would require a footprint of approximately 63 feet, 3 inches by 22 feet each. Installation of an Actiflo® facility to increase treatment capacity will also require upgrades to downstream processes such as disinfection and the outfall to treat and discharge the additional flow. Figure 3-4 shows a conceptual layout of the Actiflo® system.

Figure 3-4. Actiflo® Conceptual Layout

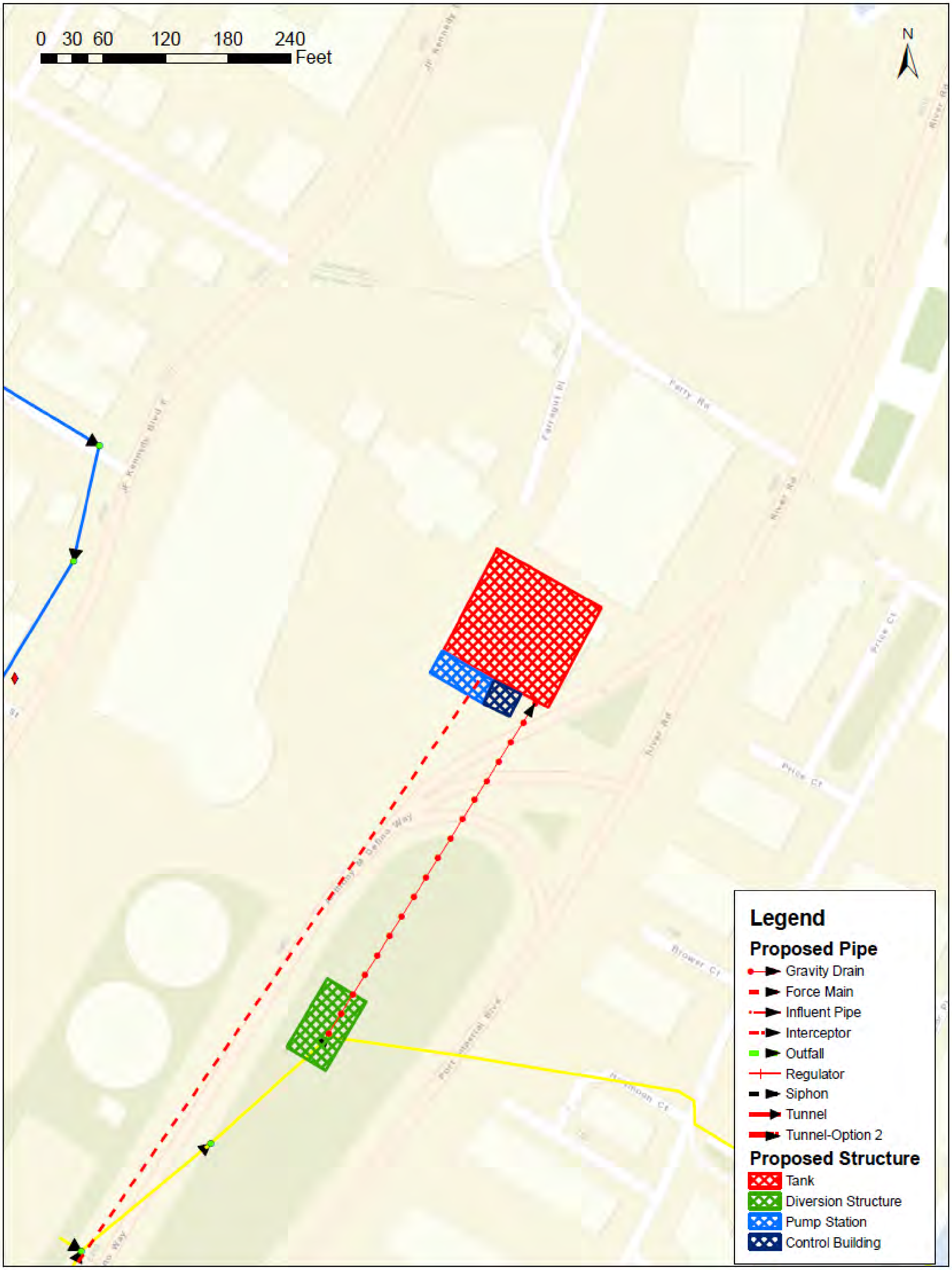


3.1.2 Construct 8-MG Storage Tank Near WNY1 Outfall

In addition to conveying more flow through the plant, an 8-MG storage tank will be constructed at a plot of land adjacent to the plant that is currently vacant and being acquired by the Authority. The tank will store CSO volume when the WWTP is at capacity during a rain event and slowly convey flow to the WWTP after the rain event when there is adequate capacity at the plant. Figure 3-5 shows the location of the proposed tank.

The approximate footprint available for the storage tank, control building, and pump station is 12,670 square feet. Based on the volume required, the tank could be approximately 85 feet in height with a portion of the tank above ground and a portion below ground. The overall cost of construction is highly dependent on geotechnical conditions in the area that are currently unknown.

Figure 3-5. Proposed Storage Tank Location



3.1.3 Raise Regulator Weirs at UC1, UC2, and WNY2

The JOSO outfall currently has three regulators (UC1, UC2 and WNY2) in the network that direct wet weather flow to the JOSO relief sewer as needed. To avoid additional expensive, disruptive, and challenging in-rock construction, it is recommended to raise the overflow weirs in the regulators to direct more flow to WNY1 and less overflow to JOSO. This would be accomplished with minimal construction and/or break in service, and without the hassles of in-rock construction.

Multiple weir heights were simulated in the model to determine not only the effect on volume to the outfall but also the effects upstream. Based on results in the model, raising the weirs 1 foot would have a significant effect on the CSO-controlled volume and minimal effect on infrastructure upstream, but raising the weirs higher (1.5 feet, 2 feet) produces diminishing returns. It is recommended to implement these changes after increasing capacity downstream at the WNY1 outfall.

3.2 Percent Capture After Implementation

All the alternatives in Section 3.1 were simulated in the collection system hydraulic model and optimized for performance. Table 3-1 shows the resulting yearly CSO volumes and frequencies.

Table 3-1. Combined Sewer Overflow Volume by Drainage Basin in the Typical Year

Drainage Basin	CSO Volume Typical Year, MG
JOSO	32.7
WNY1	38

Table 3-2 shows the volumes that are captured at the WWTP in the typical year after LTCP implementation.

Table 3-2. Wet Weather Volume at the Wastewater Treatment Plant in the Typical Year After Long Term Control Plan Implementation

WWTP Flow	Volume Typical Year, MG
Sanitary Flow at WWTP in Dry Weather	236.9
Wet Weather Flow at WWTP	543.7
Total Wet Weather Volume at WWTP	780.6

Applying the calculation presented in Section 2.2, the percent capture of the proposed plan is 92%.

SECTION 4

Operational Plan

As required in section IV.F of the CSO Permit, the Authority created an Operations and Maintenance (O&M) Program and associated Manual to manage the various assets of the CSS under its operation. The O&M Manual documents the following:

1. Directory of O&M staff, their roles and contact information
2. Description of the fats, oils, and grease program
3. Up-to-date characterization of the entire collection system

The O&M Program and Manual are an important and low-cost part of minimizing the impacts of CSO discharges on the receiving water bodies and surrounding community by ensuring that the CSS system is clear of obstruction and that damage or issues are repaired and resolved in a timely manner.

Under the LTCP, new CSO controls and assets will be constructed within the CSS system in order to mitigate the effects of CSO discharges. The LTCP Operational Plan will expand on the existing O&M Program. As new assets are brought online and major changes to the CSS are completed the O&M Program and associated manual will be updated accordingly. Training will be provided, when necessary, to ensure that staff have the skills to successfully operate new CSO controls.

As part of the Authority’s continuing efforts to improve the health and environment of the community it serves, updated sections of the O&M Manual and logs of CSO Control Training courses and attendance will be incorporated into LTCP Progress Reports.

SECTION 5

Public Participation

As defined in the Public Participation Progress Report, the objectives of the Authority's Public Participation Program are:

- To communicate key program information to the general public and stakeholders
- To enable stakeholders to provide feedback to the Authority
- To fulfill all public information and notification requirements of the NJPDES permit

The Public Participation Program enables the Authority to educate the public, foster productive dialogue with the cities and towns in the Authority's service area, and ensure that key messages are delivered consistently. The LTCP and the public participation aspects are being conducted in compliance with the Authority's NJPDES permits and federal LTCP guidance (EPA 1995a). Throughout the LTCP timeline, opportunities for public engagement were presented. The following methods were used for public outreach:

- Development of the Community Advisory Board (CAB)
- Public meetings
- Advertorials and newsletters
- Posting information on the Authority's website
- Posting information on social media

These methods are detailed in this section and public participation materials are included in Appendix C.

5.1 Community Advisory Board

The NJDEP transmitted to the Authority a resource document via email on May 17, 2016 titled "Forming and Utilizing Your Supplemental CSO Team, For New Jersey's Combined Sewer Overflow (CSO) Permits and Long Term Control Plans." As a result, the CAB was formed and consists of leaders for various community activist groups within the service area. The CAB was formed consistent with this document.

The CAB includes members from representing Hoboken, West New York, Weehawken, and Union City. members were identified by the Authority's leadership to include a diverse group representing all aspects of life in the community it serves. CAB members represent the business community, environmental groups, and community citizen action groups. The following are the members of the Authority's CAB:

- Brian Battaglia: Battaglia's Home (Hoboken business), Hoboken Chamber of Commerce, Hoboken resident
- Larry Bijou: Bijou Properties (Hoboken business), Weehawken resident
- Jason Capizzi: Port Imperial Homeowners Association, West New York resident
- Carter Craft: Hoboken Cove Community Boathouse Board, Rebuild-by-Design, Hudson River Citizens' Advisory Group, Hoboken resident
- Mary Kelly: Hoboken Quality of Life/Nature Conservatory Committees, Hoboken resident
- Frank Raia: Raia & Sirignano Mgt., long-time member of HOPES, former NHSA Commissioner, Hoboken resident
- Robert Sosa: Weehawken Parking Authority, Weehawken Resident
- Anthony Squire: Union City resident

- Debra Tantleff: New Jersey Committee of the Regional Plan Association and the Board of Directors for Downtown New Jersey, New Jersey Future and New Jersey Mixed-Use, Developers, West New York resident

Prior to public meetings, the Authority met with the CAB to discuss ongoing activities, important findings during the LTCP, and planned activities.

5.2 Public Meetings

Throughout development of the LTCP, six public meetings were conducted. The dates and focus of the meetings are listed as follows:

- February 2019: discuss the LTCP requirements and how they relate to NHSA facilities
- May 2019: introduce the various CSO control strategies and alternatives
- August 2019: discuss the evaluation and elimination process for various alternatives.
- November 2019: introduce possible control scenarios for the LTCP
- March 2020: discuss the final selection of CSO control strategies
- May 2020: discuss the final LTCP project selections and implementation schedule to be submitted to the NJDEP

At each meeting, a presentation on the subject matter was conducted and handouts were available for review. Minutes were collected during the meetings and the Authority was available to answer any questions. All presentation materials were also posted to the Authority's website.

5.3 Advertorials and Newsletters

Throughout the development of the LTCP, advertorials and newsletters were published and distributed to describe the current state of the LTCP and any upcoming meetings. A total of 5 newsletters and advertorials were published throughout the LTCP development period. Each one was published in the Hudson County Reporter and mailed to each of the Authority's accounts. The content was as follows:

- Advertorial and Newsletter 1 discussed what CSOs are and how the goals of the LTCP will help reduce them.
- Advertorial and Newsletter 2 introduced the System Characterization and explained why it is necessary for the LTCP.
- Advertorial and Newsletter 3 introduced the various CSO control alternatives that were analyzed for the LTCP.
- Advertorial and Newsletter 4 discussed potential comprehensive plans for the service area.
- Advertorial and Newsletter 5 discussed the proposed LTCP, associated construction costs, and implementation schedule.

5.4 Online Presence

Throughout the LTCP timeline, information on upcoming meetings and current projects within the Authority have been made available at the Authority's website, www.nhudsonsa.com.

The website is a central location to find the most current information on the LTCP. The entire Authority website was updated and upgraded to allow for a greater focus to be placed on the LTCP section. The website generally covers the following topics:

- Brief review of LTCP Program Mission and Goals
- Highlights on progress towards program goals and objectives
- Upcoming program activities and meetings
- Opportunities for more information/ways to provide feedback

The LTCP Program section of the Authority's website was created after System Characterization work was performed. This section was initially created as the CSO Waterbody Advisory System under Public Information, but was redesigned with general CSO information, general LTCP information, and specific project information related to the Authority's LTCP Program. Updates were developed and posted to the website upon initiation of activities and completion of key program milestones.

The CSO Waterbody Advisory System pages on the Authority's website provide the public with real-time information on CSO occurrences and CSO impacts. An interactive map of CSO outfall locations is provided to alert the public when a dry or wet weather CSO discharge occurs at an NHSA outfall to the Hudson River. The system uses level sensors in the sewer system to monitor and report CSO activity in real time.

Selected construction project information is currently provided on Public Information website pages (i.e. H5 Wet Weather Pump Station). Information on CSO-related construction projects will be posted on the website before beginning construction. The purpose of the project, its value to the community it serves, and the schedule will be provided. Completed projects will also be listed.

5.5 Public Outreach Activity

All public outreach activities (meetings, tours, publications, etc.) conducted as part of the development of the LTCP to date (2015 to 2020) are summarized in Table 5-1.

Table 5-1. Public Outreach Activity Log

Date	Event	Presentation
6/23/2015	Rebuild By Design Kickoff Meeting	Available for Q&A
10/24/2015	Felician College Water Symposium	System and CSO Overview
10/25/2015	Hoboken Community Advisory Group Plant Tour	Plant Tour
10/27/2015	Hoboken Charter School 23 - 3rd Grade Plant Tour	Plant Tour
12/10/2015	Rebuild By Design Public Meeting	NHSA CSO Program Update
12/14/2015	Rebuild By Design Drop-In Session in Hoboken	Available for Q&A
12/15/2015	Rebuild By Design Drop-In Session in Weehawken	Available for Q&A
6/29/2016	NJ CSO Permittee Network Workshop	NHSA CSO Program Update
7/28/2016	Rebuilding By Design Public Meeting	NHSA CSO Program Update
9/8/2016	Rebuild By Design Preferred Alternative Public Meeting	Available for Q&A
10/8/2016	Weehawken Day	NHSA CSO Program Update
11/10/2016	All Saints Day School – 4th Grade Class Tour	Plant Tour, Lab Visit, The Water Cycle
11/14/2016	Supplemental CSO Team Kickoff Meeting	NHSA History and CSO Program Update
3/13/2017	Supplemental CSO Team Meeting 2	NHSA Overview and CSO Program Update
5/4/2017	The Hudson School - 6th Grade Plant Tour	Water Cycle, Plant Tour

Table 5-1. Public Outreach Activity Log

Date	Event	Presentation
6/1/2017	All Saints Day School - 6th Grade Plant Tour	Water Cycle, Plant Tour
6/3/2017	Hoboken 6th Annual Green Fair	NHSA Tent – Coloring Book and T-Shirt Give Away for Kids NHSA Overview and CSO Program Update Presentation
9/20/2017	Supplemental CSO Team Meeting 3	NHSA CSO Program Update
10/7/2017	Weehawken Day	NHSA Tent – Coloring Book and T-Shirt Give Away for Kids NHSA Overview and CSO Program Update Presentation
10/18/2017	All Saints Day School – 4th Grade Plant Tour	Water Cycle, Plant Tour, Lab, GIS, CSO Model
11/30/2017	Northwest Resiliency Park Public Meeting 1	NHSA CSO Program Update
2/27/2018	Northwest Resiliency Park Public Meeting 2	NHSA CSO Program Update
3/5/2018	NHSA CSO Advisory Board Meeting 4	NHSA CSO Program Update
4/9/2018	Northwest Resiliency Park Public Meeting 3	NHSA CSO Program Update
4/11/2018	New York – New Jersey Harbor & Estuary Program Water Quality Work Group Meeting	NHSA CSO Public Notification System
4/18/2018	The Hudson School - 7th Grade Plant Tour	Water Cycle, Plant Tour, Lab, GIS, CSO Model
5/30/2018	Rebuild By Design - Workshop on Design Zones 2 & 3	Available for Q&A (Hosted at NHSA)
7/23/2018	Plant Tour for Hoboken City Councilwoman and staff	CSO Program and Plant Tour
8/6/2018	NHSA CSO Advisory Board Meeting 5	NHSA CSO Program Update and Alternatives Analysis Concepts
10/3/2018	Hoboken Green Infrastructure Bike Tour	Discussion about CSOs and Vactor Truck Screen Cleaning Demonstration
11/27/2018	Plant Tour for US Naval Academy Professor and 4 Students	Plant Tour, and discussion about Wet Weather Pump Stations
12/6/2018	St. Augustine School - 4th and 5th Grade Plant Tour	Water Cycle, Plant Tour
2/19/2019	Hoboken 9th and Madison Project Public Meeting	Available for questions about the 9th and Madison Upgrades
2/25/2019	NHSA LTCP Public Meeting 1	The CSO Program Overview
2/28/2019	St. Augustine School STEM Fair	Judged engineering projects
3/14/2019	Hoboken North End Redevelopment Meeting	Available for questions about the H6/H7 Storm System
3/18/2019	NHSA CSO Advisory Board Meeting 6	NHSA CSO Program Update with Alternatives Analysis Update
3/26/2019	Delegation from South Korea	Plant Tour and CSO Program Overview
4/24/2019	Hudson School 7th Grade Plant Tour	Wastewater Treatment and Plant Tour
5/8/2019	Hudson School 10th Grate Plant Tour	Wastewater Treatment and Plant Tour

Table 5-1. Public Outreach Activity Log

Date	Event	Presentation
5/20/2019	NHSA LTCP Public Meeting 2	The CSO Program Overview and Update
5/30/2019	Hoboken High School Plant Tour	Wastewater Treatment and Plant Tour
6/8/2019	Hoboken Green Fair	CSO Program Update and available for questions
6/12/2019	Delegation from South Korea	Plant Tour and CSO Program Overview
7/15/2019	NHSA CSO Advisory Board Meeting 7	NHSA CSO Program Update and LTCP Development
8/19/2019	NHSA LTCP Public Meeting 3	NHSA CSO Program Update and LTCP Development
9/5/2019	Hudson River Foundation and NY/NJ Harbor & Estuary Program Water Quality Workgroup Meeting	Presentation about LTCP Evaluation of Alternatives
10/4/2019	Northwest Park Groundbreaking Ceremony	Richard gave a speech at the ceremony about how the Storage Tank benefits our CSO LTCP.
10/5/2019	Weehawken Day 2019	NHSA Tent – Coloring Book and T-Shirt Give-Aways for Kids
10/24/2019	Delegation from South Korea (Seoul Water Works)	Plant Tour and CSO Program Overview
11/11/2019	NHSA CSO Advisory Board Meeting 8	NHSA CSO Program Update and Alternatives Discussion
11/18/2019	NHSA LTCP Public Meeting 4	NHSA CSO Program Update and Alternatives Discussion
2/24/2020	NHSA CSO Advisory Board Meeting 9	NHSA CSO Program Update and discussion of the final selection of CSO control strategies.
03/9/2020	NHSA LTCP Public Meeting 5	NHSA CSO Program Update and discussion of the final selection of CSO control strategies.
05/11/2020	NHSA CSO Advisory Board Meeting 10 and NHSA LTCP Public Meeting 6	NHSA LTCP Program Final Project Selections and Implementation Schedule to be submitted to the NJDEP.

GIS = geographic information system
Q&A = question and answer

5.6 Public Input and Effect on Long Term Control Plan

While compiling the LTCP, the main feedback received from the public included concerns regarding the proposed satellite storage tanks and treatment units, including those proposed on public property and along the Hudson River, and those that involved in-street construction. These concerns are expected because these alternatives can put a strain on community actions. For these reasons, public input had an effect on selecting the LTCP by placing a focus on expanding the capacity of the WWTP as much as possible, and once the capacity is expanded, increase the volume conveyed to the WWTP. Alternatives such as storing or treating outside of the plant, while effective strategies, would cause more disruption to public activity.

5.7 Public Participation Throughout Long Term Control Plan Implementation

Throughout LTCP Implementation, the Authority will continue to provide the most current LTCP information via multiple sources including the website, advertorials, newsletters; public meetings, social media, and other engagements; and update the Water Body Advisory System. The goal will be to maintain open communication and answer any questions on potential projects to ensure the needs and concerns of the public are met throughout the implementation of the improvements to CSO infrastructure.

Compliance Monitoring

During and after LTCP implementation, compliance monitoring will be conducted and results will be compared to data from the baseline compliance monitoring to evaluate the effectiveness of implemented CSO controls. The compliance monitoring program will be adequate to verify baseline and existing conditions, the effectiveness of the CSO controls, compliance with water quality standards, and protection of designated uses. A summary of the baseline conditions results can be found in the System Characterization Report in Appendix A.

The goal of the monitoring program is to determine compliance with ambient water quality monitoring standards to protect human health and the environment. Through implementation of the LTCP alternatives/CSO controls, the CSS will achieve reductions in duration, frequency, and spatial extent of CSOs. This will ultimately aid in maintaining water quality improvement goals.

At a minimum, the compliance-monitoring program will include the following, as outlined in the CSO permit Section IV.G.9.a:

I. Ambient in-stream monitoring
II. Discharge frequency for each CSO (days and hours per month)
III. Duration of each discharge for each CSO (number of days)
IV. Quality of the flow discharged from each CSO, which shall include pathogen monitoring at a minimum
V. Rainfall monitoring in the vicinity of each CSO/municipality

Following the completion of construction of the first project in the LTCP, monitoring will begin and continue no less than once per permit cycle and be documented in the LTCP Progress Reports as outlined in Section IV.G.9.b of the CSO permit. These continued results will be compared with baseline results to show compliance and progress. The elements of the compliance monitoring are detailed in this section.

6.1 Ambient Water Quality Monitoring

As a member of the New Jersey Harbor Dischargers Group, annual monitoring for bacterial indicator organisms will continue in the Hudson River and surrounding water bodies impacted by both treated effluent discharge as well as CSO discharges. The results will be documented and archived in LTCP progress reports. The results of annual compliance monitoring will be reevaluated every permit cycle in order to fill in any potential data gaps necessary to determine the progress of the LTCP and its CSO controls.

6.2 Combined Sewer Overflow Discharge and Frequency Monitoring

The float sensors in the regulators diverting flow to the Authority's permitted CSO outfalls during wet weather events will continue to operate and be maintained during and after LTCP implementation. The sensors are connected to the Authority's supervisory control and data acquisition (SCADA) system logging the frequency and duration of CSO events. The logged data are also incorporated into the public notification system. This information will be archived and incorporated into the LTCP progress reports.

6.2.1 Rainfall Monitoring

The Authority currently has three rain gauges installed within the service area, one at each of the following locations:

- H1 Wet Weather Pump Station (farthest south in the service area)
- Baldwin Pump Station, near the plant (about the middle of the service area)
- Port Imperial Pump Stations (north section of the service area)

Data collected from these rain gauges will be compared with CSO discharge data (previous section) to verify the effectiveness of the CSO controls. This information will be archived and incorporated into the LTCP Progress Reports.

6.3 Combined Sewer Overflow Water Quality Monitoring

Based on the implementation schedule, water quality monitoring will be conducted at the regulators of the affected outfalls 3 months after construction of a control has been completed to verify effectiveness of the controls. Table 6-1 shows locations where the monitoring will be conducted:

Table 6-1. Water Quality Sampling Locations

Basin ID	Location
WNY1	JF Kennedy Blvd. at Anthony Del Fino Way

This will be done at minimum once per permit cycle and incorporated into the LTCP Progress Report.

6.4 Future Flow Metering in the Sewer System

Flow metering was conducted at 19 regulators within the NHSA sewer shed from May 17, 2016 through November 16, 2016. A rain gauge was installed at the River Road WWTP for the same period. The data collected were used to update and calibrate the Authority's hydraulic model. The hydraulic model was used to evaluate potential alternatives for the LTCP.

Flow metering during and after the LTCP is not an express requirement under the permit, however, future monitoring within the CSS system will be conducted when necessary to collect data before, during, or after implementation of LTCP alternatives in order to eliminate data gaps necessary for design or construction. The Authority will submit a flow metering plan, if necessary, to the NJDEP for approval. The locations and numbers of meters will vary based on the LTCP alternative project needs.

The goal of periodic flow metering is to continually update the hydraulic model in order to provide the Authority with a tool for evaluating both the success of an LTCP CSO control and the potential impacts as various LTCP CSO controls are implemented. Flow monitoring will be conducted in any given location for at least 1 year until enough rain events are recorded over the monitoring period. Ideally, monitoring will capture 5 to 10 wet weather events with total rainfall volume greater than 0.5 inch and with no snow/snowmelt impacts.

SECTION 7

Implementation Schedule

As part of LTCP compliance, the Authority has prepared an implementation schedule detailing the sequence of construction and financing of the program. The schedule considers any use impairment of receiving water, funding availability, sewer rate, and the overall financial capability of the Authority. This section further details these elements.

7.1 Current Assets and Mission

The Authority owns all of the combined sewer infrastructure within both the Adams Street WWTP Service area and River Road WWTP service area. Table 7-1 summarizes of the infrastructure owned by the Authority in each service area. Additional detail on the sewer infrastructure is included in the System Characterization in Appendix A.

Table 7-1. Combined Sewer Overflow Infrastructure, River Road and Adams Street Service Area

Combined Sewer Piping (including interceptors, siphons and force mains)	106 miles
Wastewater Pump Stations	9
Wet Weather Pump Stations	3
CSO Regulators	17
CSO Outfalls	10
Solids/Floatables Screening Facilities	11

The mission of the Authority, as expressed on its website, is presented below.

> "The North Hudson Sewerage Authority is dedicated to a single over-riding mission. That is, on behalf of its customers, the Authority will safeguard the local waterways, while operating a cost-efficient, streamlined regional wastewater treatment system.
>
> The Authority dedicates itself to the highest standards of performance. To that end, it has committed itself to developing a private-sector culture within its operations. The hallmarks of this approach are: rewarding creativity and productivity inside the organization and valuing our ratepayers' interests as stakeholders in the Authority's enterprise. By fostering a culture in which dedication to excellence is paramount, the Board of Commissioners imposes upon itself the discipline to manage its business cost-effectively, to fulfill its obligations with honesty and integrity, to maintain the highest ethical standards throughout the organization, and to discharge its most important responsibility as a protector of one of the most important waterways in the world, the Hudson River."

The Authority's focus on both environmental stewardship and fiscal management has resulted in significant infrastructure investments over the years, substantial improvements in wastewater discharges and a significant debt burden. As noted previously in this report, the combined sewage capture rate in the River Road service area is 60% on a volumetric basis; this result reflects investments already made. The financing plan presented herein can focus further attention on the LTCP because of the state-of-good-repair improvements that have been previously been made to existing infrastructure. Recognizing its substantial historical capital improvements, the NHSA must be prudent in the timing of its future investments so as to maintain: 1) a sustainable amount of total debt, 2) a strong credit rating that enables it to efficiently borrow money, and 3) reasonable rates and charges for its customer base. The financing plan is intended to achieve this balance.

The Authority plans to utilize proceeds of loans from the New Jersey Infrastructure Bank (NJIB), the proceeds of some new NHSA debt, and cash from user revenues to finance the LTCP.

7.2 Financial Capability Assessment

The purpose of this analysis is to evaluate the financial capability of the Authority and its sewer rate payers to fund future investments in combined sewer infrastructure; taking into consideration what the Authority has spent to achieve 60% CSO capture or elimination to date.

As listed in the River Road WWTP permit, the permittee's financial capability must be submitted along with the implementation schedule to verify the financing that will accompany the projects is available. To complete the assessment, the U.S. Environmental Protection Agency (EPA) Guidance for Financial Capability Assessment and Schedule Development was referenced as consistent with the nine minimum controls for the LTCP (EPA 1995b).

The Financial Capability Assessment (FCA) is modeled based on the EPA guidance, *Combined Sewer Overflows Guidance for Financial Capability Assessment and Schedule Development*, developed in 1997 to outline the process for determining financial impacts and affordability associated with mitigating CSOs. The assessment aims to evaluate both environmental impacts and financial burdens permittees face when determining the requirements of a LTCP. Evaluating the Authority's financial capability to implement capital projects including CSO controls involves two-phases, the residential indicator, and financial capability indicators. After determining these two indicators, they are combined in the financial capability matrix to give an overall assessment. Appendix D provides the FCA worksheets based on the EPA guidance. A summary of the FCA results follows.

While this report addresses the technical requirements for the Adams Street CSO drainage area, the financial data contained herein reflects the entire Authority service area, including the Adams Street drainage area.

7.2.1 Resident Indicator

From the EPA guidance, Phase one determines the residential indicator, i.e. the permittee's average cost per household (CPH) for wastewater treatment and CSO controls as a percentage of median household income (MHI). This reflects the residential share of current and planned wastewater treatment and CSO controls needed to meet the requirements of the Clean Water Act. Details regarding the CPH are provided in Appendix D. Table 7-2 provides the calculations for the Residential Indicator.

Table 7-2. Residential Indicator

Line #	Item	MHI	Comment
201	MHI for NHSA Service Area (2018)	$82,400	US Census. American Community Survey. S1903-Median Income In The Past 12 Months.
202	MHI Adjustment Factor	1.016	(1 + CAGR for CPI 2018 to 2019)
203	Adjusted MHI (2019 Dollars)	$83,758	Line 201 x Line 202
204	**Annual Sewer CPH**	$1,100	from Table D-1 -- CPH
205	**Residential Indicator (% of MHI)**	**1.43**	Line 204 / Line 203 * 100 Line
	Annual Typical Residential Bill	$755	
	Typical Residential Bill as % MHI	0.90	Typical Residential Bill / Line 203 * 100

A value range for this indicator characterizes whether the costs impose a low, mid-range, or high financial impact on residential users. Table 7-3 shows these ranges that reflect EPA's previous experience with water pollution control programs. Based on these ranges presented in this table, the Residential Indicator for NHSA is a mid-range financial impact. This means that based on the weighted MHI for the NHSA service, the costs allocated to residential customers is suggested to have a mid-range financial impact. It is important to recognize that 50% of the households have income less than the median value and depending on the income distribution and if such households are sewer ratepayers the financial impact could fall in the mid to high ranges.

CPH can be misleading because it does not directly translate into what residential customers actually pay for sewer service. Another metric to evaluate is the Typical Residential Bill; with the assumption of one residential unit (for the NHSA Facility Charge and 70,000 gallons per year (5,833 gallons per month), the current Bill is computed to be $188.63 per quarter or $754.50 annually.

Table 7-3. North Hudson Sewerage Authority Residential Indicator

Financial Impact	Residential Indicator CPH as % of MHI
Low	Less than 1.0% of MHI
Mid-Range	1.0-2.0% of MHI
High	Greater than 2.0% of MHI

7.2.2 Financial Capability Indicators

From the EPA guidance, Phase Two assesses the permittee's financial capability indicators. These six indicators evaluate the debt, socioeconomic, and financial conditions that affect a permittee's financial capability to implement the CSO controls. Details regarding each of the Financial Indicators are provided in Appendix D in Tables D-3 through D-7. The financial indicators included in the FCA are listed below and are summarized in Table 7-4:

- Permittee bond rating
- Net Debt as a percentage of full market property value
- Unemployment rate
- MHI
- Property tax revenue as a percentage of full market property value
- Property tax collection rate

The Authority credit ratings are presented in Table 7-4 below. It is noted that the general obligation credit rating of each of the four participant municipalities differs from that of the NHSA.

Since the Authority does not assess and collect property taxes, data was collected from available sources at the County and the local level. Unemployment and MHI figures are from the U.S. Department of Labor. All data is prior to the effects of COVID-19.

The total debt burden on ratepayers considers not only Authority debt, but also the debt of each municipality, the school system in each community and the municipalities' share of the total County debt. It is also prudent to consider the applicable debt of Suez Water, the drinking water provider to each of the communities in the service area; however, it is not feasible to calculate the water-related debt of Suez for the service area and, therefore, it is not included herein.

Table 7-4 NHSA Financial Capability Indicators

Item	Value	Score	Line #
Bond Rating	"A" and "A+"	3	901
Overall Net Debt as a % of Full Market Property Value	2-5%	2	902
Unemployment Rate	+/- 1% of the national average	2	903
Median Household Income	+/- 25% of national MHI	3	904
Property Tax Revenues as a % of Full Market Property Value	2-4%	2	905
Property Tax Revenue Collection Rate	Above 98%	3	906
	Overall Score:	2.5	907
	Rating	Mid-Range	

The financial indicators serve as the basis that will characterize the permittee's financial capability as weak, midrange, or strong. Based on the results presented in Table 7-4, the Authority falls within the mid-range to strong category, which means based on the results of the FCA, the Authority's service area has a moderate to reasonable financial capability for addressing LTCP and CSO program costs. The main sources for the mid-range rating are the overall net debt, unemployment and property tax revenues. However, the effects of the property tax revenue should not have a large effect as the Authority does not collect property taxes.

The Authority's rates and charges are applied uniformly to the service area as a whole. It is noted that the Authority has a wide range of property values and incomes across the service area. These local factors are further explained in the following section.

7.2.2.1 Local Factors

The EPA's FCA guidance documents are a way of facilitating discussions between utility operators, State, and Federal agencies for Consent Orders and project implementation. While standard approaches have been developed to assist a permittee in developing an FCA, it is challenging to implement one systematic approach with communities that vary in size, income, and utility system complexity. While EPA guidance is helpful within specific data ranges, other communities have found it inadequate when assessing affordability, which is the case for NHSA service area. This section provides demographic data that was utilized in the FCA and helps to illustrates how these metrics can vary throughout the NHSA service area.

Population

Within the service area, the total population served by the Authority is estimated at 189,829. Of this population, the largest population resides in Union City and the smallest in Weehawken.

Households

The estimated number of households within the service area is 75,386. Of all households, the largest number of households are located in Hoboken and the least in Weehawken.

Median Household Income

A review of Median Household Income (MHI) was conducted to determine the approximate percentage of income residents have available to contribute to sewer rates. Based on this review, the MHI within the service area is $82,400.

Poverty

Poverty Guidelines are developed annually by the Department of Health and Human Services and published in the Federal Register. The poverty guidelines are organized by persons in household and income. Table 7-5**.** provides the 2018 poverty guidelines prepared by the Department of Health and Human Services.

Table 7-5. Federal Poverty Guidelines for 2020

Persons in Family/Household	Poverty Guideline
1	$12,140
2	$16,460
3	$20,780
4	$25,100
5	$29,420
6	$33,740
7	$38,060
8	$42,380
>8	Add $4,320 for each additional person

Source: Department of Health and Human Services Poverty Guidelines

Based on these guidelines, a weighted average of approximately 16.9 percent of the total population in the service area is at or below the poverty line as of 2018. Cities with the greatest household income (Hoboken, Weehawken) have the lowest level of poverty while those with the lowest household income (Union City, West New York) have the highest levels of poverty. It is not practical to determine which bill-paying customers of the Authority are households in poverty and those households in poverty that rent from a landlord and presumably pay sewer charges through their rent. The available data does not permit such an analysis.

7.2.3 Financial Capability Matrix

From the EPA guidance, the Financial Capability Matrix combines the residential indicator and financial capability indicator to give an overall assessment of the permittee's financial capability. Table 7-6 shows the matrix based on EPA guidance that is used to evaluate the financial burden on permittee (i.e., NHSA). Based on the results of the Residential and Financial Indicators, there is a medium burden on the Authority.

Table 7-6. Financial Capability Matrix

Financial Capability Indicator Score	Residential Indicator (CPH as % of MHI)		
	Low (Below 1.0%)	**Mid-Range (1.0%-2.0%)**	**High (Above 2.0%)**
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (1.5-2.5)	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

While the formula-based evaluation of financial capability suggests a medium burden, the Authority has a unique service area in that while the MHI is above the nationwide average, this is not uniform throughout the service area. In addition, the cost of living in the service area is likely to be higher than in many other sections of the country so that income after taxes and other expenses may not reflect the proportionally higher MHI.

To supplement this analysis, the Authority conducted further financial analysis on the existing debt service, debt payments and loan availability as well as the potential rate schedule to have a more accurate portrayal on what is the expected impact of the program. The details and results of this analysis are presented in the following section.

7.3 Long Term Control Plan Schedule

Projections were initially made of Authority cash flows and rates through FY 2050 without considering the impacts of the LTCP. This Base condition included the debt service on outstanding obligations, anticipated debt service on future borrowing for state-of-good repair improvements, operation and maintenance expenses and other obligations. Components of the LTCP were then added to the Base in the project order presented herein. The following assumptions were made when projecting the Class 5 construction costs of each part of the LTCP:

- Capital costs increase by 3.0% per year from the Class 5 cost estimates prepared as of January 2020
- O&M expenses increase by 2.0% per year from the Class 5 cost estimates prepared as of January 2020

There are numerous assumptions in the projections for both the Base and with the inclusion of the LTCP. The principal assumptions are listed below:

- Operating expenses will increase at an average rate of 2.0% per year and the general rate of inflation in consumer prices will be 2.0% per year
- Capital costs will increase at an average rate of 3.0% per year
- The NJ I-Bank will have sufficient loan funds available in each year to finance routine capital improvements for the Authority's system plus up to $25.0 million in each year to finance the proposed LTCP projects
- The capital markets are readily accessible in each year to borrow funds at reasonable terms and interest rates
- No other capital investments and operation and maintenance expenses will be mandated by the federal or state governments, unless such mandates are fully funded by the applicable agency(ies)
- There will be a 2. 0% per year increase in revenue from all customer charges for the next 10 years (2031); after which revenues from customer charges will increase between 3.0-3.5% per year

- The financial impacts on the Authority of the COVID-19 shelter-in-place requirements are yet to be determined at the time of this report. Depending upon the severity and duration of such impacts, the schedule for the LTCP could be affected.

Additional assumptions that are an integral part of the Authority's financing plan are listed below.

- **Authority debt** – Senior debt will be issued for financings requiring greater than $25 million in a given year, 30-year bonds, 6.0% interest , level principal & interest payments
- **Capital Improvement Plan (CIP) Near-Term** - $70.1 million in NJIB loans expected to close within FY 2021 – FY 2024, 20-year loans, 2.5% to 4.0% interest
- **Cash-financed portion of LTCP** – A portion of year-end cash balances are reserved and spent ($78 million) from FY 2036 through FY 2048 on LTCP construction needs
- **CIP needs after Near-Term, Unrelated to LTCP (debt-financed and cash-financed)** – $5.0 million per year for state-of-good-repair (SOGR) improvements starting in FY 2025, increasing by $500K per year
- **Connection fee receipts** – Constant at $3.1 million annually
- **Customer demand** – 1. 0% per year decline thru FY 2026, 0.5% per year decline for FY 2027 thru FY 2038, and 0.25% per year thereafter
- **Debt Service** – principal & interest payments on existing senior lien debt are substantial through FY 2045, payments on existing NJIB junior lien debt decrease in the coming years, however, debt service on new loans will be increasing
- **Debt Service Coverage** – target of 1.50 or higher for senior debt to sustain the Authority's credit rating and the ability to borrow at reasonable interest rates
- **Efficiency of bill collection:** An average of 98% to 100%/year (receipts/billings)
- **Facility charge units** – Constant throughout the period of FY 2021 through FY 2050
- **Interest on investments** – Constant at $0.6 million annually after FY 2021
- **NJIB loans** – additional loans for the LTCP debt-financed CIP in FY 2025 through FY 2048, no greater than $25. 0 million in a given year, 20-year loans, 4.0% interest
- **NJIB loans** – to be used for the debt-financed portion of the CIP after the Near-Term, Unrelated to LTCP, 20-year loans, at 4.0% annual interest
- **Operating expenses** – increase at the rate of 2.0% per year for new LTCP facilities
- **Year-End Cash Balances** – the cash flows in each year result in a balance of funds to provide coverage, reserve deposits & capital cash (these are assumed to be available after FY 2023 due to COVID-19)

To finance the LTCP projects, the Authority plans to build year-end balances up to a point that additional debt service on loans or bonds is manageable within the overall debt burden and affordable to the customer base. The schedule assumes NJIB financing of LTCP projects starting in fiscal year (FY) 2025, with the debt service on each loan beginning in the following year. The NJIB loans in a given year for the LTCP period are assumed to be limited to $25.0 million; if additional funds are needed in that year, Authority debt is assumed to finance the remainder of the projects. If the availability of NJIB’s loans is more restricted than noted previously, there may be delays in the financing of individual projects within the overall schedule, depending upon conditions in the financial markets and the Authority’s ability to borrow funds at reasonable rates of interest.

Year-end balances are accumulated and drawn down on occasion to provide cash-financing for a portion of the LTCP. The schedule as presented assumes that $18.0 million is used in FY 2036 and $60.0 million is used in FY 2045 through FY 2048.

Table 7-7 shows the proposed implementation schedule as well as the Class 5 cost estimates for the selected alternatives for the River Road WWTP service area. An AACE International Class 5 cost estimate is a concept screening estimate developed through parametric models, judgment, or analogy to similar projects. The costs presented here represent the expected cost with a range as wide as +30-100% or as narrow as -20 to 50%. The $96-million-dollar investment (in January 2020 dollars) achieves 87% CSO capture based on the 2004 Typical Year. Actual construction cost will be higher through the effects of inflation from January 2020 to the Projected Start Dates. It is noted that the schedule has been coordinated with upgrades at the River Road WWTP and accounts for the gaps between. The complete schedule for both the Adams Street and River Road WWTPs can be seen in the Executive Summary.

Table 7-7- Long Term Control Plan Implementation Schedule, River Road Wastewater Treatment Plant

Drainage Basin	Project	Construction Cost	Projected Start Date
WNY1	Land Purchase for WNY1 Storage Tank	$4,000,000	2021
River Road WWTP	Increase Capacity at River Road WWTP to 35 MGD	$13,000,000	2025
JOSO	Raise JOSO Weirs	$2,000,000	2029
WNY1	Construct 8-MG Storage Tank	$77,000,000	2045
TOTAL		**$96,000,000**	

7.4 Potential COVID-19 Impacts on the Authority in FY 2020-21

Governor Murphy's stay-at-home Executive Order has been in effect since March 21st, 2020. The estimated effect of the COVID-19 restrictions on the FY 2020-21 revenues of the NHSA is a reduction in the range of $5.6 million to $9.8 million. This range is an estimate as of April 2020 and is subject to change. The following lists the expected sources of restrictions:

- Significant reduction in connection fee receipts
- Decline in non-residential consumption due to closures and limited operations
- Delay in payments from some customers
- Reduction in interest earnings on reserves since interest rates have dropped sharply
- Reduction in late payment interest income – The NHSA is offering assistance to its customers in this difficult period by: 1) delaying the due date for its next two quarterly bills, and 2) not charging interest penalties for late payment for a total of three months.

For the current fiscal year, the Authority can accommodate this potential revenue shortfall by drawing initially upon funds designated for cash-financed construction or defeasance and, if necessary, drawing from cash reserves. The duration and severity of the COVID-19 impacts on non-residential customers is yet to be determined and may have additional impacts on cash receipts, rates and year-end cash balances. Thus, COVID-19 may affect the Authority's schedule for implementing the selected LTCP.

SECTION 8

Summary

The Selection and Implementation of Alternatives summarizes the LTCP for the River Road WWTP service area. The proposed program listed in this report apply under the specific conditions stated here and any deviations to the assumptions listed may result in a change in the overall result of implementation, cost, and scheduling.

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Appendix A
System Characterization

North Hudson Sewerage Authority

Long Term Control Plan

Combined Sewer System Characterization Report for the River Road Wastewater Treatment Plant

NJPDES Permit: NJ0025321

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SECTION 1

Acronyms and Abbreviations

ACO	Administrative Consent Order
BCMP	Baseline Compliance Monitoring Program
CCTV	Closed Circuit Television
CIP	Cured in Place Pipe
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
CWA	Clean Water Act
DCIA	Directly Connect Impervious Area
DIP	Ductile Iron Pipe
EDP	Effective Date of Permits
GPCD	Gallons per capita per day
I/I	Infiltration and Inflow
IDM	Inch-Diameter Mile
JOSO	Joint Overflow Sewer Outlet
LTCP	Long Term Control Plan
MGD	Million Gallons per Day
NHSA	North Hudson Sewerage Authority
NJDEP	New Jersey Department of Environmental Protection
NJHDG	New Jersey Harbor Discharges Group
NJPDES	New Jersey Pollution Discharge Elimination System
PACP	Pipeline Assessment and Certification Program
PVSC	PVSC – Passaic Valley Sewerage Commission
PCCP	Pre-stressed Concrete Cylinder Pipe
RCP	Reinforced concrete pipe
RDII	Rainfall Derived Infiltration and Inflow
S/F	Solids/Floatables
SCADA	Supervisory control and data acquisition
STP	Sewage Treatment Plant
TIGER	Topologically Integrated Geographic Encoding and Referencing
USEPA	U.S. Environmental Protection Agency
VCP	Vitrified clay pipe
WWTP	Wastewater Treatment Plant

Regulators

UC1	Union City 1
UC2	Union City 2
WNY1	West New York 1
WNY2	West New York 2

Introduction

The North Hudson Sewerage Authority is required to prepare a long-term control plan (LTCP) to address combined sewer overflows and a component of the LTCP is the Combined Sewer System Characterization Report. This section outlines the regulatory requirements and components of the long-term control plan, and provides an overview of the combined sewer system (CSS) tributary to the River Road Wastewater Treatment Plant (WWTP).

2.1 Background

The North Hudson Sewerage Authority (NHSA, also referred to in this report as the Authority) has been mandated by the New Jersey Department of Environmental Protection (NJDEP) to prepare a long-term control plan (LTCP) to address combined sewer overflows (CSOs). NHSA has already made significant progress towards achievement of its LTCP, having completed mapping of the collection system, closed circuit television (CCTV) inspections, flow monitoring, completion of several work plans and the initiation of a web-based public notification system. This report provides the Combined Sewer System Characterization for the drainage area tributary to the River Road Wastewater Treatment Plant (WWTP) including a sewer system inventory and condition assessment, hydraulic model development which includes calibration and validation, and a baseline system characterization to calculate the system response to the typical year rainfall.

2.2 Regulatory Requirements

NHSA owns two WWTPs and the combined sewer systems (CSS) tributary to these facilities. The Adams Street and River Road WWTPs are regulated by the NJDEP under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit program.

Under this permit, NHSA established and implemented solids and floatables control of combined sewer overflows and undertook and developed various system studies as required to characterize the CSS. The General Permit for CSSs was revoked and re-issued in 2004. Under the 2004 Permit, NHSA continued to be in compliance with the nine minimum controls of the CSO LTCP as listed in the National CSO Control Policy, as required under the permit, and was required to initiate a public participation program and assess CSO control alternatives. NHSA submitted the required documents to the NJDEP in April 2007 to address pollutant and bacteriological water quality improvements, and a review of the means and methods needed to reduce the frequency of CSO discharges.

On March 12, 2015 the NJDEP issued the individual permits, with an effective date of July 1, 2015, to municipalities and authorities that own and operate segments of CSSs. The NJPDES permits address requirements for overall water quality improvements, routine reporting, and development of a CSO LTCP.

Pursuant to NJPDES Permit NJ0025321 (River Road WWTP), Part IV, Combined Sewer Management Section, Section D.3.b.ii., a System Characterization Report for the LTCPs shall be submitted to NJDEP within 36 months of the Effective Date of the Permits (EDP). The EDP for the River Road WWTP permit is July 1, 2015. The System Characterization Report is due July 1, 2018.

2.3 Purpose and Scope

As a component of the overall LTCP, this report provides the collection and treatment system characterization for the drainage area tributary to the River Road WWTP. The collection system characterization provides an understanding of how the sewer system responds to a range of precipitation events, estimates the frequency, duration and volume of CSO discharges and provides an understanding of system limitations which may contribute to other issues such as basement backups, street flooding, or other potential health concerns. The collection system model can serve as a tool for the development and evaluation of CSO controls that will ultimately be identified as the recommended plan in the CSO LTCP.

To develop a comprehensive characterization of the combined sewer system, the following tasks have been carried out, with the findings of each task presented in this report:

- Sewer System Inventory
- Wastewater Treatment Plant Analysis
- Service Area and Land Use Analysis
- Identification of Sensitive Areas
- Collection System Assessment
- Inflow & Infiltration Assessment
- Hydraulic Collection System Modelling
- Baseline Characterization

The following goals were established for the model and were intedned to agree with the overall objectives of the sewer system characterization as outlined by USEPA's Guidance for Long-Term Control Plans (USEPA 832-B-95-002):

- To predict overflow occurrence, volume, and, in some cases, quality for rain events other than those which occurred during the monitoring phase. These can include a storm event of large magnitude (long recurrence period) or numerous storm events over an extended period of time.
- To predict the performance of portions of the CSS that have not been extensively monitored.
- To develop CSO statistics, such as annual number of overflows and percent of combined sewerage captured as described in the CSO Control Policy.
- To optimize CSS performance as part of Nine Minimum Control (NMC) implementation.
- To evaluate and optimize control alternatives, from simple controls described under the NMC to more complex controls proposed in a municipality's LTCP.

2.4 System History and Description

The River Road WWTP (NJPDES No. NJ0025321) is located at 6400 Anthony M. Defino Way in West New York (shown in Figure 2-1 below). It was constructed in 1992 as a secondary wastewater treatment facility using trickling filters to provide the required treatment level, and has been upgraded several times since. The service area of the River Road WWTP is approximately 1.4 square miles and includes the Town of West New York as well as parts of Union City and Weehawken. No other communities contribute flows to the system. The estimated population serviced by the River Road WWTP is 73,000, determined based on data from the US Census Bureau. The River Road WWTP is permitted by NJDEP to discharge 10 MGD and has a wet weather capacity of 20 MGD.

The NHSA owns the following facilities in its two WWTP service areas:

- 2 WWTPs (Adams Street and River Road)
- 106 miles of combined sewer (including interceptors, siphons and force mains)
- 9 Wastewater Pump Stations
- 2 Wet Weather Pump Stations
- 17 CSO Regulators
- 10 CSO Outfalls
- 11 Solids/floatables screening facilities

Of these, the River Road service area includes:

- 1 WWTP (River Road)
- 31.4 miles of combined sewer
- 4 Pumping Stations (49th Street, Landings, Port Imperial, Liberty Place)
- 4 CSO Regulators (UC1, UC2, WNY1, WNY2)
- 2 CSO Outfalls (001A/002A, 003A)
- 2 Solids/floatables screening facilities (WNY1, JOSO)

The River Road WWTP service area is shown in Figure 2-1 below. There are nine drainage basins within the service area of the River Road WWTP. The River Road WWTP service area combined sewers range in diameter from 6 to 96 inches. The piping consists mainly of brick, vitrified clay, and reinforced concrete. The individual connections from buildings to the NHSA sewer mains are owned and maintained by the property owners.

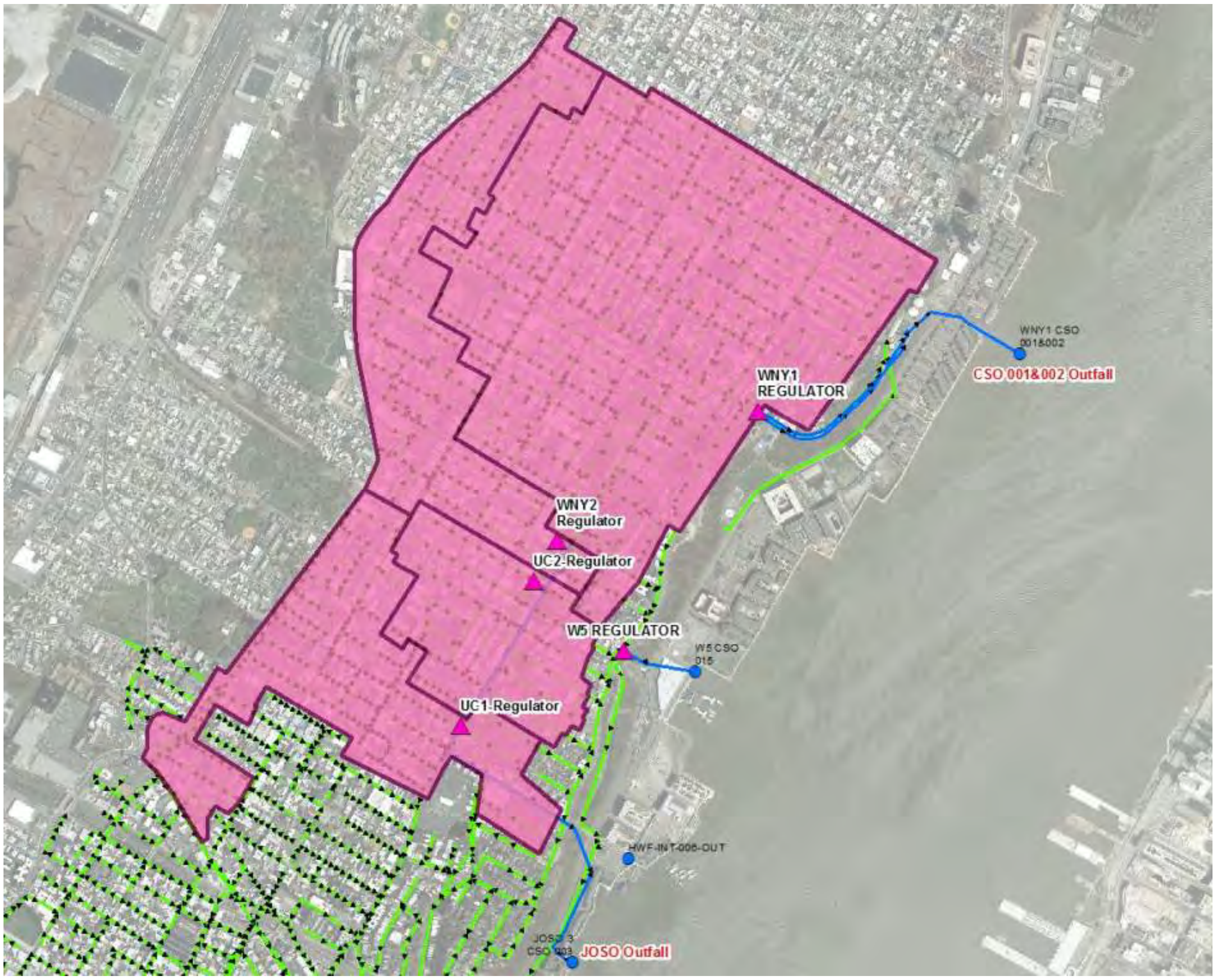
The collection system in the River Road WWTP Service Area was originally designed to convey both sanitary sewage and stormwater directly to the Hudson River. The network of trunk and interceptor sewers that convey wastewater to the River Road WWTP was built in the 1950's. The wastewater collection system includes regulators, pump stations, interceptor sewers, force mains, combined sewers, and local collector and trunk sewers.

The regulators in the River Road WWTP Service Area direct all sewage flows during dry weather to the River Road WWTP and convey excess flows during large wet weather events directly to the Hudson River. There are a total of four regulators in the River Road WWTP Service Area (shown in Figure 2-2). Regulator WNY1 discharges to outfall 001A/002A and regulates CSO discharges using mechanical float operated regulator. The other three regulators regulate CSOs using side overflow weirs that divert excess combined sewage to the Joint Overflow Sewer Outlet (JOSO) which discharges to the Hudson River.

Figure 2-1: River Road WWTP Service Area

The drainage area to each of the four regulators is shown in Figure 2-2 below:

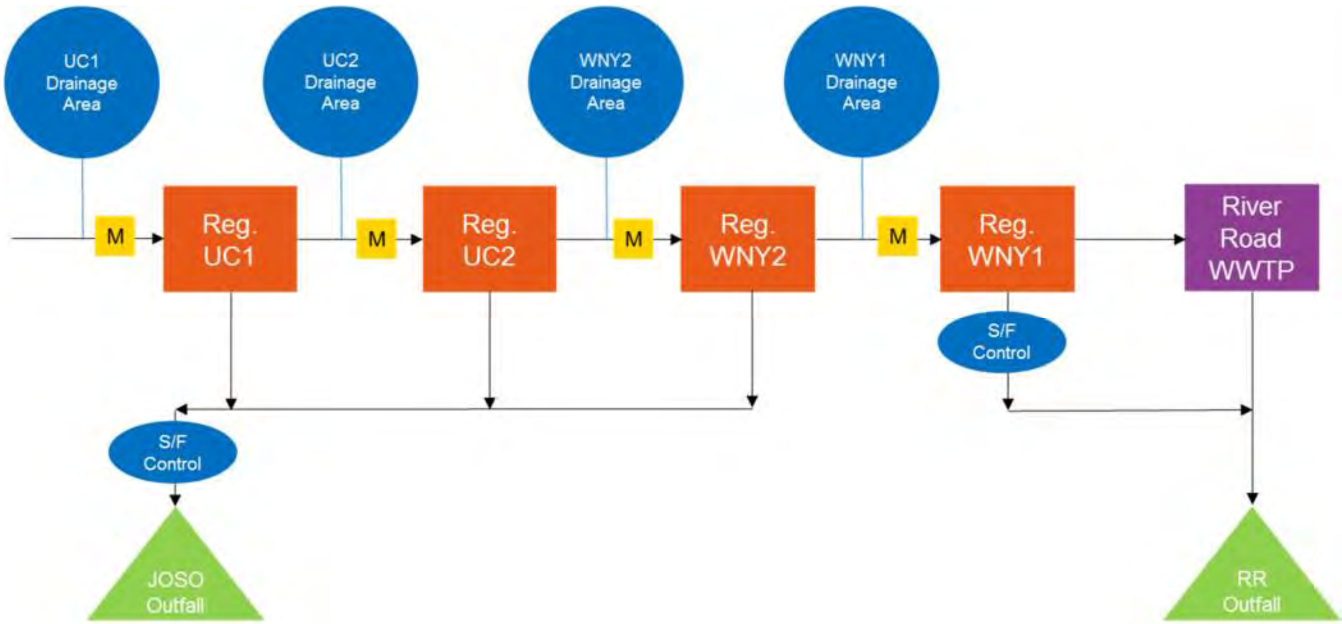
Figure 2-2: Regulator Drainage Areas



Note: Regulator (W5) and outfall (015A) are not part of this study. The River Road system outfalls are only JOSO (003A) and River Road (001A/002A).

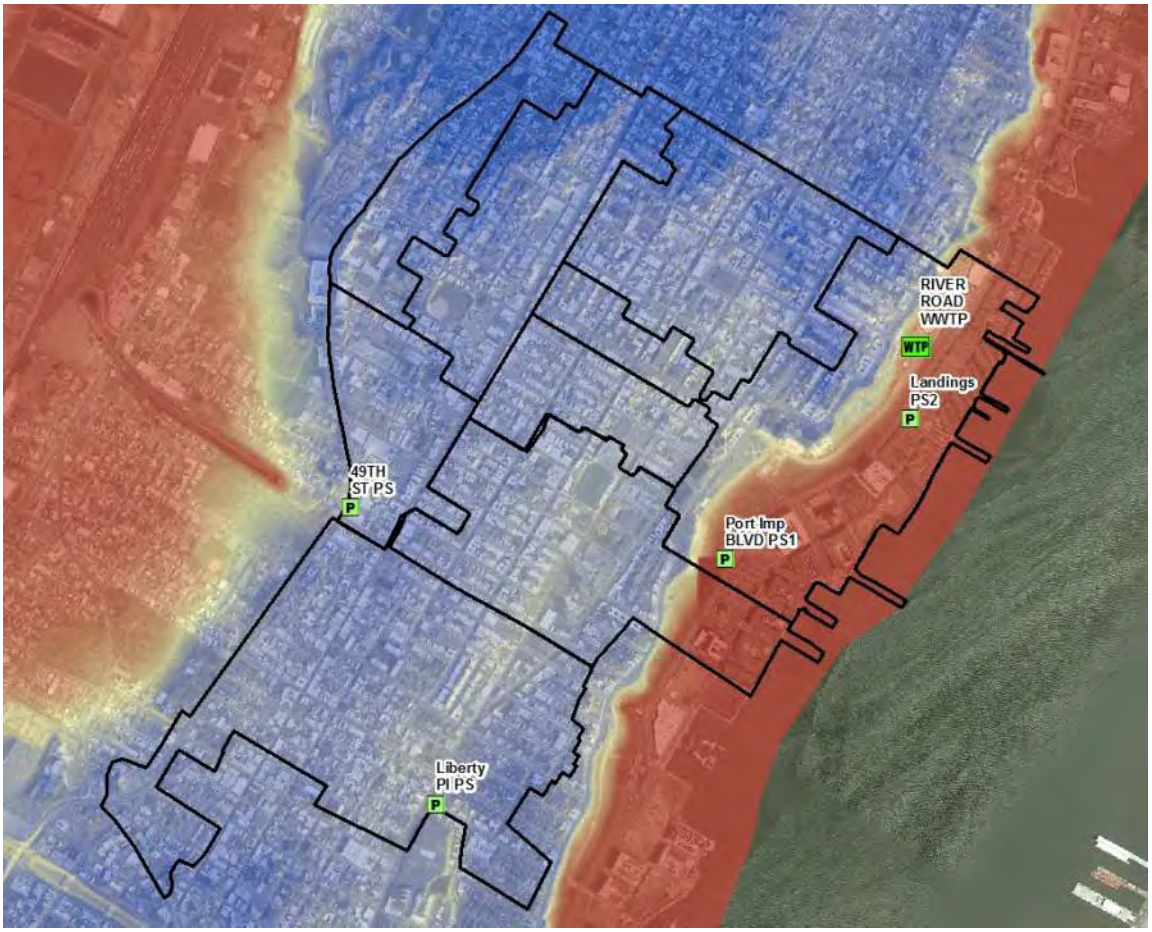
The flow schematic of the system including regulators, the WWTP and outfalls is shown below in Figure 2-3:

Figure 2-3: Flow Schematic of River Road System



The USGS National Elevation Dataset (NED) One Meter Digital Elevation Model (DEM) was used to evaluate the topography of the service area and its vulnerability to flooding (shown in Figure 2-4). The northern corner of the service area is at a much higher elevation than the rest of the service area, and slopes downward towards in the southeasterly direction. At the northeastern corner, elevations are around 250 ft (NAVD88). The majority of the service area is around 170 feet with a steep cliff drop of about 100 feet located around 1,000 feet from the eastern coast. Much of the area east of the cliffs is only about 10 feet above sea level, thus is vulnerable to storm surge and flooding. However, the area east of the cliffs is separately sewered with both storm and sanitary sewers thus flooding in these areas does not negatively impact CSOs. There is also a localized low-lying area of elevation 150 feet in the middle of the service area, but NHSA staff have indicated that this area is not vulnerable to flooding, which is discussed further in Section 6.5.Figure 2-4 below depicts this topography, with blue representing higher elevations and red indicating lower elevations:

Figure 2-4: Study Area Topography



2.5 Surface Water Quality Conditions

The Authority's CSOs discharge to the Hudson River. These saline waters are classified by the State of New Jersey as SE2. The designated uses of SE2 waters are maintenance, migration and propagation of the natural and established biota; migration of diadromous fish; maintenance of wildlife; secondary contact recreation; and any other reasonable uses. The dissolved oxygen water quality standard is never less than 4.0 mg/L. The bacteria water quality standard for fecal coliform is a geometric mean of 770 cfu/100mL.

The State of New Jersey integrates its Water Quality Inventory Report (required under Section 305(b) of the federal Clean Water Act) with their List of Water Quality Limited Segments (required under Section 303(d) of the Clean Water Act), as per a 2001 recommendation by the U.S. Environmental Protection Agency (USEPA). New Jersey submitted its first Integrated Water Quality Monitoring and Assessment Report (Integrated Report) in 2002 and reissues the report every two years. The last readily available report published on the NJDEP's website (http://www.nj.gov/dep/wms/bears/assessment.htm) was the 2014 report. The 2016 report is listed as "in progress" on the NJDEP website at the of writing this document. The 2014 Integrated Report listed both Hudson River assessment units (Hudson River Upper and Hudson River Lower) as not supporting aquatic life-general and not supporting fish consumption. The report lists both Hudson River waters as fully supporting recreation.

SECTION 3

Collection System Investigations

A comprehensive characterization of the combined sewer system was developed through records review, monitoring, modeling and other means to establish the baseline conditions for the LTCP.

3.1 Sewer System GIS Update

A sewer atlas was originally developed for the River Road WWTP service area in 1998 by CH2M HILL. NHSA performed a sewer GIS update in 2015. The 1998 Sewer Atlas was used as the basis for the 2015 GIS update. GPS data was obtained in degrees-minutes-seconds for all CSO regulators, pump stations and outfalls, pursuant to Part IV, Combined Sewer Management, Section D.2.a of the NJPDES permits, as well as manholes, catch basins and solids/floatables facilities. This GPS information was included on an updated GIS map that now supersedes the NHSA's Sewer Atlas. The updated GIS data was transmitted to NJDEP on September 17, 2015. Since then, the GIS database of River Road WWTP collection system components has been updated based on as-built drawings, field surveys, and interpolations made in the InfoWorksICM modelling software.

3.2 Condition Assessments

A condition assessment of NHSA's collection system was completed by RedZone between 2017 and 2018 on approximately 350,000 feet of sewers and 2,600 manholes. Within the River Road service area, 78% of sewer in Union City, 46% of Weehawken sewers, and 11% of West New York sewers were inspected by RedZone. CCTV inspections were completed throughout the collection system to determine sewer condition as well as gather information on cross-sections, length, material, depth of sediment, connections, etc. Manholes were inspected to determine condition and identify any defects or problems. The results of the condition assessment are discussed in Section 3. Figure 4-3 depicts the extends of the condition assessment completed by RedZone as well as condition information on the portion of the system that was analyzed.

The following resources were utilized and field visits were undertaken to document the properties and conditions of system infrastructure:

- North Hudson Sewerage Authority Long Term Control Plan System Characterization Work Plan for the River Road STP (CH2M Hill, 2016)
- North Hudson Sewerage Authority Fiscal Year 2017 Annual Report (Mott MacDonald, 2017)
- River Road CSO Control Cost and Performance Analysis Report (Metcalf & Eddy | AECOM, 2007)
- River Road WWTP Cost and Performance Analysis Report (Metcalf & Eddy | AECOM, 2007)
- Results of RedZone sewer condition assessment – export from ICOMM database
- Field investigations:
    - 11/30/2017 – regulators
    - 5/11/2018 – regulators and S/F facilities
    - 5/16/2018 – pumping stations, outfalls

3.3 Rainfall Monitoring and Sewer Metering

Rainfall monitoring and combined sewer metering were completed to obtain data with which to calibrate the hydrologic/hydraulic model of the River Road collection system. The metering program was designed to characterize dry and wet weather flow generated by the drainage basins and to determine overflow frequencies. The metering was also used to characterize the response of the system to various precipitation events and to detect and identify infiltration in the system.

3.3.1 Precipitation and Flow Metering

NHSA retained Greeley and Hansen and its subconsultant ADS Environmental Services to install nineteen (19) ADS Flowshark Triton continuous flow monitoring meters and two (2) rain gauges across their system, which recorded data between May 17, 2016 and November 16, 2016. Four of these flow meters and one rain gauge were located in the River Road drainage area.

The rain gauge located at the River Road WWTP recorded precipitation at 5-minute intervals. A tipping bucket rain gage was used, such that rainfall enters the funnel collector and is directed to the tipping bucket assembly. When an incremental amount of precipitation has been collected (0.01 inches of rainfall), the bucket assembly tips discharging the sample through the base of the gage and activates a switch that records the tipping event, and the process is repeated.

Over the monitoring period, a total of 14 rainfall events over 0.5 inches were recorded, with four of those events recording over a total of 1 inch of rain. A total of 43 rain events in which there was at least 24 hours of no rain between events were captured during the 6-month flow monitoring period. The highest intensity rainfall recorded at the River Road WWTP rain gauge (RG1) was on 7/31/16, when a total of 0.3 inches fell during a 5-minute interval yielding an intensity of 3.6 inches/hour.

The flow meters were installed to obtain information to analyze the monitoring tributary areas for dry weather flow, as well as inflow during rain events and infiltration during high groundwater periods. Flow meters were installed upstream of the regulators thus represented flow before the flow split to the overflow line. The four flow metering locations in the River Road drainage area are summarized in Table 3-1 below:

Table 3-1: Flow Monitoring Locations

Meter ID	**Location**	**Pipe Size**
UC1	Park Avenue at 43rd Street, Union City	48”
UC2	131 49th Street, Union City	75”
WNY1	East of JFK Blvd and Anthony M. Defino Way Intersection, West New York	75”
WNY2	211 51st Street, West New York	84”

Continuous metering was conducted to record the depth, velocity and flow data in 5-minute intervals throughout the 6-month monitoring period to capture the following conditions:

Table 3-2: Flow Metering Conditions

Condition	Result	Goal Satisfied?
Total precipitation volume is greater or equal to eight (8) inches (water equivalent)	Total rainfall depth over the monitoring period was 17.15 inches	Yes
At least two (2) small rainfall events, with precipitation, excluding contributions from snow melt, less than 0.5” of rainfall in 24 hours	Twenty-one (21) events with depth less than 0.5” of rainfall in 24-hour period	Yes
At least two (2) medium rainfall events, with precipitation, excluding contributions from snow melt, 0.5” to 1.5” of rainfall in a 24-hour period	Eleven (11) events with rainfall depth between 0.5” and 1.5” in 24-hour period	Yes
At least two (2) significant rainfall events, with precipitation, excluding contributions from snow melt, equal to or exceeding 1.5” of rainfall in a 24-hour period	Two (2) events with depth equal to or exceeding 1.5” of rainfall in 24-hour period	Yes
At least two high intensity events during which the hourly rainfall exceed 0.5”/hr	Five (5) events with hourly intensity greater than 0.5”/hr	Yes

The data collected from this program was used as the basis of hydraulic model calibration and validation.

A flow schematic of the River Road system is depicted in Figure 3-1 below, and the drainage area to each regulator/meter (i.e. metershed) is shown on Figure 3-2 below:

Figure 3-1: River Road System Flow Schematic

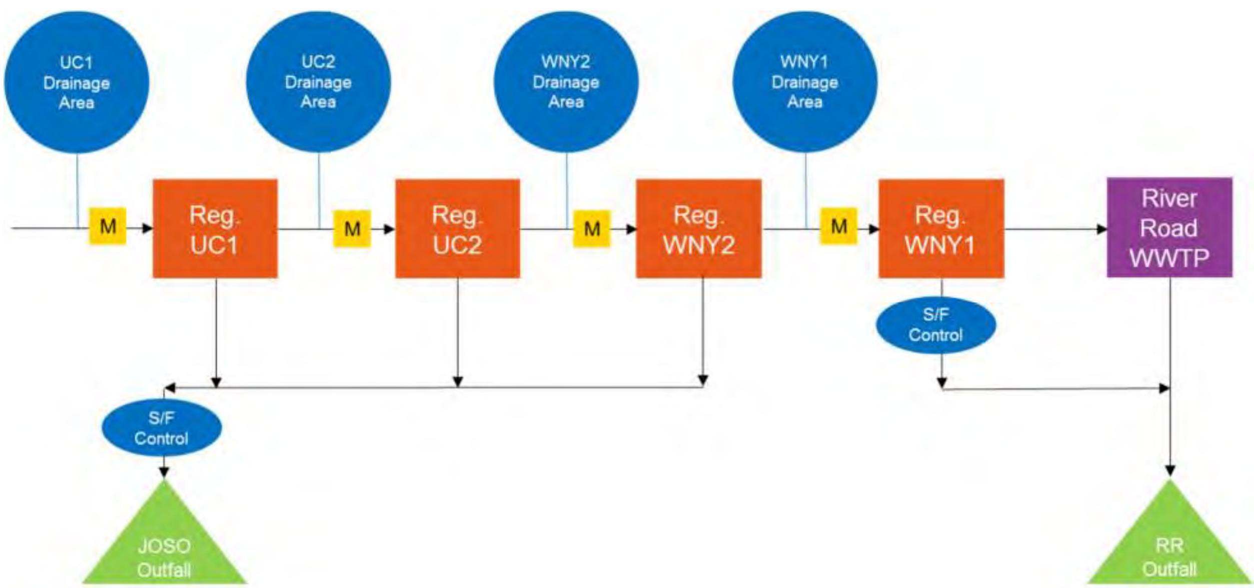
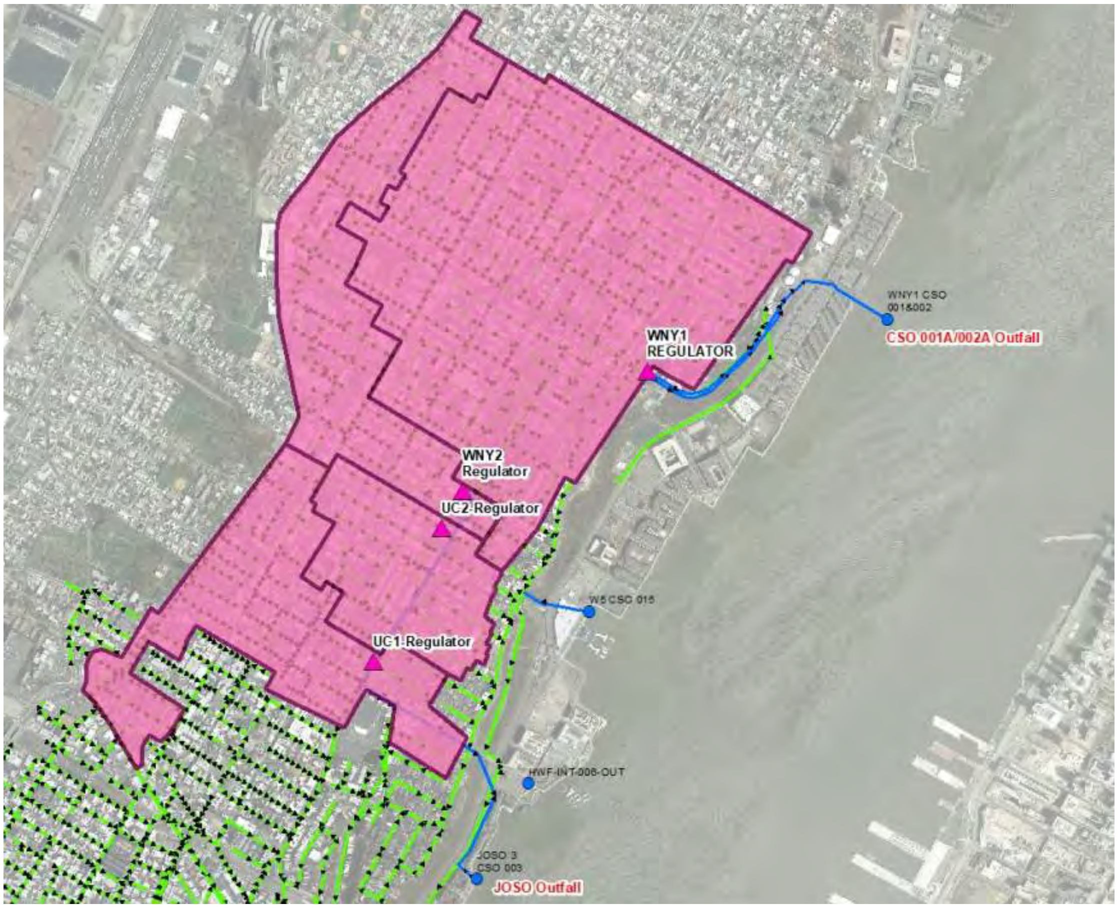


Figure 3-2: Regulator Drainage Areas (Metersheds)



Note: Regulator (W5) and outfall (015A) are not part of this study. The River Road system outfalls are only JOSO (003A) and River Road (001A/002A).

As can be seen in the schematic above, the regulators are located in series along the main WNY interceptor sewer, and one meter was located upstream of each regulator prior to the flow split. As such, the meter upstream of the UC1 regulator is the only meter not impacted during wet weather by the hydraulic performance of the other regulators.

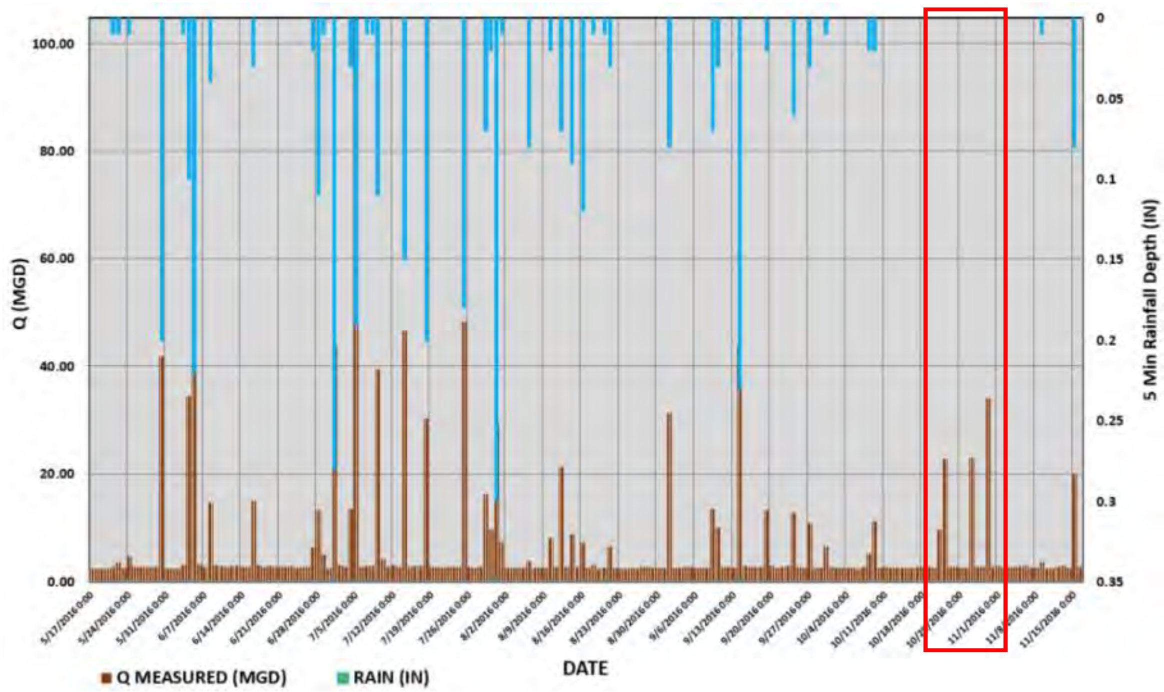
Flow and rainfall data is documented in the “Collection System Flow Monitoring Data Report” produced by Greeley and Hansen in February 2017.

3.3.2 Supplementary Rainfall Data

Rainfall data from the River Road rain gauge was compared with rainfall data from other sources to confirm its accuracy.

When comparing rainfall data from the monitoring program to NOAA 5-minute data from the nearby Teterboro station as well as the flow meter data, the River Road rain gauge did not detect three storms in October 2016. This period is shown in the red box in Figure 3-3 below. Flow data (Q) presented in the figure below is the measured data from one of the temporary flow meters, and rain data shown is measured from the River Road gain gauge. Rain data from the rain gauge at Teterboro Airport was substituted into the rain dataset for this period for the continuous simulations of the model during the monitoring period.

Figure 3-3: Rainfall Data Checking



An analysis was performed for Passaic Valley Sewerage Commission, which used calibration data from April 2016 to March 2017. The rain data used for this analysis was primarily from the Teterboro rain gauge this data was used to fill in the missing rainfall period in the River Road rain gage time series.

In addition to calibrating the model based on metered rainfall and flow data, the system was further characterized based on CSO performance in a typical year. The NJ CSO Group, a group of municipalities which discharge to the tidally connected waterbodies in the NY/NJ Harbor Estuary that are working cooperatively to fulfill the requirements of the last CSO General Permit, identified 2004 as the typical year. The selection of 2004 as the typical year was summarized in the May 2018 memo submitted to the NJDEP. The NJDEP provided a letter response on May 31, 2018 indicating that all questions and comments had been addressed to the Department's satisfaction. As such 2004 rainfall data was applied to the hydraulic model to determine the system's typical long-term performance. The findings from this typical year simulation are provided in Section 8.

3.4 CSO Event Monitoring

NHSA records the incidence of CSO events at both River Road outfalls (WNY1 and JOSO) via hydraulic elevation meters which directly relay discharge information to the Mission website, installed in February 2016, as well as the NHSA website.

This Mission data is incorporated into the NHSA's Waterbody Advisory System which provides the public with real-time information related to CSOs into the Hudson River, and is used to creat the Discharge Monitoring Reports. Figure 3-4 below depicts the waterbody advisory system map designated to alert the public when a CSO event occurs. The map depicts inactive CSOs as green circles, indicating no CSO activity near that outfall. Red circles indicate that the CSO is currently active and contact with the water in areas within 100 feet of the outfall should be avoided. The circles can be clicked on to see the last time the CSO was active.

It is noted that there was no means to independently verify if there was an actual discharge corresponding to the data reported by the Mission system thus this information could only be used to indicate that a combined sewer overflow discharge event may have occurred, and does not provide definitive evidence that a discharge occurred.

Figure 3-4: NHSA Public Advisory Map

Overflows detected from February 2016 to February 2017 are shown in Table 3-3 below and are based on mission data, noting that an overflow was counted only if it there is a period of no overflow for the 24 hours preceding it.

Table 3-3: Overflows Detected by NHSA from February 2016 to February 2017

Outfall	Regulator	Service Area	Number of Overflows
DSN002A	River Road / WNY	River Road	66
DSN003A	JOSO	River Road	29

Note: JOSO outfall mission data did not indicate overflows from February to April

It is noted that tidal impacts were not considered in this study due to the steep drop in elevation (approximately 200 feet) from the drainage area to the outfalls at the base of the Palisades. In addition, the outfalls have check valves, so there is no tidal influence as a result of backflow. The Mission floats are upstream of the weirs, so they would also not be effected by the tides.

3.5 CSO Water Quality Sampling

The goal of the event sampling was to capture representative combined sewer samples from dry weather as well as threewet weather events. All samples collected were analyzed for fecal coliform and enterococcus; freshwater samples were also analyzed for E. coli. The Authority performed water quality sampling of its combined sewer systems from August 2016 to August 2017. CSO water quality sampling was designed to characterize CSO discharges to the Hudson River. The data collected enables a water quality characterization of combined sewer overflow discharges for the Authority's sewer system characterization.

The characterization focused on bacteriological indicators used in current and future recreational standards - fecal coliform and Enterococcus. Representative sampling locations at CSO regulators were selected to enable the water quality characterization of CSO discharges and to facilitate evaluation of LTCP alternatives. Sampling locations were selected based on GIS information of drainage area land use types and availability of monitoring systems to detect overflows. Sampling locations are listed in Table 3-4 with site characteristics.

Table 3-4: CSO Water Quality Sampling Locations

Basin ID	Location	Land Usage	% Imperviousness	Monitoring System
H3	3rd St. at River St. (In crosswalk)	Low/Medium Residential	71%	ADS/Mission (H3 + H4)
H7	14th St. East at Washington St.	Commercial/ Industrial	46%	ADS/Mission (H6 + H7)
18TH Street PS	W 18th St.	Open Space/ Park	39%	Mission
W2	506 Gregory Ave.	High Residential	59%	ADS/Mission
WNY1	John F. Kennedy Blvd. at Anthony M. Defino Way	Mixed Uses	~75%	Mission

Sampling was performed at five regulators during dry and wet weather events from August 2016 to August 2017. The goal of the wet weather sampling was to monitor at least three rain events with rainfall greater than 0.5 inches in a 24-hour period. Sampling and analysis was performed in accordance with the NJDEP approved Quality Assurance/Quality Control Plan that was submitted to the NJDEP on July 27, 2016 as part of the Authority's System Characterization Work Plans for the Adams Street and River Road WWTPs. A description of the sampling effort and the data collected are discussed in an abridged technical memorandum provided in **Appendix B**.

3.6 Baseline Compliance Monitoring Program

The data from the sampling program is being shared with the NJ CSO Group to support the establishment of area-wide ambient water quality conditions in CSO receiving waters. This is documented as part of the Baseline Compliance Monitoring Program (BCMP), which included three parallel data collection efforts:

1. Baseline Sampling, to supplement the approved routine sampling program of the New Jersey Harbor Discharges Group (NJHDG). The sampling frequency was as follows:
   a. Spring (May-Jun): Biweekly (4 dates);
   b. Summer (Jul-Sep): Weekly (12 dates); and

c. Winter (Oct-Apr): Monthly (7 dates).

2. Source Sampling, which targeted the major influent streams within the study area to establish non-CSO loadings, and coincided with the NJHDG and Baseline Sampling.
3. Event Sampling, which was timed to coincide with rainfall to capture three discrete wet-weather events over the course of the year on each segment of the NY-NJ Harbor complex impacted by CSOs.

The sampling locations as part of the NJ CSO Group's efforts are shown below in Figure 3-5, followed by the findings at sampling locations relevant to the River Road Service Area shown in Figure 3-6 and Figure 3-7.

Figure 3-5: NJ CSO Group Baseline Compliance Monitoring Program Sampling Locations (from Baseline Compliance Monitoring Program Data Summary Memo, HDR Engineering, October 2017)

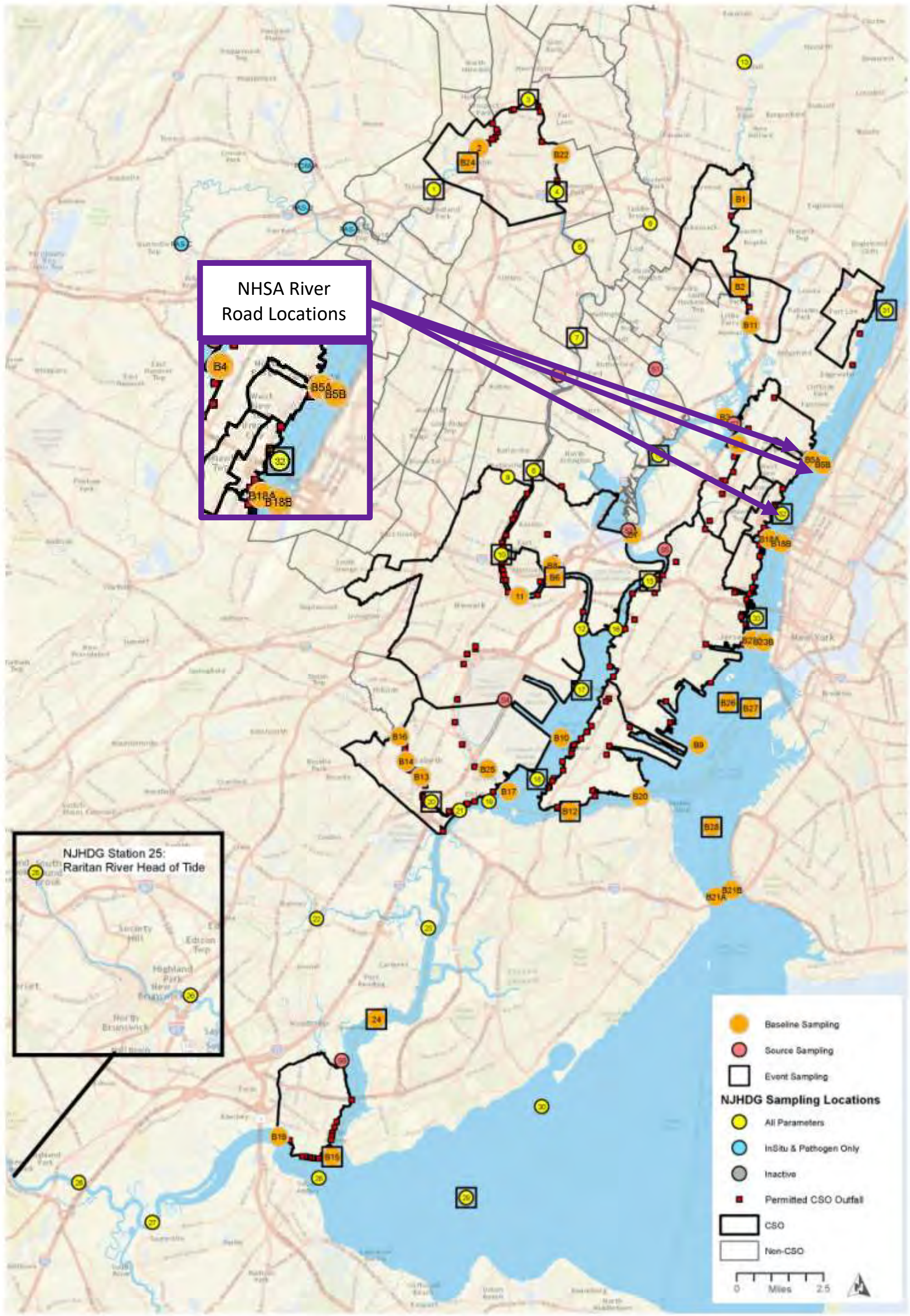
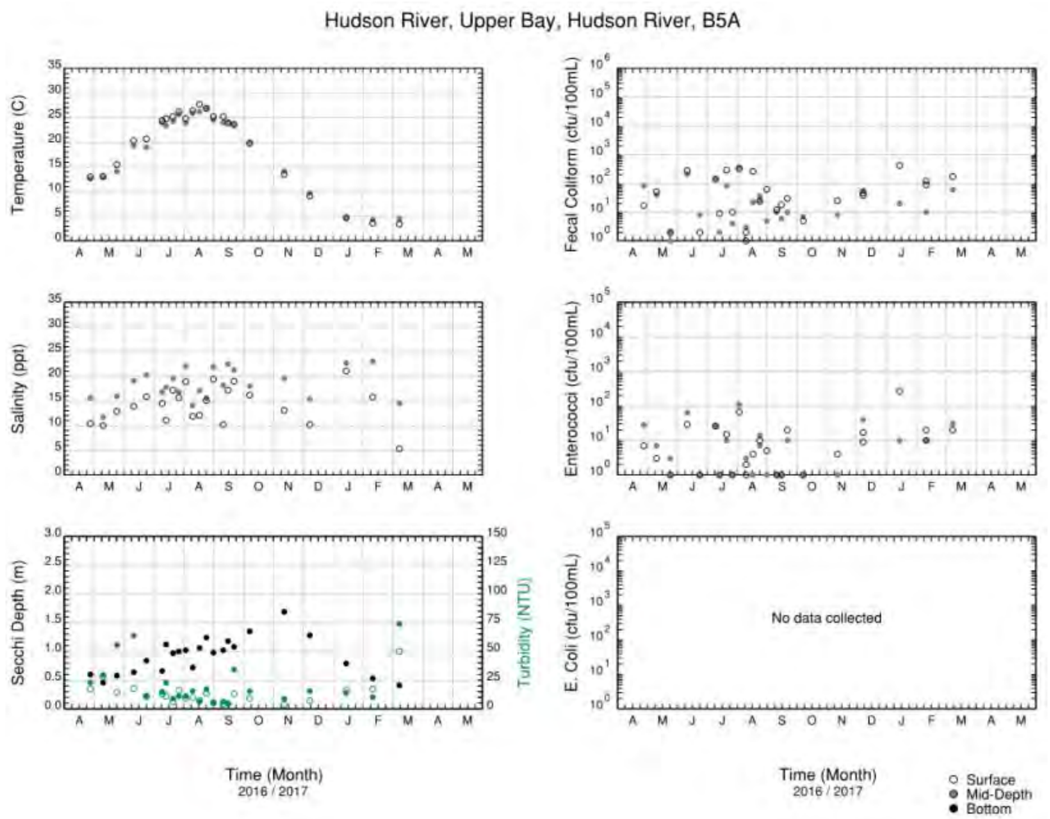


Figure 1 - Source, Routine, and Event Sampling Stations

Figure 3-6: Hudson River Sampling Locations B5A and B



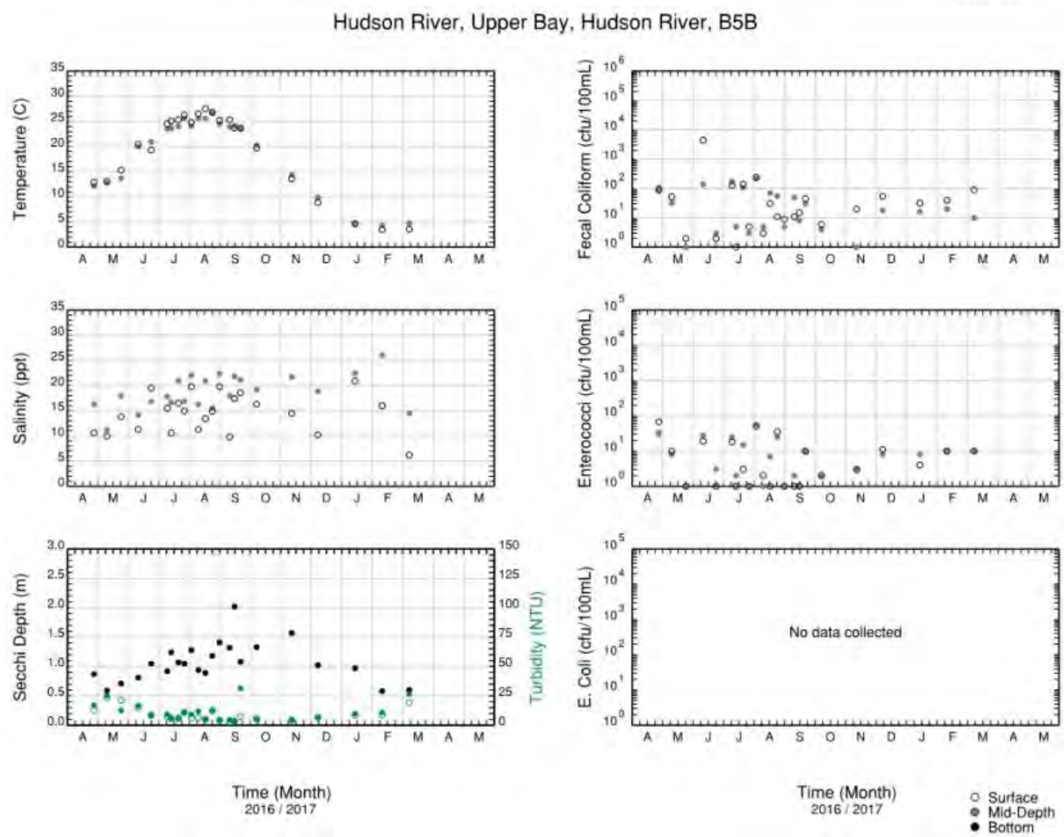
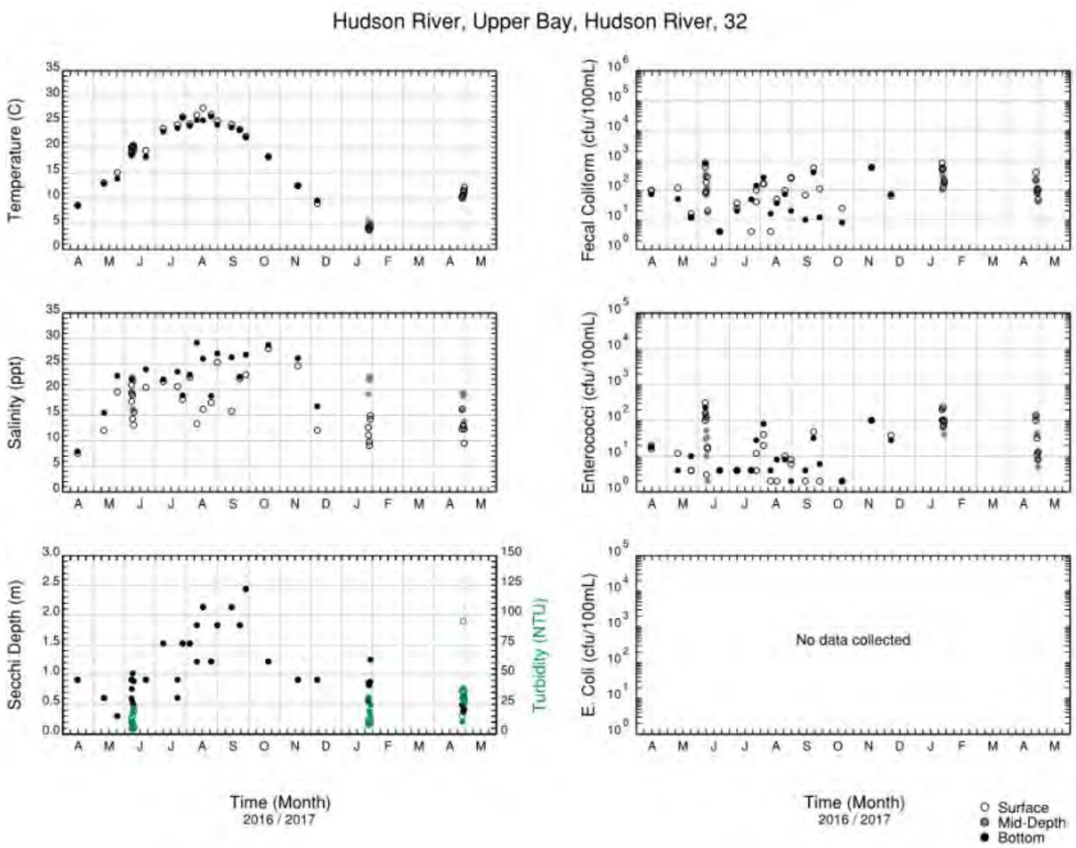


Figure 3-7: Hudson River Sampling Location 32



SECTION 4

Sewer System Inventory

A critical component of the NHSA system characterization includes reviewing, compiling, and analyzing existing data to identify usable data and data gaps. Existing documents and drawings were reviewed and an inventory and condition assessment was completed to develop a comprehensive GIS representation of the system.

4.1 Combined Sewer Collection System

The GIS database of the collection system provided by the Authority in June 2017 was used as the basis of the sewer system inventory, supplemented by fieldwork and available drawings. The GIS database includes sewer locations, sizing, lengths, manhole inverts and rims, locations of regulating structures, pumping stations and treatment plants. An overall map of the River Road service area is shown below in Figure 4-1:

Figure 4-1: River Road WWTP Service Area

Note: Regulator (W5) and outfall (015A) are not part of this study. The River Road system outfalls are only JOSO (003A) and River Road (001A/002A).

4.1.1 Combined Sewer Inventory

The length of pipe within each basin and the percentage of the total amount are shown in Table 4-1. The pipes are of various materials, shapes and sizes, as can be seen in Table 4-2 through Table 4-4.

Table 4-1: NHSA River Road Service Area Inventory

Basin ID	Number of Manholes	Number of Pipes	Total Length of Pipe (ft)	Percentage of Total Pipe
A	107	107	11,826	7%
B	103	95	9,828	6%
C	166	165	18,084	11%
D	203	191	25,026	15%
E	78	77	9,254	6%
F	33	32	4,029	2%
G	198	199	25,171	15%
H	72	75	16,354	10%
JOSO	414	404	46,371	28%
Total	**1,374**	**1,345**	**165,943**	**100%**

Table 4-2: NHSA River Road Service Area Material Inventory by Basin

Material	A	B	C	D	E	F	G	H	JOSO
BRK	-	-	-	1%	-	-	-	-	15%
CIP	-	-	-	-	-	-	-	-	0.2%
CONC	-	-	-	-	-	-	-	1%	-
DIP	-	-	-	-	-	-	-	8%	-
RCP	-	-	-	-	-	-	-	2%	-
VCP	-	-	-	16%	-	-	-	-	81%
UNKNOWN	100%	100%	100%	82%	100%	100%	100%	89%	4%

As shown in Figure 4-2 below, pipe materials are mainly unknown in West New York, however because the majority of the surrounding sewers in Union City and Weehawken are known to be vitrified clay pipe (VCP), it was assumed that the sewers in West New York are also made of VCP. This is consistent with observations that were made in field work and with the construction materials used when the area was developed. The Manning's number was assigned to these pipes accordingly in the model.

Figure 4-2: Pipe Materials in the River Road Service Area

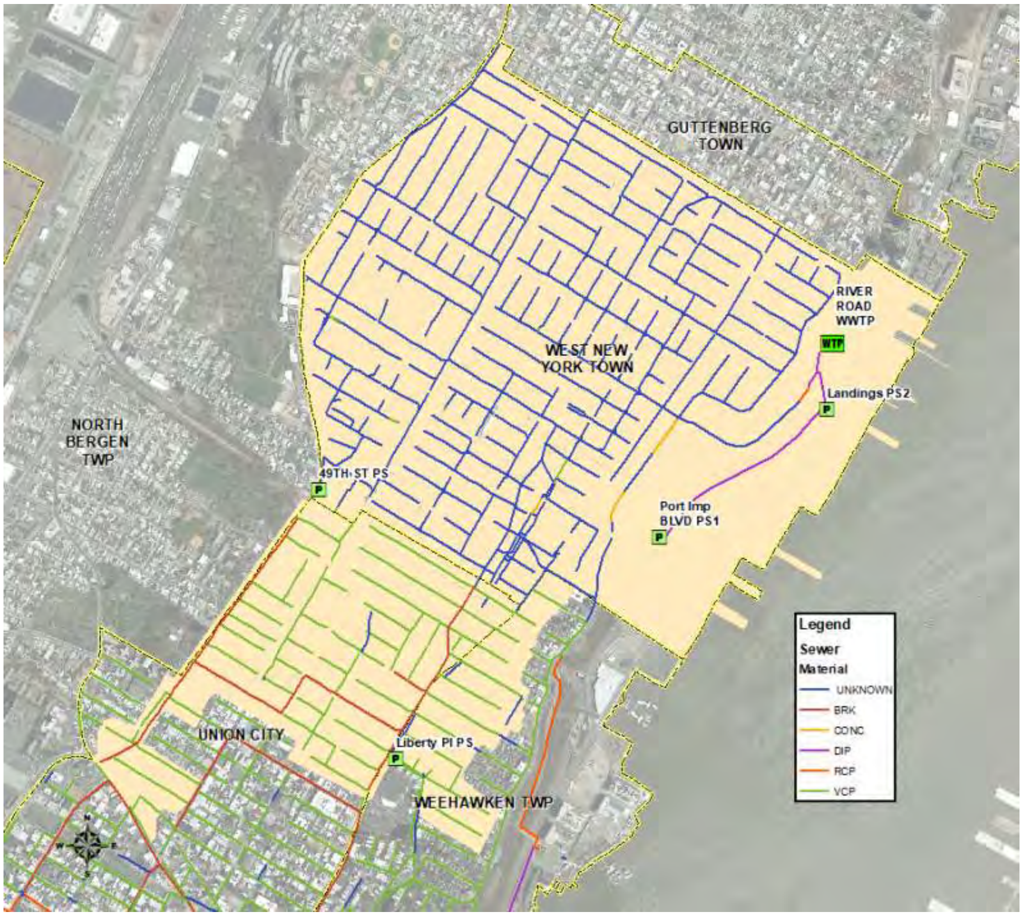


Table 4-3: NHSA River Road Service Area Inventory by Size

Diameter	A	B	C	D	E	F	G	H	JOSO
6”	-	-	-	-	-	-	-	-	0.2%
8”	-	1%	1%	1%	3%	-	0.3%	-	-
10”	7%	-	6%	18%	23%	13%	6%	12%	-
12"	37%	35%	44%	41%	37%	49%	51%	39%	50%
15"	6%	22%	15%	18%	6%	18%	14%	6%	16%
18"	25%	3%	13%	7%	5%	12%	5%	3%	12%
20"	5%	-	-	-	-	-	-	-	1%
24"	3%	-	7%	1%	-	8%	13%	12%	5%
27"	-	-	-	-	-	-	-	11%	-
30"	3%	-	2%	-	-	-	2%	7%	-
36"	11%	-	6%	-	-	-	4%	-	2%
42"	-	-	3%	-	-	-	-	-	-
48"	2%	12%	2%	-	14%	-	4%	-	1%
54"	-	12%	-	-	-	-	-	-	-
60"	-	10%	-	6%		-	-	-	1%
72”	-	-	-	-	-	-	-	-	1%
75"	-	-	-	4%	-	-	-	-	1%
84"	-	-	-	5%	0.3%	-	-	2%	-
90"	-	-	-	-	12%	-	-	2%	-
96"	-	-	-	-	-	-	-	3%	-
24” x 36”	-	-	-	-	-	-	-	-	2%
30” x 45”	-	-	-	-	-	-	-	-	1%
40” x 60”	-	-	-	-	-	-	-	-	1%
50” x 75”	-	-	-	-	-	-	-	-	4%
UNKNOWN	-	6%	-	-	0.3%	-	-	3%	4%

Table 4-4: NHSA Adams Street Service Area Shape Inventory by Basin

SHAPE	A	B	C	D	E	F	G	H	JOSO
CIRCULAR	100%	94%	100%	100%	100%	100%	100%	100%	89%
OVAL	-	-	-	-	-	-	-	-	7%
UNKNOWN	-	6%	-	-	-	-	-	-	4%

4.1.2 Collection System Condition

The WNY-1 interceptor sewer is the main trunk line in the River Road service area. It conveys combined sewage from Regulator WNY-1 to the River Road WWTP and was reportedly installed in bedrock by blasting. A 30-foot section of this interceptor was lined with gunite to prevent rock intrusion. Drawings of this sewer length are not available.

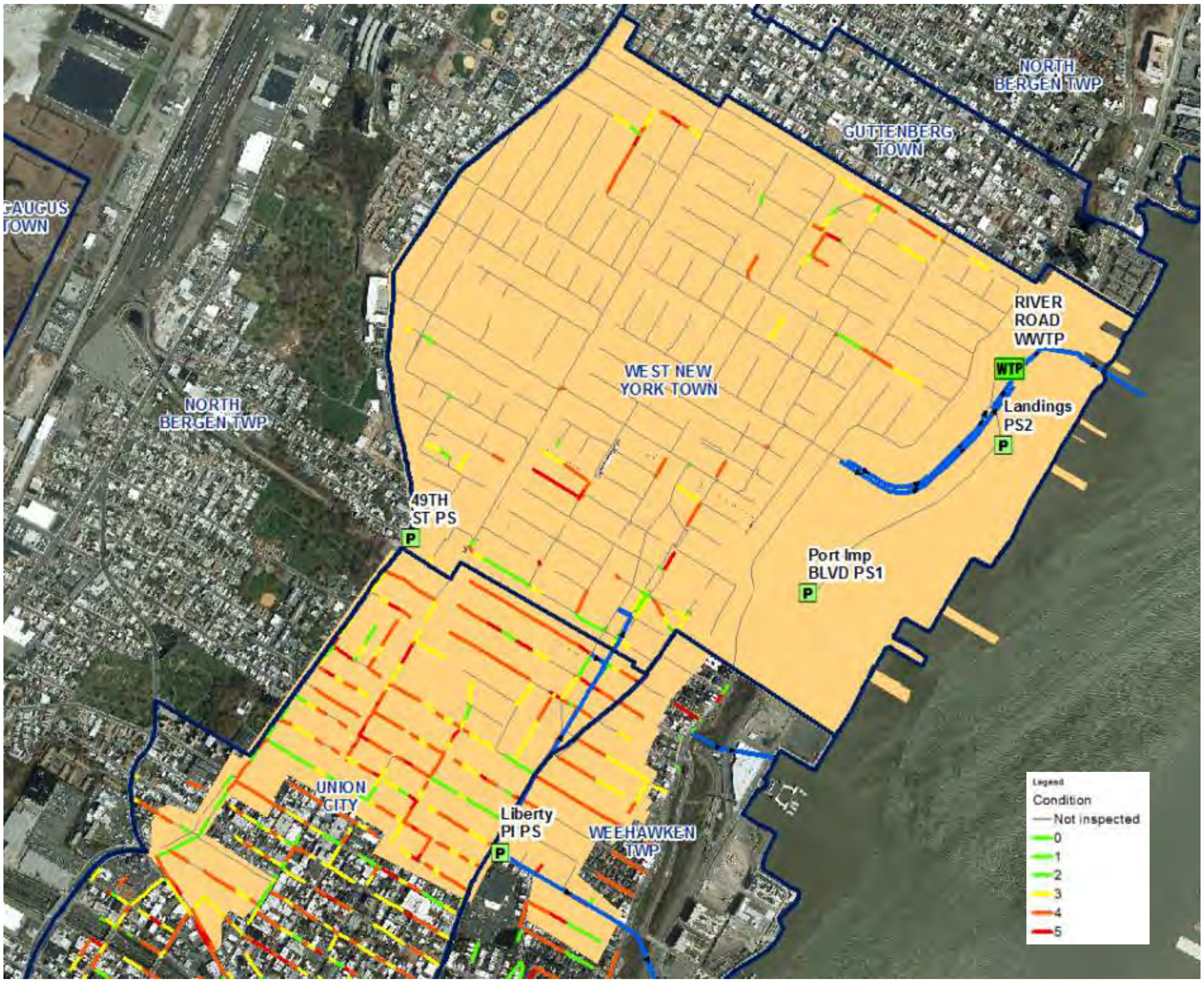
Figure 4-3 below depicts the results of the condition assessment of the sewers in the River Road service area that was completed by RedZone described in Section 2. The sewers are rated according to the NASSCO Pipeline Assessment and Certification Program (PACP) rating system on a scale of 1 to 5, in which 1 (green) represents least likelihood of failure while 5 (red) represents the greatest likelihood of failure. It is noted that the PACP system gives a 5 rating for one crack or hole in the top of the pipe, and these pipes can continue working in that condition for decades.

The collection system that services the River Road WWTP has been constructed within rock known as the Palisades Formation. When these combined sewers were originally constructed, the blasted rock was used as backfill, which in some cases has caused damage to the pipe. Also, the majority of the material used to construct the small diameter sewers is VCP with joints spaced only at eight to ten feet. This type of construction has created a situation in which has introduced a great deal of Infiltration into the combined sewer system from watermain leaks.

The Authority has utilized the CCTV work to identify watermain leaks and proceed to develop an asset management program to prioritize the cleaning and lining of the combined sewers. The Authority is also working with the local water purveyor to locate and remediate watermain leaks.

The Authority has been very proactive in reducing I&I to the River Road WWTP by collaborating with Suez Water on a leak detection program and has spent almost $2,000,000 on CIPP Lining of the combined sewers in the River Road Service Area.

Figure 4-3: Service Area Condition Assessment



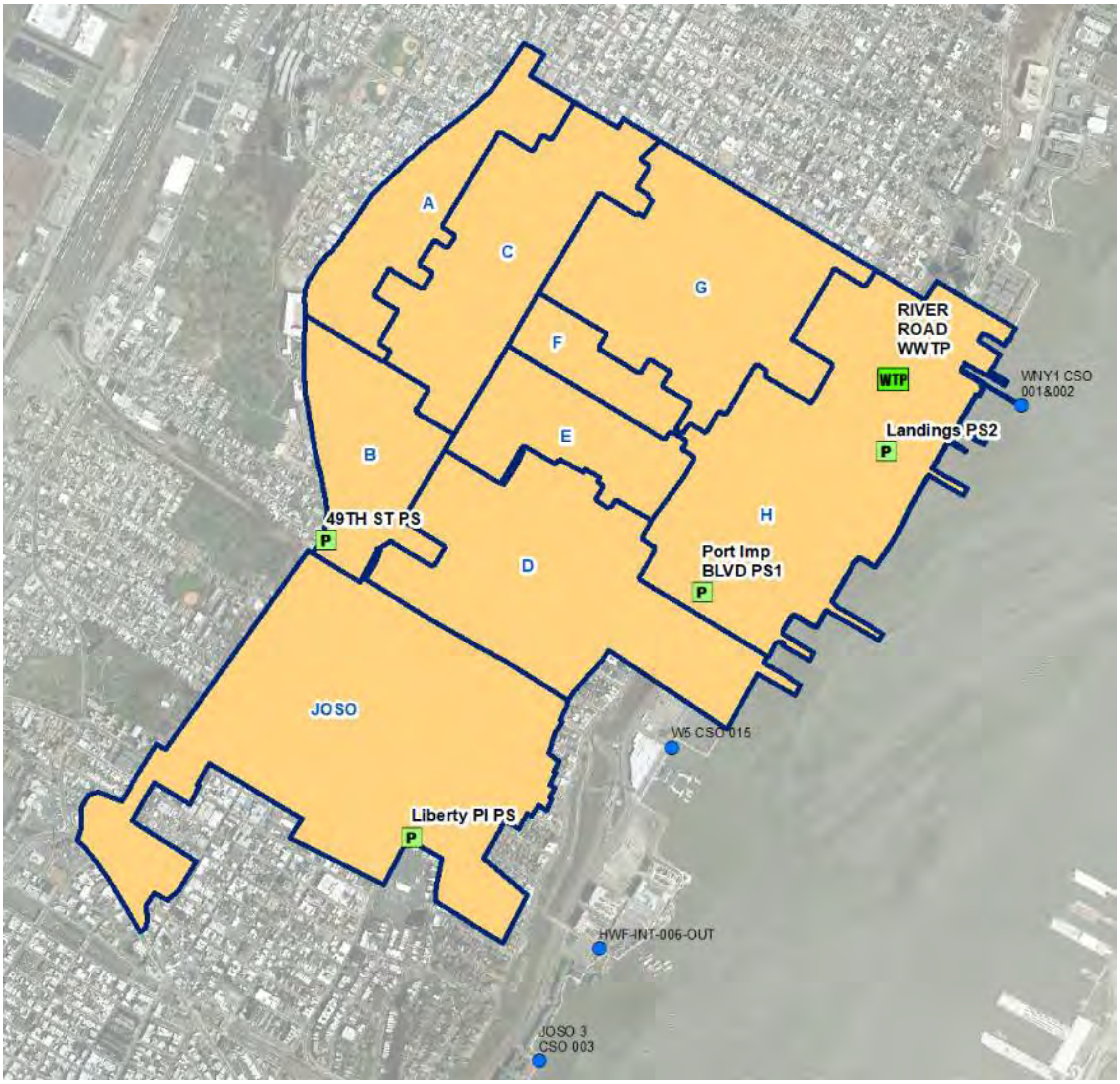
4.2 Pump Stations and Force Mains

There are four pumping stations in the River Road WWTP service area, which are listed in Table 4-5, shown in Figure 4-4 described in the sections below.

Table 4-5: NHSA Pump Station General Information

Pump Station	Basin
49th Street	B
Landings	H
Port Imperial	H
Liberty Place	JOSO

Figure 4-4: Pumping Station Locations and Drainage Basins



Note: Regulator (W5) and outfall (015A) are not part of this study. The River Road system outfalls are only JOSO (003A) and River Road (001A/002A).

4.2.1 Liberty Place Pump Station

The Liberty Place Pump Station pumps sewage from Liberty Place, Eldorado Place and Highwood Avenue into the River Road WWTP via a force main. It receives flow from the nearby residences. The pump station includes two (2) 5 hp submersible pumps and one above-grade electrical cabinet on the sidewalk. The pumps were installed in 2012 by the Authority and are the ABS Contrablock pumps with open impeller design. There is no bar rack nor comminutor at this station. Excess wet weather flow at the Liberty Place Pump Station flows by gravity to the JOSO outfall for discharge to the Hudson River.

Information on the pump curves was not available; thus the pump properties from the hydraulic model are shown below in Table 4-6 and Table 4-7:

Table 4-6: Liberty Place Pumping Station – Assumed Discharge

	Discharge (MGD)
Pump 1	0.33
Pump 2	0.33

Table 4-7: Liberty Place Pumping Station – Assumed On/Off Settings

	ON (ft AD)	**OFF (ft AD)**
Pump 1	150	143.3
Pump 2	156.3	150

Photos of the pumping station are provided below in Figure 4-5 and Figure 4-6:

Figure 4-5: Liberty Place PS – External View

Figure 4-6: Liberty Place PS Controls

4.2.2 49th Street Pump Station

The 49th Street Pump Station collects sanitary flow from several businesses and discharges into the gravity sewer at 51st Street and Kennedy Boulevard. The station receives flow from the nearby shopping center and laundromat. The station includes two (2) submersible five (5) hp pumps in a manhole in the street, and one above grade electrical cabinet on the sidewalk. One pump was replaced in 2012 by the Authority. The pumps could not be inspected but no operational issues are reported. The electrical cabinet was recently damaged as it was struck by a vehicle but this has since been repaired. The station and controls are operable. There is no bar rack nor comminutor at this station.

This pump was not included in the model as the pump properties were not known and it is known to be a very small pumping station.

Photos of the pumping station are provided below in Figure 4-7 and Figure 4-8:

Figure 4-7: 49th Street PS – External View

Figure 4-8: 49th Street PS – Controls

4.2.3 Landings Pump Station

The Landings Pump Station serves the residential development south of the River Road WWTP. It feeds directly into the treatment plant downstream of regulator WNY1, as such it does not directly contribute to CSO overflows and was not included in the model.

4.2.4 Port Imperial Pump Stations

Port Imperial has three pump stations. Port Imperial Pump Stations 1 & 2 feed directly into the treatment plant downstream of regulator WNY1, as such it does not directly contribute to CSO overflows and was not included in the model. Pump Station 3 flows to Adams Street WWTP thus is not discussed further in this report. Descriptions of Pump Station Nos. 1 and 2 are provided below.

The pump stations serve the nearby residential developments. The stations are very similar. They each consist of a JWC raw sewage grinder with hydraulic drive, three Flygt submersible pumps, VFDs, PLC based pump controls, and standby generator. The generator and controls are housed in a one story, precast concrete building, with brick veneer, to give the appearance of a brick building. The stations are new and in good condition, except as noted below.

4.2.4.1 Port Imperial Pump Station No. 1

Port Imperial Pump Station No. 1 is located on Port Imperial Boulevard (between Riverbend and Riverwalk Place) on the west side of the road. The sanitary flow from this station is conveyed to Pump Station No. 2 and from there to the River Road WWTP. The station was built in 2003 and consists of a wet well housing three (3) submersible pumps, a valve vault and an above ground building which houses an emergency generator and VFDs. The wet well depth is 25.25 ft and the wet well level is currently float controlled.

The station consists of three Flygt CP3152 submersible pumps, rated for 905 gpm @ 42 feet TDH and 20 hp each (one lead, one lag and one stand-by), three Toshiba 20 hp variable frequency drives (VFDs), one Muffin Monster comminutor, and one Cummins Onan 100DGDB diesel generator. There is one air release valve on the force main between Pump Station No. 1 and Pump Station No. 2. Both the grinder and VFDs are not in service, however a project is currently underway to replace the VFDs and level sensors and to upgrade the building HVAC system.

A drawing of Pump Station No.1 is shown below in Figure 4-9:.

Figure 4-9: Port Imperial PS No. 1 Layout

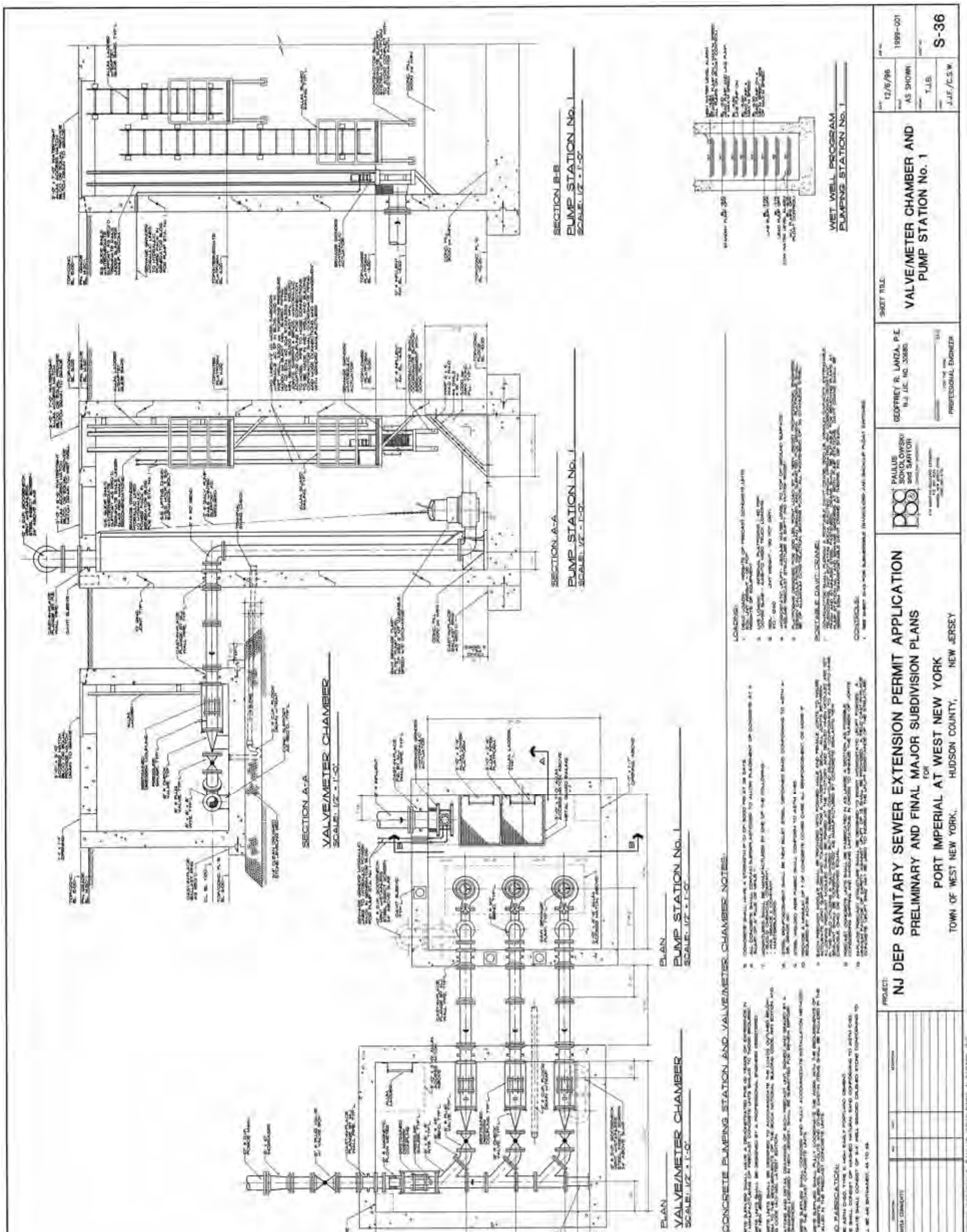


Figure 4-10 below shows the location of Pump Station No. 1 and Figure 4-11 and Figure 4-12 show photos of the Pump Station.

Figure 4-10: Port Imperial Pump Station No. 1 Location

Figure 4-11: Port Imperial Pump Station No. 1 External

Figure 4-12: Port Imperial Pump Station No. 1 Wet Well

4.2.4.2 Port Imperial Pump Station No. 2

Port Imperial Pump Station No. 2 is located at the intersection of Port Imperial Boulevard and North Park Court and conveys flow to the River Road WWTP. The station was constructed 1998. The station consists of three Flygt CP3300 submersible pumps, rated for 1935 gpm @90 feet TDH and 88 hp each (one lead, one lag and one stand-by), three Toshiba 100 hp variable frequency drives (VFDs), one Muffin Monster comminutor, and one Cummins Onan 250 DFAC diesel generator. The generator and VFDs are housed in the building and the pumps and comminutor are located in the below-ground wet well. Wet well depth is 30.5 ft. A project is underway to replace the VFDs and upgrade the HVAC system.

A drawing of Pump Station No.2 is shown below in Figure 4-13.

Figure 4-13: Port Imperial PS No. 2 Layout

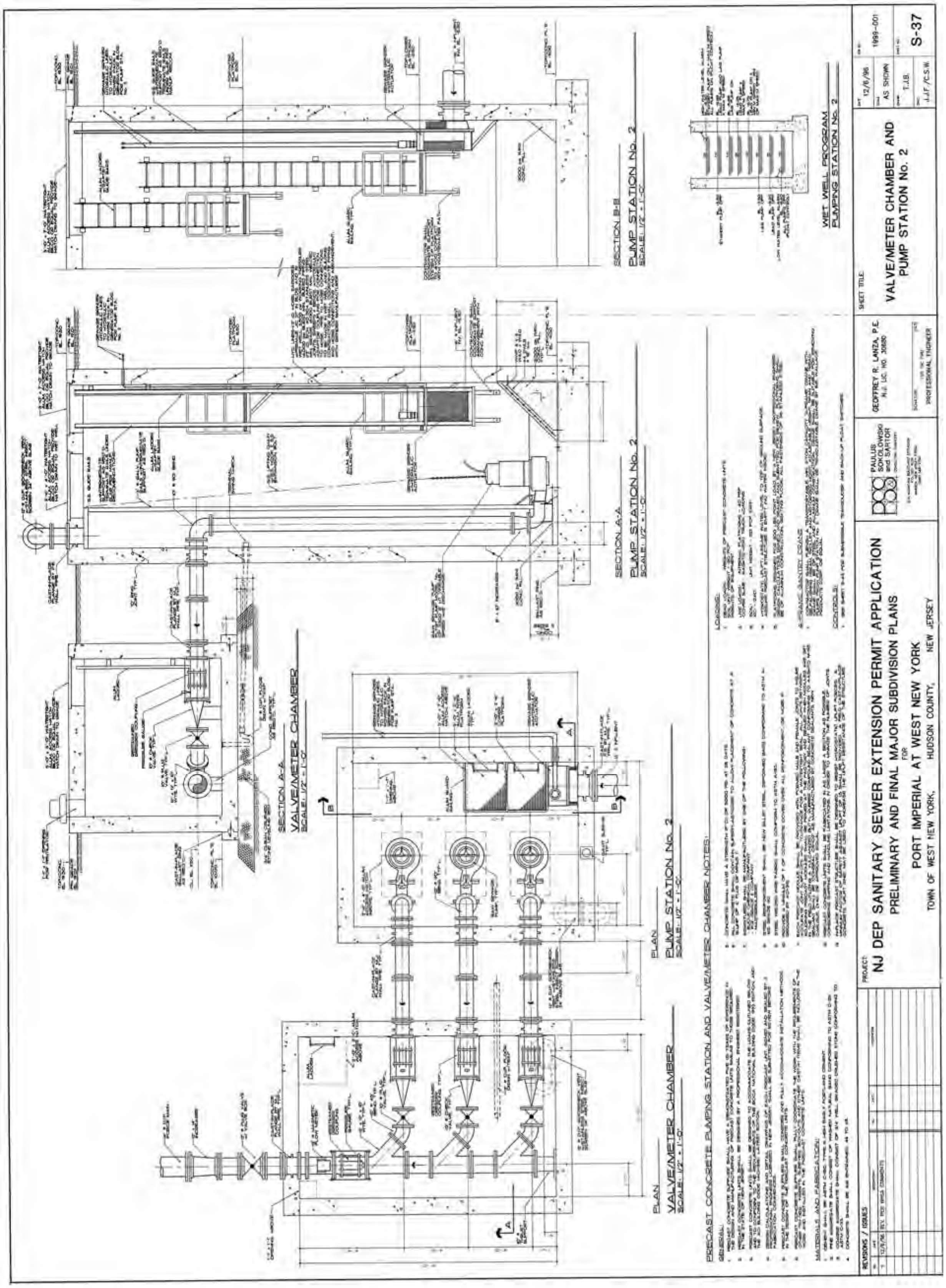


Figure 4-14 below shows the location of Pump Station No. 2 and Figure 4-15 and Figure 4.16 show photos.

Figure 4-14: Port Imperial Pump Station No. 2 Location

Figure 4-15: Port Imperial Pump Station No. 2 External

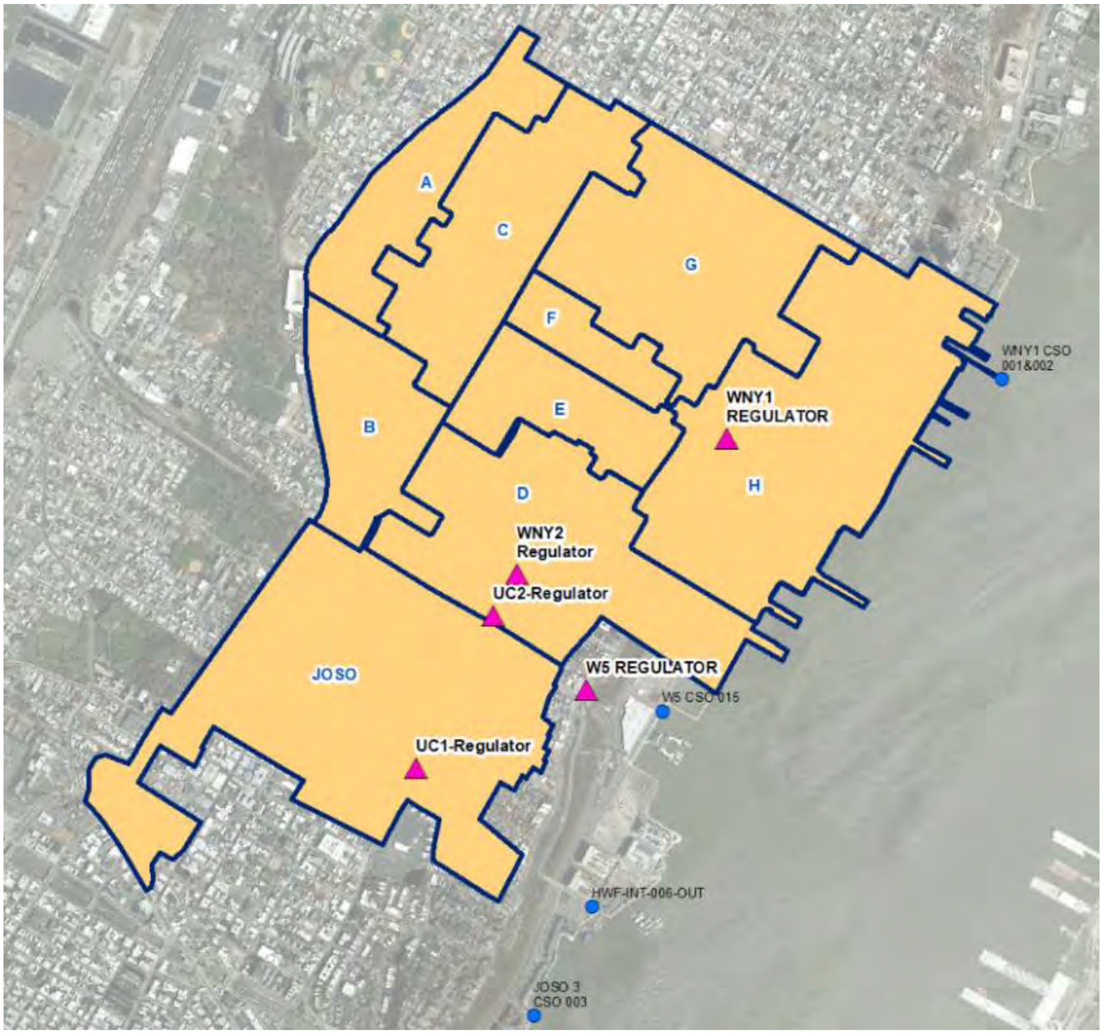
Figure 4-16: Port Imperial Pump Station No. 2 Wet Well

4.3 CSO Regulators

The regulators in the River Road WWTP Service Area direct all sewage flows during dry weather to the River Road WWTP and convey excess flows during wet weather events directly to the Hudson River. There are four regulators in the River Road WWTP Service Area, shown in in Figure 4-17 below, which are all located in series along the main WNY interceptor sewer. WNY1 regulator regulates CSO discharges using mechanical floats. This regulator conveys up to 10 million gallons per day (MGD) of flow to the River Road WWTP. The other three regulators (UC1, UC2 and WNY2) regulate CSOs using overflow weirs that divert sewage through the JOSO outfall.

All regulators were originally constructed in the 1950s and 1960s. Regulator WNY1 underwent rehabilitation in 2015.

Figure 4-17: Regulator Locations



Note: Regulator (W5) and outfall (015A) are not part of this study. The River Road system outfalls are only JOSO (003A) and River Road (001A/002A).

4.3.1 Weir Regulators UC-1, UC-2 and WNY-2

There are three side overflow weir-operated regulators that discharge excess wet weather flow into the JOSO relief sewer that combines flows from the Town of West New York, Union City and Weehawken. Two regulators are located in Union City: as shown in Figure 4-17, UC- 1 is located on Park Avenue just north of 43rd Street, and UC-2 is located on 49th Street just west of Broadway. The third regulator, WNY-2 is located in West New York on 51st Street, just west of Broadway. The JOSO relief sewer directs the excess wet weather flow to the Hudson River.

Drawings were not available for the regulators so field measurements were taken by Mott MacDonald staff, shown below in Figure 4-18 through Figure 4-20.

Figure 4-18: Regulator UC1 Field Notes

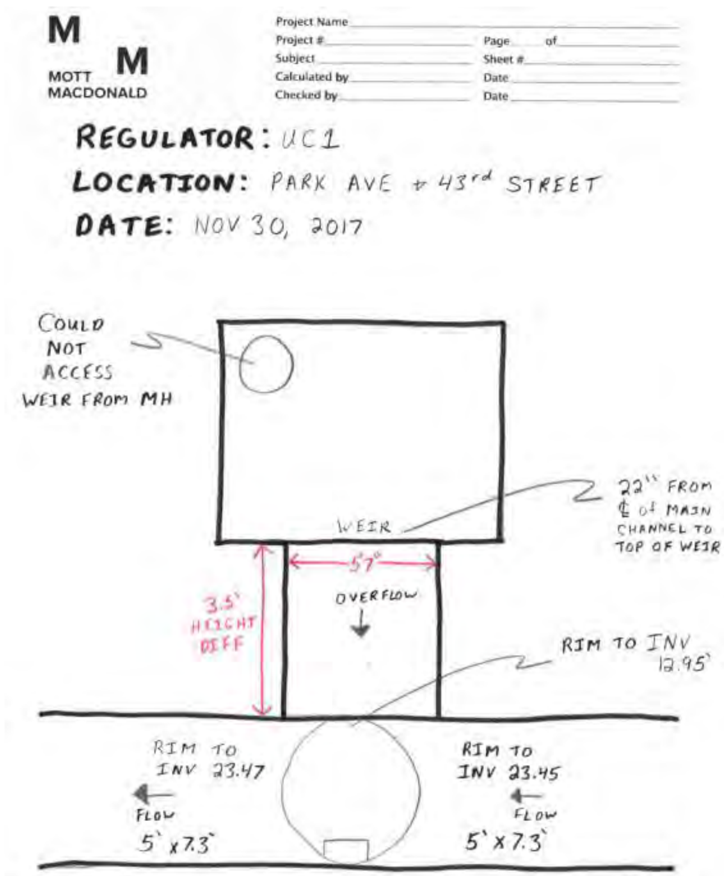


Figure 4-19: Regulator UC 2 Field Notes

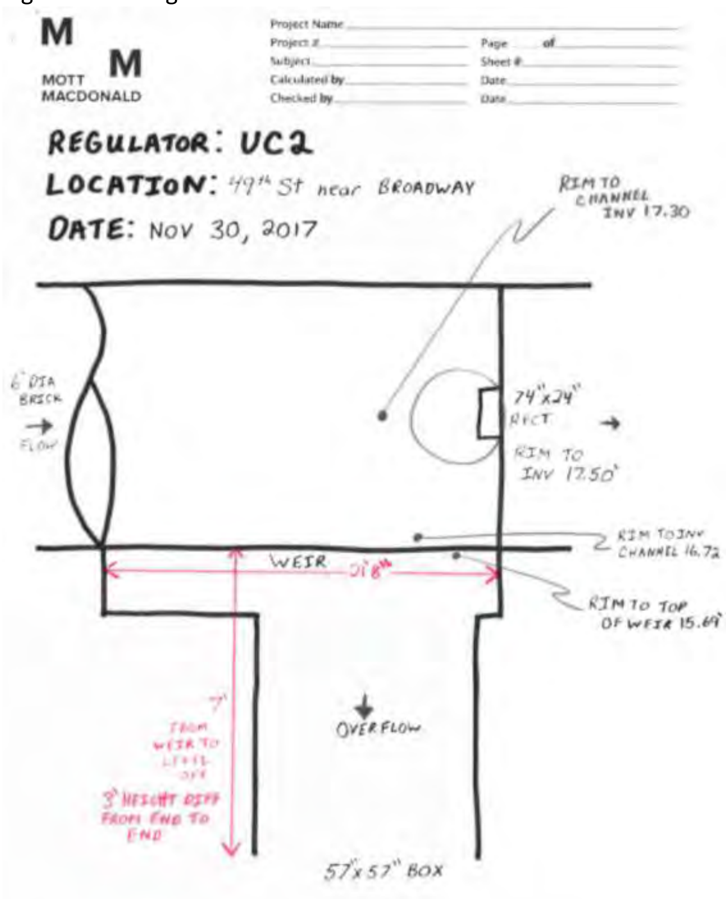
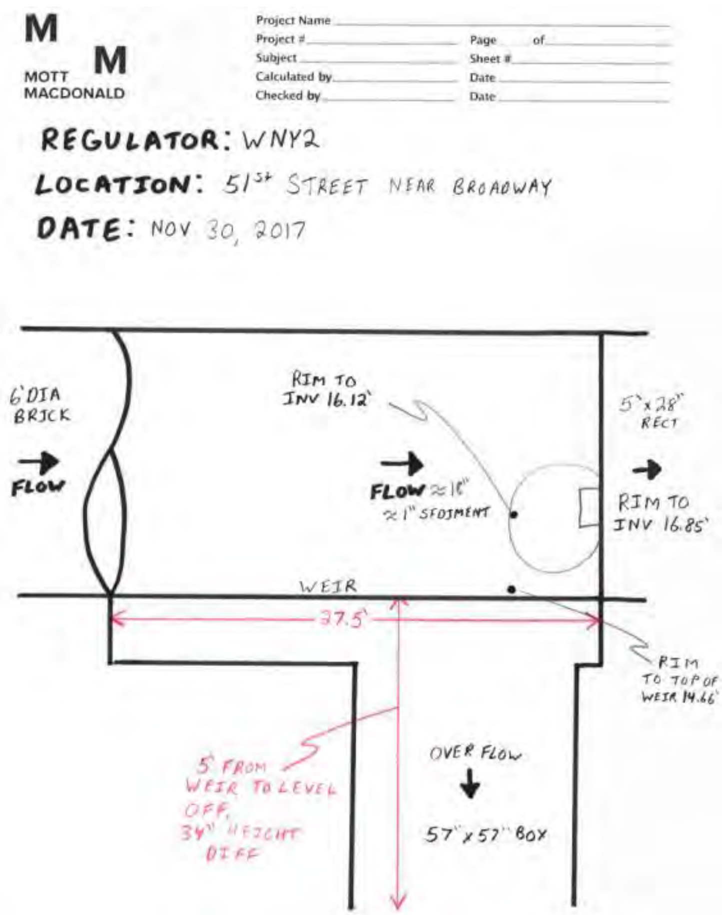


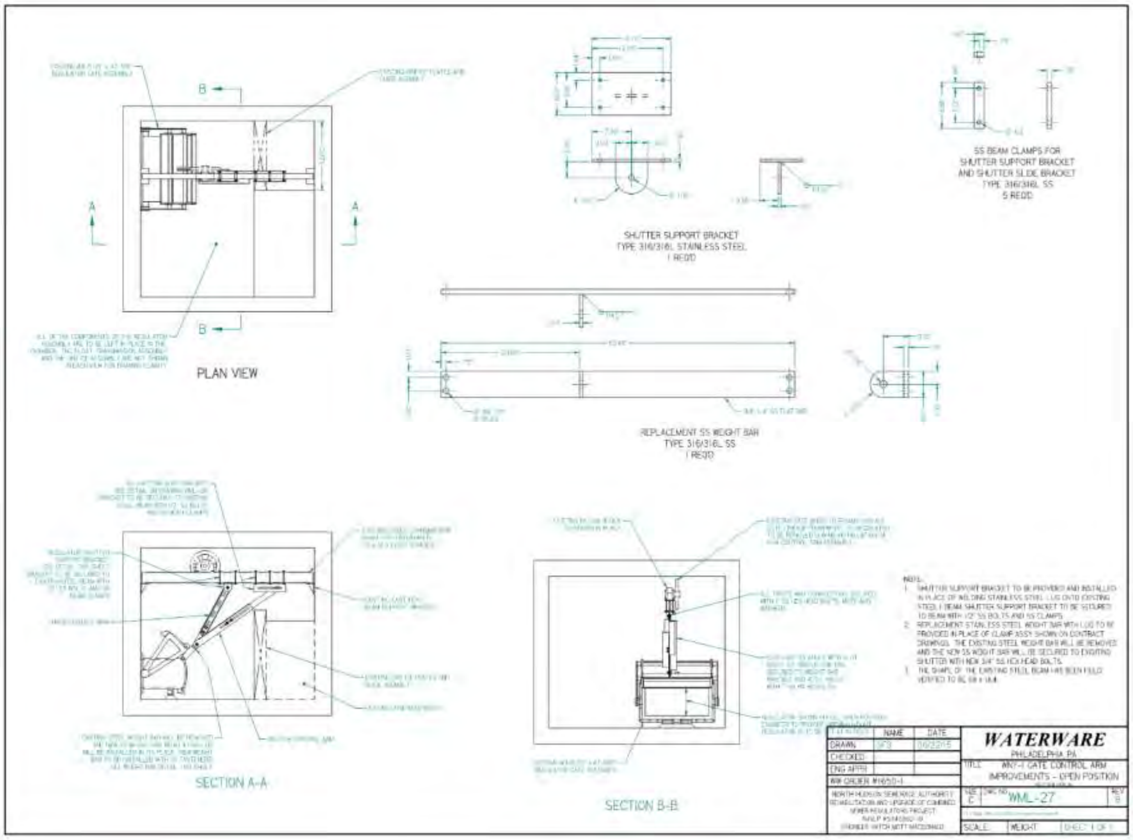
Figure 4-20: Regulator WNY2 Field Notes



4.3.2 Mechanical Regulator WNY-1

This weir controlled regulator is located on Anthony M. Defino Way, just east of the Intersection with John F. Kennedy Boulevard in West New York. The regulator is similar to those in Hoboken, with a weir and a regulator float gate. The influent line is an 84-inch diameter pipe which receives all combined sewer flows originating from the River Road WWTP service area, with the exception of overflows directed to the Joint Overflow Sewer Outlet (JOSO) for discharge to the Hudson River. A 27-inch diameter interceptor directs flow to the River Road WWTP. The River Road WWTP outfall joins the WNY-1 54-inch diameter outfall pipe prior to discharging to the Hudson River. This regulator was recently rehabilitated as part of the NHSA Regulators Improvements Project, shown in the drawings below in Figure 4-21 and the field notes are included as Figure 4-22.

Figure 4-21: Regulator WNY1 Rehabilitation Drawings



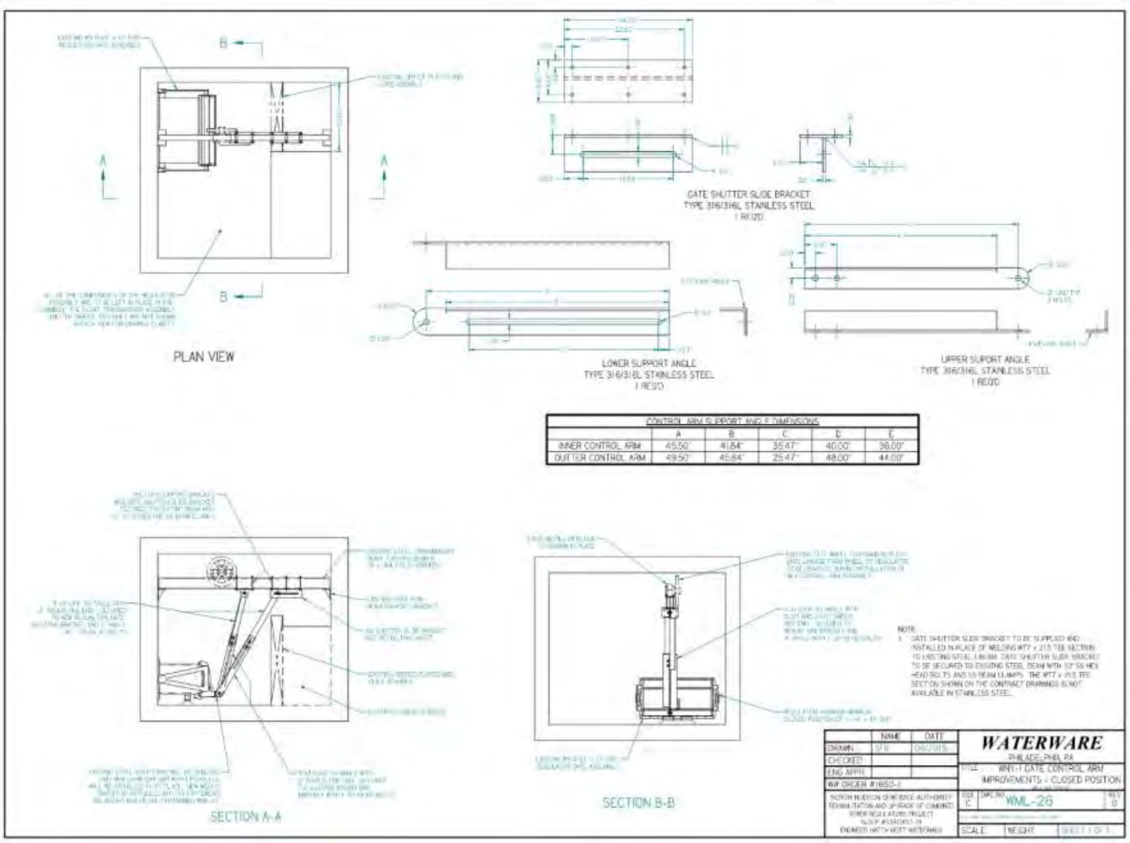
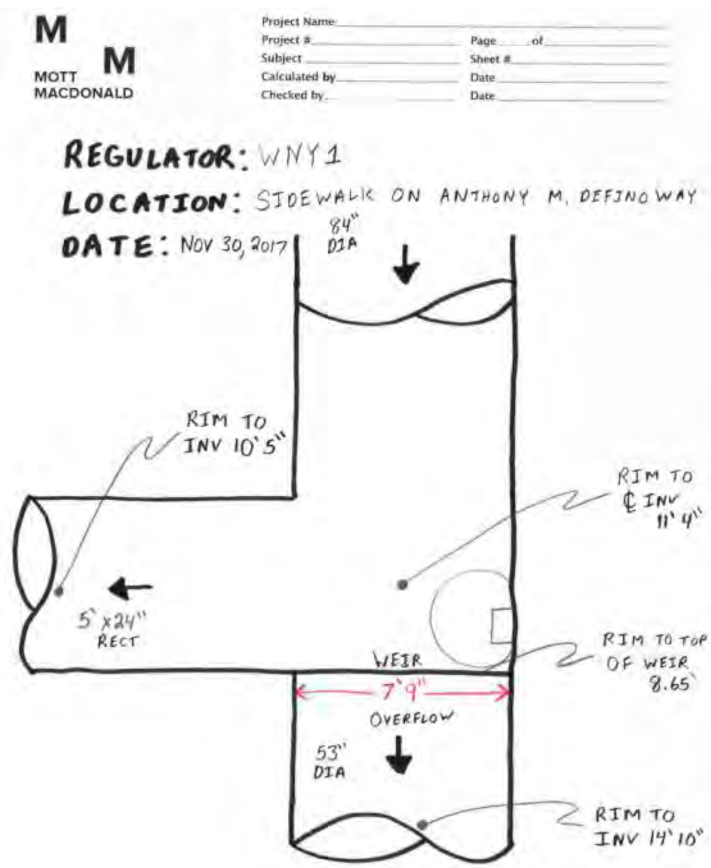


Figure 4-22: Regulator WNY1 Field Notes



4.4 CSO Outfalls

There are two CSO outfalls in the River Road WWTP service area which discharge to the Hudson River. Regulator WNY1 discharges wet weather flows to Outfall 002A, and directs dry weather flow to the River Road WWTP. CSO Outfall 002A continues down Anthony M. Defino Way where the flow is passed through the WNY1 solids and floatables facility, which provides ½ screening. After being screened it joins the WWTP outfall (001A) to form Outfall 001A/002A which continues as a single pipe extending into the Hudson River. The other outfall is JOSO/003A, as described below in Table 4-8.

Table 4-8: Summary of River Road CSO Outfalls

Outfall	NHSA Name	Basin	Dimensions	Type of Material	Location	Associated Regulator(s)
002A	WNY1	WNY1	54” circular	RCP	East of River Road WWTP in West New York, off Half Moon Ct.	WNY1
003A	JOSO	JOSO	60” circular	RCP	At the end of Liberty Place, Weehawken	UC1, UC2, WNY2

The general slope of the River Road outfall pipe was determined based on known elevations at the regulator, at the WWTP and at the outfall. The WWTP effluent is discharged by gravity into the 54-inch diameter outfall pipe (001A) which receives CSO flow just downstream of the WWTP (002A), and the WWTP discharge and CSO are conveyed together through a single pipe prior to discharging to the Hudson River. The pipe also receives overflow from the upstream regulator during wet weather events.

Figure 4-23: River Road Outfall Pipe at Low Tide

The River Road outfall pipe was inspected by divers in May 2010. It was determined that the pipeline and supporting structure are in fair condition overall, with a few repairs required to remedy some deflection in the pipeline as well as typical maintenance on minor cracking and coating loss on the support structure. There are no current capital improvement projects in progress for the River Road Outfall, and there are no future proposed capital improvement projects.

Drawings of the JOSO outfall pipe (003A) are not available, however it is known from NHSA staff that there is a drop structure located at the end of Liberty Place, which has been included in the hydraulic model. No invert elevation was available in GIS, however the sizing of the outfall pipe was confirmed in GIS. The elevation at the outfall is known, and was included in the model. A photo of the outfall sign at the JOSO outfall is included below as Figure 4-24:

Figure 4-24: JOSO Outfall Sign

4.5 Solids/Floatables Facilities

In October 2003, NJDEP issued Administrative Consent Order ID# NEA 020001-47081 (ACO 020001-47081 for Solids/Floatables Control) to NHSA. ACO 020001-47081 consisted of requirements to construct two solids/floatable construction projects, one for DSN 002 (001A/002A) and one for DSN 003 (JOSO). The solids/floatable projects for both DSN 002 and DSN 003 were completed in the summer of 2012 thus satisfying the ACO requirements. There are two solids/floatables control facilities in the River Road WWTP service area which discharge to the Hudson River. These correspond to the two outfalls 001A/002A (WNY/WWTP) and 003A (JOSO).

4.5.1 WNY1 Solids/Floatables Structure

The WNY1 solids/floatables facility treats overflows from the WNY-1 regulator. It was constructed in 2009 and is located in a building adjacent (south) of the River Road WWTP. The facility has an 84" influent PCCP pipe and a 78" effluent PCCP pipe. The facility has ½ inch bar screens which are 5'-6" in width with a span of 20'-6". Drawings of this structure are provided below in Figure 4-25 and Figure 4-26.

Figure 4-25: WNY1 Solids/Floatables Facility

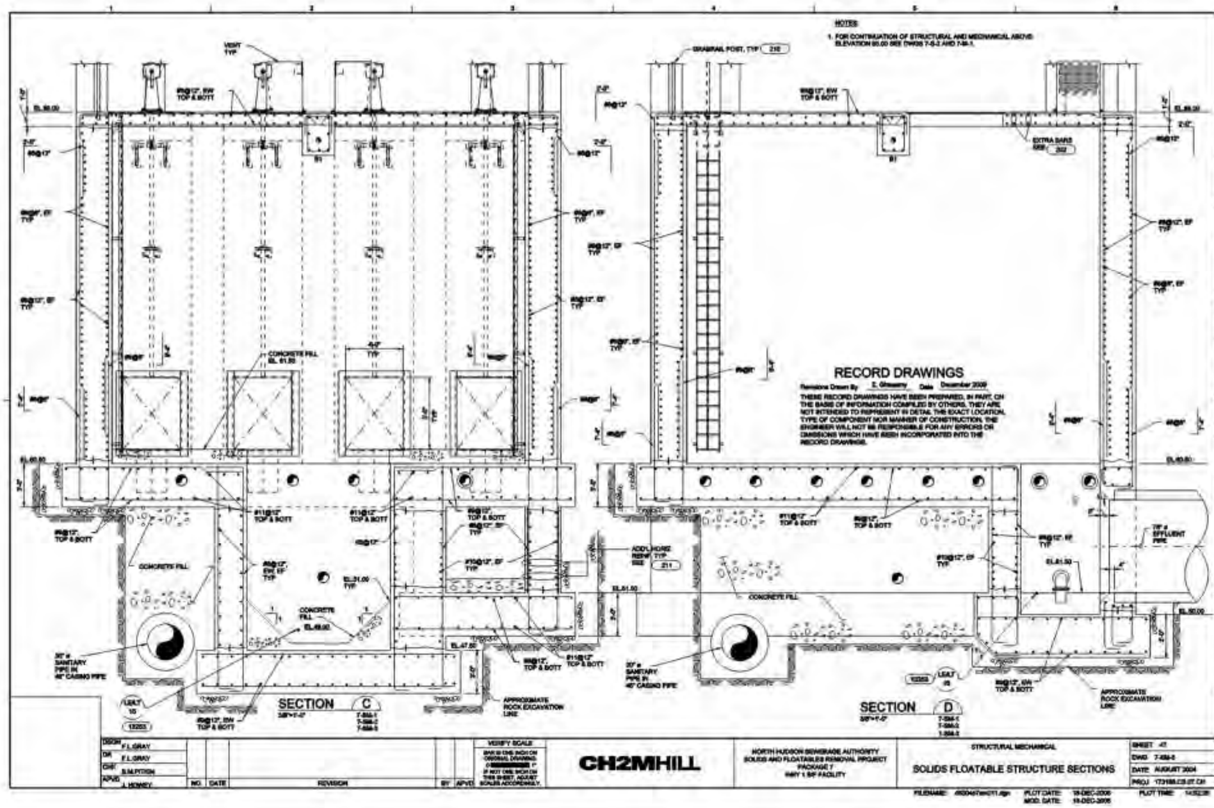
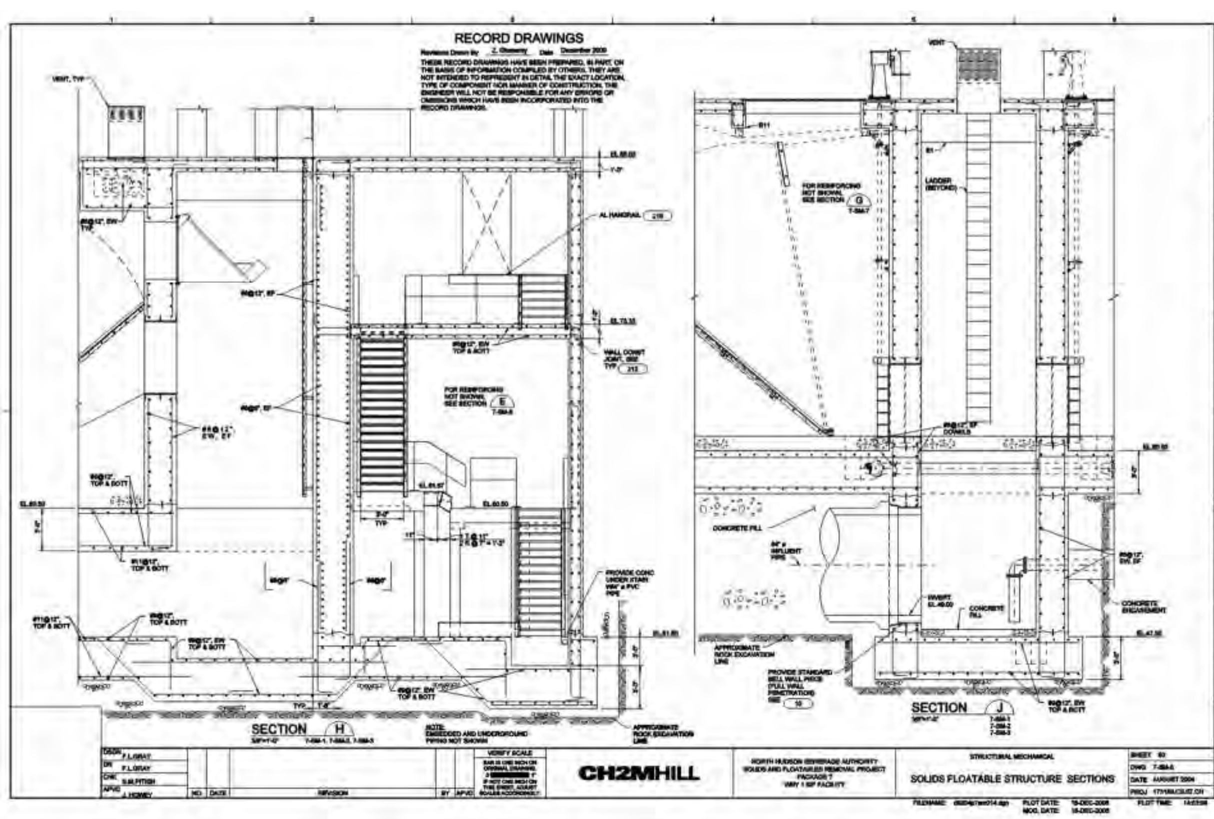


Figure 4-26: WNY1 Solids/Floatables Facility



4.5.2 JOSO Solids/Floatables Structure

The JOSO solids/floatables facility treats overflows from the UC1, UC2 and WNY2 regulators. It was constructed in 2005 and is located in a subsurface facility at the end of Henry Place, upstream (west) of the JOSO outfall. The facility has an 72" influent RCP pipe and a 72" effluent RCP pipe. The facility has bar screens are 5'-6" in width with a span of 15'-0". It has 48" Tideflex check valves and 48" x 54" sluice gates.

Drawings of this structure are provided below in Figure 4-27 through Figure 4-29.

Figure 4-27: JOSO Solids/Floatables Facility

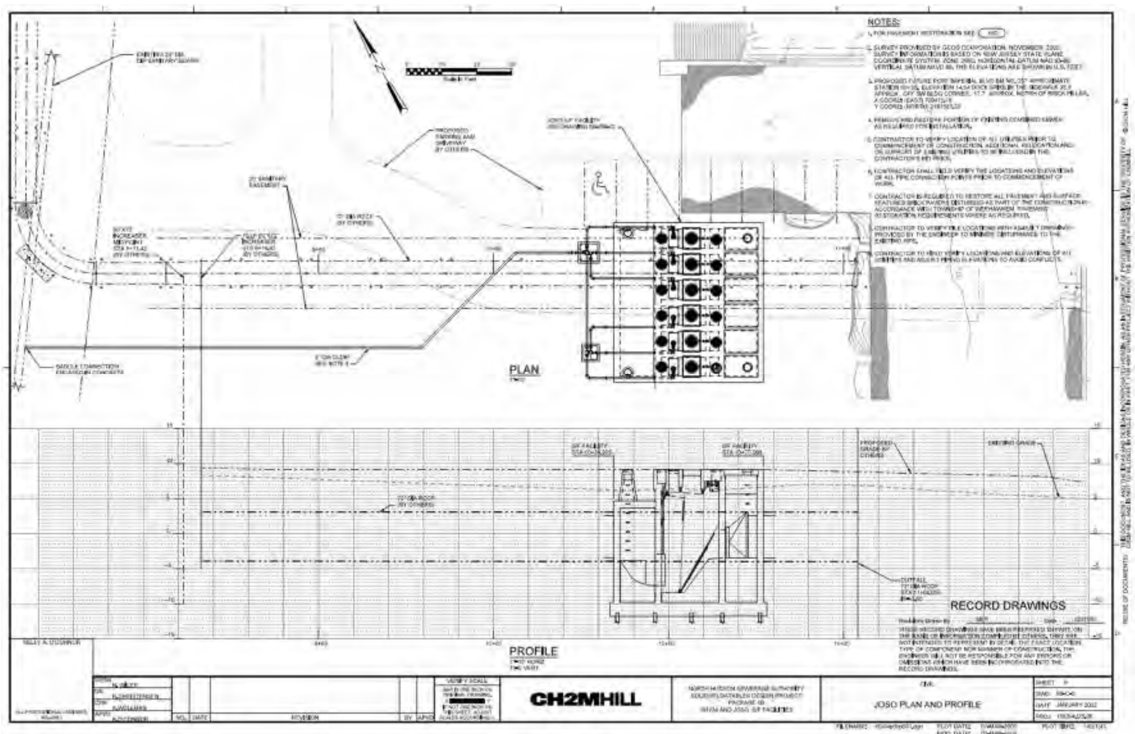


Figure 4-28: JOSO Solids/Floatables Facility

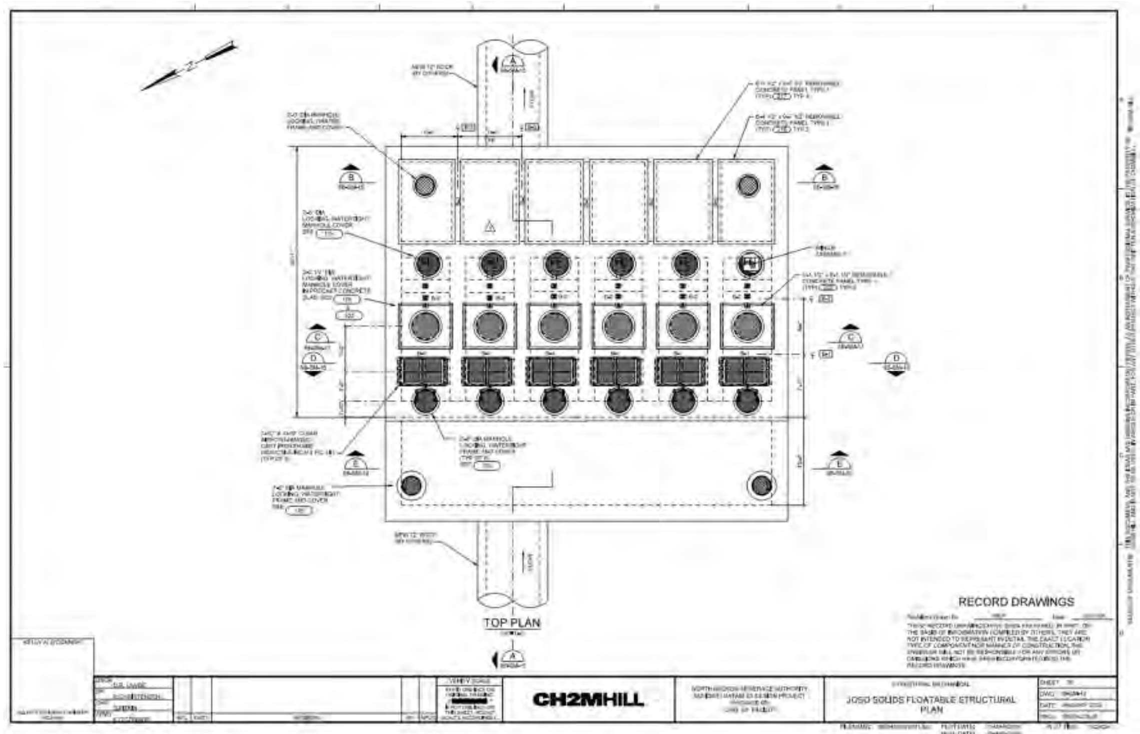
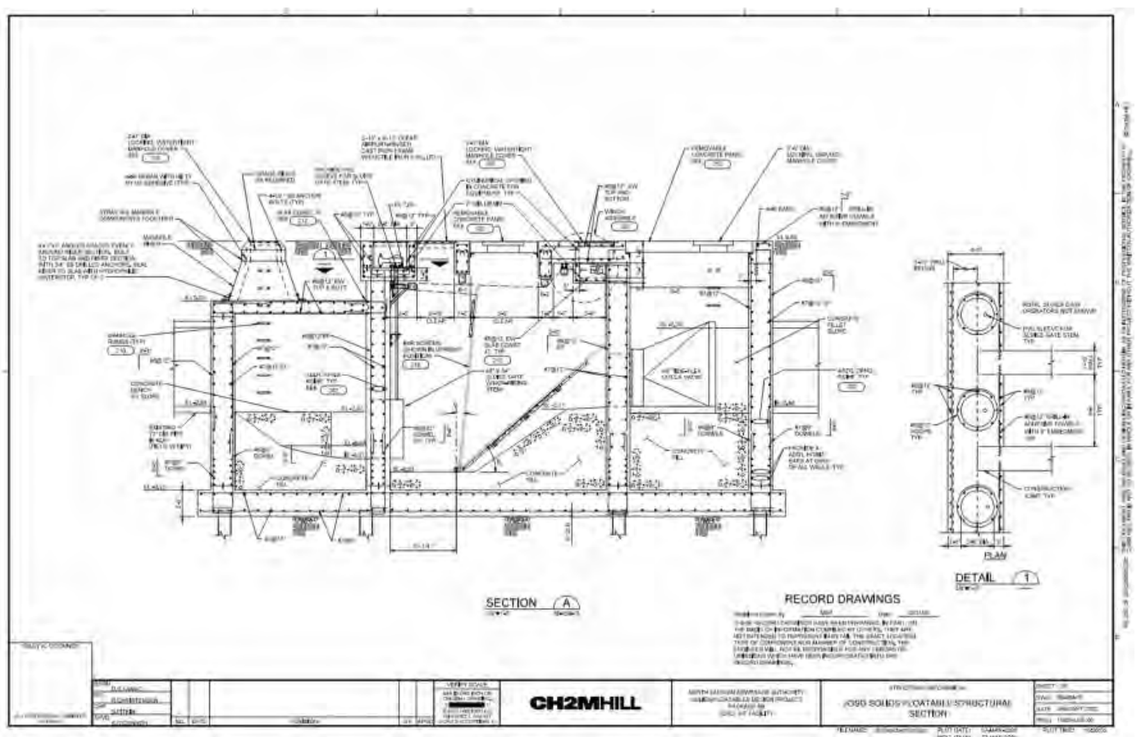


Figure 4-29: JOSO Solids/Floatables Facility



SECTION 5

Wastewater Treatment Plant

This section outlines the characteristics of the River Road WWTP, including processes, flow data, influent loadings, effluent data, and removal data associated with permit compliance.

5.1 Facility Overview

The River Road WWTP is located at 6400 Anthony M. Defino Way in West New York. The WWTP was constructed as a primary treatment plant in 1953 with a design capacity of 10.0 MGD and 20 MGD peak flow. In 1992, an upgrade to the plant was completed to provide secondary treatment using the trickling filter biological treatment process. The plant treats the sewage from the Town of West New York and from a section of Union City and Weehawken covering an area of approximately 1.4 square miles and three communities. The average flow to the facility has approached the plant capacity of 10.0 MGD in the past, but has been decreasing in recent years with aggressive I/I reduction efforts. Effluent is discharged to the Hudson River in accordance with the NJPDES permit NJ0025321.

The treatment process at the plant includes preliminary treatment consisting of influent screening and grit removal using vortex type units, micro-strainers in lieu of primary clarifiers, trickling filters, secondary clarification, effluent disinfection using sodium hypochlorite and de-chlorination using sodium bisulfite, solids handling including sludge storage and sludge thickening using two belt presses and odor control. The process flow diagram for the River Road WWTP is provided below in Figure 5-1. NHSA assumed ownership of the River Road WWTP and associated collection and conveyance facilities on November 1, 1996. The following sections describe the condition of each facility, presents any ongoing repairs/replacements, and discussed planned capital improvements to the system. The treatment capacities are superimposed on an aerial in Figure 5-2.

NHSA assumed ownership of the River Road WWTP and associated collection and conveyance facilities on November 1, 1996. The following sections describes the condition of each facility, presents any ongoing repairs/replacements, and discusses planned capital improvements to the system.

Figure 5-1: River Road WWTP Process Flow Diagram

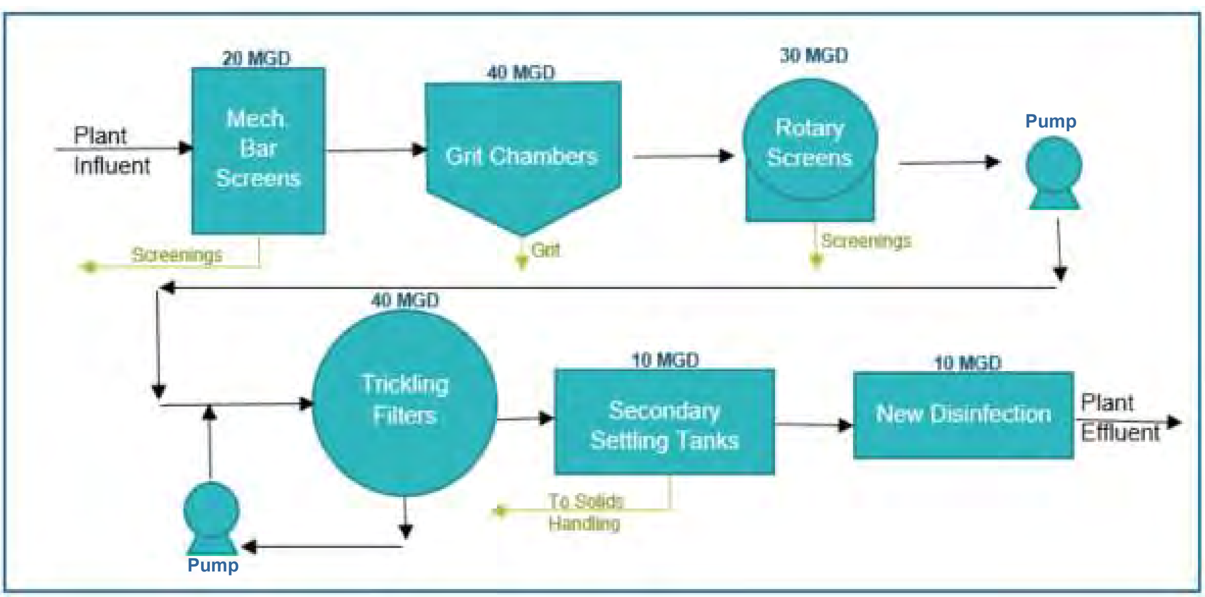


Figure 5-2: River Road Wastewater Treatment Plant

5.2 Treatment Capacities

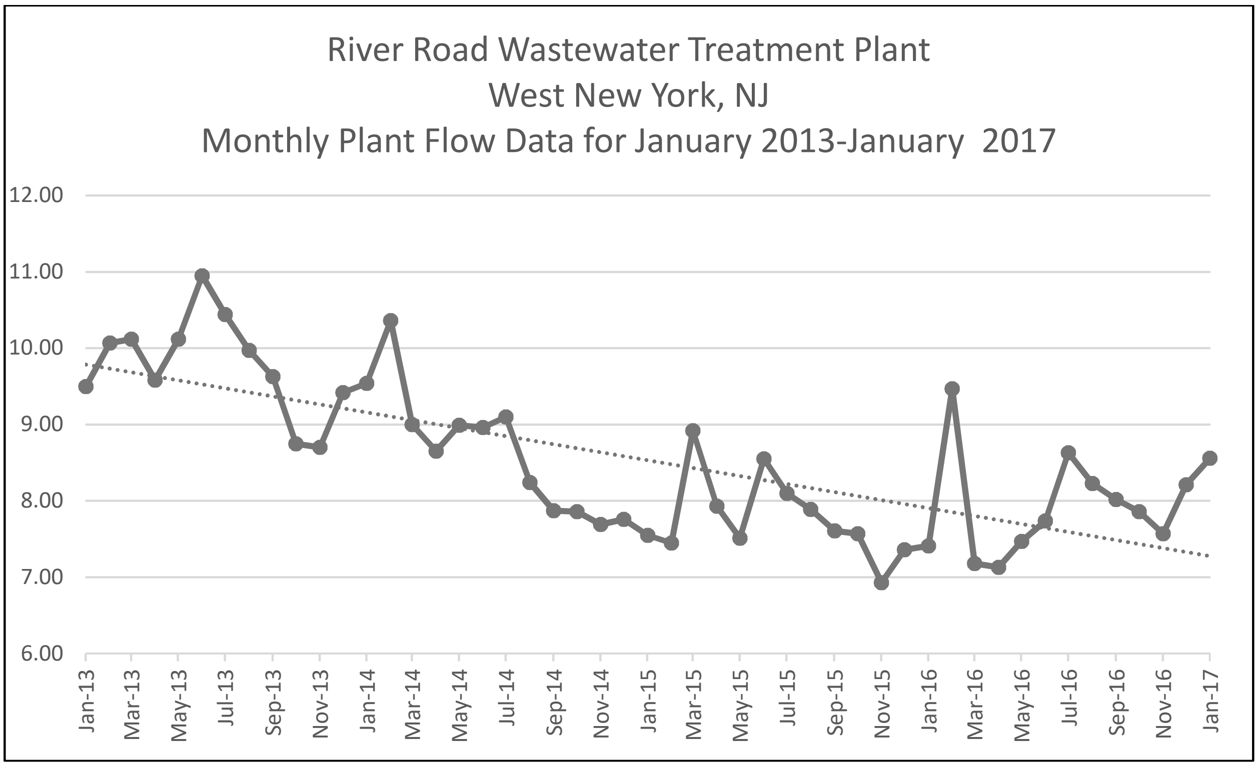
The River Road WWTP was designed for an average flow of 10 MGD, and has been able to meet the permit requirements for the last 5 years under these flow conditions due to plant improvements.

The required treatment capacity is defined as “the minimum flow, which should be used to determine the size of the treatment, achieving NJPDES General Permit limits. This flow shall be based upon the facility’s permitted flow and shall include appropriate allowances for non-excessive infiltration/inflow (I/I) and daily or seasonal variations encountered by the facility”. The individual NJPDES Permit does not limit the WWTP flow. The Permit sets effluent limitations for TSS and BOD for both mass discharges (kg/day) and concentrations (mg/L). The Permit also identifies a flow value of 10 MGD which was used in determining the load calculations. The required treatment capacity is considered equal to the flow value listed in the General Permit and defined as 10 MGD.

The primary treatment capacity is defined as “the maximum flow i.e. daily, weekly or monthly that can receive primary treatment at the existing primary treatment facilities”. Currently, there are no existing primary settling tanks at the River Road WWTP. Microscreens that are designed for 10% BOD removal and 18% TSS removal are provided. Typical removal efficiencies for primary treatment facilities when treating municipal wastewater are 50 to 70% TSS removal and 25 to 40% BOD removal.

The NHSA has in place a Leak Detection Program in cooperation with Suez Water (Suez) to address infiltration into the gravity sewer of the West New York collection system. Upon obtaining results from a flow monitoring study performed by Emnet, Inc., it was determined that significant amounts of infiltration from the Suez water distribution system was entering the collection system. This infiltration drove the influent flows entering the WWTP over the facility's design capacity of 10 MGD. The Authority has initiated an ongoing collaboration with Suez to systematically address leaks within their water distribution system. As a direct result of this program, there has been a reduction in flows from a peak month of 11 MGD prior to program commencement to less than 9 MGD, as shown in Figure 5-3. The plant monthly average flow is near the design capacity for the plant.

Figure 5-3: Historic Flow Rates 2013-January 2017, River Road Wastewater Treatment



5.2.1 WWTP Facilities Review

Using the 2017 Annual Report and prior facilities reports the condition of the WWTP was evaluated to provide an understanding if LTCP work could be coupled with other planned improvements.

5.2.1.1 Preliminary Treatment

The Preliminary Treatment Building (PTB) houses the screening, grit removal and micro-strainer equipment. The influent sewage flows through two (2) stainless steel, mechanical bar screens where rags and debris are removed. The rags and debris are conveyed to a dumpster. The sewage then flows through a channel to two (2) vortex type grit removal units where heavy sand and grit settle to a grit sump. The organics in the sewage flow are maintained in suspension by a rotating paddle to maintain velocity within the vortex unit. The grit is pumped by vacuum primed grit pumps manufactured by Smith and Loveless. The grit is pumped to two (2) grit classifiers which wash and dewater the grit and convey it to containers, see Figure 5-4.

Figure 5-4: Mechanical Screen and Grit Removal System



The deck grating above the influent channels to the screening facility were replaced during FY2016. The mechanical bar screens appear to be in good working order. The grit equipment including the vortex unit paddles and drives, and the grit pumps are at the end of their useful life and should be replaced and updated. The grit classifiers were replaced in kind in 2012. The grit pumps are vacuum primed “pista grit” pumps that are reported to have reached the end of their useful life and require periodic patching of the volutes due to the abrasive nature of the grit. A possible improvement is the replacement of the vacuum primed pumps with self- priming type pumps. The self-priming pumps do not require the separate, often maintenance intensive, vacuum priming system. Materials of construction for the new grit removal equipment should be carefully selected for corrosion resistance and should include stainless steel as much as possible.

In general, the area contains high levels of moisture which leads to corrosion of the exposed steel in the building structure. This is caused by the extremely humid and wet conditions from the exposed sewage and the gasses generated from the sewage. This area is known as the “Operations Deck” and currently has no odor control. Odorous air is discharged directly outside. It is recommended that all channels and water surfaces be covered with lightweight aluminum or fiberglass. A small odor control system could be added to create a slightly negative pressure beneath the covers to pull odorous air from the channels and treat it before discharge to the outside, see Figure 5-5. The covers and small odor control system would improve the working atmosphere in the building and help to prevent further corrosion which eventually could lead to costly structural repairs. The covering of the open channels, tanks and equipment as discussed above would also reduce the odor emissions from this area, possibly without the addition of a large odor control system for treating the entire volume of air in the building.

Figure 5-5: Odor Control System

The influent and effluent gates need replacement and new air monitoring equipment in the building is needed to detect Hydrogen Sulfide (H2S), Lower Explosive Limit (LEL), Carbon Monoxide (CO) and Oxygen (O2). The current unit monitors LEL only.

5.2.1.2 Micro-strainers

The micro-strainers are designed to remove the solids in the wastewater that are not removed by the screens and vortex grit removal units. The units are used in lieu of primary clarifiers to further remove solids prior to treatment in the trickling filters. The micro-strainers remove material that is greater than 0.03 inches in diameter. There are six (6) units with internal hot water nozzles for cleaning. The micro-strainers discharge the removed debris to a screw conveyor which conveys the debris to two (2) screenings presses that dewater the material and discharge it to a pipe that dumps into a container located on the deck level.

Four (4) of the six units were replaced in 2010 and the remaining two (2) units were replaced in 2016. The sump pumps are located in the lower area that is difficult to access for maintenance and cleaning and were subject to frequent clogging and. New sump pumps and controls were installed. Chopper type sump pumps were selected due to the debris that is required to be pumped.

5.2.1.3 Trickling Filters and Intermediate Pump Station

The trickling filter system includes the intermediate pump station (IPS) and two (2) 100-foot diameter trickling filters with aluminum covers and 28-foot deep cross-flow type plastic media. The trickling filter system also includes forced air ventilation, two odor control systems and a Recirculation Pump Station. The Intermediate Pump Station pumps micro-strainer effluent plus recirculation flow to the rotary distributors located on the top of each trickling filter. The recirculation pump station pumps recirculation flow to the intermediate pump station, see Figure 5-6.

Figure 5-6: Trickling Filters and Pumps

During FY 2008, the media in the north trickling filter (TF 2) collapsed and the media was replaced by June 2009. In addition, the hydraulically operated rotary distribution mechanism was replaced with a mechanically driven unit and the trickling filter floor and underdrain system were repaired. In FY 2011, inspection of the media in TF 1 revealed that it was in poor condition and sections may have failed. The media in TF 1 was replaced in FY 2012. The failure of the media results in the trickling filter producing an effluent below design performance and above NJPDES discharge permit requirements which, in part, caused the Administrative Consent Order (ACO). The repairs of TF 1 and TF 2 were part of the remedies to satisfy the requirements of the ACO.

The TF recirculation pumps and the intermediate pump station VFDs were replaced in FY 2011. The replacement consisted of installing four (4) new VFDs such that each pump speed is controlled by a dedicated VFD. All four Intermediate Pump Station pumps are reported to have had operational problems. The pumps have been rebuilt several times and will need to be replaced in the next 5-10 years. One of the four check valves at the Intermediate Pump Station was replaced in FY 2009 due to improper seating and severe corrosion and two of the remaining three were cleaned and made operational in FY 2010. All four check valves are being replaced in 2018.

The Intermediate Pump Station pumps the micro-strainer effluent from the Intermediate Pump Wet Well to the Trickling Filters. The wet well is very small and changes in flow quickly fill or deplete the wet well. If the pumps stop for any reason, the wet well rapidly fills and overflows to a catch basin system that returns the overflow to the treatment plant. The pumps are vertical type centrifugal pumps with the motors mounted on the top of the pumps. The pumps are elevated high above the operating floor which makes accessibility for maintenance difficult. Normally, it is recommended that the low level in the wet well be maintained slightly above the volute of the pump to maintain a flooded suction condition and help prevent air binding. The vertical orientation of the pumps causes the pump volute to be significantly higher than the suction piping which reduces the effective volume of the small wet well.

The current odor control system is a wet scrubber type system that uses sodium hypochlorite as the oxidizing chemical, however this system is currenly being removed and will be replaced with a ventilation fan system. Caustic (sodium hydroxide) and the Oxidation Reduction Potential (ORP) control system are not used.

Future capital improvement plans include replacing intermediate pumps and repairing spalled concrete at precast concrete wall panels and joints between panels. A new pump control system (programmable logic controller (PLC) and ultrasonic level meter) are currently being installed.

5.2.1.4 Secondary Clarifiers

There are two (2) 90-foot by 90-foot secondary clarifiers (SC), see Figure 5-7. Each vessel contains 9-feet of water. These units were originally constructed in 1953 as primary clarifiers. The units are equipped with circular sludge collection mechanisms that include corner sweeps. The sludge collection mechanism consists of a set of rakes that push the settled sludge to a center sludge pit where the sludge is removed by the secondary sludge pumps, see Figure 5-8. The secondary clarifiers were upgraded about 10 years ago. The addition of energy dissipating baffles upstream of the secondary clarifiers greatly improved treatment performance of the plant.

Figure 5-7: Secondary Clarifier

Figure 5-8: Secondary Pumping

Secondary sludge is pumped from the clarifiers to a sludge storage tank prior to sludge thickening. The sludge pumping system includes three (3) Wemco vortex type sludge pumps.

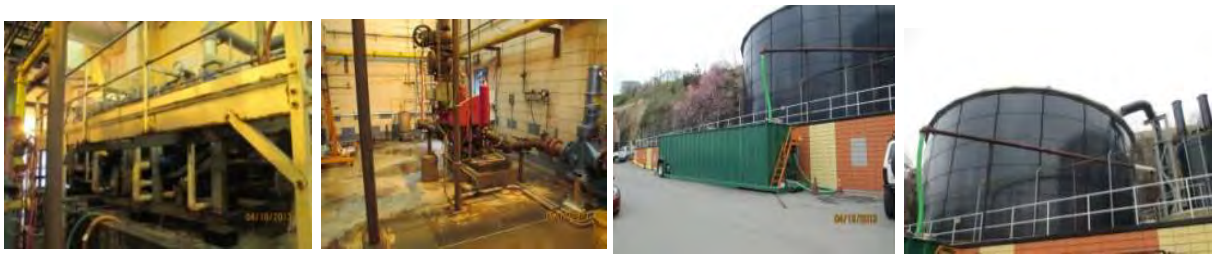
5.2.1.5 Disinfection System

Sodium hypochlorite is used for disinfection and sodium bisulfite is used for de-chlorination in order to meet the chlorine produced oxidants (CPO) permit requirements that were imposed in 2006. Contact time is provided by a chlorine contact tank that is located just east of the secondary clarifiers. Hypochlorite is dosed to the effluent of the clarifiers prior to the chlorine contact tank and bisulfite is dosed at the end of the chlorine contact tank just prior to the flow entering the 54” diameter outfall pipe to the Hudson River. The existing chlorine contact tank (CCT) provides a very short contact time. At 9 MGD flow, the contact time is only 13 minutes which does not meet NJDEP standards. (30 minutes at average flow and 20 minutes at peak flow). The tank appeared to have excessive freeboard that could potentially be used to increase the water depth in the tank and increase the detention time without adversely impacting the plant hydraulics, however calculations demonstrated that increasing the water level would not meaningfully impact the contact time. In addition, there is available space at the southern end of the tank for a potential tank addition to increase the available volume. The size of the chlorine contact tank is inadequate to provide the required contact time for consistent disinfection. In order to achieve the required degree of disinfection, additional sodium hypochlorite is dosed which also requires additional sodium bisulfite for de-chlorination. The sodium bisulfite system includes a tank and pump system, a standby pump and heat traced and insulated chemical feed lines. New chemical feed pumps were installed about 3 years ago. Sodium hypochlorite is stored in four (4) fiberglass storage tanks that are located in the chlorine building, installed during 2016.

5.2.1.6 Solids Handling

Sludge from the treatment plant is limited to the secondary sludge that is pumped from the secondary clarifiers. Secondary sludge is pumped to a single sludge storage tank where it is mixed and aerated. The sludge is then pumped to two (2) belt filter presses that were converted to gravity belt thickeners (GBT) and the sludge is thickened to up to 6.5% solids, see Figure 5-9. The thickened sludge is then stored in a "frac tank" and hauled to the Passaic Valley Sewerage Commission (PVSC) treatment plant in Newark for processing and disposal.

Figure 5-9: Solids Handling



5.3 Performance

FY2017 BOD and TSS removal performance of the River Road WWTP is presented in the table below. The NPDES discharge permit also stipulates routine monitoring of several effluent parameters. These criteria include reporting of maximum and/or average conditions of flow, BOD5, TSS, dissolved oxygen, effluent pH, oil and grease and fecal coliform. The plant demonstrated compliance with 99% of the permit criteria during FY2017, see Table 5-1 and Table 5.2.

Table 5-1: River Road WWTP Monthly Performance, FY2017

	Average Daily Flow	Average BOD5			Average TSS		
Month	Influent (MGD)	Influent (mg/l)	Effluent (mg/l)	Removal Efficiency (%)	Influent (mg/l)	Effluent (mg/l)	Removal Efficiency (%)
Feb. 2016	9.47	123	16	87	145	13	91
Mar. 2016	7.18	164	18	89	184	14	92
Apr.2016	7.13	156	13	92	147	11	93
May 2016	7.58	167	15	91	155	16	90
Jun 2016	7.75	174	16	91	151	12	92
July 2016	8.63	170	17	90	209	18	91
Aug. 2016	8.23	178	16	91	221	17	92
Sept. 2016	8.02	186	16	91	199	15	92
Oct. 2016	7.86	175	20	89	178	20	89
Nov. 2016	7.57	167	20	88	162	18	89
Dec. 2016	8.18	154	22	86	162	20	88
Jan. 2017	8.56	126	22	83	170	23	86
Average	8.01	165	18	89	176	17	90
Maximum	9.47	186	22	92	221	23	93
Minimum	7.13	126	13	83	147	11	86
NPDES Permit Limit	NA	N/A	25	85	N/A	30	85

Table 5-2: River Road WWTP Performance Summary, FY2017

Parameter	**Permit Limit**	**WWTP Operation Data**		
		Annual	Minimum	Maximum
Flow	Report Only	8.01	7.13	9.47
pH Influent, Monthly Maximum	Report Only	8.42	8.1	8.9
pH Influent, Monthly Minimum	Report Only	7.1	6.8	8.9
pH Effluent, Monthly Maximum	9.00 SU	7.6	7.4	7.9
pH Effluent, Monthly Minimum	6.00 SU	6.85	6.4	7.3
TSS Effluent	30 MG/L Monthly Ave.	16.4	11	23
	85 Percent Removal Monthly Ave.	90.5	86	93
CBOD Effluent	25 mg/L Monthly Ave.	17.58	13	22
	85 Percent Removal Monthly Ave.	88.9	83	92
Oil and Grease	10 mg/L Monthly Ave.	4.66	0.70	9.8
Fecal Coliform	200 CFU Monthly Geometric Mean	11.83	1	30
	400 CFU Weekly Geometric Mean	76	3	442
Chlorine	0.13 MG/L Daily Max	0.07	0.02	0.29
Dissolved Oxygen, Minimum Weekly Average	4 MG/L Weekly Ave. Min	8.02	6.34	10.91

SECTION 6

Service Area and Land Uses

Service area and land use were analyzed to delineate and characterize CSO drainage basin areas and subareas for use in developing the hydraulic model and in planning modifications and improvements to NHSA's service area. GIS software was used to obtain, organize, and process the population and land use/land cover data.

6.1 Service Area Drainage Basins

The service area for the River Road WWTP is entirely urbanized land, with land uses shifting from industrial towards higher density residential in recent years. Land uses, zoning and percent impervious characteristics of the study area are described in the following section.

There are nine drainage basins within the service area of the River Road WWTP, shown in Figure 6-1 below and listed in Table 6-1:

Figure 6-1: Basins within the River Road WWTP Service Area

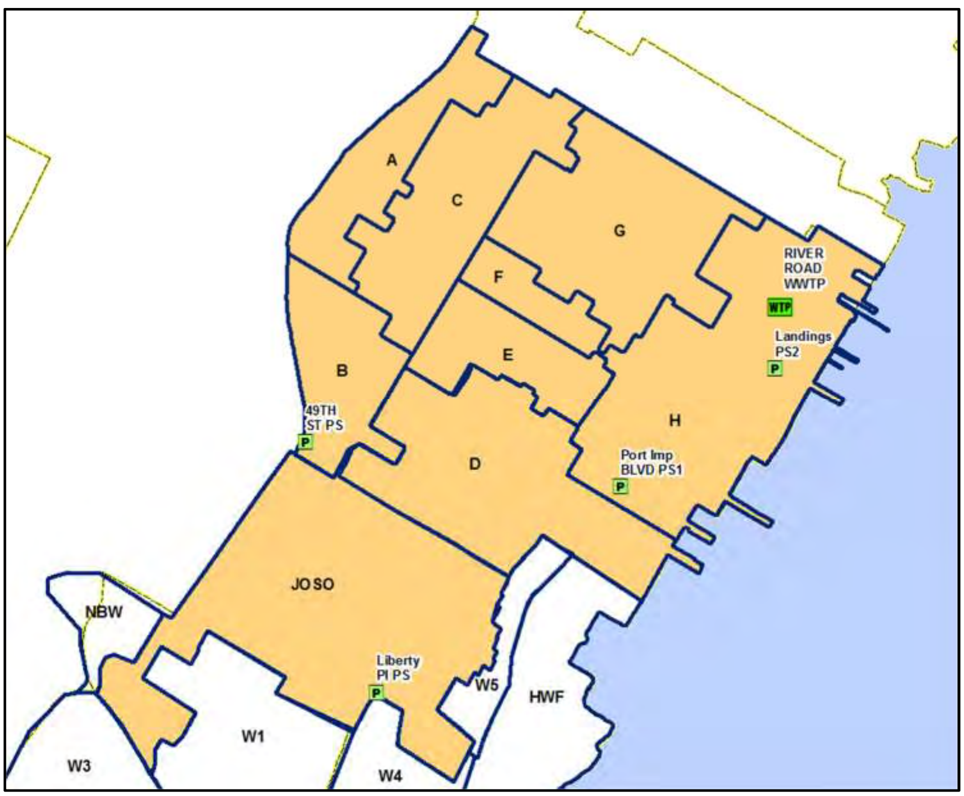


Table 6-1: River Road Basin Areas

Basin	**Area (acres)**
A	53.44
B	53.53
C	85.84
D	122.08
E	44.06
F	22.44
G	108.91
H	167.20
JOSO	205.36
TOTAL	**862.86 acres = 1.35 sq. mi.**

Most of the area is serviced by a combined sewer system, with the eastern portion of Basin H serviced by a separate storm sewer which bypasses the treatment plant.

As shown in Figure 2-1 and Figure 2-2, the basin boundaries do not correspond to the drainage areas for each regulator. The regulator areas are provided in Table 6-2 below. The total regulator area is less than the total basin area because the separately sewered portion of basin H adjacent to the waterfront at the northeast portion of the area does not pass through any of the regulators.

Table 6-2: River Road Regulator Areas

Regulator	**Area (acres)**
UC1	131.50
UC2	212.41
WNY2	136.41
WNY1	376.77
TOTAL	**857.09 acres = 1.34 sq. mi.**

6.2 Land Uses, Zoning and Imperviousness

This section summarizes the land cover characteristics within the River Road service area.

6.2.1 Zoning

As per the Master Plan for the Town of West New York, adopted in January 2015 (see Figure 6-2 and Figure 6-3 for existing and proposed zoning maps from Master Plan) the existing zoning in West New York is primarily medium-density residential with some areas of high-density residential, several commercial corridors and the waterfront zoned as controlled waterfront development. The proposed zoning maintains the controlled waterfront development area, with some of the commercial areas re-zoned as high-density residential. Industrial lands have also been re-zoned as high-density residential, as well as the additional of several parcels re-zoned as public lands. There is also an area in the south-west corner of the town zoned as transit-oriented development which is contiguous to the similarly zoned area in Union City. Two small areas of one- and two-family housing have been preserved.

Figure 6-2: West New York - Existing Zoning

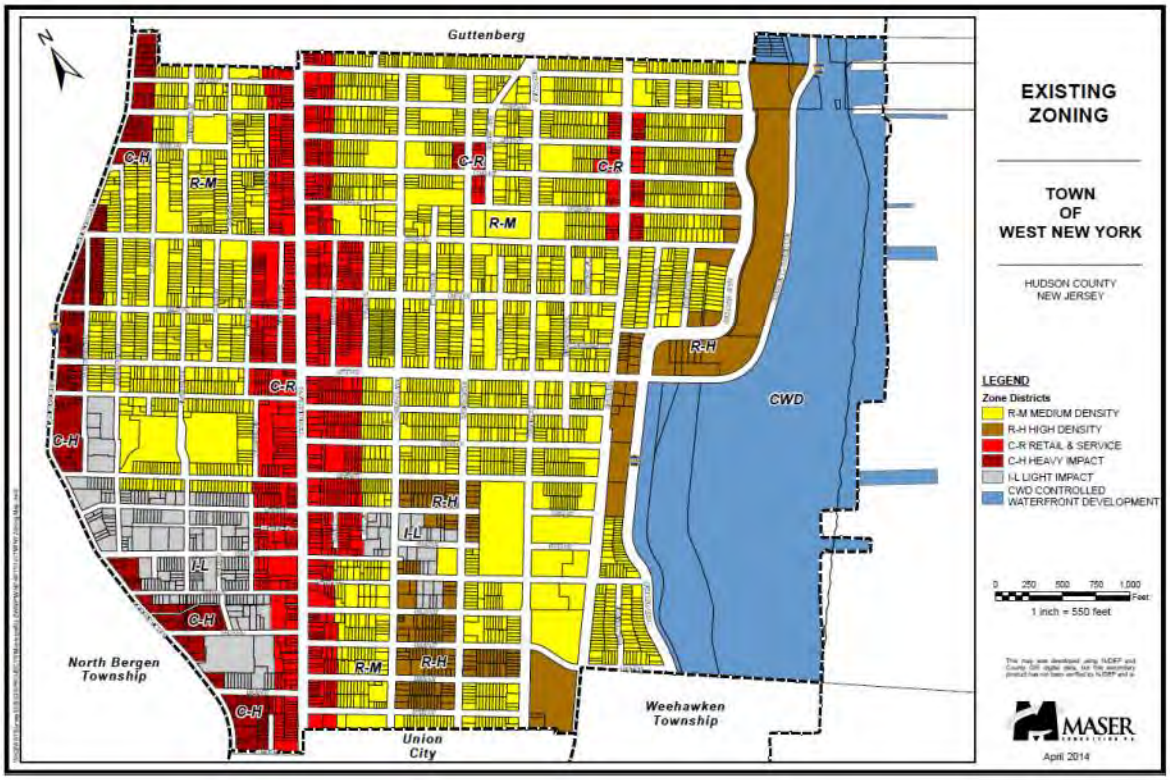
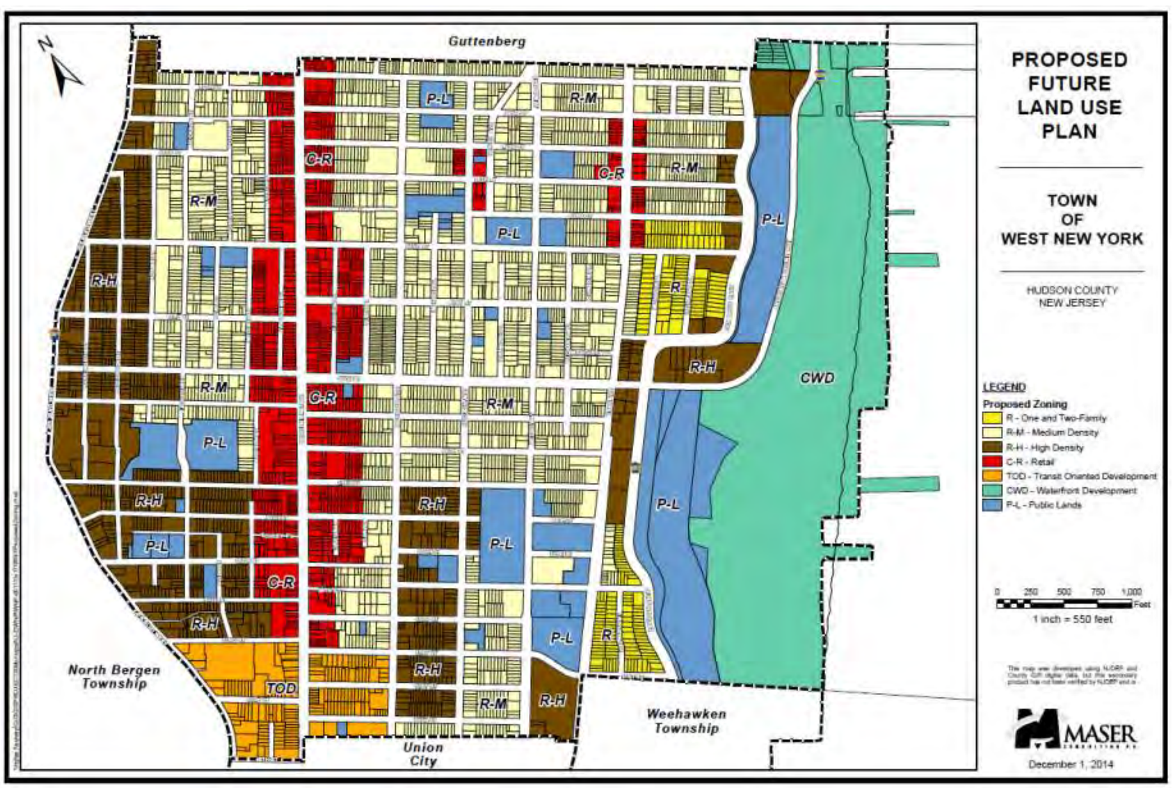
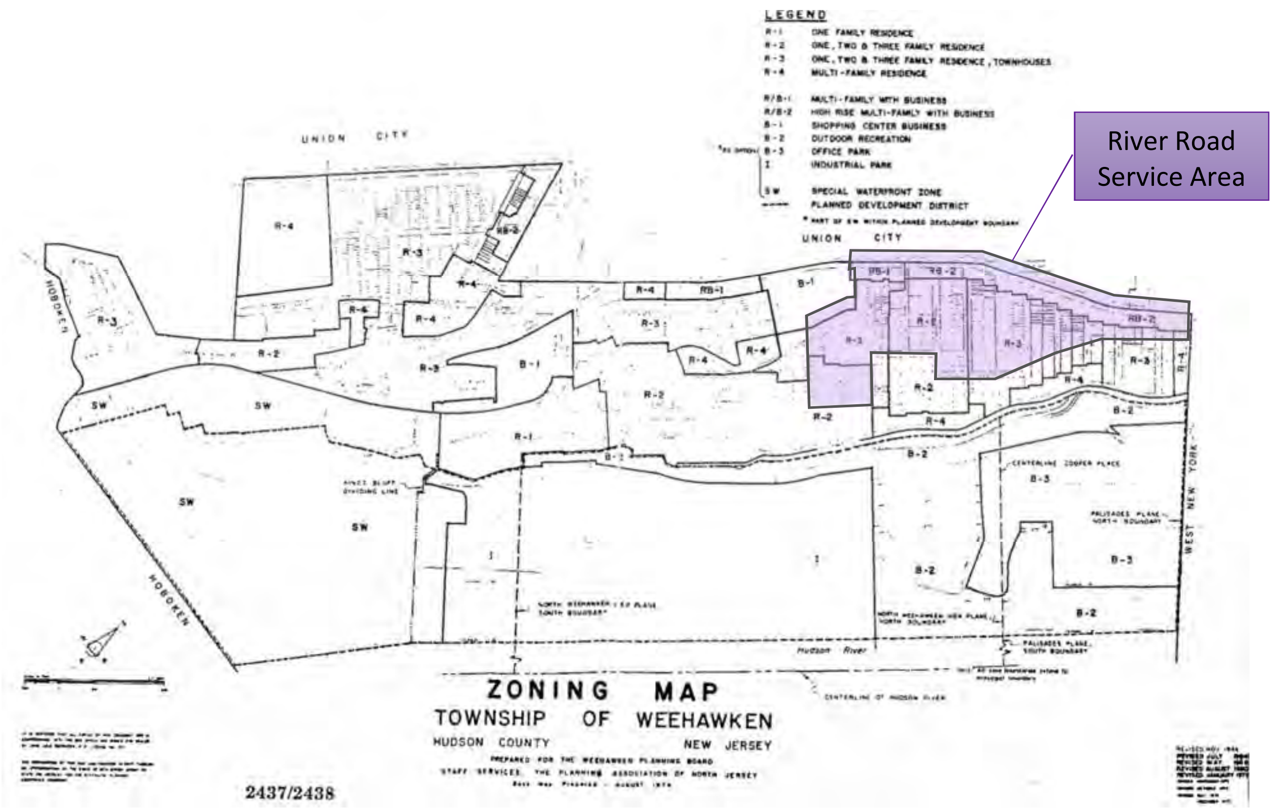


Figure 6-3: West New York - Proposed Zoning



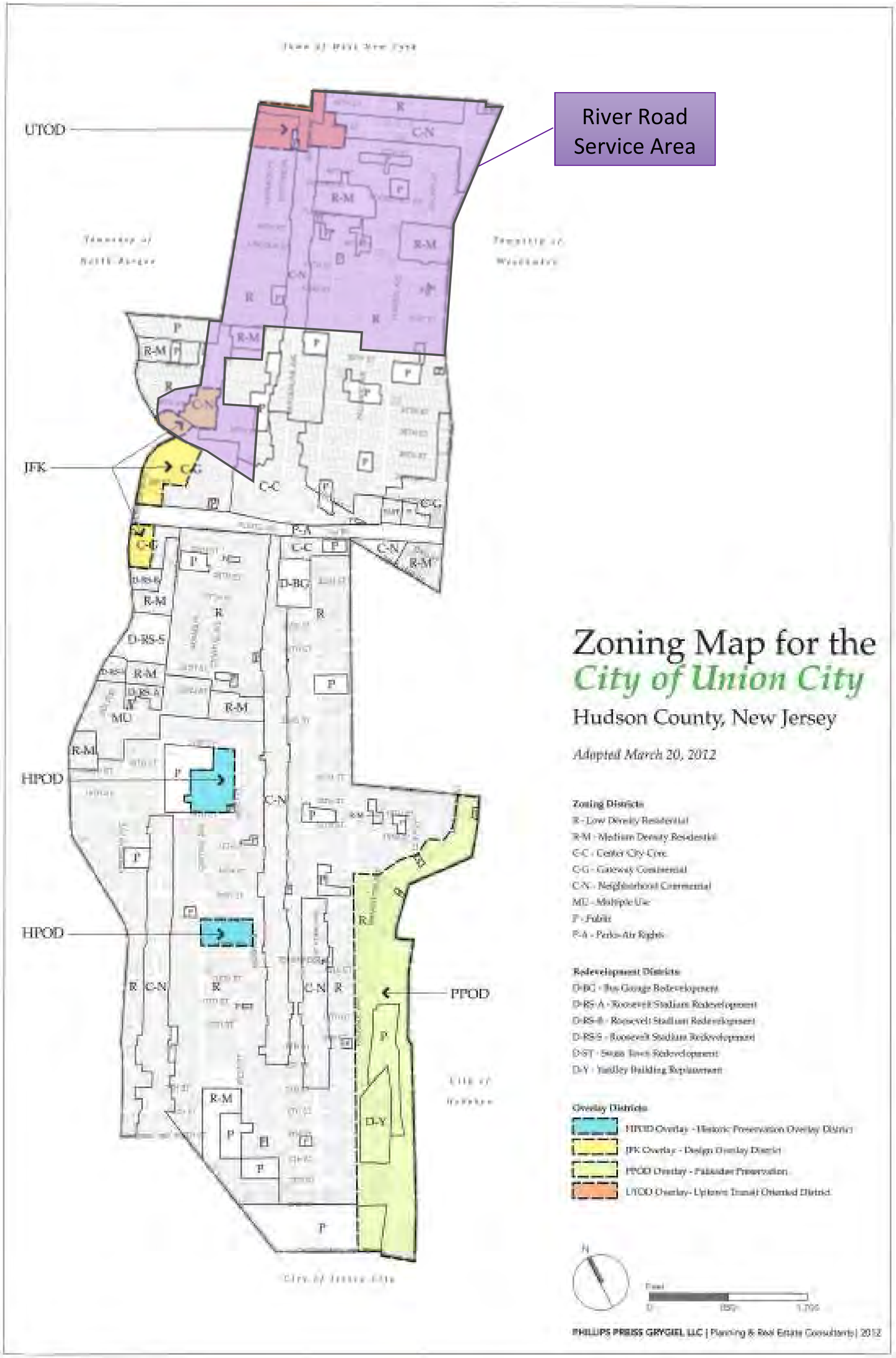
As per the August 1974 Zoning Map (see Figure 6-4) provided by the Township of Weehawken, the area of Weehawken within the service area is zoned as entirely residential. It is primarily R-3 (one, two and three-family residences and townhouses) and R-2 (one, two and three family residence). There are also smaller areas zoned as RB-1 (multi-family with business) and RB-2 (high rise multi-family with business).

Figure 6-4: Weehawken Zoning



As per the 2012 Zoning Map for the City of Union City (see Figure 6-5), the majority of the portion of Union City that falls within the service area of the River Road WWTP is zoned as primarily low-density residential, with a few interspersed areas zoned as medium-density residential and parking. There is also one area of commercial-neighborhood and a section in the north-west zoned as transit-oriented development.

Figure 6-5: Union City Zoning



6.2.2 Land Uses

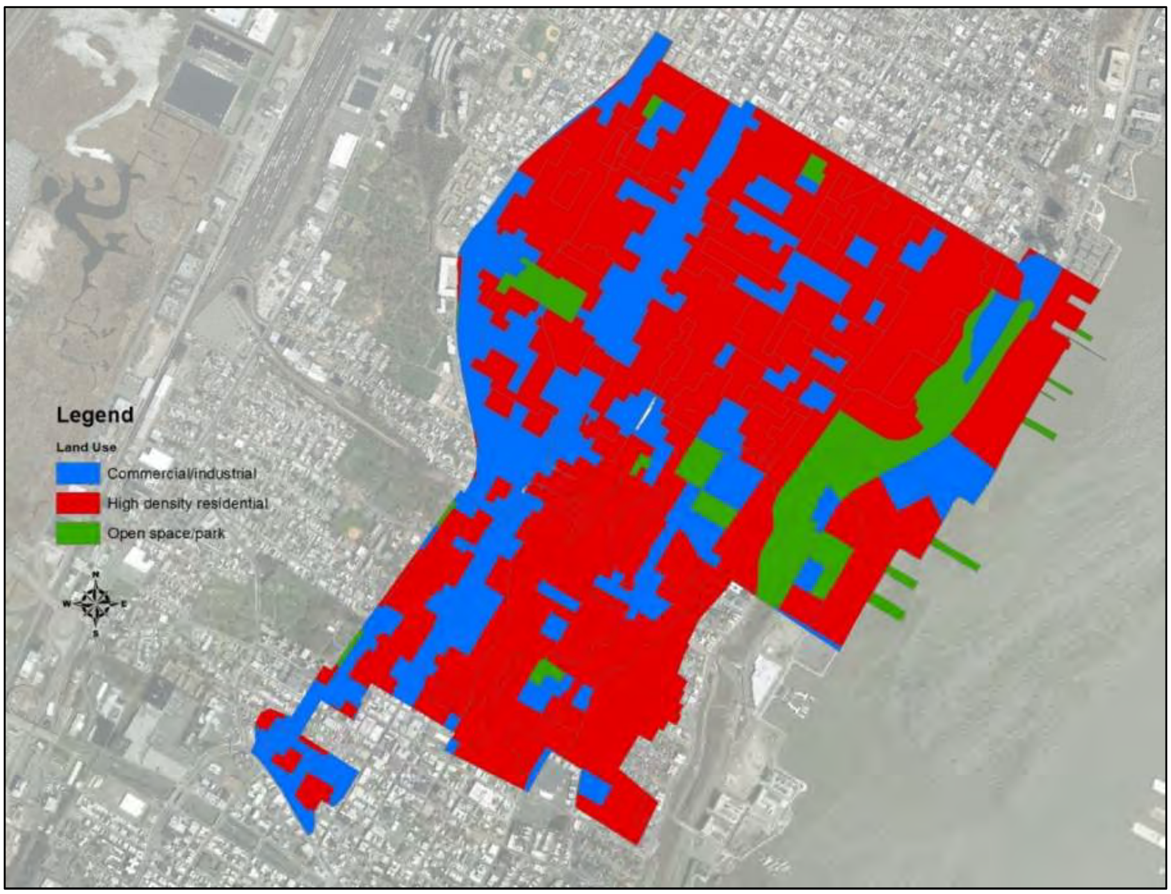
Data from NJ-GeoWeb state database was used to classify land use throughout the total service area based on 2012 land use classifications. As can be seen in Table 6-3 below, the primary land uses in this area are high density residential and commercial/industrial.

Table 6-3: Overall River Road Land Use Areas

Land Use	Area (acres)	Percentage
Low/medium density residential	0	0%
High density residential	554.2	64%
Commercial/industrial	235.8	27%
Open space/park	72.8	8%
Total	**862.8**	**100%**

This categorization is shown in Figure 6-6 below.

Figure 6-6: 2012 Land Use in River Road Service Area



Divided by basin, the land use breakdown is Table 6-4 and Table 6-5 as follows:

Table 6-4: River Road Land by Basin – Areas (acres)

Land Use	A	B	C	D	E	F	G	H	JOSO	Total Area (acres)
Low/medium density residential	0	0	0	0	0	0	0	0	0	0
High density residential	32.9	18.2	50.2	74.1	34.9	18.6	86.2	94.9	144.2	554.2
Commercial/industrial	17.8	35.2	30.9	29.9	9.2	3.9	21.4	28.7	58.8	235.8
Open space/park	2.7	0.1	4.7	18.1	0.0	0.0	1.3	43.6	2.3	72.8
Total	**53.4**	**53.5**	**85.8**	**122.1**	**44.1**	**22.4**	**108.9**	**167.2**	**205.4**	**862.8**

Table 6-5: River Road Land by Basin – Percentages (%)

Land Use	A	B	C	D	E	F	G	H	JOSO
Low/medium density residential	0%	0%	0%	0%	0%	0%	0%	0%	0%
High density residential	4%	2%	6%	9%	4%	2%	10%	11%	17%
Commercial/industrial	2%	4%	4%	3%	1%	0%	2%	3%	7%
Open space/park	0%	0%	1%	2%	0%	0%	0%	5%	0%
Total	**6%**	**6%**	**10%**	**14%**	**5%**	**3%**	**13%**	**19%**	**24%**

6.2.3 Impervious Cover

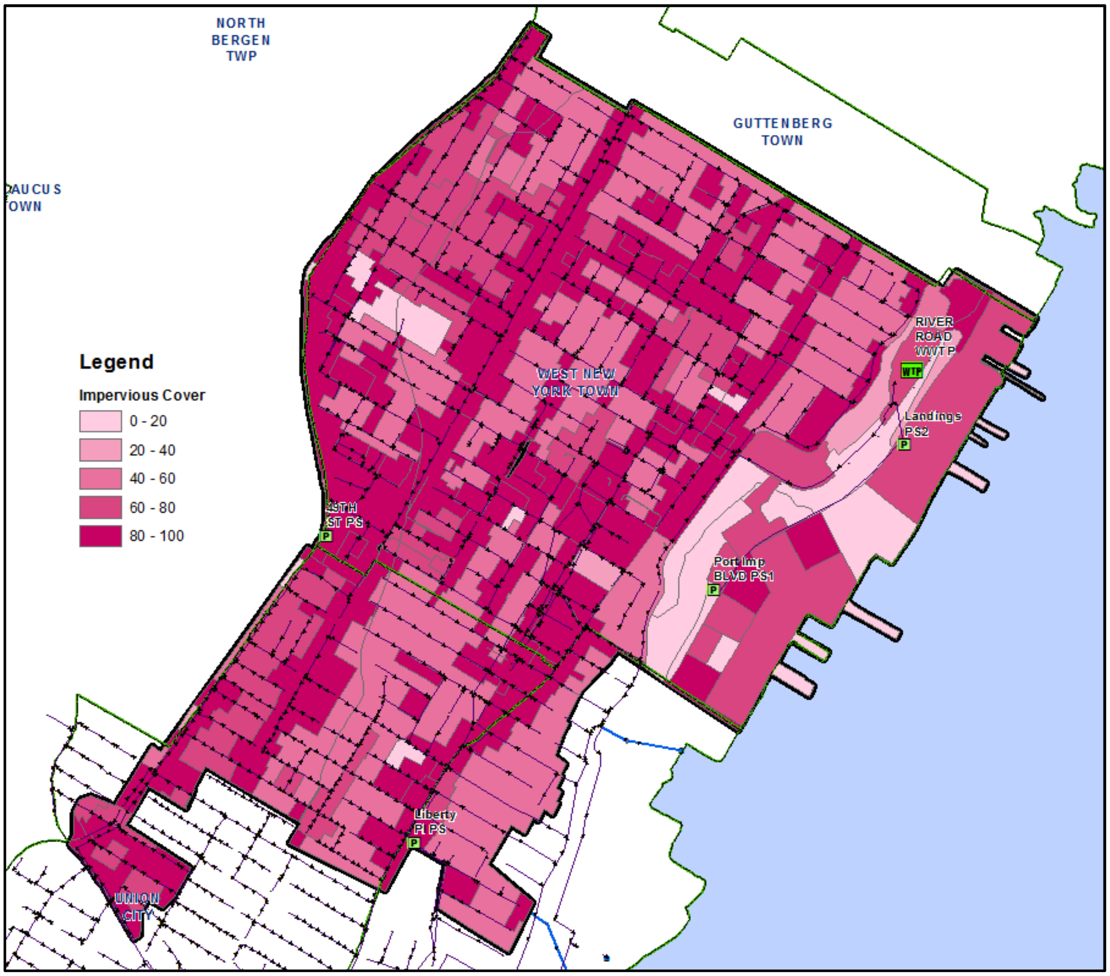
Statewide land use/land cover data is publicly available through the New Jersey Department of Environmental Protection (NJDEP), Bureau of GIS. The latest available data that was used for this study is dated 2012. This data divides all areas by unique land-cover-type polygons and captures the percent imperviousness of each polygon depending on the land-cover type.

The percent impervious attribute of each land-cover polygon in the NJDEP dataset was used to calculate the acreage of impervious and pervious land surfaces for each basin, see Table 6-6. The overall percent impervious was determined as an area weighted average taking into account the area of each basin. Subcatchment areas which are basins sub-divided into areas less than 5 acres, were also analyzed by land use, see Figure 6-7. The overall area is about 78% impervious.

Table 6-6: River Road Impervious Area

Basin	Total Area (ac)	Impervious Area (ac)	Overall Percent Impervious
A	53.44	41.15	77%
B	53.53	46.04	86%
C	85.84	62.66	73%
D	122.08	94.00	77%
E	44.06	32.16	73%
F	22.44	15.48	69%
G	108.91	86.04	79%
H	167.2	135.43	81%
JOSO	205.36	160.18	78%
Overall	**862.86**	**673.15**	**78%**

Figure 6-7: Percent Impervious Cover in River Road WWTP Service Area



6.3 Population and Sewage Flows

All of West New York is within the service area of the River Road WWTP. The US Census indicates that the population of West New York was 49,708 as of April 2010. The population density was 49,363 persons/square mile with a land area of 1.01 square miles. The average household size is 2.64 persons.

A portion of Union City is within the service area of the River Road WWTP. The US Census indicates that the population of Union City was 66,455 as of April 2010. The population density was 51,797 persons/square mile with a land area of 1.28 square miles. The portion of Union City in the River Road WWTP service area is 0.26 square miles. The average household size is 2.88 persons.

A portion of Weehawken is within the service area of the River Road WWTP. The US Census indicates that the population of Weehawken was 12,554 as of April 2010. The area of Weehawken is 0.79 square miles and the portion of Weehawken in the River Road WWTP service area is 0.08 square miles. The average household size is 2.2 persons.

The population distribution within the service area was analyzed on a subcatchment-level basis as part of the process of quantifying the dry weather flow through the system. Population data was obtained for each block in the study area from TIGER (Topologically Integrated Geographic Encoding and Referencing) line files from the US Census Bureau, based on 2010 Census data (Link:

https://www.census.gov/geo/maps-data/data/tiger-data.html). Spatial analysis was performed on this data to develop a population estimate for each subcatchments, as well as the area captured by each of the four meters (metersheds) described in Section 8. The percent increase in population of Hudson County of 6.89% from April 2010 to July 2016 as determined by the New Jersey Department of Labor and Workforce Development was applied to these populations to determine estimates for 2016. These populations were applied to the subcatchments in the model.

The population estimate for each metershed is shown in Table 6-7 below, with a total estimated population of about 73,000 in the service area.

Table 6-7: Total Estimated Service Population

Location	Population
West New York	13,116
Union City	8,710
Weehawken	51,191
Total	**73,017**

6.4 Significant Indirect Users

NJDEP has identified two significant indirect users (SIUs) within the River Road service area, both located in West New York in Basin B, see Figure 6-8.

The first is located at 420 51st Street, in a building operated by Prime Uniform Supply Incorporated (DEP Site ID WNYMUA005), which is a laundering company providing commercial linen, uniform rentals, and cleaning services. They have an air flotation pretreatment system, and they produce a quarterly analysis. Their average daily flow is 9,522 GPD (0.0095 MGD).

The second is located at 543 56th Street, in a building owned by Hill Cross Company (DEP Site ID NJ0145998), which is an electroplating company. They submit discharge monitoring reports to the NJDEP. Their average daily flow is 2,234 GPD (0.0022 MGD).

The wastewater flow from both of these users is directed to regulator WNY2 and then WNY1 further downstream, and they are tributary to the 001A/002A outfall. Given the small flows from the SIUs of approximately 0.01 MGD, no special analysis is required to allocate flow within the collection system model.

Figure 6-8: Locations of Major Indirect Users

6.5 Areas Prone to Flooding

Apart from the seperately sewered area near the waterfront that is described in Section 2.4, there are no other locations in the River Road WWTP service area that are prone to flooding. NHSA staff have confirmed they have not received any reports and are not aware of any observed incidents of flooding related to the combined sewer system within the River Road WWTP service area.

SECTION 7

Infiltration and Inflow Assessment

Flow through the sewer system was analyzed by basin, per capita consumption, average dry weather flow, and estimated infiltration and inflow. This section summarized this analysis.

7.1 Interpreting information from Condition Assessment

As shown in Figure 4-3 of this report, which depicts the results of the RedZone condition assessments, many of the sewers investigated in Weehawken and Union City were categorized as category 4 or 5 on the PACP rating scale, indicating that they are more susceptible to failure. This finding is consistent with the sewer metering results, in which the metered flow tended to be slightly higher than the initially modelled flow, demonstrating that there is likely some inflow/infiltration into the collection system as a result of leakage/damage. The degree of inflow/infiltration as a result of the condition of the collection system is further quantified in the following sections.

In addition, the greatest amount of pipes in poor condition were identified in metershed UC1, which is consistent with the analysis below which shows the greatest amount of groundwater infiltration per inch-mile of sewer relative to the other three metersheds.

7.2 Components of Combined Sewer Flow

Combined sewer flow is assumed to be made up of three components:

- Base Sanitary Flow (BSF) - Dry weather flow (DWF) component that is the residential, commercial, institutional, and industrial flow discharged to a sanitary sewer system. BSF normally varies with water use patterns within a service area throughout a 24-hour period with higher flows during the morning period and lower during the night (diurnal pattern). BSF typically represents the majority of the flows treated at wastewater treatment facilities. It is typically estimated based on population and land use.
- Groundwater infiltration (GWI) - DWF component that represents the infiltration of groundwater that enters the collection system through leaking pipes, pipe joints, and manhole walls. It follows a continuously gradually varying pattern that varies in response to changing seasons or antecedent moisture conditions and usually occurs when the groundwater level is above the sewer invert level. The trends higher in late winter and spring as groundwater levels and soil moisture levels rise, and subsides in late summer or after an extended dry period. It is assumed to be 90% of the observed minimum average night time flow, as per USEPA guidance.

GWI and BSF together comprise the Dry Weather Flow (DWF) that occurs in a sanitary sewer system.

- Rainfall Derived Inflow and Infiltration (RDII) – Wet weather flow (WWF) that enters the collection system through pipe defects, laterals and other entry points

The flow monitoring data collected between May 17, 2016 and November 16, 2016 was disaggregated into these three components as the first step of the model calibration and validation process.

7.2.1 Identification of Dry Weather Days

To separate the DWF component of the flow from the total sewer flow, the dry weather days were identified; these are days with minimal rainfall input to the sewer system and as such, the data recorded by flow meters on these days will primarily reflect sanitary flow and groundwater infiltration inputs.

To facilitate the separation of groundwater infiltration baseflow and sanitary flow, the flow meter data was examined against the rain gage data to identify the dry weather days. For the purposes of this project, dry weather days were defined as:

- Minimum three (3) days of no rainfall following a day with rainfall more than 0.25 inches, OR,
- Minimum two (2) days of no rainfall following a day with rainfall less than 0.25 inches, AND,
- No rainfall on that day itself.

Days with less than 0.02" of rain were considered to as "no rainfall" for this purpose. Using this method, seventy-three (73) dry weather days were identified during the May 19 – November 14, 2016 flow monitoring period (184 days total). Of the 73 dry weather days, fifty-two (52) were weekdays while twenty (21) were weekend days.

Once the dry weather days were identified, the days were split into weekdays and weekends. This breakdown was based upon the fact that InfoWorksICM has the ability to use two (2) diurnal patterns to model sanitary flows. The assumption is that all weekdays exhibit the same flow patterns, as do all weekend days.

The days identified as dry vs. wet weather days are listed in Appendix C.

7.2.2 Dry Weather Flow Analysis

Once the two categories of data were verified, the metered flows for the dry weather days were combined by averaging corresponding time steps together throughout a full 24-hour day. Any data showing notable irregularities was classified as an outlier and not included in the average. These days were identified by visually inspecting the data and looking for days with missing data or data grossly different from the typical trends, for example during the Labor Day long weekend. Once this data cleaning process was completed, average DWF were established for the typical weekday and weekend for each flow meter.

The next step was to extract the groundwater infiltration (GWI) component of the overall DWF. The infiltration component was extracted by assuming the groundwater infiltration was 90% of the observed average minimum night time flows. This is consistent with the USEPA guidance in "Computer Tools for Sanitary Sewer System Capacity Analysis and Planning" dated October 2007 which states that an inferred GWI measurement "can be accomplished where an assumed fraction (usually between 80 and 90 percent in predominantly residential areas) of the minimum diurnal low flows can be attributed primarily to GWI". This is a widely used technique to extract groundwater infiltration from DWF, and is applicable to this primarily residential area.

The difference of the overall DWF and the GWI yields the base sanitary flow (population input). Diurnal patterns for these flows were analyzed for weekday and weekends. The diurnal patterns are represented by hourly peak flow factors that were calculated by the ratio of the flow value for an individual time step to the average value of the entire day. Once all the hourly factors were calculated for all flow meters, these were input into InfoWorksICM model, along with the calculated average sanitary flows and GWI, for dry weather flow generation.

Representative figures from the DWF analysis are shown below in Figure 7-1 through Figure 7-4, see Appendix D for graphs of all meters.

Figure 7-1: Weekday Dry Weather Flow Analysis (UC2)

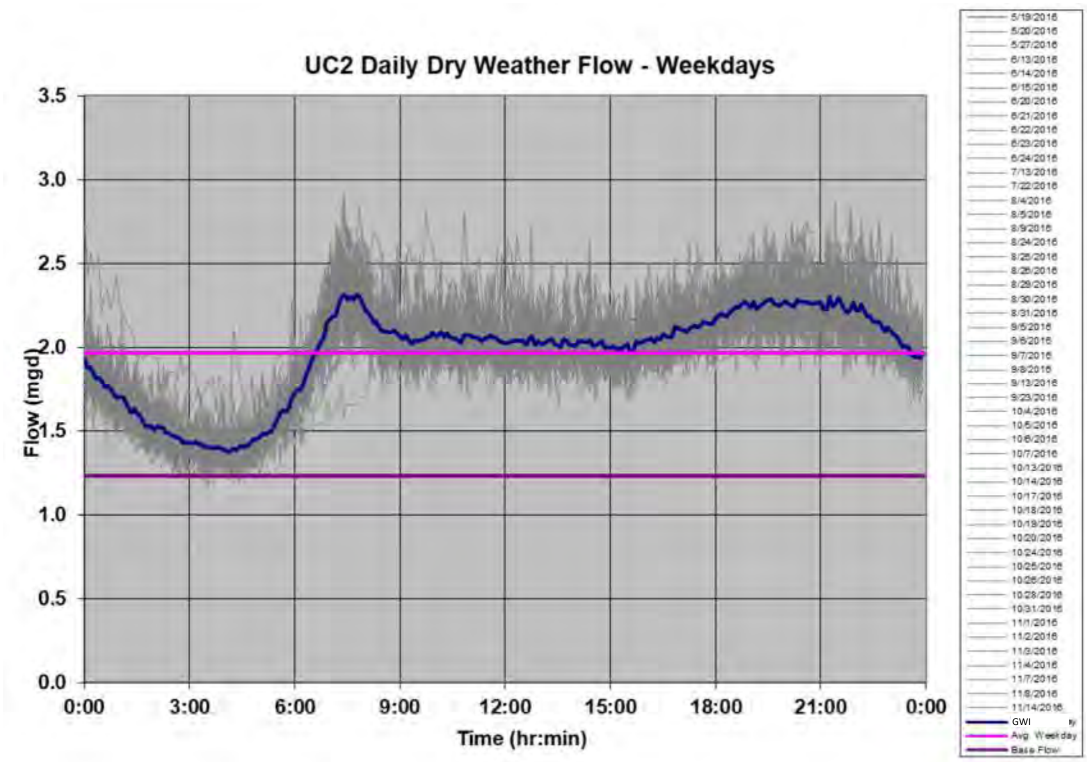


Figure 7-2: Weekend Dry Weather Flow Analysis (UC1)

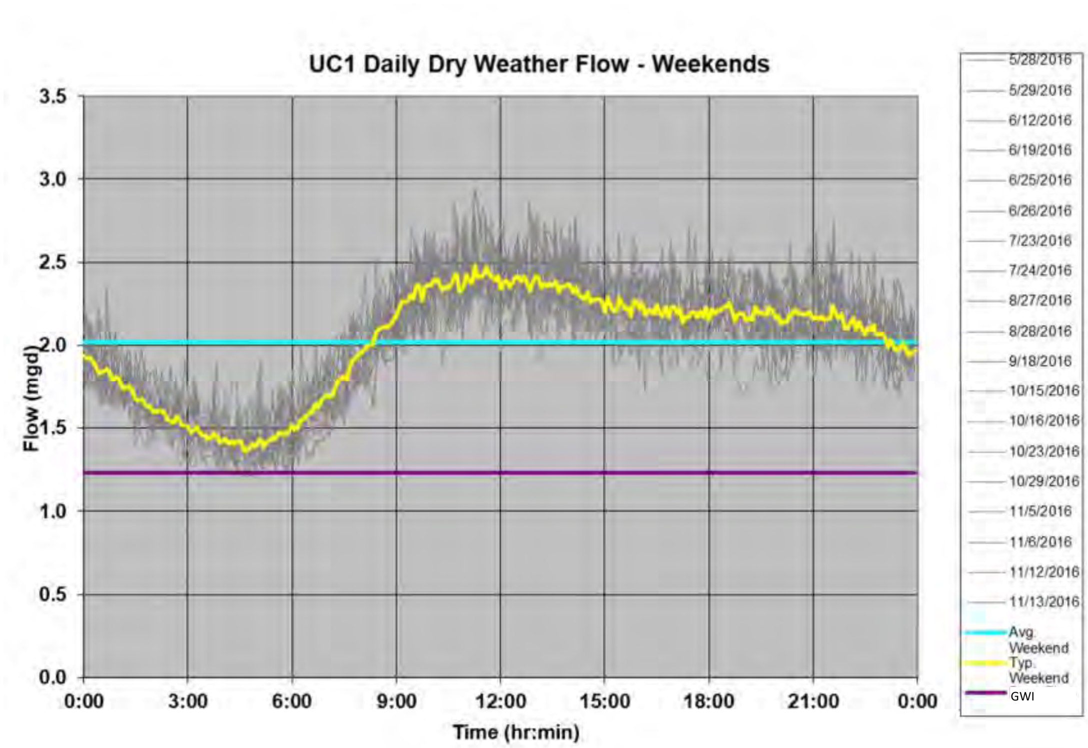


Figure 7-3: Dry Weather Flow Diurnal Peak Factors (UC1)

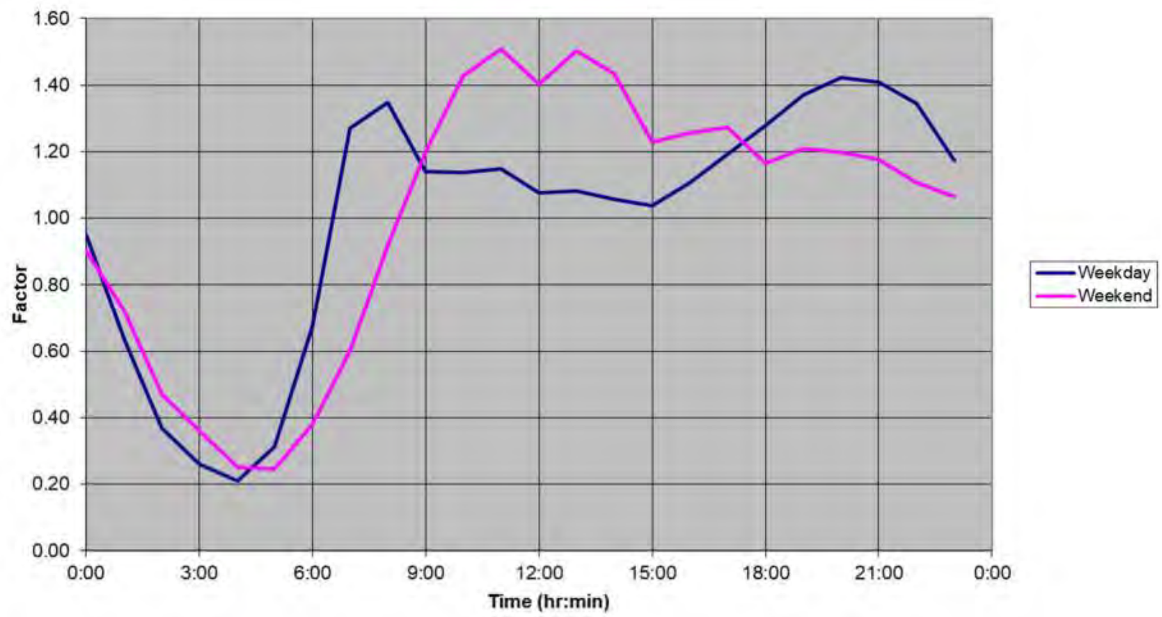
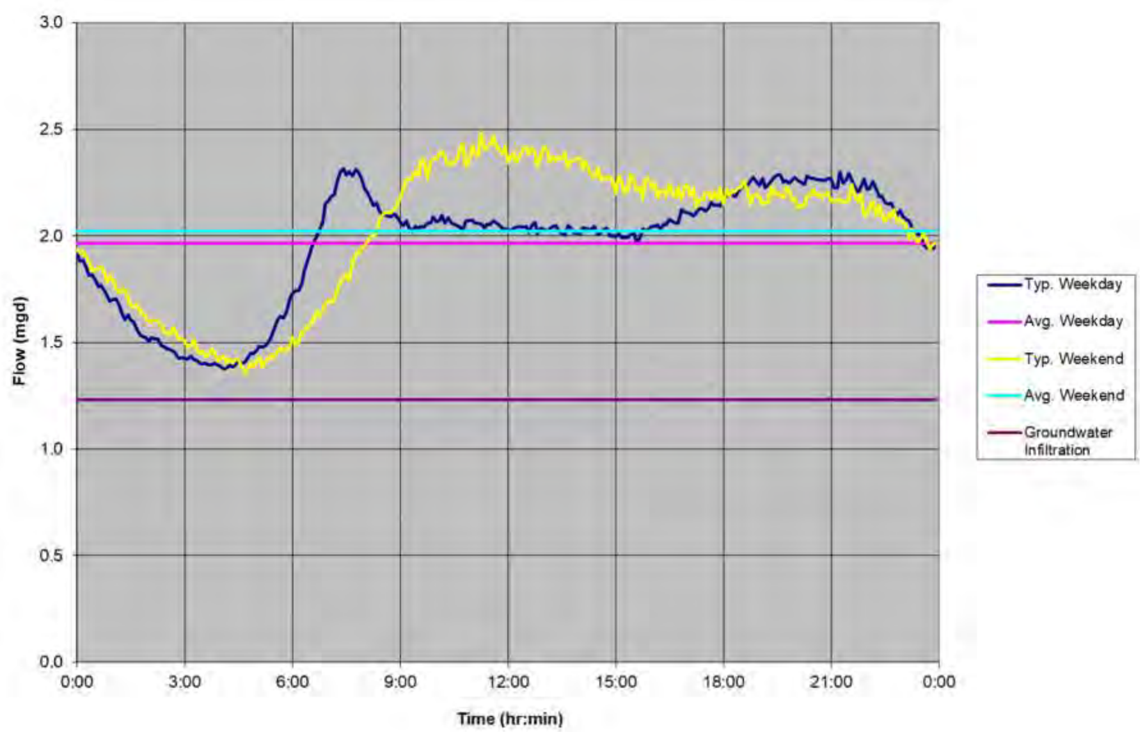


Figure 7-4: Dry Weather Flow Summary (UC1)



A general trend is that the peak flows on a weekday occur approximately before and after work/school hours and on weekends the peak flow occurs later in the day and extends for a longer period. In addition, the average flow is slightly higher on weekends than on weekdays, consistent with people spending more time at home on weekends.

After the volumes and flow patterns were been established for each meter, that information was applied throughout the collection system. In a highly residential area such as the River Road system, distributing the flow by population is appropriate. It is noted that only the River Road combined sewer system was metered and that the combined sewers are pumped directly to the WWTP for these areas.

7.2.3 Population Analysis and Per-Capita Sanitary Flows

As described in the earlier sections of this report, influent sewersheds to the four flow meters were delineated using available GIS and publicly available DEM data. The approach was to correlate the demographic characteristics in the service area to the corresponding flow meter data from which population based flow estimates (sanitary flows, gallons/capita/day) can be estimated.

Population data from the US Census Bureau was used in this study. Census block level population data is publicly available from the US Census Bureau's American Fact Finder web platform. The population count is available for download in table format, while the census blocks are available in GIS format. These two datasets were used to create a GIS spatial layer of the census blocks with total population count in each block. This GIS dataset was compared with the delineated metersheds to calculate total population at each metershed. A visual representation of the US Census Bureau data for the service area is provided in the figure below:

Figure 7-5: Populations in River Road Service Area

Water usage derived from the meter data and the population estimates were used to allocate sanitary flow throughout the system. Once the population count by metersheds were available, this data was correlated with the flow meter data. Previously, as part of the flow meter data analysis, the sanitary component of the overall DWF was extracted (in Million Gallons/day) from the recorded meter data. This value, divided by the metershed population, provides an estimate of the sanitary flow rates at each metershed level in gallons per capita per day (GPCD). Wastewater profiles were created in the collection system model for each of the four unique metersheds. Each such wastewater profile had the GPCD flow estimate as the average sanitary flow, coupled with the diurnal peak factors for weekday and weekends calculated earlier.

The population analysis was re-run with the 232 individual subcatchments, representing the metersheds further delineated into drainage areas less than 5 acres. Each subcatchment was assigned a wastewater profile corresponding to the metershed they fall under. With this, each subcatchment generates sanitary flows utilizing the subcatchment population and the GPCD estimates from meter data. This is shown in Table 7-1 below. It is noted that UC1 flows into UC2, which flows into WNY2, which flows into WNY1. As such, upstream metersheds contribute to the downstream metersheds. To account for this, the upstream flow contributions were subtracted from the downstream meters.

Table 7-1: GPCD Summary

Location	**Original BSF (MGD)**	**Revised BSF (subtracting upstream flows) (MGD)**	**Population (based on data from US Census Bureau)**	**GPCD**
UC1	0.76	0.76	10,886	70
UC2	1.05	0.29	8,522	34
WNY2	1.57	0.52	10,395	50
WNY1	3.08	1.50	37,974	40

7.2.4 Inch-Mile Analysis for Groundwater Infiltration (GWI)

The groundwater infiltration (GWI) was determined for each metershed as described in Section 7.2.2 and the results of this are summarized in Table 7-2 below. The distribution of groundwater infiltration within each subcatchment was estimated by performing an Inch Diameter Mile Length (IDM) analysis. The GWI in each metershed was divided by the inch-mile of pipe in the metershed and a GWI flow rate was determined for each inch-mile of pipe, see Table 7-2. Using spatial analysis in GIS, the length and diameter of sewer in each subcatchment was calculated. This was multiplied by the GWI per inch-mile within the respective metershed to obtain the GWI for that subcatchment, which was representative of the infiltration potential within that area.

Table 7-2: Summary of Sanitary and Groundwater Inflows for Metersheds

Meter #	**GWI (MGD)**	**Revised GWI (subtracting upstream flows) (MGD)**	**In-Miles**	**GWI Baseflow/In-Mile (MGD)**
UC1	1.23	1.23	126.293	0.010
UC2	1.28	0.05	90.679	0.001
WNY2	1.80	0.52	127.708	0.004
WNY1	3.27	1.47	295.072	0.005

The GWI for the UC1 area is much higher than the other areas. This is consistent with the sewer system condition assessment results from RedZone which indicated that the sewers in UC1 are in poor condition.

Hydraulic Collection System Modeling

The Authority developed a hydraulic model of the River Road WWTP service area using existing the GIS database submitted to the NJDEP in 2015. The GIS data is based on field collected data on sewer lengths, elevations, size, material and connectivity. The model calibration and validation process are describing in the following sections.

8.1 Collection System Model

The goal of the modeling process was to create a model that would accurately reflect the combined sewer system's dry and wet weather flow generation and response to conveying flow, and that would provide a basis for evaluating future system improvements and modifications. To understand the existing operation of the combined sewer system and the impacts of future projects, a computer model of the Authority's combined sewer system was developed to serve as a tool to evaluate the "baseline" conditions in the network. The model is intended to be used in the baseline and alternatives evaluation of the typical year. As such the calibration was focused on the rainfall similar to those occurring in the typical year i.e. the model was not calibrated around high-return period storms.

8.1.1 Model Development

The hydraulic model was constructed using the Innovyze Infoworks® ICM computer program, which is a distributed and dynamic rainfall-runoff simulation model that can be used for single event or long-term (continuous) simulation of runoff quantity and quality. It is capable of simulating 1D flow in conveyance links, 2D overland flows and runoff flows in drainage systems, components of which can be represented by using a combination of nodes, links, mesh elements, weirs, orifices etc. available in the program. InfoWorksICM provides the capability to simulate backwater effects, flow reversals, surcharging, looped connections, pressure flows, tidal outfalls, and interconnected ponds by using the full dynamic wave (hydrodynamic) flow routing option. The dynamic wave algorithms solve the one-dimensional unsteady state St. Venant's continuity and momentum equations to produce theoretically accurate results for a drainage scenario. InfoWorksICM is widely used in major combined and separate system modelling throughout the world. The software is capable of loading all physical inputs from a GIS based platform such as a geodatabase or shapefile.

Three types of flow inputs are necessary for combined sewer models, namely, sanitary, storm, and groundwater flows. The components of sewer flow were discussed in further detail in Section 7. Sanitary flows were calculated based on population. Groundwater flows are based on the inch-mile analysis of the network.

Storm flow was applied to the network via subcatchments which are characterized based on land surface, pervious vs. impervious area, which impacts the amount of runoff from the subcatchment than enters the sewer system. Pervious surfaces are considered to infiltrate a portion of the rainfall based on empirical equations (e.g. Horton Equation). The basic premise of such equations is that the portion of the rainfall infiltrated can be estimated based on the characteristics of the underlying soil. Rainfall will continue to infiltrate as long as the intensity of rain is less than the soil absorption capacity. More intense and/or prolonged rainfalls will produce surface runoff which will enter the downstream collection system. Impervious surfaces (e.g. buildings, paved roads) in an urban environment such as the River Road service area are considered as Directly Connected Impervious Areas (DCIA) have only a small amount of initial losses from depression storage, and as a result a major portion of the rainfall will become runoff.

The physical inputs of to the InfoWorksICM model were based on the GIS data that was gathered previously and updated by survey and physical inspection using closed circuit television (CCTV). The GIS data was processed to define connections between sewers and adjacent manholes to form a complete network, and to define pipe sizing in inches, prior to exporting to the model software. Pipe profiles throughout the system were checked in the model to ensure no anomalies or missing information. In addition to filling in missing data, the model was checked to identify any anomalies such as locations of negative slopes, orphan pipes, inconsistent pipe sizes, and inconsistent inverts. Any changes made in the model were flagged with data field flags.

The model's flow inputs were based upon data gathered from the land use and population analysis described in previous sections. Flow data from the meters that were installed at the regulators were used for calibration and verification of the dry weather flow (DWF) and wet weather flow (WWF) estimations from the model.

8.1.2 Model Geometry

The model geometry is made up of pipes, manholes, structures, regulators, pump stations etc. that regulate and/or impact flows in a sewer system. The Authority's GIS dataset of the combined sewer network was obtained from the Authority in June 2017 and was imported into InfoWorksICM for model development. InfoWorksICM has a GIS interface to import/export GIS data to aid in rapid model construction. The manholes and inlets were coded as node objects, while the pipes were coded as links that connect multiple nodes.

The majority of structure and pipe geometry data (size, material, inverts etc.) was available in GIS, however there were instances when certain geometry data could not be obtained due to lack of information in GIS and absence of as-built drawings or survey information. Under such circumstances, the geometry data was inferred based on known data, surveys were conducted to obtain information, or as a last option, assumptions were made. InfoWorksICM can infer (interpolate) missing pipe inverts based on upstream and downstream known inverts, connecting pipe slopes, or known inverts at a connecting structure with multiple pipe connections. This is a reasonable approach, because the pipes are expected to have positive slope downstream. The missing information can be filled in with reasonable assumptions made based on known data. As-built drawings were referenced and field visits were completed to further increase the accuracy of the representation of the system. Some pipes in the system, which may have previously been coded "0" or "-99" in GIS and then re-labeled as "null", were tagged as having inverts about 100 feet above ground level. As such, an inference was designed in the model to interpolate these pipe inverts. Data field flags were used to identify where pipe elevation data was interpolated or if any changes or assumptions based on sound judgement were made that differed from what was in the original GIS.

Once the initial model geometry was determined, the project team met with operations staff from the Authority on January 31, 2018 to discuss the model and clarify any operational requirements as well as assumptions that were made to ensure that the model provides an accurate representation of the system. Operations staff indicated that UC1, UC2, WNY2 are all static regulators and are not adjustable, while regulator WNY1 has a float operated regulator mechanism to limit flows to 18 MGD. The operation of the gate was represented in the model as a customized hydraulic structure. Operations staff indicated that there is no chronic flooding in this drainage basin due to elevations, and that there is a JOSO drop structure located at the end of Liberty Street. They confirmed that flow from the Port Imperial pumping station is conveyed directly to the plant. This information was incorporated into the model.

8.1.2.1 Pipe Roughness

Hydraulic roughness, which is represented by the Manning's roughness coefficient ("n"), accounts for the effect on the resistance to flow of pipe materials, irregularities, debris, and other obstructions. Flow through pipes can incur a higher headloss depending on the roughness. As such, it is important to capture the roughness accurately in a system to properly identify the flow patterns.

Pipe roughness was assigned to links in the model based on pipe materials identified during the GIS dataset development, as shown in Table 8-1 below.

Table 8-1: Summary of Manning's Roughness Coefficients Used in Model

Pipe/ Lining Material	**Label**	**Manning's N used in Model**	**Source of Manning's N**
Clay/ Terracotta Pipe	VCP	0.014	NJDOT Drainage Design Manual
Brick Pipe	BRK	0.015	NJDOT Drainage Design Manual, VT chow
Reinforced Concrete Pipe	RCP	0.012	NJDOT Drainage Design Manual
Concrete Lining	CONC	0.012	VT Chow
Cured-in-Place Pipe	CIP	0.012	Same as RCP and Concrete Pipe
Ductile Iron Pipe	DIP	0.013	http://www.concretepipe.org/wp-content/uploads/2014/09/DD_10.pdf

As noted in Section 3, pipe materials were mainly unknown in West New York. Because the majority of the surrounding sewers in Union City and Weehawken are known to be VCP, it was assumed that the sewers in West New York are also made of VCP and the Manning's number was assigned to these pipes accordingly in the model.

8.1.2.2 Subcatchments

Publicly available Digital Elevation Model (DEM) data from US Geological Survey National Elevation Dataset as well as the GIS dataset representing the pipe network was analyzed to divide the study area into subcatchments having drainage areas of typically five acres or less.

232 subcatchments were delineated within the River Road drainage area, having areas of less than 5 acres each. The goal of this was to strategically divide the area into smaller subcatchments so that the model could be used to evaluate hydraulic characteristics of smaller areas efficiently. A figure depicting the delineation of the 232 subcatchments is provided in Figure 8-1.

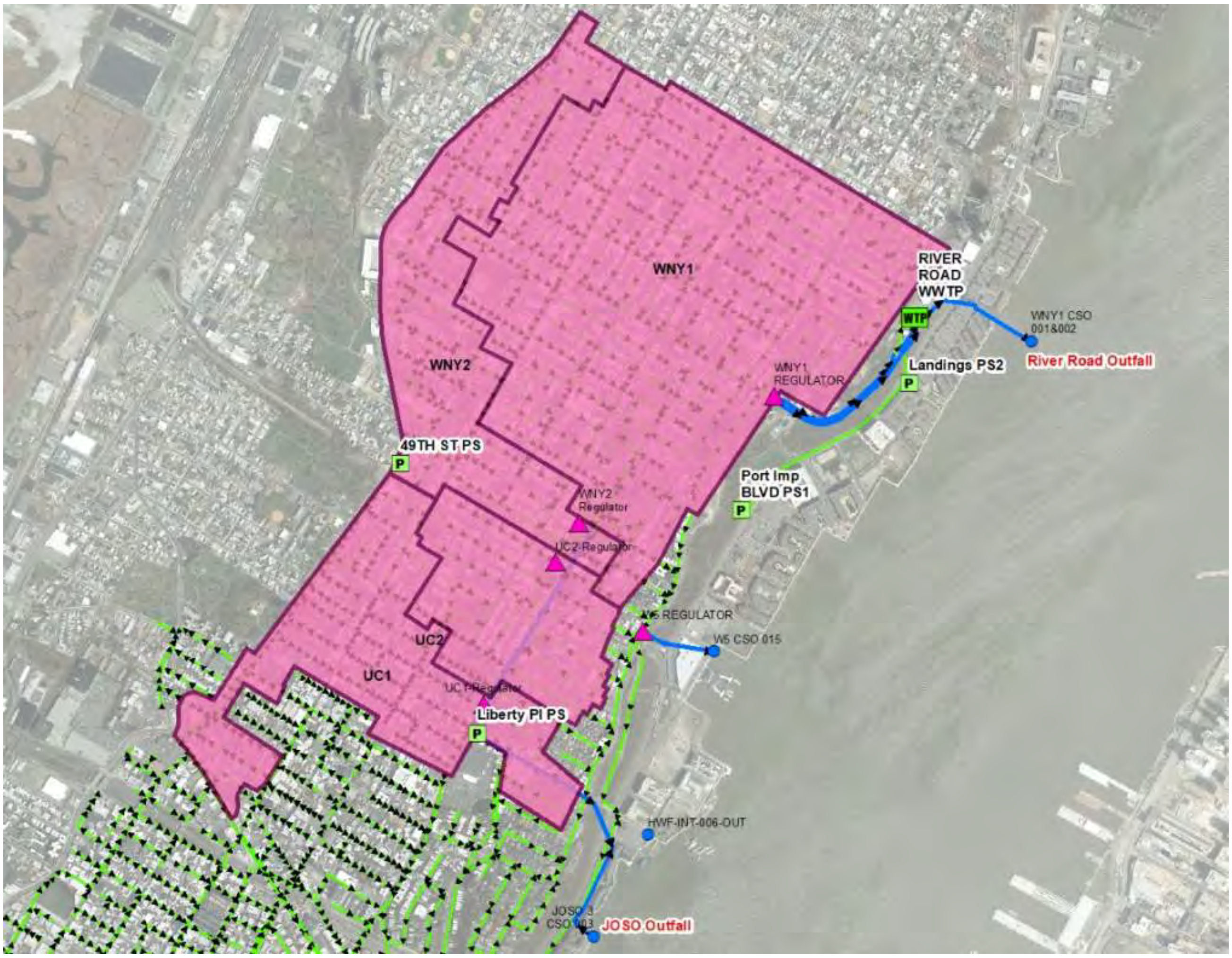
Figure 8-1: Subcatchments Delineation

The large subcatchment located immediately south of the River Road WWTP represents the separately sewered area at the base of the Palisades. This area is connected directly to the plant node in the model, thus does not impact the flow through the regulators or CSO flow estimations.

The subcatchments were parameterized with the population, land cover and GWI baseflow information that was determined in previous sections. Slopes of the subcatchments range primarily from 0% to 6%, with a couple of steeply sloped subcatchments (12.5% and 39.3%) at the northwest end of the service area where there are steep drops in elevation.

Figure 8-2: representing the drainage areas to the four meters is presented below:

Figure 8-2: River Road Metersheds



8.1.2.3 Pumping Stations

Only the Liberty Street pumping station is represented in the model. The Port Imperial pumping station and Landings pumping station convey combined sewer flow from the homes at the base of the Palisades up to the WWTP. This flow is conveyed directly to the WWTP, so was not represented in the model as it has no impact on the occurrence of CSO events. There was no information on the pump curves at the 49th Street Pump Station and because it services only a few commercial buildings, it was not included in the model.

8.1.2.4 Regulators

Hydraulic flow control structures, such as regulators divide the incoming flow based on the elevation of the hydraulic grade line at the upstream side of the structure. For a combined sewer system, accurate depiction of such structures is important since the hydraulic model computes system overflows based on the flow hydraulics at these structures.

The River Road regulators consist of side flow weirs and a short segment of reduced pipe size. Refer to the regulator sketches in Section 3. As the level of the incoming flow increases inside the structure, when the water level exceeds the top (crest) of the weir, a portion of the flow is diverted to an outfall.

For the purposes of hydraulic modeling, flow regulators were modeled using weir links to capture the flow split in the system. Under dry weather flow conditions, the incoming flow passes through the regulator and the overflow line is dry. Under wet weather flow conditions, when the hydraulic grade line inside the structure is higher than the crest of the weir, a portion of the flow overtops the weir and continues to flow through the overflow line. All four regulators are included in the model and the modelled discharge coefficients are presented below:

Table 8-2: Regulator Characteristics in Model

Regulator	Discharge Coefficient
UC1	0.50
UC2	0.53
WNY2	0.53
WNY1	0.80

It is noted that elevations of the outfall pipes were inferred in the model based on known elevations, however this would not have any hydraulic impact because of the steep drop in ground elevation of the land between the regulators and the outfall elevations. Because of the steep drop in elevation, tidal impacts on the outfalls were not considered in this study.

8.2 Rainfall Data Analysis

Precipitation is one of the model forcing functions in a rainfall-runoff simulation. Stormwater runoff generated and entering the sewer system is directly dependent on the amount of precipitation and its intensity, both of which may vary spatially for a large storm system. Even for small sewersheds, runoff generation and consequent model predictions may be very sensitive to spatial variations of the rainfall. For instance, thunderstorms (convective rainfall) may be highly localized, and nearby rain gages may have very dissimilar readings. While rainfall may be spatially variable over any area, given the study area size of 1.4 square miles the use of a single gauge was considered appropriate.

The total sewershed area that contributes flows into the River Road combined sewer system is approximately 900 acres (1.4 square miles). Table 8-3 below summarizes the start and end times, depth, duration and maximum 1-hr and 15-min rainfall intensity of the rainfall events measured by the rain gauge over the monitoring period of May 17, 2016 to November 16, 2016.

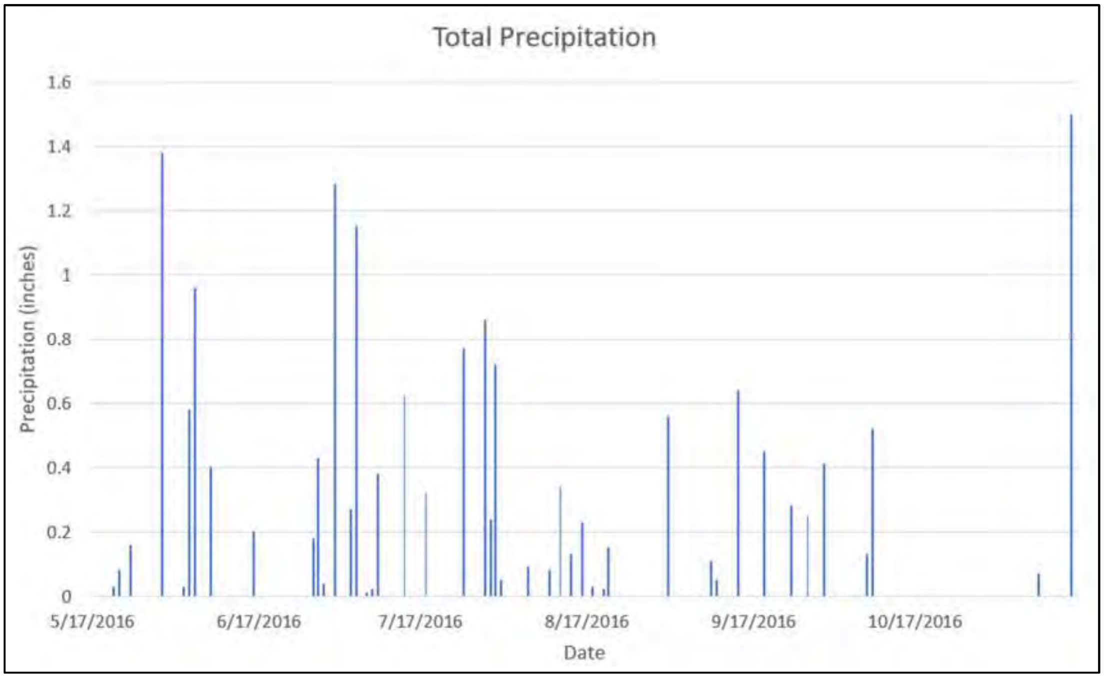
The rain gauge was not working for a period of time in October 2016, thus the three storms that took place during this time are not shown below. The values listed in the table below are based on the rain gauge data. It is noted that some of the information in the table below such as start and end times may differ from the calibration storms listed in Appendix D, to account for any time lag between dry weather flow and wet weather flow based on the runoff hydrographs.

Table 8-3: Start and End Times of Rainfall Events and Calculated Intensities

Storm #	START DATE	END DATE	START TIME	END TIME	RAINFALL DEPTH (IN)	RAINFALL DURATION (HRS)	AVG RAINFALL INTENSITY (IN/HR)	MAX 1-HR RAINFALL INTENSITY (IN/HR)	MAX 15-MIN RAINFALL INTENSITY (IN/HR)
1	5/21/2016	5/22/2016	19:30	6:20	0.11	10.83	0.01	0.05	0.12
2	5/24/2016	5/24/2016	2:40	9:20	0.16	6.67	0.02	0.05	0.12
3	5/30/2016	5/30/2016	1:20	10:40	1.38	9.33	0.15	0.85	1.68
4	6/3/2016	6/3/2016	8:40	9:00	0.03	0.33	0.09	0.03	0.08
5	6/4/2016	6/5/2016	19:10	20:05	1.54	24.92	0.06	0.49	1.4
6	6/8/2016	6/8/2016	12:55	16:25	0.40	3.50	0.11	0.27	0.36
7	6/16/2016	6/16/2016	4:25	8:10	0.20	3.75	0.05	0.17	0.36
8	6/27/2016	6/29/2016	21:35	1:10	0.65	27.58	0.02	0.31	0.72
9	7/1/2016	7/1/2016	15:45	22:20	1.28	6.58	0.19	0.87	2.28
10	7/4/2016	7/5/2016	20:45	5:35	1.42	8.83	0.16	0.81	2.04
11	7/9/2016	7/9/2016	22:20	23:30	0.38	1.17	0.33	0.35	0.96
12	7/14/2016	7/14/2016	16:05	16:30	0.62	0.42	1.49	0.62	1.64
13	7/18/2016	7/18/2016	16:45	17:35	0.32	0.83	0.38	0.32	0.92
14	7/25/2016	7/25/2016	16:10	20:10	0.77	4.00	0.19	0.48	1.04
15	7/29/2016	7/29/2016	1:15	9:20	0.86	8.08	0.11	0.31	0.48
16	7/30/2016	7/30/2016	15:45	21:35	0.24	5.83	0.04	0.11	0.16
17	7/31/2016	8/1/2016	8:35	0:50	0.77	16.25	0.05	0.49	1.44
18	8/6/2016	8/6/2016	16:30	16:35	0.09	0.08	1.08	0.09	0.36
19	8/10/2016	8/10/2016	12:50	13:15	0.08	0.42	0.19	0.08	0.2
20	8/12/2016	8/12/2016	0:15	19:05	0.34	18.83	0.02	0.28	0.56
21	8/14/2016	8/14/2016	19:25	19:35	0.13	0.17	0.78	0.13	0.52
22	8/16/2016	8/16/2016	16:25	20:55	0.23	4.50	0.05	0.17	0.64
23	8/18/2016	8/18/2016	4:45	5:20	0.03	0.58	0.05	0.03	0.08
24	8/21/2016	8/21/2016	4:50	21:40	0.15	16.83	0.01	0.06	0.24
25	9/1/2016	9/1/2016	1:15	15:25	0.56	14.17	0.04	0.33	0.8
26	9/9/2016	9/10/2016	21:55	23:30	0.16	25.58	0.01	0.10	0.4
27	9/14/2016	9/14/2016	10:10	18:20	0.64	8.17	0.08	0.62	2.12
28	9/19/2016	9/19/2016	6:25	15:20	0.45	8.92	0.05	0.20	0.24
29	9/24/2016	9/24/2016	0:50	5:20	0.28	4.50	0.06	0.24	0.36
30	9/27/2016	9/27/2016	2:20	10:45	0.25	8.42	0.03	0.18	0.32
31	9/30/2016	9/30/2016	10:05	23:00	0.41	12.92	0.03	0.10	0.12
32	10/8/2016	10/9/2016	14:20	12:50	0.65	22.50	0.03	0.16	0.24
33	11/9/2016	11/9/2016	11:30	19:00	0.07	7.50	0.01	0.03	0.04
34	11/15/2016	11/15/2016	4:05	16:50	1.50	12.75	0.12	0.37	0.6

Figure 8-3 below shows the precipitation totals for each day during the monitoring period.

Figure 8-3: Daily Precipitation Totals (inches)



Based on experience with local rainfall patterns and definitions in the QAPP, rainfall events with a broad distribution of total rainfall volume and peak 15 min intensities were used for calibration. A preference was applied towards larger events that would allow the model to be calibrated most accurately around events similar to the 5th largest storms event. Events were selected for calibration based on:

- Depth
  - Low <0.50 inches
  - Medium 0.50-1.50 inches
  - High >1.50 inches
- 15 min intensity
  - Low intensity <0.25 in/hr
  - Medium Intensity 0.25>0.65 in/hr
  - High intensity >0.650 in/hr

The following storms were selected for calibration:

- May 30, 2016 high volume (1.38 inches) high intensity (1.68 in)
- September 19, 2016 low volume (0.45 inches) low intensity (0.24 in/hr)
- September 24, 2016 low volume (0.28 inches) medium intensity (0.36 in/hr)
- November 15, 2016 high volume (1.50 inches) medium intensity (0.60 in/hr)

Similarly, storms were selected for validation:

- July 1, 2016 high volume (1.28 inches) high intensity (2.28 inches)
- September 14, 2016 medium volume (0.64 inches) high intensity (2.12 in/hr)
- October 8, 2016 medium volume (0.65 inches) low intensity (0.24 in/hr)

8.3 Model Calibration

The usefulness of a computer model representation of a sewer system is dependent upon how well the model can simulate the real-world performance of the combined sewer system. To formulate a model that closely matches measured values, a process of calibration and validation was performed to refine the model input parameters to best match the flow meter data collected in the field. The first step, which has been described in the previous sections was to provide the model with the most accurate input data available. Calibrating a sewer collection system model consists of changing various characteristics of the sewer conveyance network and sewersheds in the hydraulic model to achieve close agreement between calculated and observed flows, depths and velocities based on the monitoring data collected during the monitoring program. It is also critical that the model accurately reproduce the flow monitoring data collected at the regulators. The calibration process typically takes multiple time periods from the flow monitoring data and refines the model input parameters to achieve a good fit with the measured data across a wide variety of system conditions (i.e. wet weather calibration will typically involve selecting storms of different intensity and durations).

Calibration was performed in two stages. The first stage was completion of dry weather flow (DWF) calibration to ensure the hydraulics of the model operate similar to the actual sewer system under typical dry weather (sunny day) conditions. Only minor model adjustments were needed for the hydrologic and hydraulic model to accurately reproduce the DWFs since the DWF inputs were directly calculated from the flow meter data and known population statistics. After successfully completing DWF calibration, the model was evaluated under wet weather conditions as the second stage. Wet weather calibration ensure the hydraulic model accurately mimics the sewer system's response to rainfall. Since the hydrologic factors that affect wet weather flow generation are more complex, more user adjustment of variables to achieve an acceptable agreement between the model predicted output and the observed flow meter data was needed. The overall goal of the model calibration process was to adjust the internal parameters so that the model calculations of flow, velocity, and depth match the observed flow monitoring data collected from the observed rain events. The River Road model was calibrated using a continuous simulation that covered a range of conditions.

Different monitored rainfall periods were utilized for the calibration to ensure the model could represent a range of varying rainfall conditions. In addition, the model was run continuously over the calibration period and compared against the collected flow monitoring data. This calibration method was devised to provide a hydraulic model that is accurate in long-term continuous simulations for watershed and long-term control planning.

After the model was successfully calibrated under dry weather and wet weather conditions, it was verified under conditions not used during model calibration. This verification process confirmed the expected performance of the model under rainfall conditions separate and distinct from the data used for calibration. It is important to verify the model under a wide range of possible dry weather and wet weather conditions to ensure model calculation confidence under a broad range of rainfall and seasonal conditions. The storms used to verify the model are storms not used during calibration.

8.3.1 Dry Weather Flow Calibration

Succesful calibration was based upon matching the dry weather period as described earlier. Statistical criteria shown in Table 8-3 below, based on the industry standard Chartered Institution of Water and Environmental Management (CIWEM) Code of Practice for the Hydraulic Modelling of Urban Drainage Systems, Version 01, November 2017. CIWEM is the successor document to the WAPUG criteria typically applied to collection system network modeling. These standards were applied to give a numerical evaluation of each flow meter used for model calibration and verification. In addition, some "common sense" checks like no overflows during dry weather days were also employed during this process. Table 8-4 summarizes the CIWEM criteria for DWF calibration.

Table 8-4: CIWEM DWF Calibration and Validation Criteria

Criteria	Calibration Range	Notes
Peak Flow Rate	±10% or 0.1MGD	Use of actual value instead of percentage applied to meters with very small flows
Volume	±10% or 0.1MGD	Use of actual value instead of percentage applied to meters with very small flows
Timing of Peaks	±1 Hour	For both peaks (high flows) and troughs (low flows)
Depth	0.33 feet to +0.33 feet of observed peak depth	
Shape	The shape of the measured and simulated curves should be similar for flow and depth	

8.3.2 Depth Calibration

Initially, there was a discrepancy between the metered and modeled flow depth in spite of good agreement between the flows. The metered scattergraph was reviewed and it was determined that the flow velocity would drop to zero before the depth reached zero, as shown in Figure 8-4 through Figure 8-6. There are several potential causes for this, both of which relate to a downstream obstruction, either in the form of an adversely sloped pipe or sediment. Portions of the interceptor blocked by sediment were simulated in the to the modeled pipe profiles to replicate this effect.

Figure 8-4: UC1 Depth Versus Velocity Plot

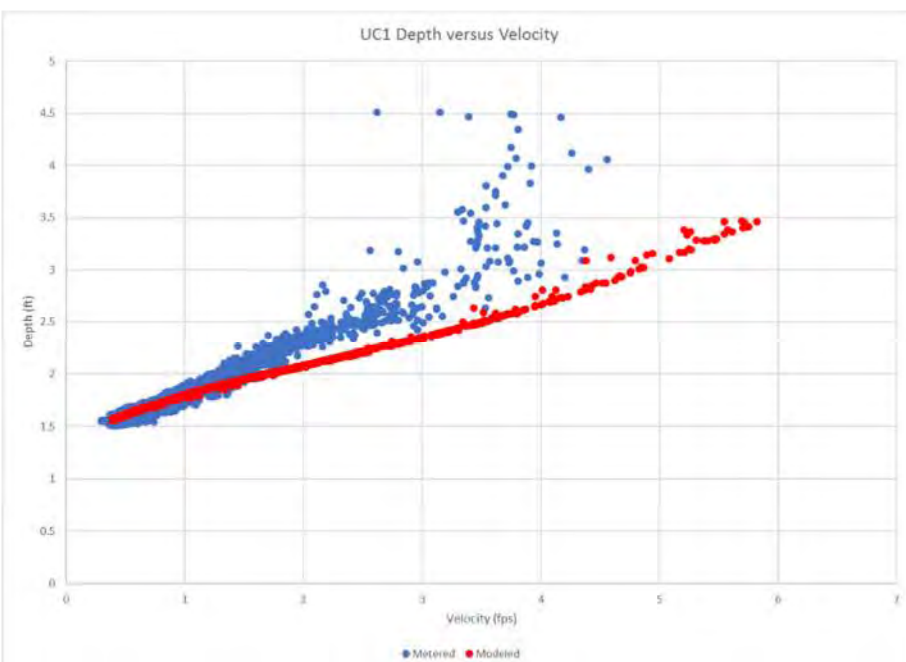


Figure 8-5: UC2 Depth Versus Velocity Plot

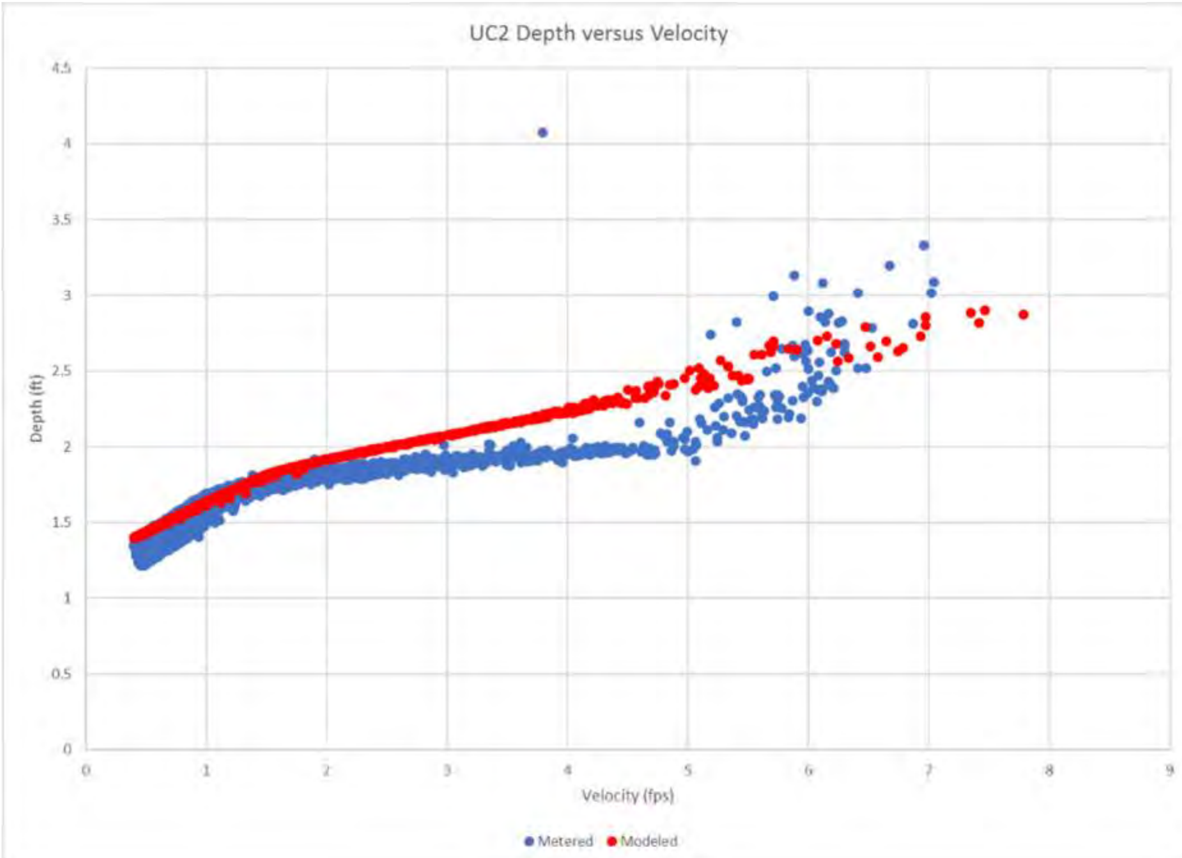
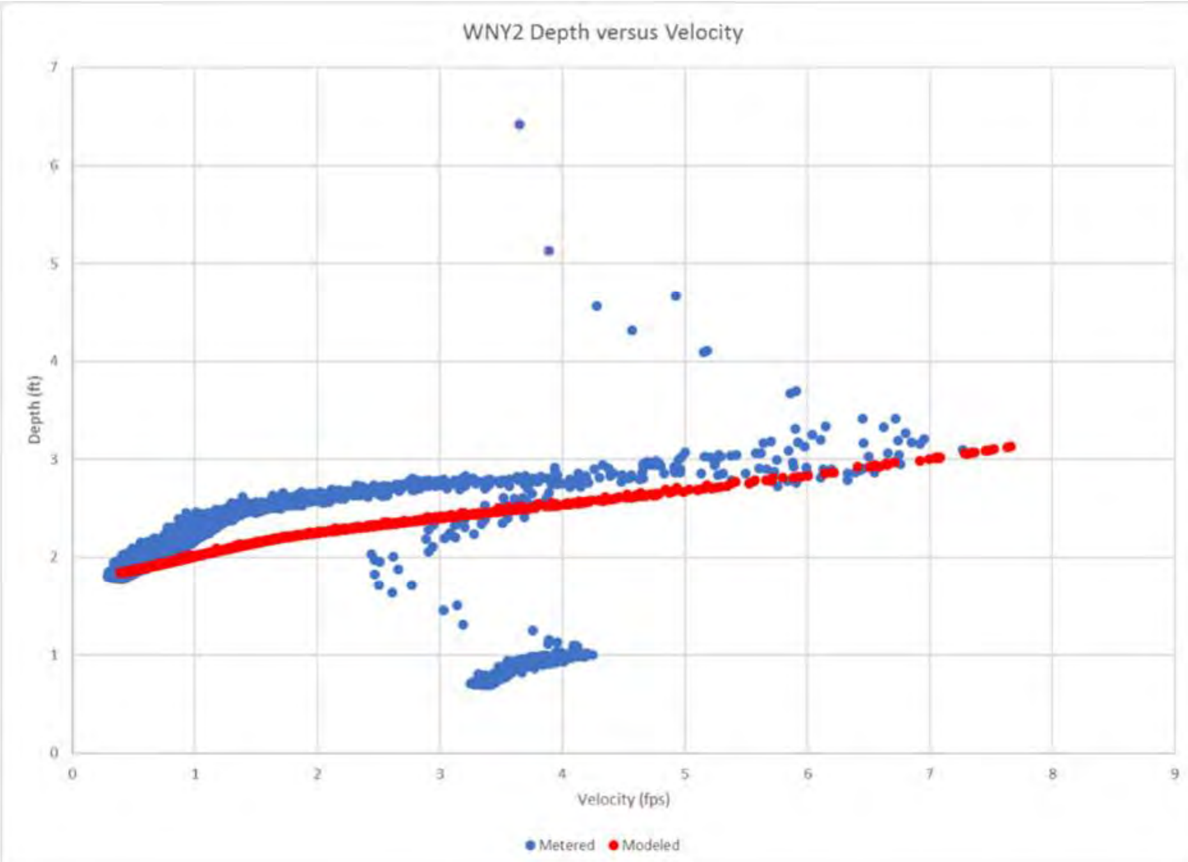


Figure 8-6: WNY2 Depth Versus Velocity Plot



8.3.3 Dry Weather Flow Calibration Results

The following figures are examples of measured vs. calculated flows for DWF calibration. The blue line represents the measured (metered) flow hydrograph, and the red line represents the calculated (modeled) hydrograph. The goal of calibration is to make the calculated hydrograph match the measured hydrograph as closely as possible, by varying model input parameters that impact flow generation. As can be seen from the figure, the model was able to closely match the peaks and troughs of DWF, and also accurately capture their timings and the general shape of the DWF hydrograph. Overall, the dry weather flow results from the model compared favorably with those from the flow meter data. The overall calibration statistics are provided in Table 8-5. Below are examples of the modeled versus measured results for UC1 and WNY1 for the period of June 19 through June 26, this period encompasses both weekdays (6/20-6/24) and weekends (6/19, 6/25, 6/26). As can be seen there is good agreement between both flow rates, depth and flow patterns. Occasionally the model fails to capture the peak flow within the CIWEM prescribed 10%, however likely this is due to meter noise. The results of this period are summarized in Figure 8-7 through Figure 8-10: and in Table 8-5. Comparison graphs and charts of dry weather flow calibration for all flow meters are provided in the appendices of this report.

Figure 8-7: Comparison of Measured vs. Simulated Dry Weather Flows (UC1)

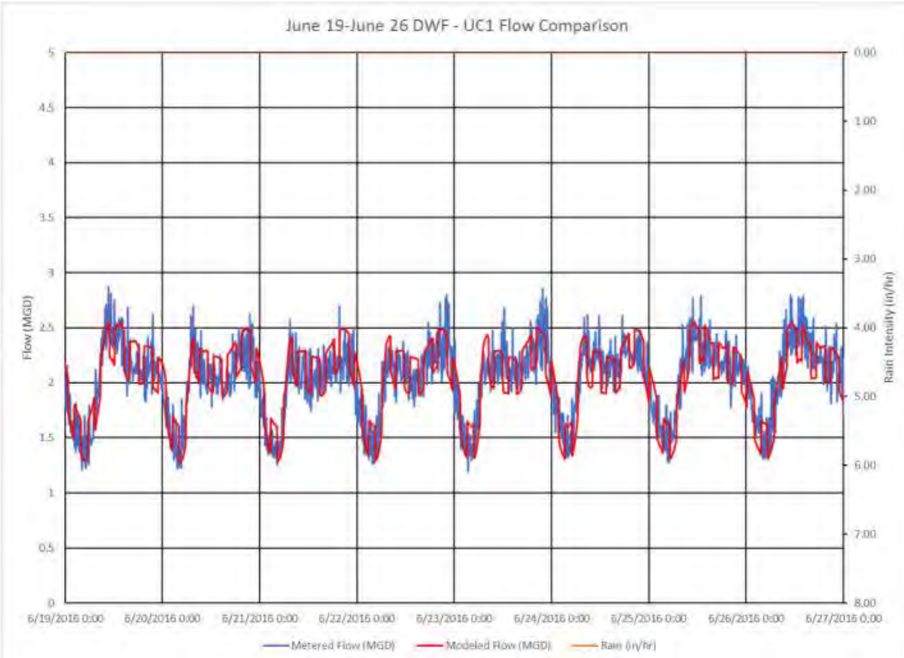


Figure 8-8**:** Comparison of Measured vs. Simulated Dry Weather Flow Depths (UC1)

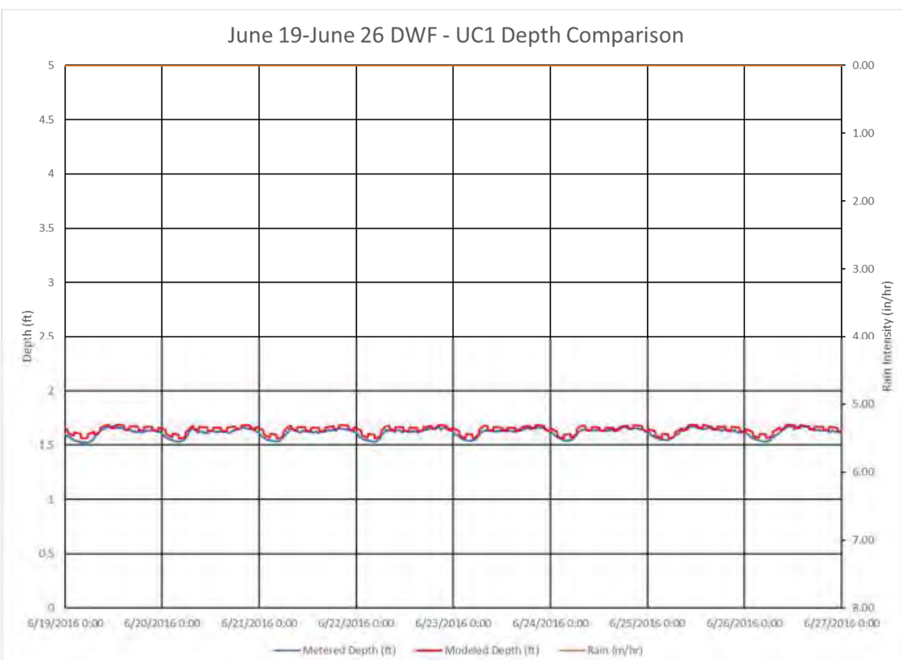


Figure 8-9: Comparison of Measured vs. Simulated Dry Weather Flows (WNY1)

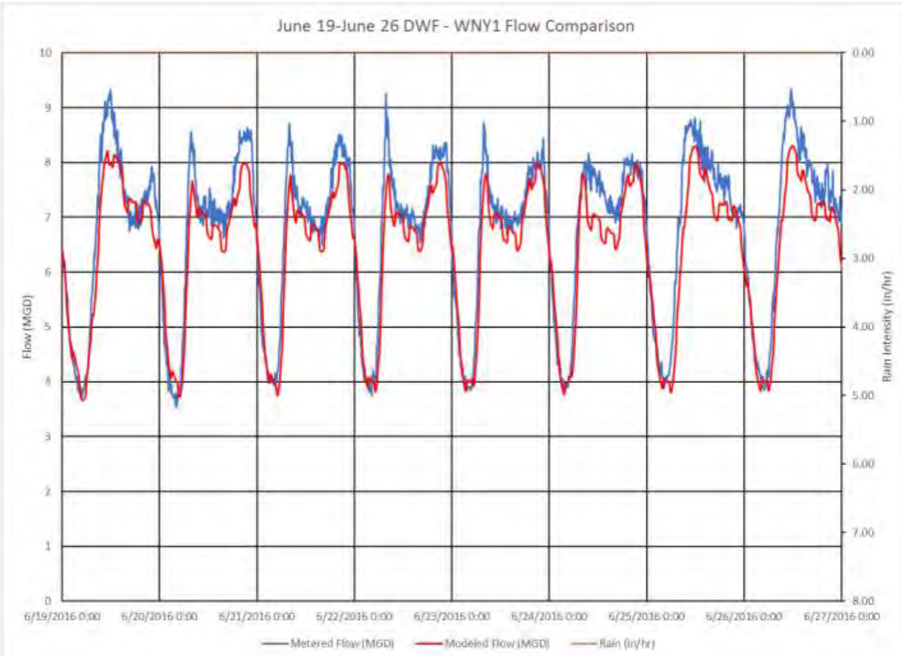


Figure 8-10: Comparison of Measured vs. Simulated Dry Weather Flow Depths (WNY1)

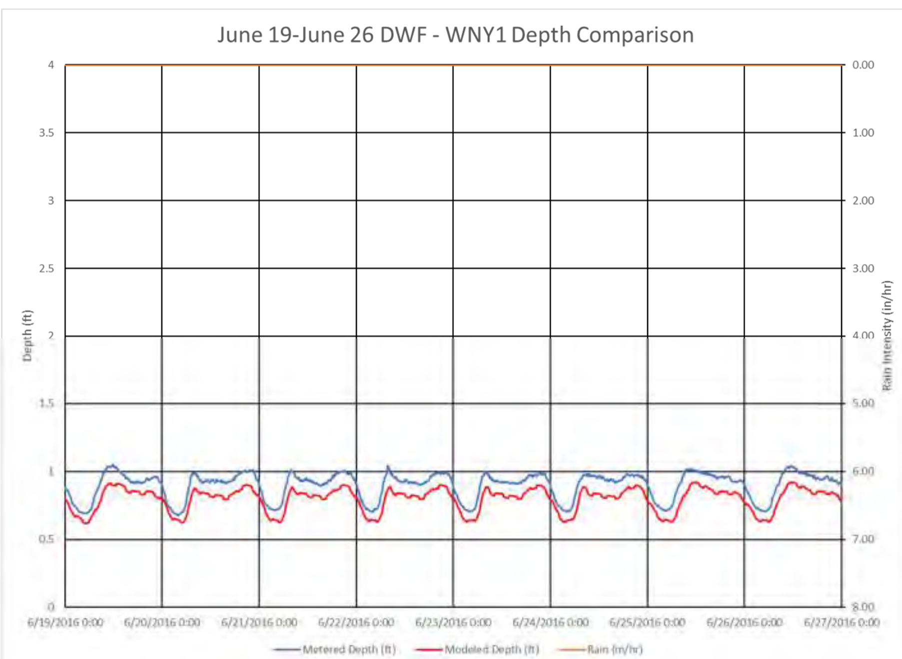


Table 8-5: Summary of Dry Weather Flow Period Modeling

Regulator	Metered Volume (MG)	Modeled Volume (MG)	Volume Diff %	Peak Flow (MGD)	Modeled Peak (MGD)	Peak Diff %	Meter Depth (ft)	Modeled Depth (ft)	Depth Diff (ft)
UC1	16.2	16.4	1%	2.9	2.6	-11%	1.7	1.7	0.0
UC2	18.0	18.6	3%	3.1	3.0	-5%	1.4	1.5	0.1
WNY2	26.3	26.8	2%	4.6	4.3	-7%	2.0	2.0	-0.1
WNY1	54.1	51.3	-5%	9.3	8.3	-11%	1.1	0.9	-0.1

Meets CIWEM Criteria

8.3.4 Wet Weather Flow Calibration

The process of calibrating the hydraulic model for wet weather flow was more complex than for dry weather flows. Pre-selected rainfall events (calibration and validation storms) were modelled and compared to the wet weather flow response to the corresponding measured data for those periods. Model parameters were adjusted within reasonable limits to match the flow meter response. Table 8-6 summarizes the CIWEM criteria for WWF calibration.

Table 8-6: CIWEM WWF Calibration and Validation Criteria

Criteria	**Calibration Range**	**Notes**
Peak Flow Rate	+25% to -15%	Use of actual value instead of percentage applied to meters with very small flows
Volume	+20% to -10%	Use of actual value instead of percentage applied to meters with very small flows
Timing of Peaks	Timing for peaks (high flows) and troughs (low flows) should be similar having regard to the duration of the event	
Depth	0.33 feet to +0.33 feet of observed peak depth for non-surcharge conditions -0.33 feet to +1.64 feet of observed peak depth for surcharged conditions	
Shape	The shape of the measured and simulated curves should be similar until the flow has substantially returned to DWF rates	

8.3.4.1 Initial Abstraction and Runoff Coefficients

Initial abstraction and runoff coefficients are the fundamental mechanisms of conversion of rainfall to runoff. Initial abstraction, sometimes referred to as depression storage, is the volume that must be filled prior to the occurrence of surface runoff on both pervious and impervious surfaces. It represents the “loss” caused by phenomena such as surface ponding, surface wetting, interception and/or evaporation that depletes an initial fraction of the rainfall after which surface runoff occurs, regardless of the storm intensity or duration. Evaporation was assumed to be 0.1 in/day. Once runoff begins, the volume of runoff generated for a given rainfall is dependent on the surface type. Runoff coefficient is the ratio of the total volume of runoff to total rainfall volume, over the study area.

The initial abstraction and runoff coefficients for the runoff surfaces were used as calibration parameters that were adjusted to match the model hydrographs with flow meter data. The main adjustment that was made to the model in this regard was that UC1 was adjusted slightly to have more infiltration. In general, initial abstraction rates were very low, which is in line with the highly urbanized nature of the drainage area.

The land cover was categorized into four types based on the land use characteristics of each of the four metersheds. The characteristics of these four types input into the model are summarized in the table below:

Table 8-7: Subcatchment Characteristics

Runoff Surface	Surface Type	Runoff Routing Value	Initial Loss Value (ft)	Runoff Coefficient	Horton Initial (in/hr)	Horton Limiting (in/hr)	Horton Decay (1/hour)	Horton Recovery (1/hour)
1	Pervious	0.035	0.0167	N/A	2.5	0.15	2.0	0.41
2	Impervious (WNY1/WNY2)	0.015	0.0025	0.75	N/A	N/A	N/A	N/A
3	Impervious (UC1)	0.015	0.0025	0.87	N/A	N/A	N/A	N/A
4	Impervious (UC2)	0.015	0.0025	0.90	N/A	N/A	N/A	N/A

8.3.4.2 Initial Subcatchment Width Selection

Subcatchment width is used to determine the length of the overland flow within the subcatchment for the kinematic wave routing that is performed by the computer model using the SWMM method. It can be used as a calibration parameter. To set the initial value, the subcatchment area was divided by the square root of the subcatchment area as that was taken to represent the distance across the diagonal of an assumed square shaped subcatchment. This width can them be adjusted to fine tune the calibration if needed. If was found that because the subcatchments were relatively small, the subcatchment width did not have much impact on the peak flow rate at the meters.

The subcatchment widths range as follows, with the two largest subcatchment being the separately sewered area and the area that the treatment plant is located on.

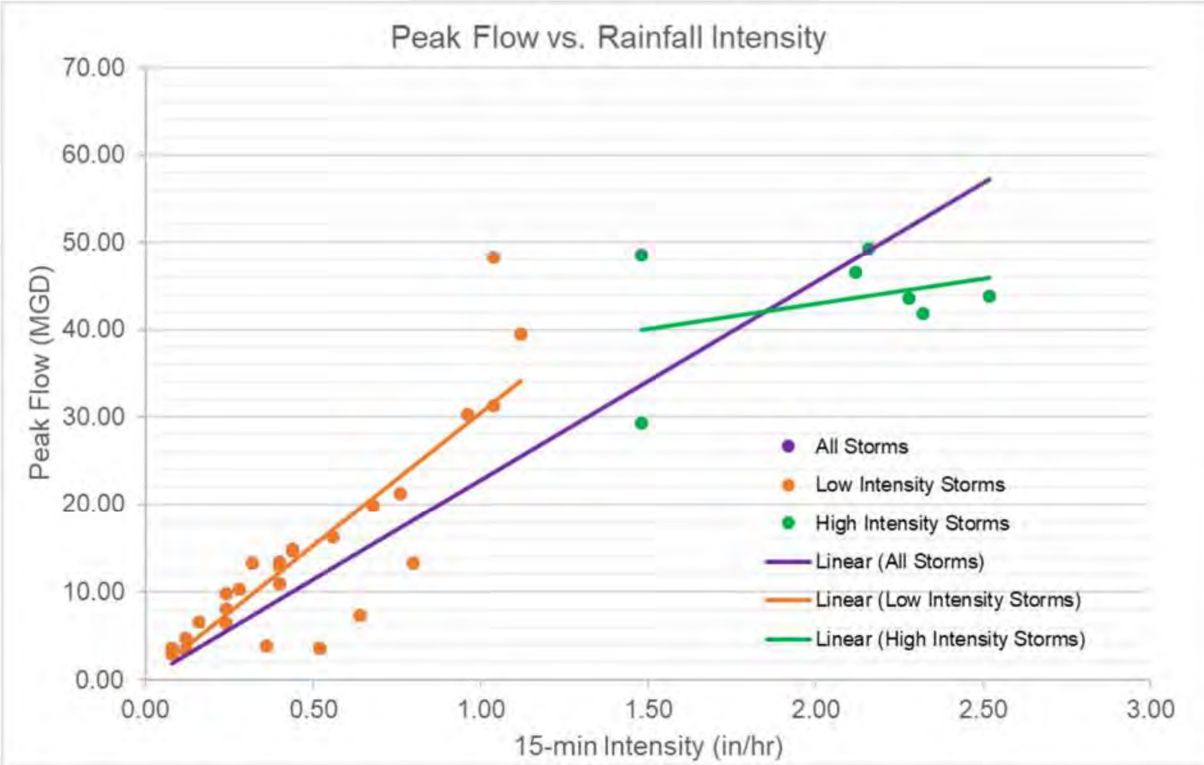
Table 8-8: Subcatchment Widths

Width	Count
100 ft < W < 300 ft	30
300 ft < W < 500 ft	200
500 ft < W	2

8.3.5 Inlet Openings

During the calibration process, peak flow in the system seemed to increase at a slower rate and almost flatline for high intensity storms (>1”/hr), as shown below in Figure 8-11 of the monitored peak 15-min intensity vs. peak flow. The initial model run exhibited good agreement for volumes but modeled peak flows were typically high. Efforts to reduce the peak flows through typical methods such as adjusting subcatchment width and runoff coefficients were either ineffective or detrimental to the lower intensity storm calibration. It was suspected that the capacity of the inlets was limiting the flow entering the collection system during these high intensity events. This was supported by checking the profiles and determining that the collection system piping was not the limiting factor. To replicate this, the manholes with flow inputs were converted into inlets, and the inlet openings were reduced in order to replicate the reduction in peak flow. This adjustment was effective in better replicating the flow characteristics of the sewer system. This is because converting the manholes to inlets impacted the peak flow rates within the collection system. The first step in the calibration was to replicate the flow rate, following which, steps were taken to improve the velocity and depth calibration. Impacts to depth and velocity as a result of modifications to the inlets were not specifically evaluated.

Figure 8-11: Monitored Peak Flow vs. 15-min Intensity



8.3.6 Wet Weather Flow Calibration Results

Overall, the hydraulic model's performance compared acceptably with the measured flow meter data. Flow volumes and peak overflows matched well. Example graphs of UC1 for the three calibration storms are provided below Figure 8-12 through Figure 8-15, and the complete calibration charts and individual flow meter calibration are included in Appendix D.

Figure 8-12: May 30, 2016 Calibration Storm Flows (UC1)

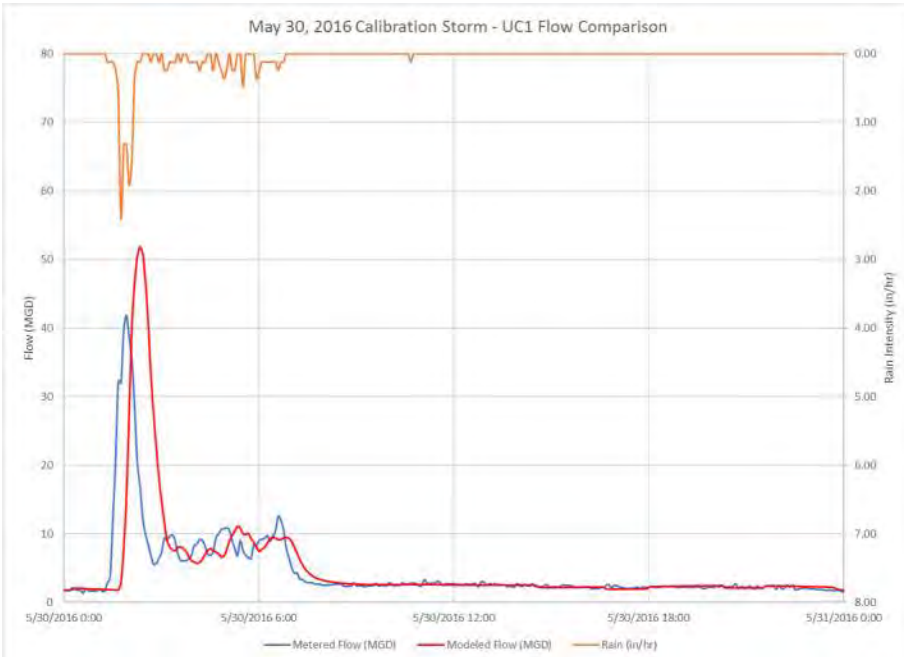


Figure 8-13: May 30, 2016 Calibration Storm Flow Depths (UC1)

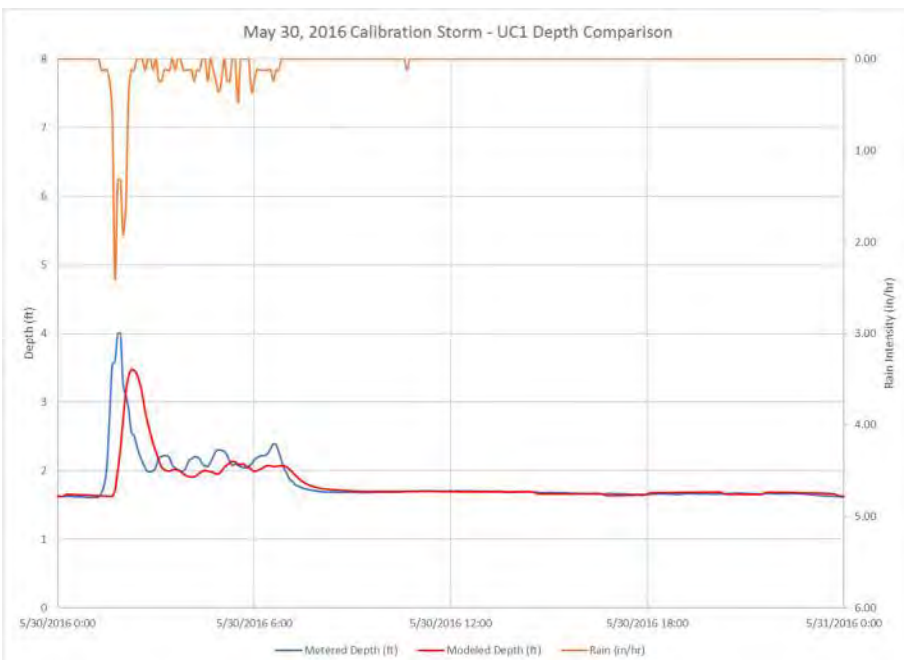


Figure 8-14: November 15, 2016 Calibration Storm Flows (UC1)

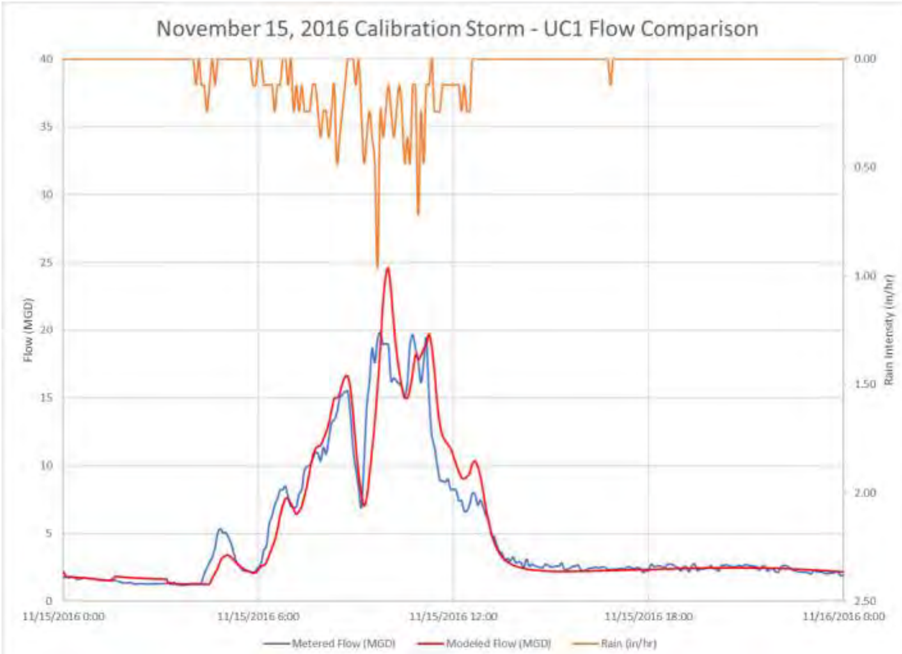
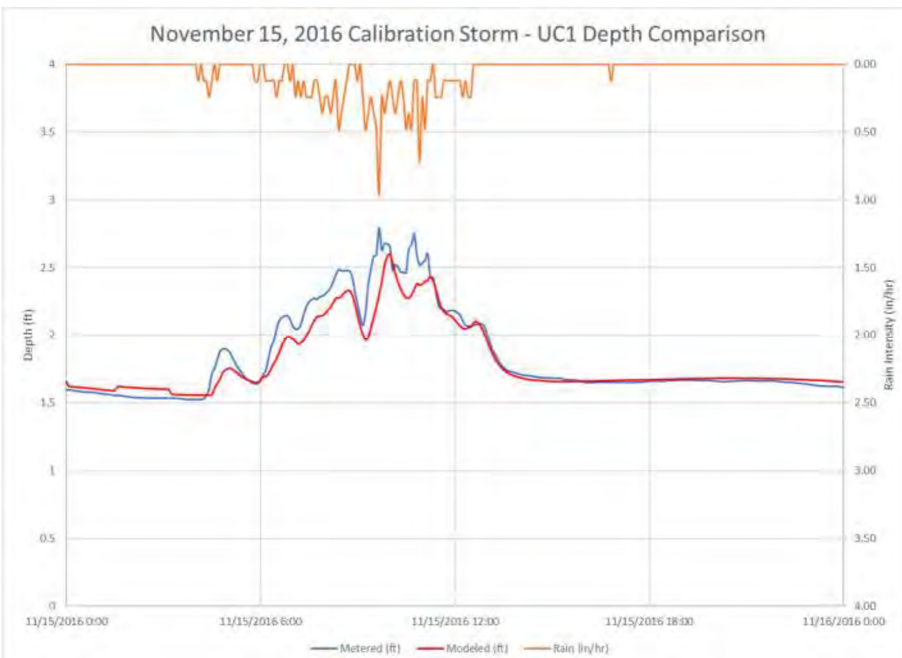


Figure 8-15: November 15, 2016 Calibration Storm Flow Depths (UC1)



The scatterplot for WNY2 (Figure 8-6) shows a discrepancy in a portion of the metering data. This may be the result of a downstream obstruction such as sediment being washed away during a storm or an error in the meter. This discrepancy impacted the calibration of the November 15, 2016 storm. At UC1, UC2 and WNY1 there was good agreement, however at WNY2 the results for flow and depth were quite poor, as can be seen in Figure 8-16 and Figure 8-17. A review of the graph shows a conflict between the dry weather flow depth and flow rate before and after the storm, accordingly this storm was omitted from consideration at WNY2.

Figure 8-16: November 15, 2016 Calibration Storm Flows (WNY2)

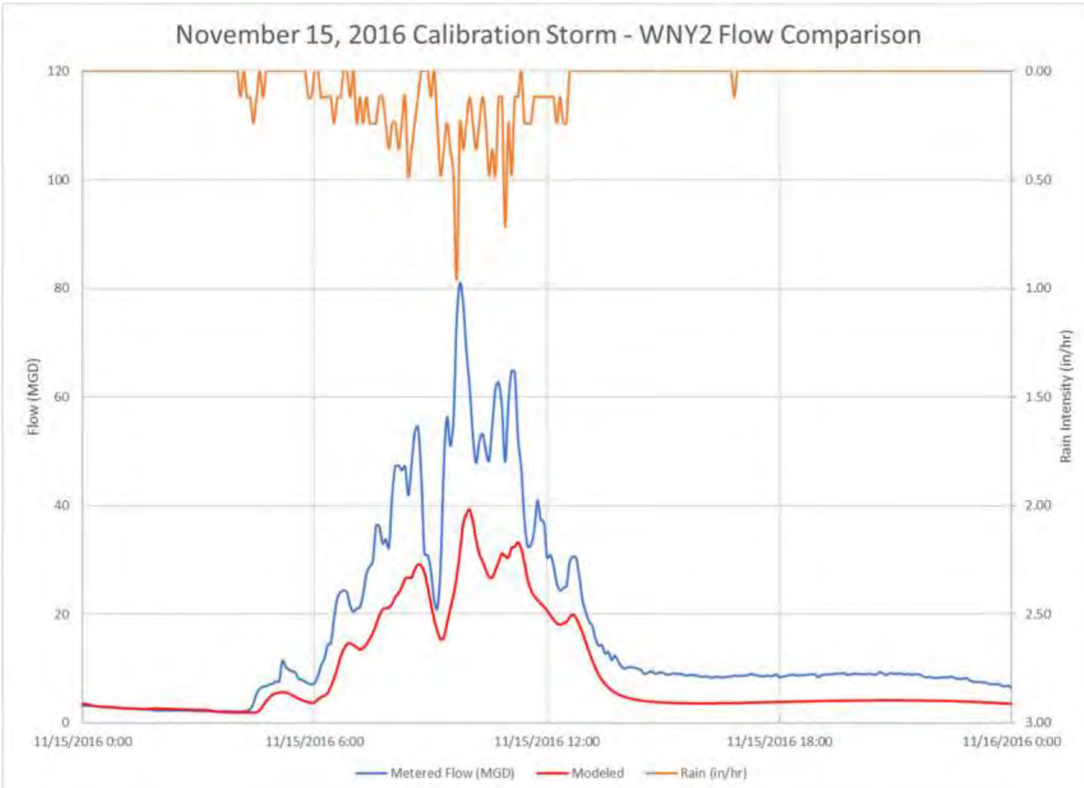
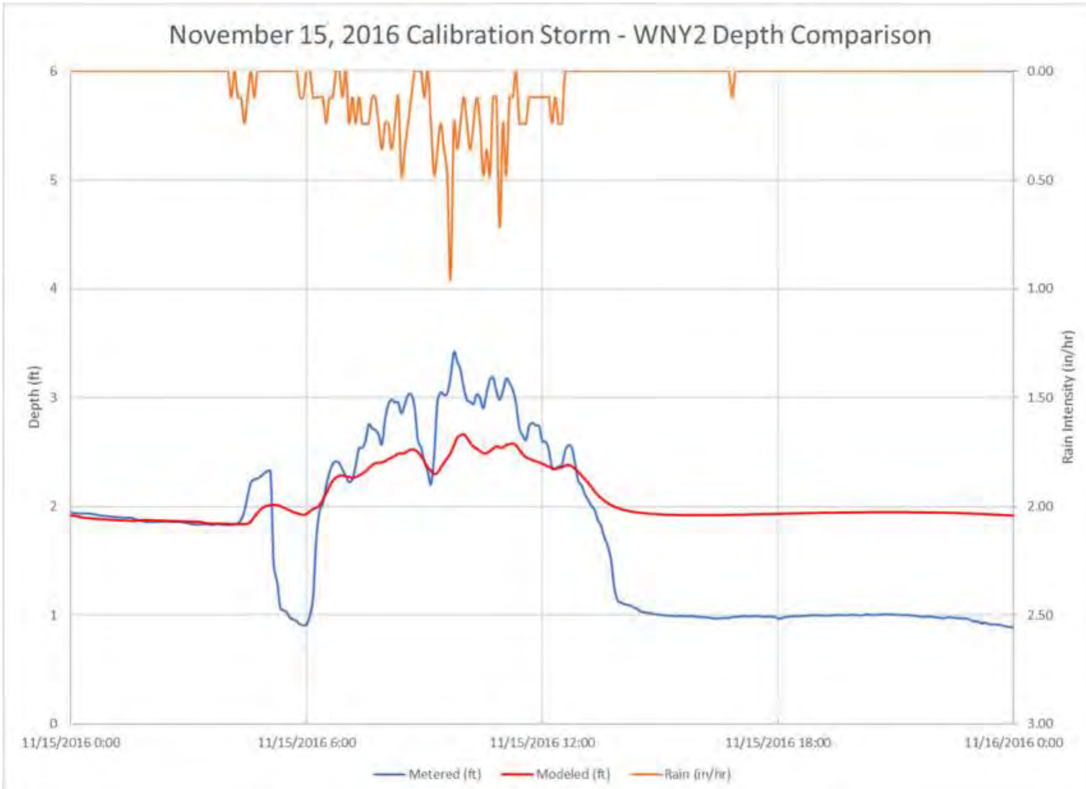
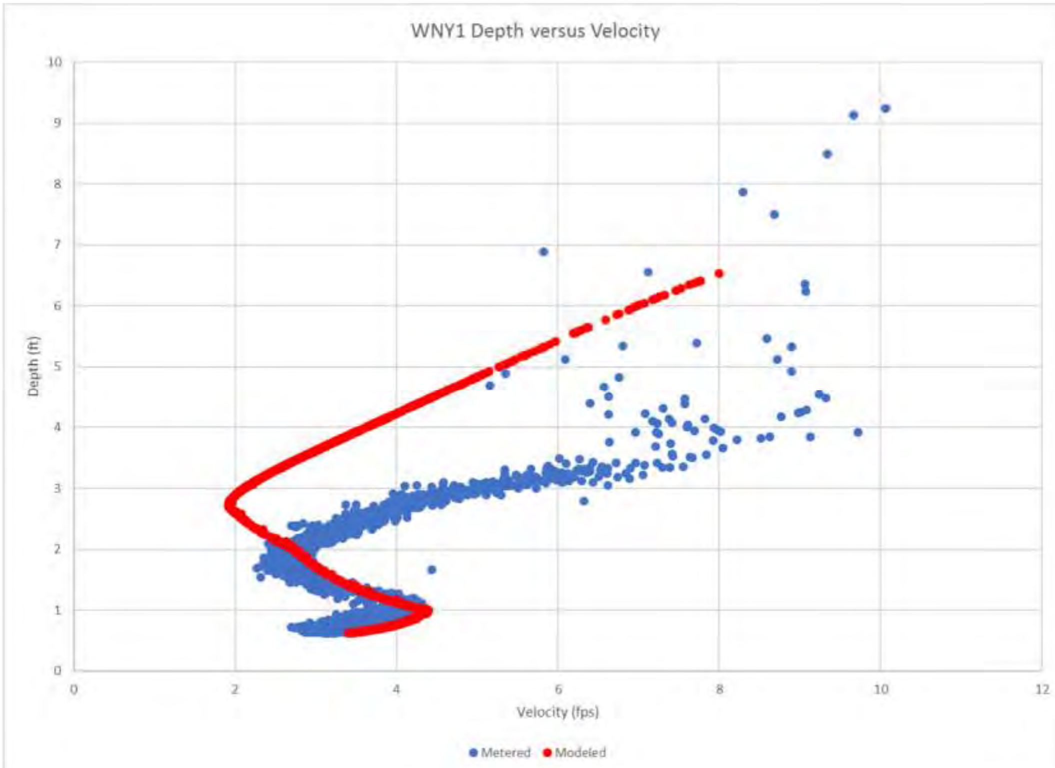


Figure 8-17: November 15, 2016 Calibration Storm Flow Depths (WNY2)



There was also a challenge matching depths for the higher flows at WNY1. The gate performance was aligned to the flow versus depth relationship for lower flows and then limited to 24 MGD (the maximum flow the plant sees) when the interceptor is fully surcharged. However, the flow versus depth relationship from the metered data implies that the weir is lower than measured in the field. Since the flows to the plant are limited by the gate, this was not thought to have a major impact on the overflow rates or volumes and the field measured elevation of the weir was used. The flow to depth relationship can be seen below in Figure 8-18.

Figure 8-18: WNY1 Depth versus Velocity Plot



8.4 Model Validation

The validation process followed the calibration process by using a sample of the monitoring data for the model that was completely independent of those used for the calibration process. If the model reasonably reproduced the results of the validation event(s), the model is considered validated.

Three different storms (small, medium, large) were selected from the metering period, and measured data was tested against the calibrated model. Example graphs of UC1 for two validation storms are provided below in Figure 8-19 through Figure 8-22, and the complete validation charts are included in Appendix D.

Figure 8-19: May 30, 2016 Validation Storm Flows (UC1)

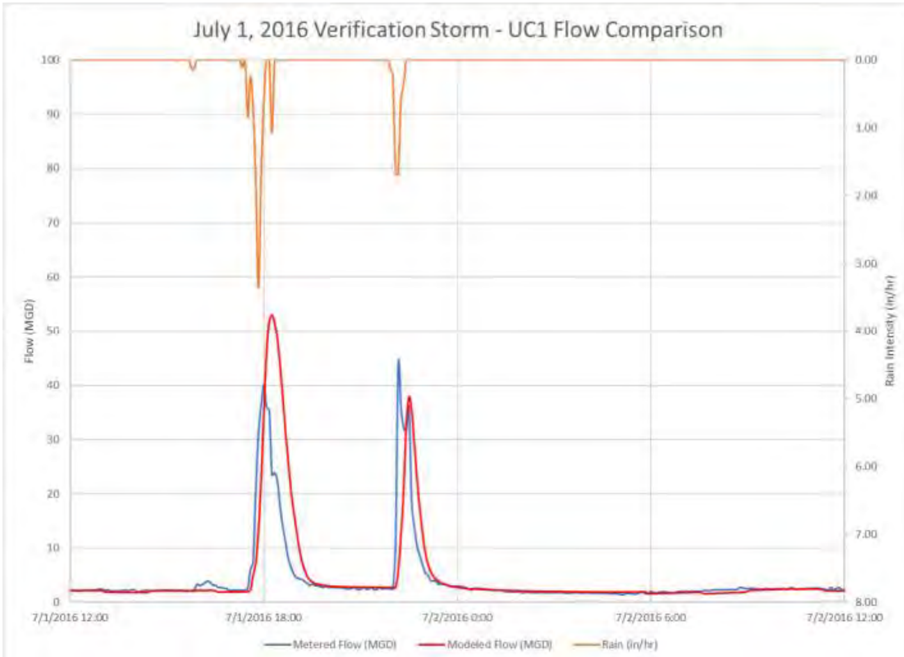


Figure 8-20: May 30, 2016 Validation Storm Flow Depths (UC1)

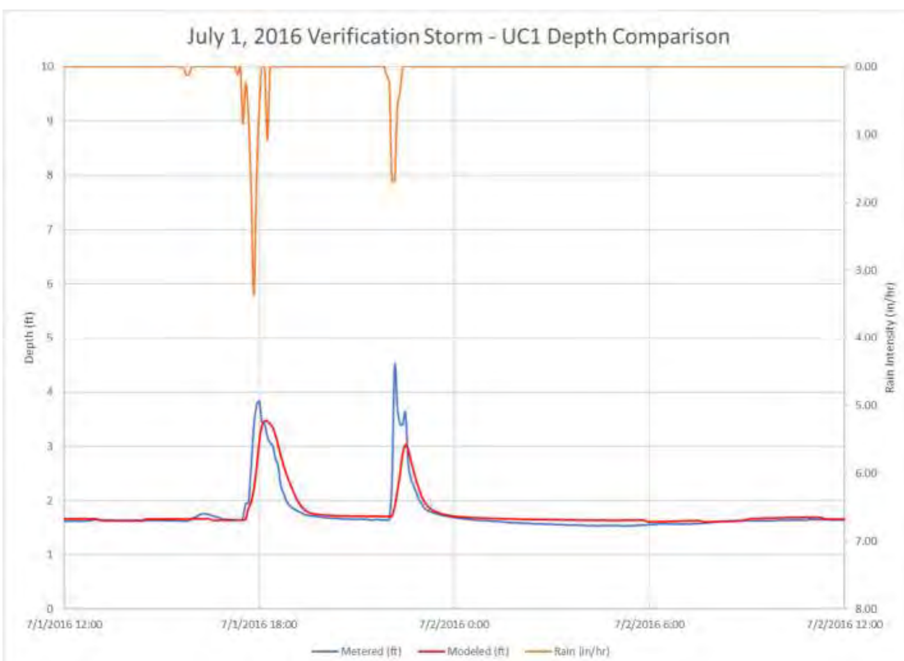


Figure 8-21: September 14, 2016 Validation Storm Flows (UC1)

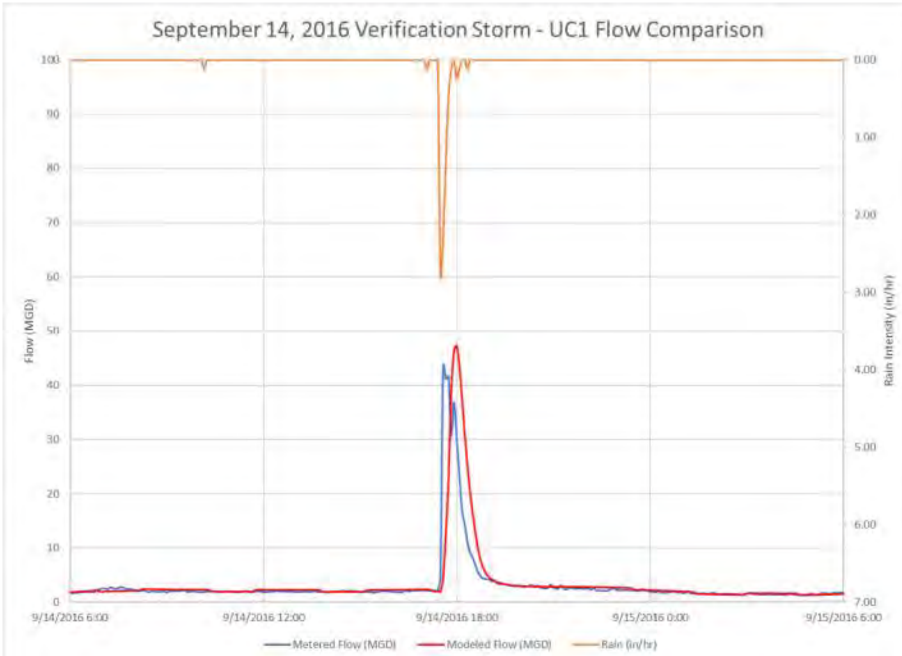
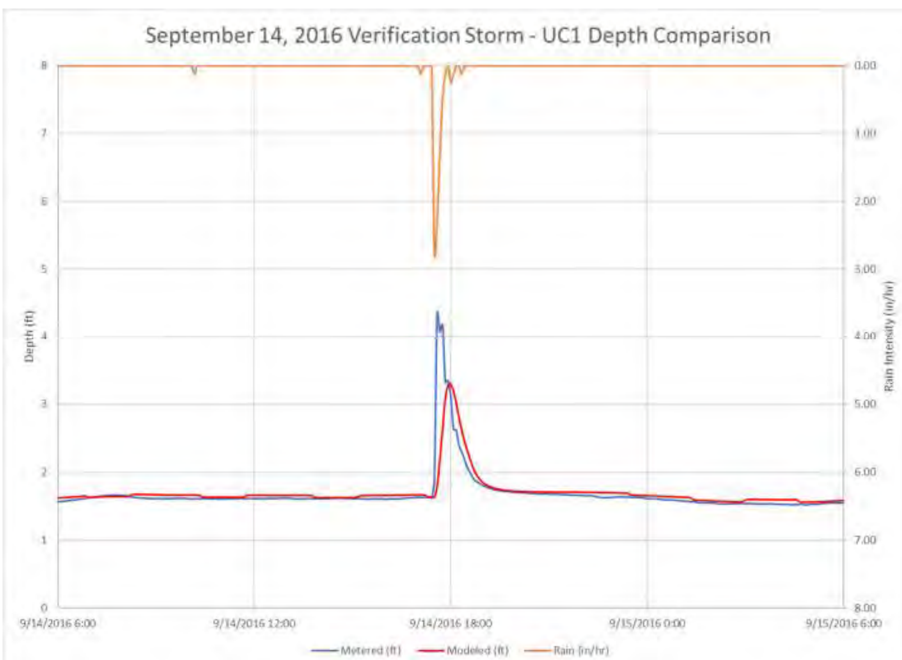


Figure 8-22: September 14, 2016 Validation Storm Flow Depths (UC1)



Overall, the hydraulic model's performance compared acceptably with the measured flow meter data. Flow volumes and peak overflows matched well. The goodness-of-fit in terms of the flow volumes is the most important when it comes to wet weather flow calibration and validation. The goodness-of-fit plots shown below in Figure 8-23 through Figure 8- for all flow meters across the calibration and validation events include lines to reflect the range of CIWEM criteria. These figures show that the model generally provided good simulation of flow generation and overall system hydraulics and performed well under varied rainfall totals, durations and intensities.

The goal of the calibration and validation process was that 2/3 of the data should meet the CIWEM criteria, which in general was achieved as shown in the figures below.

Figure 8-23: Goodness-of-Fit Plot Peak Flow UC1

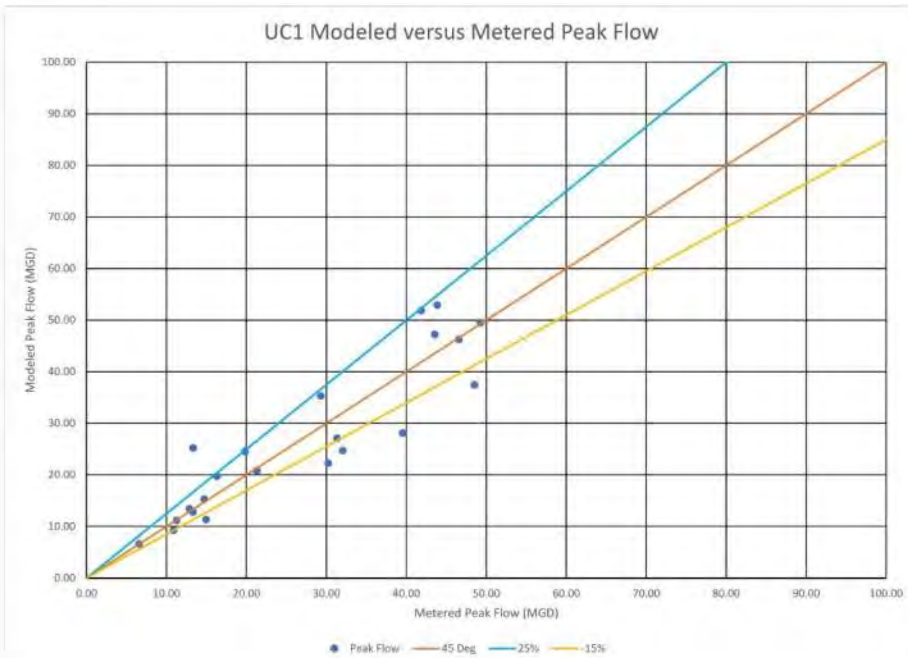


Figure 8-24: Goodness-of-Fit Plot Volume UC1

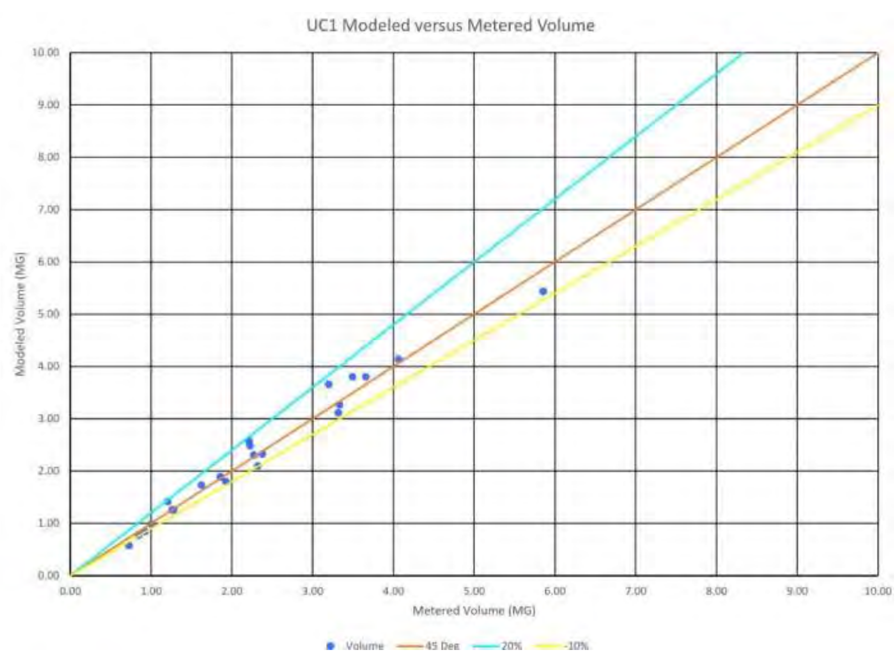


Figure 8-25: Goodness-of-Fit Plot Peak Flow UC2

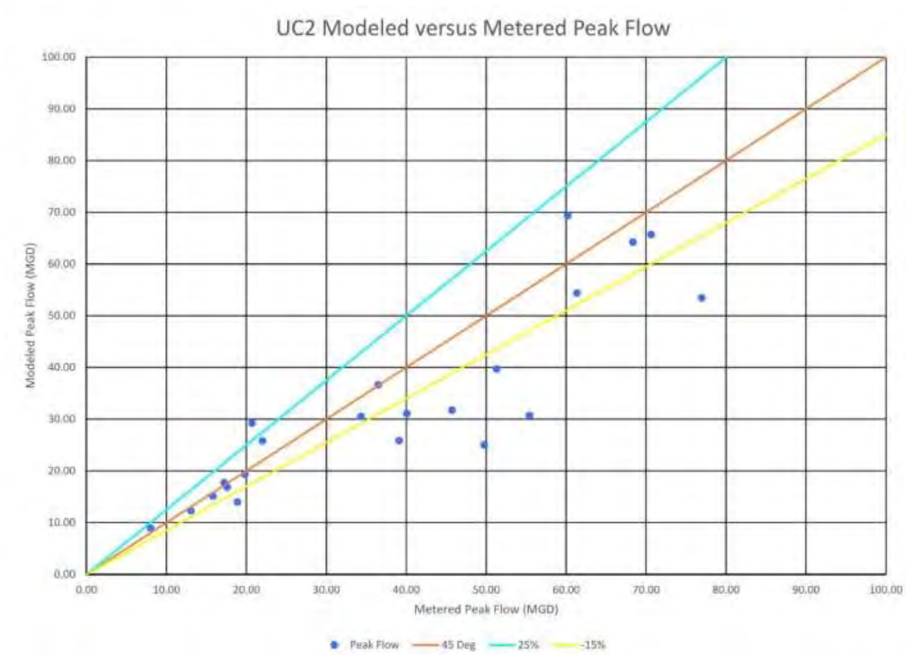


Figure 8-26: Goodness-of-fit Plot Volume UC2

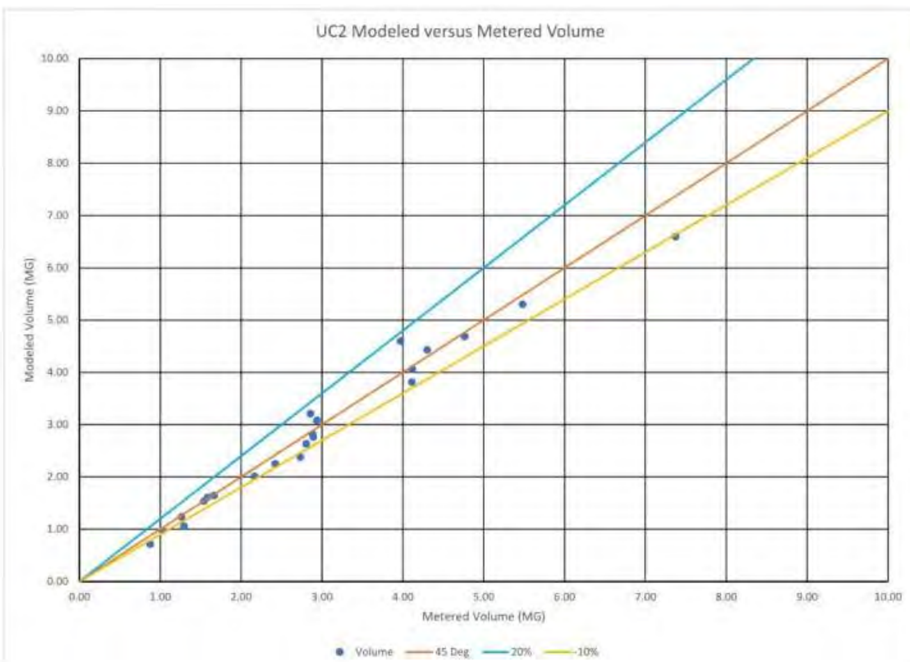


Figure 8-27: Goodness-of-Fit Plots Peak Flow WNY2

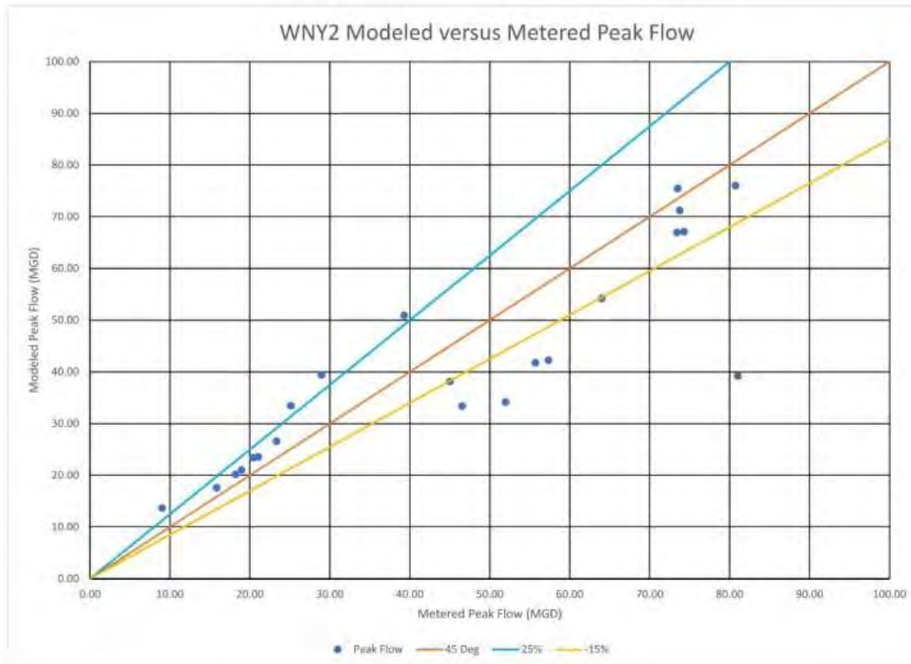


Figure 8-28: Goodness-of-Fit Plot Volume WNY2

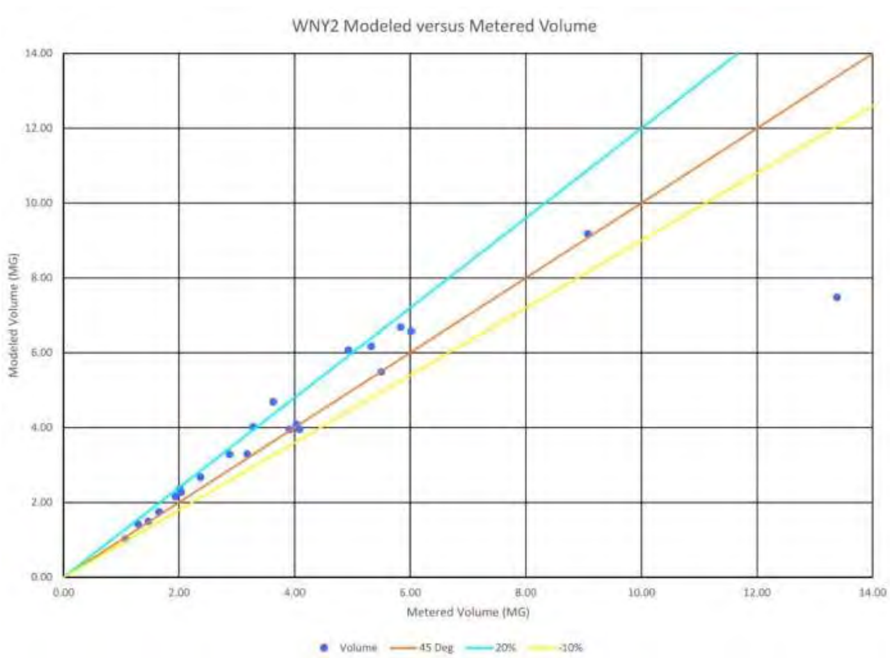


Figure 8-29: Goodness-of-Fit Plot Peak Flow -WNY1

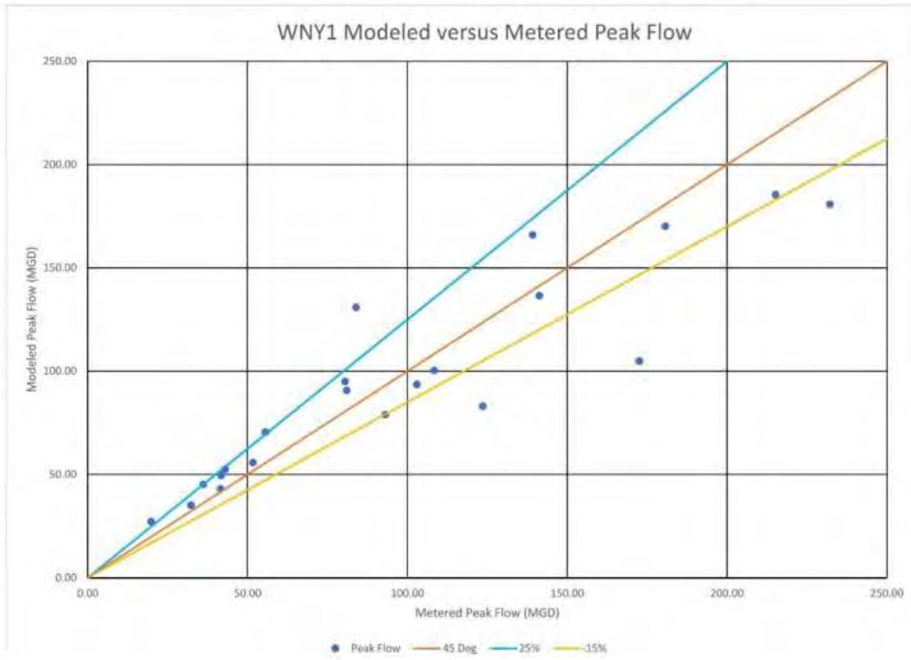
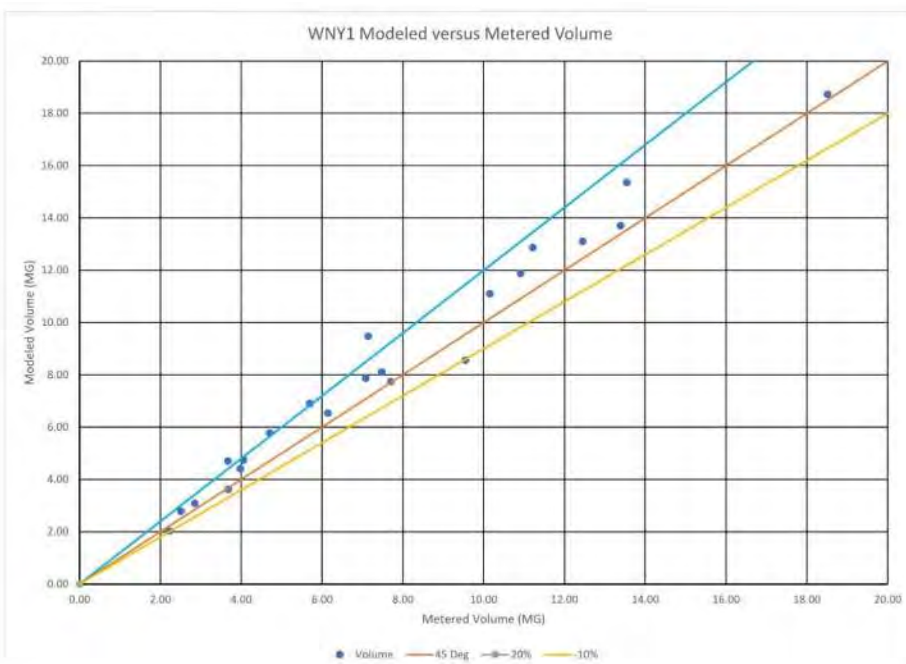


Figure 8-30: Goodness-of-Fit Plots Volume WNY1



The number of overflows calculated during the metering period of May 17, 2016 to November 16, 2016 was also measured, and was compared with mission data from NHSA as another test of the accuracy of the model. Although the mission data did not measure the volumes of CSO discharges, it provided the start and end times of CSO events by means of a float mechanism. While 33 CSO events were measured at River Road and 24 were measured at JOSO, the modelled rainfall did not include the three days of rain in October when the River Road rain gauge did not work. Taking this into account, the comparison of modeled events to measure events is shown below in Table 8-9. NHSA staff indicated that the float switches which measure overflow events are very sensitive, so may overestimate the number of overflows occurring.

Table 8-9: Mission vs. Modelled Overflows

	CSOs observed during metering period	**CSOs simulated in model**	**% Difference**
WNY1 (002A)	30	28	-7%
JOSO (003A)	21*	28	33%*

The model corresponds well with the mission results for WNY1 but shows less agreement for JOSO. The Mission System data for the JOSO line registered no overflows from May 26, 2016 through June 23, 2016, whereas at least three (3) significant rainfall events occurred, so it is thought that the recorded number of overflow may be lower than the actual number of overflows and the models prediction of overflow are more accurate than listed in Table 8-9.

Baseline Characterization

The calibrated model was used to identify the number, location, frequency and volumes of overflows expected for a typical year, and to calculate inputs to a pathogen water quality model of New York-New Jersey Harbor being developed by the NJ CSO Group.

9.1 Typical Year Selection

In accordance with the USEPA CSO Control Policy the CSO control alternatives are to be assessed on a "system-wide, annual average basis." This is accomplished by continuous simulation using a typical hydrologic period for the combined sewer system (CSS) and receiving water quality modeling applications. The CSO Policy supports continuous simulation modeling, i.e., using long-term precipitation records rather than records for individual storms. Long-term continuous precipitation records enable simulations to be based on a sequence of storms so that the additive effect of storms occurring close together can be examined. They also enable storms with a range of characteristics to be included.

NHSA is part of the NJ CSO Group, a group of municipalities which discharge to the tidally connected waterbodies in the NY/NJ Harbor Estuary that are working cooperatively to fulfill the requirements of the last CSO General Permit. Passaic Valley Sewerage Commission (PVSC) was selected to lead the technical work required for CSO permit compliance and led the analysis for the selection of the typical year which would be used for the long-term continuous precipitation modeling. The typical year of rainfall used in this baseline characterization is based on the "Typical Hydrologic Year Report" produced by PVSC in May 2018. The NJDEP provided a letter response on May 31, 2018 indicating that all questions and comments had been addressed to the Department's satisfaction.

The typical year was selected by PVSC based on statistical analysis of precipitation records in recent 46 years (1970-2015). The objective of selecting the typical year was to provide a representative and unbiased approximation of future expected conditions in terms of both averages and historical variability. Based on data from the Newark Liberty International Airport rain gauge, the PVSC report recommended that 2004 should be selected as the typical hydrologic year for the CSO LTCP. This is because 2004 had the least deviation from criteria including annual rainfall, storm volume, number of events, peak intensity, etc. The 2004 rainfall year also contains a wide range of storms and antecedent conditions, and it has close to an average CSO volume and event number based on the hydrologic and hydraulic model results.

Hourly precipitation data for 2004 was obtained for the Newark rain gauge for the completion of the typical year analysis.

9.2 Frequency and Volumes of CSO Discharges

The River Road model was run under the 2004 rainfall typical yield rainfall condition to calculate CSO overflow characteristics under these conditions. The results are as follows:

- WNY1 (002A) – 60 overflows
- JOSO (003A) – 61 overflows

The overflow characteristics are summarized in Figure 9-1 through Figure 9-4 below and provided in detail in Appendix E.

The following charts depict the volume and peak flows of all calculated overflows in the typical year and highlight the 5th largest storms for each outfall which would be consistent with the level of control requiredunder the presumptive approach which allows for four (4) overflow in a typical year.

Figure 9-1: WNY1 (002A) – Typical Year CSO Volumes

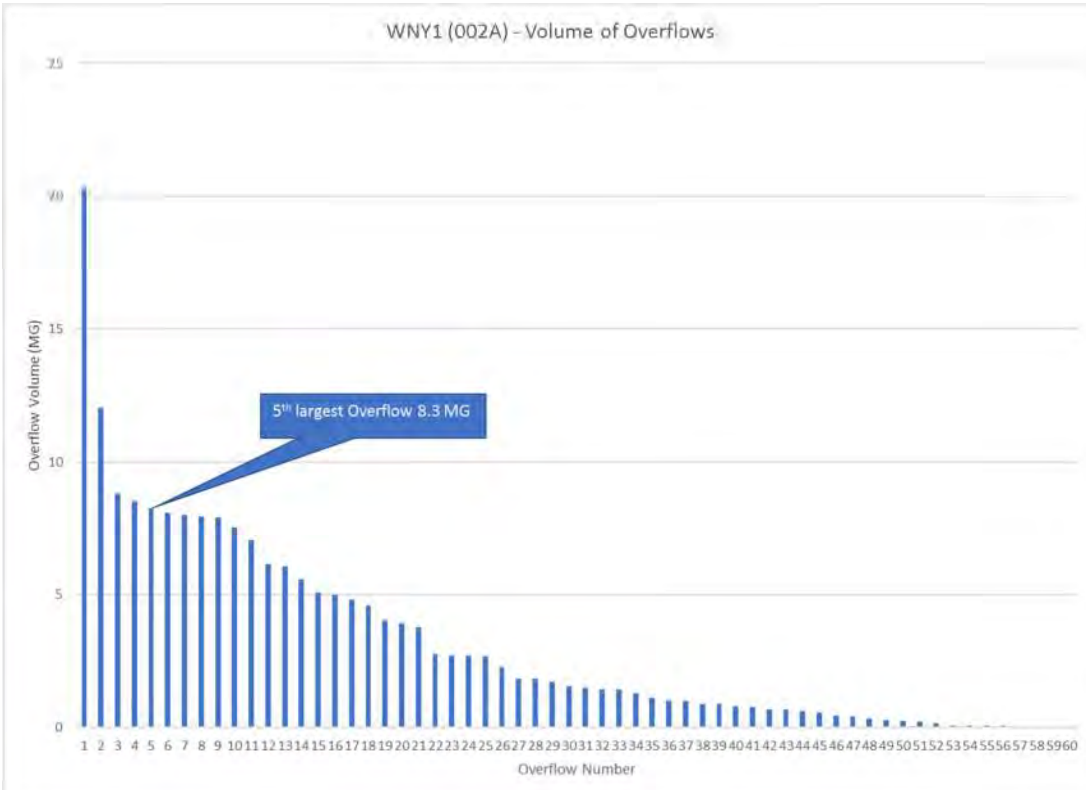


Figure 9-2: JOSO (003A) – Typical Year CSO Volumes

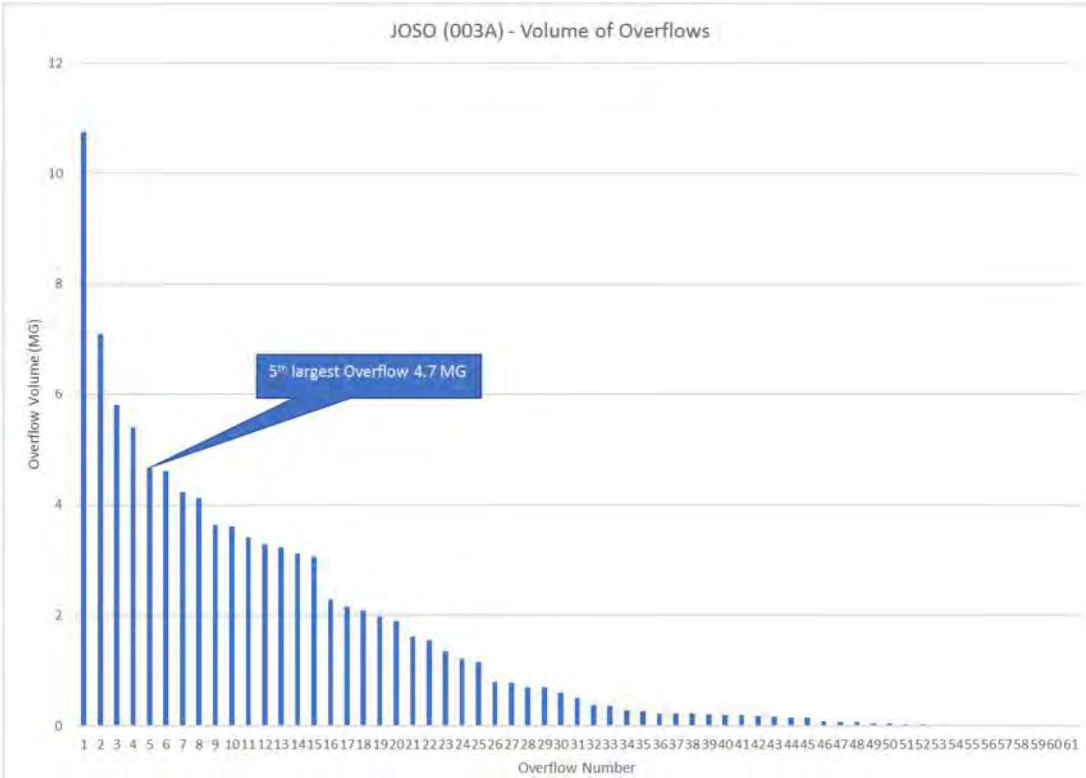


Figure 9-3: WNY1 (002A) – Typical Year CSO Peak Flows

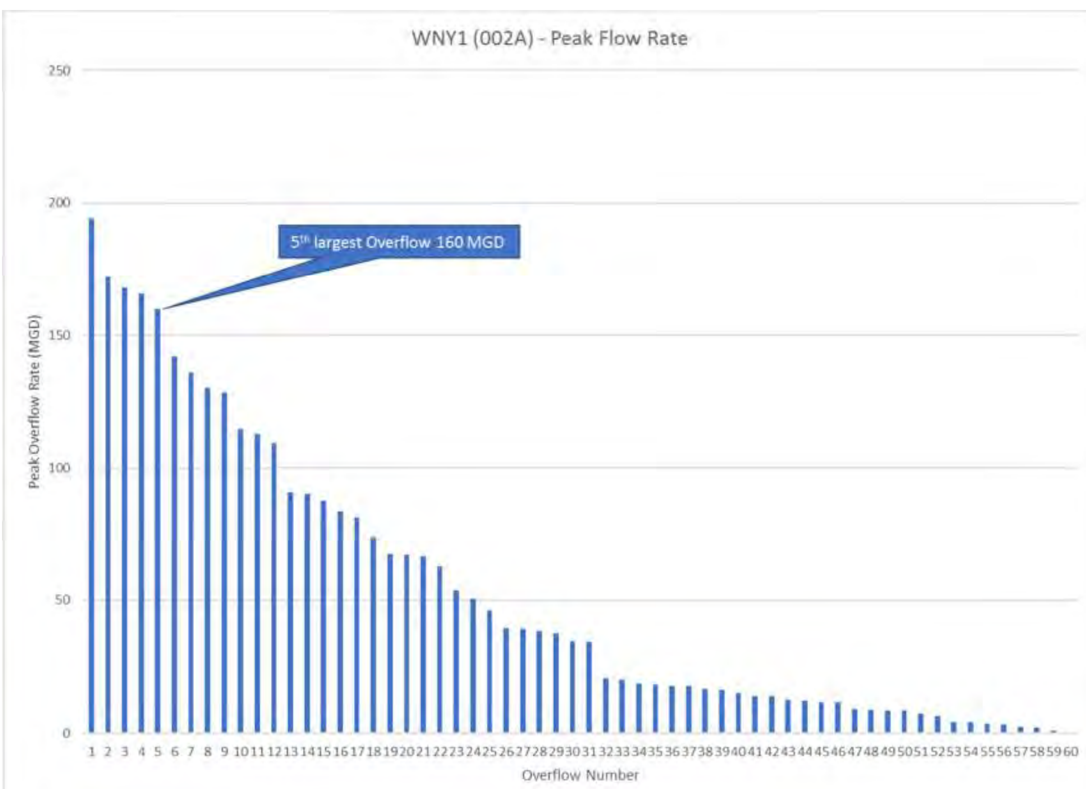


Figure 9-4: JOSO (003A) – Typical Year CSO Peak Flows

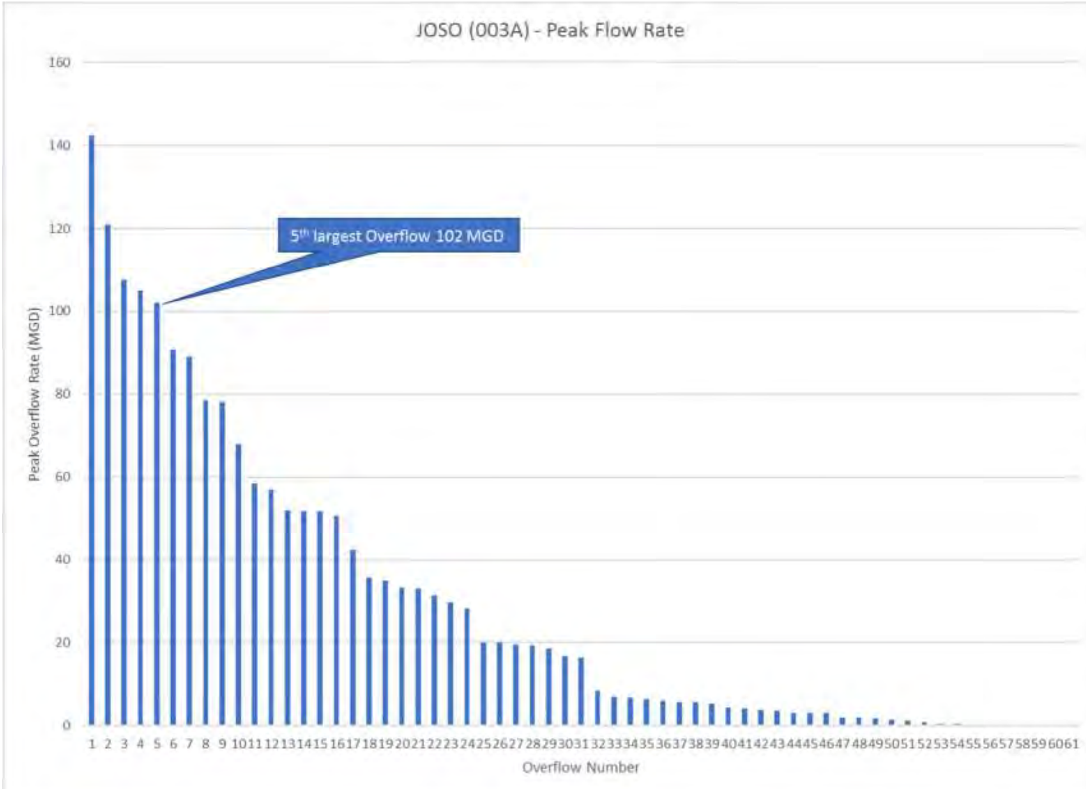
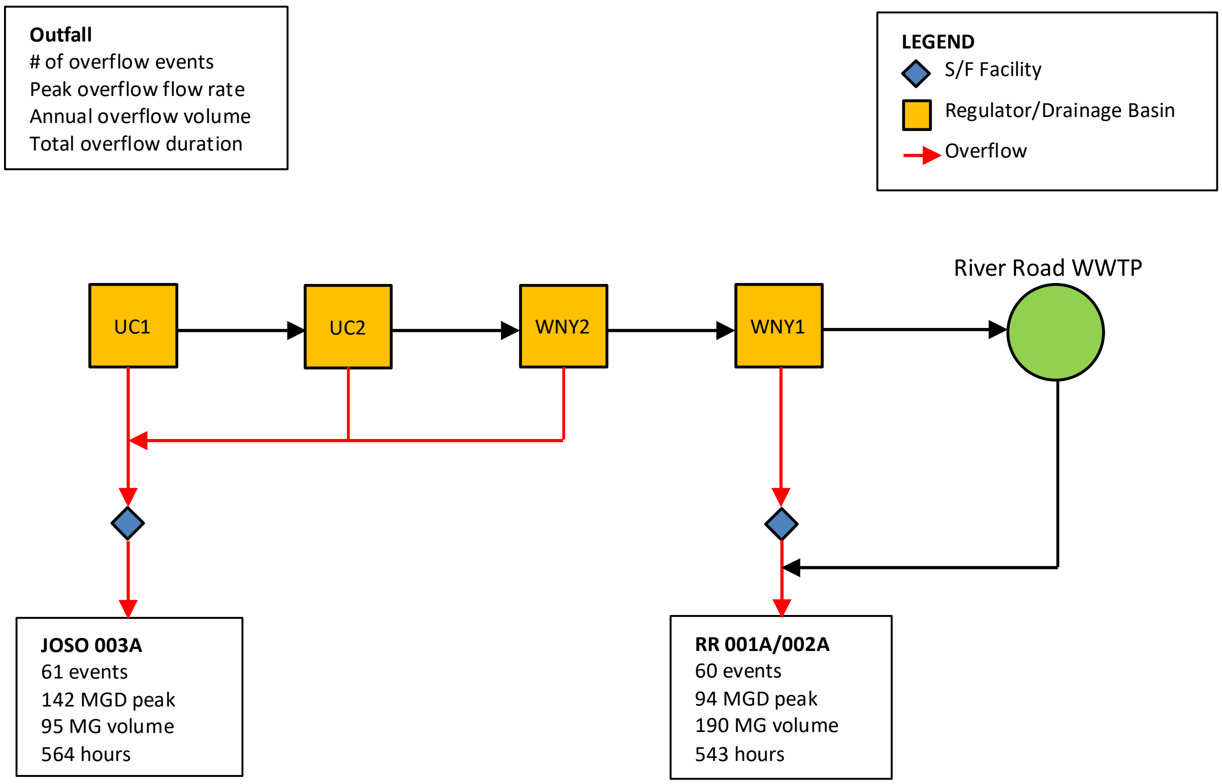


Figure 9-5 shows the schematic of the River Road WWTP collection system, summarizing the typical year CSO calculations by outfall. The typical year CSO summary includes the number of overflow events, the magnitude of the peak flow, and the total volume of overflow for the typical year for each outfall. Overflow events were defined as any event for which the model calculated at least 0.05 MG of overflow at an outfall and an inter-event time of 24 hours.

Figure 9-5: River Road WWTP Baseline Characterization - Typical Year CSOs



9.2.1 Runoff Distribution in River Road Service Area

Figure 9-6 depicts a simplified water budget chart for the total runoff generated from the modeled combined sewer area using data exported from the existing conditions hydraulic model simulation for the 2004 representative year precipitation record. The volume of precipitation falling upon the overall combined sewer area (estimated to be 960.2 Mgal) has been partitioned into 3 broad components, given the data available through the modeling software. The total annual surface runoff volume calculated to enter the modeled collection system is divided into a treated runoff volume and an overflow runoff volume, while the balance of the water budget outflows (i.e. losses), such as evaporation, interception, infiltration, and direct runoff to water bodies, has been classified as overall water losses. The surface runoff volume tributary to the collection system (i.e., the treated and overflow runoff volumes) represents 49% of the precipitation volume. The water budget calculated by the InfoWorks model is consistent with published EPA documents that indicate for an urban area such as West New York and Union City, which is approximately 78% impervious, runoff would be expected to comprise about 55% of the annual rainfall, as shown in Figure 9-7.

Figure 9-6: River Road WWTP Baseline Characterization - Typical Year CSOs

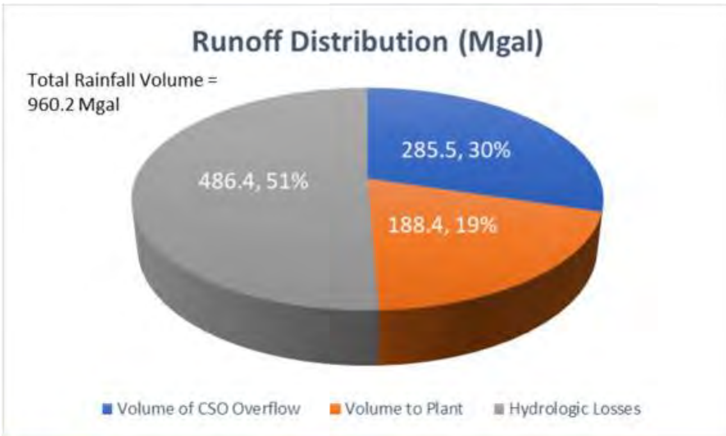
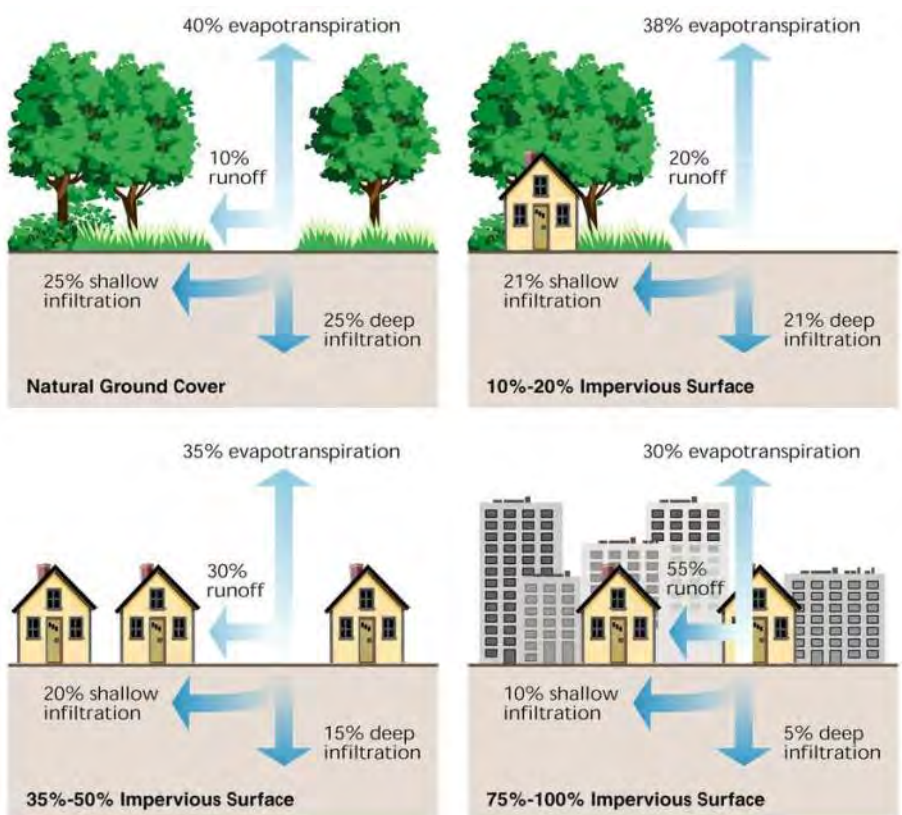


Figure 9-7: Relationship between Impervious Cover and Surface Runoff



Source: EPA, "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters"

The output from the model was analyzed to determine the percentage by volume captured during wet weather in the typical year. Wet weather was defined using the typical year rainfall data at 15 minute increments, only periods when rain was recorded were identified as wet weather. First, the dry weather flow (base sanitary flow and GWI) occurring during wet weather periods was extracted from the model data. This was added to the total runoff from service area, to obtain a value for the total volume that could be captured during wet weather. The total volume of system flow was then divided by the total overflow volume (sum of JOSO and River Road outfalls) to obtain a percent capture of approximately 52%, as summarized in Table 9-1. It is noted that the intial dry weather flow volume was only calculated during rainfall:

Table 9-1: River Road Wet Weather % Capture

DWF Captured during Wet Weather	118.8 MG
Total Runoff Captured	473.8 MG
Total Wet Weather Capture Volume	592.6 MG
Overflow Volume	285.5 MG
% Capture	**51.8%**

The equation showing the calculation is as follows:

$$\%\ Capture = 1 - \left(\frac{Overflow\ Volume}{Total\ Wet\ Weather\ Capture\ Volume}\right)$$

$$1 - \left(\frac{285.5}{592.6}\right) = 51.8\%$$

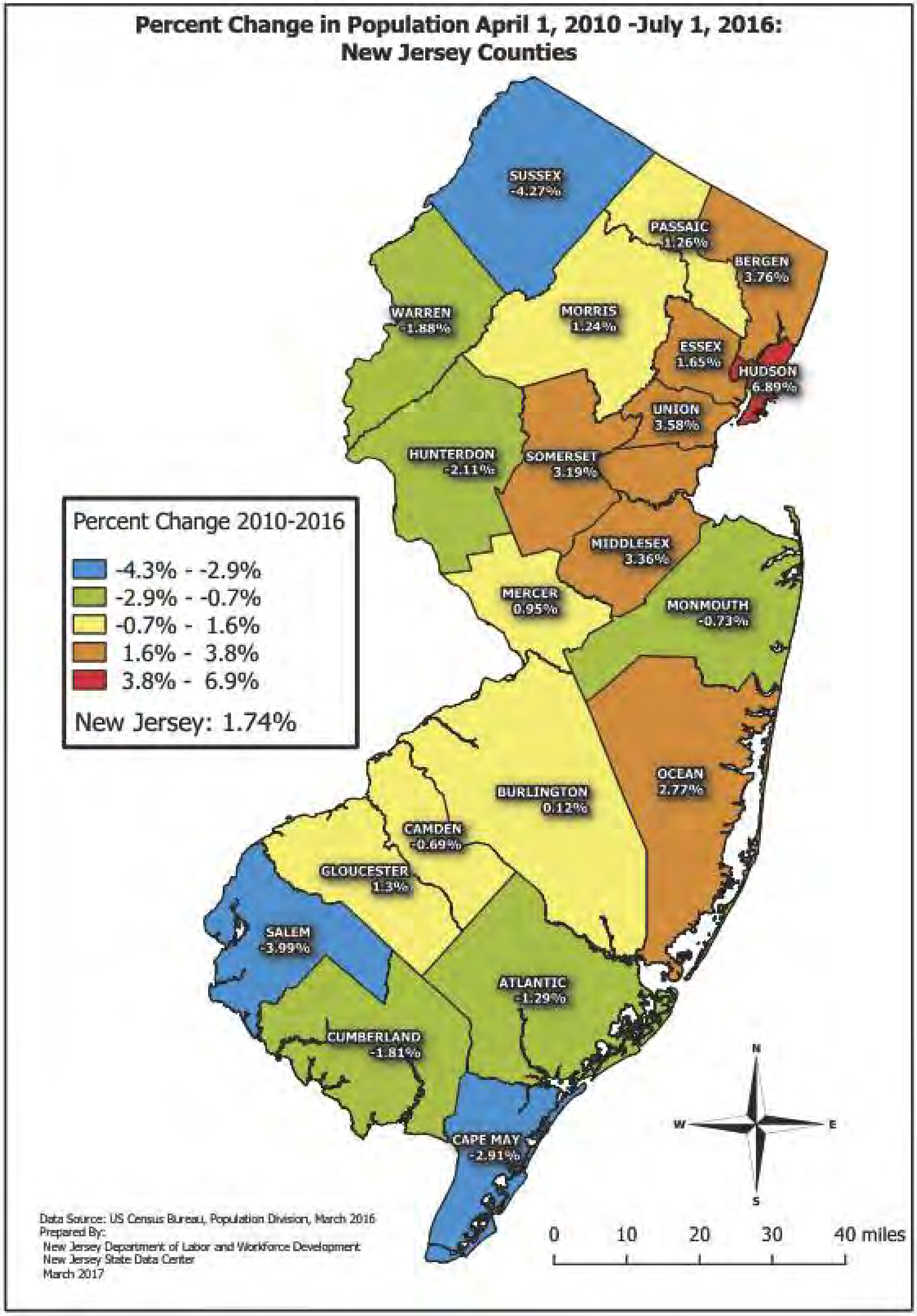
SECTION 10

References

1. North Hudson Sewerage Authority Long Term Control Plan System Characterization Work Plan for the River Road STP (CH2M Hill, 2016)
2. North Hudson Sewerage Authority Fiscal Year 2017 Annual Report (Mott MacDonald, 2017)
3. River Road CSO Control Cost and Performance Analysis Report (Metcalf & Eddy | AECOM, 2007)
4. River Road WWTP Cost and Performance Analysis Report (Metcalf & Eddy | AECOM, 2007)
5. Underwater Investigation of the North Hudson Sewer Treatment Outfall, West New York, NJ, May 17-20, 2010 (Ocean and Coastal Consultants, 2010)
6. Chartered Institution of Water and Environmental Management (CIWEM) Code of Practice for the Hydraulic Modelling of Urban Drainage Systems, Version 01, November 2017
7. Results of RedZone sewer condition assessment – export from ICOMM database
8. Field investigations:
    a. 11/30/2017 – regulators
    b. 5/11/2018 – regulators and S/F facilities
    c. 5/16/2018 – pumping stations, outfalls

Appendices

11.1 Appendix A – Population Change



11.2 Appendix B – CSO Water Quality Sampling Memo

DRAFT TECHNICAL MEMORANDUM

North Hudson Sewerage Authority Long Term Control Plan Combined Sewer Overflow Water Quality Sampling

PREPARED FOR:	Fredric Pocci, PE
COPY TO:	Don Conger, PE; Phil Reeve
PREPARED BY:	Erin McGovern; Amy Gao, PE
DATE:	June 21, 2018
PROJECT NUMBER:	676549
REVISION NO.:	**DRAFT FINAL**
APPROVED BY:	Bill McMillin, PE

CH2M performed water quality sampling of the North Hudson Sewerage Authority's combined sewer systems from August 2016 to August 2017. The data collected will enable a water quality characterization of combined sewer overflow discharges for the Authority's sewer system characterization and will aid in development of a Long Term Control Plan. This technical memorandum describes the sampling effort and the data collected.

1.0 Introduction

The following provides information on this effort, its goals and the sampling plan.

1.1 Background

The North Hudson Sewerage Authority (the Authority or NHSA) owns and operates the Adams Street and River Road Wastewater Treatment Plants (WWTPs) and their associated collection systems in Hoboken, West New York, Weehawken and Union City. The collection systems in all of these communities are combined sewer systems (CSS). The Adams Street and River Road WWTPs are regulated by the New Jersey Department of Environmental Protection (NJDEP) and under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit program. The Authority's CSS and WWTPs are operated under a long-term contract with Operations Management International (OMI).

On March 12, 2015, the NJDEP issued final individual NJPDES permits to municipalities and authorities that own and operate segments of CSS. The final NJPDES permits address requirements for overall water quality improvements, routine reporting, and development of a Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP). The NJPDES requires that a comprehensive characterization of the CSS developed through records review, monitoring, modeling and other means, as appropriate, to establish the existing baseline conditions, evaluate the efficacy of the CSO technology based controls, and determine the baseline conditions upon which the LTCP will be based. The characterization must include a thorough review of the entire collection system to adequately address the response of the CSS to various precipitation events and to identify the number, location, frequency and characteristics of CSOs.

The Authority submitted a Sewer System Characterization Work Plan to the NJDEP in December 2015 that was prepared by CH2M. The Work Plan describes collection system water quality monitoring that has since been performed to characterize bacterial concentrations in CSO discharges to the Hudson River. Dry and wet weather sampling has been performed to assure that representative Fecal Coliform and Enterococcus concentrations will be used for CSO discharges in surface water quality modeling to determine baseline compliance and for developing the LTCP.

1.2 Project Description

The CSO Water Quality Sampling Program was designed to characterize CSO discharges to the Hudson River. Sampling was performed at five regulators during dry and wet weather events from August 2016 to August 2017. The goal of the wet weather sampling was to monitor at least three rain events with rainfall greater than 0.5 inches in a 24-hour period.

1.2.1 Sampling Locations

Sampling locations were selected at CSO regulators based on GIS information of drainage area land use types evaluated by CH2M and availability of monitoring systems to detect overflows. Maps of the Authority's service area with sampling locations highlighted is provided at the end of this document. The sampling locations are also listed in Table 1-1 with site characteristics.

Regulator overflows are monitored by the Authority with Mission float sensors at CSO regulators. These sensors monitor water surface elevations in the sewers at the regulators and are linked to the Authority's Supervisory Control and Data Acquisition (SCADA) system. They indicate in real time that an overflow may be occurring when the water surface elevation rises above the regulator overflow weir elevation. The system is also used for the Authority's public notification system and records the times when overflows may be occurring. The sensors at regulators in Hoboken may indicate an overflow but tidal conditions may be higher than the water surface in the CSS preventing an overflow. All other regulators are above tidal ranges and are overflowing when the Mission sensor indicates so.

Hydraulic elevations were also metered upstream of CSO regulators from April to December 2016 under a separate LTCP characterization effort by ADS as a subcontractor to Greeley & Hansen.

TABLE 1-1
CSO Water Quality Sampling Locations

Basin ID	Location	Land Usage	% Impervious	Monitoring System
H3	3rd St. at River St. (In crosswalk)	Low/Medium Residential	71%	ADS/Mission (H3 + H4)
H7	14th St. East at Washington St.	Commercial/ Industrial	46%	ADS/Mission (H6 + H7)
18TH Street PS	W 18th St.	Open Space/ Park	39%	Mission
W2	506 Gregory Ave.	High Residential	59%	ADS/Mission
WNY1	JF Kennedy Blvd. at Anthony Delfino Way	Mixed Uses	~75%	Mission

1.2.2 Scope of Sampling

Dry weather event sampling was performed by collecting three (3) samples over a six-hour period at each designated sampling location. Dry weather event sampling was preceded by 24 hours of dry weather and monitored flows at the WWTP during the time of sampling were consistent with dry weather conditions.

The goal for wet weather sampling was to sample at least three (3) wet weather events between the months of August 2016 and August 2017 at each location. Mobilization for sampling was initiated when wet weather events were forecasted with rainfall of 0.5 inches or greater in a 24-hour period preceded by three (3) days of dry weather. Samples were to be collected at the following time intervals following the start of overflow at a regulator: 0.5, 1, 2, 4, 6, and 8 hours. Sampling ended following the 8th hour of overflow from the first regulator that opened, or when the overflow stopped, whichever came first. Samples were transported to the Eurofins QC Laboratories where they were analyzed for the parameters identified in Table 1-2.

TABLE 1-2
Analytical Parameters

Parameter	Description	Method
FC	Fecal Coliform	Membrane Filter Technique (SM 9222D-1997)
EC	Enterococci	Membrane Filter Technique (EPA 1600)

1.3 Quality Control

The Quality Assurance Project Plan (QAPP) integrated quality control policies and project-specific work tasks to successfully conduct water quality monitoring to support development of the CSO Long Term Control Plan. The QAPP was submitted to NJDEP on July 27, 2016 as part of the Authority's System Characterization Work Plans for the Adams Street and River Road WWTPs. The same QAPP was submitted in both work plans. All laboratory services were performed by Eurofins QC Laboratories.

2.0 Dry and Wet Weather Sampling

One dry weather sampling event and several wet weather events were sampled between August 2016 and August 2017. Sampling was suspended during winter months. The following describes the dry and weather sampling events and the data collected.

2.1 Dry Weather Sampling

Dry weather sampling was conducted at five (5) regulator locations on August 23, 2016. This sampling event was preceded by more than 24 hours of dry weather. Three representative samples were grabbed from each of the sampling locations at different times throughout the day. Enterococcus concentrations ranged from <100,000 cfu/100 mL to approximately 4.5 million cfu/100 mL. Fecal Coliform concentrations ranged from <100,000 cfu/100 mL to approximately 18 million cfu/100 mL. The results of dry weather sampling are shown below in Table 2-1.

TABLE 2-1
Dry Weather Sampling Event – August 23, 2016

Sampling Location	Time	Enterococcus Concentration (cfu/100mL)	Fecal Coliform Concentration (cfu/100mL)
H3	9:30	1,900,000 Q	1,200,000 Q
	13:02	3,600,000	7,000,000 F
	15:30	300,000	<100,000
H7	9:56	<100,000 Q	900,000 Q
	13:20	1,900,000	18,000,000
	15:50	100,000	200,000
18th Street PS	9:42	<100,000 Q	900,000 Q
	13:06	600,000	1,000,000
	16:05	<100,000	300,000
W2	8:50	400,000 Q	700,000 Q
	12:53	3,800,000	3,900,000

TABLE 2-1
Dry Weather Sampling Event – August 23, 2016

Sampling Location	Time	Enterococcus Concentration (cfu/100mL)	Fecal Coliform Concentration (cfu/100mL)
	15:23	100,000	500,000
WNY1	8:30	<100,000	1,600,000 Q
	12:34	4,500,000	4,800,000
	14:58	<100,000	600,000

Notes:

E - Count is outside of recommended range of test. Reported value may be considered estimate.

Q - Samples analyzed outside of hold time.

2.2 Wet Weather Sampling

Wet weather sampling was performed during four (4) events on the following dates:

- October 27, 2016
- November 29, 2016
- April 25, 2017
- August 8, 2017

Wet weather sampling events are defined as events with total rainfall of 0.5 inches or greater within a 24-hour period. Rainfall data, collected from the Authority's rain gage at the Baldwin Avenue Pump Station, confirms that all the wet weather sampling events had rainfall greater than 0.5 inches within a 24-hour period. Table 2-2 summarizes rainfall data for each of the wet weather events sampled including total rainfall depth, duration and maximum intensity.

TABLE 2-2
Wet Weather Sampling Rainfall Data

Event #	Date	Total Rainfall (inches)	Duration (hours)	Maximum Intensity (inches/hour)
1	10/27/16	1.15	13.00	0.15
2	11/29/16	1.97	12.25	0.14
3	4/25/17	0.70	6.75	0.13
4	8/7/17	0.59	11.00	0.04

Wet weather sampling was conducted as regulators opened. Some events did not provide sufficient rainfall to open all five (5) regulators that were desired for sampling. A summary of the number of samples that were analyzed at each sampling location per wet weather event is shown in Table 2-3.

TABLE 2-3
Wet Weather Sampling Event Summary

Sampling Location	# of Samples Taken				Total # Wet Weather Samples/ Location
	10/27/2016 *	11/29/2016	4/25/2017	8/7/2017	
H3	0	0	0	0	0
H7	0	6	0	0	6
18th Street PS	0	0	0	1	1
W2	0	6	4	5	15
WNY1	1	6	0	6	13

*Unfavorable event, insufficient rainfall to continue sampling

2.2.1 Wet Weather Event 1 - October 27, 2016

On October 27, 2016, one (1) water quality sample was collected from the WNY1 sampling location. The sampling team mobilized at 6:00 am to capture the forecasted rainfall, however, increased rainfall accumulation did not occur until later in the evening as shown in Figure 2-1. Sampling was called off after the WNY1 regulator opened at 11:27 am and then closed shortly after at 12:08 pm due to a lack of precipitation. Total rainfall recorded on October 27, 2016 was 1.15 inches with a majority of the rainfall occurring later in the evening. The data from this sampling event are shown in Table 2-4.

FIGURE 2-1
Wet Weather Sampling Event 1 – October 27, 2016 – Rainfall Accumulation

* This is the initial opening of the regulator. Regulator closed and re-opened several times during the event.

TABLE 2-4

Wet Weather Sampling Event 1 – October 27, 2016

Sampling Location	Time from Regulator Opening (mins)	Sample Time	Enterococcus Concentration (cfu/100mL)	Fecal Coliform Concentration (cfu/100mL)
WNY1	40	11:27	30,000,000	120,000,000 [E]

E - Count is outside of recommended range of test. Reported value may be considered estimate.

2.2.2 Wet Weather Event 2 - November 29, 2016

On November 29, 2016 eighteen (18) water quality samples were collected. During this event, 1.97 inches of rainfall was recorded over 12.25 hours, the H7, W2 and WNY1 regulators opened as shown in Figure 2-2 below.

FIGURE 2-2

Wet Weather Sampling Event 2 – November 29, 2016 – Rainfall Accumulation

Regulators H7, W2 and WNY1 remained open for the duration of rainfall allowing the sampling team to grab samples at each of the target times following the start of overflow (approximately 0.5, 1, 2, 4, 6, and 8 hours). The concentrations of Enterococcus and Fecal Coliform for this wet weather event are shown in Figures 2-3 and 2-4, respectively. The data from this sampling event are also shown in Table 2-5.

FIGURE 2-3

Wet Weather Sampling Event 2 – November 29, 2016 – Enterococcus Concentrations

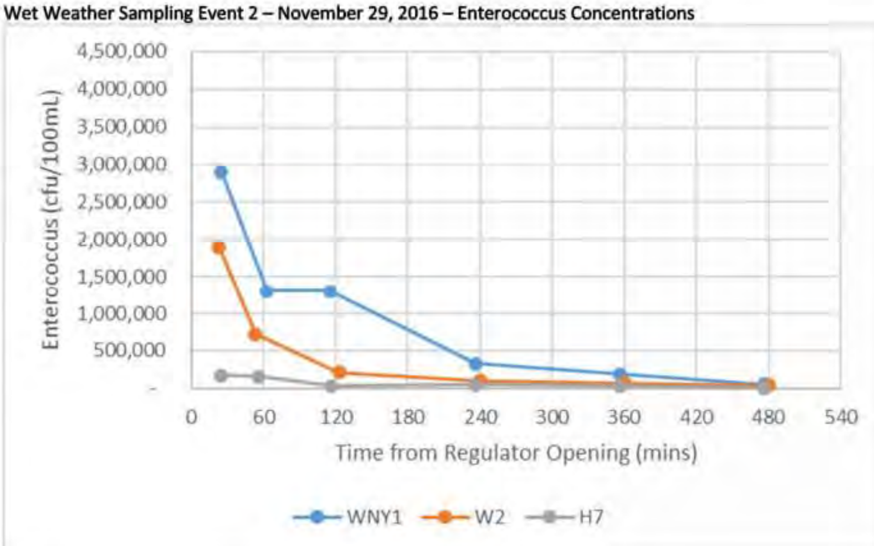


FIGURE 2-4

Wet Weather Sampling Event 2 – November 29, 2016 – Fecal Coliform Concentrations

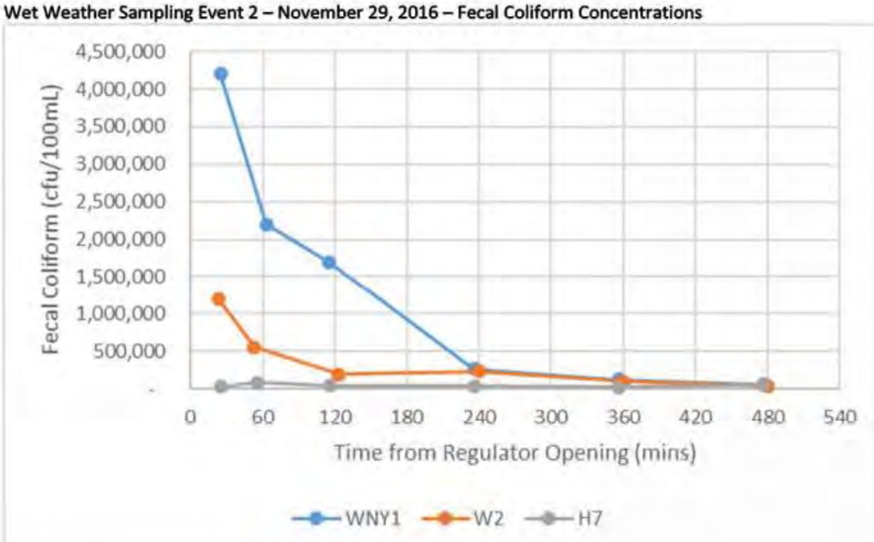


TABLE 2-5

Wet Weather Sampling Event 2 – November 29, 2016

Sampling Location	Time from Regulator Opening (mins)	Sample Time	Enterococcus Concentration (cfu/100mL)	Fecal Coliform Concentration (cfu/100mL)
WNY1	25	9:50	2,900,000	4,200,000
	63	10:28	1,300,000 E	2,200,000
	115	11:20	1,300,000 E	1,700,000 E
	236	13:21	330,000	260,000
	356	15:21	190,000 E	120,000 E
	476	17:21	57,000	58,000
W2	23	10:10	1,900,000 E	1,200,000 E
	53	10:40	720,000 E	550,000
	123	11:50	210,000	190,000
	240	13:47	100,000 E	230,000
	360	15:47	71,000 E	98,000 E
	480	17:47	42,000 E	40,000
H7	25	11:40	170,000 E	27,000
	56	12:11	160,000 E	81,000 E
	116	13:11	35,000	44,000
	236	15:11	47,000	35,000
	356	17:11	35,000	23,000
	476	19:11	1,800 E	50,000 E

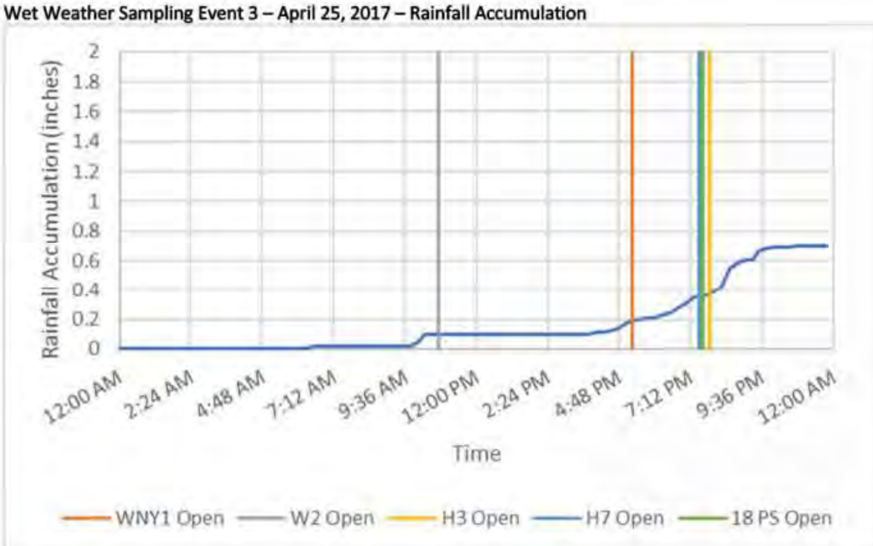
E - Count is outside of recommended range of test. Reported value may be considered estimate.

2.2.3 Wet Weather Event 3 - April 25, 2017

Sixteen (16) water quality samples were collected on April 25, 2017 between 11:00 am and 4:00 pm. The rainfall recorded during the event was 0.7 inches from about 10:00 am to 9:30 pm. The Authority's Mission system was being monitored and initially indicated that overflows may have been occurring once the rainfall started. Upon collecting Mission system data after the event, only the W2 regulator had elevations indicating an overflow may have been occurring during the sampling period. The Mission system data indicated that Regulators WNY1, H3, H7 and the 18th Street Pump Station likely discharged later in the evening as rainfall accumulation increased. But weather flow from about 0.1 inches of rainfall was in the CSS during sampling. See Figure 2-5 below for rainfall accumulation and Mission data.

FIGURE 2-5

Wet Weather Sampling Event 3 – April 25, 2017 – Rainfall Accumulation



Only the samples collected from W2 are likely representative of a wet weather event. The observed concentrations of enterococcus and fecal coliforms are shown in Figures 2-6 and 2-7, respectively. The data of all other samples are likely not representative of a wet weather event as the other regulators did not open until later in the evening when the rainfall intensity increased and sampling had ended. The bacteria data for all samples are shown in Table 2-6.

FIGURE 2-6

Wet Weather Sampling Event 3 – April 25, 2017 – Enterococcus Concentrations

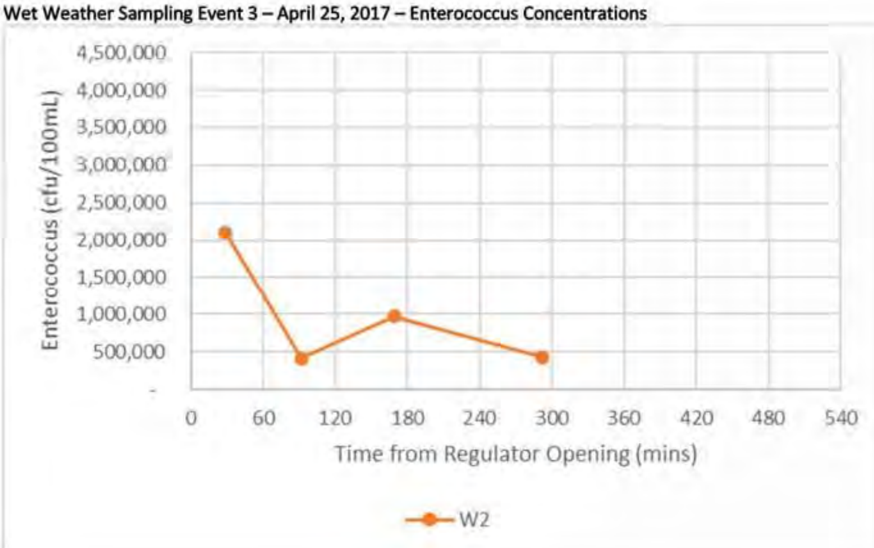


FIGURE 2-7

Wet Weather Sampling Event 3 – April 25, 2017 – Fecal Coliform Concentrations

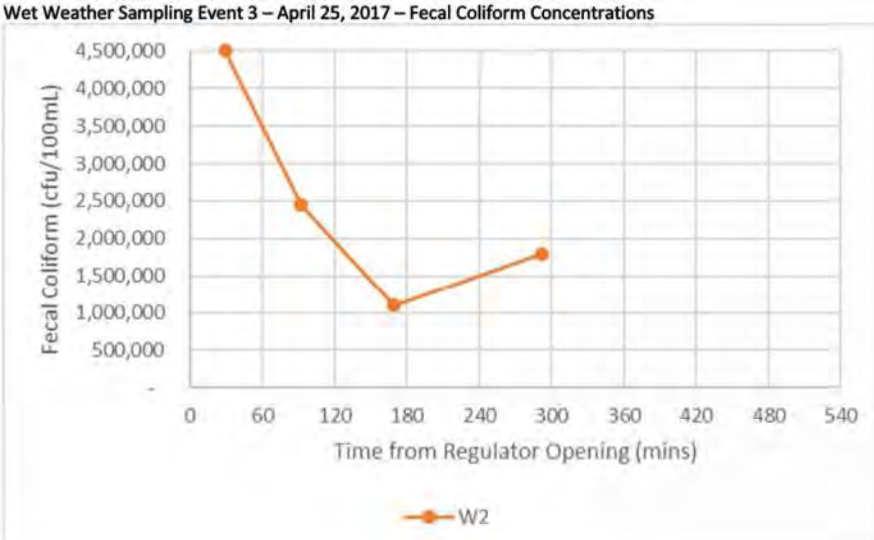


TABLE 2-6
Wet Weather Sampling Event 3 – April 25, 2017

Sampling Location	Time from Regulator Opening (mins)	Sample Time	Enterococcus Concentration (cfu/100mL)	Fecal Coliform Concentration (cfu/100mL)
WNY1	30	11:00	210,000	390,000
	90	12:00	420,000	2,500,000
	168	13:18	700,000 [E]	2,500,000
	275	15:05	450,000	1,400,000 [E]
W2	29	11:12	2,100,000	4,500,000
	92	12:15	410,000	2,450,000 [E]
	169	13:32	972,973 [E]	1,100,000 [E]
	292	15:35	430,000	1,800,000 [E]
H7	30	11:30	380,000	3,200,000
	90	12:32	540,000	2,500,000
	147	13:47	250,000	620,000 [E]
	275	15:40	280,000	763,636 [E]
H3	30	11:50	300,000	630,000 [E]
	92	12:50	240,000	1,700,000 [E]
	167	13:57	1,500,000 [E]	1,600,000 [E]
	280	16:05	2,600,000	3,100,000

E - Count is outside of recommended range of test. Reported value may be considered estimate.

2.2.4 Wet Weather Event 4 - August 7, 2017

On August 7, 2017, a total of twelve (12) water quality samples were collected. The rainfall recorded was 0.59 inches of over eleven hours. Rainfall and Mission system data showing overflow conditions for Regulators W2, WNY1 and the 18th Street Pump Station are shown in Figure 2-8.

FIGURE 2-8

Wet Weather Sampling Event 4 – August 7, 2017 – Rainfall Accumulation

* This is the initial opening of the regulator. Regulator closed and re-opened several times during the event.

The sampling of this event was modified slightly from the QAPP to collect viable samples. The WNY1 regulator opened and closed several times throughout the event. Samples taken from WNY1 followed the QAPP in that they were taken until approximately eight hours after the initial regulator opening. Some samples were grabbed while the regulator was not overflowing but wet weather flow was in the CSS. The data for this sampling event are shown in Figures 2-9 and 2-10 below as well as in Table 2-7.

FIGURE 2-9

Wet Weather Sampling Event 4– August 8, 2017 – Enterococcus Concentrations

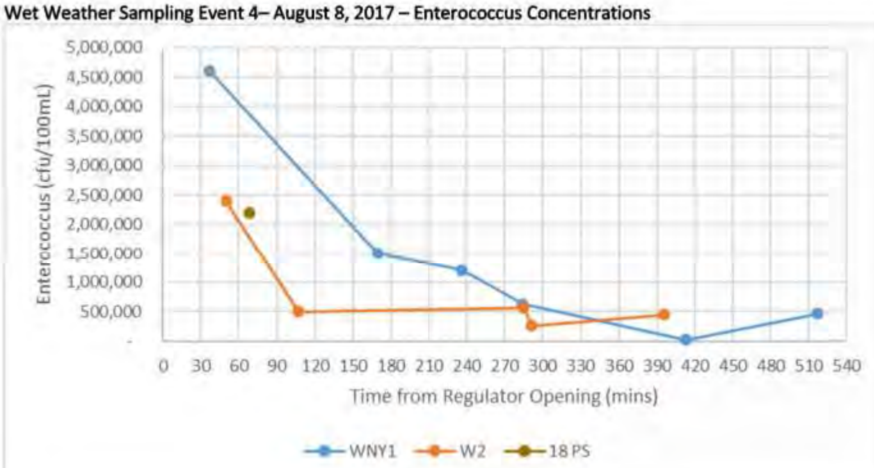


FIGURE 2-10

Wet Weather Sampling Event 4– August 8, 2017 – Fecal Coliform Concentrations

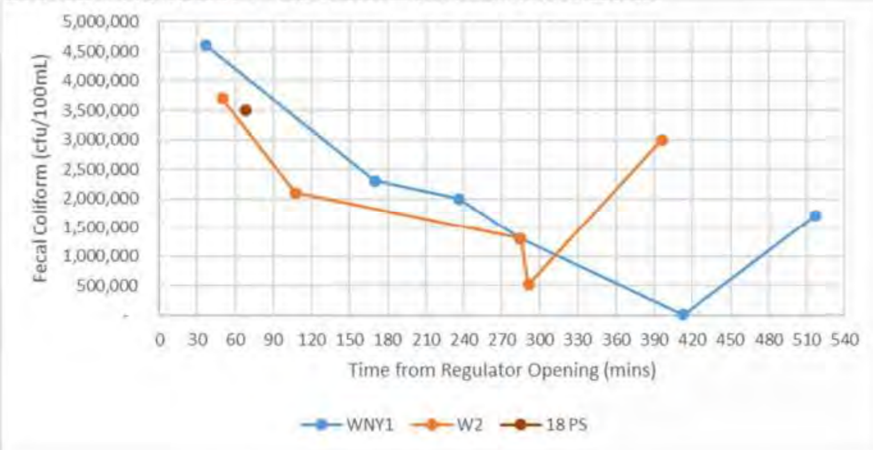


TABLE 2-7

Wet Weather Sampling Event 4 – August 8, 2017

Sampling Location	Time from Regulator Opening (mins)	Sample Time	Enterococcus Concentration (cfu/100mL)	Fecal Coliform Concentration (cfu/100mL)
WNY1	37	10:20	4,600,000	4,600,000
	170	12:33	1,500,000 E	2,300,000
	236	13:39	1,200,000 E	2,000,000
	284	14:27	630,000 E	1,300,000 E
	413	16:36	25,000	4,100
	517	18:20	470,000	1,700,000 E
W2	50	12:50	2,400,000	3,700,000
	107	13:47	500,000	2,100,000
	285	14:45	570,000	1,300,000
	291	16:51	260,000	520,000
	396	18:36	450,000	3,000,000
18 PS	68	19:21	2,200,000	3,500,000

E - Count is outside of recommended range of test. Reported value may be considered estimate.

3.0 Summary of Findings

This work effort was performed to characterize bacterial concentrations in CSO discharges to the Hudson River. The procedures in the QAPP were executed and quality control was followed. Many analytical results were outside the recommended range of tests and should be considered estimates. Bacterial samples collected from wastewater, stormwater, combined sewage and surface waters can vary by orders of magnitude at the same location on the same day in dry and wet weather depending on the conditions when the sample was collected.

Dry weather sampling provided a range of baseline concentrations for sanitary enterococcus and fecal coliform within the CSS. Dry weather enterococcus samples ranged from less than 100,000 cfu/100mL to 4,500,000 cfu/100mL. Fecal coliform samples ranged from less than 100,000 cfu/100mL to 18,000,000 cfu/100mL.

Wet weather sampling provided a range of concentrations that may be expected to be discharged at times of combined sewer overflows. Wet weather enterococcus samples generally ranged from 1,800 cfu/100mL to 4,500,000 cfu/100mL, although a 30,000,000 cfu/100mL was reported in one sample. Fecal coliform samples generally ranged from 4,100 cfu/100mL to 4,600,000 cfu/100mL, although a 120,000,000 cfu/100mL was reported in one sample. All wet weather samples showed data starting with high concentrations at the beginning of the event and dropping during the event, indicating a first flush followed by more dilution as rainfall fell and wet weather flow increased.

The NJ CSO Group was also performing stormwater and CSO sampling at the same time for the hydraulically connected permittees in northern New Jersey. CSO samples were collected in Paterson, Newark, Harrison and Kearny. In general, their wet weather CSO data ranged from 625,000 cfu/100mL to 8,500,00 cfu/100mL for enterococcus and 2,700.000 cfu/100mL to 72,000,000 cfu/100mL for fecal coliform. The Authority's data was in the same range as the NJ CSO Group data.

NORTH HUDSON SEWERAGE AUTHORITY
LONG TERM CONTROL PLAN COMBINED SEWER OVERFLOW WATER QUALITY SAMPLING

CH2M HILL ENGINEERS, INC. 15 OF 17

NORTH HUDSON SEWERAGE AUTHORITY
LONG TERM CONTROL PLAN COMBINED SEWER OVERFLOW WATER QUALITY SAMPLING

16 OF 17

CH2M HILL ENGINEERS, INC.

NORTH HUDSON SEWERAGE AUTHORITY
LONG TERM CONTROL PLAN COMBINED SEWER OVERFLOW WATER QUALITY SAMPLING

11.3 Appendix C– Wet and Dry Days

Summary of Dry and Wet Weather Days for the Monitoring Period

DATE	Rainfall (in)	Dry/Wet	Weekday/Weekend
5/17/2016	0.00	Wet	Weekday
5/18/2016	0.00	Wet	Weekday
5/19/2016	0.00	Dry	Weekday
5/20/2016	0.00	Dry	Weekday
5/21/2016	0.03	Wet	Weekend
5/22/2016	0.08	Wet	Weekend
5/23/2016	0.00	Wet	Weekday
5/24/2016	0.16	Wet	Weekday
5/25/2016	0.00	Wet	Weekday
5/26/2016	0.00	Wet	Weekday
5/27/2016	0.00	Dry	Weekday
5/28/2016	0.00	Dry	Weekend
5/29/2016	0.00	Dry	Weekend
5/30/2016	1.38	Wet	Weekday
5/31/2016	0.00	Wet	Weekday
6/1/2016	0.00	Wet	Weekday
6/2/2016	0.00	Wet	Weekday
6/3/2016	0.03	Wet	Weekday
6/4/2016	0.58	Wet	Weekend
6/5/2016	0.96	Wet	Weekend
6/6/2016	0.00	Wet	Weekday
6/7/2016	0.00	Wet	Weekday
6/8/2016	0.40	Wet	Weekday
6/9/2016	0.00	Wet	Weekday
6/10/2016	0.00	Wet	Weekday
6/11/2016	0.00	Wet	Weekend
6/12/2016	0.00	Dry	Weekend
6/13/2016	0.00	Dry	Weekday
6/14/2016	0.00	Dry	Weekday
6/15/2016	0.00	Dry	Weekday
6/16/2016	0.20	Wet	Weekday
6/17/2016	0.00	Wet	Weekday
6/18/2016	0.00	Wet	Weekend
6/19/2016	0.00	Dry	Weekend
6/20/2016	0.00	Dry	Weekday
6/21/2016	0.00	Dry	Weekday
6/22/2016	0.00	Dry	Weekday

DATE	Rainfall (in)	Dry/Wet	Weekday/Weekend
6/23/2016	0.00	Dry	Weekday
6/24/2016	0.00	Dry	Weekday
6/25/2016	0.00	Dry	Weekend
6/26/2016	0.00	Dry	Weekend
6/27/2016	0.18	Wet	Weekday
6/28/2016	0.43	Wet	Weekday
6/29/2016	0.04	Wet	Weekday
6/30/2016	0.00	Wet	Weekday
7/1/2016	1.28	Wet	Weekday
7/2/2016	0.00	Wet	Weekend
7/3/2016	0.00	Wet	Weekend
7/4/2016	0.27	Wet	Weekday
7/5/2016	1.15	Wet	Weekday
7/6/2016	0.00	Wet	Weekday
7/7/2016	0.01	Wet	Weekday
7/8/2016	0.02	Wet	Weekday
7/9/2016	0.38	Wet	Weekend
7/10/2016	0.00	Wet	Weekend
7/11/2016	0.00	Wet	Weekday
7/12/2016	0.00	Wet	Weekday
7/13/2016	0.00	Dry	Weekday
7/14/2016	0.62	Wet	Weekday
7/15/2016	0.00	Wet	Weekday
7/16/2016	0.00	Wet	Weekend
7/17/2016	0.00	Wet	Weekend
7/18/2016	0.32	Wet	Weekday
7/19/2016	0.00	Wet	Weekday
7/20/2016	0.00	Wet	Weekday
7/21/2016	0.00	Wet	Weekday
7/22/2016	0.00	Dry	Weekday
7/23/2016	0.00	Dry	Weekend
7/24/2016	0.00	Dry	Weekend
7/25/2016	0.77	Wet	Weekday
7/26/2016	0.00	Wet	Weekday
7/27/2016	0.00	Wet	Weekday
7/28/2016	0.00	Wet	Weekday
7/29/2016	0.86	Wet	Weekday
7/30/2016	0.24	Wet	Weekend
7/31/2016	0.72	Wet	Weekend
8/1/2016	0.05	Wet	Weekday
8/2/2016	0.00	Wet	Weekday
8/3/2016	0.00	Wet	Weekday
8/4/2016	0.00	Dry	Weekday

DATE	Rainfall (in)	Dry/Wet	Weekday/Weekend
8/5/2016	0.00	Dry	Weekday
8/6/2016	0.09	Wet	Weekend
8/7/2016	0.00	Wet	Weekend
8/8/2016	0.00	Wet	Weekday
8/9/2016	0.00	Dry	Weekday
8/10/2016	0.08	Wet	Weekday
8/11/2016	0.00	Wet	Weekday
8/12/2016	0.34	Wet	Weekday
8/13/2016	0.00	Wet	Weekend
8/14/2016	0.13	Wet	Weekend
8/15/2016	0.00	Wet	Weekday
8/16/2016	0.23	Wet	Weekday
8/17/2016	0.00	Wet	Weekday
8/18/2016	0.03	Wet	Weekday
8/19/2016	0.00	Wet	Weekday
8/20/2016	0.02	Wet	Weekend
8/21/2016	0.15	Wet	Weekend
8/22/2016	0.00	Wet	Weekday
8/23/2016	0.00	Wet	Weekday
8/24/2016	0.00	Dry	Weekday
8/25/2016	0.00	Dry	Weekday
8/26/2016	0.00	Dry	Weekday
8/27/2016	0.00	Dry	Weekend
8/28/2016	0.00	Dry	Weekend
8/29/2016	0.00	Dry	Weekday
8/30/2016	0.00	Dry	Weekday
8/31/2016	0.00	Dry	Weekday
9/1/2016	0.56	Wet	Weekday
9/2/2016	0.00	Wet	Weekday
9/3/2016	0.00	Wet	Weekend
9/4/2016	0.00	Wet	Weekend
9/5/2016	0.00	Dry	Weekday
9/6/2016	0.00	Dry	Weekday
9/7/2016	0.00	Dry	Weekday
9/8/2016	0.00	Dry	Weekday
9/9/2016	0.11	Wet	Weekday
9/10/2016	0.05	Wet	Weekend
9/11/2016	0.00	Wet	Weekend
9/12/2016	0.00	Wet	Weekday
9/13/2016	0.00	Dry	Weekday
9/14/2016	0.64	Wet	Weekday

DATE	Rainfall (in)	Dry/Wet	Weekday/Weekend
9/15/2016	0.00	Wet	Weekday
9/16/2016	0.00	Wet	Weekday
9/17/2016	0.00	Wet	Weekend
9/18/2016	0.00	Dry	Weekend
9/19/2016	0.45	Wet	Weekday
9/20/2016	0.00	Wet	Weekday
9/21/2016	0.00	Wet	Weekday
9/22/2016	0.00	Wet	Weekday
9/23/2016	0.00	Dry	Weekday
9/24/2016	0.28	Wet	Weekend
9/25/2016	0.00	Wet	Weekend
9/26/2016	0.00	Wet	Weekday
9/27/2016	0.25	Wet	Weekday
9/28/2016	0.00	Wet	Weekday
9/29/2016	0.00	Wet	Weekday
9/30/2016	0.41	Wet	Weekday
10/1/2016	0.00	Wet	Weekend
10/2/2016	0.00	Wet	Weekend
10/3/2016	0.00	Wet	Weekday
10/4/2016	0.00	Dry	Weekday
10/5/2016	0.00	Dry	Weekday
10/6/2016	0.00	Dry	Weekday
10/7/2016	0.00	Dry	Weekday
10/8/2016	0.13	Wet	Weekend
10/9/2016	0.52	Wet	Weekend
10/10/2016	0.00	Wet	Weekday
10/11/2016	0.00	Wet	Weekday
10/12/2016	0.00	Wet	Weekday
10/13/2016	0.00	Dry	Weekday
10/14/2016	0.00	Dry	Weekday
10/15/2016	0.00	Dry	Weekend
10/16/2016	0.00	Dry	Weekend
10/17/2016	0.00	Dry	Weekday
10/18/2016	0.00	Dry	Weekday
10/19/2016	0.00	Dry	Weekday
10/20/2016	0.00	Dry	Weekday
10/21/2016	0.00	Dry	Weekday
10/22/2016	0.00	Dry	Weekend
10/23/2016	0.00	Dry	Weekend
10/24/2016	0.00	Dry	Weekday
10/25/2016	0.00	Dry	Weekday
10/26/2016	0.00	Dry	Weekday
10/27/2016	0.00	Dry	Weekday

DATE	Rainfall (in)	Dry/Wet	Weekday/Weekend
10/28/2016	0.00	Dry	Weekday
10/29/2016	0.00	Dry	Weekend
10/30/2016	0.00	Dry	Weekend
10/31/2016	0.00	Dry	Weekday
11/1/2016	0.00	Dry	Weekday
11/2/2016	0.00	Dry	Weekday
11/3/2016	0.00	Dry	Weekday
11/4/2016	0.00	Dry	Weekday
11/5/2016	0.00	Dry	Weekend
11/6/2016	0.00	Dry	Weekend
11/7/2016	0.00	Dry	Weekday
11/8/2016	0.00	Dry	Weekday
11/9/2016	0.07	Wet	Weekday
11/10/2016	0.00	Wet	Weekday
11/11/2016	0.00	Wet	Weekday
11/12/2016	0.00	Dry	Weekend
11/13/2016	0.00	Dry	Weekend
11/14/2016	0.00	Dry	Weekday
11/15/2016	1.50	Wet	Weekday
11/16/2016	0.00	Wet	Weekday

11.4 Appendix D Model Calibration and Output

Calibration Summary Tables

Dry Weather Flow Plots

Modeled versus Metered Plots

Calibration and Validation Individual Storm Plots

UC1 Calibration Summary

START DATE	END DATE	Calibration Validation	RAINFALL DEPTH (IN)	MAX 5-MIN RAINFALL INTENSITY (IN/HR)	Metered Volume	Modeled Volume	Volume Diff %	Peak Flow	Modeled Peak	Peak Diff %	Meter Depth	Modeled Depth	Depth Diff
6/19/2016 0:00	6/27/2016 0:00	Dry	0.00	0.0	16.16	16.37	1%	2.87	2.56	-11%	1.7	1.7	0.0
5/30/2016 1:20	5/30/2016 10:40	Calibration	1.38	2.4	3.20	3.66	14%	41.86	51.82	24%	4.0	3.5	-0.5
7/1/2016 15:45	7/1/2016 22:20	Validation	1.28	3.4	2.21	2.58	17%	43.55	47.23	8%	4.3	3.3	-1.0
9/14/2016 10:10	9/14/2016 18:20	Validation	0.64	2.8	1.62	1.73	7%	12.86	13.46	5%	2.4	2.2	-0.2
9/19/2016 5:25	9/19/2016 16:20	Calibration	0.45	0.2	1.93	1.80	-7%	43.85	52.93	21%	4.5	3.5	-1.0
9/24/2016 0:50	9/24/2016 5:30	Calibration	0.28	0.7	0.84	0.77	-8%	11.27	11.21	-1%	2.3	2.1	-0.2
10/8/2016 13:20	10/9/2016 13:50	Validation	0.65	0.2	3.33	3.27	-2%	13.31	12.82	-4%	2.4	2.2	-0.2
11/15/2016 4:05	11/15/2016 16:50	Calibration	1.50	1.0	4.06	4.14	2%	19.83	24.55	24%	2.8	2.6	-0.2
6/4/2016 18:10	6/5/2016 21:05	Check	1.54	2.6	5.86	5.44	-7%	6.58	6.63	1%	2.0	1.9	-0.1
6/8/2016 11:55	6/8/2016 17:25	Check	0.40	0.5	1.26	1.26	0%	49.28	49.46	0%	4.5	3.4	-1.1
6/16/2016 4:25	6/16/2016 8:10	Check	0.20	0.4	0.73	0.58	-20%	46.56	46.29	-1%	4.0	3.3	-0.7
6/27/2016 20:35	6/29/2016 2:10	Check	0.65	1.3	3.49	3.80	9%	16.31	19.74	21%	2.6	2.4	-0.1
7/4/2016 19:45	7/5/2016 6:35	Check	1.42	2.3	3.66	3.80	4%	10.88	9.26	-15%	2.3	2.1	-0.2
7/9/2016 21:20	7/10/2016 0:30	Check	0.38	1.3	1.01	0.99	-2%	13.34	25.24	89%	2.4	2.6	0.2
7/14/2016 15:05	7/14/2016 17:30	Check	0.62	1.8	1.21	1.42	17%	32.04	24.72	-23%	3.1	2.6	-0.5
7/18/2016 15:45	7/18/2016 18:35	Check	0.32	2.4	0.92	0.84	-9%	14.71	15.28	4%	2.5	2.3	-0.2
7/25/2016 16:10	7/25/2016 20:10	Check	0.77	2.2	1.86	1.89	2%	29.31	35.32	20%	3.2	2.9	-0.3
7/29/2016 0:15	7/29/2016 10:20	Check	0.86	0.8	2.23	2.48	11%	31.34	27.13	-13%	3.4	2.7	-0.7
7/31/2016 7:35	8/1/2016 1:50	Check	0.77	3.6	3.32	3.12	-6%	21.29	20.83	-2%	2.8	2.5	-0.3
8/12/2016 0:00	8/12/2016 20:05	Check	0.34	0.8	2.38	2.33	-2%	14.96	11.35	-24%	2.5	2.1	-0.3
9/1/2016 0:15	9/1/2016 16:25	Check	0.56	1.0	2.27	2.31	2%	30.24	22.29	-26%	3.2	2.5	-0.7
9/27/2016 1:20	9/27/2016 11:45	Check	0.25	0.4	1.28	1.26	-2%	48.52	37.47	-23%	4.5	3.0	-1.5
9/30/2016 9:05	9/30/2016 23:59	Check	0.41	0.1	2.32	2.10	-10%	39.52	28.10	-29%	4.5	2.7	-1.8

Meets CIWEM Criteria

* Note “START DATE” and “END DATE” refer to the beginning of wet weather response used for volume calculations and do not refer to start and end times of the rain.

UC2 Calibration Summary

START DATE	END DATE	Calibration Validation	RAINFALL DEPTH (IN)	MAX 5-MIN RAINFALL INTENSITY (IN/HR)	Metered Volume	Modeled Volume	Volume Diff %	Peak Flow	Modeled Peak	Peak Diff %	Meter Depth	Modeled Depth	Depth Diff
6/19/2016 0:00	6/27/2016 0:00	Dry	0.00	0.0	18.01	18.62	3%	3.10	2.96	-5%	1.4	1.5	0.1
5/30/2016 1:20	5/30/2016 10:40	Calibration	1.38	2.4	4.30	4.43	3%	70.62	65.72	-7%	3.1	2.9	-0.2
7/1/2016 15:45	7/1/2016 22:20	Validation	1.28	3.4	2.94	3.08	5%	76.96	53.48	-31%	3.3	2.7	-0.7
9/14/2016 10:10	9/14/2016 18:20	Validation	0.64	2.8	2.17	2.01	-7%	17.22	17.71	3%	1.9	2.1	0.2
9/19/2016 5:25	9/19/2016 16:20	Calibration	0.45	0.2	2.42	2.25	-7%	60.19	69.37	15%	4.1	2.9	-1.2
9/24/2016 0:50	9/24/2016 5:30	Calibration	0.28	0.7	1.03	0.97	-5%	15.82	15.14	-4%	1.9	2.0	0.1
10/8/2016 13:20	10/9/2016 13:50	Validation	0.65	0.2	4.12	4.06	-1%	17.61	16.86	-4%	1.9	2.1	0.1
11/15/2016 4:05	11/15/2016 16:50	Calibration	1.50	1.0	5.48	5.30	-3%	34.33	30.54	-11%	2.2	2.3	0.2
6/4/2016 18:10	6/5/2016 21:05	Check	1.54	2.6	7.37	6.60	-11%	8.01	8.96	12%	1.8	1.9	0.1
6/8/2016 11:55	6/8/2016 17:25	Check	0.40	0.5	1.59	1.61	2%	68.35	64.27	-6%	3.0	2.8	-0.2
6/16/2016 4:25	6/16/2016 8:10	Check	0.20	0.4	0.88	0.72	-18%	61.34	54.42	-11%	3.1	2.7	-0.4
6/27/2016 20:35	6/29/2016 2:10	Check	0.65	1.3	3.97	4.60	16%	22.01	25.81	17%	2.0	2.2	0.3
7/4/2016 19:45	7/5/2016 6:35	Check	1.42	2.3	4.76	4.69	-2%	13.07	12.29	-6%	1.9	2.0	0.1
7/9/2016 21:20	7/10/2016 0:30	Check	0.38	1.3	1.26	1.24	-2%	20.71	29.25	41%	1.9	2.3	0.4
7/14/2016 15:05	7/14/2016 17:30	Check	0.62	1.8	1.67	1.65	-1%	55.42	30.71	-45%	2.9	2.3	-0.5
7/18/2016 15:45	7/18/2016 18:35	Check	0.32	2.4	1.29	1.06	-18%	19.78	19.36	-2%	1.9	2.1	0.2
7/25/2016 16:10	7/25/2016 20:10	Check	0.77	2.2	2.73	2.38	-13%	36.47	36.65	1%	2.2	2.4	0.2
7/29/2016 0:15	7/29/2016 10:20	Check	0.86	0.8	2.86	3.21	12%	45.70	31.77	-30%	2.5	2.3	-0.2
7/31/2016 7:35	8/1/2016 1:50	Check	0.77	3.6	4.11	3.81	-7%	39.10	25.89	-34%	2.3	2.2	-0.1
8/12/2016 0:00	8/12/2016 20:05	Check	0.34	0.8	2.89	2.76	-5%	18.87	13.99	-26%	1.9	2.0	0.1
9/1/2016 0:15	9/1/2016 16:25	Check	0.56	1.0	2.88	2.82	-2%	49.74	25.04	-50%	2.7	2.2	-0.5
9/27/2016 1:20	9/27/2016 11:45	Check	0.25	0.4	1.54	1.54	0%	51.31	39.70	-23%	2.6	2.5	-0.2
9/30/2016 9:05	9/30/2016 23:59	Check	0.41	0.1	2.80	2.63	-6%	40.07	31.09	-22%	2.3	2.3	0.0

Meets CIWEM Criteria

* Note “START DATE” and “END DATE” refer to the beginning of wet weather response used for volume calculations and do not refer to start and end times of the rain.

WNY2 Calibration Summary

START DATE	END DATE	Calibration Validation	RAINFALL DEPTH (IN)	MAX 5-MIN RAINFALL INTENSITY (IN/HR)	Metered Volume	Modeled Volume	Volume Diff %	Peak Flow	Modeled Peak	Peak Diff %	Meter Depth	Modeled Depth	Depth Diff
6/19/2016 0:00	6/27/2016 0:00	Dry	0.00	0.0	26.32	26.80	2%	4.63	4.31	-7%	2.0	2.0	-0.1
5/30/2016 1:20	5/30/2016 10:40	Calibration	1.38	2.4	5.32	6.17	16%	73.50	75.47	3%	4.1	3.1	-1.0
7/1/2016 15:45	7/1/2016 22:20	Validation	1.28	3.4	3.91	3.95	1%	73.41	66.96	-9%	4.3	3.0	-1.3
9/14/2016 10:10	9/14/2016 18:20	Validation	0.64	2.8	2.37	2.68	13%	21.05	23.55	12%	2.7	2.4	-0.2
9/19/2016 5:25	9/19/2016 16:20	Calibration	0.45	0.2	3.18	3.29	4%	80.75	76.01	-6%	6.4	3.1	-3.3
9/24/2016 0:50	9/24/2016 5:30	Calibration	0.28	0.7	1.29	1.41	9%	18.96	21.02	11%	2.7	2.4	-0.3
10/8/2016 13:20	10/9/2016 13:50	Validation	0.65	0.2	4.93	6.07	23%	20.41	23.42	15%	2.7	2.4	-0.2
11/15/2016 4:05	11/15/2016 16:50	Calibration	1.50	1.0	13.38	7.48	-44%	81.03	39.23	-52%	3.4	2.7	-0.8
6/4/2016 18:10	6/5/2016 21:05	Check	1.54	2.6	9.07	9.18	1%	9.03	13.69	52%	2.5	2.3	-0.2
6/8/2016 11:55	6/8/2016 17:25	Check	0.40	0.5	2.01	2.36	17%	73.77	71.20	-3%	4.6	3.1	-1.5
6/16/2016 4:25	6/16/2016 8:10	Check	0.20	0.4	1.07	1.02	-4%	74.30	67.12	-10%	3.7	3.0	-0.7
6/27/2016 20:35	6/29/2016 2:10	Check	0.65	1.3	5.83	6.68	15%	25.12	33.44	33%	2.7	2.6	-0.2
7/4/2016 19:45	7/5/2016 6:35	Check	1.42	2.3	6.02	6.57	9%	15.83	17.58	11%	2.6	2.3	-0.3
7/9/2016 21:20	7/10/2016 0:30	Check	0.38	1.3	1.65	1.74	5%	28.95	39.40	36%	2.7	2.7	-0.1
7/14/2016 15:05	7/14/2016 17:30	Check	0.62	1.8	1.94	2.16	11%	45.03	38.13	-15%	2.9	2.6	-0.2
7/18/2016 15:45	7/18/2016 18:35	Check	0.32	2.4	1.47	1.50	2%	23.33	26.58	14%	2.7	2.5	-0.2
7/25/2016 16:10	7/25/2016 20:10	Check	0.77	2.2	2.87	3.28	14%	39.29	50.92	30%	2.8	2.8	0.0
7/29/2016 0:15	7/29/2016 10:20	Check	0.86	0.8	3.63	4.68	29%	55.72	41.77	-25%	2.9	2.7	-0.2
7/31/2016 7:35	8/1/2016 1:50	Check	0.77	3.6	5.50	5.49	0%	46.53	33.40	-28%	2.9	2.6	-0.3
8/12/2016 0:00	8/12/2016 20:05	Check	0.34	0.8	4.08	3.96	-3%	18.20	20.21	11%	2.6	2.4	-0.3
9/1/2016 0:15	9/1/2016 16:25	Check	0.56	1.0	4.03	4.08	1%	51.99	34.18	-34%	2.9	2.6	-0.3
9/27/2016 1:20	9/27/2016 11:45	Check	0.25	0.4	2.03	2.27	12%	64.01	54.19	-15%	3.0	2.9	-0.1
9/30/2016 9:05	9/30/2016 23:59	Check	0.41	0.1	3.28	4.02	23%	57.33	42.26	-26%	2.9	2.7	-0.2

Meter Data Inconsistent   Meets CIWEM Criteria

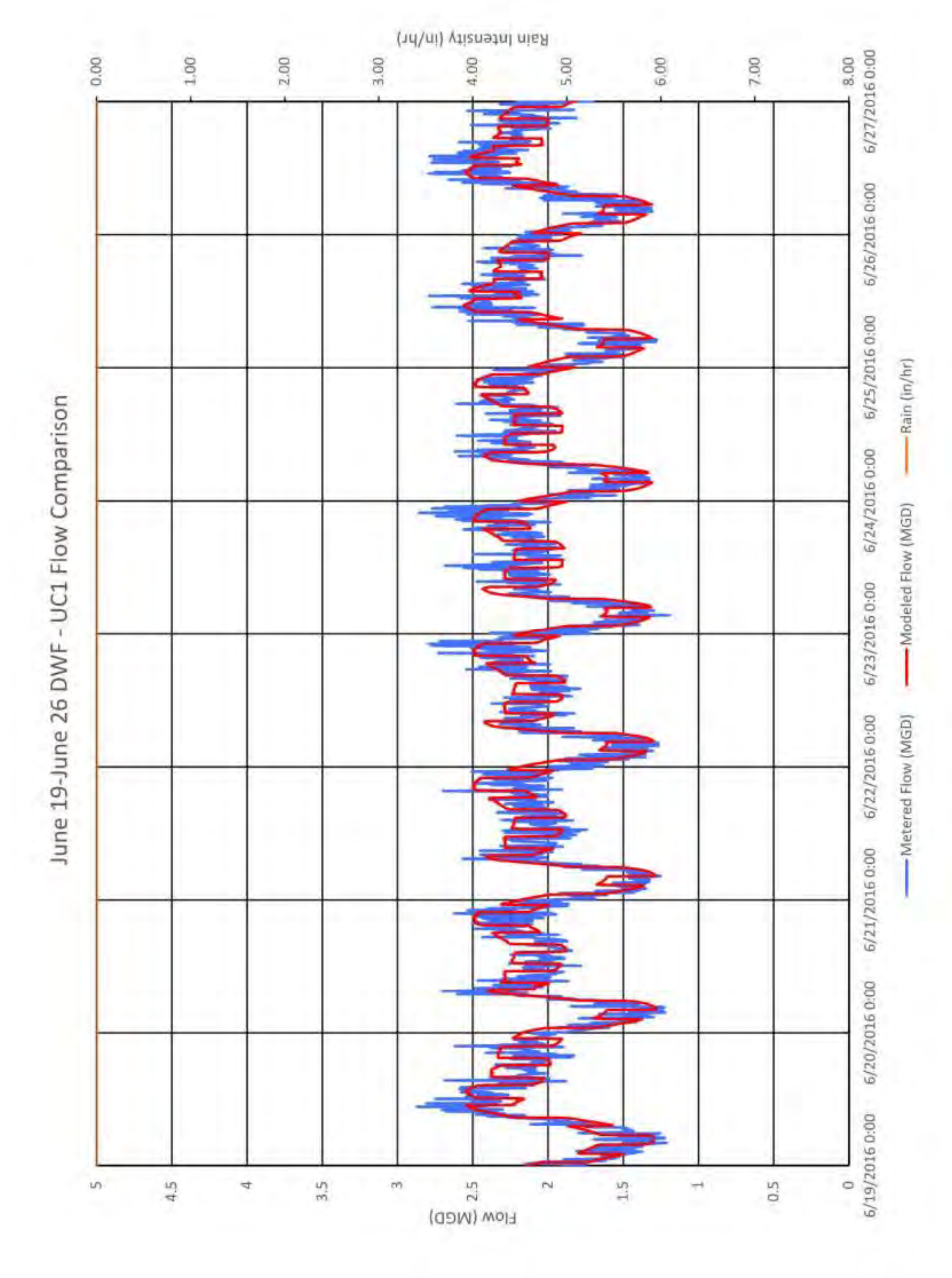
* Note "START DATE" and "END DATE" refer to the beginning of wet weather response used for volume calculations and do not refer to start and end times of the rain.

WNY1 Calibration Summary

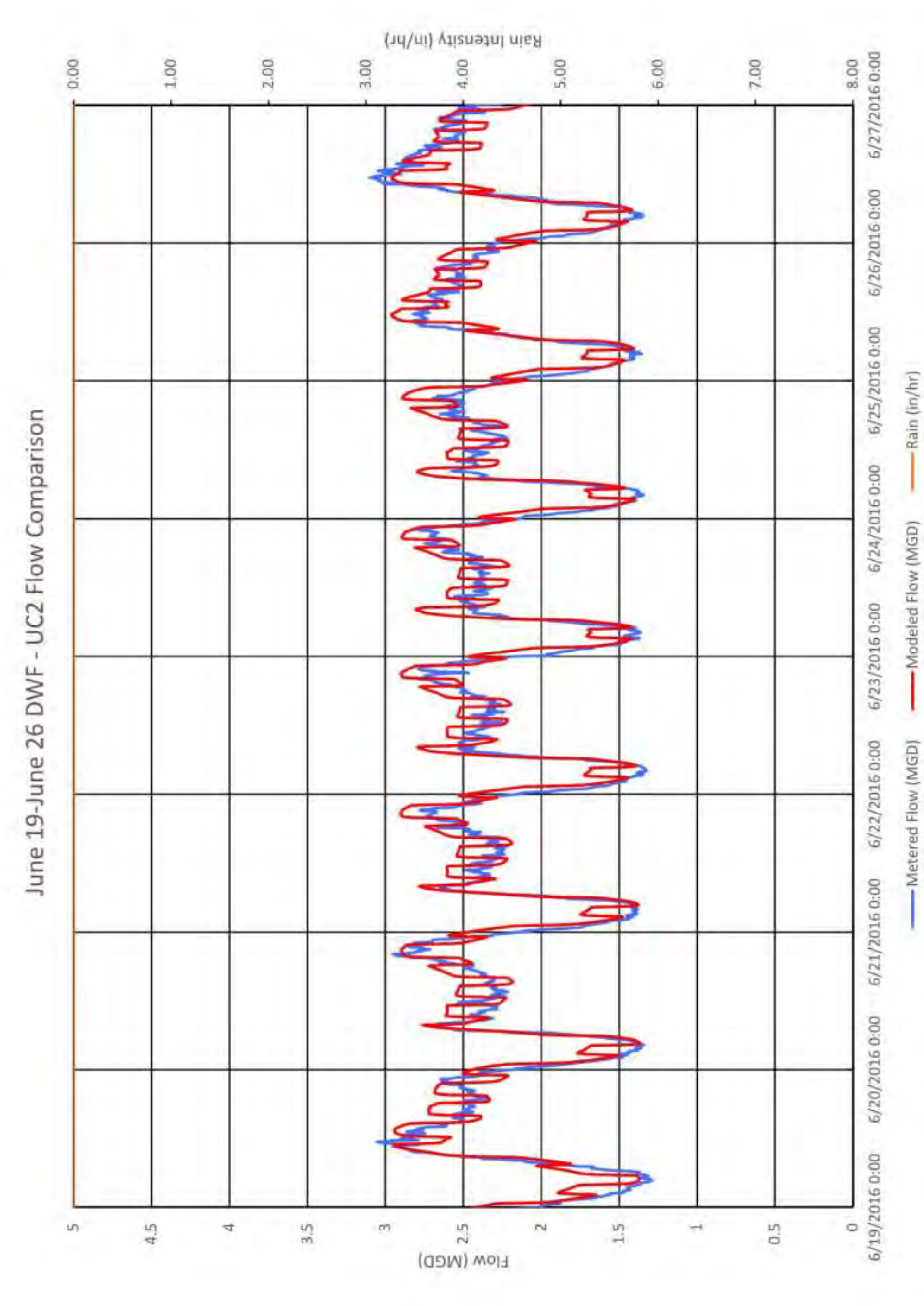
START DATE	END DATE	Calibration Validation	RAINFALL DEPTH (IN)	MAX 5-MIN RAINFALL INTENSITY (IN/HR)	Metered Volume	Modeled Volume	Volume Diff %	Peak Flow	Modeled Peak	Peak Diff %	Meter Depth	Modeled Depth	Depth Diff
6/19/2016 0:00	6/27/2016 0:00	Dry	0.00	0.0	54.09	51.26	-5%	9.34	8.30	-11%	1.1	0.9	-0.1
5/30/2016 1:20	5/30/2016 10:40	Calibration	1.38	2.4	11.22	12.87	15%	215.20	185.47	-14%	6.9	6.4	-0.5
7/1/2016 15:45	7/1/2016 22:20	Validation	1.28	3.4	9.55	8.56	-10%	180.70	170.21	-6%	5.3	6.2	0.9
9/14/2016 10:10	9/14/2016 18:20	Validation	0.64	2.8	4.71	5.78	23%	43.01	52.55	22%	2.8	4.0	1.2
9/19/2016 5:25	9/19/2016 16:20	Calibration	0.45	0.2	6.15	6.54	6%	250.30	193.05	-23%	9.2	6.5	-2.7
9/24/2016 0:50	9/24/2016 5:30	Calibration	0.28	0.7	2.51	2.79	11%	36.11	45.20	25%	2.7	3.8	1.1
10/8/2016 13:20	10/9/2016 13:50	Validation	0.65	0.2	10.91	11.88	9%	41.77	49.59	19%	2.8	3.9	1.1
11/15/2016 4:05	11/15/2016 16:50	Calibration	1.50	1.0	13.54	15.36	13%	81.03	90.77	12%	3.4	4.8	1.4
6/4/2016 18:10	6/5/2016 21:05	Check	1.54	2.6	18.51	18.73	1%	19.83	27.23	37%	2.2	3.2	1.1
6/8/2016 11:55	6/8/2016 17:25	Check	0.40	0.5	4.06	4.75	17%	232.20	180.82	-22%	8.5	6.3	-2.2
6/16/2016 4:25	6/16/2016 8:10	Check	0.20	0.4	2.22	2.03	-9%	139.20	166.02	19%	3.9	6.1	2.2
6/27/2016 20:35	6/29/2016 2:10	Check	0.65	1.3	12.45	13.11	5%	55.57	70.58	27%	3.1	4.4	1.3
7/4/2016 19:45	7/5/2016 6:35	Check	1.42	2.3	13.39	13.70	2%	32.32	35.17	9%	2.7	3.5	0.8
7/9/2016 21:20	7/10/2016 0:30	Check	0.38	1.3	3.68	3.62	-2%	80.50	95.08	18%	3.3	4.9	1.6
7/14/2016 15:05	7/14/2016 17:30	Check	0.62	1.8	3.67	4.71	28%	103.00	93.60	-9%	3.9	4.9	1.0
7/18/2016 15:45	7/18/2016 18:35	Check	0.32	2.4	2.85	3.09	8%	51.69	55.86	8%	3.0	4.1	1.1
7/25/2016 16:10	7/25/2016 20:10	Check	0.77	2.2	5.70	6.91	21%	83.97	130.92	56%	3.5	5.5	2.1
7/29/2016 0:15	7/29/2016 10:20	Check	0.86	0.8	7.14	9.48	33%	108.40	100.43	-7%	4.1	5.0	0.9
7/31/2016 7:35	8/1/2016 1:50	Check	0.77	3.6	10.15	11.10	9%	93.08	78.99	-15%	3.5	4.6	1.1
8/12/2016 0:00	8/12/2016 20:05	Check	0.34	0.8	7.70	7.74	1%	41.57	43.10	4%	2.9	3.7	0.8
9/1/2016 0:15	9/1/2016 16:25	Check	0.56	1.0	7.48	8.11	8%	123.60	83.11	-33%	4.8	4.7	-0.2
9/27/2016 1:20	9/27/2016 11:45	Check	0.25	0.4	3.98	4.41	11%	141.30	136.61	-3%	4.5	5.6	1.1
9/30/2016 9:05	9/30/2016 23:59	Check	0.41	0.1	7.08	7.87	11%	172.60	104.87	-39%	6.6	5.1	-1.5

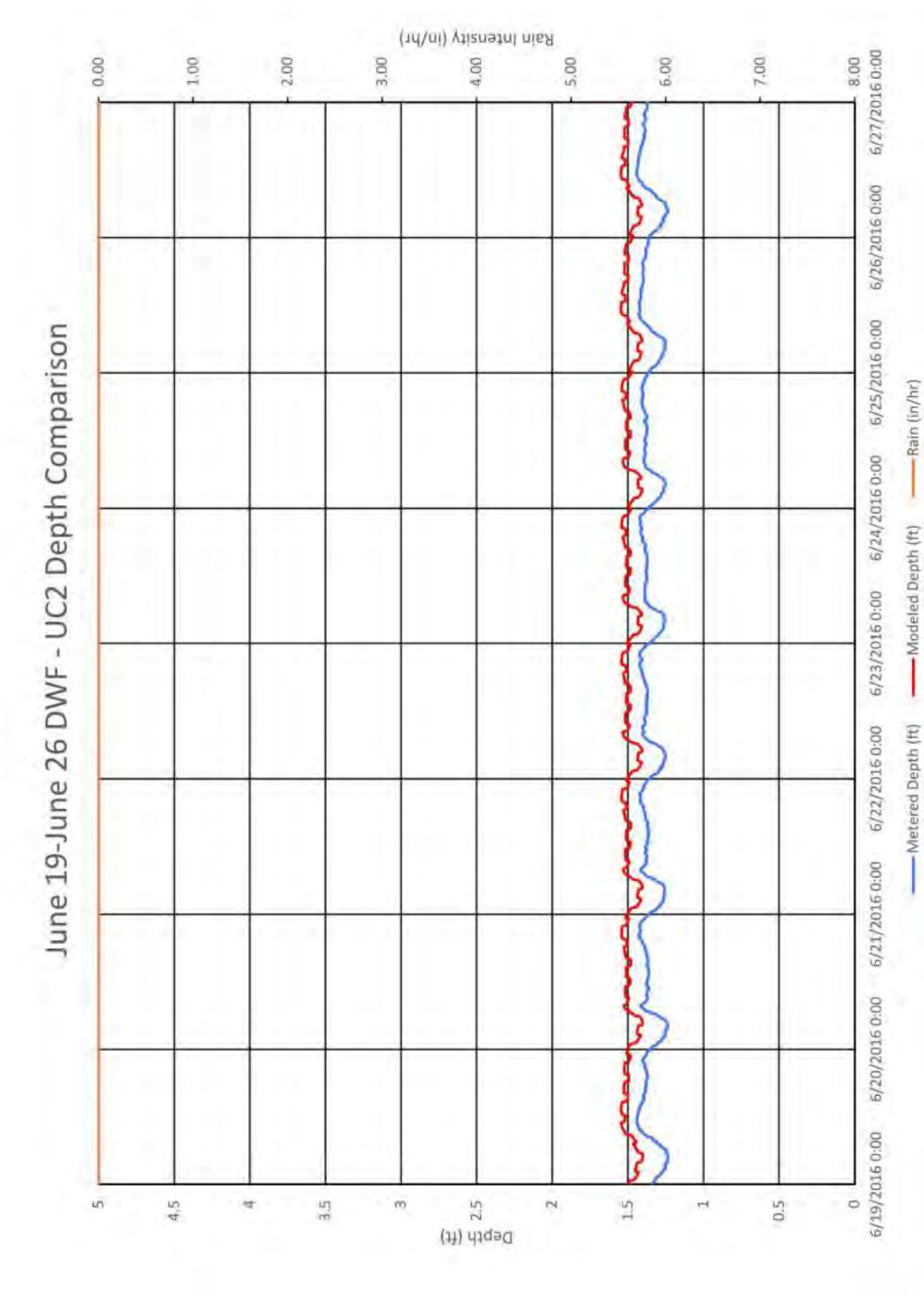
Meets CIWEM Criteria

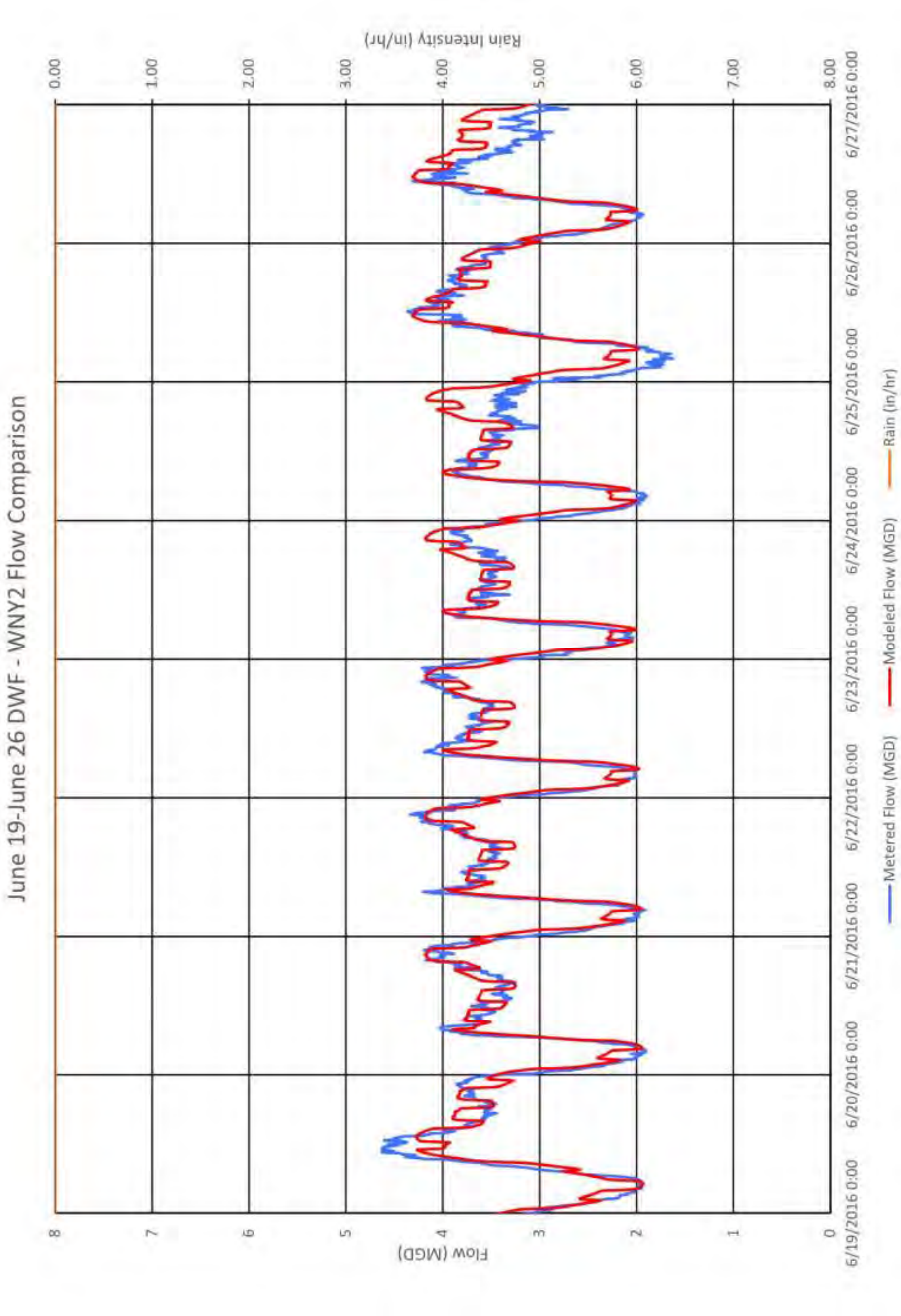
* Note "START DATE" and "END DATE" refer to the beginning of wet weather response used for volume calculations and do not refer to start and end times of the rain.


June 19-June 26 DWF - UC1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

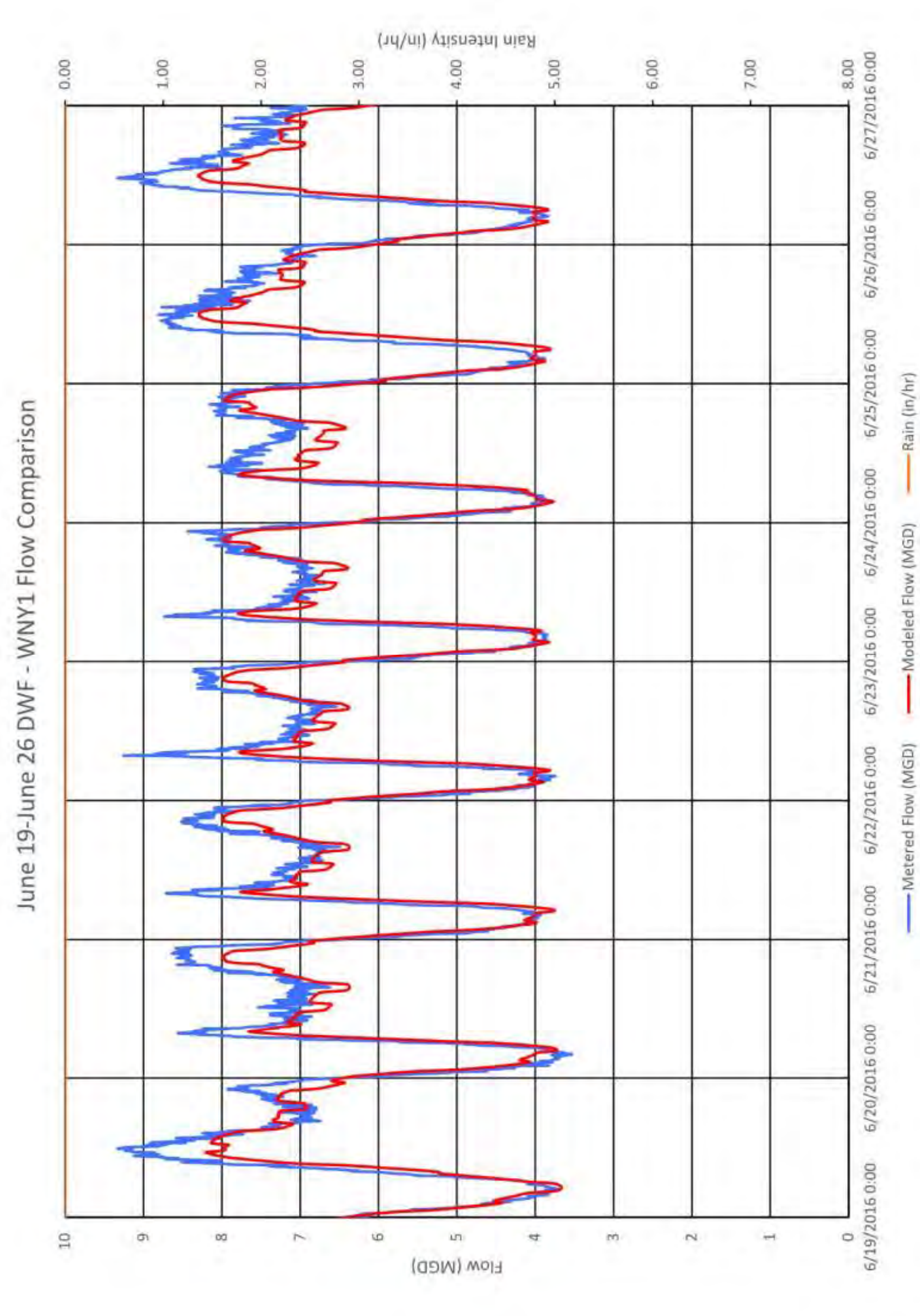
June 19-June 26 DWF - UC1 Depth Comparison
Depth (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00
Metered Depth (ft)
Modeled Depth (ft)
Rain (in/hr)

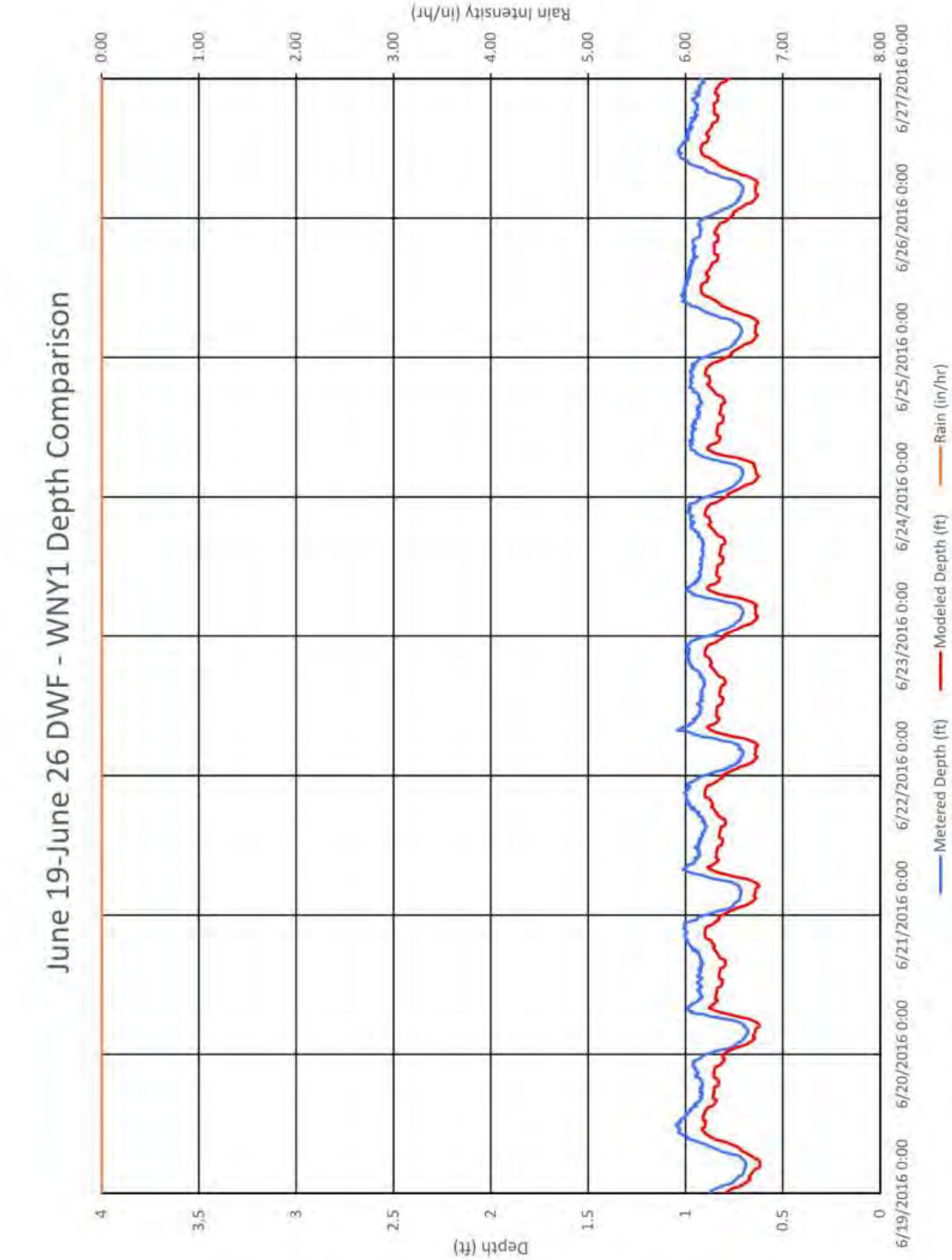

June 19-June 26 DWF - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00

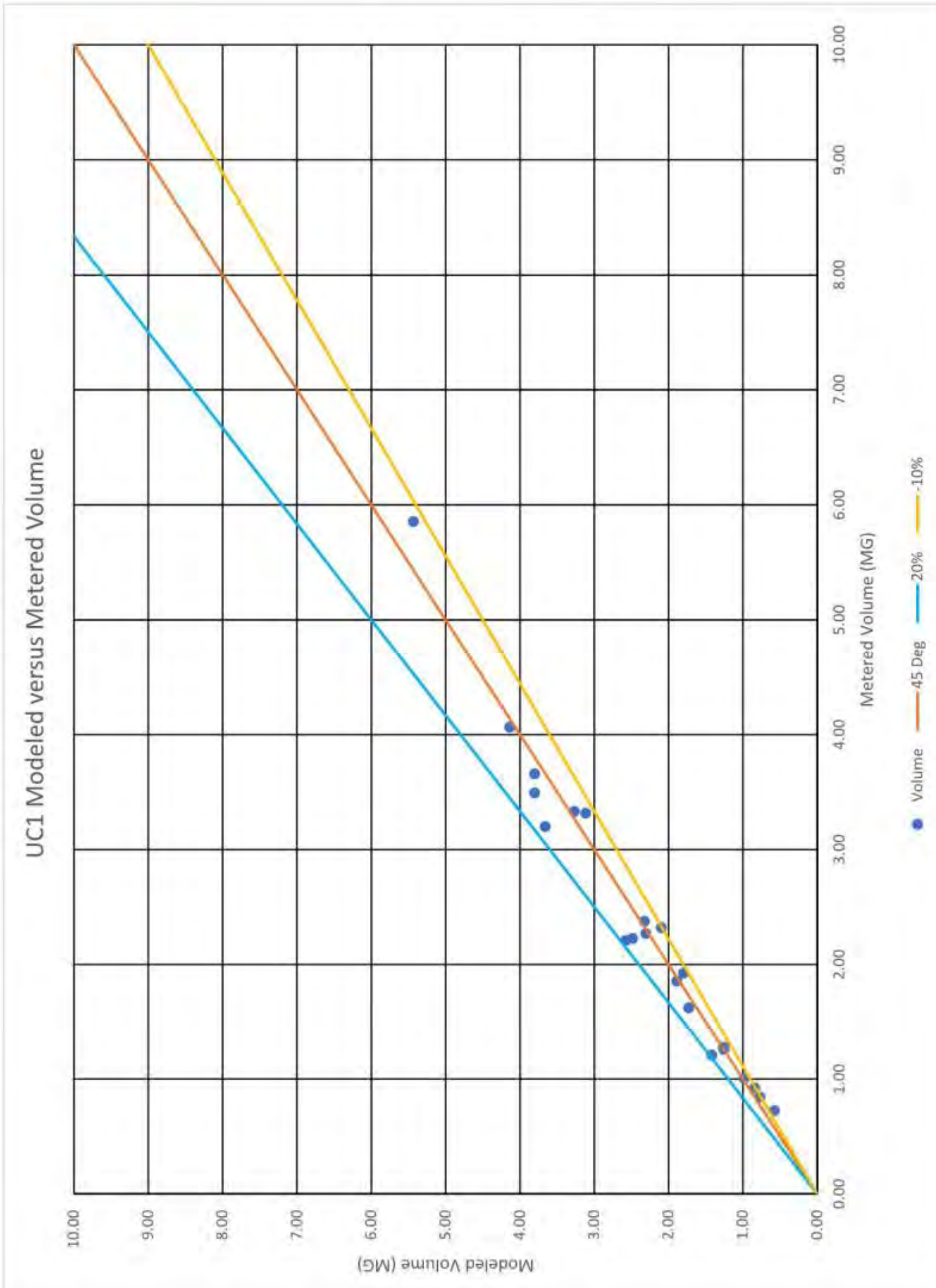

June 19-June 26 DWF - UC2 Depth Comparison
Depth (ft)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00
Metered Depth (ft)
Modeled Depth (ft)
Rain (in/hr)

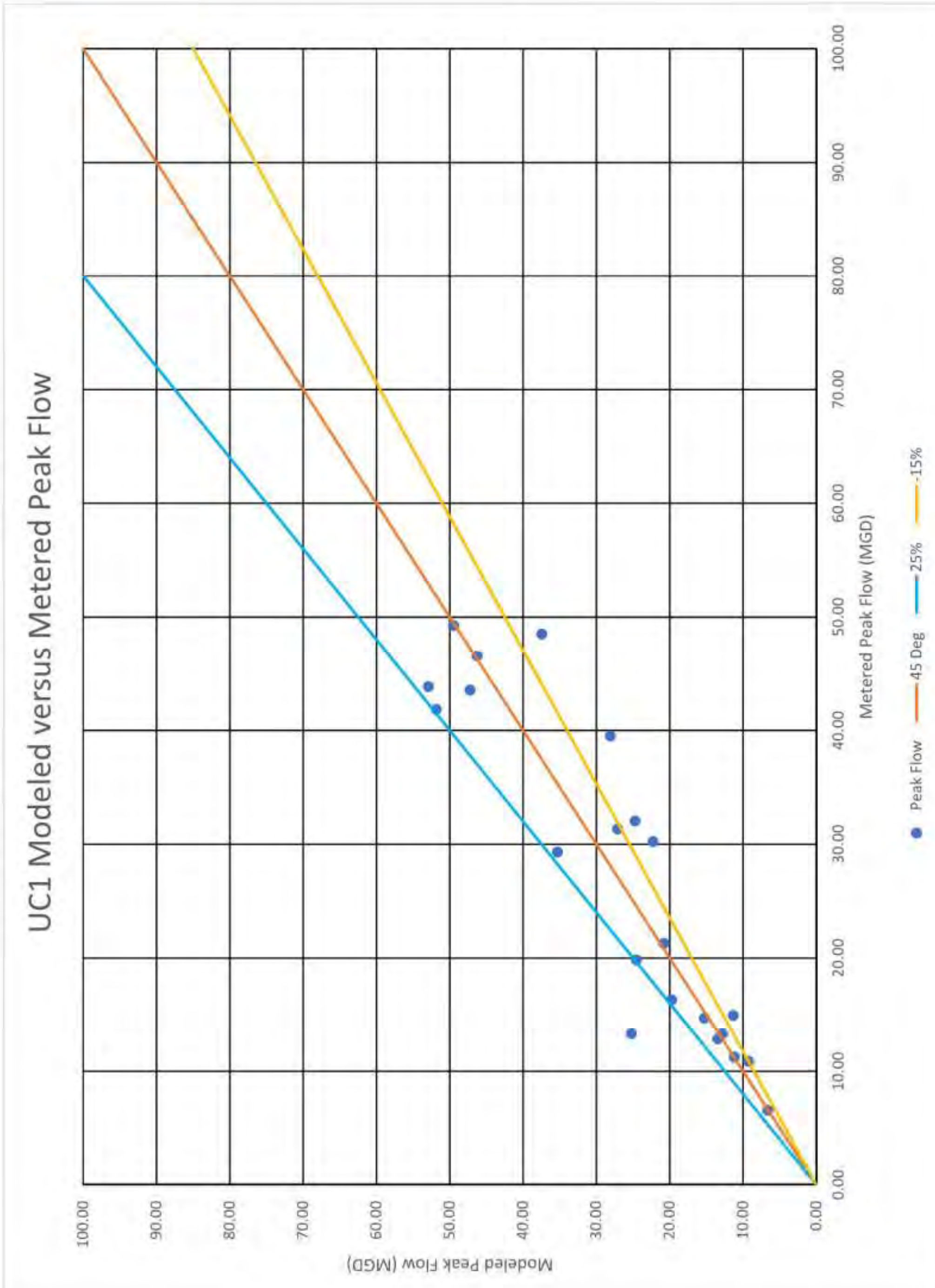

June 19-June 26 DWF - WNY2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
7
8
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

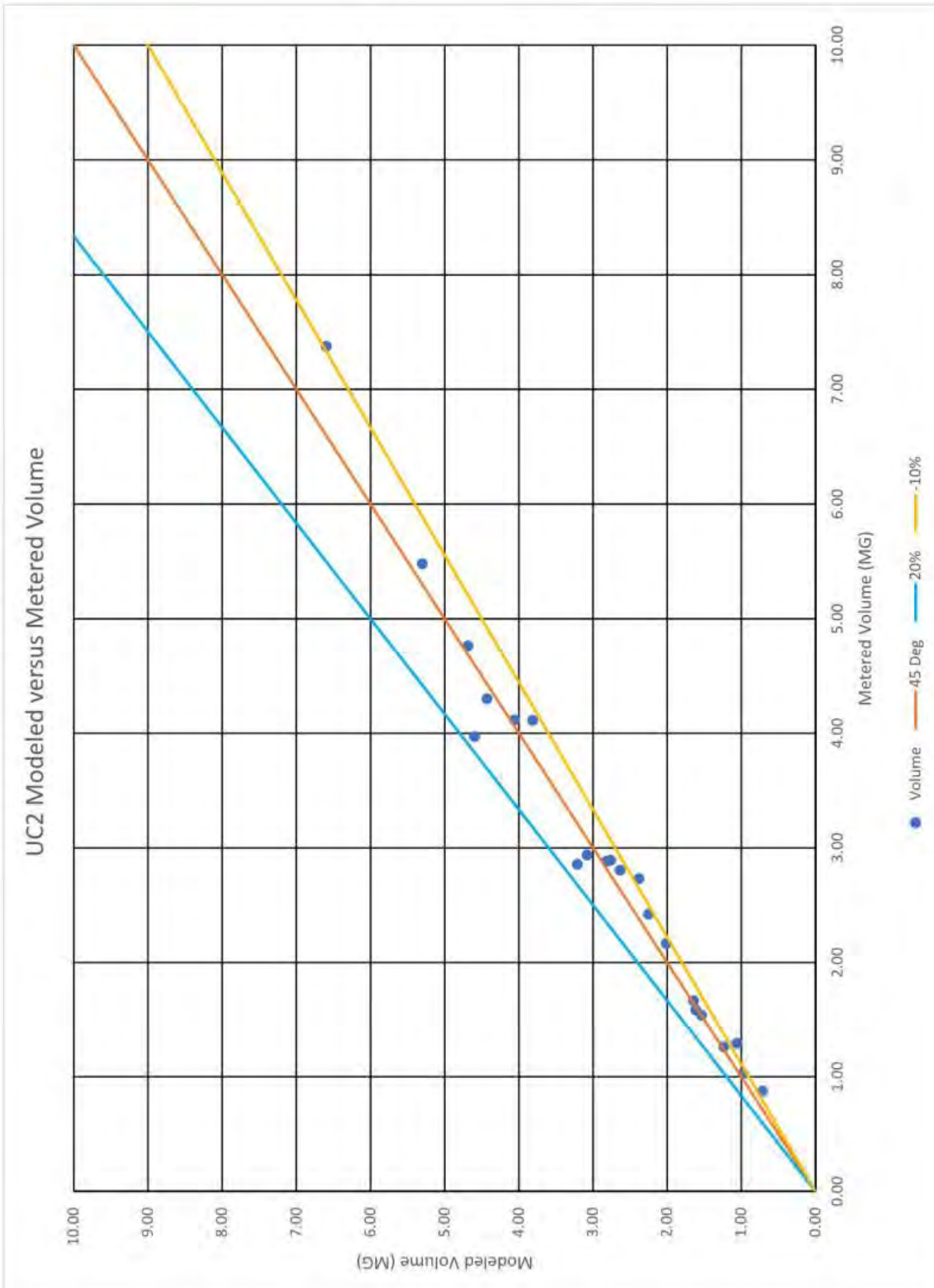

June 19-June 26 DWF - WNY2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00
Metered Depth (ft)
Modeled Depth (ft)
Rain (in/hr)

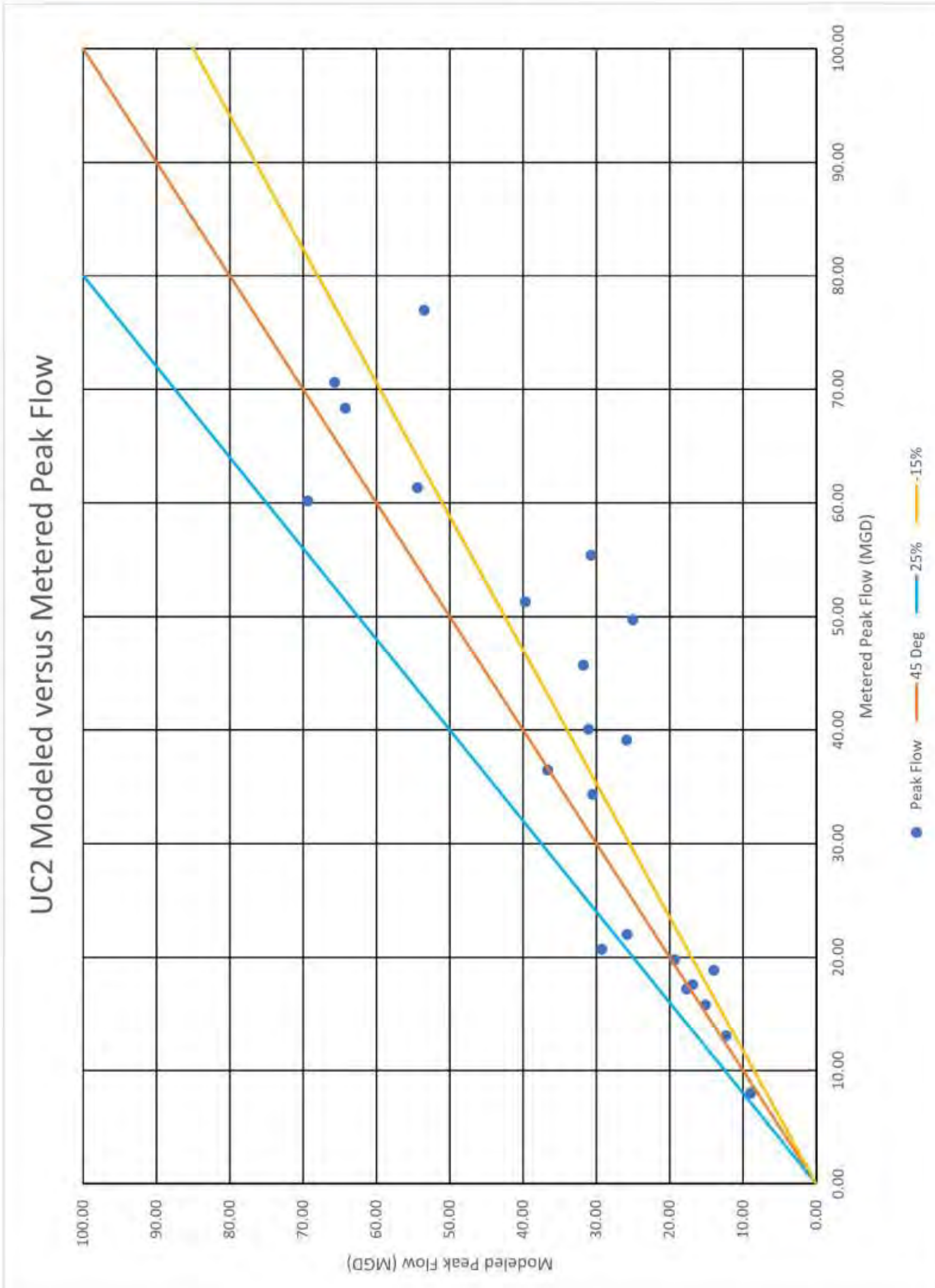

June 19-June 26 DWF - WNY1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
7
8
9
10
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

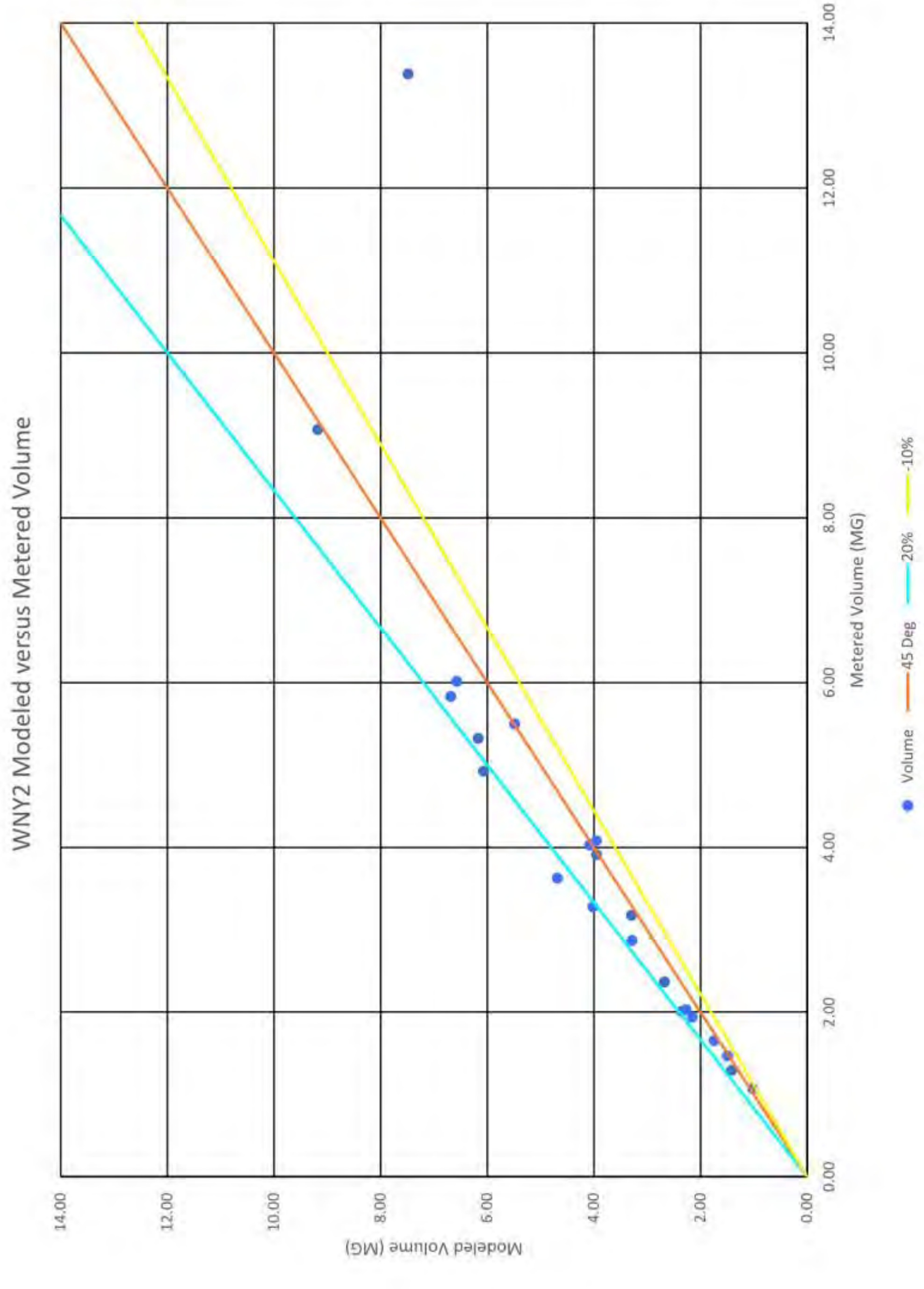

June 19-June 26 DWF - WNY1 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
0.5
1
1.5
2
2.5
3
3.5
4
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
6/19/2016 0:00
6/20/2016 0:00
6/21/2016 0:00
6/22/2016 0:00
6/23/2016 0:00
6/24/2016 0:00
6/25/2016 0:00
6/26/2016 0:00
6/27/2016 0:00
Metered Depth (ft)
Modeled Depth (ft)
Rain (in/hr)

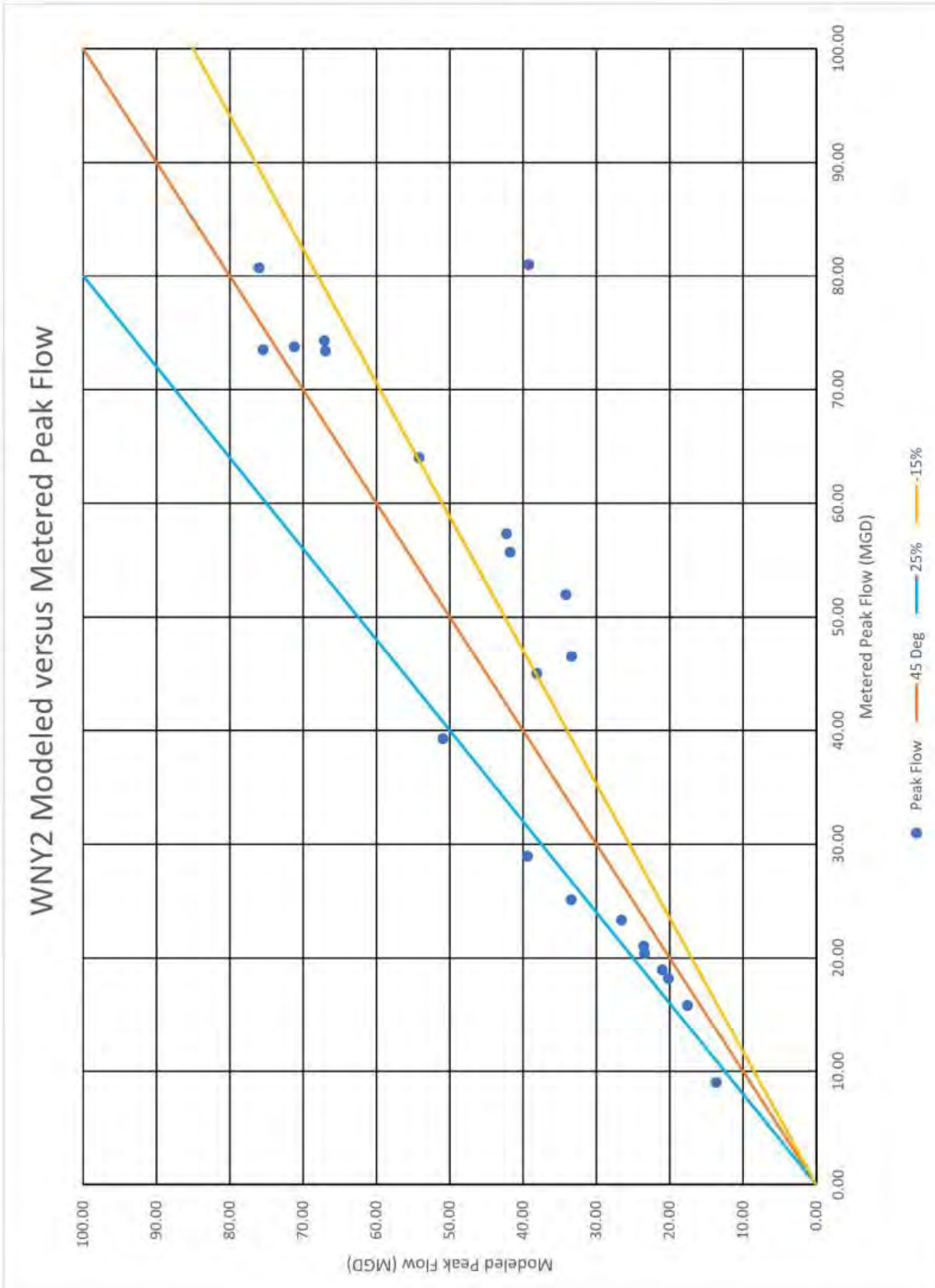

UC1 Modeled versus Metered Volume
Modeled Volume (MG)
Metered Volume (MG)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Volume
45 Deg
20%
-10%


UC1 Modeled versus Metered Peak Flow
Modeled Peak Flow (MGD)
Metered Peak Flow (MGD)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Peak Flow
45 Deg
25%
-15%

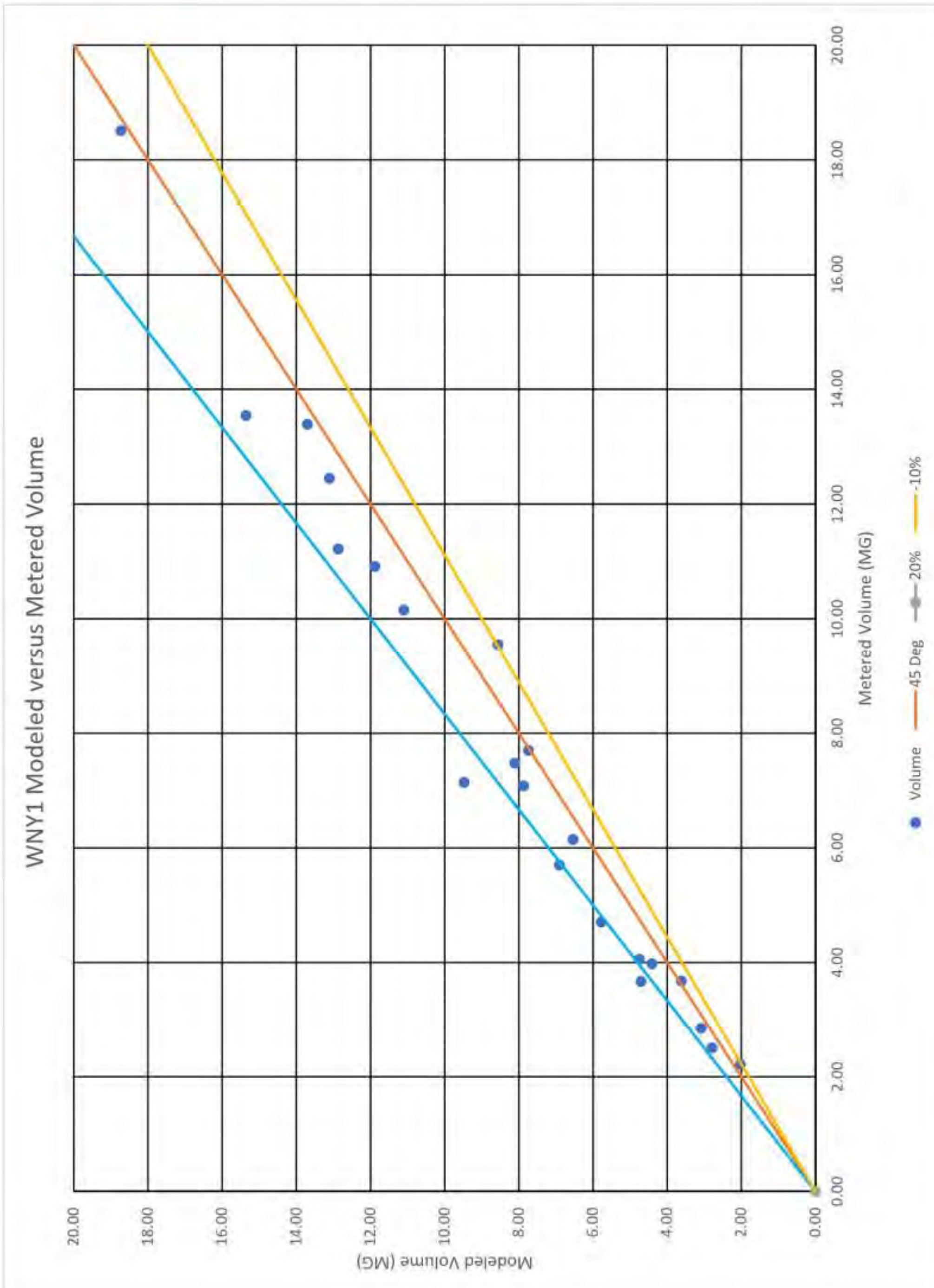

UC2 Modeled versus Metered Volume
Modeled Volume (MG)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Metered Volume (MG)
Volume
45 Deg
20%
10%

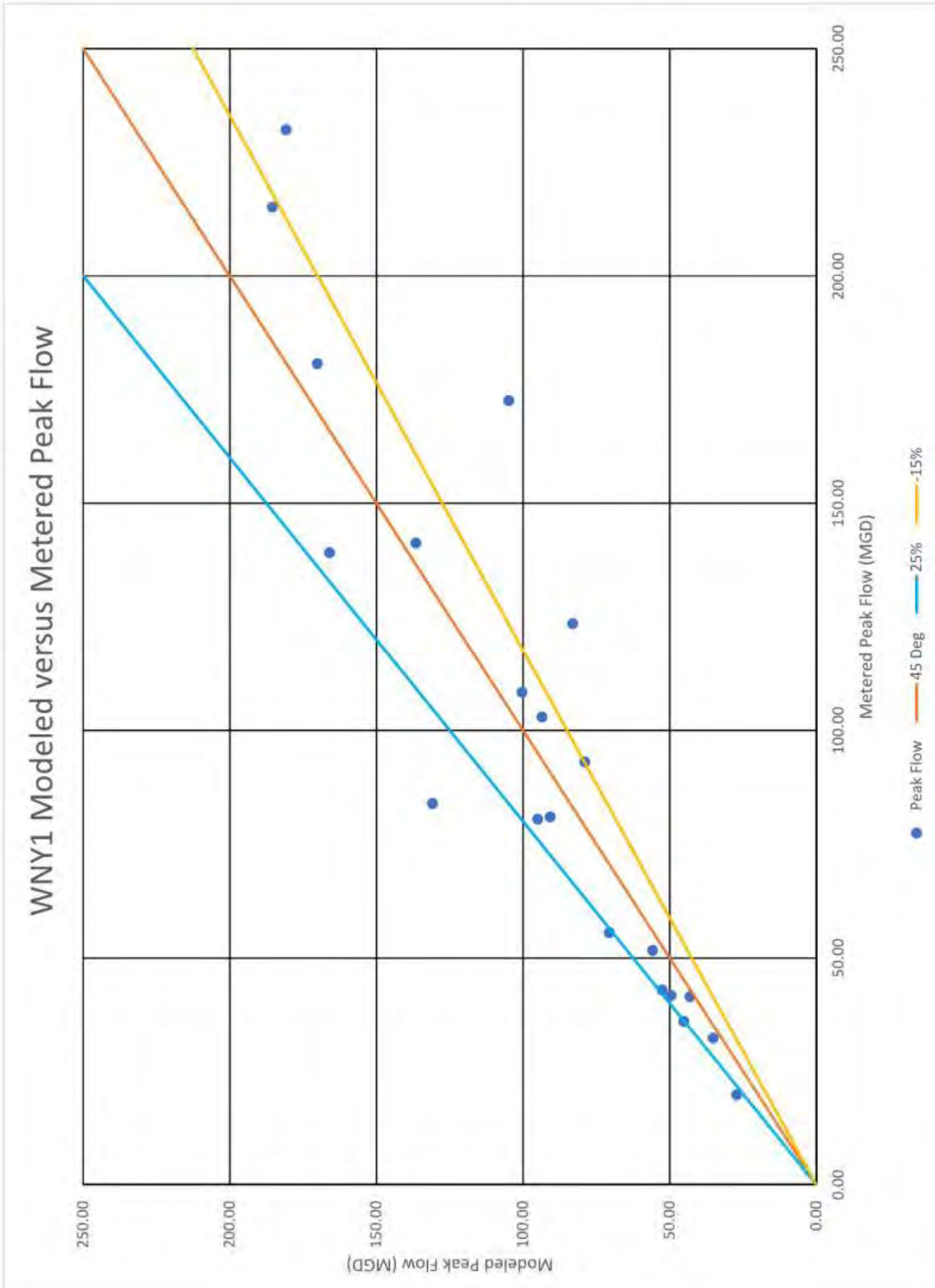

UC2 Modeled versus Metered Peak Flow
Modeled Peak Flow (MGD)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Metered Peak Flow (MGD)
Peak Flow
45 Deg
25%
-15%


WNY2 Modeled versus Metered Volume
Modeled Volume (MG)
Metered Volume (MG)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
Volume
45 Deg
20%
-10%



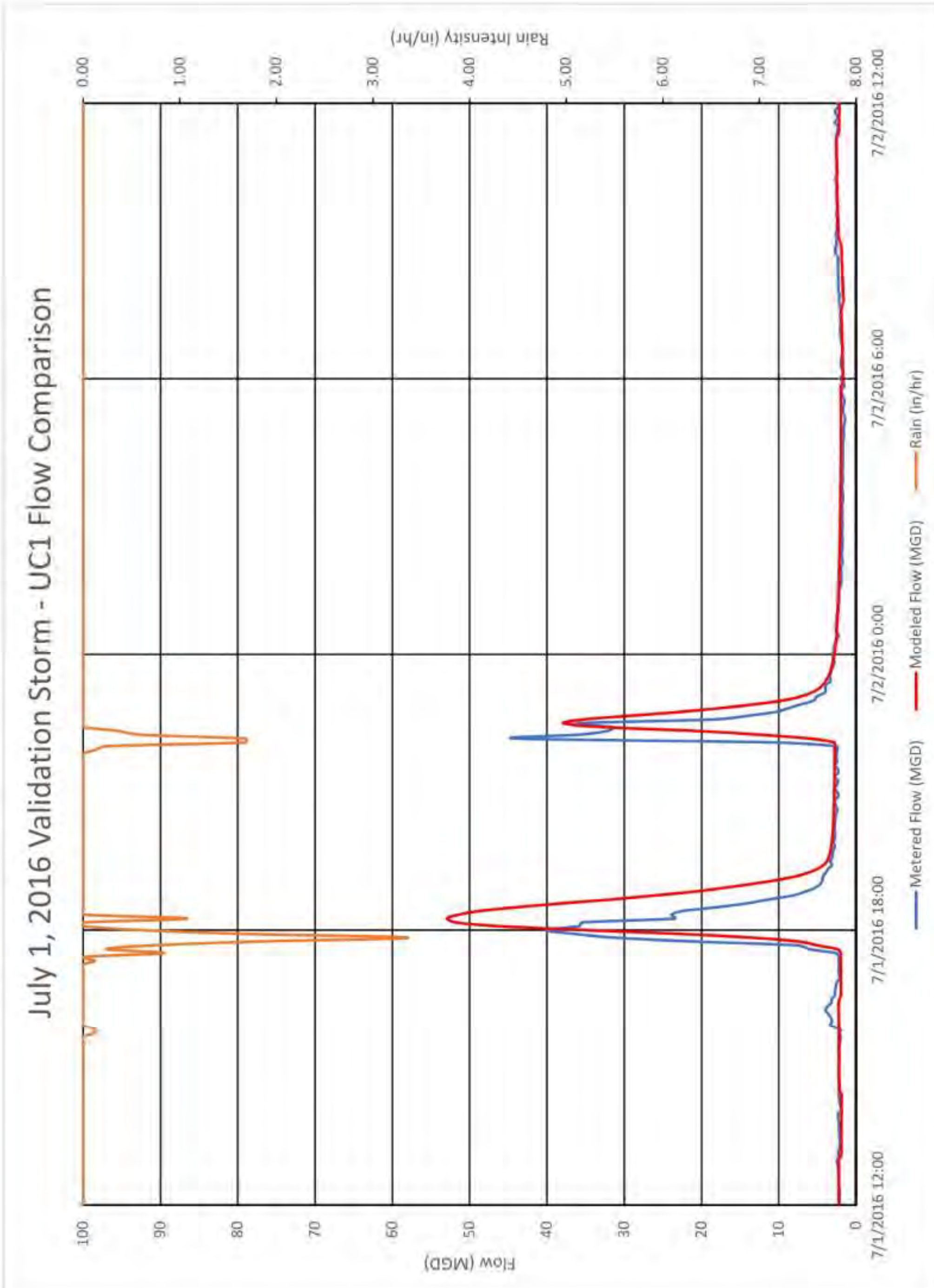
WNY2 Modeled versus Metered Peak Flow
Modeled Peak Flow (MGD)
Metered Peak Flow (MGD)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Peak Flow
45 Deg
25%
-15%

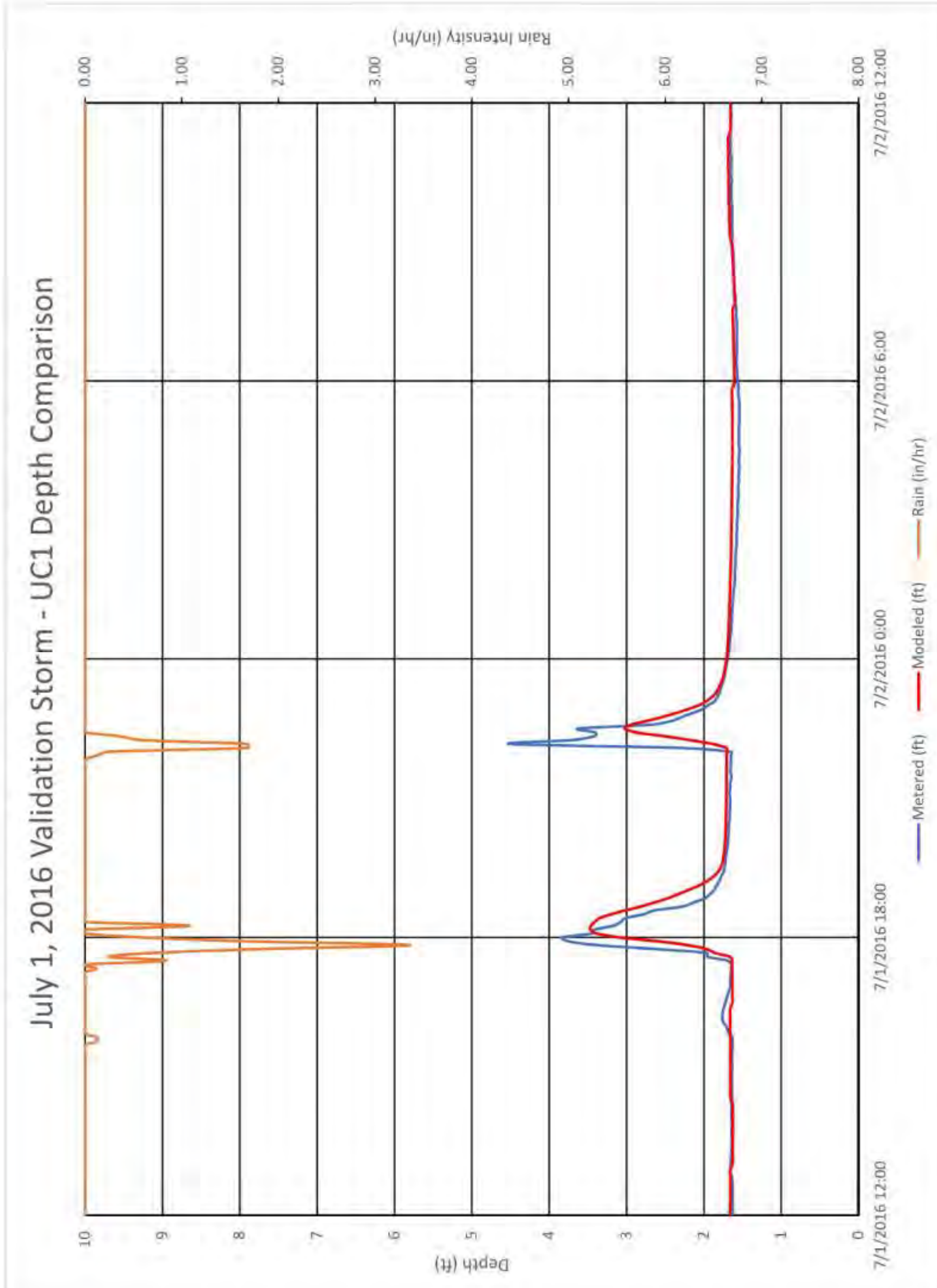

WNY1 Modeled versus Metered Volume
Modeled Volume (MG)
Metered Volume (MG)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Volume
45 Deg
20%
-10%


WNY1 Modeled versus Metered Peak Flow
Modeled Peak Flow (MGD)
Metered Peak Flow (MGD)
0.00
50.00
100.00
150.00
200.00
250.00
Peak Flow
45 Deg
25%
-15%

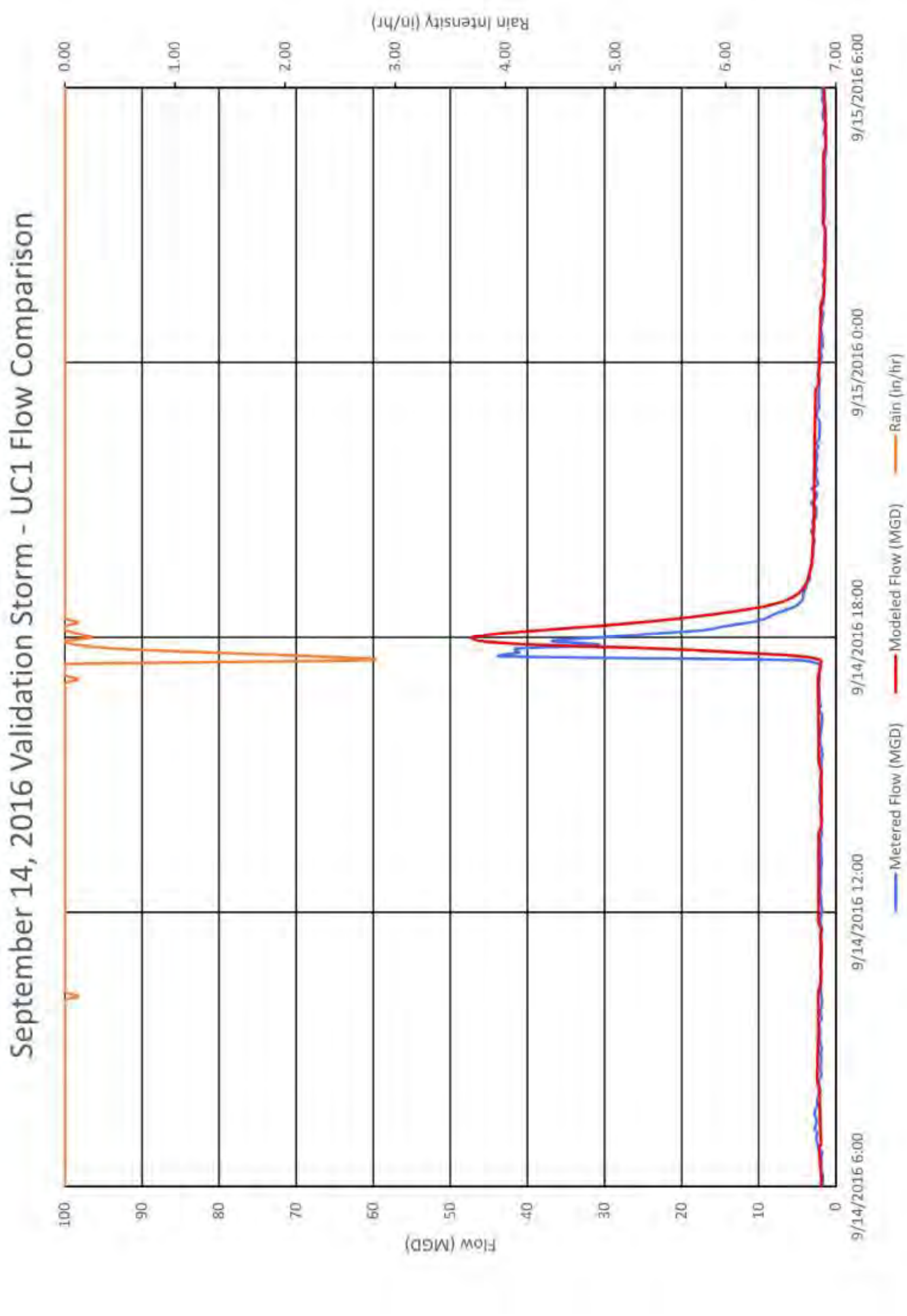

May 30, 2016 Calibration Storm - UC1 Flow Comparison
Flow (MGD)
0
10
20
30
40
50
60
70
80
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)


May 30, 2016 Calibration Storm - UC1 Depth Comparison
Depth (ft)
0
1
2
3
4
5
6
7
8
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered Depth (ft)
Modeled Depth (ft)
Rain (in/hr)

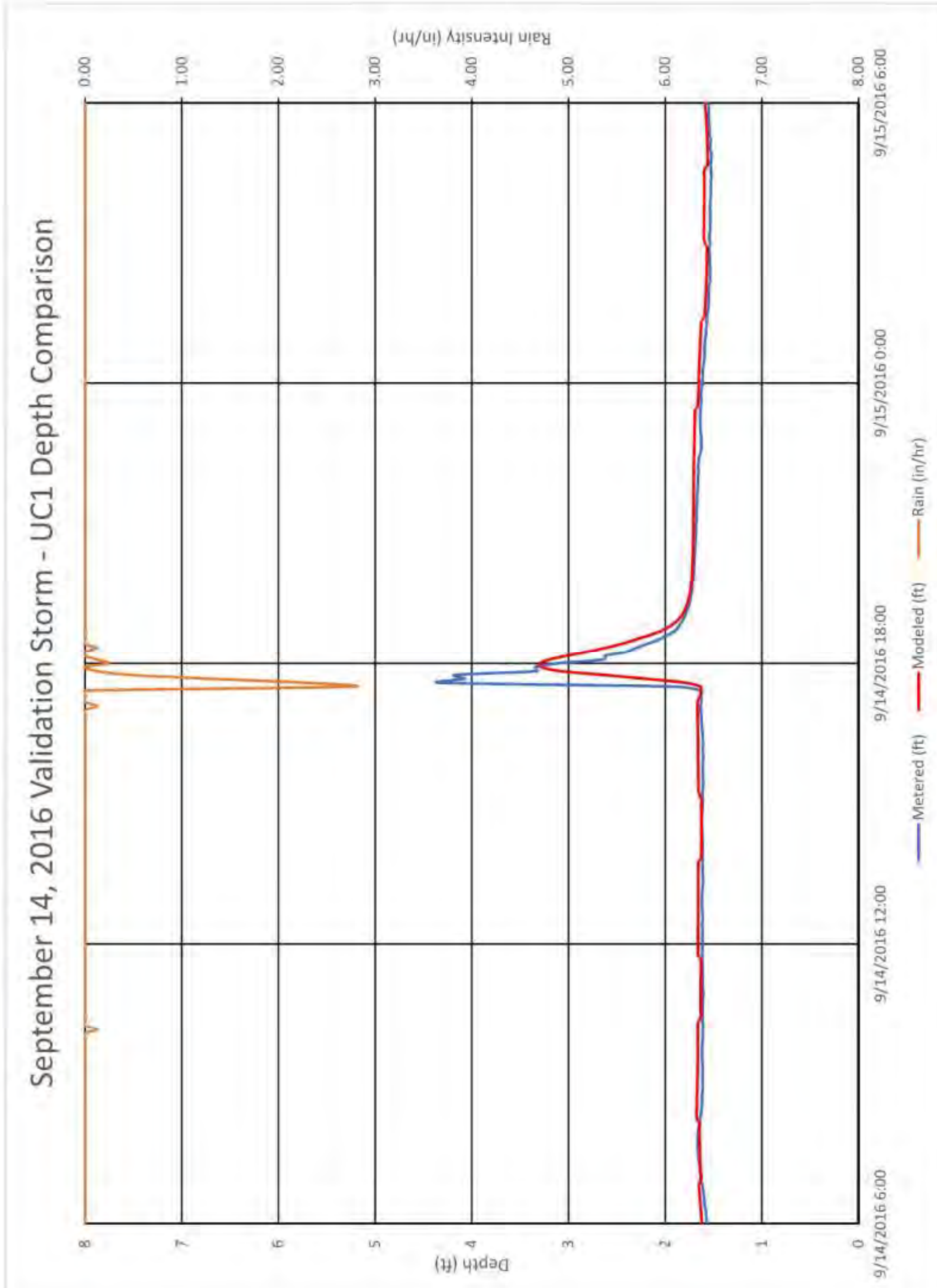

July 1, 2016 Validation Storm - UC1 Flow Comparison
Flow (MGD)
0
10
20
30
40
50
60
70
80
90
100
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

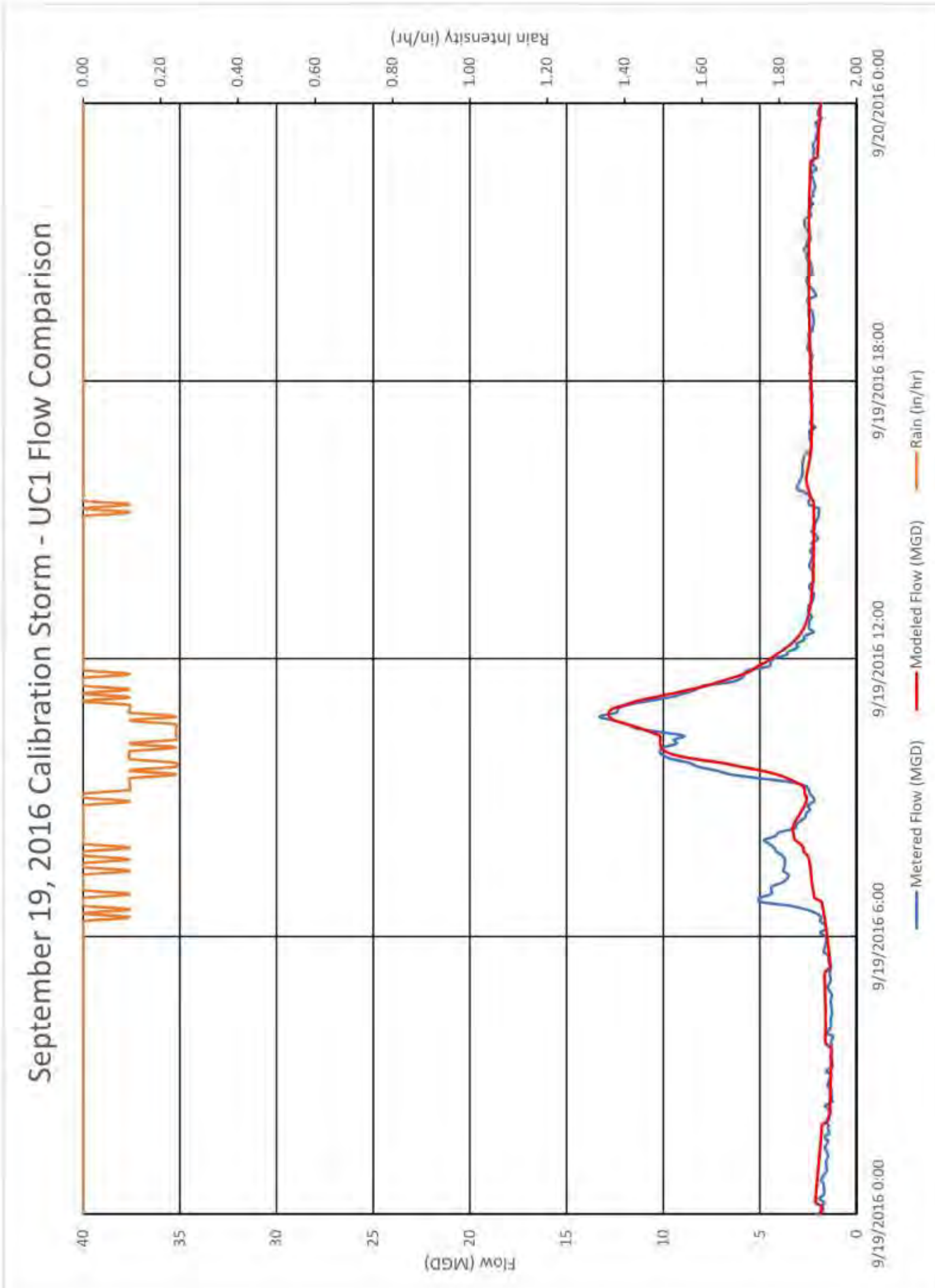


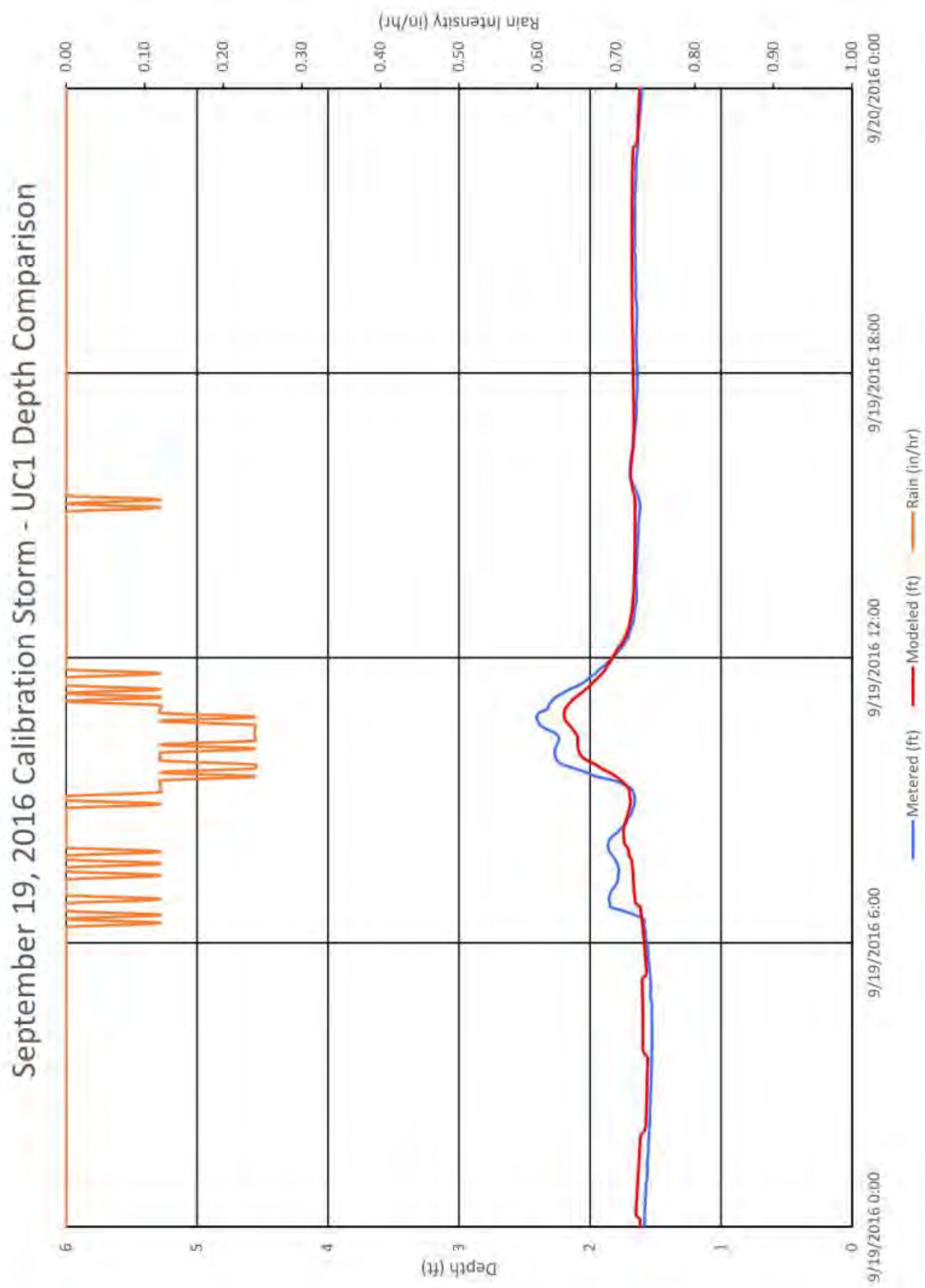
July 1, 2016 Validation Storm - UC1 Depth Comparison
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Depth (ft)
10
9
8
7
6
5
4
3
2
1
0
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

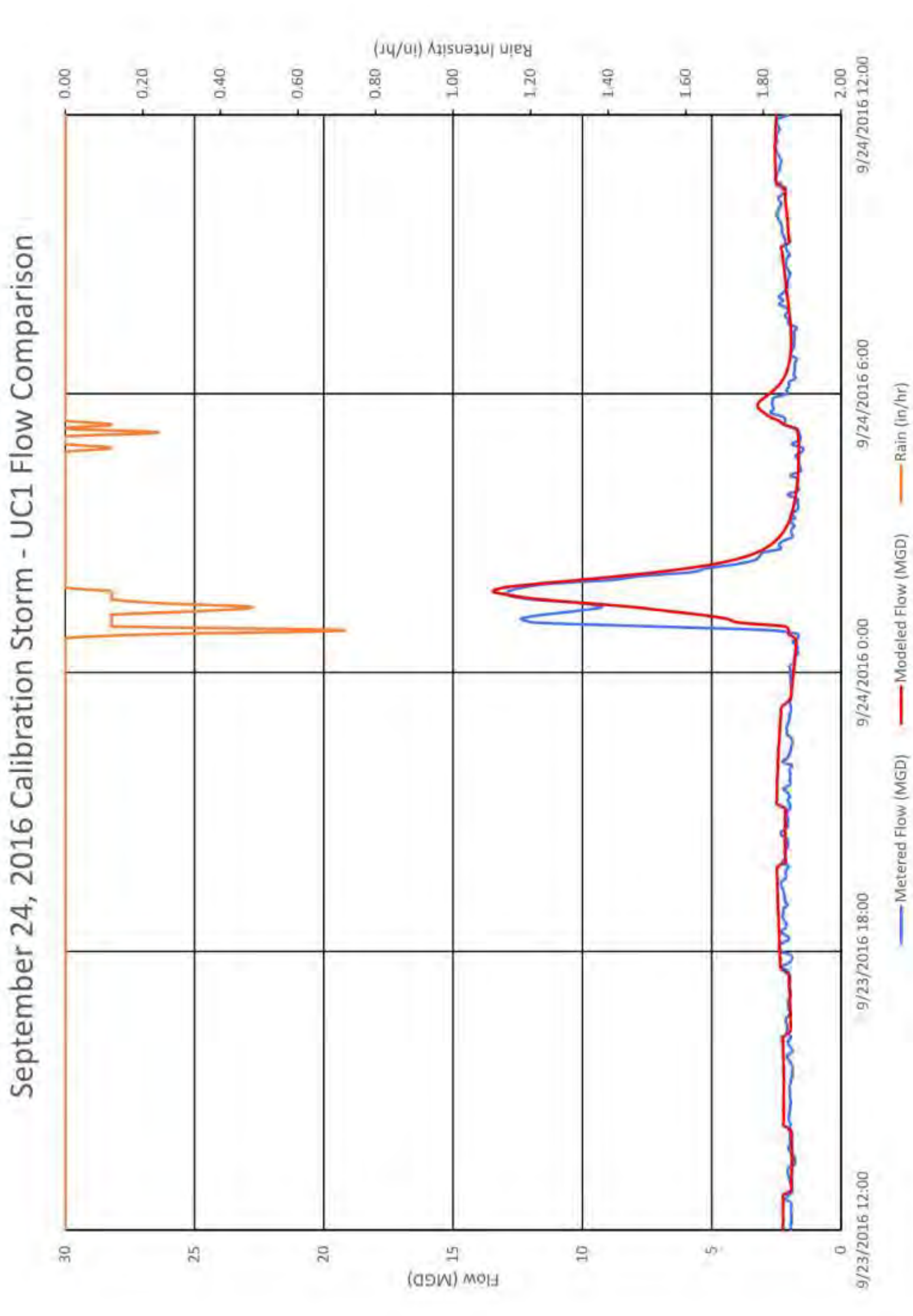


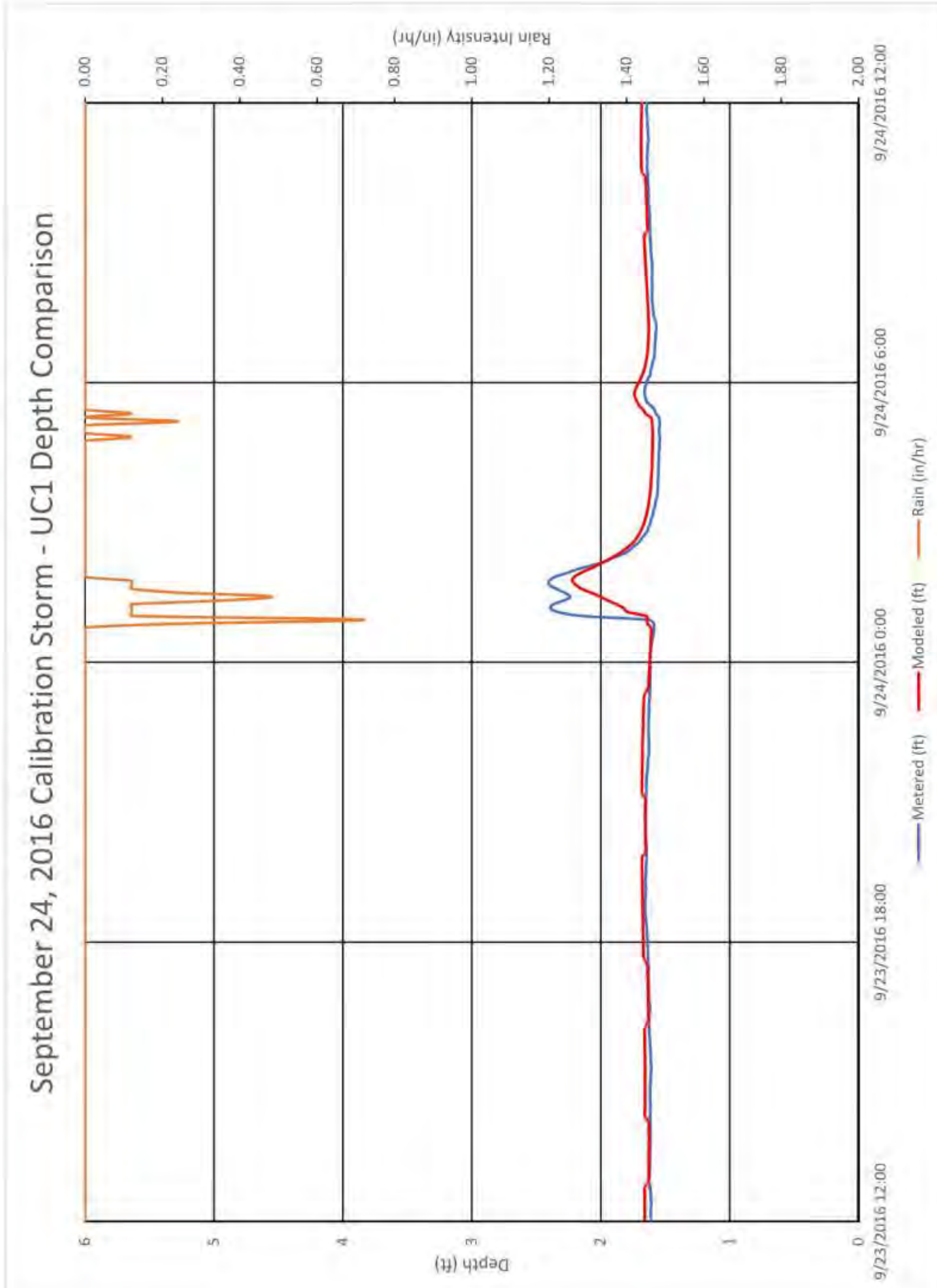
September 14, 2016 Validation Storm - UC1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

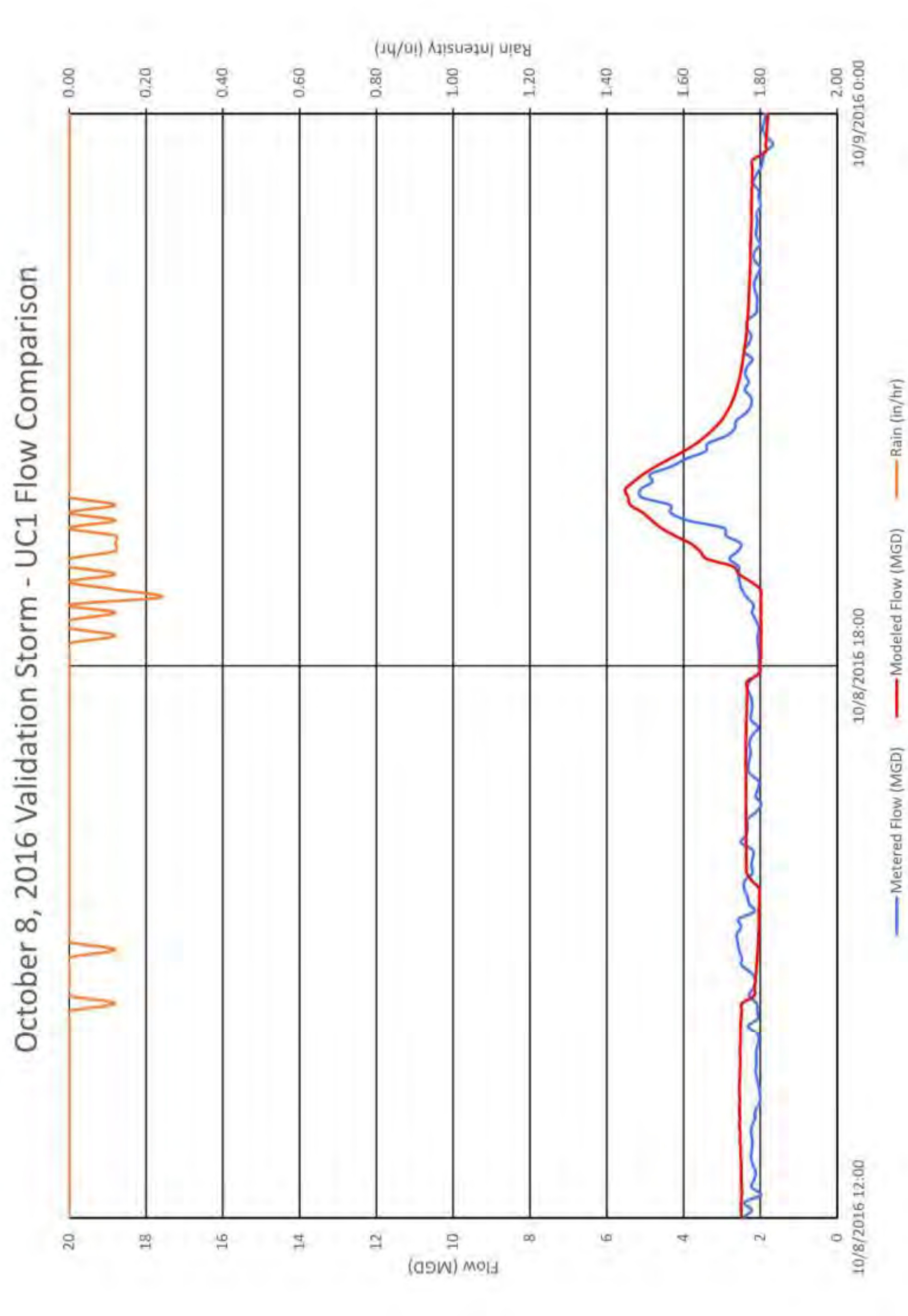

September 14, 2016 Validation Storm - UC1 Depth Comparison
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Depth (ft)
8
7
6
5
4
3
2
1
0
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

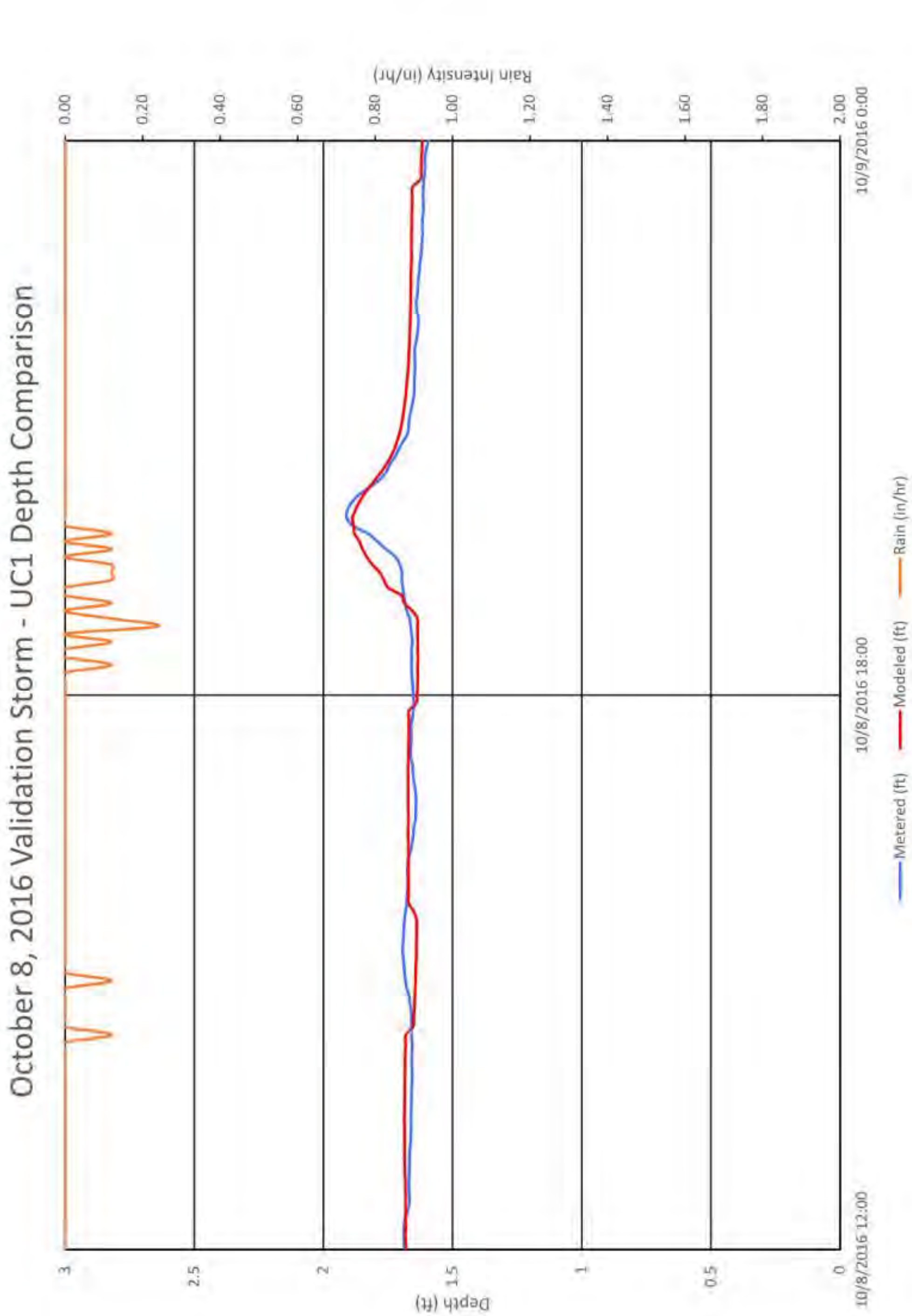

September 19, 2016 Calibration Storm - UC1 Flow Comparison
Flow (MGD)
0
5
10
15
20
25
30
35
40
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

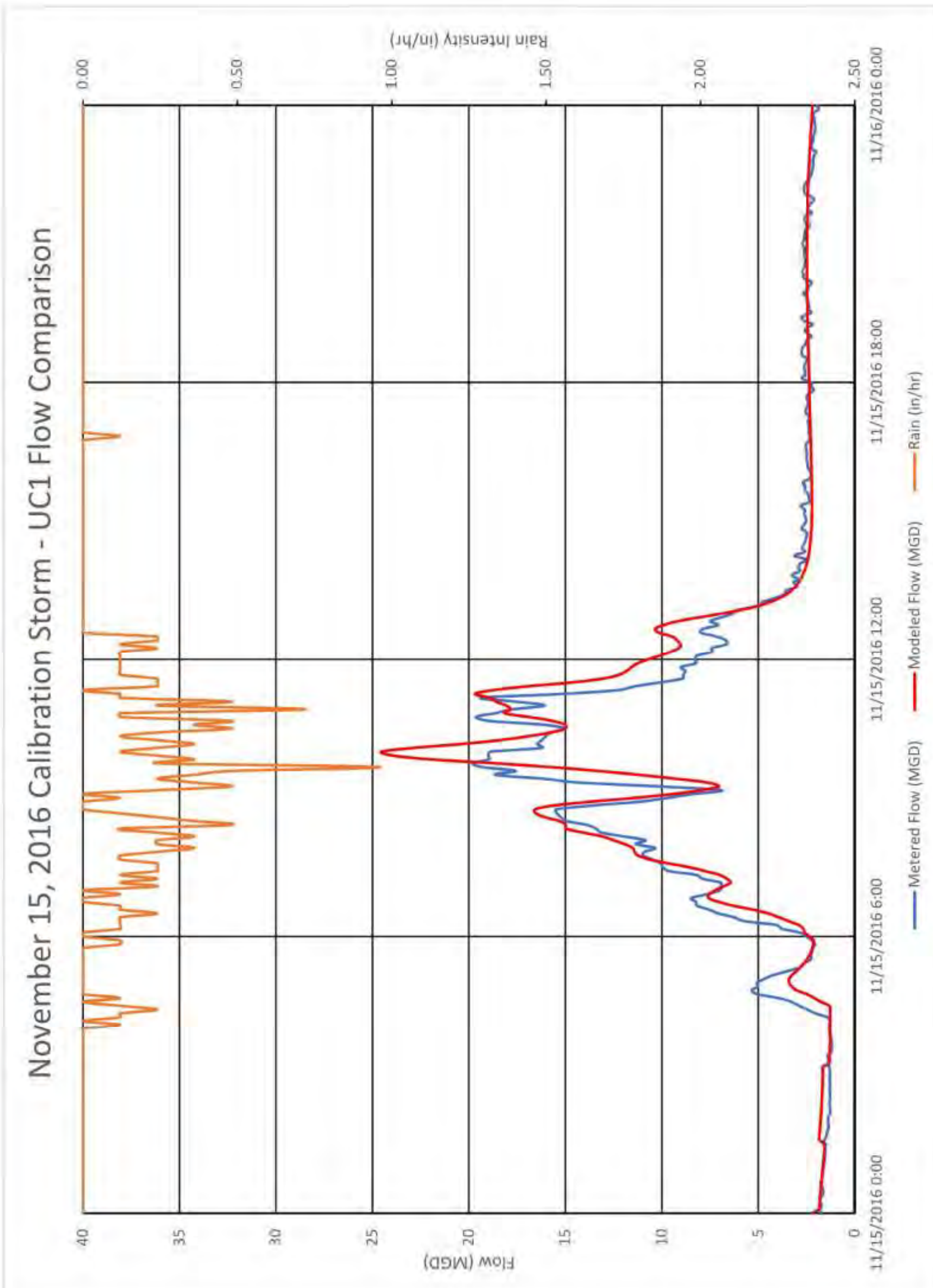

September 19, 2016 Calibration Storm - UC1 Depth Comparison
Depth (ft)
0
1
2
3
4
5
6
Rain Intensity (in/hr)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)


September 24, 2016 Calibration Storm - UC1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
5
10
15
20
25
30
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

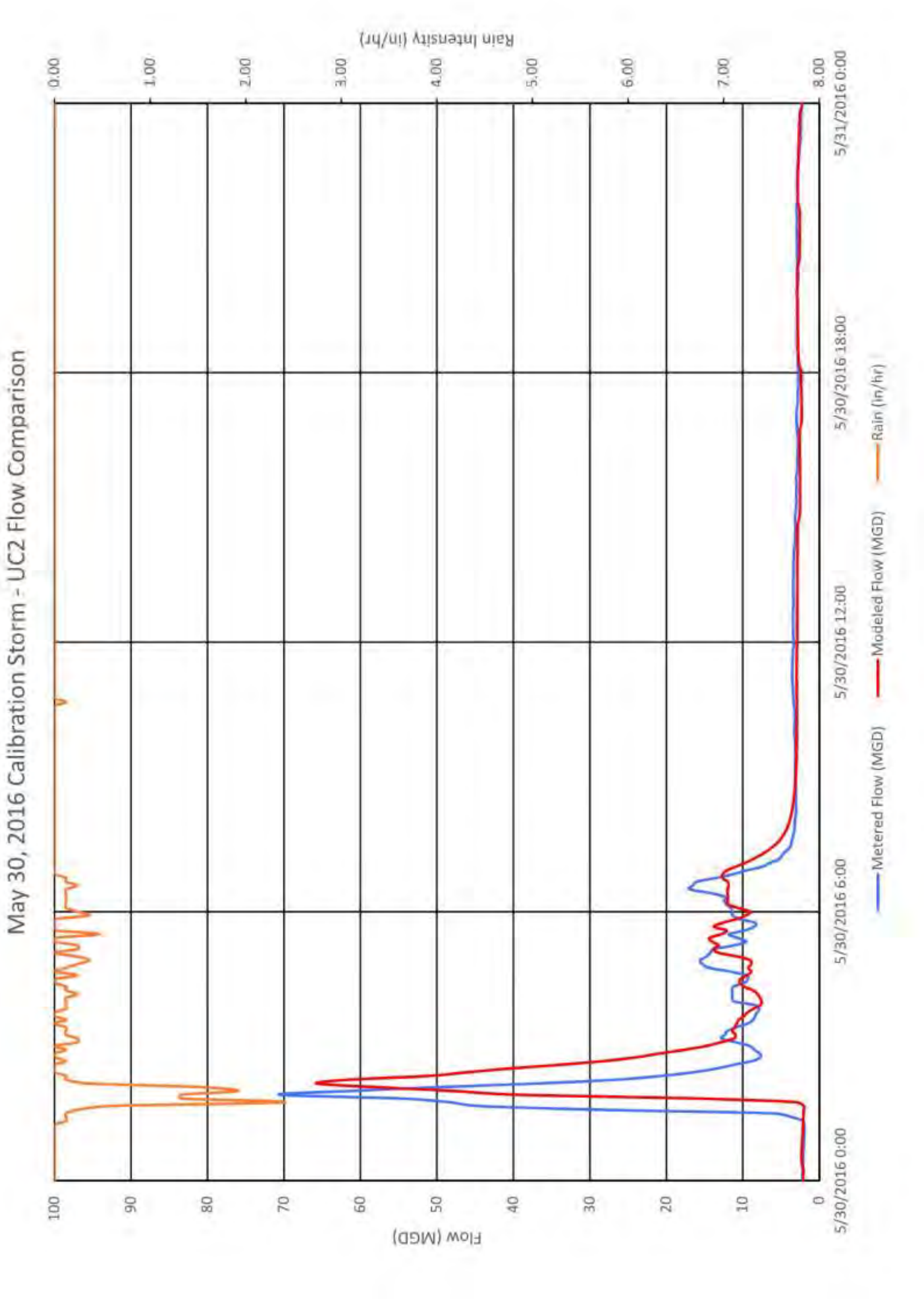

September 24, 2016 Calibration Storm - UC1 Depth Comparison
Depth (ft)
0
1
2
3
4
5
6
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

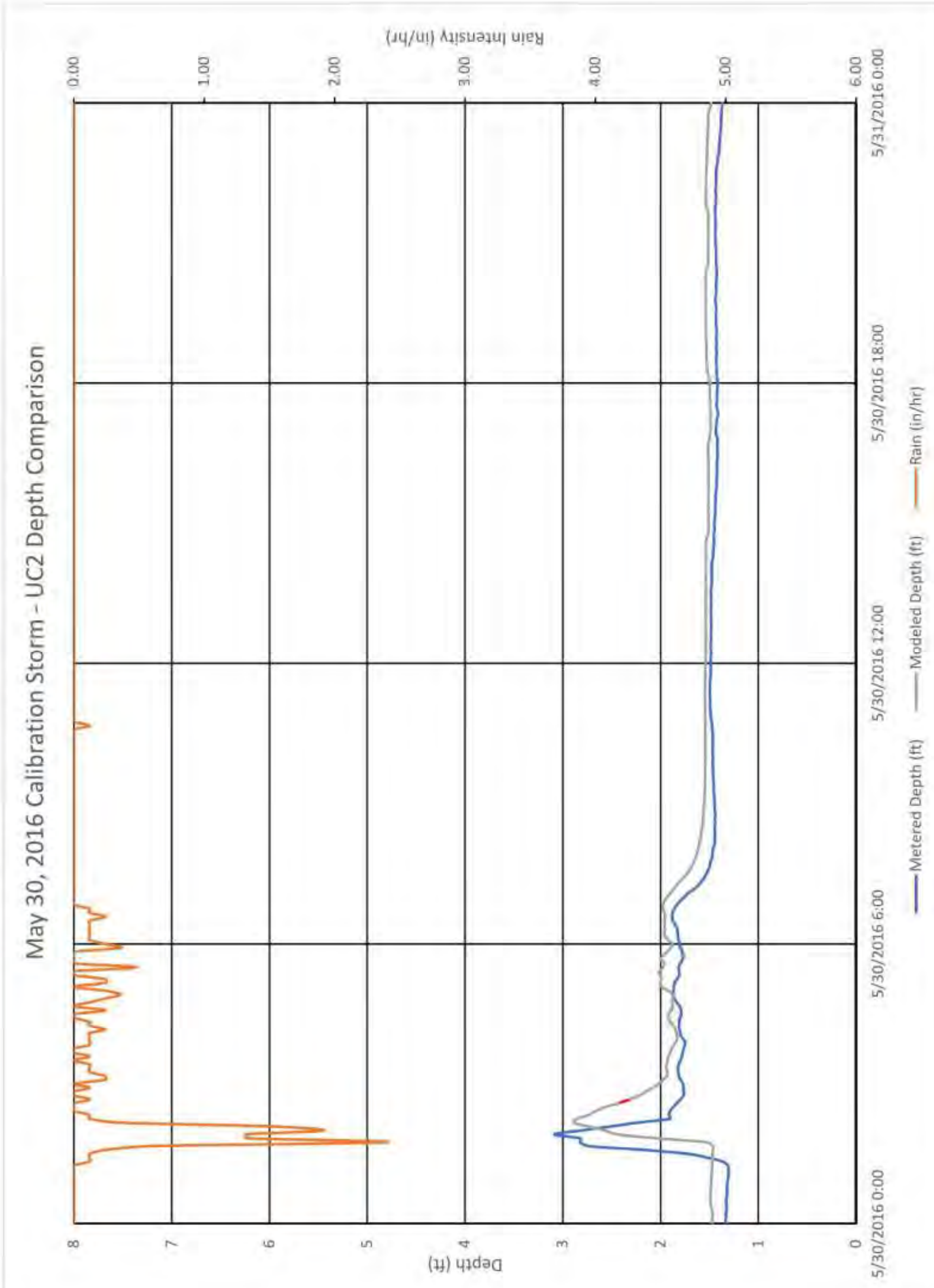

October 8, 2016 Validation Storm - UC1 Flow Comparison
Flow (MGD)
20
18
16
14
12
10
8
6
4
2
0
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

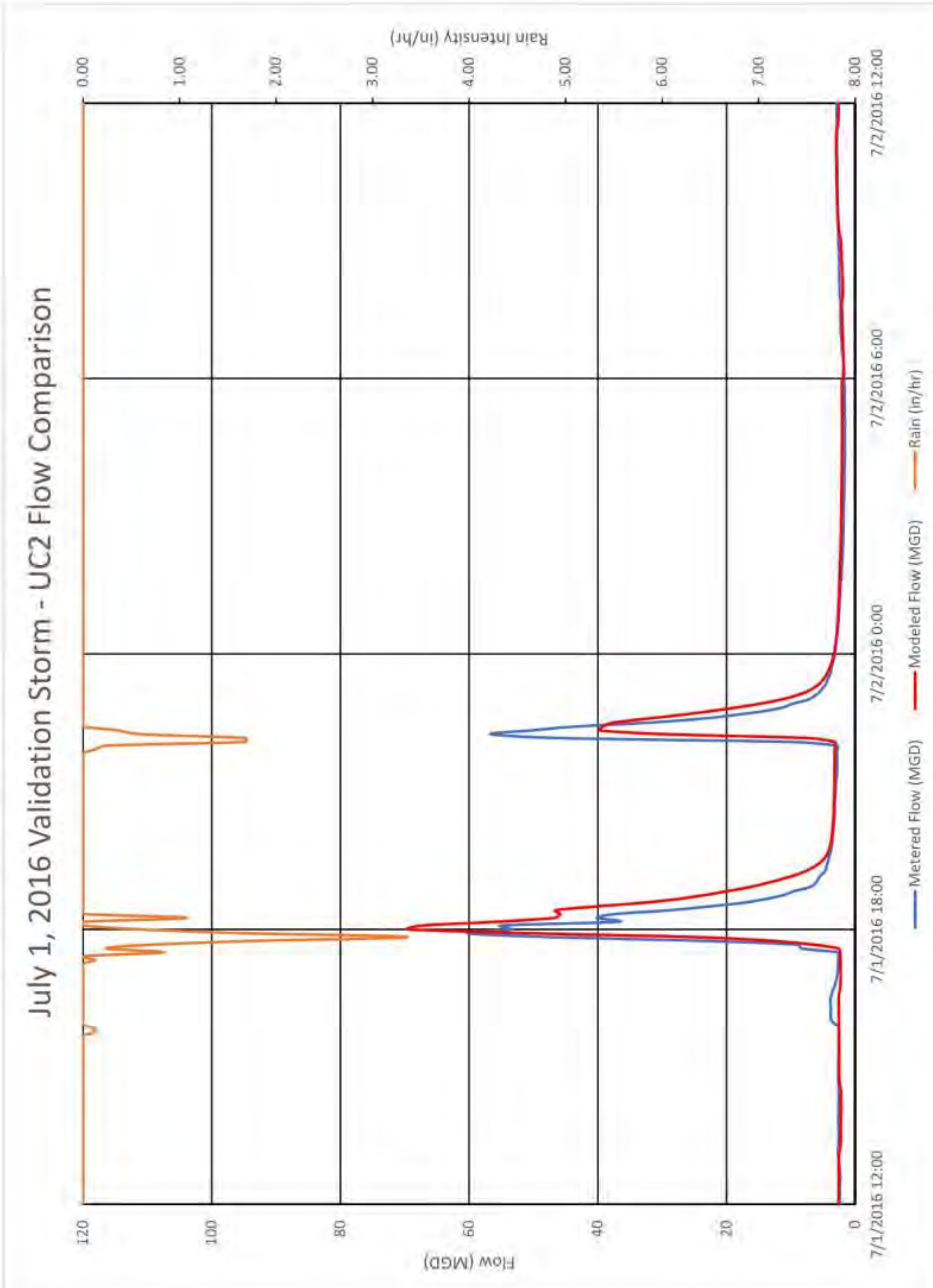

October 8, 2016 Validation Storm - UC1 Depth Comparison
Depth (ft)
3
2.5
2
1.5
1
0.5
0
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

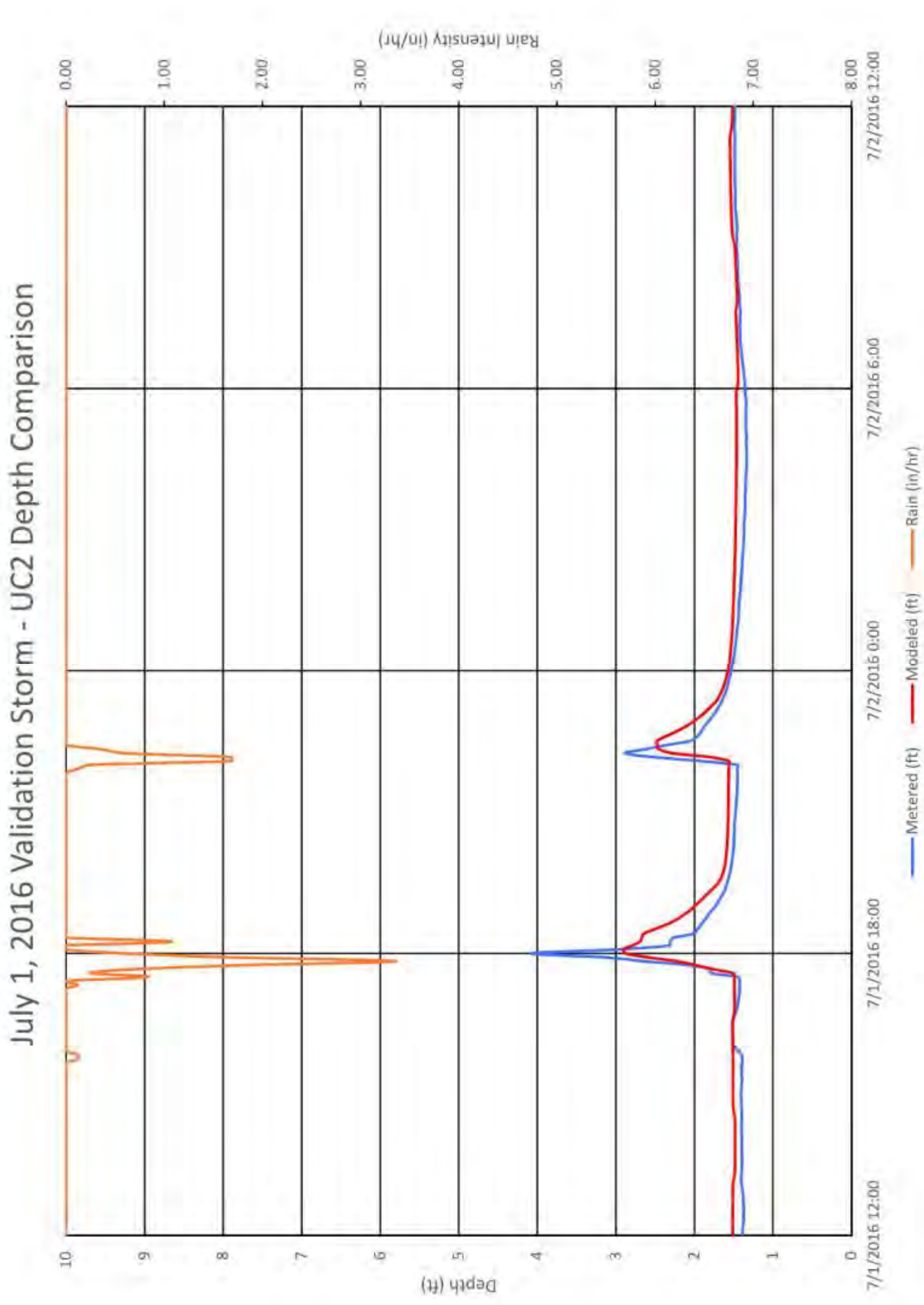

November 15, 2016 Calibration Storm - UC1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
5
10
15
20
25
30
35
40
0.00
0.50
1.00
1.50
2.00
2.50
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

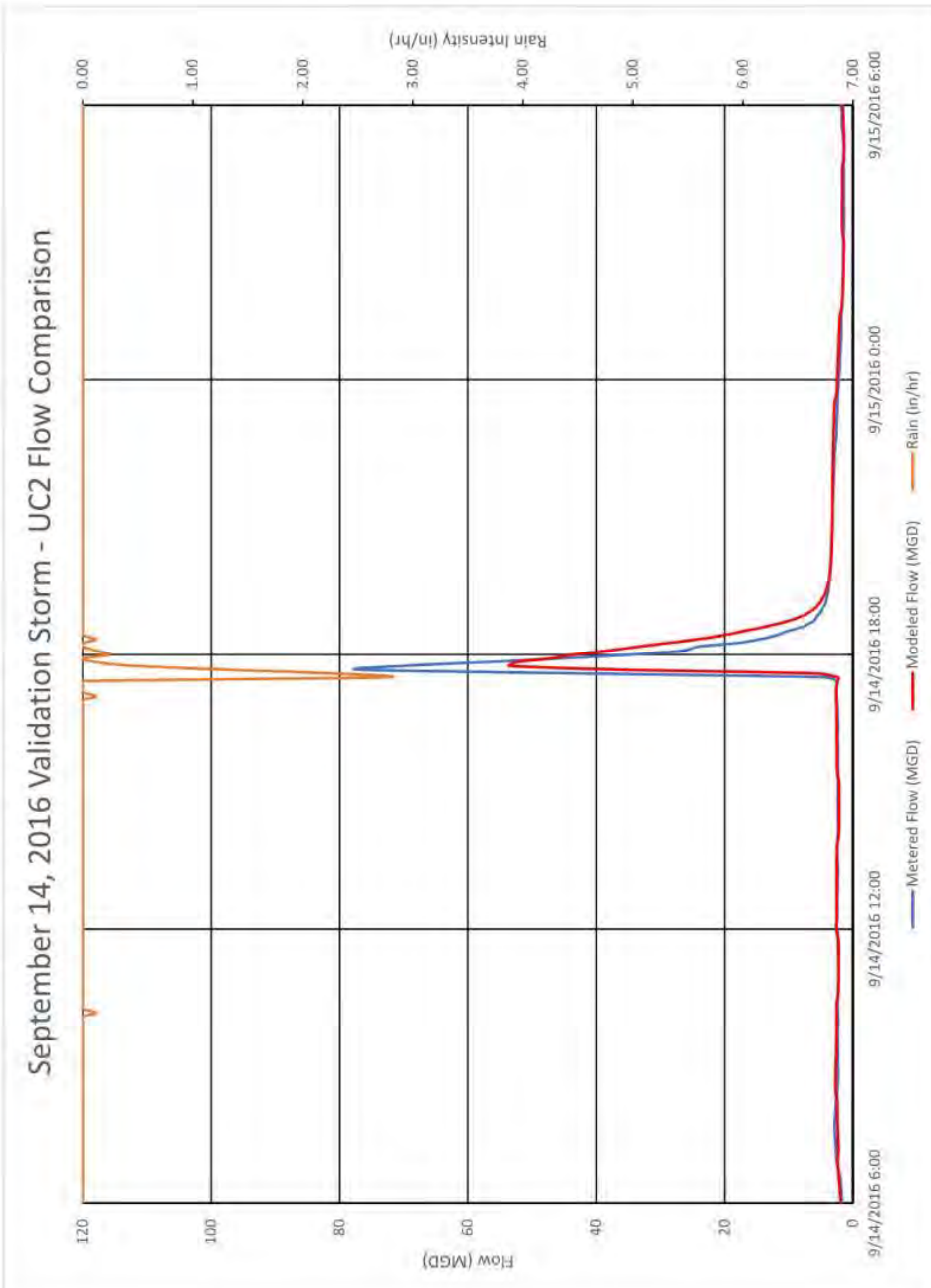

November 15, 2016 Calibration Storm - UC1 Depth Comparison
Rain Intensity (in/hr)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Depth (ft)
4
3.5
3
2.5
2
1.5
1
0.5
0
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

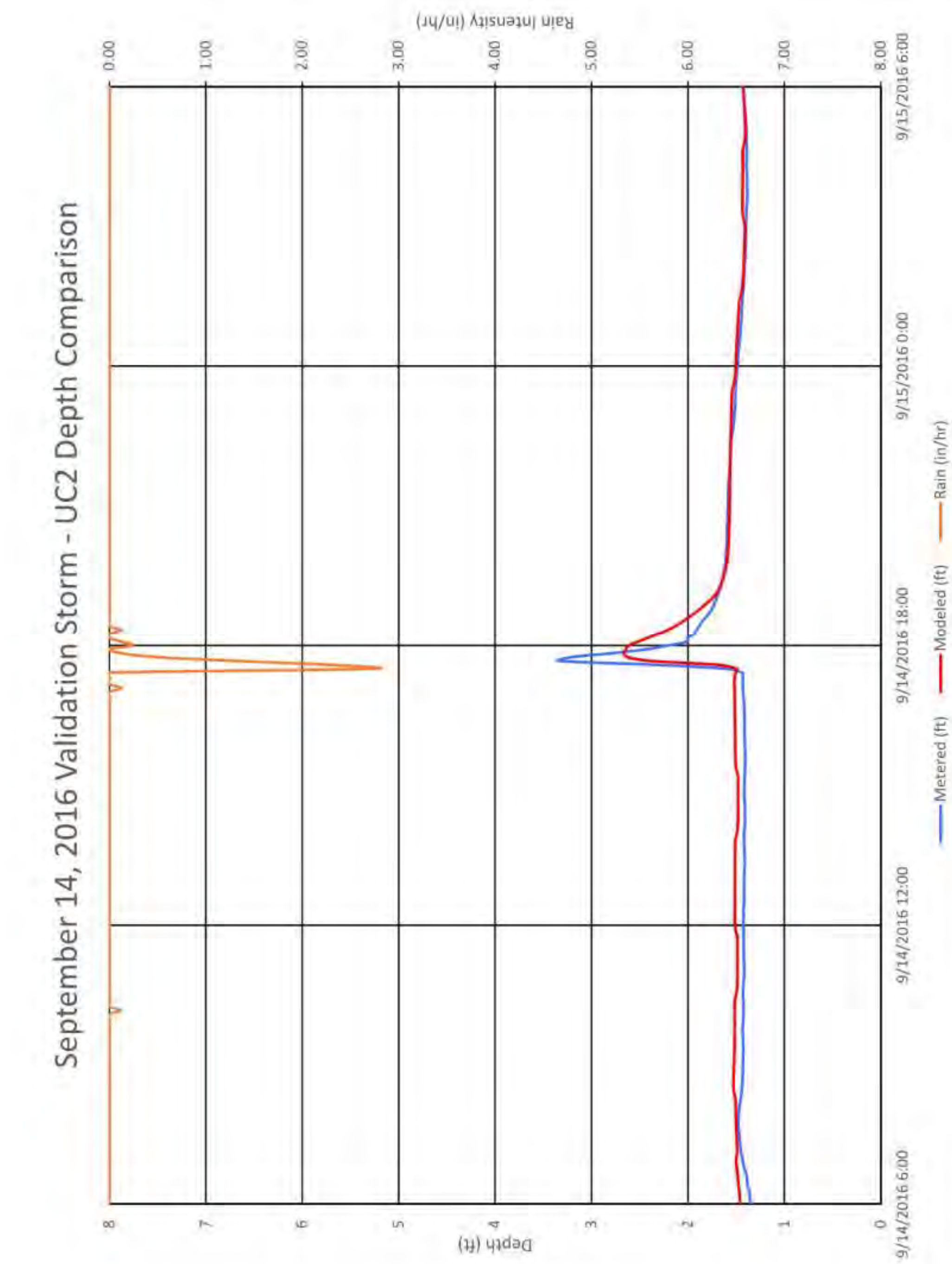

May 30, 2016 Calibration Storm - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
100
90
80
70
60
50
40
30
20
10
0
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

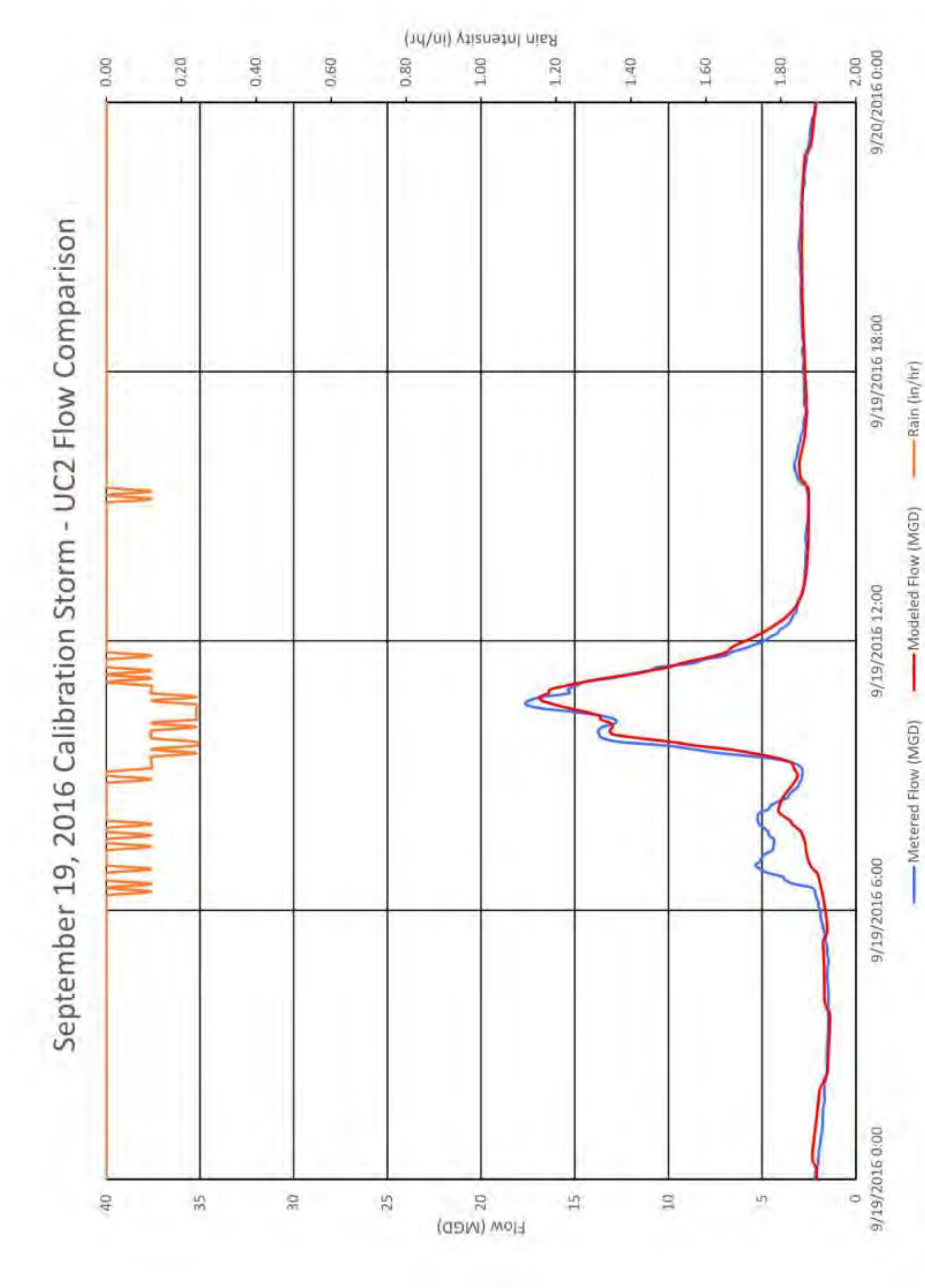

May 30, 2016 Calibration Storm - UC2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
7
8
0.00
1.00
2.00
3.00
4.00
5.00
6.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered Depth (ft)
Modeled Depth (ft)
Rain (in/hr)

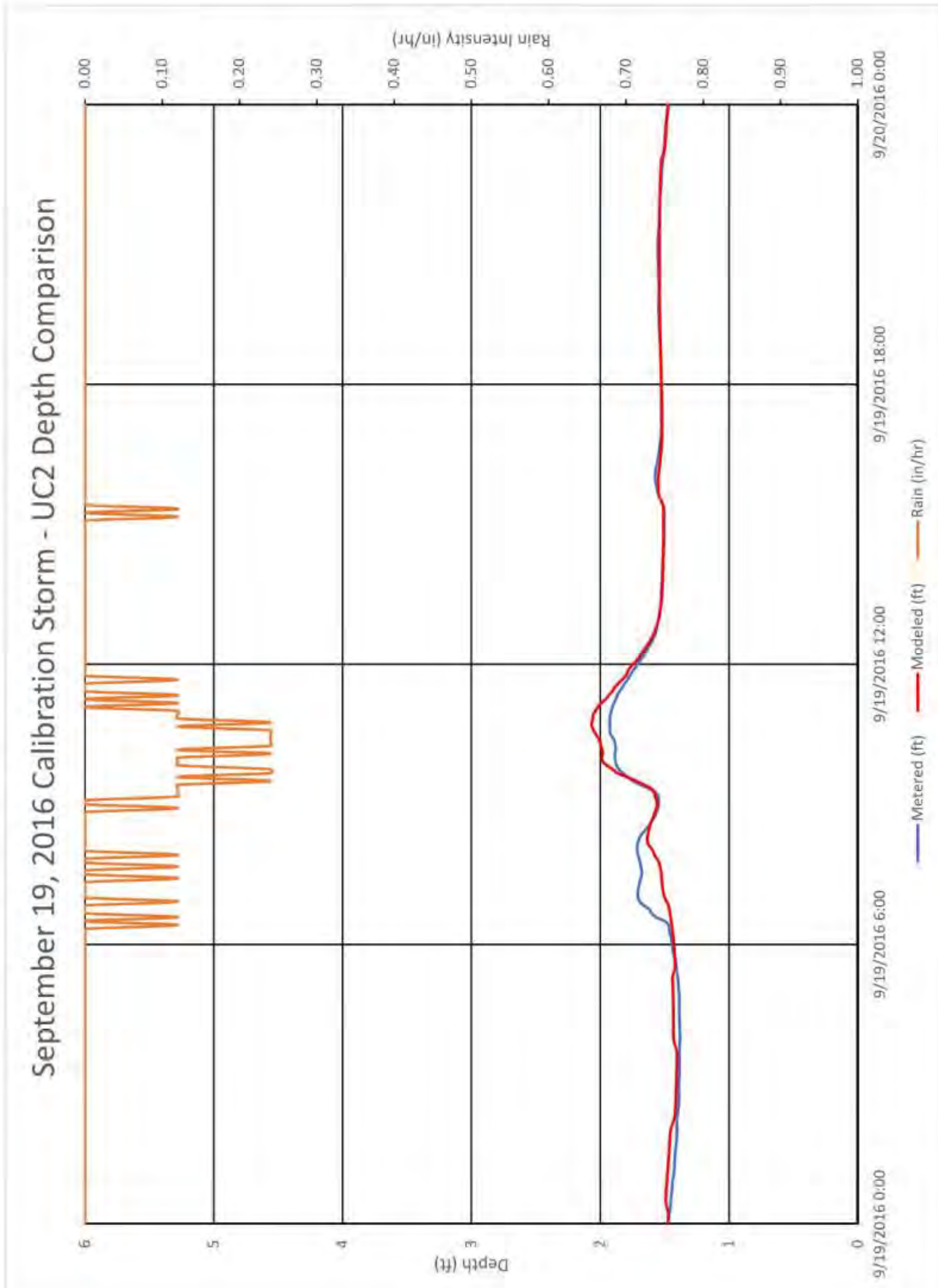

July 1, 2016 Validation Storm - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
20
40
60
80
100
120
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

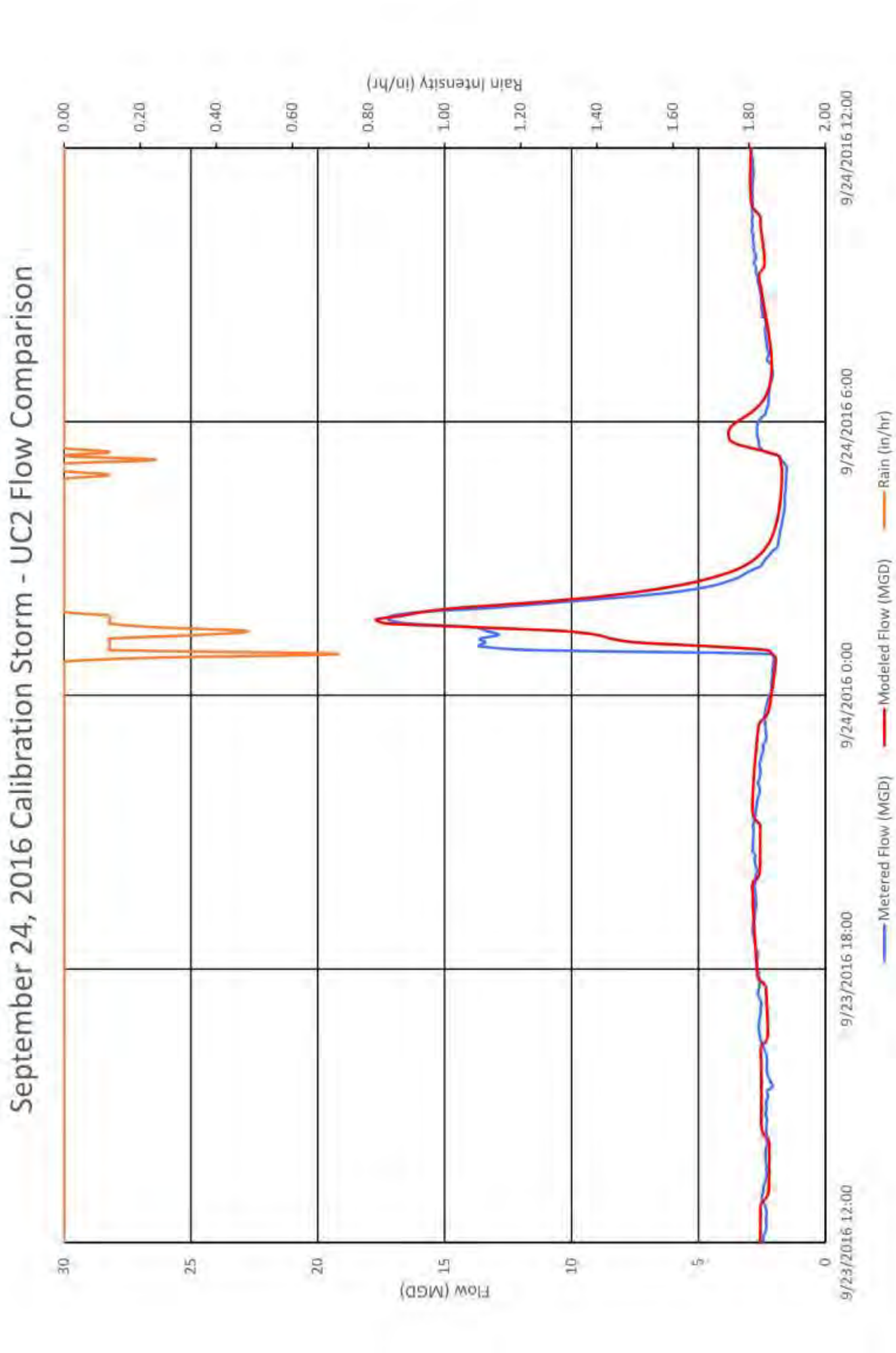

July 1, 2016 Validation Storm - UC2 Depth Comparison
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

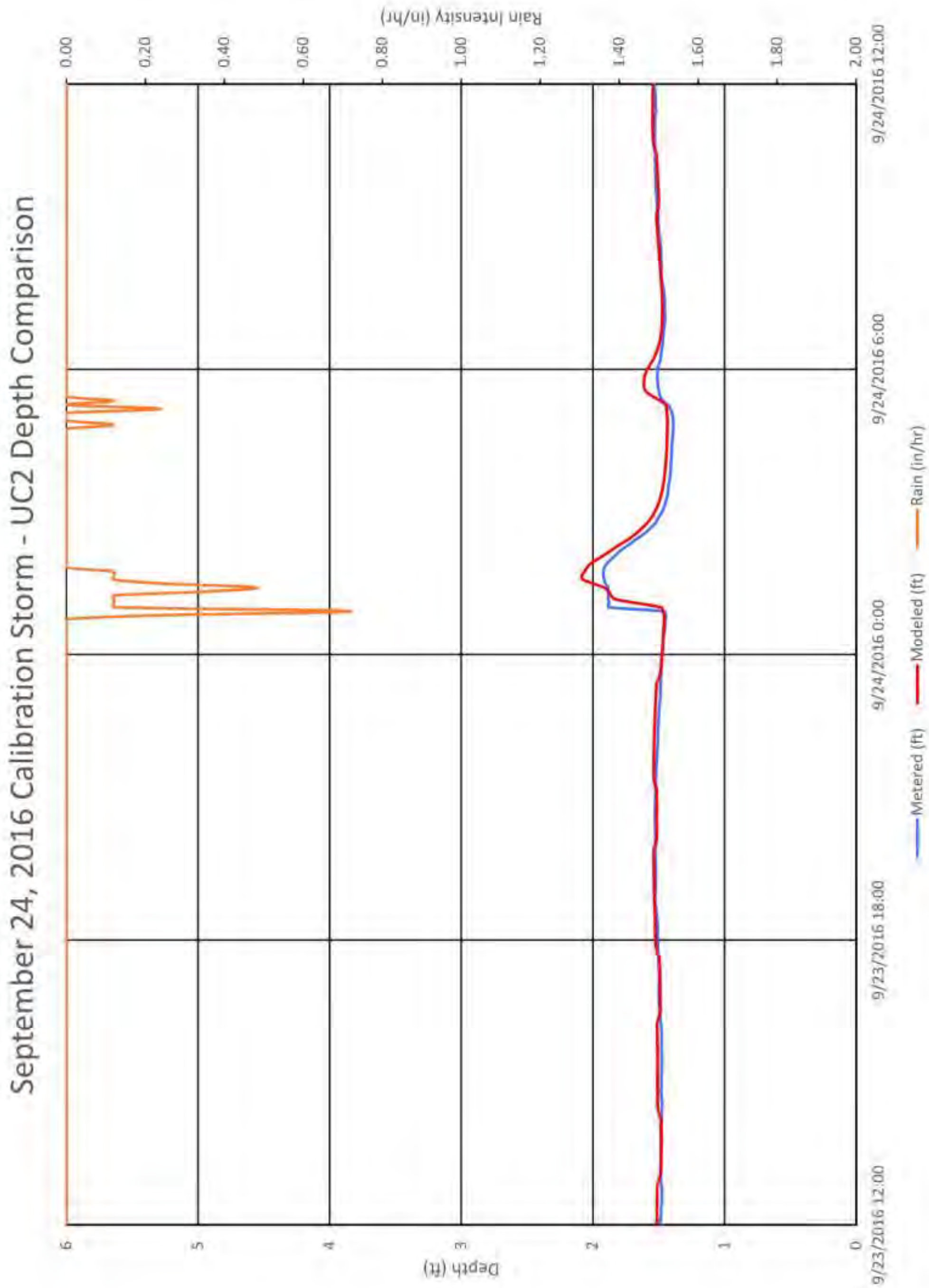

September 14, 2016 Validation Storm - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
20
40
60
80
100
120
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

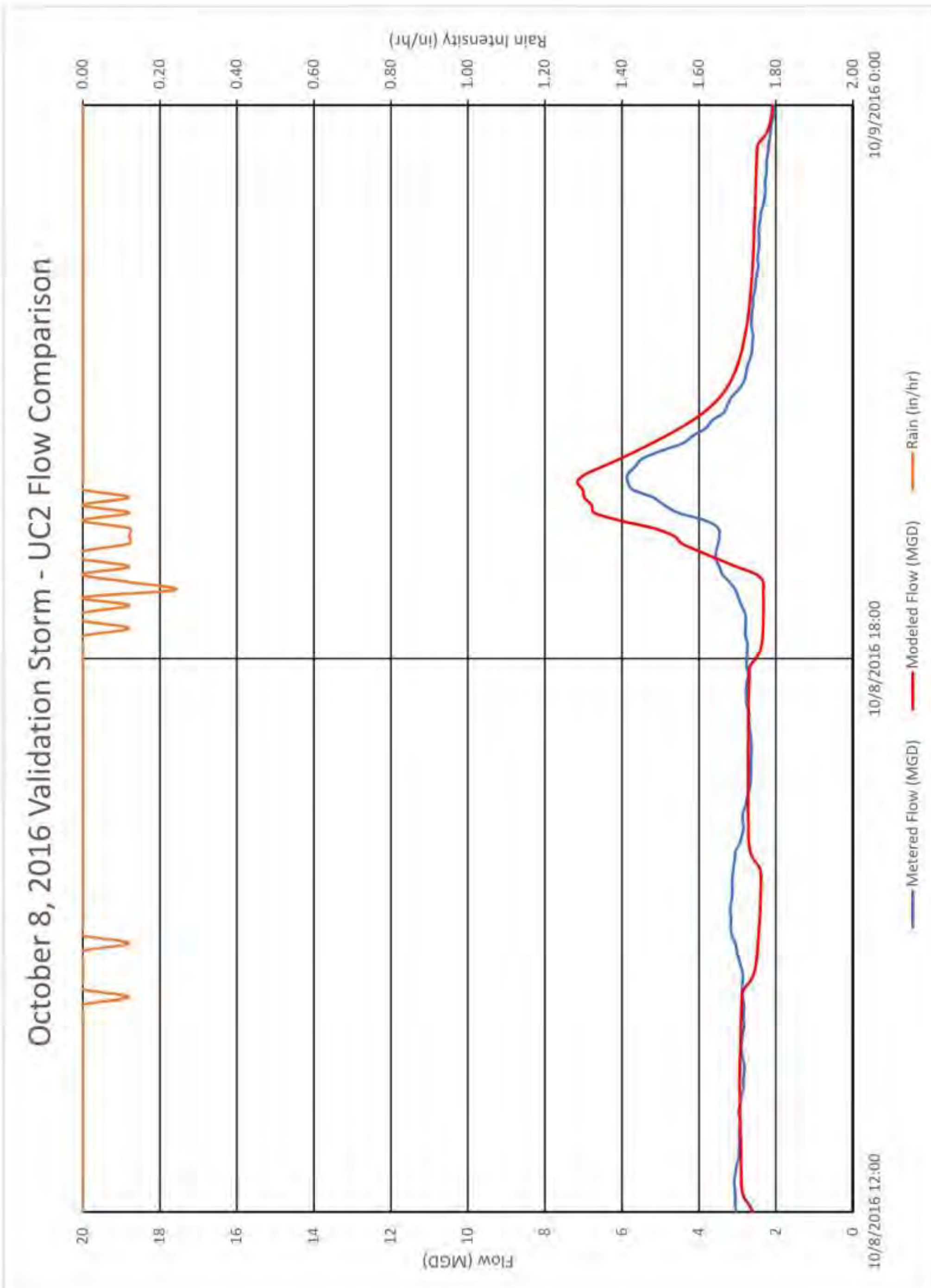

September 14, 2016 Validation Storm - UC2 Depth Comparison
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Depth (ft)
8
7
6
5
4
3
2
1
0
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

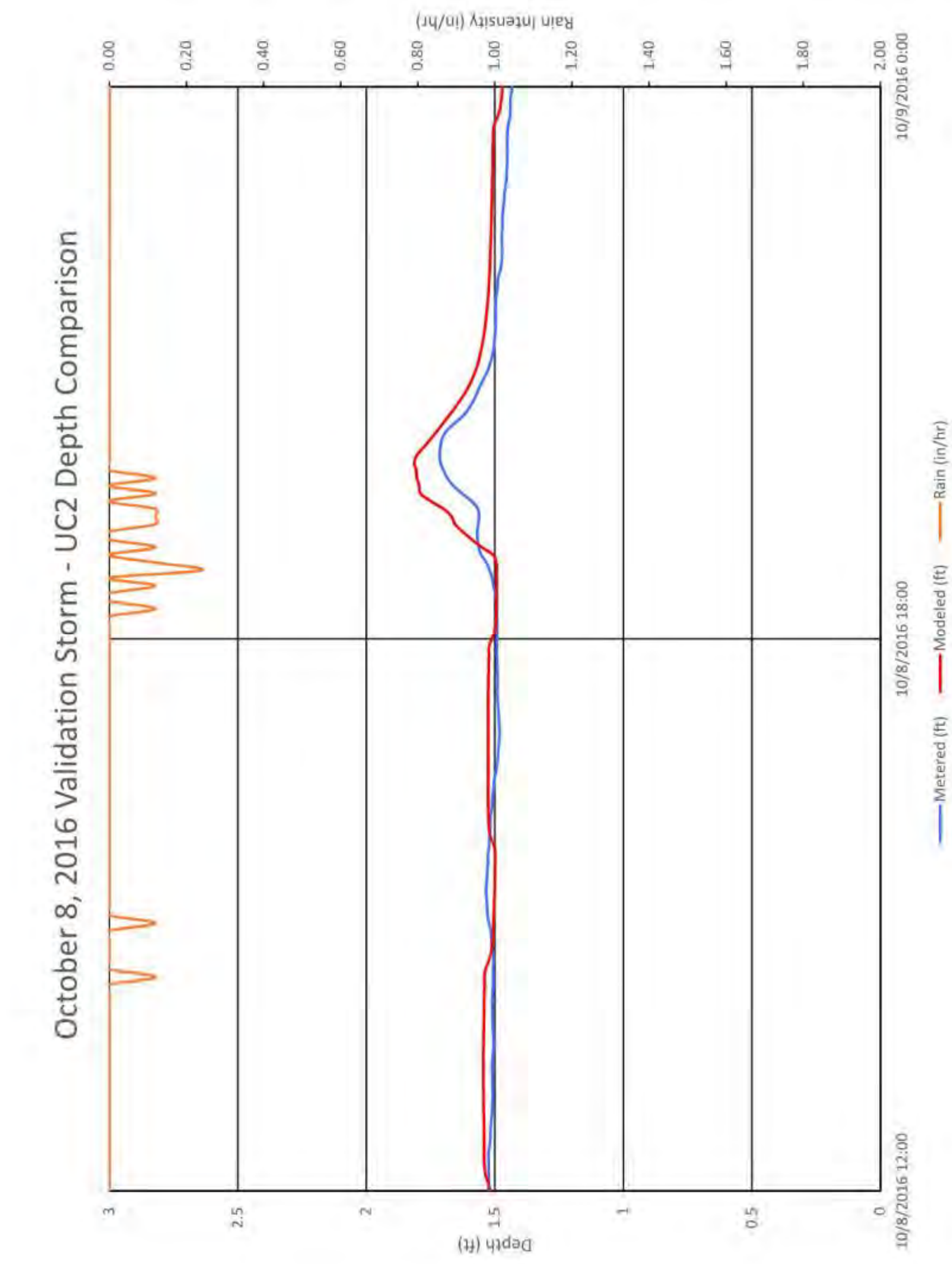

September 19, 2016 Calibration Storm - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
5
10
15
20
25
30
35
40
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

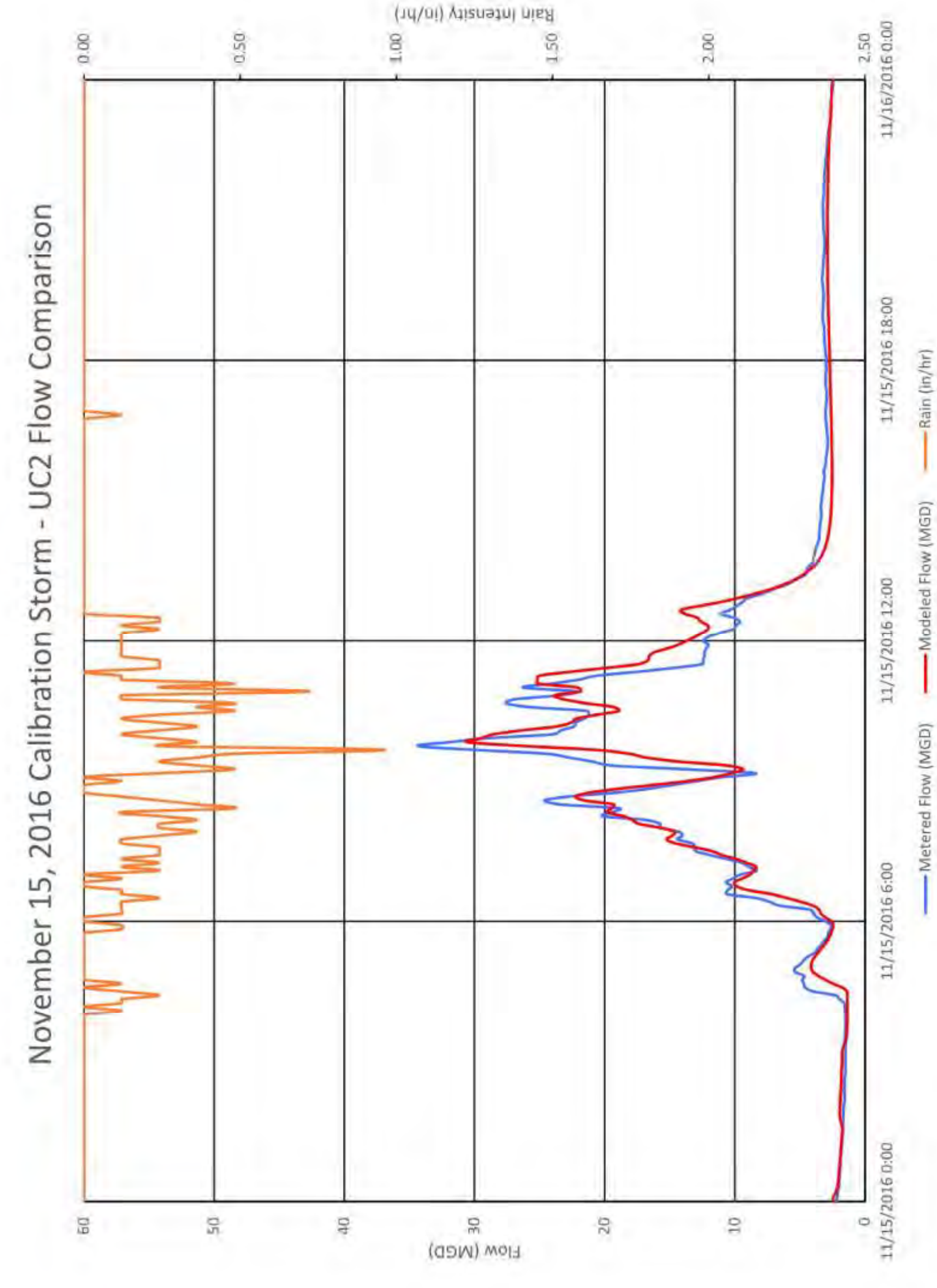

September 19, 2016 Calibration Storm - UC2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)


September 24, 2016 Calibration Storm - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
5
10
15
20
25
30
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

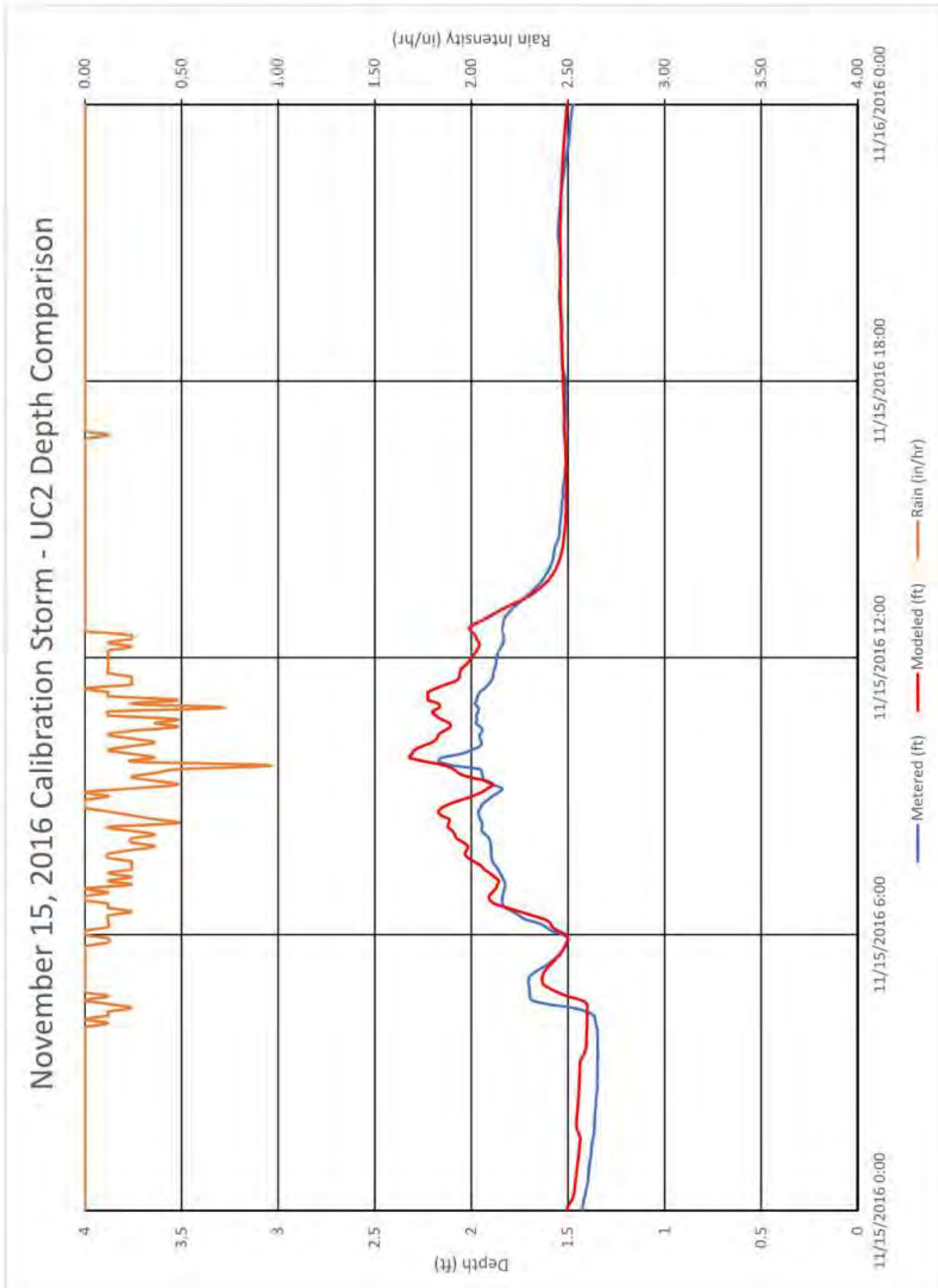

September 24, 2016 Calibration Storm - UC2 Depth Comparison
Depth (ft)
0
1
2
3
4
5
6
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

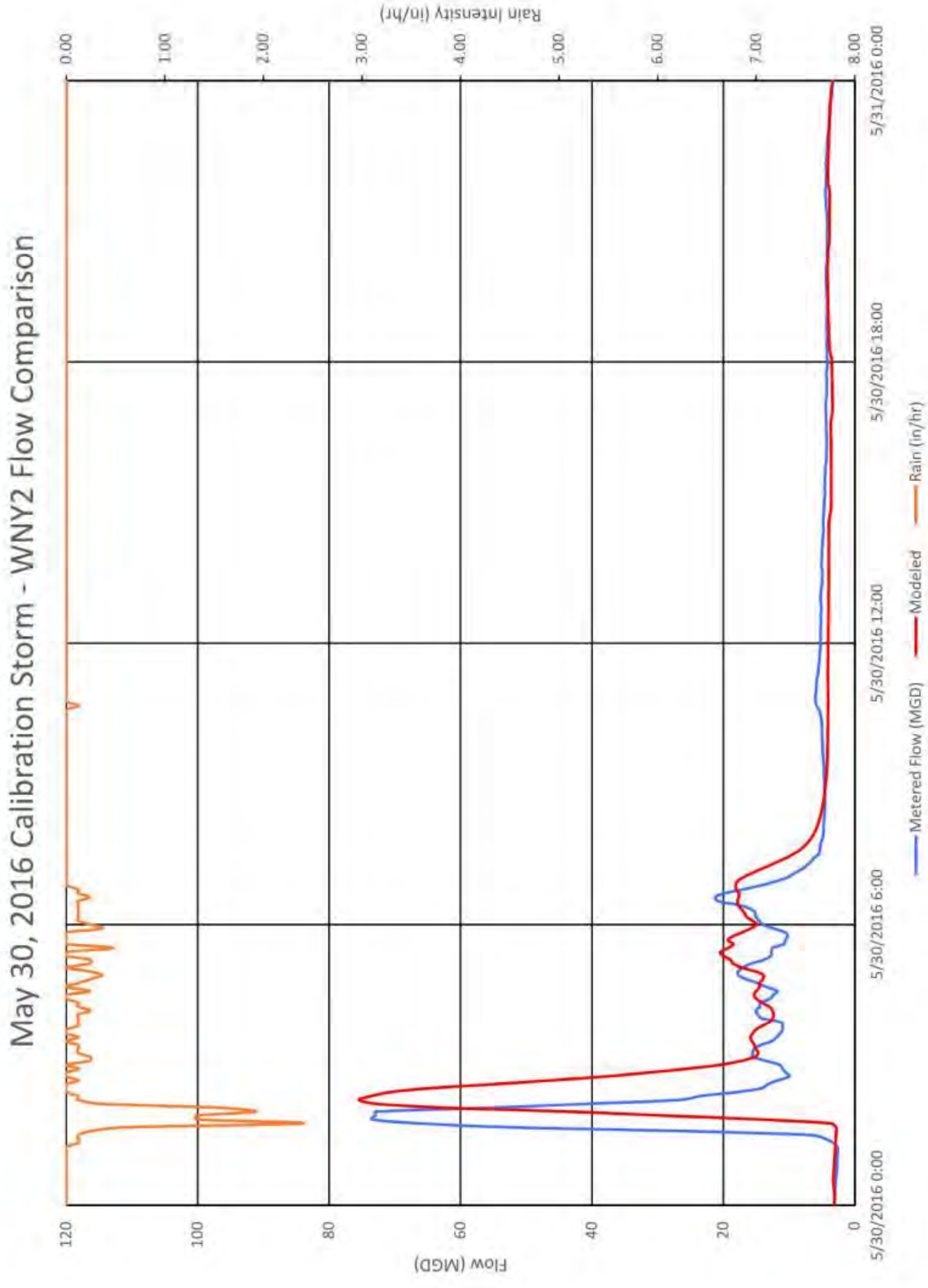

October 8, 2016 Validation Storm - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

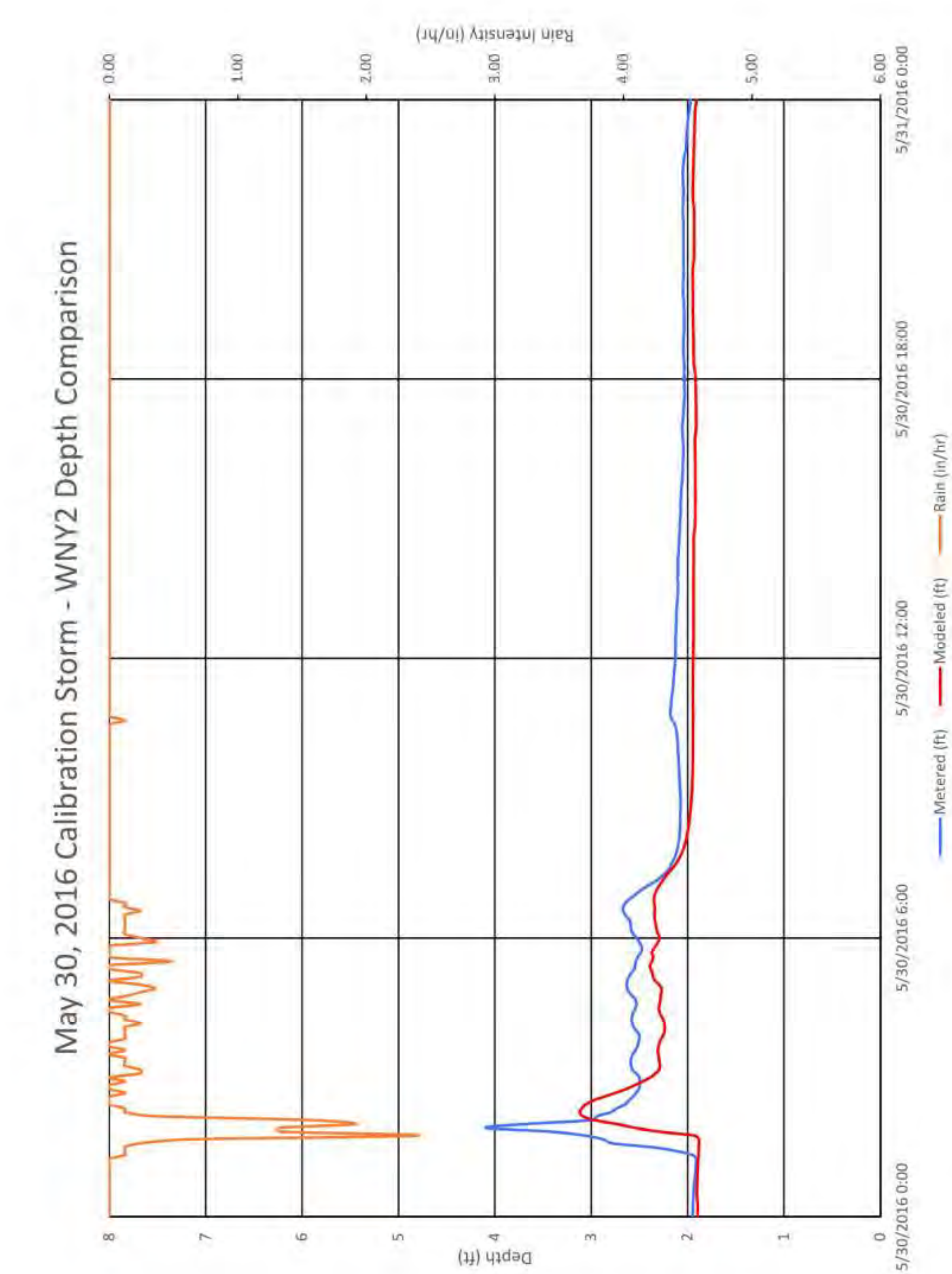

October 8, 2016 Validation Storm - UC2 Depth Comparison
Depth (ft)
3
2.5
2
1.5
1
0.5
0
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

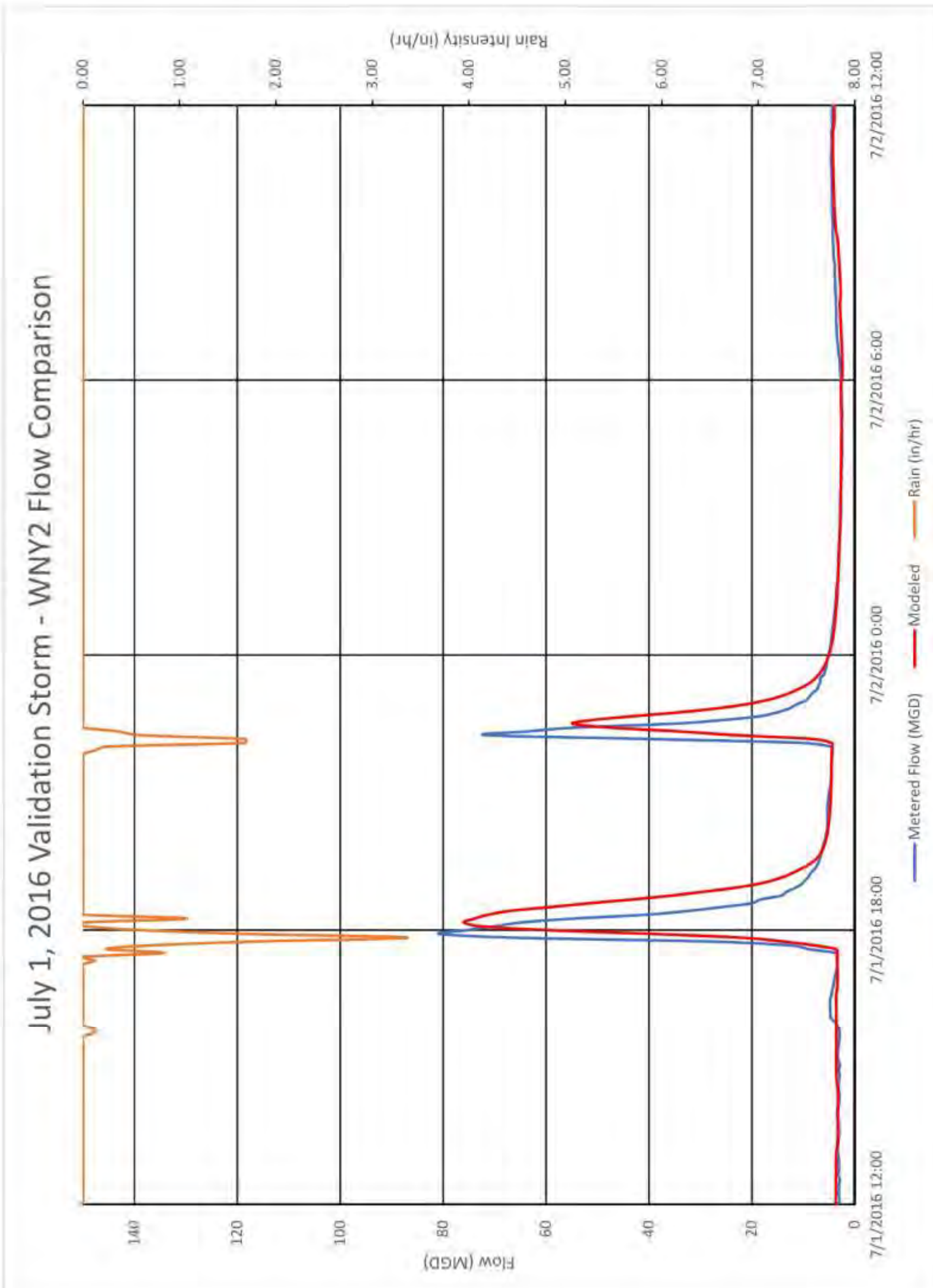


November 15, 2016 Calibration Storm - UC2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
10
20
30
40
50
60
0.00
0.50
1.00
1.50
2.00
2.50
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

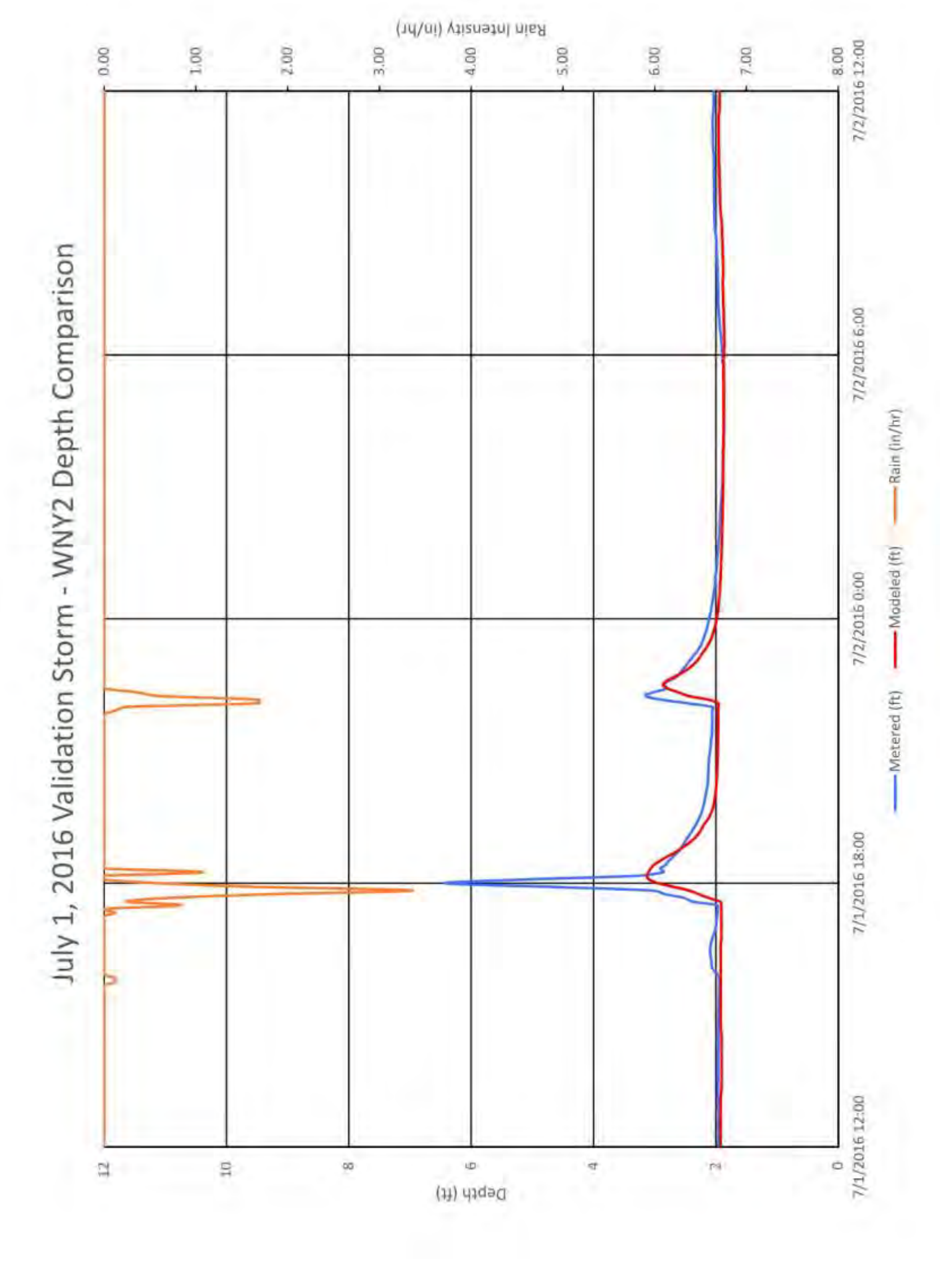

November 15, 2016 Calibration Storm - UC2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
0.5
1
1.5
2
2.5
3
3.5
4
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

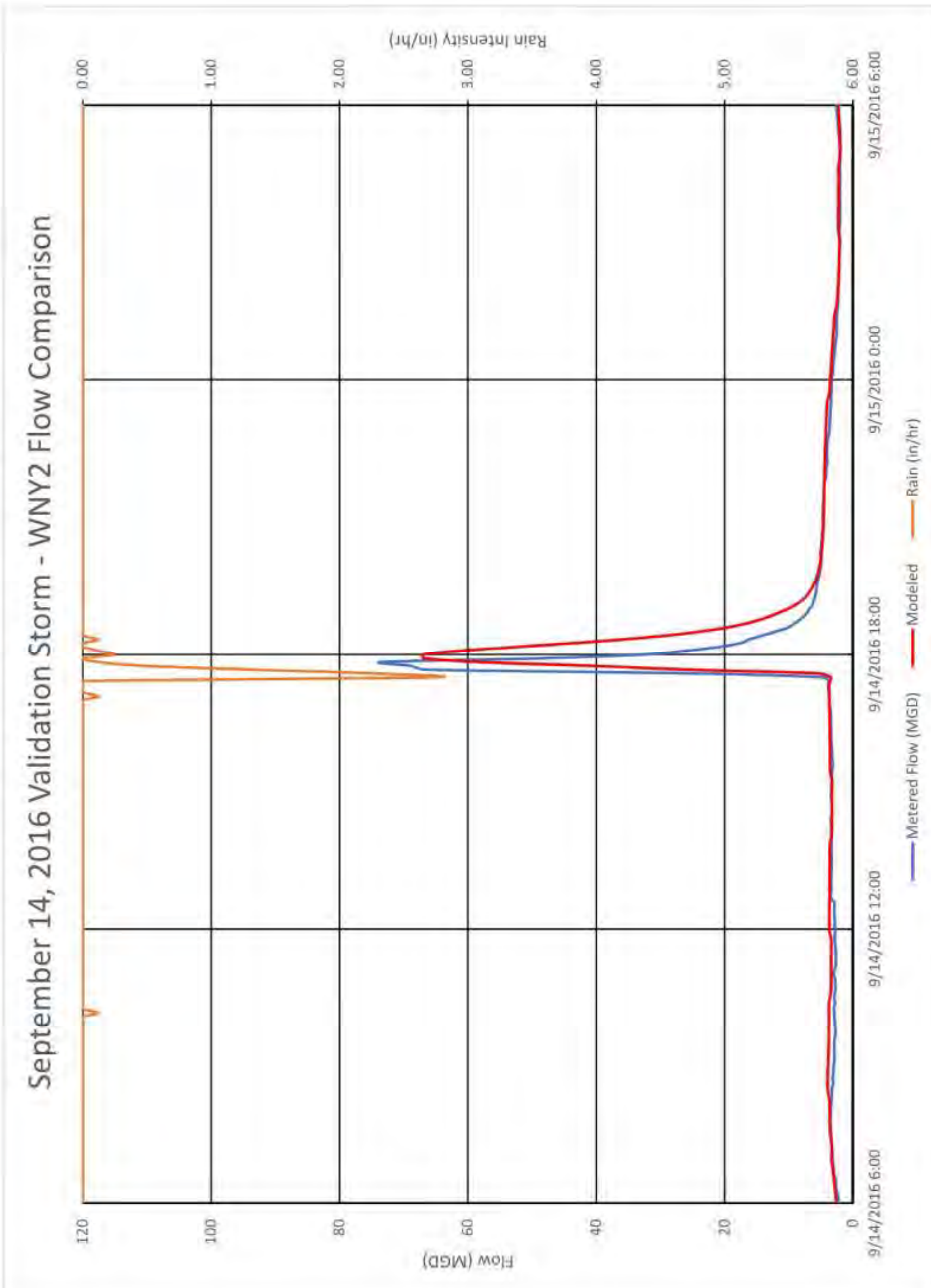

May 30, 2016 Calibration Storm - WNY2 Flow Comparison
Flow (MGD)
120
100
80
60
40
20
0
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

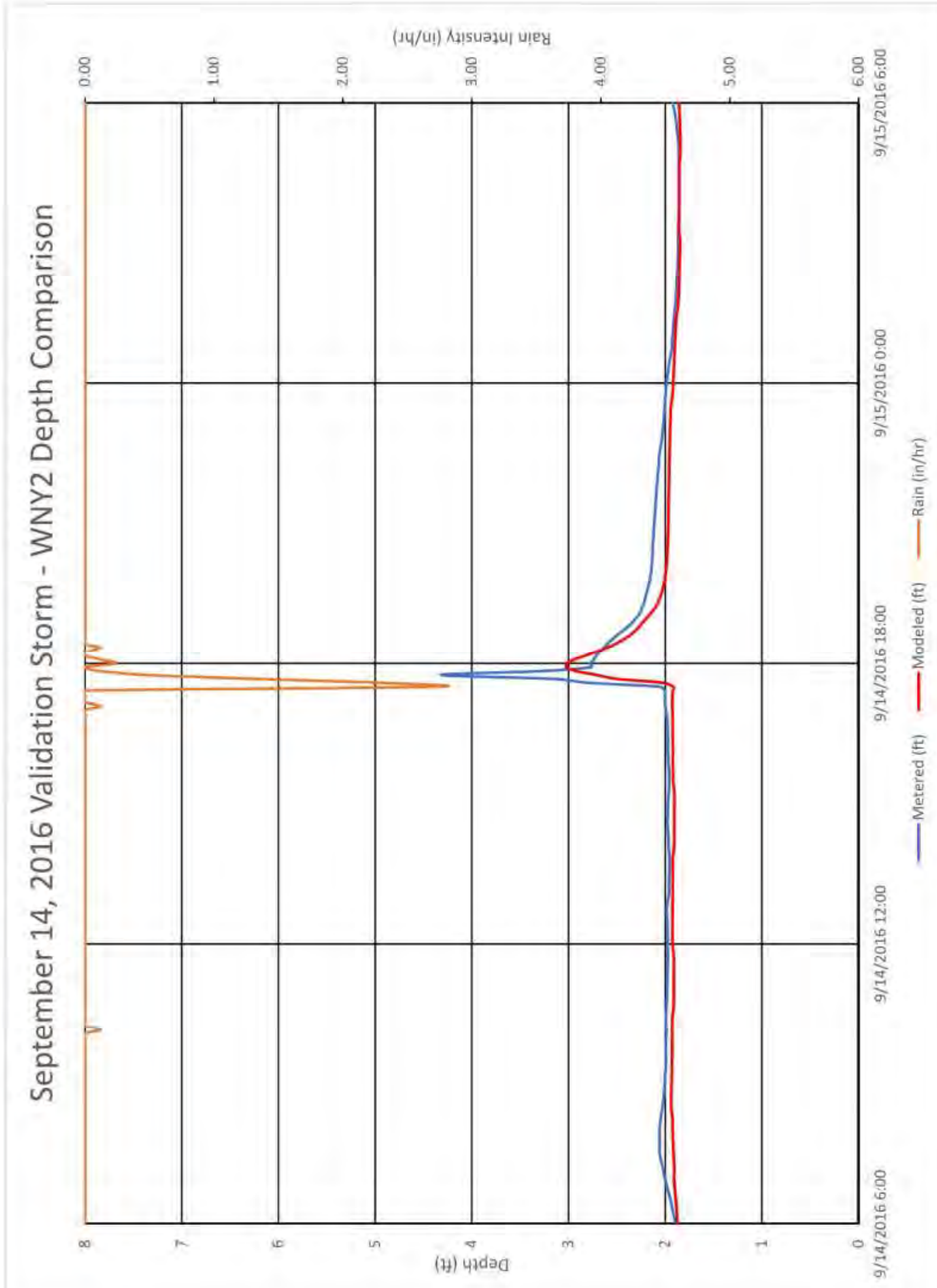

May 30, 2016 Calibration Storm - WNY2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
7
8
0.00
1.00
2.00
3.00
4.00
5.00
6.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

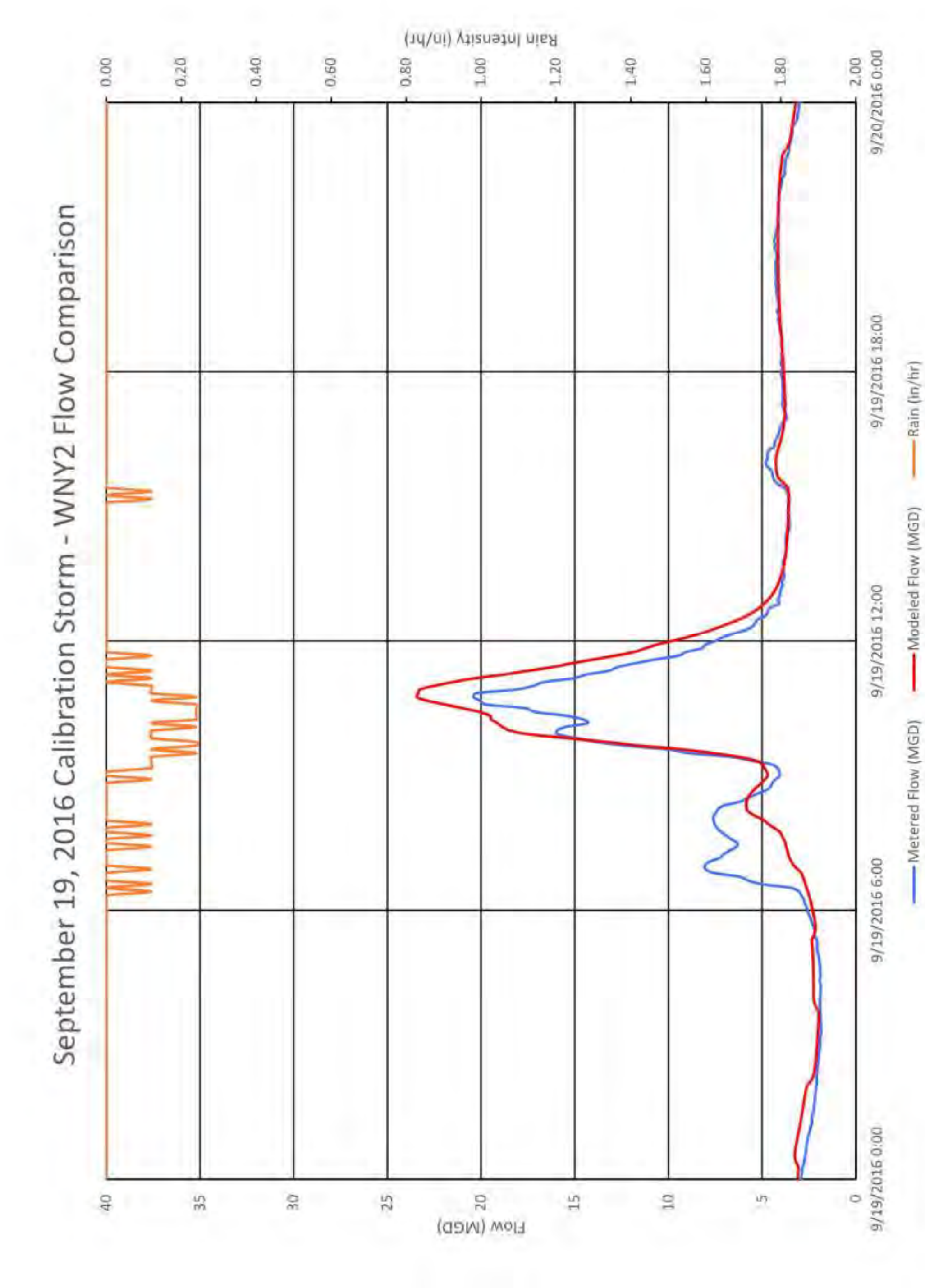


July 1, 2016 Validation Storm - WNY2 Flow Comparison
Flow (MGD)
0
20
40
60
80
100
120
140
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

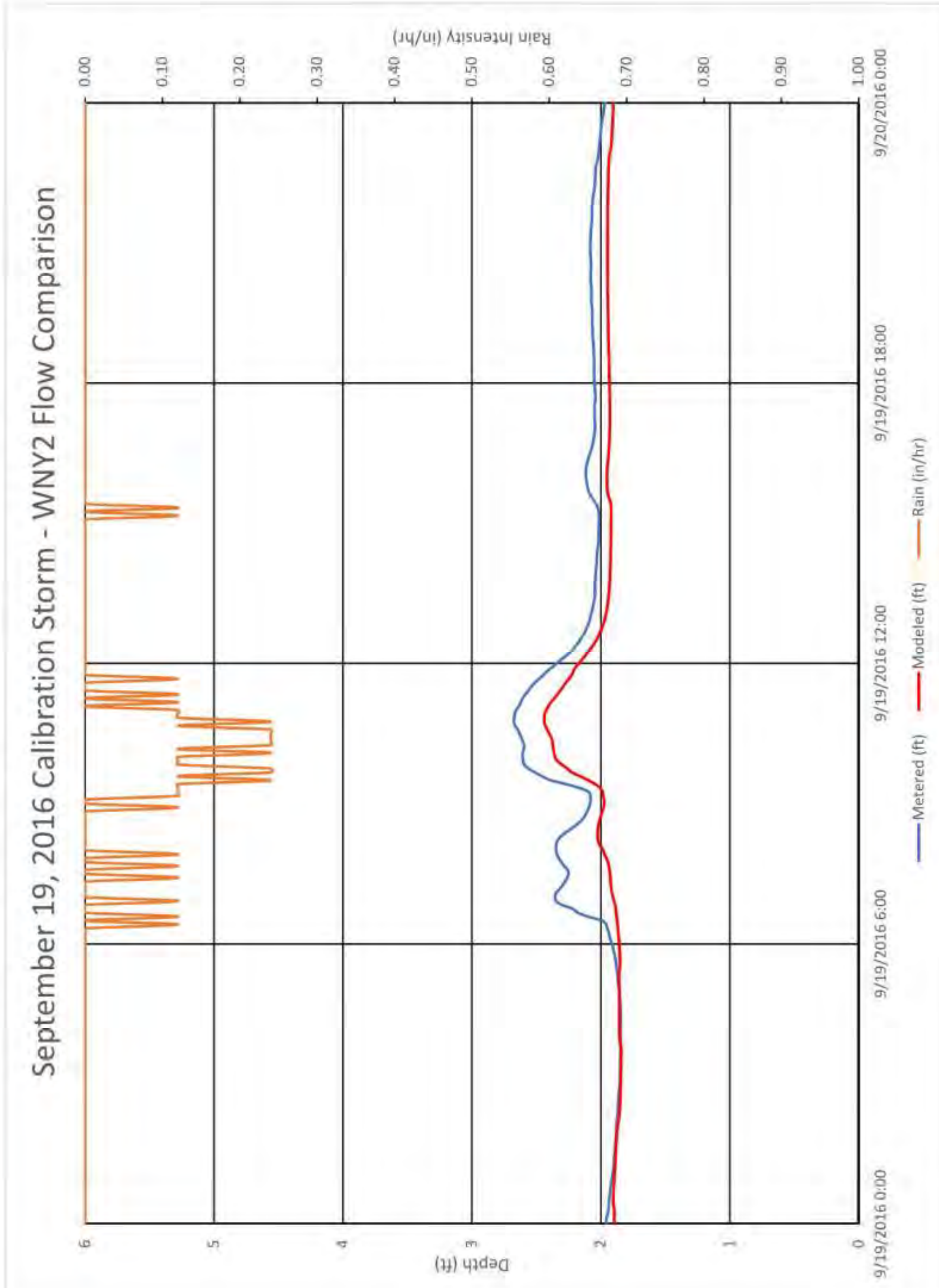

July 1, 2016 Validation Storm - WNY2 Depth Comparison
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Depth (ft)
12
10
8
6
4
2
0
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

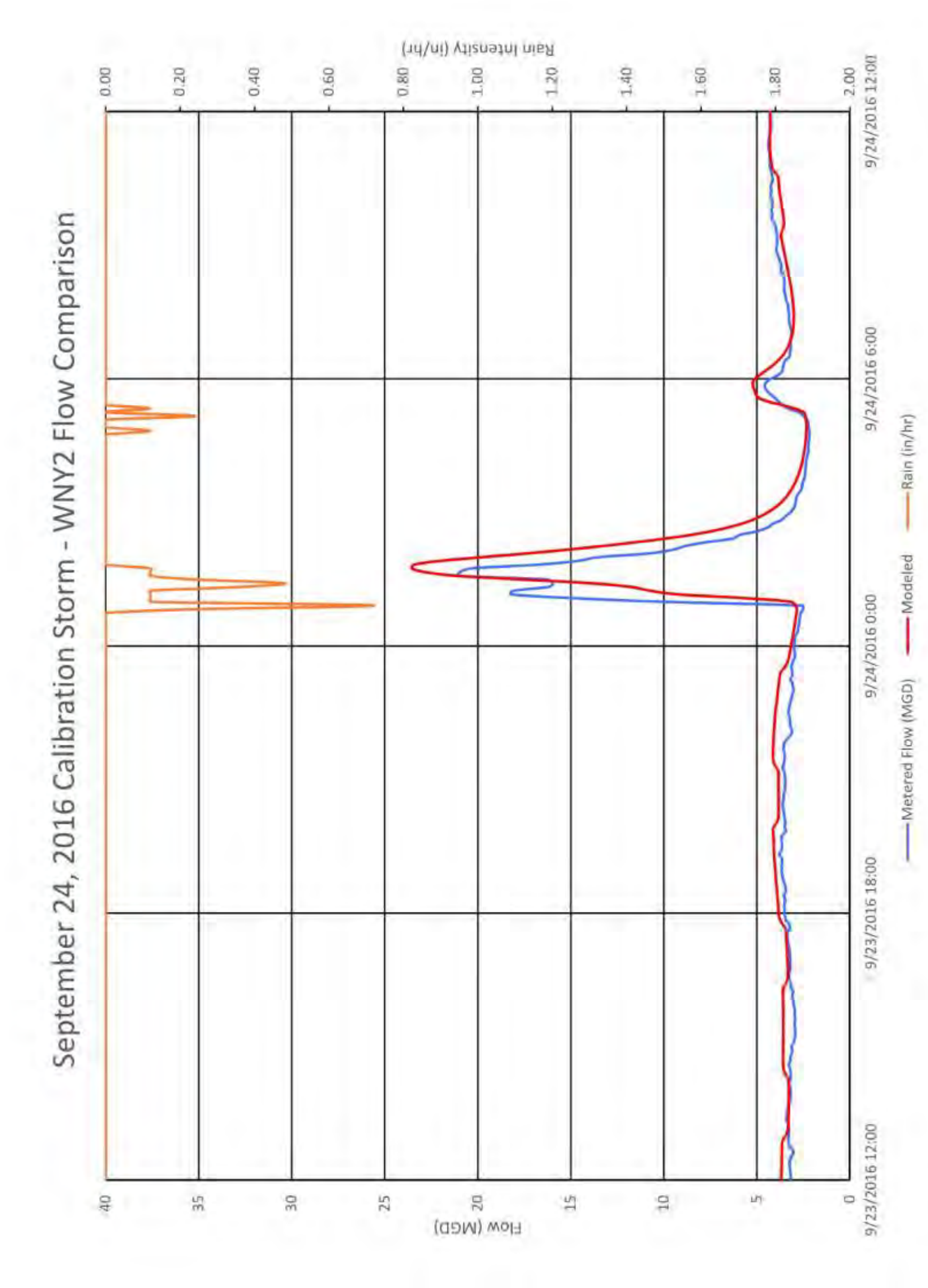

September 14, 2016 Validation Storm - WNY2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
20
40
60
80
100
120
0.00
1.00
2.00
3.00
4.00
5.00
6.00
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

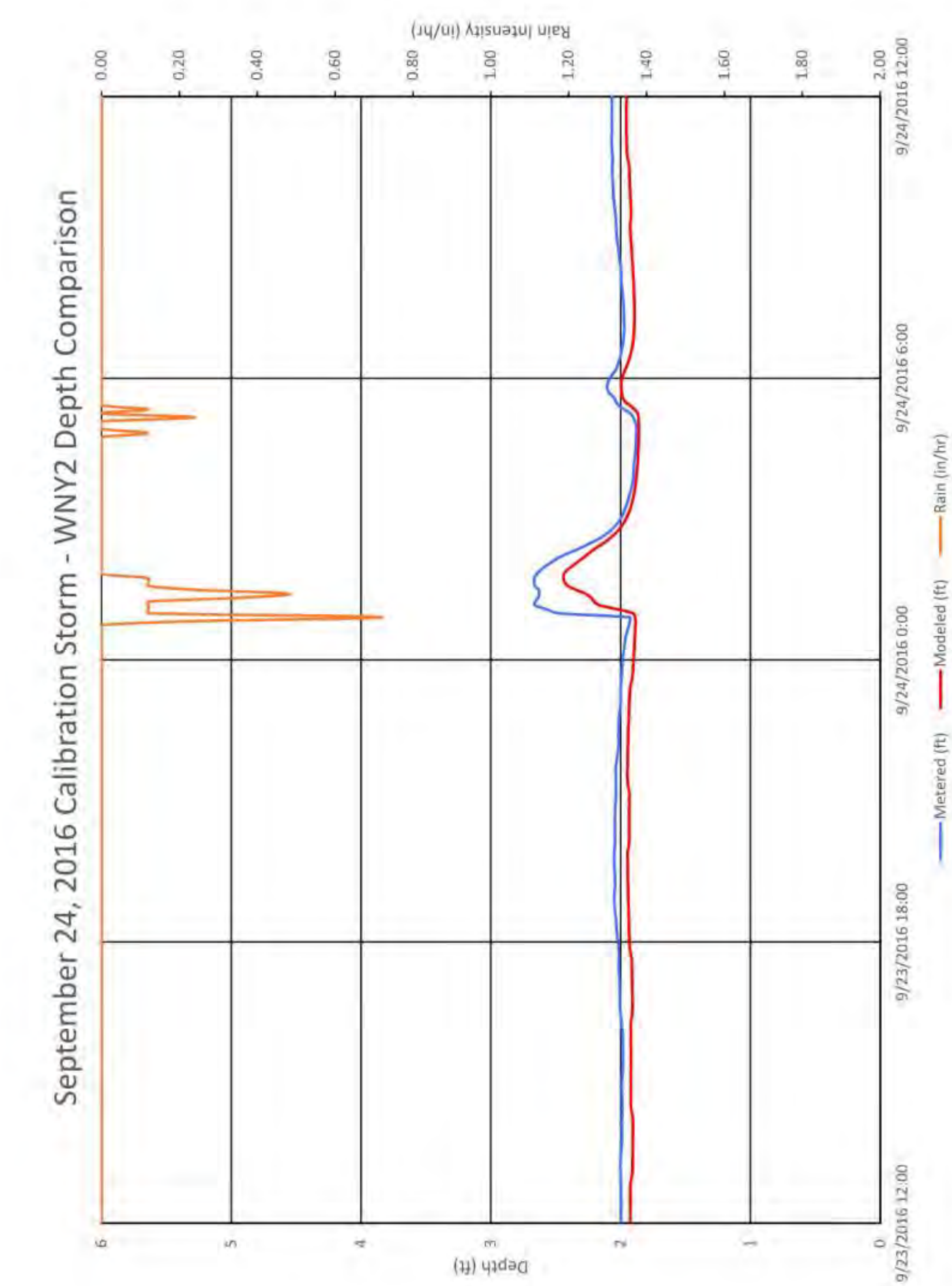

September 14, 2016 Validation Storm - WNY2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
7
8
0.00
1.00
2.00
3.00
4.00
5.00
6.00
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

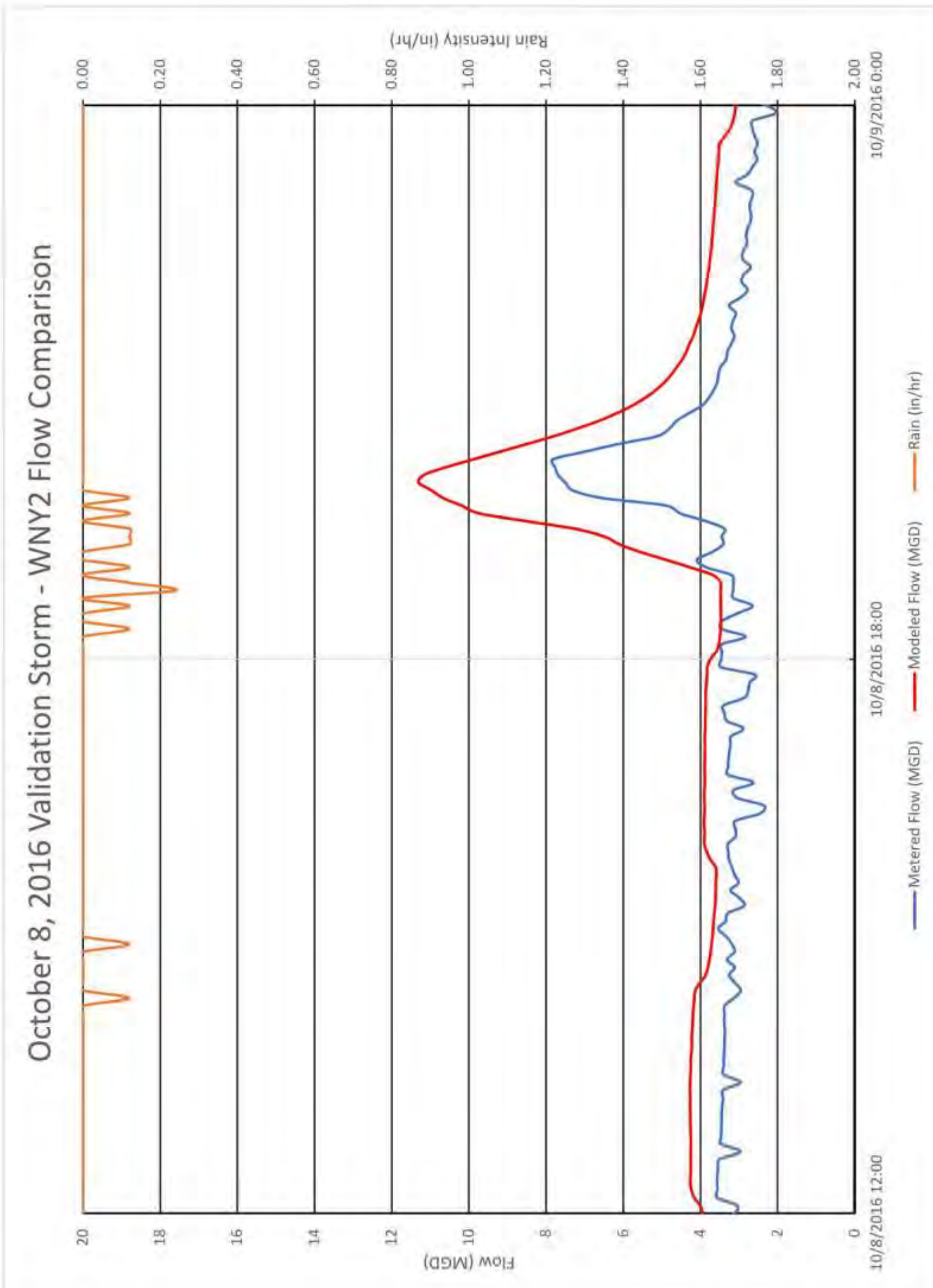


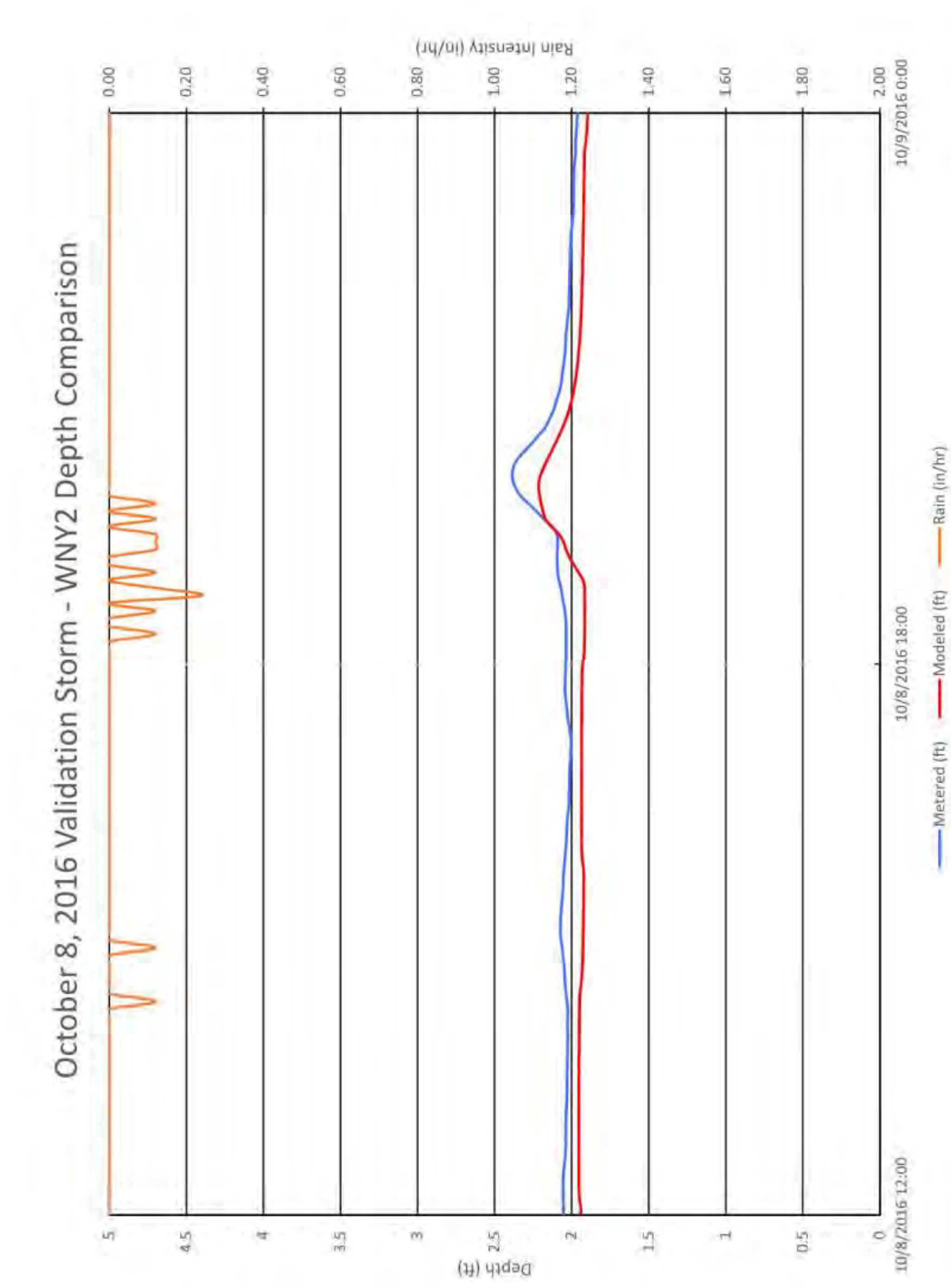
September 19, 2016 Calibration Storm - WNY2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
40
35
30
25
20
15
10
5
0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

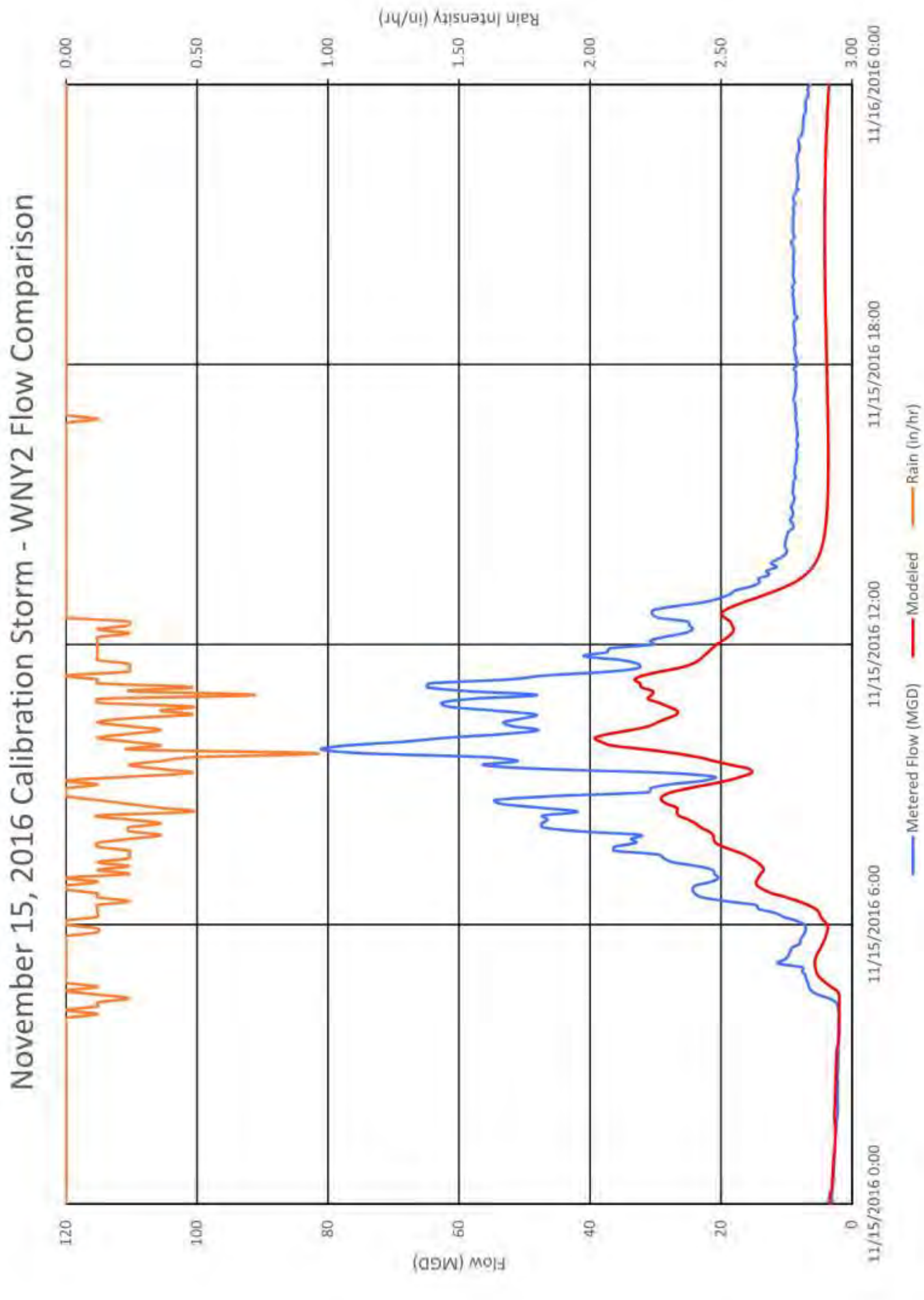

September 19, 2016 Calibration Storm - WNY2 Flow Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

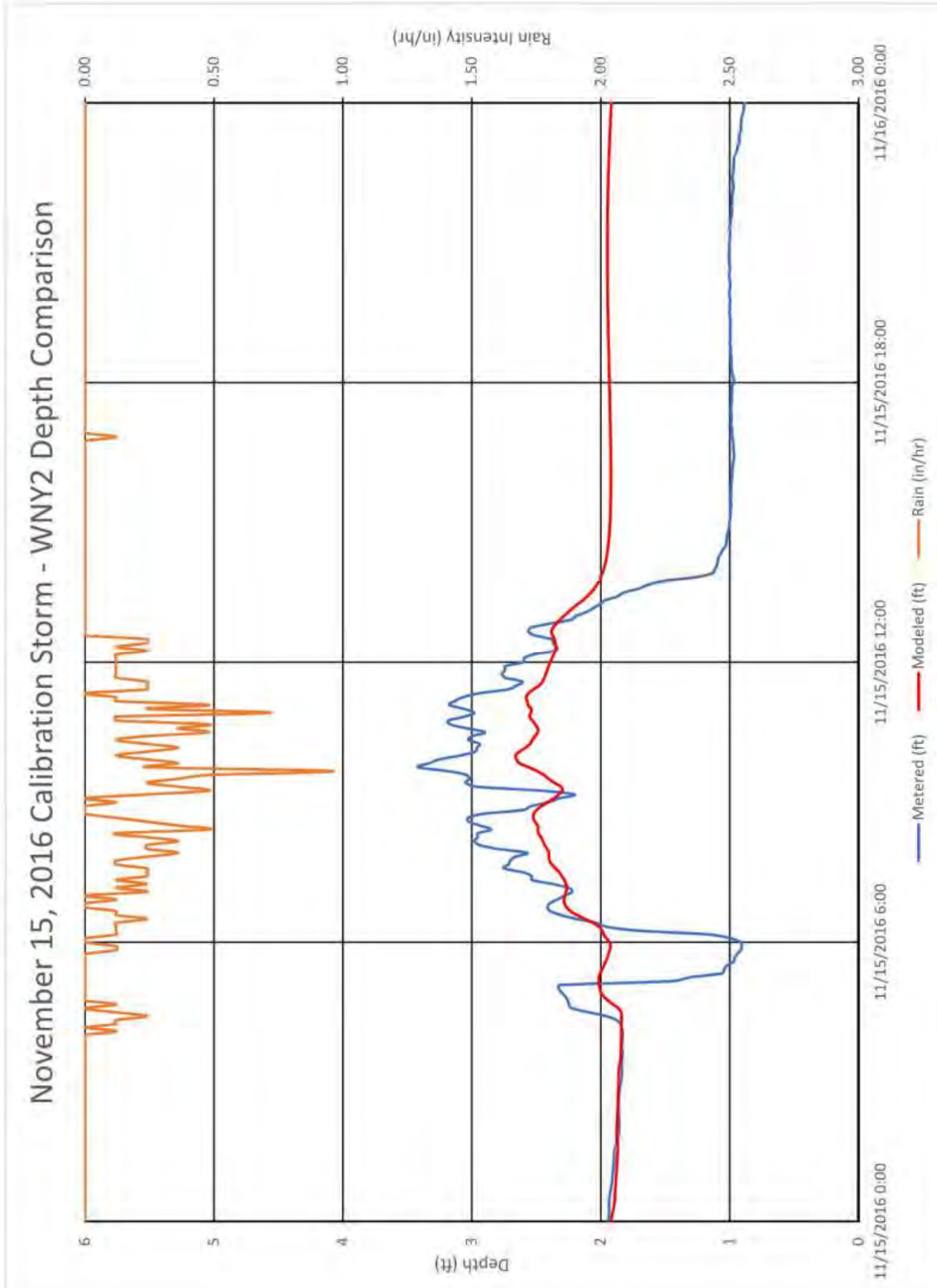

September 24, 2016 Calibration Storm - WNY2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
5
10
15
20
25
30
35
40
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

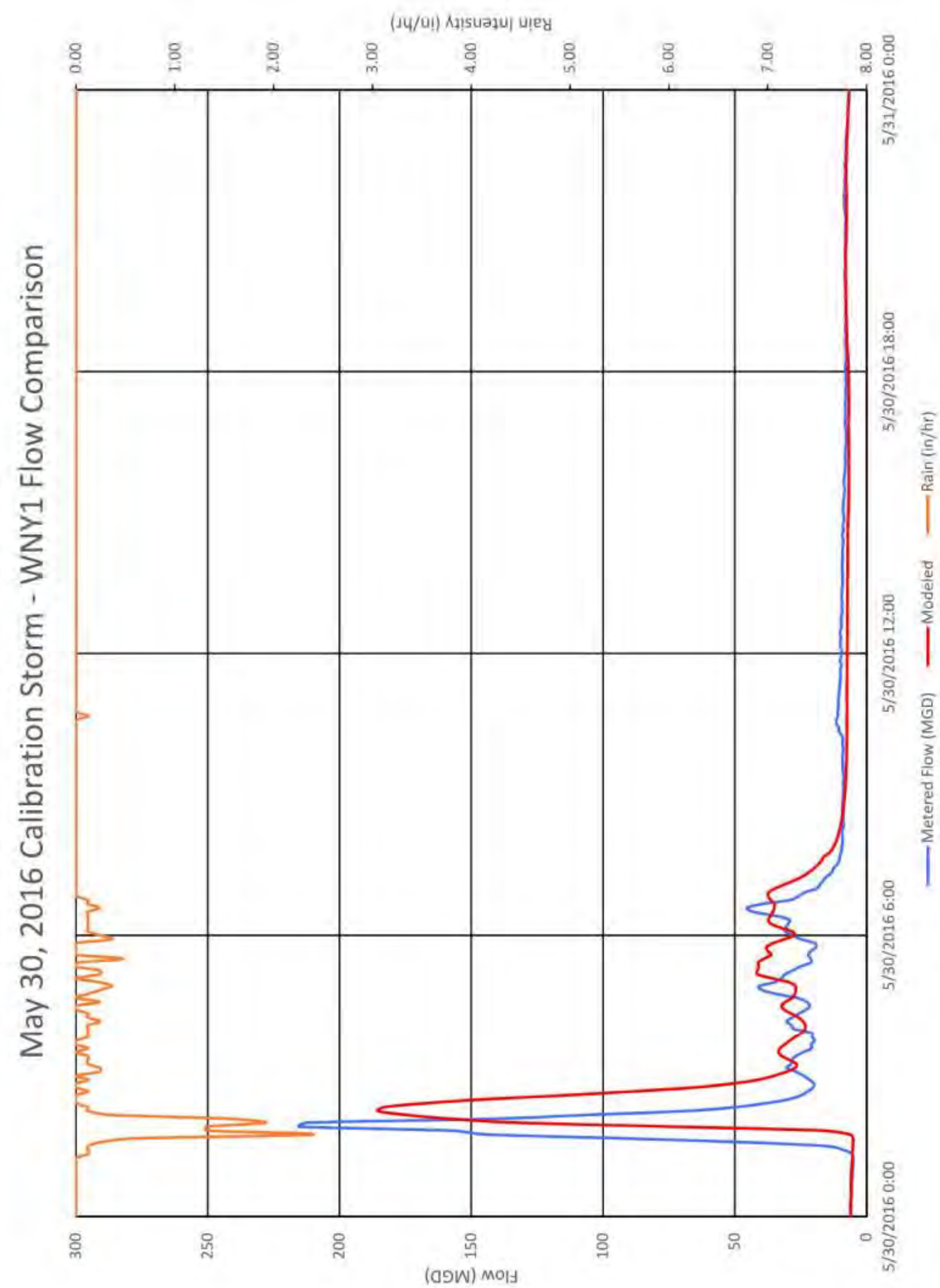

September 24, 2016 Calibration Storm - WNY2 Depth Comparison
Depth (ft)
0
1
2
3
4
5
6
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

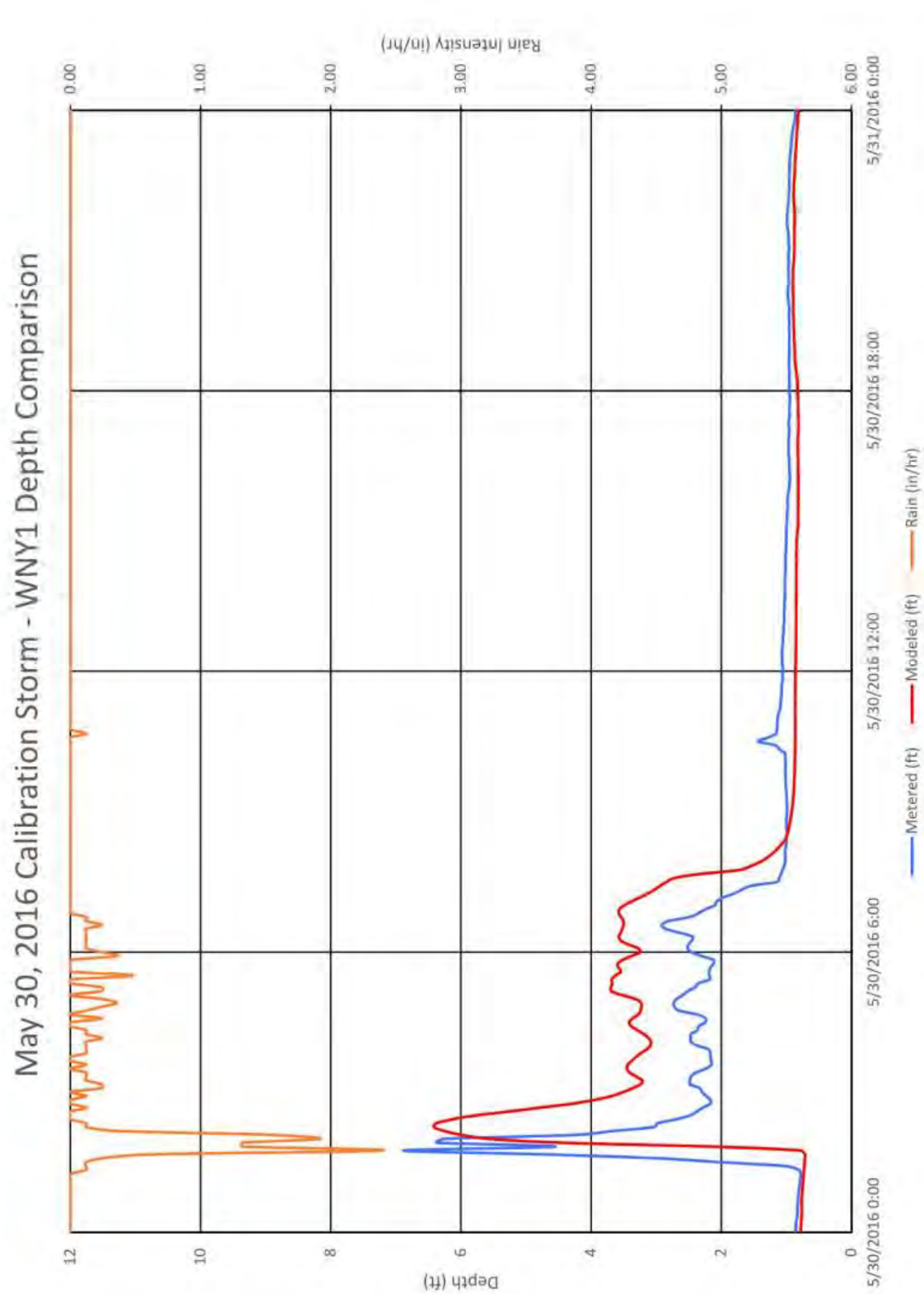

October 8, 2016 Validation Storm - WNY2 Flow Comparison
Flow (MGD)
20
18
16
14
12
10
8
6
4
2
0
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

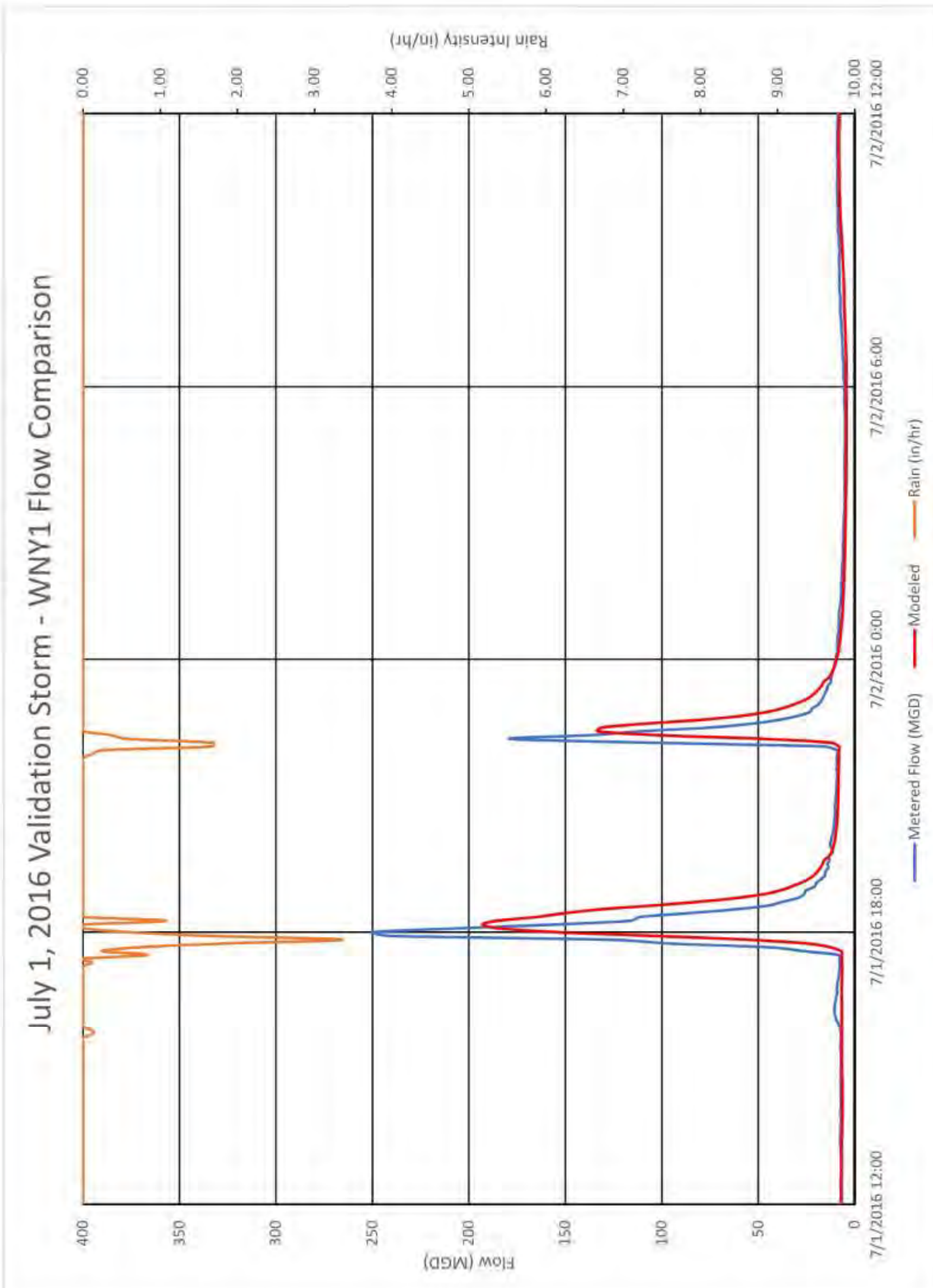

October 8, 2016 Validation Storm - WNY2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

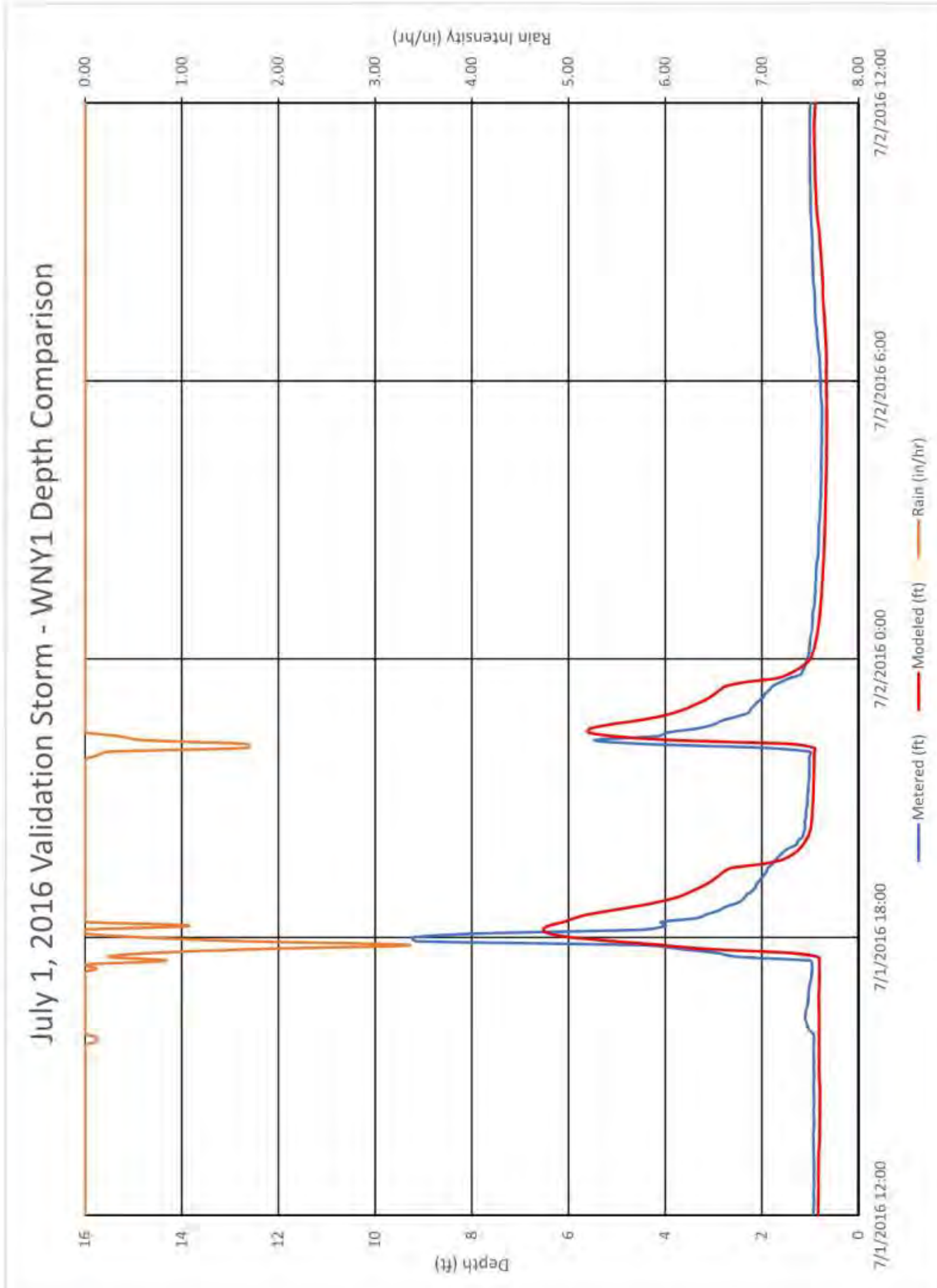

November 15, 2016 Calibration Storm - WNY2 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
20
40
60
80
100
120
0.00
0.50
1.00
1.50
2.00
2.50
3.00
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

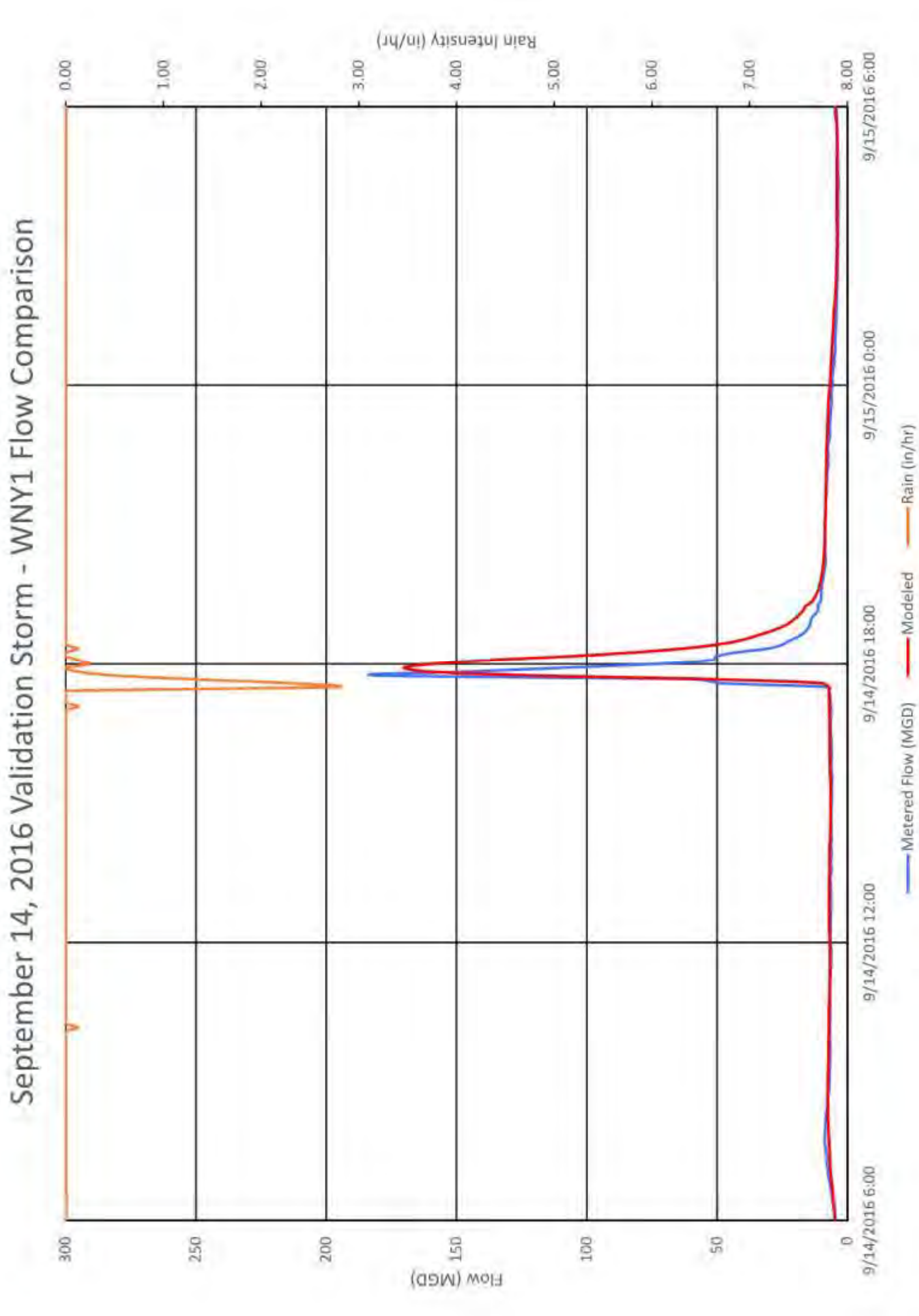

November 15, 2016 Calibration Storm - WNY2 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
0.00
0.50
1.00
1.50
2.00
2.50
3.00
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

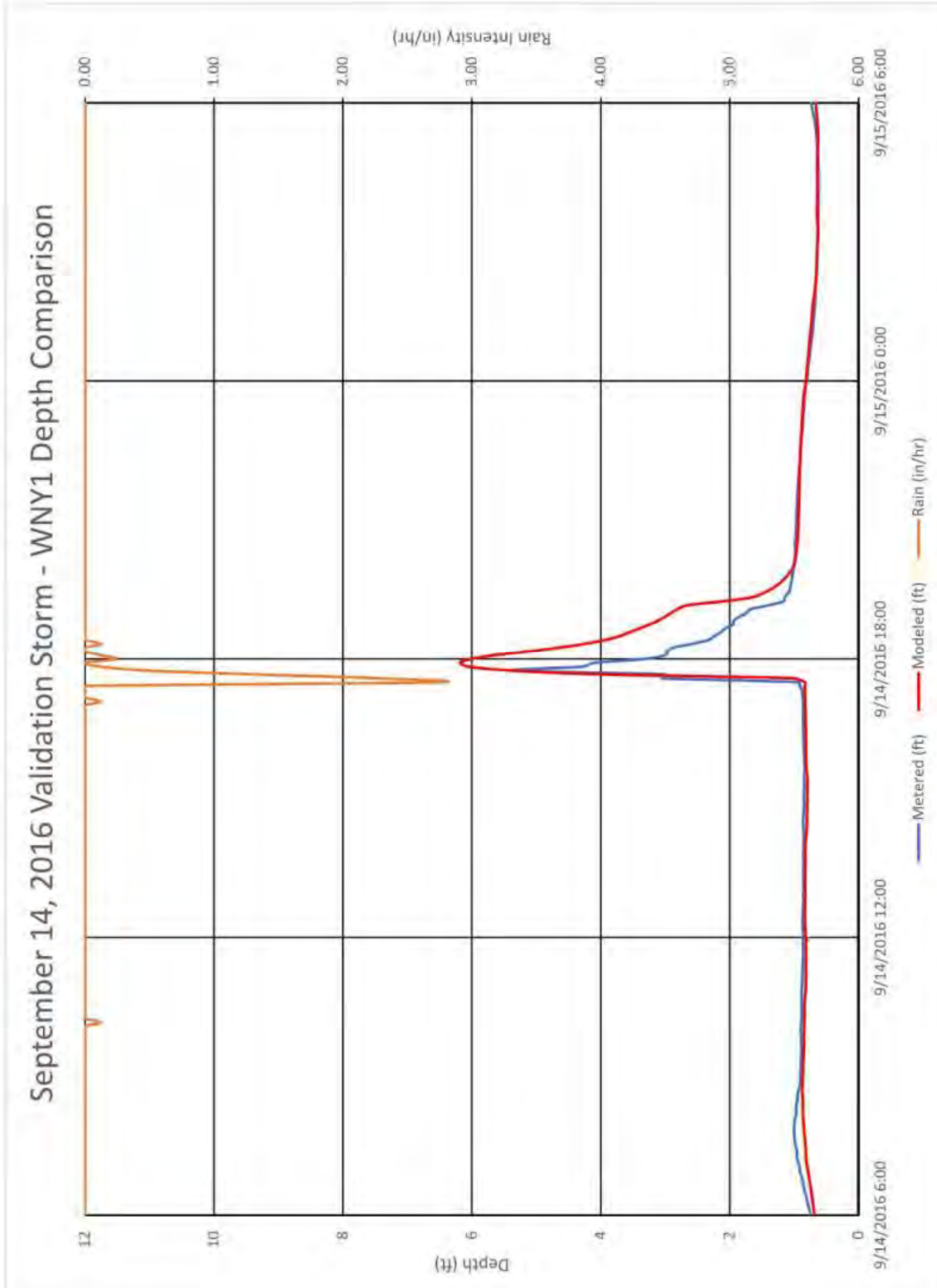

May 30, 2016 Calibration Storm - WNY1 Flow Comparison
Flow (MGD)
300
250
200
150
100
50
0
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

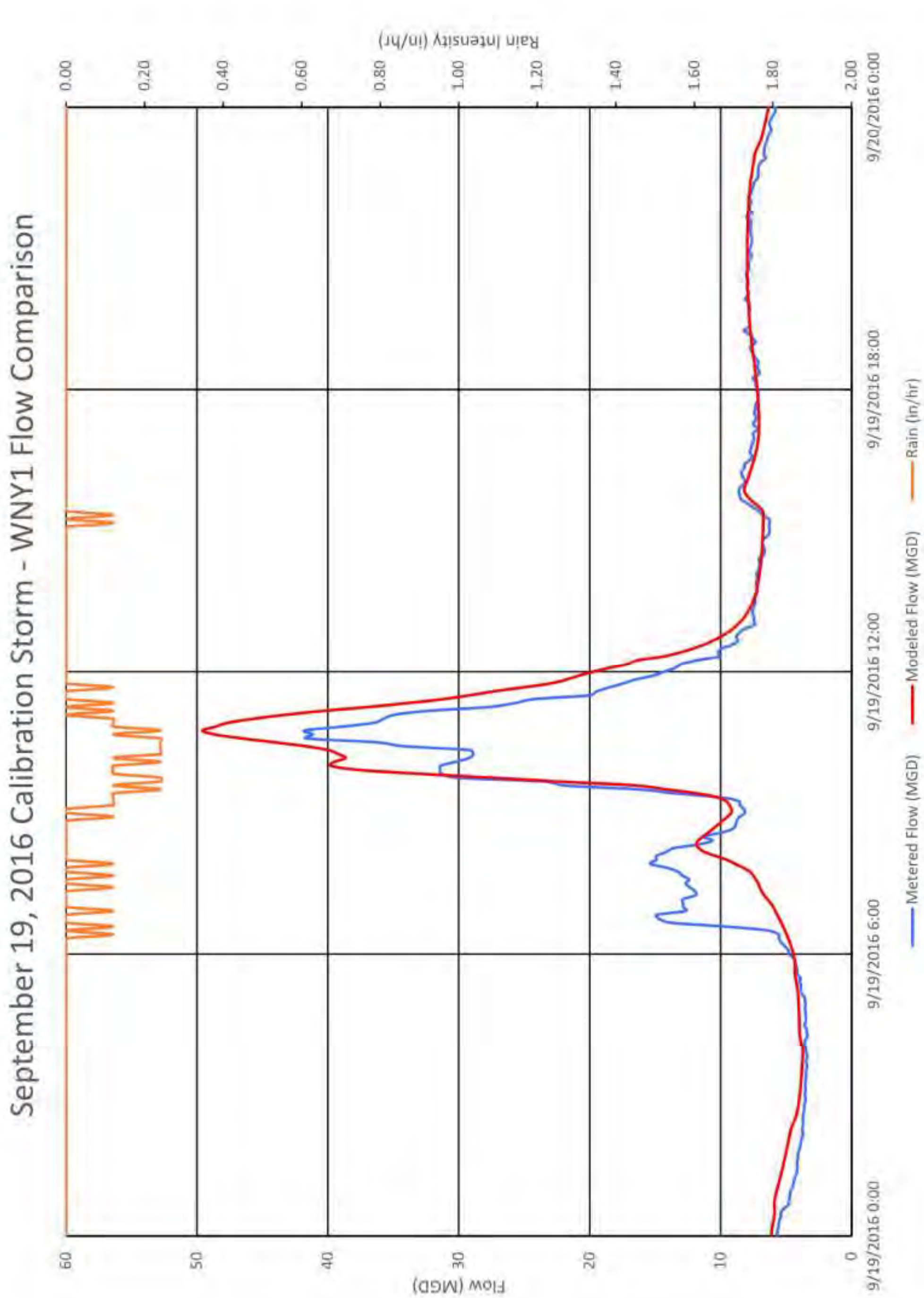

May 30, 2016 Calibration Storm - WNY1 Depth Comparison
Depth (ft)
0
2
4
6
8
10
12
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
5/30/2016 0:00
5/30/2016 6:00
5/30/2016 12:00
5/30/2016 18:00
5/31/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)


July 1, 2016 Validation Storm - WNY1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
50
100
150
200
250
300
350
400
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

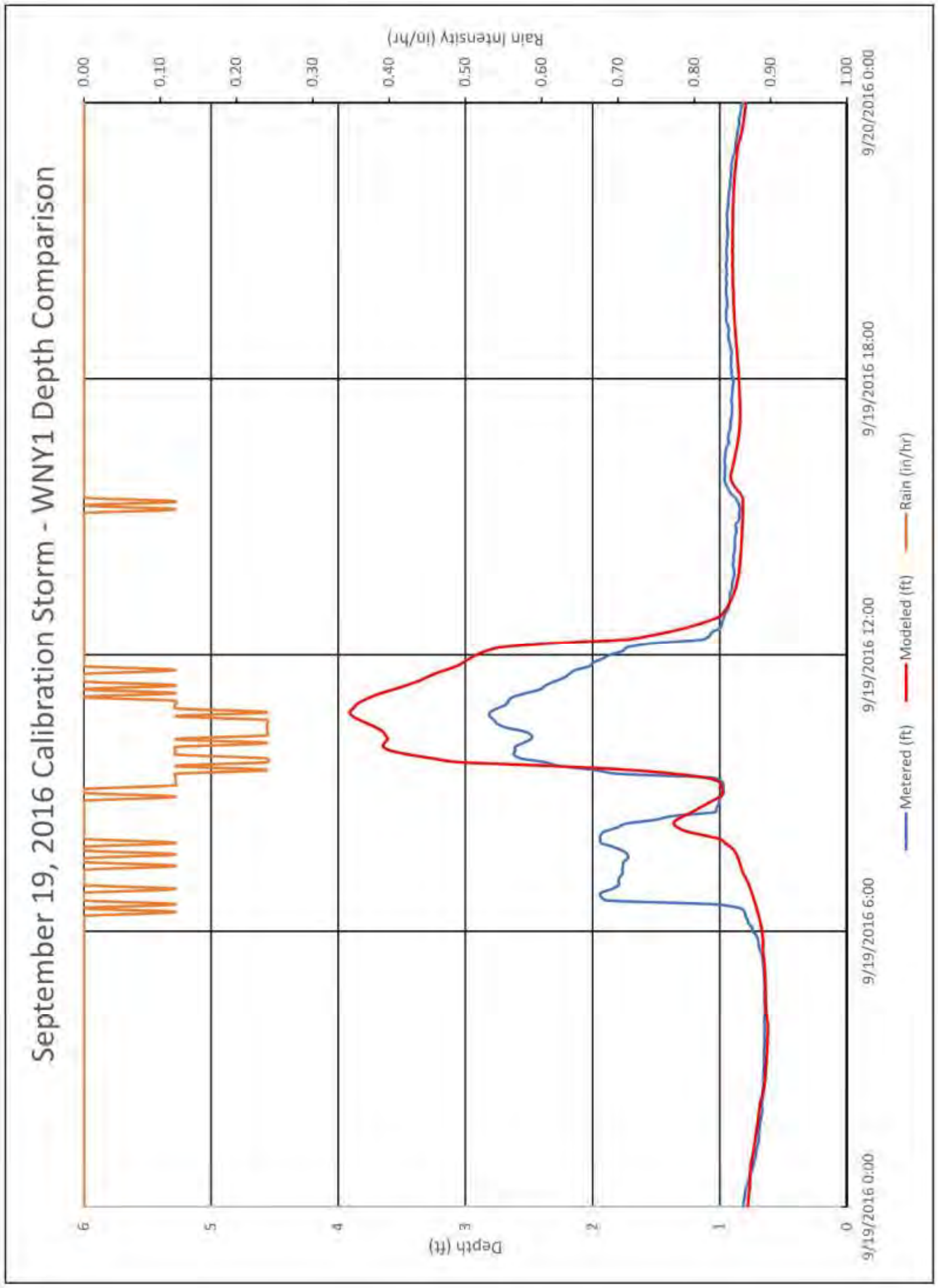

July 1, 2016 Validation Storm - WNY1 Depth Comparison
Depth (ft)
0
2
4
6
8
10
12
14
16
Rain Intensity (in/hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
7/1/2016 12:00
7/1/2016 18:00
7/2/2016 0:00
7/2/2016 6:00
7/2/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

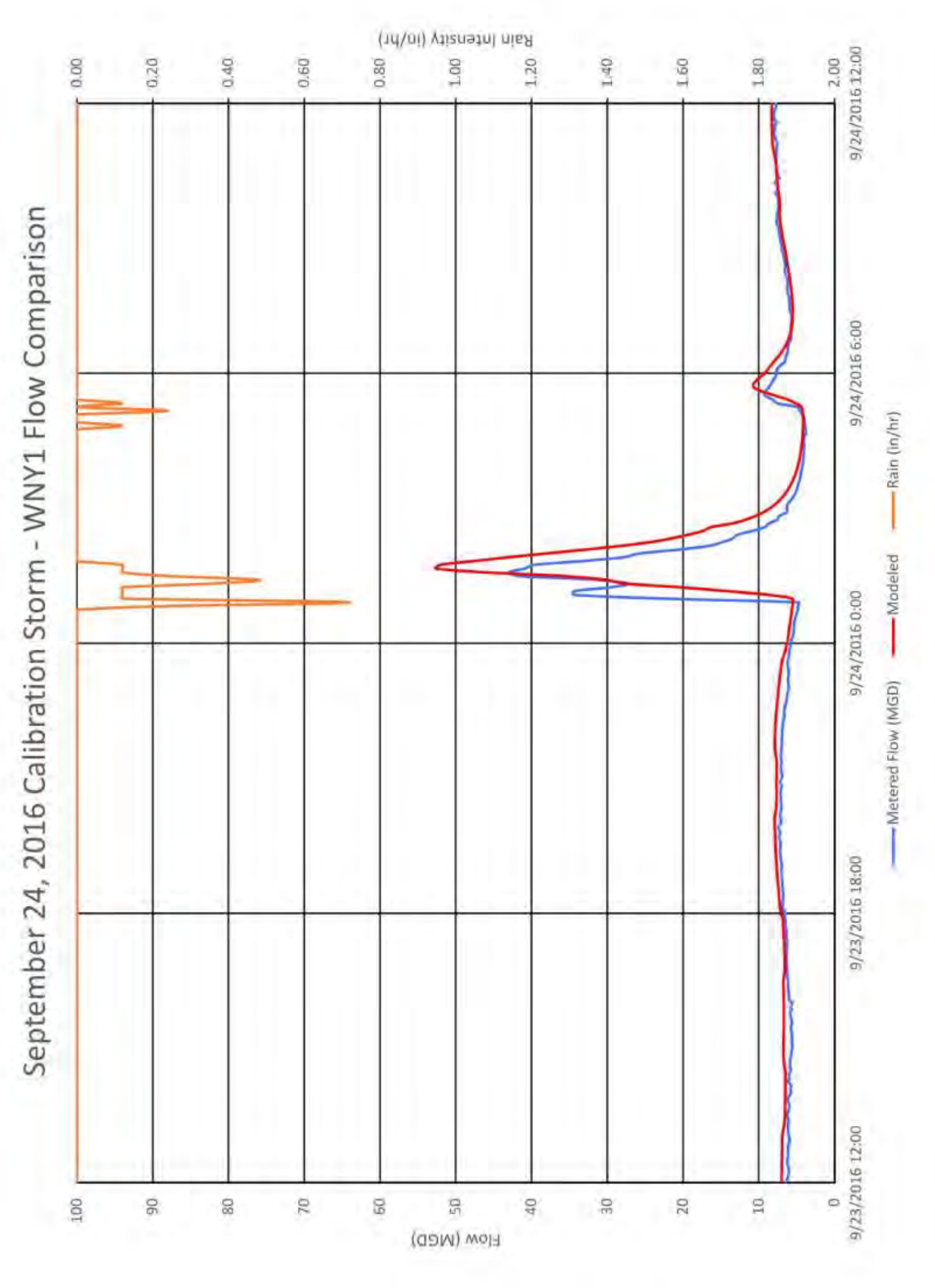

September 14, 2016 Validation Storm - WNY1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
0
50
100
150
200
250
300
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered Flow (MGD)
Modeled
Rain (in/hr)

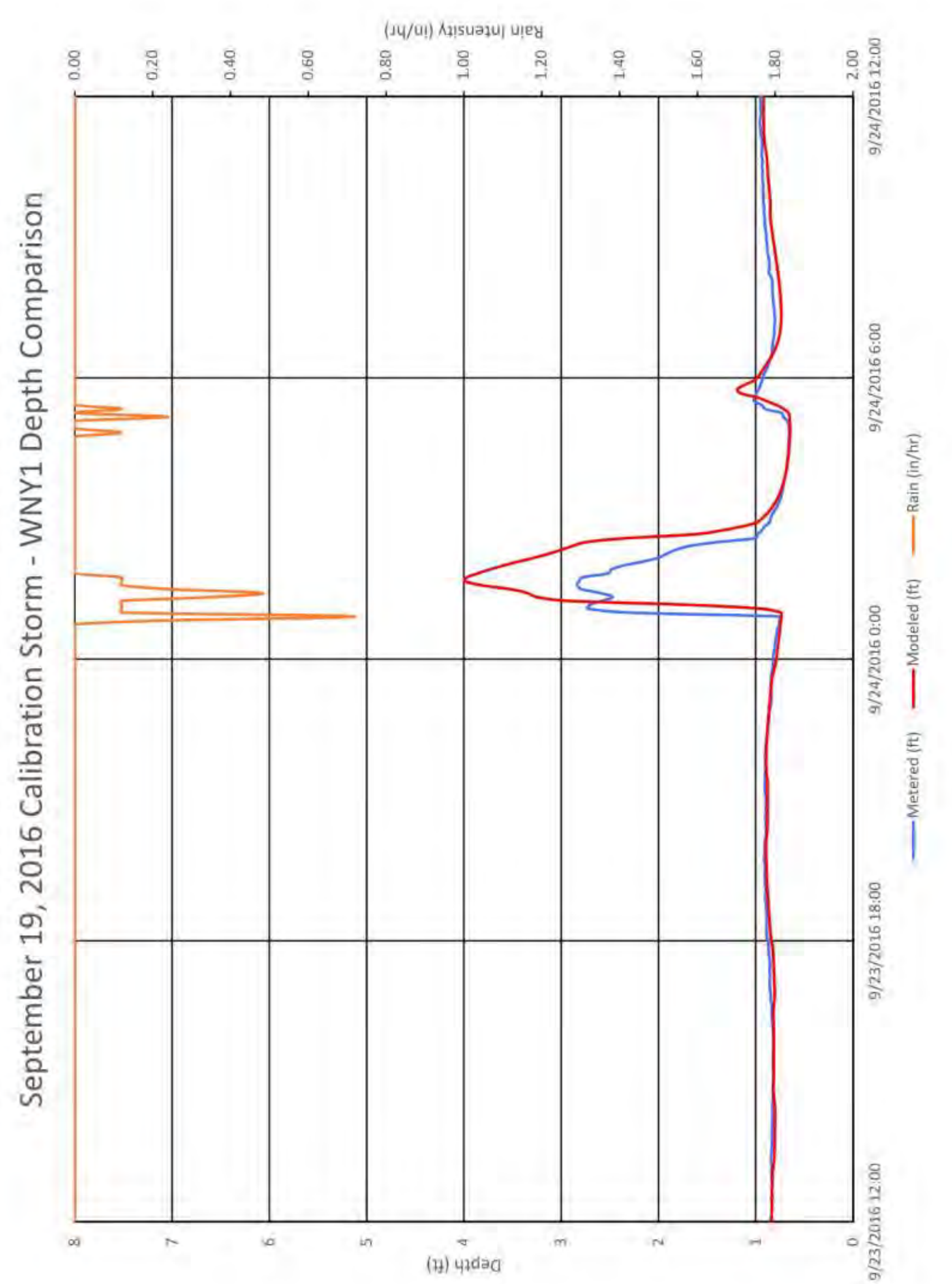

September 14, 2016 Validation Storm - WNY1 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
2
4
6
8
10
12
0.00
1.00
2.00
3.00
4.00
5.00
6.00
9/14/2016 6:00
9/14/2016 12:00
9/14/2016 18:00
9/15/2016 0:00
9/15/2016 6:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

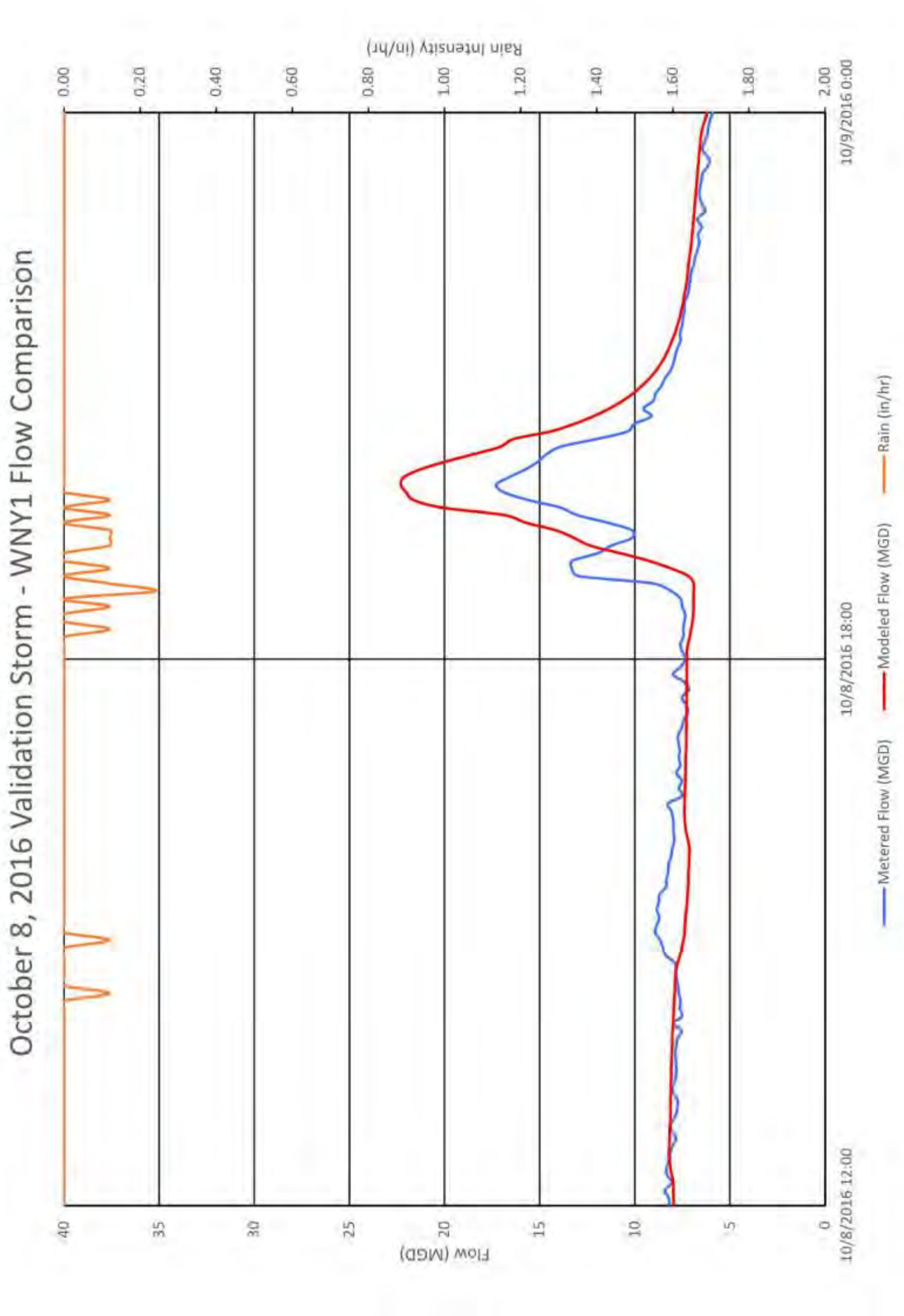


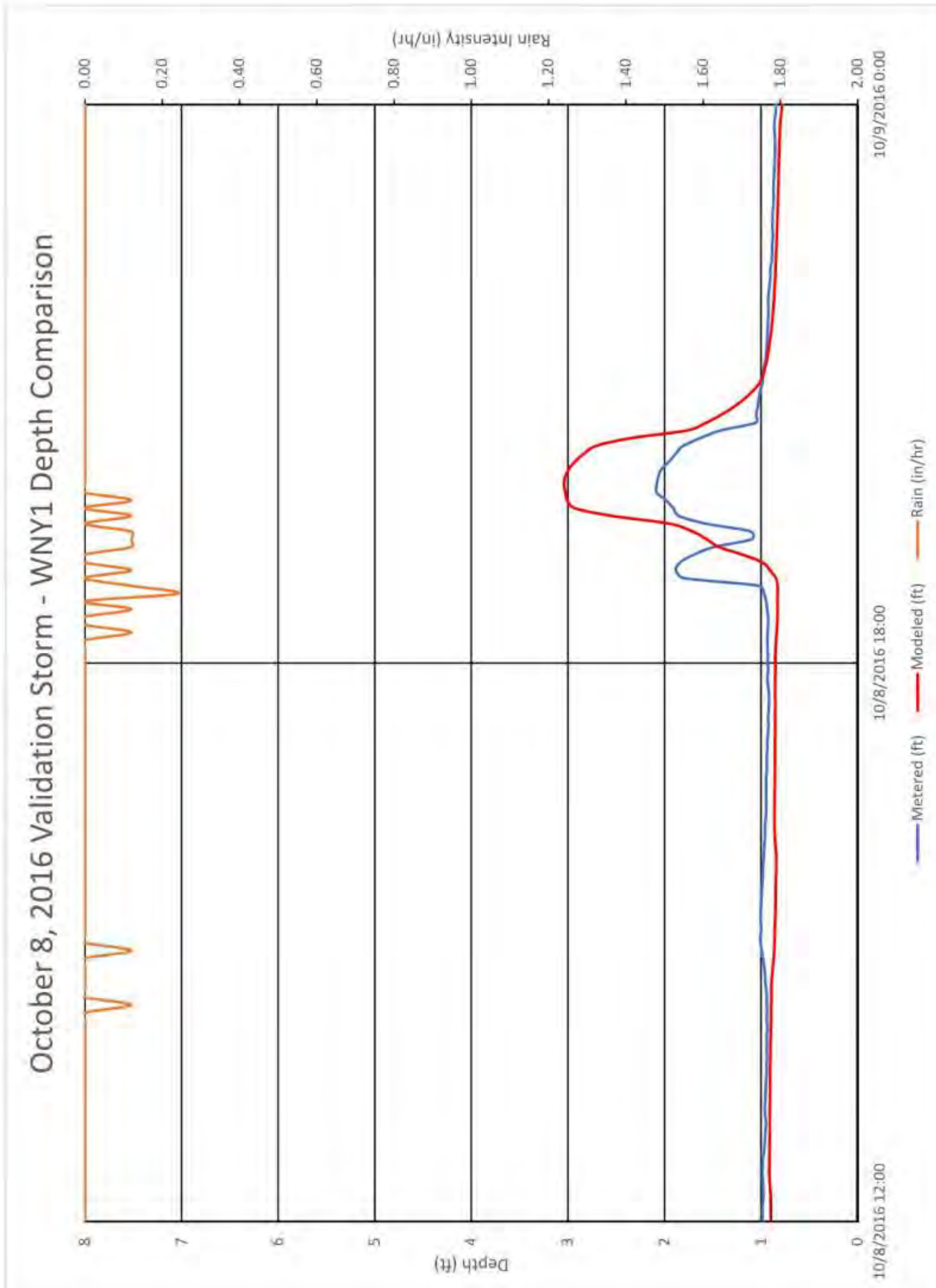
September 19, 2016 Calibration Storm - WNY1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)

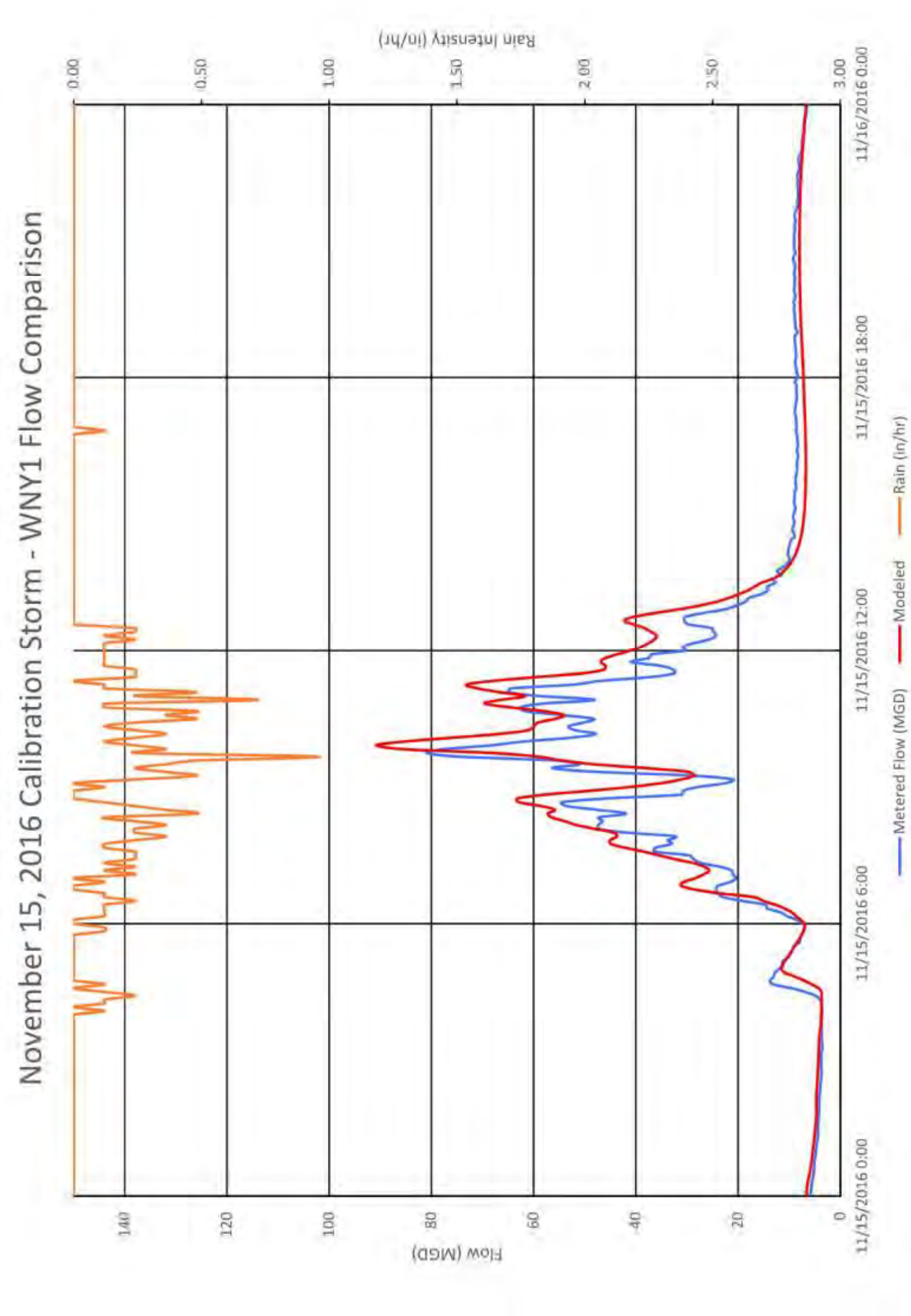

September 19, 2016 Calibration Storm - WNY1 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
9/19/2016 0:00
9/19/2016 6:00
9/19/2016 12:00
9/19/2016 18:00
9/20/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

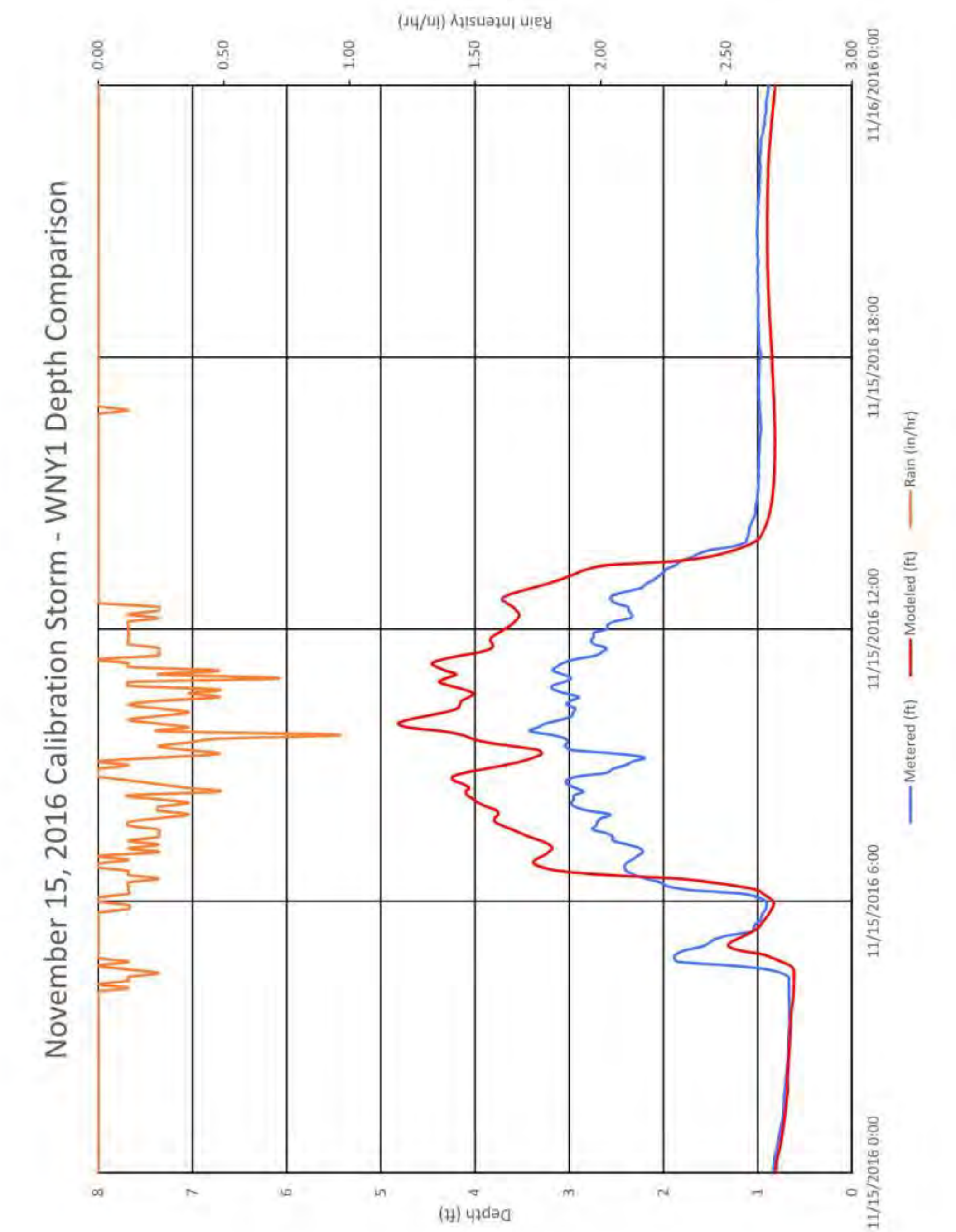

September 24, 2016 Calibration Storm - WNY1 Flow Comparison
Flow (MGD)
Rain Intensity (in/hr)
100
90
80
70
60
50
40
30
20
10
0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered Flow (MGD)
Modeled
Rain (in/hr)


September 19, 2016 Calibration Storm - WNY1 Depth Comparison
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (ft)
8
7
6
5
4
3
2
1
0
9/23/2016 12:00
9/23/2016 18:00
9/24/2016 0:00
9/24/2016 6:00
9/24/2016 12:00
Metered (ft)
Modeled (ft)
Rain (in/hr)


October 8, 2016 Validation Storm - WNY1 Flow Comparison
Flow (MGD)
40
35
30
25
20
15
10
5
0
Rain Intensity (in/hr)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered Flow (MGD)
Modeled Flow (MGD)
Rain (in/hr)


October 8, 2016 Validation Storm - WNY1 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0
1
2
3
4
5
6
7
8
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
10/8/2016 12:00
10/8/2016 18:00
10/9/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)


November 15, 2016 Calibration Storm - WNY1 Flow Comparison
Flow (MGD)
0
20
40
60
80
100
120
140
Rain Intensity (in/hr)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered Flow (MGD)
Modeled
Rain (in/hr)


November 15, 2016 Calibration Storm - WNY1 Depth Comparison
Depth (ft)
Rain Intensity (in/hr)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
8
7
6
5
4
3
2
1
0
11/15/2016 0:00
11/15/2016 6:00
11/15/2016 12:00
11/15/2016 18:00
11/16/2016 0:00
Metered (ft)
Modeled (ft)
Rain (in/hr)

11.5 Appendix E Typical Year Overflow Rates and Volumes

WNY1 (CSO 002A)

Overflow Number	Spill Volume (MG)	Duration (hrs)
1	20.3	22.05
2	12.0	40.00
3	8.8	4.99
4	8.5	46.62
5	8.3	10.40
6	8.1	2.24
7	8.0	4.41
8	7.9	20.16
9	7.9	5.73
10	7.5	13.57
11	7.1	8.49
12	6.2	29.91
13	6.1	2.16
14	5.6	21.47
15	5.1	7.66
16	5.0	11.58
17	4.8	7.84
18	4.6	1.66
19	4.0	3.73
20	3.9	2.25
21	3.8	4.91
22	2.8	1.99
23	2.7	7.28
24	2.7	16.23
25	2.7	4.66
26	2.3	2.08
27	1.8	7.66
28	1.8	2.32
29	1.7	30.08
30	1.5	21.28
31	1.5	1.66
32	1.4	4.47
33	1.4	1.16
34	1.3	17.55
35	1.1	27.20
36	1.0	6.72

Overflow Number	Peak Flow (MGD)	Duration (hrs)
1	194.0	2.24
2	172.3	2.16
3	168.2	11.58
4	165.8	1.66
5	160.0	5.73
6	141.9	4.99
7	135.9	40.00
8	130.2	29.91
9	128.5	22.05
10	114.6	2.25
11	112.7	4.66
12	109.4	8.49
13	90.8	10.40
14	90.2	1.16
15	87.4	3.73
16	83.5	4.41
17	81.1	1.99
18	73.6	7.28
19	67.4	4.47
20	66.9	2.08
21	66.3	21.47
22	62.6	46.62
23	53.6	20.16
24	50.5	13.57
25	46.2	1.31
26	39.4	2.32
27	39.1	7.84
28	38.4	4.91
29	37.5	1.66
30	34.4	7.66
31	34.3	30.08
32	20.8	1.25
33	20.1	17.75
34	18.6	27.20
35	18.4	2.58
36	17.9	21.28

Overflow Number	Spill Volume (MG)	Duration (hrs)
37	1.0	6.86
38	0.88	17.75
39	0.86	1.31
40	0.79	2.58
41	0.76	1.91
42	0.68	11.73
43	0.68	2.88
44	0.61	1.74
45	0.56	1.25
46	0.45	2.16
47	0.43	25.29
48	0.33	2.32
49	0.26	2.54
50	0.23	9.07
51	0.22	1.07
52	0.16	0.82
53	0.07	7.15
54	0.07	1.37
55	0.06	15.98
56	0.06	0.61
57	0.04	0.66
58	0.02	0.55
59	0.01	0.82
60	0.00	0.08

Overflow Number	Peak Flow (MGD)	Duration (hrs)
37	17.7	2.88
38	16.5	1.74
39	16.4	1.91
40	15.2	2.54
41	14.1	11.73
42	13.9	6.86
43	12.5	16.23
44	12.4	2.16
45	11.8	2.32
46	11.5	17.55
47	9.0	1.07
48	8.6	0.82
49	8.5	7.66
50	8.3	6.72
51	7.4	25.29
52	6.4	9.07
53	4.2	15.98
54	4.2	0.61
55	3.6	0.55
56	3.2	7.15
57	2.4	0.66
58	2.2	1.37
59	0.9	0.82
60	0.1	0.08

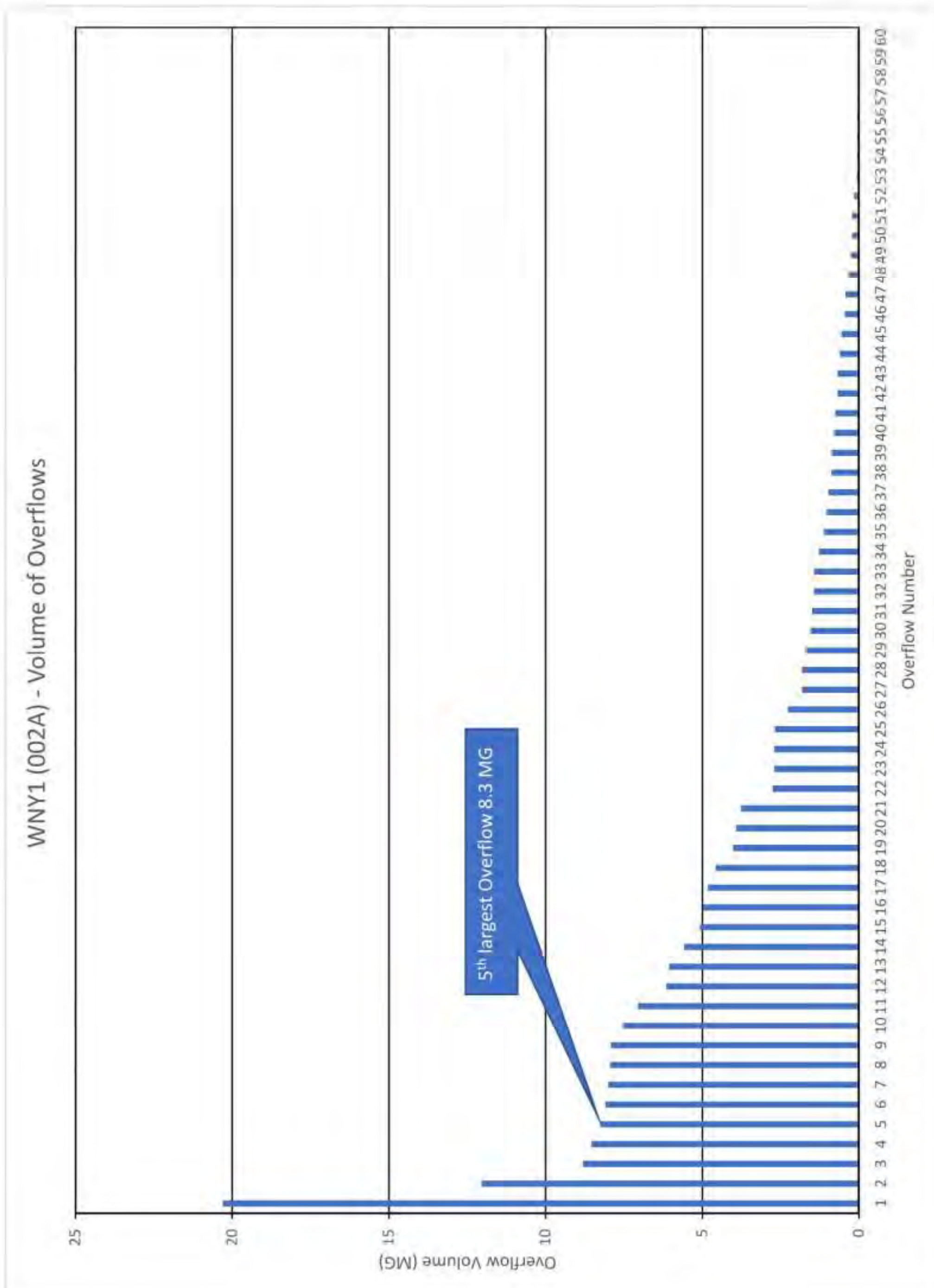
JOSO (CSO 003A)

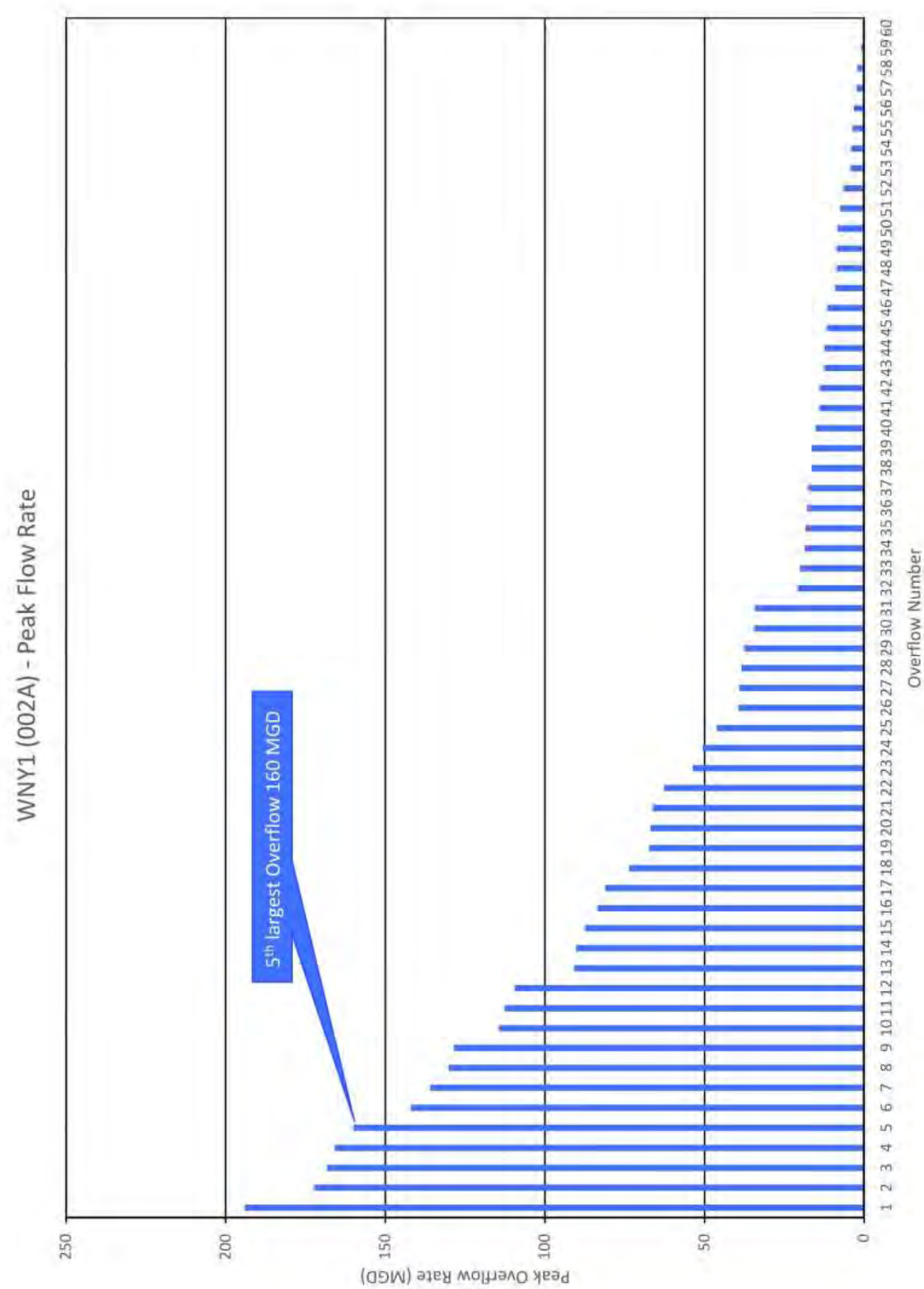
Overflow Number	Spill Volume (MG)	Duration (hours)
1	10.8	22.52
2	7.1	40.13
3	5.8	2.43
4	5.4	5.11
5	4.7	9.67
6	4.6	4.42
7	4.2	10.46
8	4.1	2.27
9	3.6	8.57
10	3.6	46.93
11	3.4	20.22
12	3.3	11.69
13	3.2	29.98
14	3.1	2.61
15	3.1	13.60
16	2.3	2.45
17	2.2	23.37
18	2.1	3.73
19	2.0	7.71
20	1.9	7.83
21	1.6	4.92
22	1.5	2.04
23	1.4	4.70
24	1.2	7.40
25	1.2	2.23
26	0.80	2.37
27	0.79	1.23
28	0.70	4.47
29	0.69	1.86
30	0.60	37.14
31	0.50	16.33
32	0.38	1.34
33	0.36	21.54
34	0.28	27.26
35	0.26	7.82
36	0.23	17.90
37	0.22	17.41
38	0.22	1.96
39	0.22	2.65

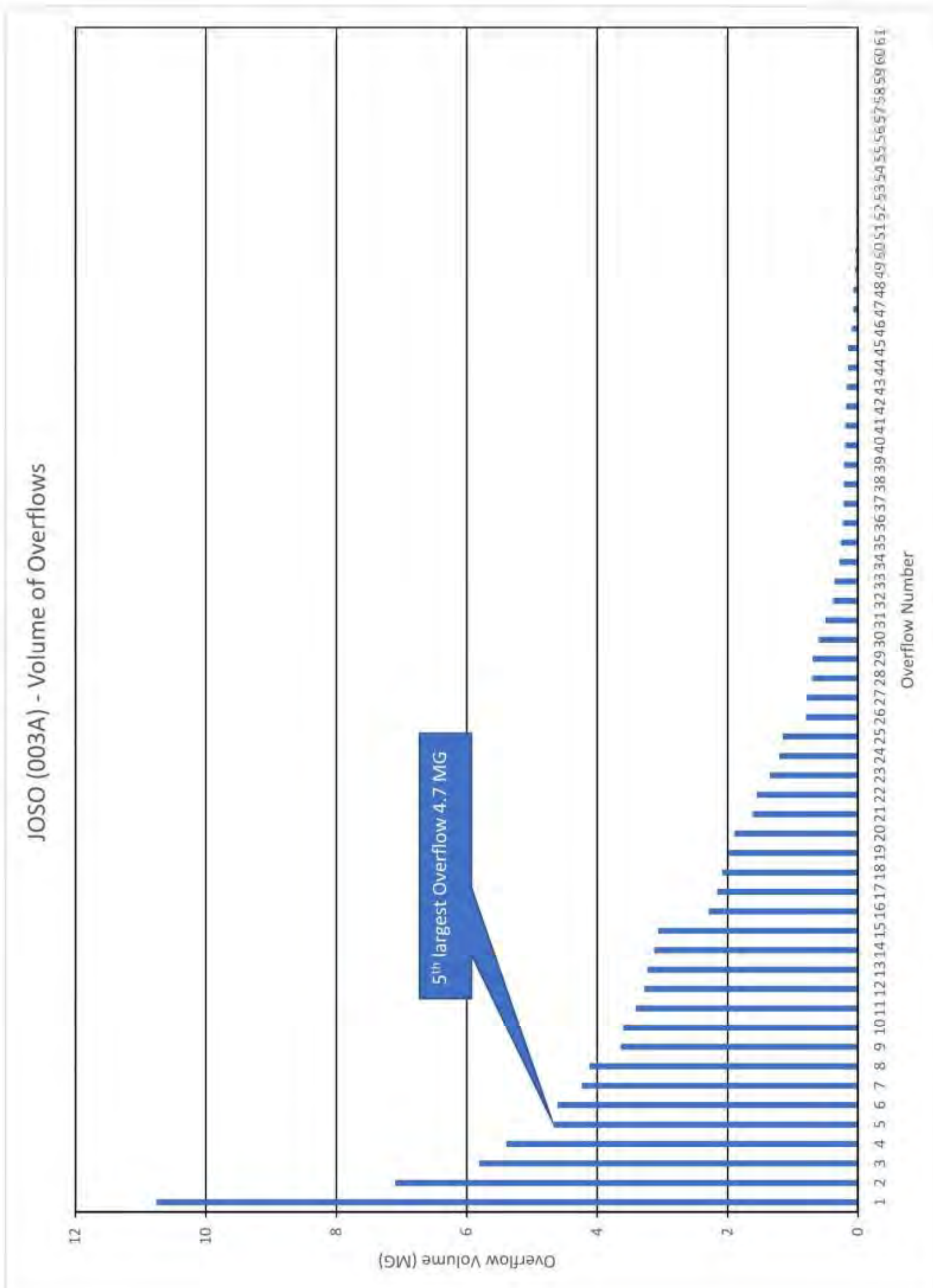
Overflow Number	Peak Flow (MGD)	Duration (hours)
1	142.5	2.43
2	120.9	2.27
3	107.5	11.69
4	105.0	2.61
5	102.0	9.67
6	90.8	5.11
7	89.1	40.13
8	78.4	29.98
9	78.0	22.52
10	67.9	2.45
11	58.5	4.70
12	56.9	8.57
13	52.0	10.46
14	51.7	3.73
15	51.7	4.42
16	50.6	2.04
17	42.4	1.23
18	35.7	2.23
19	35.0	4.47
20	33.2	7.40
21	33.0	46.93
22	31.3	23.37
23	29.7	20.22
24	28.2	13.60
25	20.1	2.37
26	20.0	7.83
27	19.6	4.92
28	19.2	1.34
29	18.7	1.86
30	16.8	7.71
31	16.4	37.14
32	8.4	1.31
33	6.9	2.65
34	6.7	2.90
35	6.3	21.54
36	6.0	27.26
37	5.6	1.81
38	5.5	1.96
39	5.2	17.90

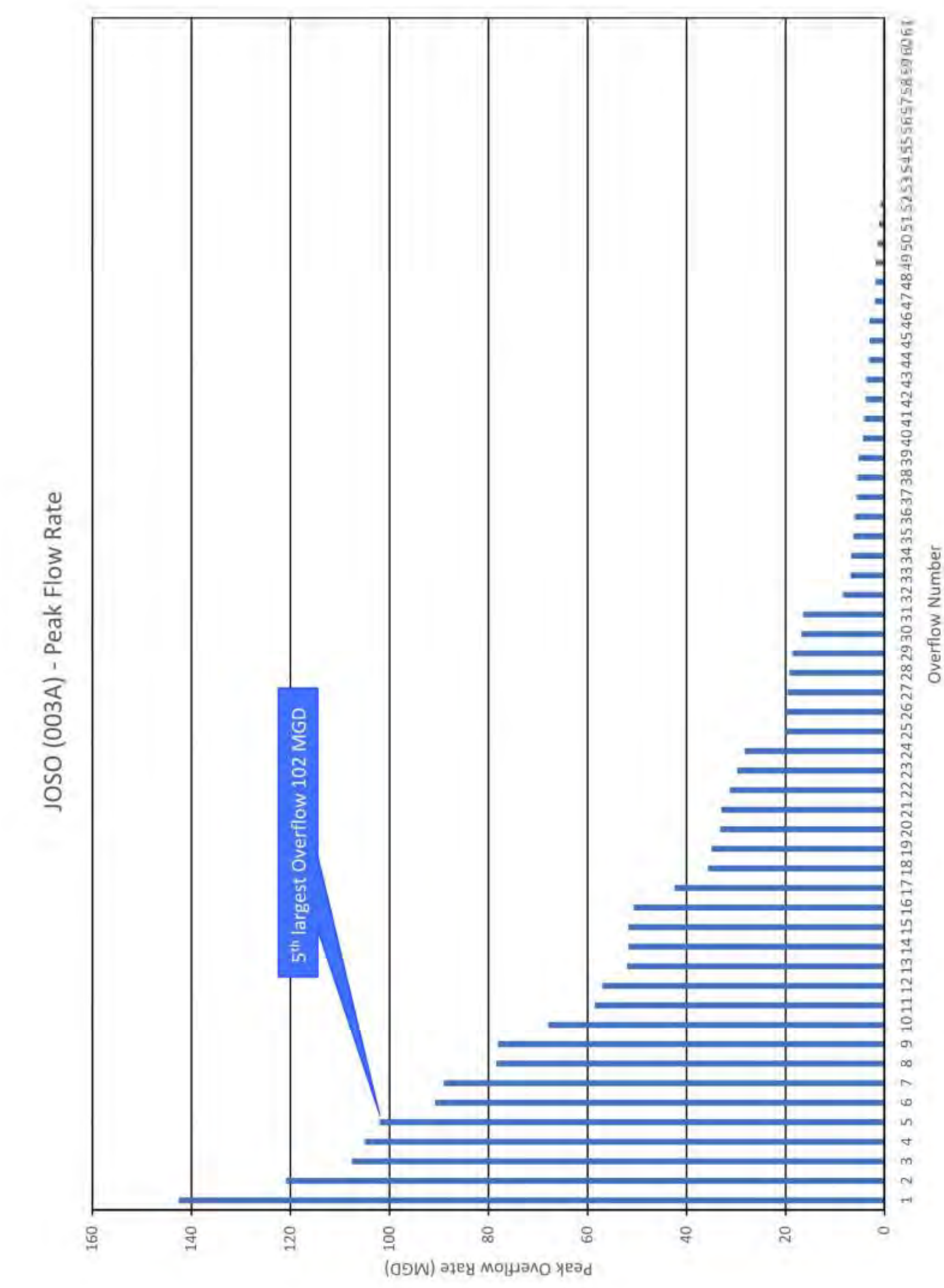
Overflow Number	Spill Volume (MG)	Duration (hours)
40	0.20	6.76
41	0.19	1.31
42	0.19	2.90
43	0.17	1.81
44	0.16	11.79
45	0.16	6.80
46	0.09	2.12
47	0.07	2.61
48	0.07	2.44
49	0.05	25.32
50	0.04	3.09
51	0.03	9.16
52	0.03	0.88
53	0.01	7.23
54	0.01	1.39
55	0.01	16.02
56	0.01	0.61
57	0.01	1.14
58	0.01	1.52
59	0.00	0.37
60	0.00	0.32
61	0.00	0.05

Overflow Number	Peak Flow (MGD)	Duration (hours)
40	4.4	6.76
41	4.1	11.79
42	3.8	2.61
43	3.7	16.33
44	3.1	2.12
45	3.0	17.41
46	3.0	2.44
47	1.9	3.09
48	1.8	6.80
49	1.8	7.82
50	1.4	0.88
51	1.1	25.32
52	0.8	9.16
53	0.4	0.61
54	0.3	16.02
55	0.3	7.23
56	0.3	1.39
57	0.3	0.37
58	0.2	1.14
59	0.2	1.52
60	0.1	0.32
61	0.1	0.05


WNY1 (002A) - Volume of Overflows
5th largest Overflow 8.3 MG
Overflow Volume (MG)
0
5
10
15
20
25
Overflow Number
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60


WNY1 (002A) - Peak Flow Rate
5th largest Overflow 160 MGD
Peak Overflow Rate (MGD)
Overflow Number
0
50
100
150
200
250


JOSO (003A) - Volume of Overflows
5th largest Overflow 4.7 MG
Overflow Volume (MG)
Overflow Number



JOSO (003A) - Peak Flow Rate
5th largest Overflow 102 MGD
Peak Overflow Rate (MGD)
0
20
40
60
80
100
120
140
160
Overflow Number

11.6 Appendix F Subcatchment Input Parameters

Subcatchment ID	System type	AREA	WIDTH	Impervious (%)	Impervious (ac)	Effective Impervious (ac)	Effective Impervious (%)	SLOPE	Manning's N Impervious	Manning's N Pervious	Maximum Infiltration Rate (in/hr)	Minimum Infiltration Rate (in/hr)	Decay Constant (1/hr)	Depression Storage Impervious (in)	Depression Storage Pervious (in)
1	sanitary	0.86	2205	0.00	0.00	0.00	0.0	4.261	0	0	0	0	0	0	0
2	sanitary	11.30	870.28	50.06	8.70	6.53	37.5	4.261	0.015	0.035	2.5	0.15	2	0.03	0.2
3	combined	4.56	445.83	56.10	2.56	1.92	42.1	5.249	0.015	0.035	2.5	0.15	2	0.03	0.2
4	combined	3.17	371.47	70.27	2.23	1.67	52.7	1.286	0.015	0.035	2.5	0.15	2	0.03	0.2
5	combined	2.51	330.43	78.70	1.97	1.48	59.0	2.777	0.015	0.035	2.5	0.15	2	0.03	0.2
6	combined	1.63	266.64	94.61	1.54	1.16	71.0	5.549	0.015	0.035	2.5	0.15	2	0.03	0.2
7	combined	3.73	403.24	82.67	3.09	2.31	62.0	1.297	0.015	0.035	2.5	0.15	2	0.03	0.2
8	combined	3.05	364.48	87.67	2.67	2.00	65.7	4.296	0.015	0.035	2.5	0.15	2	0.03	0.2
9	combined	1.26	234.43	71.77	0.90	0.68	53.8	2.02	0.015	0.035	2.5	0.15	2	0.03	0.2
10	combined	0.95	203.59	77.08	0.73	0.55	57.8	1.407	0.015	0.035	2.5	0.15	2	0.03	0.2
11	combined	1.57	261.6	61.43	0.97	0.72	46.1	4.702	0.015	0.035	2.5	0.15	2	0.03	0.2
12	combined	1.23	231.22	61.56	0.76	0.57	46.2	3.81	0.015	0.035	2.5	0.15	2	0.03	0.2
13	combined	3.52	391.42	87.32	3.07	2.30	65.5	1.165	0.015	0.035	2.5	0.15	2	0.03	0.2
14	combined	1.42	248.82	78.89	1.12	0.84	59.2	1.354	0.015	0.035	2.5	0.15	2	0.03	0.2
15	combined	2.12	304.2	84.65	1.80	1.35	63.5	0.689	0.015	0.035	2.5	0.15	2	0.03	0.2
16	combined	2.90	355.16	72.00	2.09	1.56	54.0	3.48	0.015	0.035	2.5	0.15	2	0.03	0.2
17	combined	2.52	331.27	73.18	1.84	1.38	54.9	1.454	0.015	0.035	2.5	0.15	2	0.03	0.2
18	combined	0.79	185.19	60.03	0.47	0.35	45.0	0.982	0.015	0.035	2.5	0.15	2	0.03	0.2
19	combined	2.46	327.42	63.63	1.57	1.17	47.7	0.484	0.015	0.035	2.5	0.15	2	0.03	0.2
20	combined	3.13	369.27	77.03	2.41	1.81	57.8	1.588	0.015	0.035	2.5	0.15	2	0.03	0.2
21	combined	3.29	378.69	64.13	2.11	1.58	48.1	4.084	0.015	0.035	2.5	0.15	2	0.03	0.2
22	combined	1.60	263.55	92.60	1.48	1.11	69.5	1.485	0.015	0.035	2.5	0.15	2	0.03	0.2
23	combined	2.61	337.42	74.24	1.94	1.46	55.7	3.266	0.015	0.035	2.5	0.15	2	0.03	0.2
24	combined	3.13	389	70.63	2.21	1.66	53.0	0.339	0.015	0.035	2.5	0.15	2	0.03	0.2
25	combined	3.92	413.17	89.31	3.50	2.63	67.0	6.26	0.015	0.035	2.5	0.15	2	0.03	0.2
26	combined	3.51	381.23	67.81	2.38	1.79	50.9	1.582	0.015	0.035	2.5	0.15	2	0.03	0.2
27	combined	0.35	122.87	76.95	0.27	0.20	57.7	3.426	0.015	0.035	2.5	0.15	2	0.03	0.2
28	combined	1.22	230.82	93.46	1.14	0.86	70.1	0.425	0.015	0.035	2.5	0.15	2	0.03	0.2
29	combined	4.03	418.97	73.67	2.97	2.23	55.2	2.046	0.015	0.035	2.5	0.15	2	0.03	0.2
30	combined	2.48	328.5	62.78	1.56	1.17	47.1	0.626	0.015	0.035	2.5	0.15	2	0.03	0.2
31	combined	2.92	356.45	82.83	2.42	1.81	62.1	6.015	0.015	0.035	2.5	0.15	2	0.03	0.2
32	combined	1.83	282.08	60.04	1.10	0.82	45.0	2.799	0.015	0.035	2.5	0.15	2	0.03	0.2
33	combined	3.80	407.02	60.06	2.28	1.71	45.0	5.432	0.015	0.035	2.5	0.15	2	0.03	0.2
34	combined	2.81	350.12	69.68	1.96	1.47	52.2	5.12	0.015	0.035	2.5	0.15	2	0.03	0.2
35	combined	4.79	456.85	65.69	3.15	2.36	49.3	0.89	0.015	0.035	2.5	0.15	2	0.03	0.2
36	combined	4.51	443.37	79.62	3.59	2.69	59.6	3.155	0.015	0.035	2.5	0.15	2	0.03	0.2
37	combined	3.31	379.59	68.86	2.28	1.71	51.6	1.85	0.015	0.035	2.5	0.15	2	0.03	0.2
38	combined	1.02	210.94	85.32	0.87	0.65	64.0	3.249	0.015	0.035	2.5	0.15	2	0.03	0.2
39	combined	1.23	231.52	64.66	0.80	0.60	48.5	3.856	0.015	0.035	2.5	0.15	2	0.03	0.2
40	combined	4.87	460.47	50.09	2.44	1.83	37.6	2.335	0.015	0.035	2.5	0.15	2	0.03	0.2
41	combined	3.32	380.44	33.14	1.10	0.83	24.9	1.835	0.015	0.035	2.5	0.15	2	0.03	0.2
42	combined	3.07	365.5	85.06	2.61	1.96	63.8	1.087	0.015	0.035	2.5	0.15	2	0.03	0.2
43	combined	2.07	300.01	59.92	1.24	0.93	44.9	1.926	0.015	0.035	2.5	0.15	2	0.03	0.2
44	combined	2.73	344.58	64.93	1.77	1.33	48.7	3.782	0.015	0.035	2.5	0.15	2	0.03	0.2
45	combined	1.64	267.23	56.25	0.92	0.69	42.2	1.936	0.015	0.035	2.5	0.15	2	0.03	0.2
46	combined	3.66	399.44	57.66	2.11	1.58	43.2	2.201	0.015	0.035	2.5	0.15	2	0.03	0.2
47	combined	3.09	366.56	55.24	1.70	1.28	41.4	4.877	0.015	0.035	2.5	0.15	2	0.03	0.2
48	combined	3.76	404.45	56.30	2.11	1.59	42.2	6.43	0.015	0.035	2.5	0.15	2	0.03	0.2
49	combined	3.06	364.88	61.79	1.89	1.42	46.3	0.34	0.015	0.035	2.5	0.15	2	0.03	0.2
50	combined	3.57	394.54	70.05	2.50	1.88	52.5	4.62	0.015	0.035	2.5	0.15	2	0.03	0.2
51	combined	2.26	313.23	69.35	1.56	1.17	52.0	0.754	0.015	0.035	2.5	0.15	2	0.03	0.2
52	combined	3.28	378.24	90.74	2.98	2.24	68.1	2.463	0.015	0.035	2.5	0.15	2	0.03	0.2
53	combined	1.92	289.49	92.52	1.78	1.34	69.4	0.907	0.015	0.035	2.5	0.15	2	0.03	0.2
54	combined	2.78	347.71	78.09	2.17	1.63	58.6	0.177	0.015	0.035	2.5	0.15	2	0.03	0.2
55	combined	3.28	377.8	82.48	2.70	2.03	61.9	0.688	0.015	0.035	2.5	0.15	2	0.03	0.2
56	combined	2.60	336.22	69.94	1.81	1.36	52.5	0.625	0.015	0.035	2.5	0.15	2	0.03	0.2
57	combined	3.43	386.72	75.79	2.60	1.95	56.8	0.296	0.015	0.035	2.5	0.15	2	0.03	0.2
58	combined	1.81	280.48	84.55	1.53	1.15	63.4	0.995	0.015	0.035	2.5	0.15	2	0.03	0.2
59	combined	2.53	331.93	68.30	1.73	1.30	51.2	0.262	0.015	0.035	2.5	0.15	2	0.03	0.2
60	combined	3.17	371.84	70.83	2.25	1.68	53.1	0.021	0.015	0.035	2.5	0.15	2	0.03	0.2
61	combined	3.00	361.35	91.76	2.75	2.06	68.8	0.17	0.015	0.035	2.5	0.15	2	0.03	0.2
62	combined	3.16	370.85	79.03	2.50	1.87	59.3	2.125	0.015	0.035	2.5	0.15	2	0.03	0.2

Subcatchment ID	System type	AREA	WIDTH	Impervious (%)	Impervious (ac)	Effective Impervious (ac)	Effective Impervious (%)	SLOPE	Manning's N Impervious	Manning's N Pervious	Maximum Infiltration Rate (in/hr)	Minimum Infiltration Rate (in/hr)	Decay Constant (1/hr)	Depression Storage Impervious (in)	Depression Storage Pervious (in)
63	combined	3.85	400.6	76.69	2.95	2.22	57.5	0.893	0.015	0.035	2.5	0.15	2	0.03	0.2
64	combined	4.84	458.51	67.19	3.25	2.44	50.4	2.163	0.015	0.035	2.5	0.15	2	0.03	0.2
65	combined	3.43	386.75	58.61	2.01	1.51	44.0	0.211	0.015	0.035	2.5	0.15	2	0.03	0.2
66	combined	3.64	397.99	62.13	2.26	1.69	46.6	0.851	0.015	0.035	2.5	0.15	2	0.03	0.2
67	combined	3.73	403	74.29	2.77	2.08	55.7	0.591	0.015	0.035	2.5	0.15	2	0.03	0.2
68	combined	2.70	343.15	61.89	1.68	1.26	46.5	3.382	0.015	0.035	2.5	0.15	2	0.03	0.2
69	combined	4.20	427.74	69.41	2.92	2.19	52.1	0.741	0.015	0.035	2.5	0.15	2	0.03	0.2
70	combined	2.97	359.5	78.90	2.34	1.76	59.2	5.046	0.015	0.035	2.5	0.15	2	0.03	0.2
71	combined	3.13	369.12	55.04	1.72	1.29	41.3	5.286	0.015	0.035	2.5	0.15	2	0.03	0.2
72	combined	4.70	452.58	61.40	2.89	2.17	46.0	1.847	0.015	0.035	2.5	0.15	2	0.03	0.2
73	combined	1.80	288.15	99.87	1.80	1.35	74.8	0.577	0.015	0.035	2.5	0.15	2	0.03	0.2
74	combined	3.03	363.2	82.15	2.49	1.87	61.6	1.338	0.015	0.035	2.5	0.15	2	0.03	0.2
75	combined	3.91	412.45	89.71	3.50	2.63	67.3	1.293	0.015	0.035	2.5	0.15	2	0.03	0.2
76	combined	3.88	411.01	74.96	2.91	2.18	56.2	1.852	0.015	0.035	2.5	0.15	2	0.03	0.2
77	combined	3.68	400.22	92.55	3.40	2.55	69.4	1.566	0.015	0.035	2.5	0.15	2	0.03	0.2
78	combined	3.54	392.77	83.09	2.94	2.21	62.3	0.918	0.015	0.035	2.5	0.15	2	0.03	0.2
79	combined	4.12	423.77	80.38	3.31	2.49	60.3	0.009	0.015	0.035	2.5	0.15	2	0.03	0.2
80	combined	3.90	412.38	71.13	2.78	2.08	53.3	2.011	0.015	0.035	2.5	0.15	2	0.03	0.2
81	combined	2.27	314.7	60.89	1.38	1.04	45.7	2.599	0.015	0.035	2.5	0.15	2	0.03	0.2
82	combined	2.86	352.68	70.90	2.03	1.52	53.2	0.616	0.015	0.035	2.5	0.15	2	0.03	0.2
83	combined	4.08	420.43	71.24	2.89	2.17	53.4	1.23	0.015	0.035	2.5	0.15	2	0.03	0.2
84	combined	3.84	408.05	68.47	2.63	1.97	51.4	0.741	0.015	0.035	2.5	0.15	2	0.03	0.2
85	combined	3.51	391.2	70.97	2.49	1.87	53.2	0.62	0.015	0.035	2.5	0.15	2	0.03	0.2
86	combined	1.51	286.42	94.70	1.43	1.07	71.0	0.888	0.015	0.035	2.5	0.15	2	0.03	0.2
87	combined	3.31	379.86	66.32	2.20	1.65	49.7	1.242	0.015	0.035	2.5	0.15	2	0.03	0.2
88	combined	3.60	396.08	69.16	2.49	1.87	51.9	1.576	0.015	0.035	2.5	0.15	2	0.03	0.2
89	combined	2.30	316.63	79.44	1.83	1.37	59.6	1.84	0.015	0.035	2.5	0.15	2	0.03	0.2
90	combined	3.34	381.52	94.94	3.17	2.38	71.2	1.649	0.015	0.035	2.5	0.15	2	0.03	0.2
91	combined	3.77	405.41	94.89	3.58	2.69	71.2	0.685	0.015	0.035	2.5	0.15	2	0.03	0.2
92	combined	4.76	455.13	84.44	4.02	3.01	63.3	1.876	0.015	0.035	2.5	0.15	2	0.03	0.2
93	combined	3.04	363.95	94.94	2.89	2.17	71.2	1.573	0.015	0.035	2.5	0.15	2	0.03	0.2
94	combined	4.03	419.18	78.28	3.16	2.37	58.7	4.272	0.015	0.035	2.5	0.15	2	0.03	0.2
95	combined	3.62	397.39	91.92	3.33	2.50	69.0	3.883	0.015	0.035	2.5	0.15	2	0.03	0.2
96	combined	2.42	324.47	56.52	1.37	1.02	42.4	39.346	0.015	0.035	2.5	0.15	2	0.03	0.2
97	combined	3.15	373.29	64.57	2.03	1.52	48.4	12.525	0.015	0.035	2.5	0.15	2	0.03	0.2
98	combined	4.84	469.37	76.12	3.69	2.77	57.1	0.112	0.015	0.035	2.5	0.15	2	0.03	0.2
99	combined	2.23	311.9	65.34	1.46	1.09	49.0	1.171	0.015	0.035	2.5	0.15	2	0.03	0.2
100	combined	2.65	339.84	70.62	1.87	1.40	53.0	1.112	0.015	0.035	2.5	0.15	2	0.03	0.2
101	combined	2.95	358.58	62.70	1.85	1.39	47.0	7.889	0.015	0.035	2.5	0.15	2	0.03	0.2
102	combined	3.14	369.6	74.09	2.32	1.74	55.6	1.65	0.015	0.035	2.5	0.15	2	0.03	0.2
103	combined	3.43	386.67	65.89	2.26	1.70	49.4	4.673	0.015	0.035	2.5	0.15	2	0.03	0.2
104	combined	3.55	393.01	61.76	2.19	1.64	46.3	4.845	0.015	0.035	2.5	0.15	2	0.03	0.2
105	combined	3.44	387.03	51.12	1.76	1.32	38.3	1.426	0.015	0.035	2.5	0.15	2	0.03	0.2
106	combined	4.87	460.67	84.52	4.12	3.09	63.4	3.202	0.015	0.035	2.5	0.15	2	0.03	0.2
107	combined	2.36	320.34	60.34	1.42	1.07	45.3	1.595	0.015	0.035	2.5	0.15	2	0.03	0.2
108	combined	1.27	235.24	62.28	0.79	0.59	46.7	2.341	0.015	0.035	2.5	0.15	2	0.03	0.2
109	combined	2.79	348.5	59.41	1.66	1.24	44.6	1.591	0.015	0.035	2.5	0.15	2	0.03	0.2
110	combined	3.64	398.15	94.09	3.42	2.57	70.6	1.383	0.015	0.035	2.5	0.15	2	0.03	0.2
111	combined	4.30	432.77	84.11	3.62	2.71	63.1	2.383	0.015	0.035	2.5	0.15	2	0.03	0.2
112	combined	2.24	312.22	74.13	1.66	1.24	55.6	1.372	0.015	0.035	2.5	0.15	2	0.03	0.2
113	combined	2.31	318.69	61.85	1.43	1.07	46.5	1.547	0.015	0.035	2.5	0.15	2	0.03	0.2
114	combined	4.26	430.53	77.33	3.29	2.47	58.0	1.176	0.015	0.035	2.5	0.15	2	0.03	0.2
115	combined	2.52	331.86	58.40	1.47	1.10	43.8	4.739	0.015	0.035	2.5	0.15	2	0.03	0.2
116	combined	4.63	449.18	71.18	3.30	2.47	53.4	0.809	0.015	0.035	2.5	0.15	2	0.03	0.2
117	combined	3.28	376.1	89.12	2.92	2.19	66.8	0.339	0.015	0.035	2.5	0.15	2	0.03	0.2
118	combined	2.62	337.5	92.28	2.41	2.17	83.0	0.706	0.015	0.035	2.5	0.15	2	0.03	0.2
119	combined	3.46	388.31	77.94	2.69	2.42	70.1	0.691	0.015	0.035	2.5	0.15	2	0.03	0.2
120	combined	1.85	283.7	79.82	1.48	1.33	71.9	0.719	0.015	0.035	2.5	0.15	2	0.03	0.2
121	combined	3.11	368.32	70.39	2.19	1.97	63.4	4.645	0.015	0.035	2.5	0.15	2	0.03	0.2
122	combined	3.13	369.49	67.49	2.12	1.90	60.7	4.419	0.015	0.035	2.5	0.15	2	0.03	0.2
123	combined	2.44	325.84	55.00	1.34	1.21	49.5	1.032	0.015	0.035	2.5	0.15	2	0.03	0.2
124	combined	3.67	400.04	66.49	2.44	2.20	59.8	3.426	0.015	0.035	2.5	0.15	2	0.03	0.2

Subcatchment ID	System type	AREA	WIDTH	Impervious (%)	Impervious (ac)	Effective Impervious (ac)	Effective Impervious (%)	SLOPE	Manning's N Impervious	Manning's N Pervious	Maximum Infiltration Rate (in/hr)	Minimum Infiltration Rate (in/hr)	Decay Constant (1/hr)	Depression Storage Impervious (in)	Depression Storage Pervious (in)
125	combined	2.58	335.21	93.68	2.42	2.18	84.3	1.85	0.015	0.035	2.5	0.15	2	0.03	0.2
126	combined	4.71	453.17	57.43	2.71	2.44	51.7	4.229	0.015	0.035	2.5	0.15	2	0.03	0.2
127	combined	4.58	446.88	61.68	2.82	2.54	55.5	1.708	0.015	0.035	2.5	0.15	2	0.03	0.2
128	combined	4.48	440.64	55.55	2.48	2.23	50.0	2.585	0.015	0.035	2.5	0.15	2	0.03	0.2
129	combined	4.02	418.64	69.35	2.79	2.40	59.7	3.098	0.015	0.035	2.5	0.15	2	0.03	0.2
130	combined	2.67	341.17	65.27	1.74	1.57	58.7	3.455	0.015	0.035	2.5	0.15	2	0.03	0.2
131	combined	1.55	280.14	54.99	0.85	0.77	49.5	1.95	0.015	0.035	2.5	0.15	2	0.03	0.2
132	combined	2.15	305.69	55.01	1.18	1.06	49.5	1.267	0.015	0.035	2.5	0.15	2	0.03	0.2
133	combined	2.72	343.88	64.05	1.74	1.57	57.6	6.888	0.015	0.035	2.5	0.15	2	0.03	0.2
134	combined	3.71	401.72	55.01	2.04	1.83	49.5	2.732	0.015	0.035	2.5	0.15	2	0.03	0.2
135	combined	3.96	414.95	74.83	2.96	2.66	67.3	3.392	0.015	0.035	2.5	0.15	2	0.03	0.2
136	combined	4.22	428.71	69.12	2.92	2.63	62.2	0.798	0.015	0.035	2.5	0.15	2	0.03	0.2
137	combined	3.16	371.2	66.05	2.09	1.88	59.4	0.087	0.015	0.035	2.5	0.15	2	0.03	0.2
138	combined	4.51	443.3	63.53	2.87	2.15	47.7	1.668	0.015	0.035	2.5	0.15	2	0.03	0.2
139	combined	3.74	403.82	64.24	2.40	1.80	48.2	0.65	0.015	0.035	2.5	0.15	2	0.03	0.2
140	combined	3.59	385.15	79.94	2.87	2.49	69.6	3.193	0.015	0.035	2.5	0.15	2	0.03	0.2
141	combined	3.28	377.74	57.45	1.88	1.64	50.0	3.47	0.015	0.035	2.5	0.15	2	0.03	0.2
142	combined	2.61	337.89	64.18	1.67	1.46	55.8	1.347	0.015	0.035	2.5	0.15	2	0.03	0.2
143	combined	3.03	363.1	75.95	2.30	2.00	66.1	2.928	0.015	0.035	2.5	0.15	2	0.03	0.2
144	combined	3.24	375.79	58.48	1.90	1.65	50.9	3.248	0.015	0.035	2.5	0.15	2	0.03	0.2
145	combined	4.78	458.09	69.49	3.32	2.89	60.5	3.646	0.015	0.035	2.5	0.15	2	0.03	0.2
146	combined	3.90	412.11	71.28	2.78	2.42	62.0	1.378	0.015	0.035	2.5	0.15	2	0.03	0.2
147	combined	4.06	420.83	59.21	2.40	2.09	51.5	3.937	0.015	0.035	2.5	0.15	2	0.03	0.2
148	combined	4.35	435.33	61.28	2.66	2.32	53.3	3.893	0.015	0.035	2.5	0.15	2	0.03	0.2
149	combined	4.37	436.41	69.88	3.05	2.66	60.8	0.087	0.015	0.035	2.5	0.15	2	0.03	0.2
150	combined	3.58	394.69	62.82	2.25	1.96	54.7	1.183	0.015	0.035	2.5	0.15	2	0.03	0.2
151	combined	4.98	465.56	58.66	2.92	2.54	51.0	0.134	0.015	0.035	2.5	0.15	2	0.03	0.2
152	combined	4.08	421.98	59.20	2.42	2.11	51.5	1.588	0.015	0.035	2.5	0.15	2	0.03	0.2
153	combined	4.26	433.51	66.63	2.83	2.47	58.0	1.424	0.015	0.035	2.5	0.15	2	0.03	0.2
154	combined	4.93	463.38	73.59	3.63	3.16	64.0	0.458	0.015	0.035	2.5	0.15	2	0.03	0.2
155	combined	4.75	454.79	95.01	4.51	3.92	82.7	1.674	0.015	0.035	2.5	0.15	2	0.03	0.2
156	combined	2.61	337.01	73.00	1.90	1.66	63.5	2.29	0.015	0.035	2.5	0.15	2	0.03	0.2
157	combined	2.77	347.55	70.61	1.96	1.70	61.4	1.211	0.015	0.035	2.5	0.15	2	0.03	0.2
158	combined	2.42	324.29	68.28	1.65	1.43	59.4	1.857	0.015	0.035	2.5	0.15	2	0.03	0.2
159	combined	4.41	438.31	75.85	3.34	2.91	66.0	0.91	0.015	0.035	2.5	0.15	2	0.03	0.2
160	combined	3.36	379.62	78.41	2.59	2.25	68.2	1.081	0.015	0.035	2.5	0.15	2	0.03	0.2
161	combined	4.17	426.24	84.80	3.54	3.08	73.8	0.846	0.015	0.035	2.5	0.15	2	0.03	0.2
162	combined	3.64	397.82	81.40	2.96	2.57	70.8	0.758	0.015	0.035	2.5	0.15	2	0.03	0.2
163	combined	2.04	298.18	81.52	1.67	1.45	70.9	0.795	0.015	0.035	2.5	0.15	2	0.03	0.2
164	combined	3.46	386.34	86.51	3.00	2.61	75.3	1.007	0.015	0.035	2.5	0.15	2	0.03	0.2
165	combined	3.46	388.38	83.34	2.89	2.51	72.5	2.59	0.015	0.035	2.5	0.15	2	0.03	0.2
166	combined	4.91	462.7	85.86	4.22	3.67	74.7	0.748	0.015	0.035	2.5	0.15	2	0.03	0.2
167	combined	4.72	453.42	77.46	3.66	3.18	67.4	2.348	0.015	0.035	2.5	0.15	2	0.03	0.2
168	combined	3.34	381.43	77.22	2.58	2.24	67.2	0.943	0.015	0.035	2.5	0.15	2	0.03	0.2
169	combined	3.50	390.61	95.00	3.33	2.89	82.7	0.481	0.015	0.035	2.5	0.15	2	0.03	0.2
170	combined	3.25	376.32	73.85	2.40	2.09	64.3	0.739	0.015	0.035	2.5	0.15	2	0.03	0.2
171	combined	2.16	306.42	68.79	1.48	1.29	59.8	1.067	0.015	0.035	2.5	0.15	2	0.03	0.2
172	combined	1.78	279.31	66.16	1.18	1.03	57.6	1.848	0.015	0.035	2.5	0.15	2	0.03	0.2
173	combined	1.78	279.85	63.83	1.14	0.98	55.5	0.071	0.015	0.035	2.5	0.15	2	0.03	0.2
174	combined	3.70	405.19	80.92	2.99	2.60	70.4	2.082	0.015	0.035	2.5	0.15	2	0.03	0.2
175	combined	1.78	278.94	94.99	1.69	1.47	82.6	1.303	0.015	0.035	2.5	0.15	2	0.03	0.2
176	combined	2.35	319.59	73.05	1.71	1.49	63.6	0.861	0.015	0.035	2.5	0.15	2	0.03	0.2
177	combined	3.65	398.53	91.91	3.35	2.91	80.0	3.737	0.015	0.035	2.5	0.15	2	0.03	0.2
178	combined	2.75	348.57	93.83	2.82	1.96	70.4	2.815	0.015	0.035	2.5	0.15	2	0.03	0.2
179	combined	2.88	354.06	87.28	2.51	1.88	65.5	1.843	0.015	0.035	2.5	0.15	2	0.03	0.2
180	combined	2.30	316.28	86.16	1.98	1.48	64.6	1.133	0.015	0.035	2.5	0.15	2	0.03	0.2
181	combined	4.73	453.83	68.37	3.23	2.42	51.3	3.143	0.015	0.035	2.5	0.15	2	0.03	0.2
182	combined	3.45	387.62	79.07	2.73	2.05	59.3	3.176	0.015	0.035	2.5	0.15	2	0.03	0.2
183	combined	4.37	435.51	67.42	2.95	2.21	50.6	1.644	0.015	0.035	2.5	0.15	2	0.03	0.2
184	combined	3.39	384.03	76.05	2.57	1.93	57.0	2.784	0.015	0.035	2.5	0.15	2	0.03	0.2
185	combined	4.97	465.37	84.37	4.19	3.14	63.3	2.489	0.015	0.035	2.5	0.15	2	0.03	0.2
186	combined	4.71	453.02	92.55	4.36	3.27	69.4	0.982	0.015	0.035	2.5	0.15	2	0.03	0.2

Subcatchment ID	System type	AREA	WIDTH	Impervious (%)	Impervious (ac)	Effective Impervious (ac)	Effective Impervious (%)	SLOPE	Manning's N Impervious	Manning's N Pervious	Maximum Infiltration Rate (in/hr)	Minimum Infiltration Rate (in/hr)	Decay Constant (1/hr)	Depression Storage Impervious (in)	Depression Storage Pervious (in)
187	combined	3.00	361.34	76.88	2.30	1.73	57.7	0.868	0.015	0.035	2.5	0.15	2	0.03	0.2
188	combined	3.69	400.76	94.09	3.47	2.60	70.6	0.808	0.015	0.035	2.5	0.15	2	0.03	0.2
189	combined	4.39	437.39	94.72	4.16	3.12	71.0	0.811	0.015	0.035	2.5	0.15	2	0.03	0.2
190	combined	3.92	413.1	84.07	3.29	2.47	63.1	1.629	0.015	0.035	2.5	0.15	2	0.03	0.2
191	combined	4.53	444.38	70.31	3.19	2.39	52.7	0.938	0.015	0.035	2.5	0.15	2	0.03	0.2
192	combined	4.47	441.24	91.14	4.07	3.05	68.4	1.730	0.015	0.035	2.5	0.15	2	0.03	0.2
193	combined	3.51	391.06	80.75	2.83	2.13	60.6	0.287	0.015	0.035	2.5	0.15	2	0.03	0.2
194	combined	4.70	452.28	79.54	3.74	2.80	59.7	0.815	0.015	0.035	2.5	0.15	2	0.03	0.2
195	combined	4.61	448.12	83.54	3.85	2.89	62.7	1.296	0.015	0.035	2.5	0.15	2	0.03	0.2
196	combined	3.90	411.98	71.72	2.80	2.10	53.8	0.972	0.015	0.035	2.5	0.15	2	0.03	0.2
197	combined	4.39	437.23	35.80	1.57	1.18	26.9	3.745	0.015	0.035	2.5	0.15	2	0.03	0.2
198	combined	3.93	413.53	61.95	2.43	1.82	46.5	3.53	0.015	0.035	2.5	0.15	2	0.03	0.2
199	combined	4.70	452.66	88.49	4.16	3.12	66.4	2.924	0.015	0.035	2.5	0.15	2	0.03	0.2
200	combined	4.00	417.32	73.81	2.95	2.21	55.4	0.354	0.015	0.035	2.5	0.15	2	0.03	0.2
201	combined	2.14	305.07	72.05	1.54	1.15	54.0	3.6	0.015	0.035	2.5	0.15	2	0.03	0.2
202	combined	2.54	332.59	66.09	1.68	1.26	49.6	0.16	0.015	0.035	2.5	0.15	2	0.03	0.2
203	combined	2.39	322.67	66.15	1.58	1.19	49.6	1.003	0.015	0.035	2.5	0.15	2	0.03	0.2
204	combined	3.14	369.58	81.00	2.54	1.91	60.7	0.324	0.015	0.035	2.5	0.15	2	0.03	0.2
205	combined	3.33	380.82	81.20	2.70	2.03	60.9	1.851	0.015	0.035	2.5	0.15	2	0.03	0.2
206	combined	1.71	272.53	69.85	1.19	0.89	52.4	3.479	0.015	0.035	2.5	0.15	2	0.03	0.2
207	combined	3.10	367.45	87.91	2.69	1.97	63.6	1.39	0.015	0.035	2.5	0.15	2	0.03	0.2
208	combined	2.41	325.75	69.67	1.68	1.26	52.3	1.08	0.015	0.035	2.5	0.15	2	0.03	0.2
209	combined	3.21	373.89	67.88	2.18	1.63	50.9	4.922	0.015	0.035	2.5	0.15	2	0.03	0.2
210	combined	2.87	353.84	57.03	1.64	1.23	42.8	3.980	0.015	0.035	2.5	0.15	2	0.03	0.2
211	combined	3.75	403.95	76.99	2.88	2.16	57.7	1.33	0.015	0.035	2.5	0.15	2	0.03	0.2
212	combined	4.98	404.82	72.72	3.61	2.71	54.5	0.698	0.015	0.035	2.5	0.15	2	0.03	0.2
213	combined	3.88	411.19	64.16	2.49	1.87	48.1	0.238	0.015	0.035	2.5	0.15	2	0.03	0.2
214	combined	1.30	237.78	88.66	1.14	0.86	66.0	0.471	0.015	0.035	2.5	0.15	2	0.03	0.2
215	combined	3.02	362.53	66.66	2.01	1.51	50.0	3.857	0.015	0.035	2.5	0.15	2	0.03	0.2
216	combined	2.64	339.05	64.84	1.71	1.28	48.6	3.857	0.015	0.035	2.5	0.15	2	0.03	0.2
217	combined	2.33	318.8	57.16	1.33	1.00	42.9	7.369	0.015	0.035	2.5	0.15	2	0.03	0.2
218	combined	2.37	321.54	63.56	1.51	1.13	47.7	5.551	0.015	0.035	2.5	0.15	2	0.03	0.2
219	combined	3.00	361.48	66.17	1.99	1.49	49.6	1.759	0.015	0.035	2.5	0.15	2	0.03	0.2
220	combined	2.74	345.22	63.52	1.74	1.58	57.2	0.446	0.015	0.035	2.5	0.15	2	0.03	0.2
221	combined	1.87	285.73	55.03	1.03	0.93	49.5	5.471	0.015	0.035	2.5	0.15	2	0.03	0.2
222	combined	2.33	318.5	61.14	1.42	1.24	53.2	3.264	0.015	0.035	2.5	0.15	2	0.03	0.2
223	combined	2.64	336.84	91.31	2.41	1.80	68.5	0.191	0.015	0.035	2.5	0.15	2	0.03	0.2
224	combined	3.39	384.04	18.70	0.63	0.47	14.0	1.532	0.015	0.035	2.5	0.15	2	0.03	0.2
225	combined	2.71	343.34	77.75	2.10	1.58	58.3	1.89	0.015	0.035	2.5	0.15	2	0.03	0.2
226	combined	2.13	304.6	84.50	1.80	1.35	63.4	1.306	0.015	0.035	2.5	0.15	2	0.03	0.2
227	combined	0.72	177.29	86.84	0.63	0.47	65.1	0.346	0.015	0.035	2.5	0.15	2	0.03	0.2
228	combined	0.00	55.28	1.62	0.00	0.67	0.0	265.307	0.015	0.035	2.5	0.15	2	0.03	0.2
229	combined	3.60	395.85	75.73	2.73	2.04	56.8	0.823	0.015	0.035	2.5	0.15	2	0.03	0.2
230	combined	2.74	345.9	67.09	1.84	1.38	50.3	0.429	0.015	0.035	2.5	0.15	2	0.03	0.2
231	combined	2.44	325.66	43.29	1.05	0.79	32.5	2.454	0.015	0.035	2.5	0.15	2	0.03	0.2
232	combined	2.79	348.76	74.38	2.08	1.56	55.8	0.959	0.015	0.035	2.5	0.15	2	0.03	0.2

Appendix B
Development and Evaluation of Alternatives Report

North Hudson Sewerage Authority

Long Term Control Plan

Alternatives Development and Evaluation: River Road Wastewater Treatment Plant

New Jersey Pollutant Discharge Elimination System Permit No.: NJ0025321

Date: January 2020

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Executive Summary

Under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit for the River Road Wastewater Treatment Plant (WWTP), as part of the Long-Term Control Plan, the North Hudson Sewerage Authority (the Authority) must evaluate alternatives for combined sewer overflow (CSO) technologies at the River Road WWTP and its outfalls. This report presents the results of the evaluation of identified control technologies for the WNY1 and joint overflow sewer outlet (JOSO) drainage basins and the River Road WWTP. The alternatives evaluation process included identification of alternatives, preliminary screening, development of conceptual layouts, testing the alternative in the River Road Service Area InfoWorks Integrated Catchment Modelling (ICM) hydraulic collection system model (model), and cost development.

Identification of alternatives included summarizing findings of the Alternatives Analysis workshop in June 2018 and development of evaluation criteria to assign a score to each alternative and provide a parametric comparison for the different alternatives. The Authority's priorities were identified along with the goals of CSO reduction to determine categories for evaluation criteria. These categories were assigned a weighting method based on the priorities of the Authority and the overall goals of CSO reduction to develop scores for each. The evaluation criteria can be found in Appendix A .

After alternatives identification, a preliminary screening was conducted to identify anticipated constraints, site limitations, expected feasibility and functionality for all alternatives from the identification phase. This step includes identifying any aspects of the proposed alternatives that may have a major effect on cost or schedule, and some alternatives were eliminated at this stage based on previous experience or planned projects in the area. The complete Preliminary Screening memorandum can be found in Appendix B.

For alternatives that were not eliminated after preliminary screening, conceptual layouts were developed showing the required piping, footprints of proposed structures, and potential updates to existing facilities for implementation of the alternatives. For storage and conveyance alternatives at the outfalls, these layouts were simulated in the model to extract the anticipated overflows in the Typical Year expected from implementing these alternatives with the goal of reaching 4 overflows in the Typical Year. For disinfection alternatives, the available contact time was calculated either within the existing pipes or within a proposed contact basin with the goal of disinfecting the peak hourly flow within the Typical Year. In all drainage basins, disinfection in the outfall pipes is not feasible as based on analysis, there is not adequate contact time from the proposed disinfection point to the outfall for any drainage basin. For alternatives proposed at the River Road WWTP, the current layout and processes of the treatment plant were analyzed to determine what proposed structures would be required and the approximate annual amount of chemicals required for disinfection. Class 5 cost estimates were developed once the layouts were finalized and included construction, capital, O&M, and the lifecycle cost with the projected year dependent on the type of alternative.

When the analysis, modeling, and cost estimates were complete, each alternative was assigned a weighted point total and percentage based on the evaluation criteria (Appendix A). Alternatives could receive a maximum weighted point total of 152. The weighted percentage shows the percentage that the weighted point total has received of the maximum total. The ideal alternatives have a weighted percentage closer to 100%. The weighted point totals and weighted percentages for all alternatives are shown in Table ES-1 1

Table ES-1. River Road WWTP Service Area - CSO Control Alternatives Comparison

Drainage Basin	Alternatives	Weighted Point Total	Weighted Percent	Class 5 Conceptual Construction Cost Estimate
JOSO	Combined Sewer Overflow Storage Structure In Water	74	53%	$82,160,000.00
	Raise Regulator Weirs at UC1, UC2 and WNY2	120	87%	$120,000
	Replace Existing JOSO Sideflow Weirs with Bending Weirs	119	86%	$352,000
WNY1	Combined Sewer Overflow Storage Tank near WNY1 Outfall	76	55%	$60,333,000.00
	Linear Storage Tunnel at Anthony Defino Way	81	59%	$171,450,000.00
	Cloth Media Filtration[1]	-	-	$27,700,000-$86,500,000
	Compressible Media Filtration[2]	-	-	$92,000,000
Systemwide	Inflow/Infiltration Rehabilitation	107	77%	$13,788,000
	Green Infrastructure	99	71%	$42,310,000.00
	Sewer Separation	72	52%	247,868,000.00
River Road WWTP	ActiFLO	121	87%	$11,923,000
	CoMag	121	87%	$12,191,000
	Cloth Media Filtration	122	88%	$14,961,000
	Compressible Media Filtration	122	88%	$15,425,000

1. Alternative not scored due to potential range of costs

2. Alternative not scored due to potential range of costs; cost shown assumes max TSS concentration of 320 mg/L

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Acronyms and Abbreviations

%	percent
Authority	North Hudson Sewerage Authority
CBOD	Carbonaceous biochemical oxygen demand
CCTV	closed-circuit television
CH2M	CH2M HILL Engineers, Inc.
CMF	compressible media filtration
CSO	combined sewer overflow
CSS	combined sewer system
DEFM	Demographic and Employment Forecast Mode
EPA	U.S. Environmental Protection Agency
ES	executive summary
EWRI	Environmental & Water Resources Institute
ft^2	square foot or feet
ft^3	cubic feet
GI	Green Infrastructure
GIS	geographic information system
gpad	gallons per acre per day
gpd	gallons per day
I/I	inflow and infiltration
ICM	Integrated Catchment Modeling
idm	inch diameter-mile
ID	identification
Jacobs	Jacobs Engineering Group Inc.
JOSO	joint overflow sewer outlet
LTCP	Long-Term Control Plan
MG	million gallon(s)
mgd	million gallons per day
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NJTPA	New Jersey Transportation Planning Authority
PS	pump station
RCP	reinforced concrete pipe

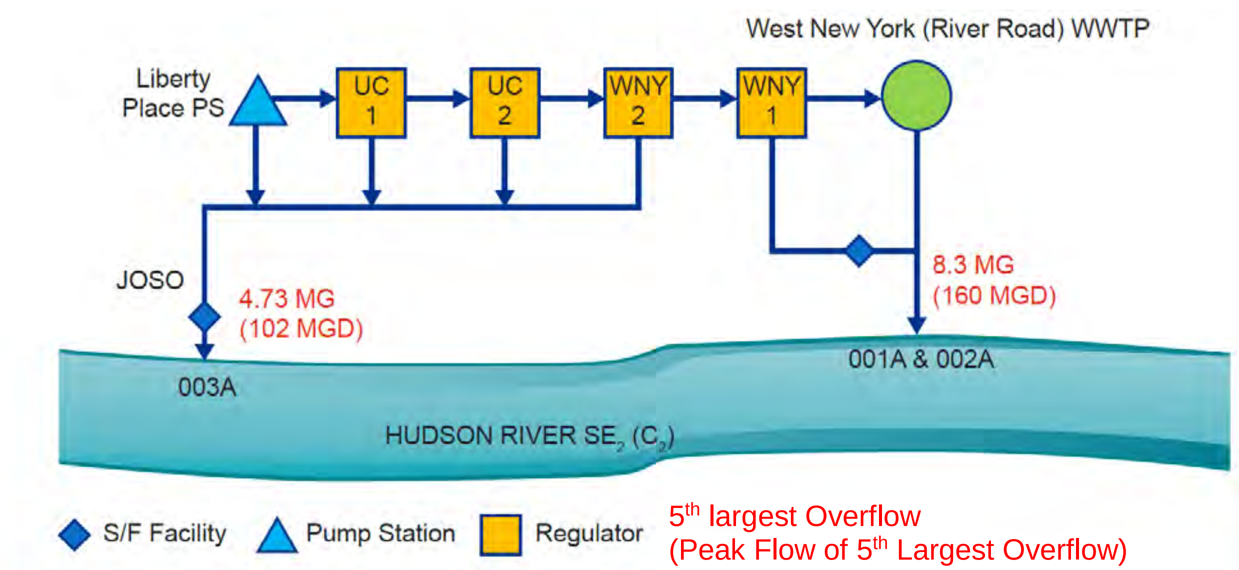
ROW	right-of-way
S/F	solids/floatables
SCADA	supervisory control and data acquisition
TAZ	Traffic Analysis Zone
TBM	tunnel boring machine
TSS	total suspended solids
U.S.	United States
USACOE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VCP	vitrified clay pipe
WEF	Water Environment Federation
WNY	West New York
WWETCO	Wet Weather Engineering and Technology
WWF	wet-weather facility
WWPS	wastewater pump station
WWTP	wastewater treatment plant

SECTION 1

1 Introduction

This report evaluates the control technologies deemed as feasible for the North Hudson Sewerage Authority's (the Authority's) River Road wastewater treatment plant (WWTP) system. Control technologies include flow control (for example, storage) and treatment. Figure 1-1 depicts the system block diagrams of the River Road WWTP outfalls. This figure provides an understanding of the relative locations and configuration of the Authority's infrastructure along the Hudson River based on the WWTP service area, as well as volume of the fifth-largest overflow from the model that will be used as a target to evaluate storage and capacity alternatives. Treatment alternatives are evaluated based on the peak available contact time within the pipes where disinfection is applied or the peak flow rate within the Typical Year shown in the figure below.

Figure 1-1. River Road WWTP Service Area



1.1 Background

The Authority owns two WWTPs and the combined sewer systems' (CSSs') tributary to these facilities. The Adams Street and River Road WWTPs are regulated by the New Jersey Department of Environmental Protection (NJDEP) under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit program.

1.2 Regulatory Requirements

In October 2015, the NJDEP issued individual permits to municipalities and authorities that own and operate segments of CSSs. The NJPDES permits addressed requirements for overall water quality improvements, routine reporting and development of a CSO LTCP.

Pursuant to NJPDES Permit NJ0025321 (River Road WWTP), Part IV, Combined Sewer Management Section, Section D.3.b.ii., a System Characterization Report for the LTCPs was submitted to NJDEP on December 31, 2015. The document fulfills the requirement in Part IV, Combined Sewer Management, Section D.3.b.ii., to submit the Development and Evaluation of Alternatives by July 1, 2019. Information generated from the System Characterization Work Plan comprises this Evaluation of Alternatives, including:

- Alternatives Analysis Workshop
- Identification and Preliminary Screening of Alternatives
- Evaluation of Alternatives in Hydraulic Collection System Model
- Class 5 Cost Estimate

1.3 Purpose and Scope

The purpose of this report is to fulfill NJDEP permit requirements to evaluate a range of CSO control alternatives predicted to accomplish the requirements of the CWA. The evaluation includes a thorough review of the collection system that conveys flow to the River Road WWTP, including areas of sewage overflows to streets, and other public and private areas, to adequately address the response of the CSS to various precipitation events. In its evaluation of each potential CSO control alternative, the approved hydrologic, hydraulic and water quality models were used to simulate the existing conditions and conditions as they are expected to exist after construction and operation of the chosen alternative(s). The practical and technical feasibility of the proposed CSO control alternative(s), and water quality benefits of constructing and implementing various remedial controls include:

- Green Infrastructure
- Increased storage capacity in the collection system.
- STP expansion and/or storage at the plant including an evaluation of the capacity of the unit processes must be conducted at the STP resulting in a determination of whether there is any additional treatment and conveyance capacity within the STP
- I/I reduction to meet the definition of non-excessive infiltration and non-excessive inflow as, defined in N.J.A.C. 7:14A-1.2 in the entire collection system that conveys flows to the treatment, works to free up storage capacity or conveyance in the sewer system and/or treatment capacity at the STP, and feasibility of implementing in the entire system or portions thereof.
- Sewer separation.
- Treatment of the CSO discharge.
- CSO related bypass of the secondary treatment portion of the STP in accordance with N.J.A.C. 7:14A-11.12 Appendix C, II C.7.

The anticipated limitations and constraints, conceptual layouts, and anticipated results of implementing the alternative using the model in the River Road WWTP service area and planning level costs are described.

1.4 Future Conditions

At the time of this analysis, no capital projects are anticipated within the River Road service area. The timeline of the proposed projects may extend well after the selection of alternatives has been completed. For this reason, an analysis on the potential changes in population was conducted to determine the potential changes in volume that the CSS and alternatives will need to report. Descriptions of the analysis is provided in the following subsection.

1.4.1 Population Projections and Future Flows

In section G.4.e. of the permit, it is indicated that “the permittee shall utilize the models to simulate the existing conditions and conditions as they are expected to exist after construction and operation of the chosen alternative(s).” It has been assumed that the alternatives that are selected through the LTCP process will be constructed and implemented over a 30-year period. As such, the population in the year 2050 has been assumed for the conditions that are expected to exist after construction and operation of the alternatives have been evaluated.

Several population projections were sourced in order to select the most reasonable projection for the design basis. These are summarized below.

1.4.1.1 U.S. Census Bureau

Census data is available from the 2010 census, and population projections for 2017 are also available from the U.S. Census Bureau. This data is shown in Table 1-1, extrapolated to 2050. It is noted that while these towns underwent some growth over the past ten years, this rate of growth is unlikely to continue as the service area is already urbanized. As such census data was not used for this analysis.

Table 1-1. 2010 and 2017 Census Data

	2010	2017	Annual Increase (%)	2050 Projection
Union City	66,455	69,815	0.72	85,655
Weehawken	12,554	14,268	1.95	22,354
West New York	49,708	53,345	1.05	70,488
Total	128,717	137,428		178,497

1.4.1.2 North Jersey Transportation Authority

The North Jersey Transportation Planning Authority is a metropolitan planning organization with federal authorization. It is responsible for the 13 northern counties in New Jersey and is responsible for overseeing certain transportation related projects and studies. The NJTPA updates its regional forecasts for population, households and employment every four years.

In 2017, NJTPA completed the latest set of forecasts. Final forecasts were approved by the NJTPA Board on November 13, 2017. The NJTPA employs the Demographic and Employment Forecast Model (DEFM). According to their website:

> The DEFM uses regional and county level forecasts of employment, population and households produced from a regional econometric modeling effort and allocates these forecasts to a localized Traffic Analysis Zone (TAZ) level. It also aggregates the TAZ level information to the municipal level. The DEFM uses data elements that influence location behavior to perform this allocation analysis including:
>
> Current land use data (residential, commercial, industrial and vacant land);
> Composite zoning estimates for density;
> Highway and transit accessibility;
> Historical growth; and
> - Known project developments.

The forecasts produced by the DEFM form the basis of the final set of forecasts produced by NJTPA. The forecasts are reviewed by the NJTPA and partner agencies and adjustments are made to incorporate local knowledge to produce NJTPA's final forecasts and are used to help distribute expected population and employment growth in the NJTPA region. The forecast is summarized in Table 1-2, as can be seen forecast population growth is minimal.

1.4.1.3 New Jersey Department of Labor

Population and labor force projections on a county-wide basis have been developed by the New Jersey Department of Labor extending to 2034. To obtain an estimated population for 2050, we assumed that River Road service area population will grow at the same rate as the county as a whole. Accordingly, since the service area made up 20.3% of the county population in 2010 it would be expected to make of 20.3% of the county population in 2050. The County population estimate for 2034 was projected to 2050, this yields the estimates in Table 1-3.

1.4.1.4 Population Summary

As can be seen available sources of data project widely varying future populations. Given that with recent development the River Road WWTP service area is essentially built out, past trends in population growth are not likely to continue. Likewise, as one of the most densely populated areas in the state, it is unlikely the service area will follow projected population trends of the overall county. The smaller growth projected by the NJTPA still represents an optimistic buildout condition that may not be achieved. Future development, redevelopment and remodeling of existing structures will continue to introduce low flow fixtures which reduce water consumption. Accordingly, it is reasonable to project that future wastewater generation within the service area will remain similar to current wastewater generation.

1.4.2 Sea Level Rise

It is acknowledged that sea levels have been rising and are expected to continue to rise over the life of the project and beyond. In low lying areas, increased sea levels would tend to reduce the volume of combined sewage overflow. However, the regulators tributary to the River Road WWTP are located well above any projected sea level rise as such there is no need to incorporate sea level rise into the analysis.

Table 1-2. NJTPA Population Extrapolation						
County	**Municipality Code**	**Municipality Name**	**2015 Population**	**2045 Population**	**Annualized % Population Change 2015-2045**	**2050 Population Extrapolation**
Hudson	3401774630	Union City	68,390	71,954	0.20%	72,566
Hudson	3401777930	Weehawken	13,706	14,868	0.30%	15,072
Hudson	3401779610	West New York	52,236	55,219	0.20%	55,732
					Total	**143,370**

Table 1-3. NJTPA Population Estimate						
	Census	**Projections to July 1**				**Projected for LTCP**
County	**4/1/2010**	**2019**	**2024**	**2029**	**2034**	**2050**
Hudson	634,266	708,100	718,700	747,400	766,500	831,008
Union City	66,455					
Weehawken	12,554					
West New York	49,708					
Total	**128,717**					**168,643**

2 Development and Evaluation of Alternatives Approach

2.1 Alternatives Analysis Concept Workshop

The Authority held a CSO Alternatives Analysis Concept Workshop on June 14 and 15, 2018. The workshop served as a brainstorming session to identify strategies and alternatives for maximizing wastewater treatment and reducing CSOs in the Authority's systems. The output from the workshop was used by the Authority and the CSO Advisory Board to further develop and evaluate CSO control alternatives (this contract) and to ultimately prepare the analysis for integration into the LTCP.

The workshop format involved reviewing the sewer systems by outfall to identify the complete list of CSO control alternatives which would be optimal strategies for CSO control, including areas of open space, and discussing current bottlenecks in the system and how to mitigate them. The mitigation strategies discussed included storage and conveyance, disinfection, green infrastructure, inflow/infiltration (I/I) solutions, and high-level storm sewers. The fifth-largest overflow from the Baseline Characterization was used to estimate the facilities required to minimize overflows to an average of four per year. The workshop results were used to compile a list of alternatives to be considered per outfall. This list was narrowed down further to identify those alternatives that would proceed to preliminary screening. The alternatives analysis workshop memorandum in Appendix C includes more information on the initial list of alternatives proposed.

2.2 Alternatives Analysis Approach

After identifying the alternatives based on information from the Alternatives Analysis Concept Workshop and the Authority's needs, a preliminary screening was conducted on each alternative to identify the overall feasibility, functionality, and anticipated constraints, as well as a preliminary layout of the expected footprint and alignment of the alternative. This screening further refined the list of alternatives and, in some cases, eliminated any alternatives that are expected to have constraints or limitations that are unable to be mitigated and therefore would not allow to meet the final permit limits. Those alternatives that did not have practical solutions to limiting constraints proceeded to evaluation. For storage and conveyance alternatives, the proposed alternatives were simulated in the River Road model under existing conditions using the Typical Year. The existing model network was edited to reflect the conceptual alignment developed in the preliminary screening for the alternatives, which proposed additional storage or increased conveyance. Model results were developed to estimate the potential number and volume of overflows in the Typical Year after implementing the alternative.

For alternatives that propose pipe disinfection, flow timeseries data from the River Road model for the Typical Year was extracted for the pipes immediately downstream of where the dosing point is proposed to the outfall pipe. Rolling averages of the velocities from the timeseries data were developed in 5-, 15-, and 60-minute intervals to determine the potential maximum contact time available in the pipeline. For alternatives that proposed a chlorine contact basin, the peak hourly flow for the Typical Year in the pipe that would be immediately upstream of the contact basin was used to determine the potential contact time. The approximate volume within the chlorine contact basin per year was also used to estimate the size of a chlorine contact basin required.

After the concept of each alternative was finalized and results were obtained from the model, Class 5 conceptual cost estimates were developed including the capital, operational, and life-cycle costs for the

CSO control alternatives. AACE International describes a class 5 cost estimate as a concept screening estimate that is developed through parametric models, judgement, or analogy to similar projects. The costs presented here represent the expected cost with a range as wide as +30-100% or as narrow as -20-50%.

After the alternative has been fully developed (i.e. testing has been completed in the model if necessary and a cost estimate produced), each alternative was assigned a raw score based on the criteria presented in Appendix A. This raw score is summed in each category and this sum is multiplied by a weighting factor to accurately compare the characteristics for each alternative. The weighted point totals are all summed and divided by the maximum possible weighted total to obtain a weighted percentage. This percentage aims to accurately compare the range of alternatives. The maximum weighted scores possible and weighting factor are shown in Table 2-1.

Table 2-1. Weighting Criteria

Category	**Maximum Weighted Score**	**Weighting Factor**
CSO Reduction	24	1.5
Feasibility	30	1.5
Regulatory Compliance	16	1
Location Constraint	40	2
Cost	16	2
Community Impact	12	1
TOTAL	138	9

2.3 Public Participation

As part of the LTCP, engaging the public is an important aspect of alternatives development to clarify the overall goal and take feedback on the project’s progress. As part of the Alternatives Analysis, public meetings were held at NHSA on the dates below with the main subject matter included:

- February 25, 2019- Discussed the combined sewer system within the service area, the requirements for the Long Term Control Plan, the necessity of CSO Control Alternatives and next steps of alternatives evaluation
- May 20, 2019-Discussed all alternatives by drainage basin listed in this report
- August 9, 2019-Discussed the ongoing selection process for the alternatives evaluation

Each meeting included an information session and was followed by a question and answer session. During the question and answer session, the public that attended were actively involved in discussions for alternatives which were proposed for public properties. . Additionally the materials presented were made available after the meeting on the NHSA website for public comment. Public participation is planned to continue throughout the alternatives selection process in compliance with the LTCP requirements.

SECTION 3

3 JOSO Basin

The following section presents the evaluation of the alternatives which passed the Preliminary Screening phase in the JOSO drainage basin. A discussion on all alternatives considered in the JOSO Basin can be found in the Preliminary Screening Memorandum in Appendix D. The following alternatives were evaluated for CSO Outfall 003A

- CSO Storage Structure in Water and divert flow to Adams Street WWTP via Pershing Road Force Main
- Raise Regulator Weirs at UC1, UC2, and/or WNY2
- Replace Existing JOSO side-flow weirs with bending weirs

3.1 Drainage Basin Overview

The JOSO drainage basin measures 205.36 acres, and the basin's overall imperviousness is 78%. The combined sewer network within this drainage basin discharges to Outfall 003A. The total length of pipe in the drainage basin is approximately 46,371 feet and most of the pipes are 12" in diameter. The majority of the surrounding sewers from JOSO basin are vitrified clay pipe (VCP). In addition to the combined sewer network, the River Road Facilities in the JOSO drainage basin are the UC1/UC2/WNY2 Regulators, the Liberty Place Pump Station and the JOSO solids/floatables facility. Each facility is shown in Figure 3-1 and additional information is provided in the following subsections.

3.1.1 JOSO Regulators

There are three side overflow weir-operated regulators that discharge excess wet weather flow into the JOSO relief sewer that combines flows from the Town of West New York, Union City and Weehawken. Two regulators are located in Union City: UC1 is located on Park Avenue just north of 43rd Street, and UC2 is located on 49th Street just west of Broadway. The third regulator, WNY2 is located in West New York on 51st Street, just west of Broadway. The JOSO relief sewer directs the excess wet weather flow to the Hudson River. All three regulators were originally constructed in the 1950s and 1960s.

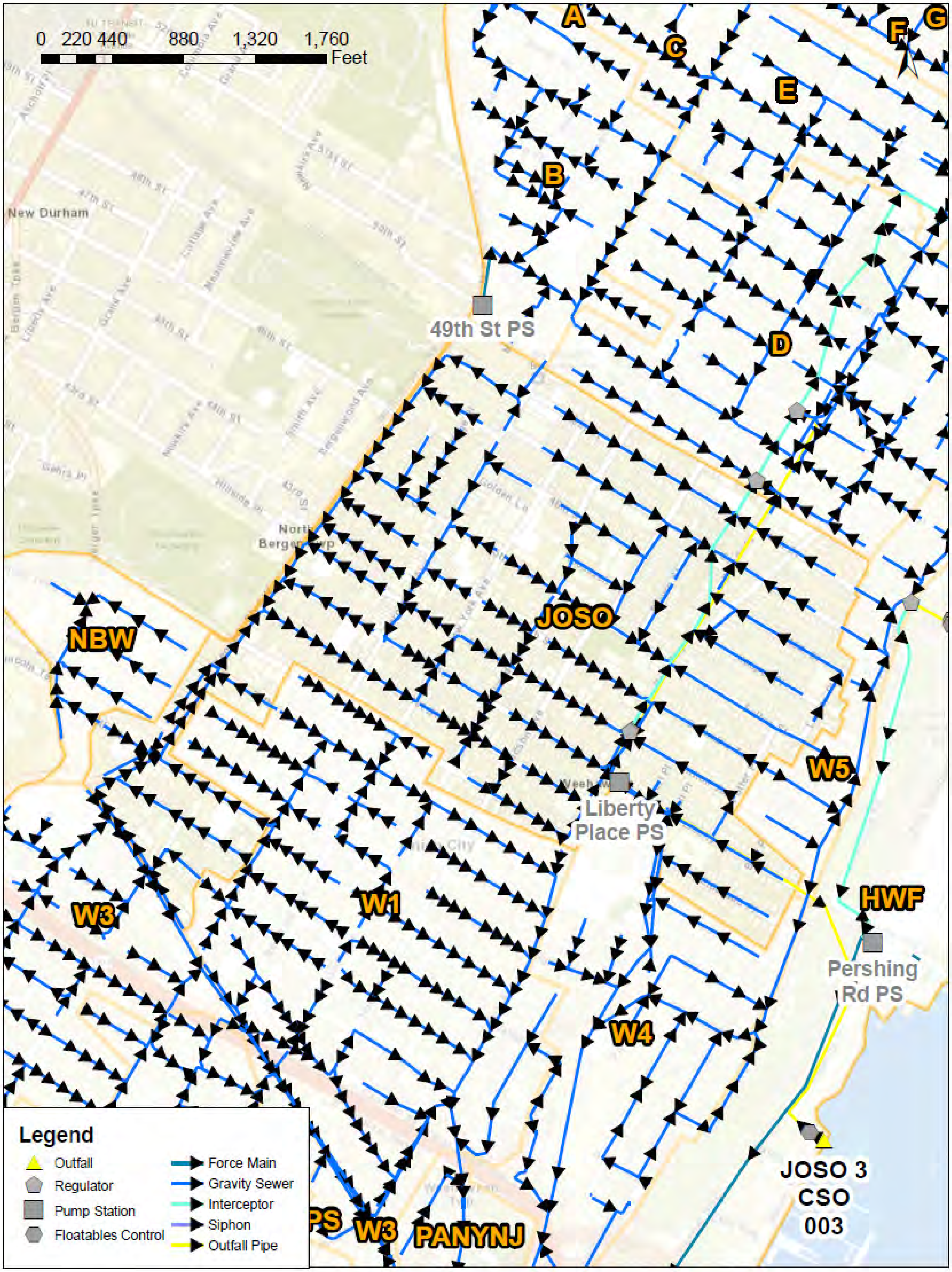
3.1.2 Liberty Place Pump Station

The Liberty Place Pump Station pumps sewage from Liberty Place, Eldorado Place and Highwood Avenue into the River Road WWTP via a force main. It receives flow from nearby residences. The pump station includes two (2) 5 hp submersible pumps and one above-grade electrical cabinet on the sidewalk. The pumps were installed in 2012 by the Authority and are the ABS Contrablock pumps with open impeller design. The pumps could not be inspected, however, they have performed well without clogging. The electrical cabinet is old but operable. There is no bar rack nor comminutor at this station. Excess wet weather flow at the Liberty Place Pump Station flows by gravity to the JOSO outfall for discharge to the Hudson River.

3.1.3 JOSO Solids/Floatables Facility

The JOSO S/F Facility treats overflows from the UC1, UC2 and WNY1 regulators. It was constructed in 2005 and is located in a subsurface facility at the end of Henry Place, upstream (west) of the JOSO outfall. The facility has a 72-inch influent RCP pipe and a 72-inch effluent RCP pipe. The facility has bar screens with 5-foot 6-inch width with a span of 15 feet. It has 48-inch Tideflex check valves and 48-inch by 54-inch sluice gates.

Figure 3-1. JOSO Drainage Basin



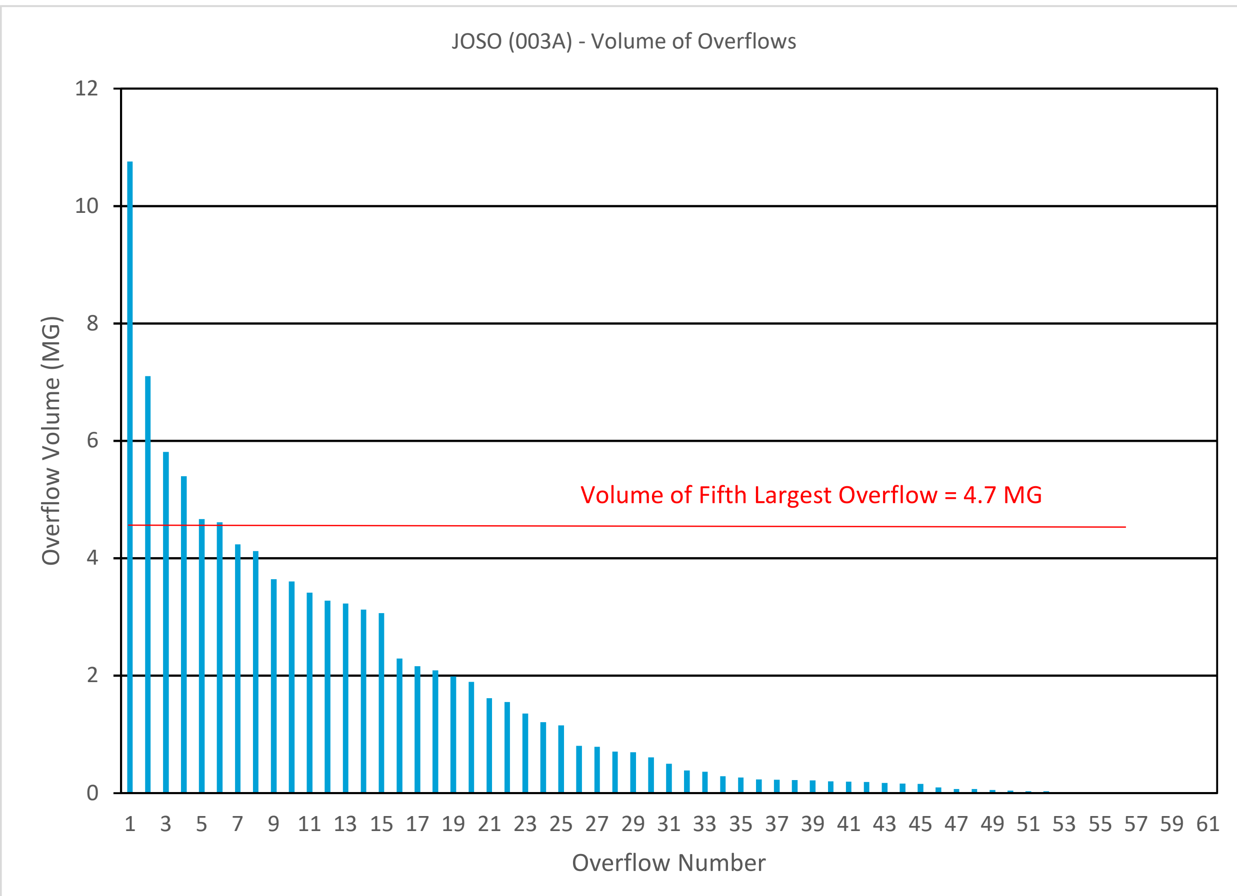
3.1.4 Outfall 003A

Outfall 003A is located at the end of Liberty Place in Weehawken. The associated regulators are UC1, UC2 and WNY2 regulators. The outfall pipe is 60-inch RCP. Drawings of the outfall pipe are not available, however from the Authority staff it is known that there is a drop structure located at the end of Liberty Place, which is included in the River Road WWTP model. The known elevation of the outfall was also included in the model. The outfall is located over 117 feet deep from the surface and was constructed from blasting the rock. The tunnel is an irregular shape and drops steeply down the Palisades to Port Imperial and end at a solids and floatables structure at the Hudson River.

3.2 Existing Conditions

Figure 3-2 shows the calculated frequency and volume of overflows based on the Typical Year. For the storage and conveyance alternatives proposed, the fifth-largest overflow is the target volume to control. For disinfection and treatment alternatives, the yearly peak flow, 15 minutes peak flow, and annual total volume for each outfall were analyzed to determine contact time and sizing of any related disinfection alternatives. The following subsections detail the proposed plan for each alternative.

Figure 3-2. JOSO Outfall-Overflow Frequency vs. Volume, Existing Condition



3.3 Alternatives

The following sections detail the alternatives that moved on from the preliminary screening to full evaluation. The alternative identification, conceptual layout, potential overflow frequency after the alternative is implemented, and conceptual cost estimate for each are described.

3.3.1 Combined Sewer Overflow Storage Structure in Water and Divert Flow to Adams Street Wastewater Treatment Plant

3.3.1.1 Identification and Preliminary Screening

A storage tank constructed in the Hudson River is proposed for the JOSO Basin for this alternative. This may include a public/private partnership with a residential development that will ultimately develop above this alternative. Based on the target volume of 4.7 million gallons (MG) and an assumed depth of 10 feet for a storage structure, an approximate area of 63,000 square feet would be required. The overall dimensions of the structure can be modified to yield a larger or smaller area by adjusting the depth of the structure.

- Anticipated Constraints and Site Limitations:
  - Foundation - If the proposed structure would include a pier, achieving the proper foundation stability would require the use of multiple piles which can require complex methods and coordination.
  - Construction in Navigable Waters and Boat Traffic - This alternative would require the use of a Cofferdam and dewatering during construction would present challenges and have significant costs
  - The proposed structure would extend beyond the current edge of all nearby existing structures with the exception of Days Point. Extending beyond the existing shoreline will require extensive permitting and would be required to meet stringent impact design criteria for boat and barge traffic so as to not disrupt currents and tides in the River. Permitting the structure as an “end of pipe” structure may allow for approval of surface water encroachments but the adjacency would need to be confirmed.
  - Sea Level Rise - This alternative being located on the shoreline presents design challenges to accommodate sea level rise. The designing of pumping system power and controls will need to meet flood damage protection criteria and sea level rise criteria which may conflict with the desire to not limit lines of sight for residents.
- Functionality and Feasibility:
  - The proposed storage structure would need to be at the water level equal with the surrounding grade to allow for a pedestrian park/development to be extended over the top of the structure. The required pumping system would also need to be enclosed in an architecturally consistent structure that does not limit lines of sight from residents. The access for structure maintenance would be from the existing lot along Henley Place
  - The proposed structure is adjacent to a new high end residential complex (Henley on Hudson). Not only will design and construction efforts need to be heavily structured and regulated, odor control measures taken after construction would be paramount. It is anticipated that the local residents along the shoreline would be difficult to gain approval as public stakeholders.

3.3.1.2 Conceptual Network Layout

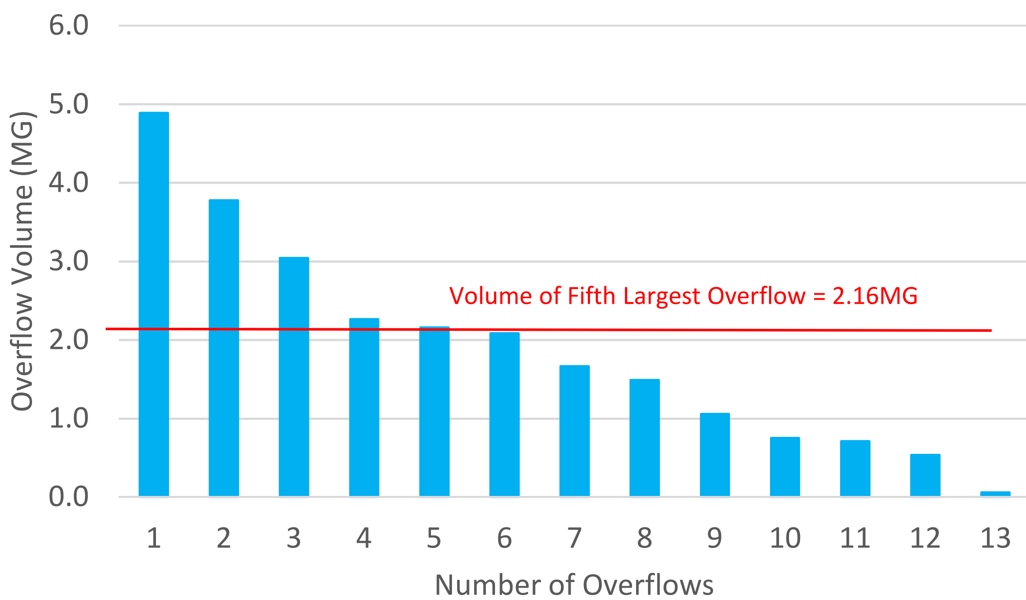
Figure 3-3 shows the required modifications to the existing network including the staging of the storage tank and required piping.

Figure 3-3. JOSO – Proposed In-Water Storage Structure

3.3.1.3 InfoWorks Integrated Catchment Modelling Modeling Results

The River Road WWTP model was used to simulate the conditions as they are expected to exist after construction and operation of this storage alternative. The model network was updated based on the conceptual GIS network. Figure 3-4 shows the plot of the Typical Year overflow volume vs. number of overflows for the JOSO outfall. Extraneous flow not contained may potentially be diverted to the Adams Street WWTP if plant capacity is increased and with extensive network adjustments between the storage tank and the plant. Possible alternatives are described in Section 12 of the Adams Street DEAR. While the alternative has been tested in the model, it is infeasible for these flows to be conveyed to the River Road treatment plant because there is approximately a 100 foot elevation difference from the outfall to JFK Blvd where the flow would need to be pumped. This would require a very large pump station and with the limited available open space it would be very difficult to site and operate.

Figure 3-4. Outfall JOSO Overflow Frequency vs. Volume, CSO Storage Tank Proposed Condition



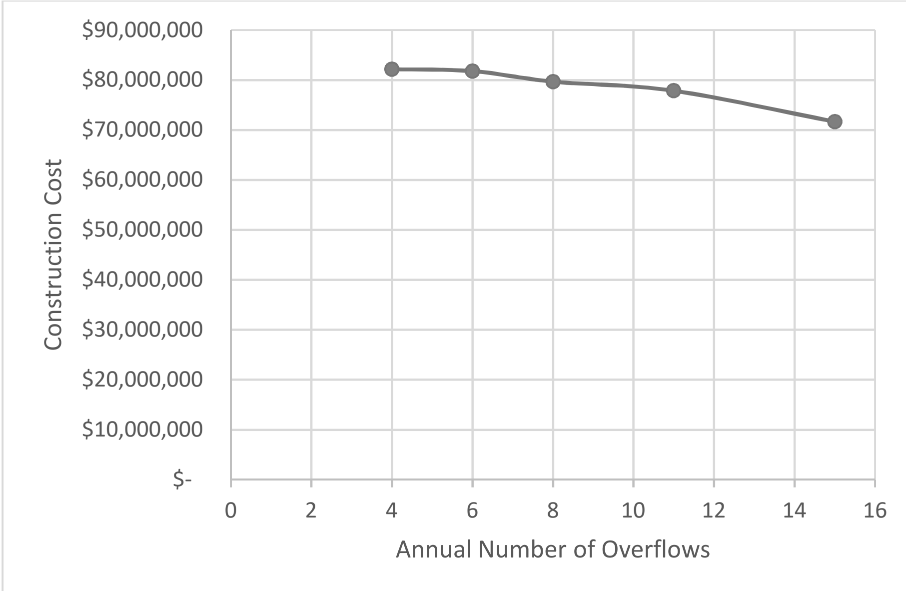
3.3.1.4 Cost

Table 3-1 lists the associated costs for this alternative.

Table 3-1. JOSO Proposed CSO Storage Tank Conceptual Cost Estimate	
Construction Cost Estimate	$82,160,000.00
Project Annual Operations and Maintenance	$76,000.00
Project Capital Cost Estimate	$108,450,000.00
Project 50 Year Present Worth Estimate	$138,010,000.00

To observe the range in costs versus number of annual overflows expected to result from smaller CSO storage volumes, Figure 3-5 shows the cost performance curve for the construction costs for annual overflow events greater than 4.

Figure 3-5. JOSO CSO Storage Cost Performance Curve



3.3.2 Raise Regulator Weirs at UC1, UC2, and WNY2

3.3.2.1 Identification and Preliminary Screening

For this alternative diverting flows from the JOSO network to the WNY1 outfall is proposed. The JOSO outfall currently has 3 regulators (UC1, UC2 and WNY2) in the network that direct wet weather flow to the JOSO relief sewer as needed. To avoid expensive, disruptive and challenging in-rock construction, an option is to raise the overflow weirs in the regulators to direct more flow to WNY1 (and less overflow to JOSO) is proposed. This could be accomplished with minimal construction and/or break in service, and without the hassles of in-rock construction.

- Anticipated Constraints and Site Limitations:
  - Capacity at River Road WWTP - Diverting additional flow to the WNY1 regulator alone may not result in CSO reduction to the desired level; the River Road WWTP needs to have sufficient capacity to treat the increased flow, otherwise, it may result in a larger or an additional WNY1 outfall with solids/floatables reduction. Since discharge from the JOSO outfall already receives solids/floatables (S/F) reduction, its mere diversion to WNY1 may not be an improvement. To ensure the desired level of CSO reduction, diverting additional flow to the WNY1 regulator should be supplemented by increased capacity at the River Road WWTP to treat additional flow.
- Functionality and Feasibility:
  - The level of CSO reduction expected would need to be verified by modeling or other theoretical means. Modeling could also help determine which regulators need their weir raised, the additional weir height necessary and any unintended consequences. No additional hiring/training is anticipated to be required for the function of this alternative. This alternative is anticipated to reduce CSOs to the desired level by improving on existing conveyance methods while avoiding challenging in-rock construction and conveying increased flow to an existing WWTP for complete treatment.
  - Managing impact on traffic and the neighborhood during construction is anticipated to be limited because these improvements would be within existing structures owned by the Authority. Relatively small capital and O&M costs are expected compared to other storage or disinfection alternatives. These improvements are also anticipated to work effectively under a

variety of flow conditions and during intermittent operation. This alternative is considered feasible.

3.3.2.2 Network Updates

The River Road Integrated Catchment Modelling (ICM) Model was adjusted to increase the weir height of UC1, UC2 and WNY2 regulators by 4-ft to reduce the outfall overflow. The existing weir heights are: 140.08-ft, 137.08-ft and 136.24-ft respectively. The proposed weir heights are: 144.08-ft, 141.08-ft and 140.24-ft respectively. These weir heights are not recommended or feasible for the existing network and may be combined when updates are implemented downstream at the WWTP.

3.3.2.3 InfoWorks Modeling Results

The River Road ICM model was adjusted to decrease the time of the overflow. It was found that the overflow at JOSO decreased from 45 times to 5 times in a Typical Year. And the fifth largest overflows dropped from 4.61 MG to 0.15 MG total overflow volume. The surface flooding upstream of regulators increase from 4.84 MG to 5.59 MG. This surface flooding would not result in standing water in the streets but basement backups would be a concern. These may be reduced with increases in capacity upstream such as increased pipe sizes or inline storage alternatives. The CSO volumes and events are summarized in Table 3-2. Figure 3-6 and Figure 3-7 show the change in overflow volume and flow rate at the JOSO outfall, respectively. While these results indicate that overflows are decreased at JOSO, results show that basins WNY1 and JOSO may be hydraulically connected and reducing the overflows at JOSO will impact the overflows at WNY1. It is not recommended to consider changes in regulator weirs as a lone alternative, but can be used to optimize another alternative.

Table 3-2. JOSO Proposed Regulator Adjustment Results

	Number of Overflows		Total CSO Volume (MG)	
	Existing	**With Weir Adjustment**	**Existing**	**With Weir Adjustment**
JOSO	45	5	95.56	4.90

Figure 3-6. Change of Overflow Volume at JOSO, Proposed Condition

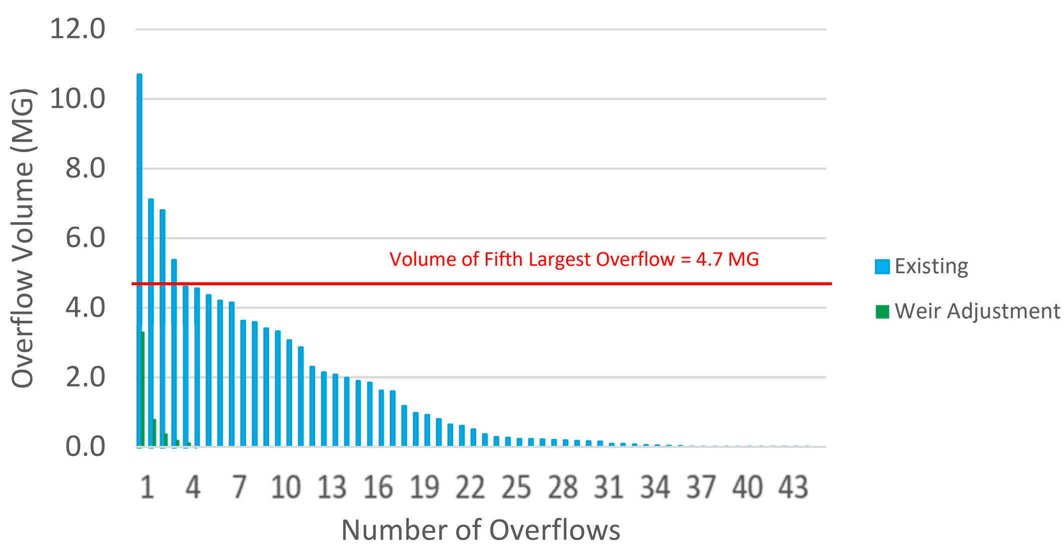
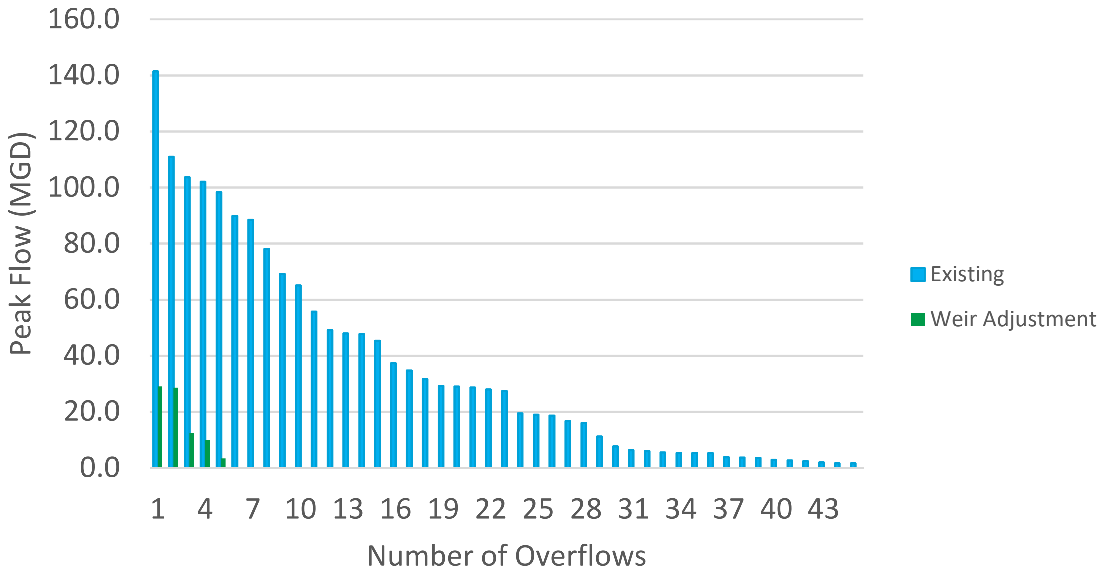


Figure 3-7. Change of Peak Flow at JOSO, Proposed Condition



3.3.2.4 Cost

Table 3-3 lists the associated costs for this alternative.

Table 3-3. JOSO Proposed CSO Storage Tank Conceptual Cost Estimate	
Construction Cost Estimate	$120,000
Project Annual Operations and Maintenance	-
Project Capital Cost Estimate	$158,400
Project 50 Year Present Worth Estimate	$194,000

3.3.3 Replace Existing Joint Overflow Sewer Outlet Sideflow Weirs with Bending Weirs

3.3.3.1 Identification and Preliminary Screening

The regulators in the River Road WWTP Service Area direct all sewage flows during dry weather to the River Road WWTP and convey excess flows during large wet weather events directly to the Hudson River. There are a total of four regulators in the River Road WWTP Service Area, which are located in series along the main WNY1 interceptor sewer, see Figure 3-8. Regulator WNY1 discharges to outfall 001A/002A and regulates CSO discharges using a mechanical float operated regulator. The other three regulators regulate CSOs using side overflow weirs that divert excess combined sewage to the Joint Overflow Sewer Outlet (JOSO) which discharges to the Hudson River.

The objective of replacing the JOSO weirs with bending weirs is to maximize storage capacity in the upstream collection system during smaller storms to reduce CSO events, while allowing flows to be diverted to the CSO outfalls during larger storms.

- Anticipated Constraints and Site Limitations:
  - Capacity at River Road WWTP - Diverting additional flow to the WNY1 regulator alone may not result in CSO reduction to the desired level. Further, if more flow is diverted from JOSO to the River Road WWTP by the bending weirs, the River Road WWTP will need to have sufficient

capacity to treat and discharge the additional flow that is diverted from JOSO. Upgrades to treatment components at the River Road WWTP may be required to provide capacity to treat this additional flow, as well as upgrades to the River Road outfall to discharge the additional flow. To ensure the desired level of CSO reduction, diverting additional flow to the WNY1 regulator should be supplemented by increased capacity at the River Road WWTP to treat additional flow.

  – Bending weirs can be prone to clogging/jamming with debris and would require periodic cleaning, thus a top-opening weir is preferable to provide easier access for cleaning. A visual inspection should be conducted every 6 months, with a thorough inspection/cleaning once per year, requiring two staff members for one day. This alternative requires replacement of the existing side overflow weirs and assumes modification of the existing access manhole to a larger rectangular hatch, which would result in temporary traffic disruption on Park Avenue, 49th Street and 51st Street, however the duration of work would be shorter than other alternatives that have been evaluated.
  – Managing impact on traffic and the neighborhood during construction is anticipated to be limited because these improvements would be within existing structures owned by the Authority. Relatively small capital and O&M costs are expected compared to other storage or disinfection alternatives.

- Functionality and Feasibility:
  – Bending weirs provide a mechanism to maximize storage capacity in the upstream collection system while minimizing potential upstream impacts associated with static weirs. This alternative also allows flexibility to consolidate flow volume at the WWTP.
  – No additional hiring/training is anticipated to be required for the function of this alternative. This alternative is anticipated to reduce CSOs to the desired level by improving on existing conveyance methods while avoiding challenging in-rock construction and conveying increased flow to an existing WWTP for complete treatment.
  – The addition of bending weirs does not require any SCADA automation or external controls for operation, thus there is minimal complexity in operation. Bending weirs are anticipated to work effectively under a variety of flow conditions and during intermittent operation. This alternative is considered feasible.

3.3.3.2 Conceptual Network Layout

There are four existing side-flow regulator weirs along the interceptor in the JOSO basin, shown on Figure 3-8. These four locations are: UC1, UC2, WNY2, and WNY1.

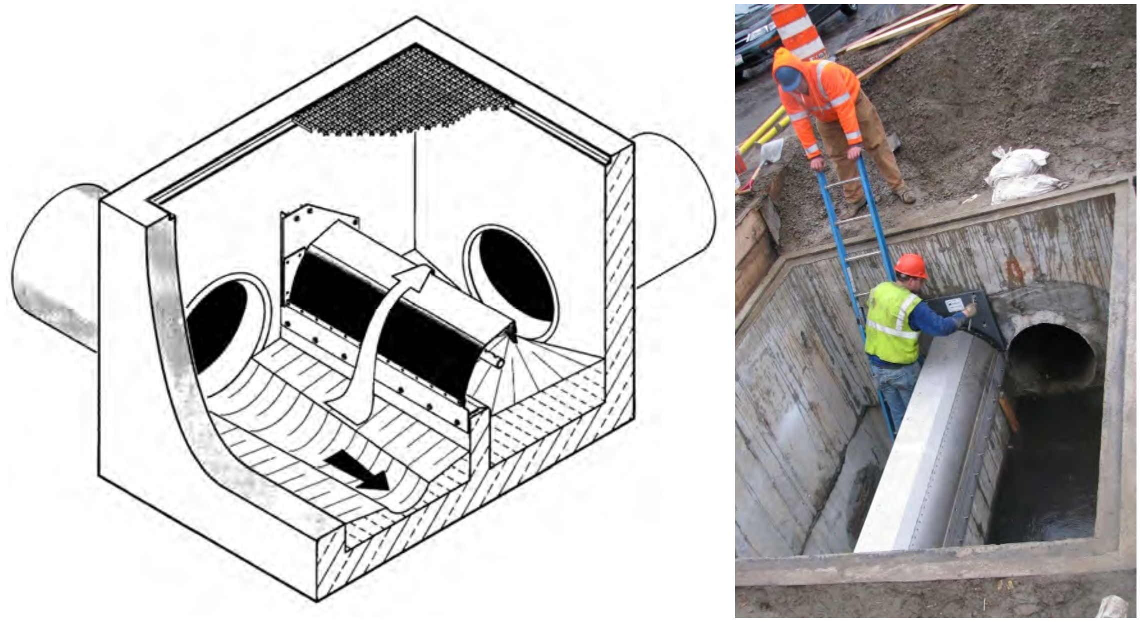
The existing regulators are side-flow weirs which are relatively close to overtopping under dry weather flow conditions. Representative photos of the side-flow weirs are shown on Figure 3-9.

Figure 3-8. Regulators in River Road Service Area

Figure 3-9. Existing Side-Flow Weirs

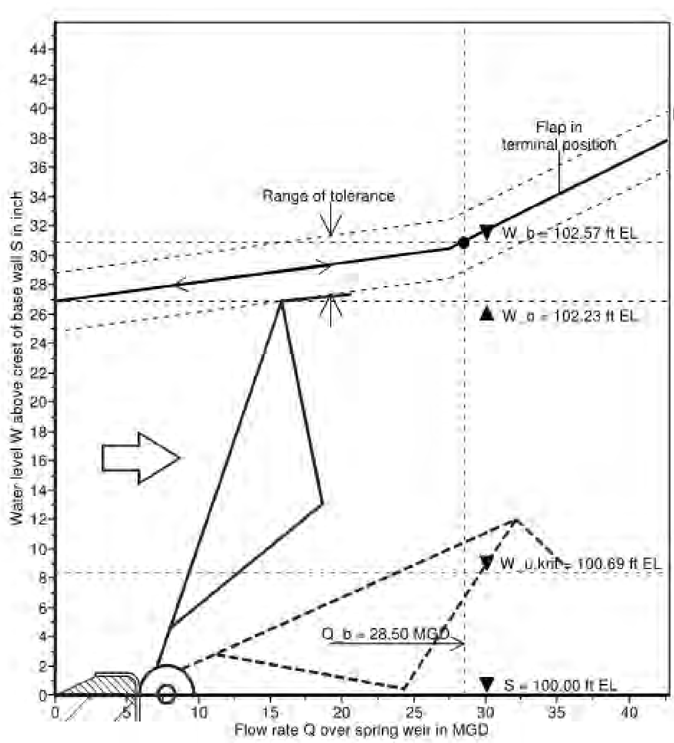
Under this alternative, the existing weirs would be replaced with bending weirs such as Hydrovex, shown on Figure 3-10.

Figure 3-10. Hydrovex Bending Weir



In conversations with the supplier of Hydrovex, based on the length of the weir and peak flow through the regulator it was found that bending weirs are not a viable alternative for Regulator WNY1, which has a peak flow of 194.7 million gallons per day (mgd) and length of 7 feet 9 inches. As such, bending weirs are only suggested for Regulators UC1, UC2 and WNY2. Figure 3-11 shows the rating curves for each of these weirs. UC2 requires two weirs in series, and WNY2 requires three weirs in series. The curves reflect the characteristics for all of the weirs at that location operating in unison.

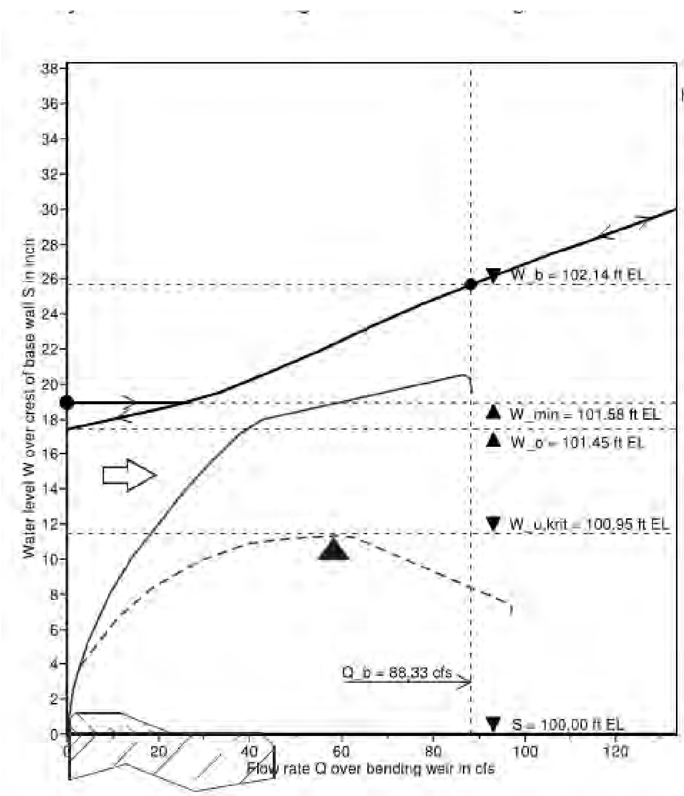
Figure 3-11. UC1 Weir Rating Curve



rating curve data

Index	W in inch	Q in MGD	W in ft EL
00	26.8	0.00	102.234
01	30.4	27.51	102.534
02	45.9	59.24	103.824

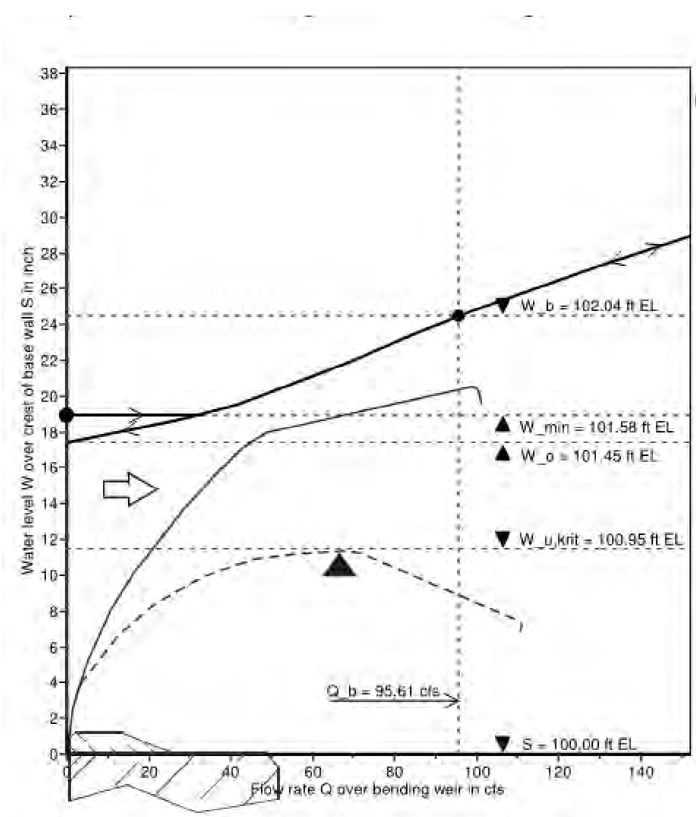
Figure 3-12. UC2 Weir Rating Curve (2 weirs in series)



rating curve data

Index	W in inch	Q in cfs	W in ft EL
00	17.4	0.00	101.451
01	18.0	11.08	101.502
02	18.7	22.17	101.556
03	19.5	33.25	101.622
04	20.7	44.33	101.724
05	21.9	55.42	101.829
06	23.3	66.50	101.942
07	24.6	77.58	102.050
08	25.7	88.67	102.142
09	27.5	106.18	102.291
10	27.9	110.84	102.323
11	29.0	121.92	102.413
12	30.0	133.00	102.499

Figure 3-13. WNY2 Weir Rating Curve (3 weirs in series)



rating curve data

Index	W in inch	Q in cfs	W in ft EL
00	17.4	0.00	101.451
01	18.0	13.81	101.502
02	18.7	27.62	101.556
03	19.5	41.42	101.622
04	20.7	55.23	101.724
05	21.9	69.04	101.829
06	23.3	82.85	101.942
07	24.6	96.65	102.050
08	25.7	110.46	102.142
09	27.5	132.28	102.291
10	27.9	138.08	102.323
11	29.0	151.89	102.413

3.3.3.3 InfoWorks Modeling Results

The River Road InfoWorks ICM model was used to simulate the impact that replacing the existing side-flow weirs with bending weirs would have on CSO volume, peak flows, and number of events, under Typical Year conditions. This alternative only generates about 0.12 MG of storage along the interceptor, but during the typical year, shifts about 67 MG from the JOSO outfall towards River Road. This additional flow would be diverted to WNY1, where during the typical year approximately 3 MG would be treated at the River Road WWTP and the remaining 64 MG would be discharged as CSO, increasing the volume of CSO discharged at 002A. Table 3-4 summarizes the results. These results are presented graphically in Figure 3-14 through Figure 3-17.

Table 3-4. Summary of Modelling Results

	Number of Overflows		Total CSO Volume (MG)	
	Existing	**With Bending Weirs**	**Existing**	**With Bending Weirs**
JOSO (003A)	61	24	95	28
River Road (002A)	60	60	190	254

Figure 3-14. Change in Volume at JOSO due to Bending Weirs

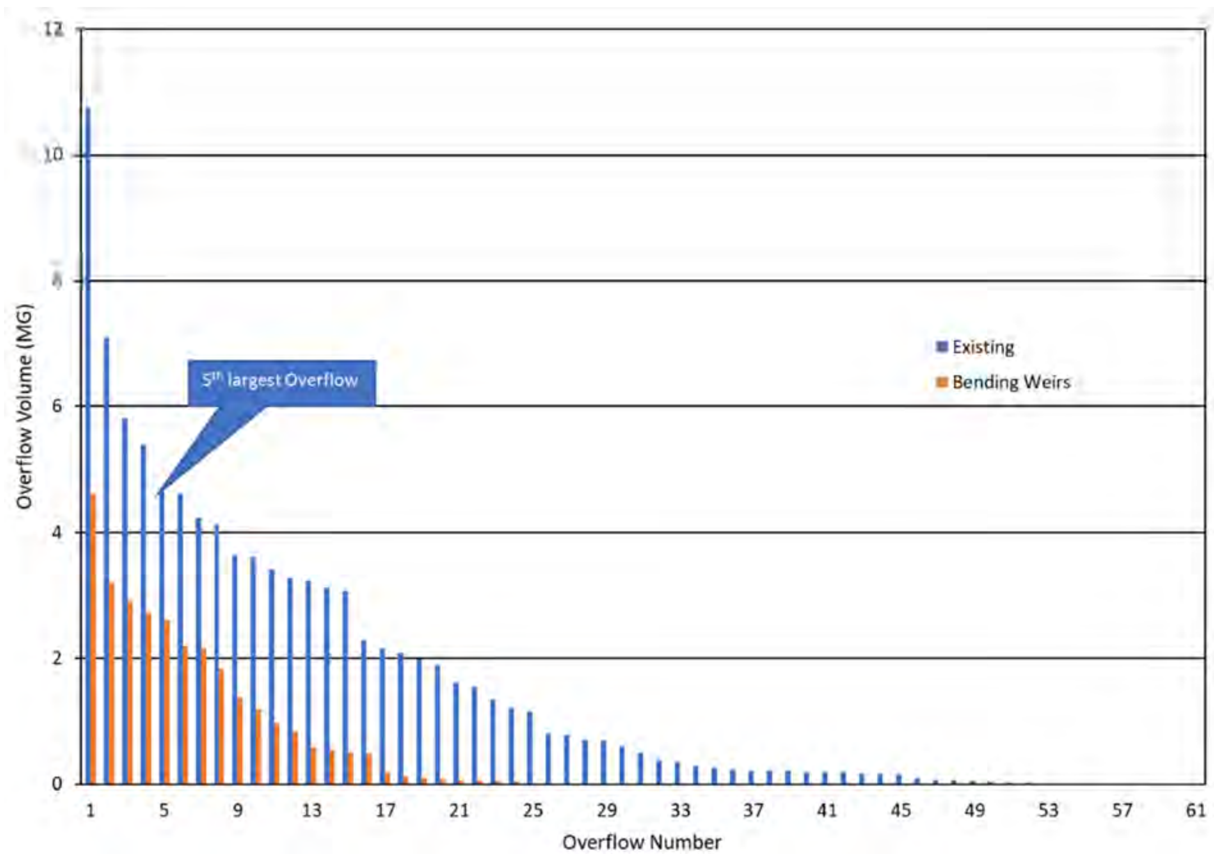


Figure 3-15. Change in Volume at River Road due to Bending Weirs

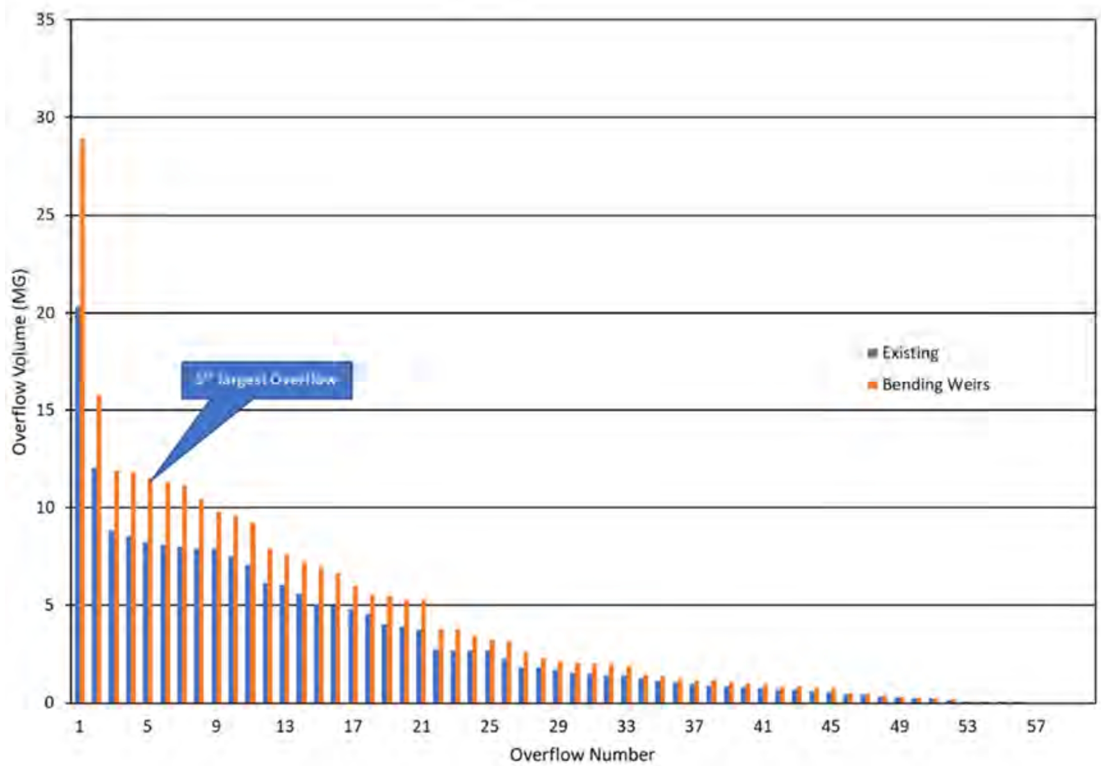


Figure 3-16. Change in Peak Flow at JOSO due to Bending Weirs

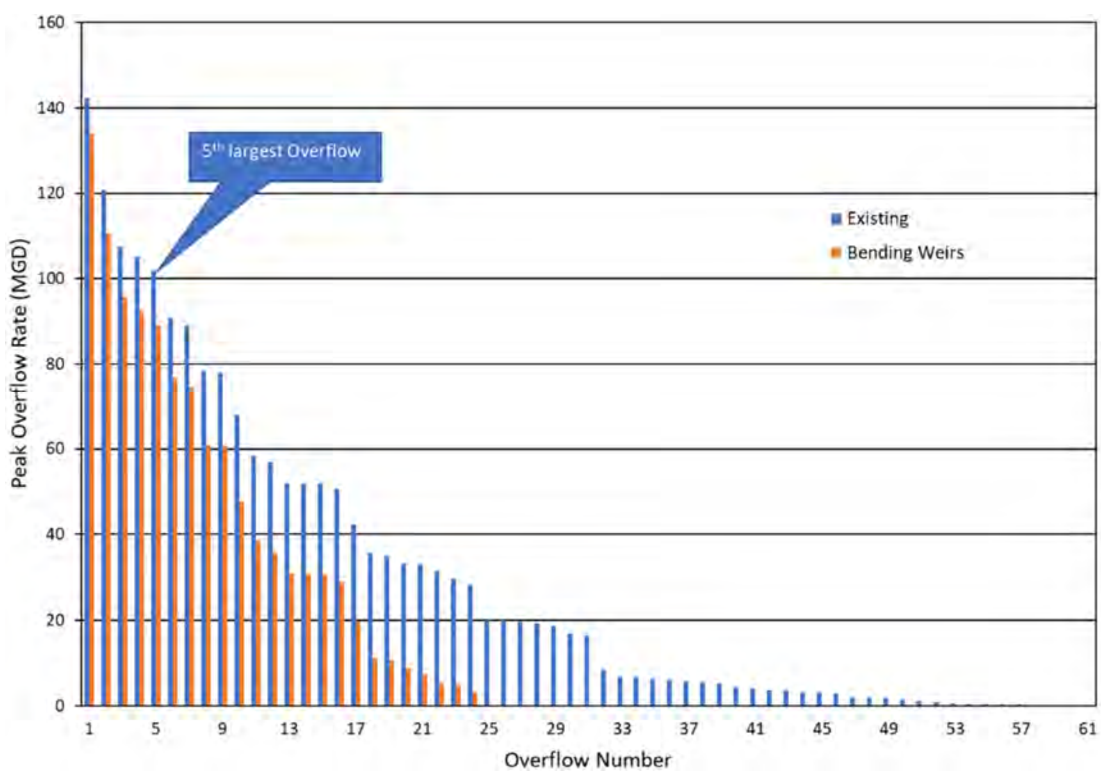
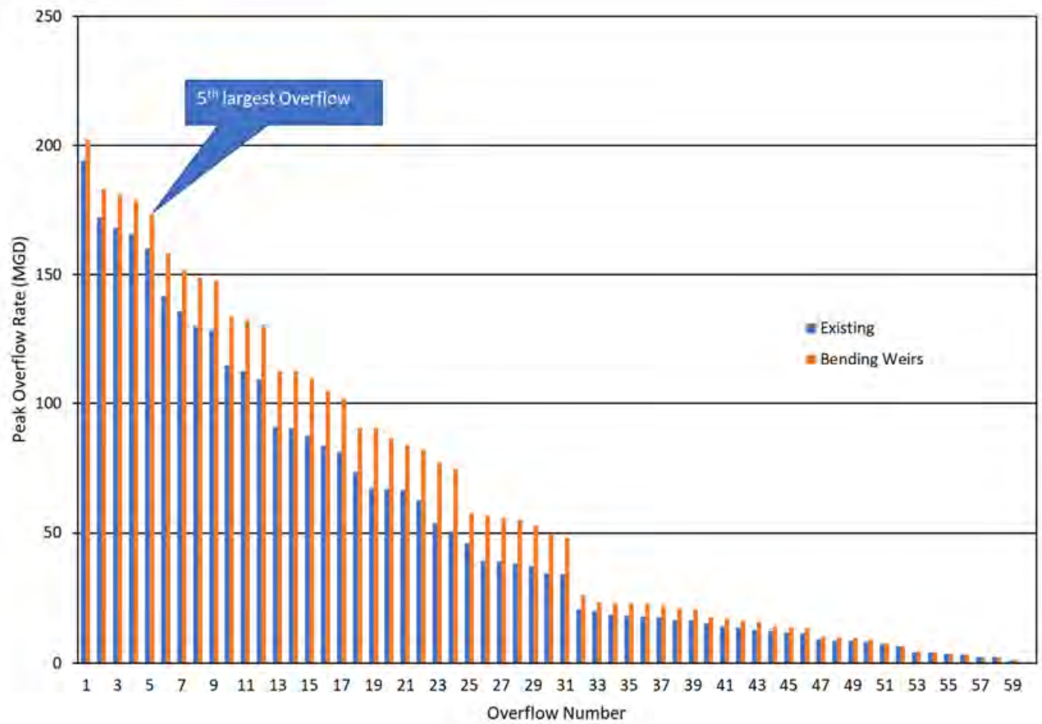


Figure 3-17. Change in Peak Flow at River Road due to Bending Weirs



3.3.3.4 Cost

Table 3-5 lists the associated costs for this alternative.

Table 3-5. JOSO Proposed Bending Weirs Conceptual Cost Estimate

Construction Cost Estimate	$352,000
Project Annual Operations and Maintenance	$3,100
Project Capital Cost Estimate	$464,000
Project 50 Year Present Worth Estimate	$544,000

3.4 JOSO Basin Alternatives Comparison

Each alternative was assigned a score based on the evaluation criteria identified in Task 1. Table 3-6 shows the weighted point total and weighted average of each alternative for the JOSO drainage basin. The full breakdown of the scoring for each alternative can be found in Appendix B. It is noted that due to limited open space and the potential large amount of space required to implement a disinfection alternative to treat the large flows from JOSO, disinfection was not deemed feasible for this drainage basin.

Table 3-6. JOSO Basin Alternatives Score Comparison

Alternative	Weighted Point Total	Weighted Percent
Combined Sewer Overflow Storage Tank in Water and Divert Flow to Adams Street WWTP	74	53%
Raise Regulator Weirs at UC1, UC2, and WNY2	120	87%
Replace Existing JOSO Sideflow Weirs with Bending Weirs	119	86%

SECTION 4

4 WNY1 Basin

The following section presents the evaluation of the alternatives which passed the Preliminary Screening phase in the WNY1 drainage basins. A discussion on all alternatives considered in the WNY1 Basins for can be found in the Preliminary Screening Memorandum in Appendix D. The following alternatives were evaluated for CSO Outfall 002A:

- CSO Storage Tank near WNY1 outfall
- Linear Storage Tunnel along Anthony M. Defino Way
- Disinfect at WNY1 S/F Facility

4.1 Drainage Basin Overview

The WNY1 drainage basin measures 657.5 acres, and the basin's overall imperviousness is 78%. The combined sewer network within this drainage basin discharges to Outfall 002A. The total length of pipe in the drainage basin is approximately 119,572 feet and most pipes are 12-inches in diameter. In addition to the combined sewer network, the River Road WWTP facilities in the WNY1 basin are the WNY1 Regulator, the WNY1 S/F Facility. Figure 4-1 shows an overview of the facilities described in the following subsections.

4.1.1 WNY1 Regulators

The WNY1 Regulator regulates CSO discharges using mechanical floats. This regulator conveys up to 10 mgd of flow to the River Road WWTP. The WNY1 Regulator is a mechanical weir controlled regulator which is located on Anthony M. Defino Way, just east of the Intersection with John F. Kennedy Boulevard in West New York. The regulator contains a weir and a regulator float gate. The influent line is an 84-inch diameter pipe which receives all combined sewer flows originating from the River Road WWTP service area, with the exception of overflows directed to JOSO for discharge to the Hudson River. A 27-inch diameter interceptor directs flow to the River Road WWTP. The River Road WWTP outfall joins the WNY1 54-inch diameter outfall pipe prior to discharging to the Hudson River. The WNY1 Regulator was originally constructed in the 1950s and 1960s and underwent rehabilitation in 2015.

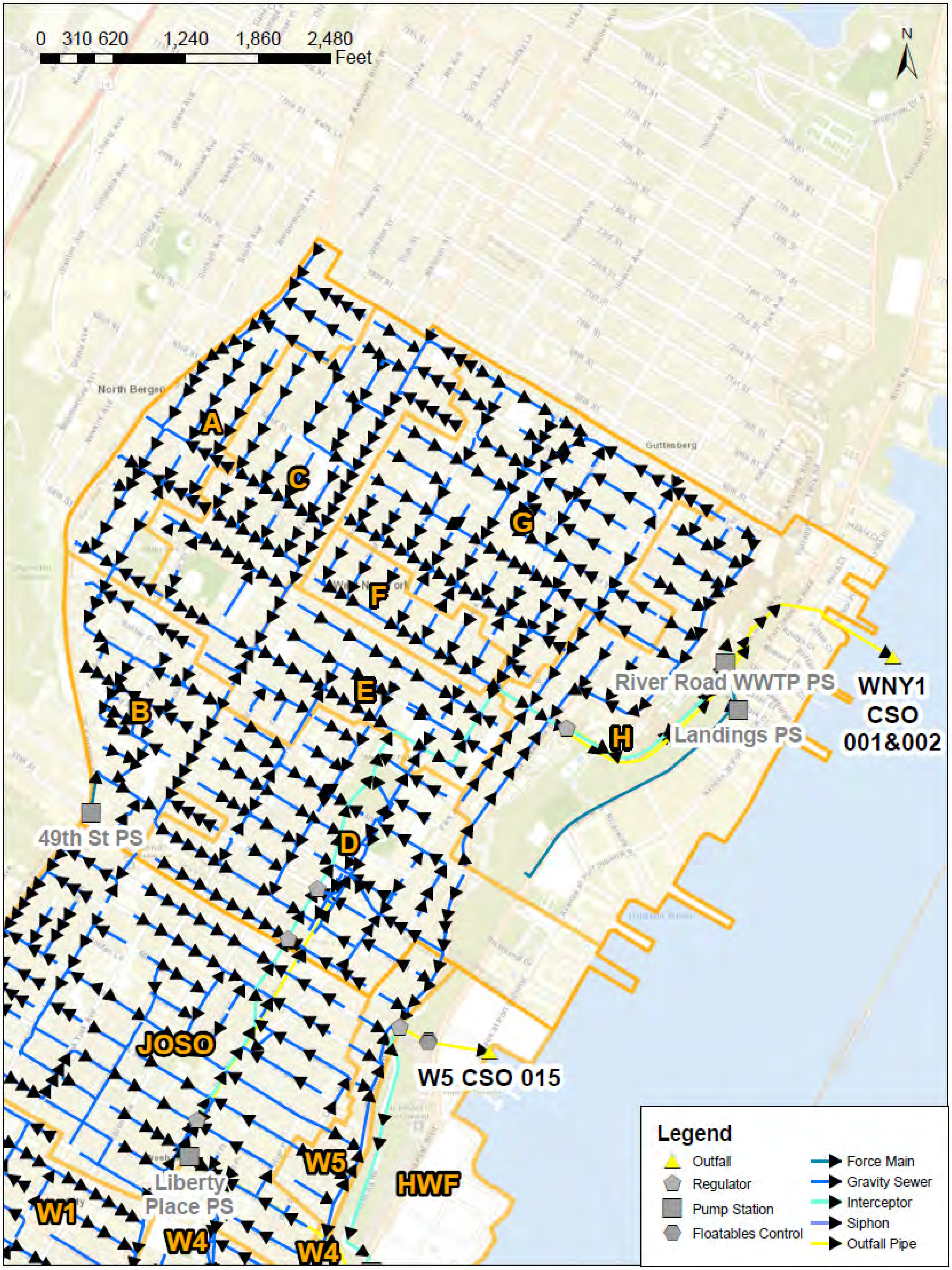
4.1.2 WNY1 Solids/Floatables Facility

The WNY1 S/F Facility treats overflows from the WNY1 regulator. It was constructed in 2009 and is located in a building adjacent (south) to the River Road WWTP. The facility has an 84-inch influent prestressed concrete cylinder pipe and a 78-inch effluent prestressed concrete cylinder pipe. The facility has 0.5-inch bar screen which is 5 feet 6 inches wide with a span of 20 feet 6 inches.

4.1.3 Outfall 002A

Outfall 002A is located at Observer Highway and River Street Regulator WNY1 discharges wet weather flows to Outfall 002A and directs dry weather flow to the River Road WWTP. CSO Outfall 002A continues down Anthony M. Defino Way where the flow is passed through the WNY1 S/F Facility. After being screened it joins the WWTP outfall (001A) to form Outfall 001A/002A which continues as a single pipe extending into the Hudson River.

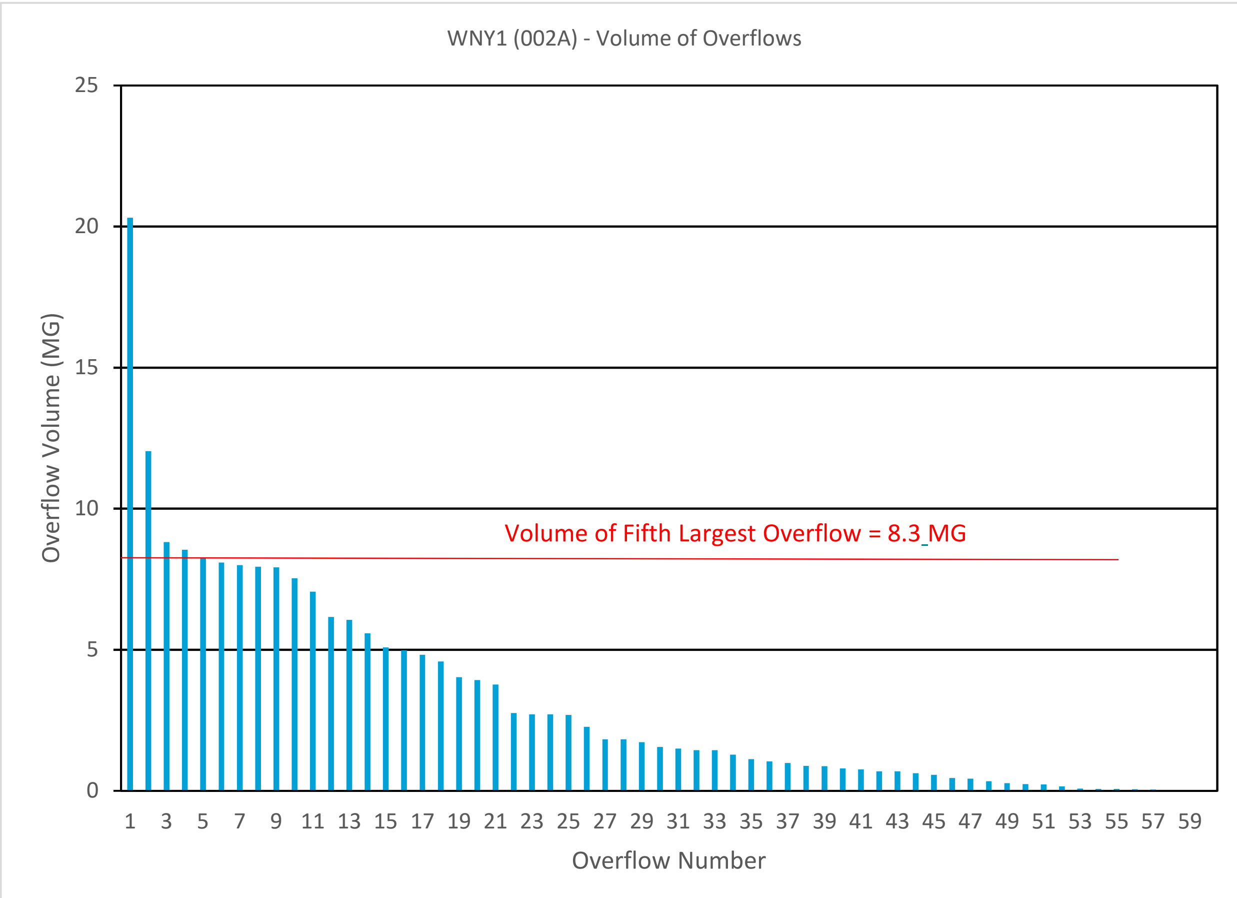
Figure 4-1. WNY1 Drainage Basin



4.2 Existing Conditions

Figure 4-2 shows the calculated frequency and volumes of overflows based on the Typical Year. For the storage and conveyance alternatives proposed, the fifth-largest overflow is the target volume to control. For disinfection and filtration alternatives, the yearly peak flow, 15 minutes peak flow, and annual total volume for each outfall were analyzed to determine contact time and sizing of any related disinfection and filtration alternatives.

Figure 4-2. WNY1 Outfall-Overflow Frequency vs. Volume, Existing Conditions



4.3 Alternatives

The following sections detail the alternatives that moved on from the preliminary screening to full evaluation. The alternative identification, conceptual layout, potential overflow frequency after the alternative is implemented, and conceptual cost estimate for each are described.

4.3.1 Combined Sewer Overflow Storage Tank Near WNY1 Outfall

4.3.1.1 Identification and Preliminary Screening

A storage alternative constructed in the water is proposed for WNY1. This may include a public/private partnership with a residential development that will ultimately develop above this alternative. Based on the target volume of 8.3 MG and an assumed depth of approximately 30 feet (height of the existing pier) the required area for a structure would be approximately 37,000 square feet. The overall dimensions of the structure can be modified to yield a larger or smaller area by adjusting the depth of the structure.

- Anticipated Constraints and Site Limitations:
  - Foundation - If the proposed structure would include a pier, achieving the proper foundation stability would require the use of multiple piles which can require complex methods and coordination.
  - Construction in Navigable Waters - This alternative would require the use of a cofferdam and dewatering during construction which would present challenges and have significant costs. Permitting the structure as an "end of pipe" structure may allow for approval of surface water encroachments, but the adjacency would need to be confirmed.
  - Sea Level Rise - This alternative being located on the shoreline presents design challenges to accommodate sea level rise. The designing of pumping system power and controls will need to meet flood damage protection criteria and sea level rise criteria which may conflict with the desire to not limit lines of sight for residents.
- Functionality and Feasibility:
  - The proposed storage structure would need to be at high water level equal with the surrounding grade to allow for a pedestrian park/development to be extended over the top of the structure. The required pumping system would also need to be enclosed in an architecturally consistent structure that does not limit lines of sight from residents. The access for structure maintenance would be from the existing lot along Fulton Court which is private property.
  - The proposed structure is adjacent to a residential complex (The Landings at Port Imperial). Not only will design and construction efforts need to be heavily structured and coordinated, odor control measures taken after construction would be paramount. It is anticipated that the local residents along the shoreline would be difficult to gain approval as public stakeholders. However, due to the proximity to the River Road WWTP and the existing outfall, incorporating a park structure or other pier as an extension of the existing pier that houses the WNY1 outfall is an option that should be tested. This alternative is considered feasible.

4.3.1.2 Conceptual Network Layout

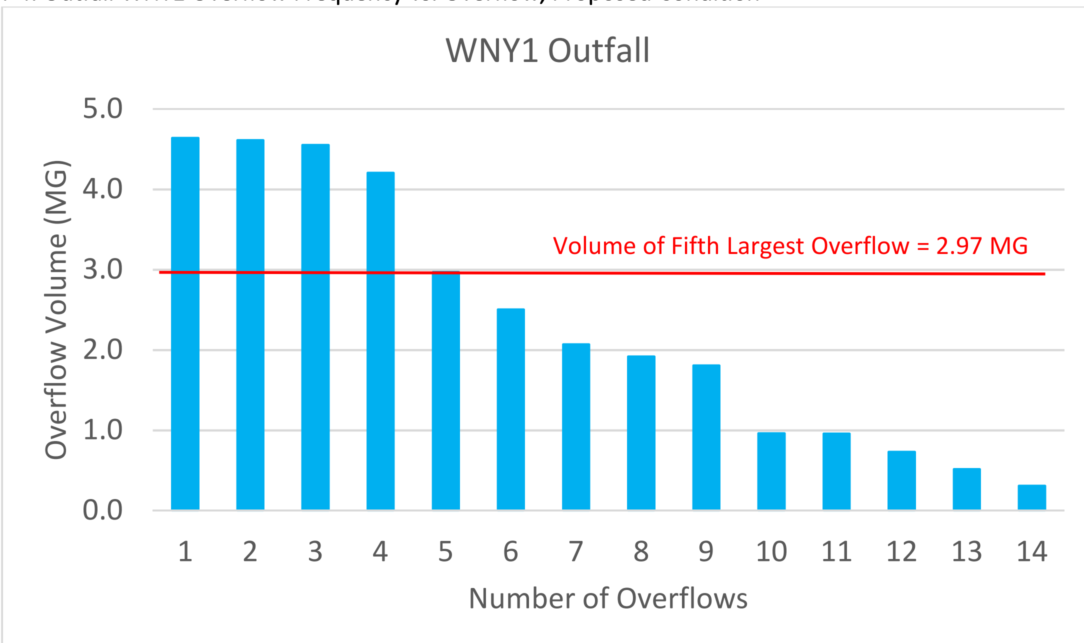
Figure 4-3 shows the required modifications to the existing network including the staging of the storage tank and required piping.

Figure 4-3. WNY1 – Proposed In-Water Storage Tank, Proposed Condition

4.3.1.3 InfoWorks Integrated Catchment Modeling Results

The River Road model was used to simulate the conditions as they are expected to exist after construction and operation of the storage alternative. The model network was updated based on the conceptual GIS network. Figure 4-4 shows the plot of the Typical Year overflow volume vs. number of overflows for Outfall 005A.

Figure 4-4. Outfall WNY1 Overflow Frequency vs. Overflow, Proposed Condition



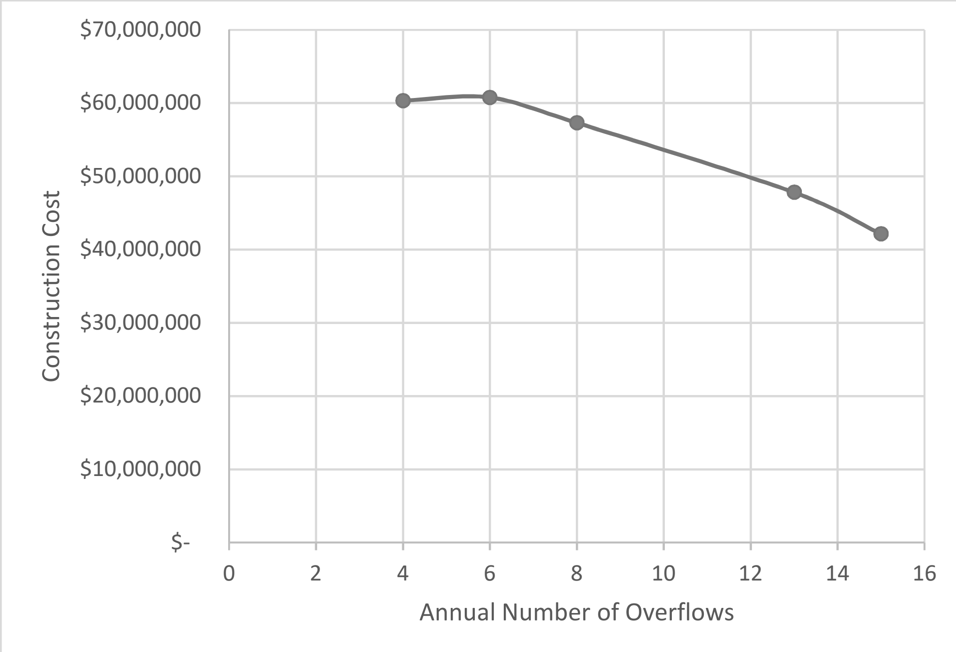
4.3.1.4 Cost

Table 4-1 lists the associated costs for this alternative.

Table 4-1. WNY1 Proposed CSO Storage Structure Conceptual Cost Estimate	
Construction Cost Estimate	$60,333,000.00
Project Annual Operations and Maintenance	$84,000.00
Project Capital Cost Estimate	$79,640,000.00
Project 50 Year Present Worth Estimate	$115,653,000.00

To observe the range in costs versus number of annual overflows expected to result from smaller CSO storage volumes, Figure 4-5 shows the cost performance curve for the construction costs for annual overflow events greater than 4.

Figure 4-5. WNY1 CSO Storage Cost Performance Curve



4.3.2 Linear Storage Tunnel at Anthony M. Defino Way

4.3.2.1 Identification and Preliminary Screening

Linear storage in the form of a subsurface tunnel between the WNY1 regulator and the outfall, along the underutilized vegetated area south of Anthony M. Defino Way and the River Road WWTP was also evaluated. Tunnels have been shown to be a feasible alternative in providing temporary CSO storage. This is also the only underutilized available land area in close proximity to the River Road WWTP that would be large enough to provide storage for the magnitude of CSO volume to be managed. Overflows would be captured by the tunnel during wet weather, providing CSO storage and subsequent pumping, primary treatment, disinfection and discharge to the river.

- Anticipated Constraints and Site Limitations:
  - The effectiveness of the tunnel hinges on the ability to provide the required storage within the available tunnel alignment. While the constructed tunnel does not utilize significant surface space in relation to the storage volume it provides, large areas are required for laydown and construction. The steep ground surface (upstream end approximate ground elevation of 135 feet, and at the downstream the approximate ground elevation is 50 feet, a change of 85 feet) may pose a challenge for siting the laydown area. The steep slope also requires that the receiving shaft and storage tunnel be very deep to function properly. It is noted that the steep slope would also prevent the post-construction ground surface above the tunnel from being utilized for a public park, parking or green infrastructure.
  - Construction would take place behind the Port Imperial monument located at the intersection of Port Imperial Boulevard and Anthony M. Defino Way. The monument will be temporarily relocated during construction.
  - Installation of a launching shaft at the downstream end of the alignment and a receiving shaft at the upstream end would be required. Filling of the tunnel would require a drop shaft such as a vortex drop structure or baffle drop structure at the upstream end to dissipate energy and emptying the tunnel would require the installation of a wet weather pumping station at the downstream end of the tunnel.

- Functionality and Feasibility:
  - A tunnel of the diameter required to capture the volume of the fifth largest storm would require a tunnel boring machine (TBM) for construction and may need to be buried up to 60 feet below the surface to avoid utilities. Deep tunnels also require specialized equipment, personnel and training to maintain and operate.
  - While some tasks could be carried out by Authority personnel, periodic tunnel inspection and various maintenance tasks would require tunnel entry. Extensive geotechnical investigations are required to determine the tunneling or mining methods to be used. Poor quality rock, excessive groundwater and other factors can increase the complexity of the construction.
  - Following construction, permanent facilities are required for pumping, odor control, grit handling, screening and dewatering, these facilities add cost, energy requirements, and operational considerations. It would also require SCADA monitoring and controls to level sensors, flow monitors, and overflow detectors. Automated gates upstream of the tunnel would be required to control the diversion of flow from the plant to the tunnel.
  - High rate treatment such as ActiFlo and a disinfection facility would be located downstream of the pumping station to provide treatment prior to discharge via the outfall. It is assumed that retention time in the tunnel would be about 24 hours prior to discharge, as such a 15 mgd high rate treatment facility would be appropriate to fully dewater the tunnel in less than 24 hours.
  - A new outfall parallel to the existing outfall is proposed to discharge treated flows from the tunnel and to serve as an emergency overflow. A tide gate would be installed in the outfall pipe to prevent backflow from the Hudson River from entering the tunnel. Flow will leave the tunnel in one of two ways: either pumping by the WWPS to the ActiFlo unit for treatment, or through an overflow once the tunnel is overtopped. Both the treatment and the overflow will discharge to the new outfall.

4.3.2.2 Conceptual Network Layout

In order to capture the 8.3 MG volume of the fifth largest storm, a tunnel of about 2,200 feet in length with a diameter of about 26 feet would be required, as shown in Figure 4-6. This figure shows the approximate alignment of the proposed tunnel at the construction stage, including the laydown area, and launch and receiving sites.

Figure 4-7 shows the area adjacent to (east of) the River Road WWTP where the launch site, wet weather pump station, high rate treatment, and disinfection facilities would be located.

Figure 4-6. Conceptual Tunnel Layout – Construction Stage

Figure 4-7. Proposed Location of Launch site and aboveground facilities

Figure 4-8 shows the layout of the treatment facilities at the site. The drop shaft would be installed as a vortex drop structure which would dissipate energy. An example of a vortex drop structure is shown in Figure 4-9.

Figure 4-8. Conceptual Layout of Tunnel Treatment Facilities

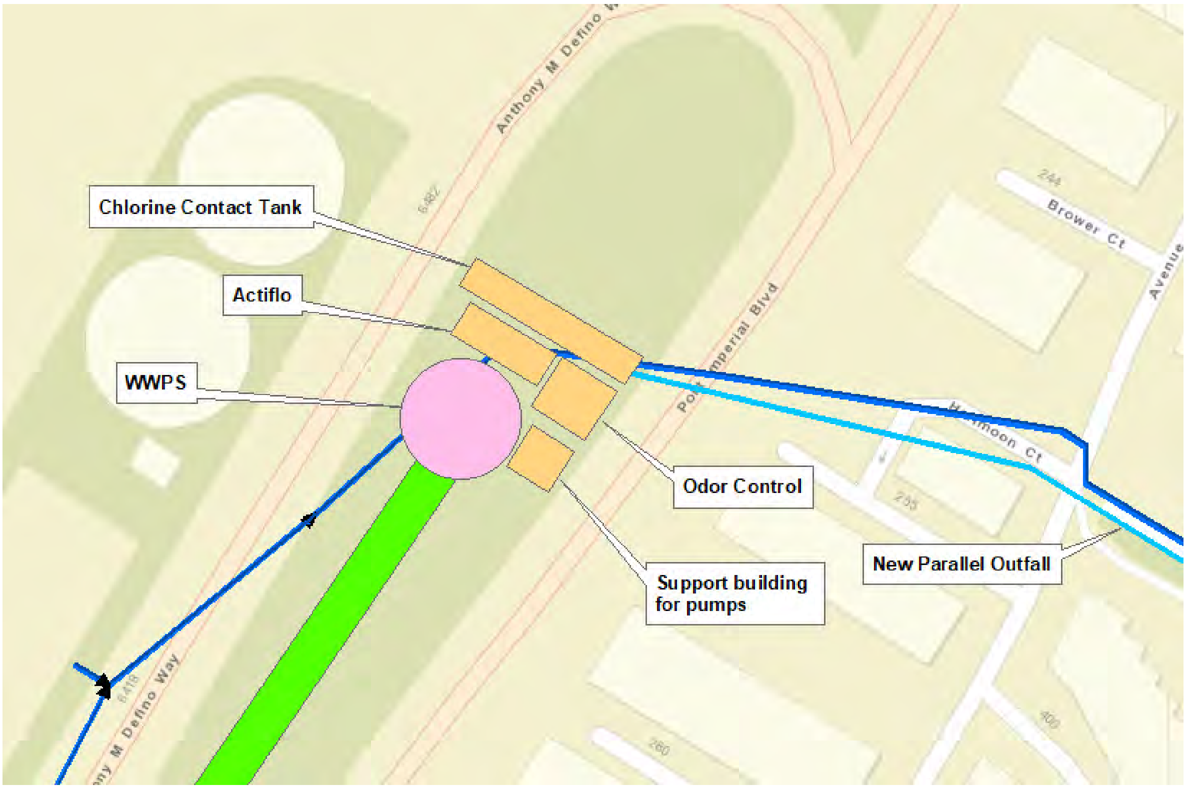
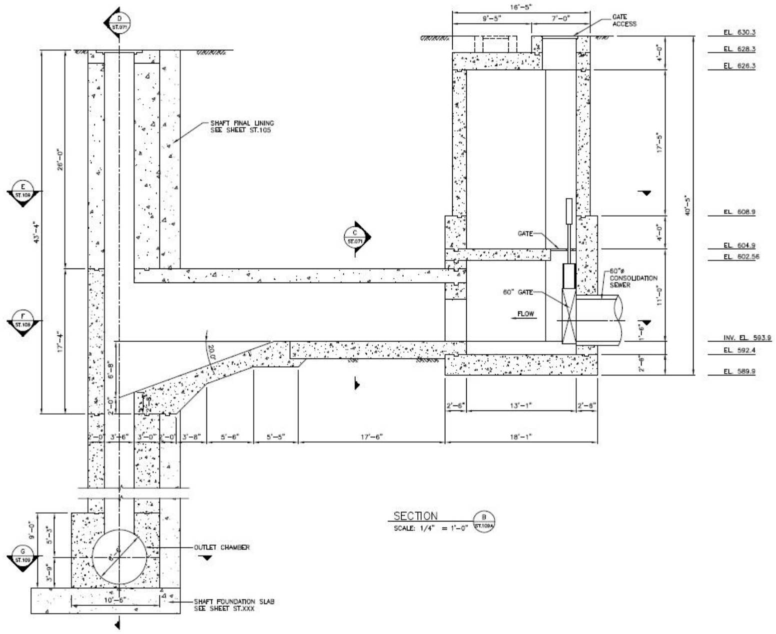
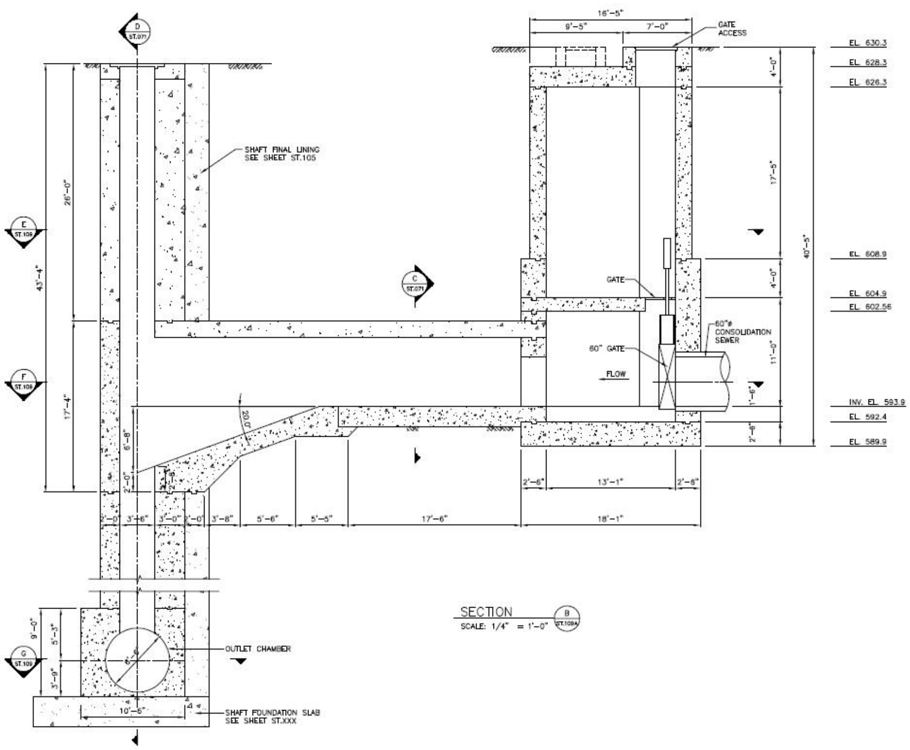


Figure 4-9. Example of Vortex Drop Structure





4.3.2.3 InfoWorks Integrated Catchment Modeling Results

The River Road InfoWorks ICM model was used to simulate the addition of a tunnel under the Typical Year conditions to determine the impacts on total CSO volume and number of overflows. It was found that with the addition of the tunnel, the number of overflow events at River Road reduced from 60 to zero, see profile below for the maximum flow condition. Figure 4-10 shows the profile of the proposed tunnel and outfall pipe. The tunnel alternative does not improve overflow events at JOSO but could be combined with weir optimization to provide improvements to JOSO. The modelling results are summarized in Table 4-2.

Figure 4-10. Modelling Results - Tunnel

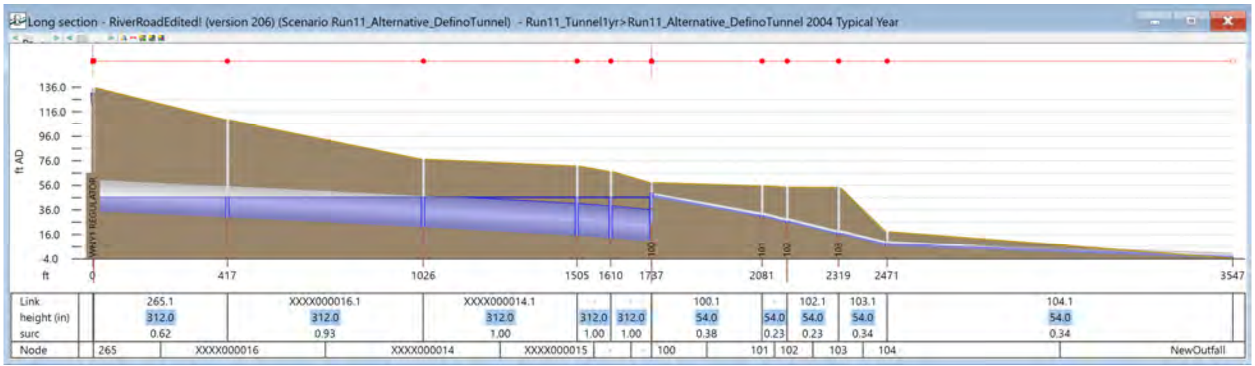


Table 4-2. Summary of Modelling Results				
	Number of Overflows		Total CSO Volume (MG)	
	Existing	With Tunnel	Existing	With Tunnel
JOSO (003A)	61	61	95	95
River Road (002A)	60	0	190	0

4.3.2.4 Cost

Table 4-3 lists the associated costs for this alternative.

Table 4-3. WNY1 Proposed CSO Tunnel Conceptual Cost Estimate	
Construction Cost Estimate	$171,450,000.00
Project Annual Operations and Maintenance	$605,000.00
Project Capital Cost Estimate	$226,314,000.00
Project 50 Year Present Worth Estimate	$241,881,000.00

4.3.3 Disinfect at WNY1 Solids/Floatables Facility

4.3.3.1 Identification and Preliminary Screening

For this alternative disinfection is proposed at the existing WNY1 S/F Facility. Outfall 002A has 60 CSO events and an annual CSO volume of 190.4 MG in a Typical Year with the largest event at 20.3 MG and a corresponding peak flow rate of 194 mgd.

- Anticipated Constraints and Site Limitations:
  - Available Space - A nominal 25-ft x 61-ft. disinfection building with 2 bulk storage tanks would need to be sited adjacent to the S/F Facility which is located against a rock cliff. A significant amount of rock blasting would be required to widen the available area to the south of the S/F Facility. A lesser amount of rock blasting would be required if a single bulk storage tank were determined to be sufficient. A disinfection building would not fit to the north of the existing S/F Facility. However, if the parking lot area could be used, it appears that there is just enough room for a single bulk storage tank facility without blocking the service roads. Additionally there is limited space available to site facilities to achieve primary clarification.

- Contact Time - The available contact time in the outfall pipeline and S/F Facility would need to be evaluated.
- Traffic/Public Access - Construction staging could require a lane closure on Anthony M Defino Way. The project may cause similar traffic constraints to those experienced during the construction of the WNY1 S/F Facility which limits road access to the north thereby requiring all construction equipment to access the site from the road. Chemical unloading could require lane closure although this would only be required a few times per year.

- Functionality and Feasibility:
  - Chemical Dose - Available detention times in the discharge pipe to the outfall and WNY1 S/F Facility would need to be determined.
  - Chemical Storage and Feed - The annual volumes to be treated and the design storm events are sufficiently large to assume two nominal 6000 gallon bulk storage tanks for screening purposes. A single tank may be possible with peracetic acid (PAA) since it does not degrade but testing would be required to determine the required dose.
  - Due to the proximity to the WWTP and the distance from residential areas, siting disinfection facilities for this alternative is considered feasible.

4.3.3.2 Conceptual Network Layout

Figure 4-11 shows the proposed disinfectant path for this alternative.

Figure 4-11. WNY1 – Proposed Disinfection

4.3.3.3 Analysis

The required contact time was analyzed within the pipeline. Table 4-4 shows the possible detention time within the pipe at 5-, 15-, and 60-minute time series based on the pipe length from the WNY1 S/F facility to the outfall and the velocity within the pipe from the model. As there is not sufficient contact time in the pipe for disinfection this alternative is not considered feasible.

Table 4-4. Pipe Detention Time (minutes)

	5-min	15-min	60-min
TOTAL	1.37	1.39	1.54

4.3.4 WNY1 Outfall Cloth Media Filtration Facility

4.3.4.1 Identification and Preliminary Screening

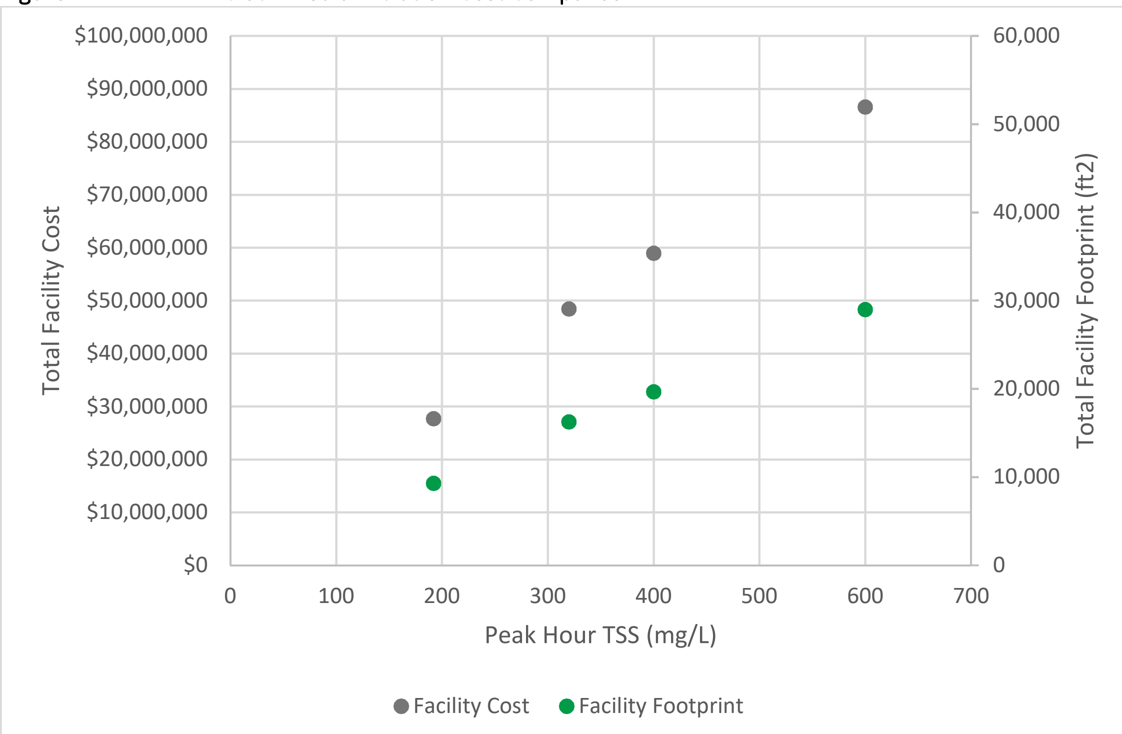
Cloth media filtration such as Aqua Prime was identified as a potential filtration method for the WNY1 outfall for this alternative. Cloth media filtration utilizes cloth woven or fiber pile construction for 10 micron TSS removal. Cloth media filtration can filter to less than 5 mg/L TSS concentration. The most common geometry and the type analyzed for this application is disc filters. Benefits to this type of implementation is the discs are vertically oriented to reduce the required footprint and have higher solids and hydraulic loading rates than other technologies. While this technology is ideal for solids removal, any application for this analysis will require disinfection to meet permit limits.

- Anticipated Constraints and Site Limitations:
  - Traffic/Public Access - Construction staging could require a lane closure on Anthony M Defino Way. The project may cause similar traffic constraints to those experienced during the construction of the WNY1 S/F Facility which limits road access to the north thereby requiring all construction equipment to access the site from the road.
- Functionality and Feasibility:
  - For design purposes at this stage, it has been assumed that the average peak TSS concentration is similar to that of the WWTP as they are within the same system. This concentration as listed in the Baseline Characterization Report is 193 mg/L.
  - Filtration technologies are often limited by the solids loading rate. If the solids loading rate is too high, the filter require frequent and excessive backwash cycles. Aqua Aerobic Systems' AquaPrime cloth media disc filters have a maximum solids loading rate (SLR) of 15 lbs/day/sf cloth area. They have a maximum hydraulic loading rate (HLR) of 6.5 gpm/sf cloth area. The influent TSS concentration at the maximum HLR and maximum SLR is 192 mg/L. Any influent TSS concentration greater than 192 mg/L at peak flows to the cloth media filtration train will be SLR limited and the overall configuration; and therefore cost may increase significantly.
  - To verify the peak TSS concentration that the system should be designed to control, it is recommended to collect hourly samples during several wet weather events immediately downstream of the location where the cloth media filtration will be implemented. Flow and TSS data is used to generate pollutographs for different storm events that plot TSS and flow versus time. The pollutograph indicates when the 'first flush' of pollutants enter the treatment facility. Often, the peak TSS concentration (first flush) occurs before the peak flow meaning a lower solids loading rate which will optimize the size of the treatment facility.

4.3.4.2 Cost

Due to the potential variation in costs described in the previous section, a cost range is presented for potential peak TSS concentrations at the WNY1 outfall. Figure 4-12 shows the variation in facility cost and footprint based on the WNY1 peak hourly flow of 189 mgd and a simultaneous peak TSS concentration ranging from 200 - 600 mg/L. Should the peak TSS concentration exceed 600 mg/L, the cost and facility footprint would increase accordingly. The cost and footprints include the influent and effluent channels, filter influent and effluent chambers, filter tanks, filter discs, valves, pumps, valve and pump gallery, and electrical building.

Figure 4-12. WNY1 – Cloth Media Filtration Cost Comparison



4.3.5 WNY1 Outfall Compressible Media Filtration

4.3.5.1 Identification and Preliminary Screening

Implementation of compressible media filtration was analyzed at the WNY1 outfall. Compressible media filtration utilizes durable synthetic balls which are compressed to create a porosity gradient resulting in the removal of large and small particles throughout the media bed. Media compression varies by vendor with Schreiber's Fuzzy Filter compressing media between two plates and WWETCO's FlexFilter compressing media using a flexible bladder. Benefits to this type of implementation are the small footprint and relatively simple operation. While this technology is ideal for solids removal, any application for this analysis will require disinfection to meet permit limits.

- Anticipated Constraints and Site Limitations:
  - The anticipated site constraints and site limitations are nearly the same as those for cloth media filtration.
- Functionality and Feasibility:
  - WWETCO's FlexFilter was used a reference for this analysis. WWETCO limits their FlexFilter to a maximum HLR of 10 gpm/sf at peak flow for CSO applications. The maximum SLR can be up to 50 lbs/day/sf. Sizing a compressible media filtration facility is an iterative process that considers

the HLR, SLR, number of cells in operation, and managing filter backwash flow. A number of options are available for managing filter backwash flow and each is evaluated to select the optimal one. Due to the number of variables in sizing a compressible media filter, the facility was sized using a maximum HLR of 10 gpm/sf and a maximum SLR of 38 lbs/day/sf. The influent TSS concentration at the maximum HLR and maximum SLR is 320 mg/L. These values are equivalent to the design HLR and SLR for WWETCO's 100 mgd compressible media (FlexFilter) CSO wet weather treatment facility in Springfield, OH and are reasonable assumptions for H1. The Springfield facility was used as a guideline for sizing and costing the H1 facility.

4.3.5.2 Cost

A compressible media filter facility for WNY1 at a peak flow TSS concentration of 320 mg/L using an HLR of 10 gpm/sf and a maximum SLR of 38 lbs/day/sf costs $92 million with a footprint of 47,727 sf. The cost and footprint includes the influent and effluent channels, filter influent and effluent chambers, filter tanks, compressible media, air compressors, and compressor and electrical building. The comparable (189 mgd at 320 mg/L TSS) cloth media filtration facility cost and footprint from Figure 4-12 is $27 million and 18,000 sf, respectively.

4.4 WNY1 Basin Alternatives Comparison

Each alternative was assigned a score based on the evaluation criteria identified in Task 1. Table 4-5 shows the weighted point total and weighted average of each alternative for the WNY1 drainage basin. The full breakdown of the scoring for each alternative can be found in Appendix B.

Table 4-5. WNY1 Basin Alternatives Score Comparison

Alternative	Weighted Point Total	Weighted Percent
Combined Sewer Overflow Storage Tank Near WNY1 Outfall	76	55%
Linear Storage Tunnel at Anthony Defino Way	81	59%

5 Systemwide Alternatives

To supplement the alternatives identified at each drainage basin, the feasibility of reducing I/I and implementing green infrastructure were analyzed throughout each drainage basin where data is available. Reduction of I/I is necessary to reduce dry weather flows which would allow for more capacity within the collection system during wet weather events, and implementing green infrastructure can capture flow in wet weather events that would otherwise be directed into the collection system. Both strategies aim to reduce the volume and frequency of overflows at the outfalls. These strategies do not aim to control the entire target volume at each outfall, but rather aim to reduce volumes required for CSO control.

5.1 Inflow and Infiltration

5.1.1 Identification and Preliminary Screening

The Authority has reported increasing issues with dry weather flows at the River Road WWTP in recent years. This can be attributed to issues with I/I due to aging infrastructure. CCTV data that was conducted for all of the River Road WWTP drainage basins indicated the severity of aging infrastructure within the service area. The analysis categorized each pipe, with a 4 or 5 on the Pipeline Assessment Certification Program rating scale indicating that they are more susceptible to failure. Using the U.S. Environmental Protection Agency (EPA) Quick Guide for estimating I/I, the approximate infiltration rate was calculated per drainage basin using the base flow extracted from the model, which represents the approximate groundwater infiltration per basin. These results are presented in Table 5-1.

Table 5-1. River Road Service Area-Estimated I/I to Be Removed By Drainage Basin

Basin	Area (acre)	Baseflow (mgd)	Baseflow (gpad)
UC1	131.624	**1.269**	9,641.10
UC2	80.911	0.047	580.89
WNY1	511.832	**1.692**	3,305.77
WNY2	135.66	0.508	3,744.66

gpad gallons per acres per day

The total inch diameter-miles of pipe is calculated for each drainage basin. This unit of length is divided by the baseflow extracted from the model (mgd) and converted to a rate to represent the approximate infiltration per inch diameter-mile, or gpd/idm, of groundwater infiltration. In the River Road WWTP Service area, RedZone data was collected for UC1, UC2, WNY1 and WNY2 metersheds. It was assumed that pipes with a Pipeline Assessment Certification Program score of at least 3 contributed to this infiltration. Based on these calculations, the approximate possible infiltration to be removed and that remaining are presented in Table 5-2.

Table 5-2. River Road Service Area-Estimated I/I to Be Removed

	Possible Removal by Lengths, Assuming All I/I Comes from Pipes (gpd)			Total I/I Removed by Replacing/Lining Pipes near Failure	Potential I/I Remaining after Lining Authority Pipes
	5	4	3		
UC1	158,731	345,656	202,407	706,793	562,207
UC2	9,980	19,014	6,999	35,993	11,007
WNY2	-	8,749	11,793	20,542	487,458
WNY1	50,594	127,385	60,676	238,655	1,453,345
			TOTAL	1,001,983	2,514,017

5.1.2 Cost

Table 5-3 and Table 5-4 list the associated costs for this alternative.

Table 5-3. JOSO Proposed Pipe Rehabilitation Conceptual Cost Estimate

Construction Cost Estimate	$10,131,000.00
Project Annual Operations and Maintenance	$210,000.00
Project Capital Cost Estimate	$13,370,000.00
Project 50 Year Present Worth Estimate	$21,757,000.00

Table 5-4. WNY1 Proposed Pipe Rehabilitation Conceptual Cost Estimate

Construction Cost Estimate	$3,675,000.00
Project Annual Operations and Maintenance	$78,000.00
Project Capital Cost Estimate	$4,850,000.00
Project 50 Year Present Worth Estimate	$7,936,000.00

5.2 Green Infrastructure

Green Infrastructure (GI) is one type of source control technology that can help to manage stormwater, reduce CSOs, and improve water quality. GI technologies most common in urban areas like the River Road WWTP drainage basins include bioretention, bioswales, stormwater planters, permeable pavement, subsurface infiltration/storage, and stormwater tree pits. For less constrained sites with additional space, GI technologies such as infiltration basins, ponds, and constructed wetlands can prove to be effective, as well as cost-efficient. Conversely, for more constrained sites with limited at grade opportunities, green (vegetated) roofs may be the only viable GI technology. When properly designed, constructed, and maintained, these technologies can provide significant levels of control over the course of a year through their performance in small to moderate-sized storms. For this analysis, the feasibility of bioretention practices and green roofs were analyzed.

5.2.1.1 Identification and Preliminary Screening

To estimate the potential for green infrastructure (GI) in the River Road WWTP service area, the feasibility of both right-of-way (ROW) bioretention features and green roofs were considered. The estimated capture volume represents a 1.1" capture depth across 20% of total impervious area within the River Road service area.

5.2.1.2 Functionality and Feasibility

The functionality of ROW GI placement and GI implementation through green roofs was analyzed for overall feasibility to compare the required area for the target capture to the available area within the drainage basins.

ROW GI Implementation Assumptions

- ***Drainage Area*** The drainage area managed by GI was assumed to equal 20% of existing impervious area within the River Road service area. This assumption is based on a high-level analysis of the land use within each River Road sewershed, a review of the 2013 Hoboken Green Infrastructure Strategic Plan, and general assumptions about feasible implementation levels of GI retrofits in urban areas. The impervious area managed includes 20% of all impervious area, including both buildings and roads. Portions of buildings would be captured by disconnecting and rerouting downspouts, where feasible. While 20% of the impervious area was assumed to be captured overall, in practice this would likely translate into certain blocks/drainage areas being managed at much higher percentages and certain blocks/drainage areas not being managed at all. In other words, GI retrofits would ideally be placed on those blocks/drainage areas where they have the best opportunity to capture 100% of the 1.1" storm or greater.
- ***GI Storage Volume*** Once the approximate drainage area was established, the corresponding GI area required was estimated. The average loading ratio utilized was 20:1 (ratio of impervious area to GI area). From the GI footprint, the storage volume was calculated based on the breakdown of storage in a typical bioretention feature with an average total depth of 6 feet. The total storage volume is the sum of surface ponding volume, soil volume, and stone volume.
- ***GI Siting*** The GI features would be bioretention systems located either in the sidewalk or in curb bump-outs extending into the street. The sizes of these features would vary depending on local site constraints (slope, utilities, parking considerations, etc), though a typical size would likely range from 10-20' long and 3-6' wide.

Based on these assumptions, the maximum storage ROW volume within the River Road service area is 4.6 MG. The storage by drainage basin is listed in Table 5-5

Table 5-5. Estimated Maximum ROW GI Storage Volume by Drainage Basin in Authority Service Area

Drainage Area ID	[1]Estimated GI Storage Volume (ft^3)
UC1	100,119
UC2	52,544
WNY1	349,324
WNY2	113,049
Total (ft^3)	**615,036**
Total (million gallons)	**4.6**

[1]Area of bioretention facilities based on 20:1 Loading Ratio of Impervious Drainage Area to GI Footprint, 3" ponding depth (80% of the bioretention area), 2.5' soil depth (20% soil porosity for storage), 3' stone depth (40% stone porosity for storage).

ft^3 cubic feet
ID identification

Further aspects of the Authority service area were examined to account for other limitations to siting GI. Specifically, the feasibility of placing GI facilities within the public ROW and on private rooftops was further explored at a planning-level.

Feasibility Analysis - Available Roadway Area for GI placement

As the public ROW is typically the primary location for GI in municipal programs, the total area of GI required was compared to potentially available area within the roads of the River Road service area. In addition to type of impervious area, other constraints were considered, including recommendations from the 2013 Hoboken Green Infrastructure Strategic Plan, proximity to existing buildings, and existing roadway width. For this analysis, the assumptions for determining feasible road area for GI implementation include:

- All roads considered public ROW
- Areas of existing buildings and areas within 7 feet of any building were not considered feasible for ROW GI implementation
- Roadways with widths less than 26 feet wide were not considered feasible for GI implementation. The minimum width of 26 feet allows for a GI feature width of 6 feet (conservatively assuming a GI feature within the cartway, i.e. a bioretention bump-out) and remaining roadway width of 20 feet. The minimum roadway width maintains travel lanes for emergency vehicle access.
- For roadways with widths of 26 feet or greater, the feasible area for GI implementation was considered the total width after subtracting 20 feet to maintain travel lanes.

With these assumptions, the total GI area required as a percentage of feasible road area is 4.6% (Table 5-6). This value indicates that there is ample feasible space in roadways for the assumed level of GI implementation in the service area. Note this is a planning-level analysis that does not consider more site-specific constraints, such as utility conflicts.

Table 5-6. GI Area and Feasible Roadway Area in the Authority Service Area

Drainage Area ID	[1]Assumed Required Right-of-Way GI Area (ft^2)	Total Roadway Area Feasible for GI Placement (ft^2)
UC1	52,694	1,168,806
UC2	27,655	653,482
WNY1	183,855	4,106,413
WNY2	59,499	1,318,698
Total (ft^2)	**323,703**	**7,247,399**
[1]Assumed GI Type is Bioretention with 20:1 Loading Ratio of Impervious Drainage Area to GI Footprint		

Feasibility Analysis – Storage Volumes on Private Rooftop Areas

Green (vegetated) roofs are a viable option for source control, especially in areas where constraints limit ground-level stormwater features like bioretention. For the urban service area, calculations assumed a 5% implementation across the service area. The estimated potential storage volume for green roofs from this assumed percentage is 0.27 million gallons (Table 5-7). This volume assumes that 5% of all rooftops, including both publicly- and privately-owned, would have an extensive green roof with 3 inches of soil depth. The assumed level of green roof implementation is relatively aggressive. To refine this analysis, it would be beneficial to consider site-level constraints to implementing green roofs, such as building structural capacity for additional loads, presence/extent of rooftop mechanical equipment, and slope.

Table 5-7. Private Rooftop Storage in the Authority Service Area

Drainage Basin ID	[1]Estimated Green Roof Storage Volume (ft^3)
UC1	6,240
UC2	3,261
WNY1	20,433
WNY2	6,734
Total (ft^3)	**36,667**
Total (million gallons)	**0.27**

[1]Rooftop area based on Hudson County Land Use GIS data. Includes both privately-owned and publicly-owned roofs. Implementation percentage of 5% applied. Storage assumes extensive green roofs (3" media depth) with 20% porosity

ft^3 cubic feet
ID identification

Site Analysis

An analysis of the JOSO sewershed was conducted to estimate the potential requirement for sidewalk bioswales. Consistent with the assumptions described above, bioswales would be sized based on the following: 20% of the total impervious area within the example block delineation divided by 20. Based on an assumed bioswale size of 5'x20', 803 bioswales (4 bioswales/acre) would be required to manage the contributing impervious area (buildings and roads). Again as noted in our report, while 20% of the impervious area was assumed to be captured overall, in practice this would likely translate into certain blocks/drainage areas being managed at much higher percentages and certain blocks/drainage areas not being managed at all. Bioswales would be placed on the street that are most feasible to capture 100% of the 1.1" storm. Our assumed approach is very similar to that applied by both the Philadelphia Water Department and NYC DEP, two organizations considered leaders in GI implementation in highly urbanized areas It is important to emphasize, however, feasibility of the required GI is dependent on confirming existing underground utilities, overhead tree cover, drainage patterns, sidewalk width or other limiting factors. These verifications would occur during detailed field investigations. Once it is confirmed that there is available space, geotechnical investigations would be conducted to confirm subsurface conditions. Those sites which are considered feasible in both forementioned categories would be included in the total number of feasible bioswales. This approach can be applied to all drainage basins. Based on the highly urbanized nature of the area, it is not expected that 803 bioswales total are feasible and with detailed field and geotechnical investigations, a lesser number would be installed. .

Recommendations for Future Analysis

When implemented in full, the maximum runoff capture volume that green infrastructure can attain in the River Road service area at any one time is 4.6 MG. The percent capture is dependent on the rainstorm volume, distribution throughout the service area and proper maintenance of green infrastructure. To be conservative with respect to maintenance and long-term performance of green infrastructure in the service area, as well as the actual CSO reduction resulting from runoff capture, an a reduction factor of 50% would yield an assumed CSO reduction of 2.3 MG. Further analysis to refine these estimates could include an investigation of publicly-owned parcels and their surrounding neighborhoods for the feasibility of large area disconnections (i.e. disconnecting large combined areas into more regional, larger GI facilities in public spaces). Additionally, an assessment of existing tree canopy would be useful to identify areas that could benefit from added vegetation, as well as areas where impacts to existing trees should be avoided.

5.2.2 Cost

Table 5-8 lists the associated costs for this alternative.

Table 5-8. River Road WWTP Service Area- Proposed Green Infrastructure Conceptual Cost Estimate

Cost	Amount
Construction Cost Estimate	$42,310,000.00
Project Annual Operations and Maintenance	$3,427,000.00
Project Capital Cost Estimate	$55,850,000.00
Project 50 Year Present Worth Estimate	$122,560,000.00

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5.3 Sewer Separation

5.3.1 Identification and Preliminary Screening

Sewer separation has been analyzed in the past for the service area to capture the increased amount of stormwater during a rainstorm and minimize volumes in the collection system and thereby increasing the capacity at the WWTP, decreasing flows to the outfalls. From EPA guidance, sewer separation can be considered wherever there is a CSS. However, an evaluation of the most appropriate CSO control should be performed prior to selecting sewer separation as in a highly urbanized area as the River Road service area, sewer separation can be fairly costly and involve extensive construction.

5.3.2 Functionality and Feasibility

To effectively separate sewers, pipes are installed parallel to the existing pipe that will solely collect stormwater and direct flow away from the WWTP. An analysis conducted based on the existing inventory of the collection system in the River Road service The table below shows the approximate total length of pipe in each drainage basin. The dominant pipe diameters within the drainage basin are included.

Table 5-9. River Road Service Area-Estimated Pipe length Per Drainage Basin

Basin	Total length of pipe (ft)	Dominant Pipe Diameter in Bains
WNY1	119,842	12”
JOSO	46,371	12”

5.3.3 Cost

Based on the values in Table 5-9, and assuming new manholes are installed parallel to existing manholes, Table 5-10 shows the expected costs for this alternative.

Table 5-10. River Road WWTP Service Area- Proposed Sewer Separation Conceptual Cost Estimate	
Cost	**Amount**
Construction Cost Estimate	$247,868,000.00
Project Annual Operations and Maintenance	$468,871
Project Capital Cost Estimate	$401,56,000.00
Project 50 Year Present Worth Estimate	$367,709,000.00

5.4 Systemwide Alternatives Comparison

Table 5-11. Systemwide Basin Alternatives Score Comparison		
Alternative	**Weighted Point Total**	**Weighted Percent**
Inflow/Infiltration Rehabilitation	107	77%
Green Infrastructure	99	71%
Sewer Separation	72	52%

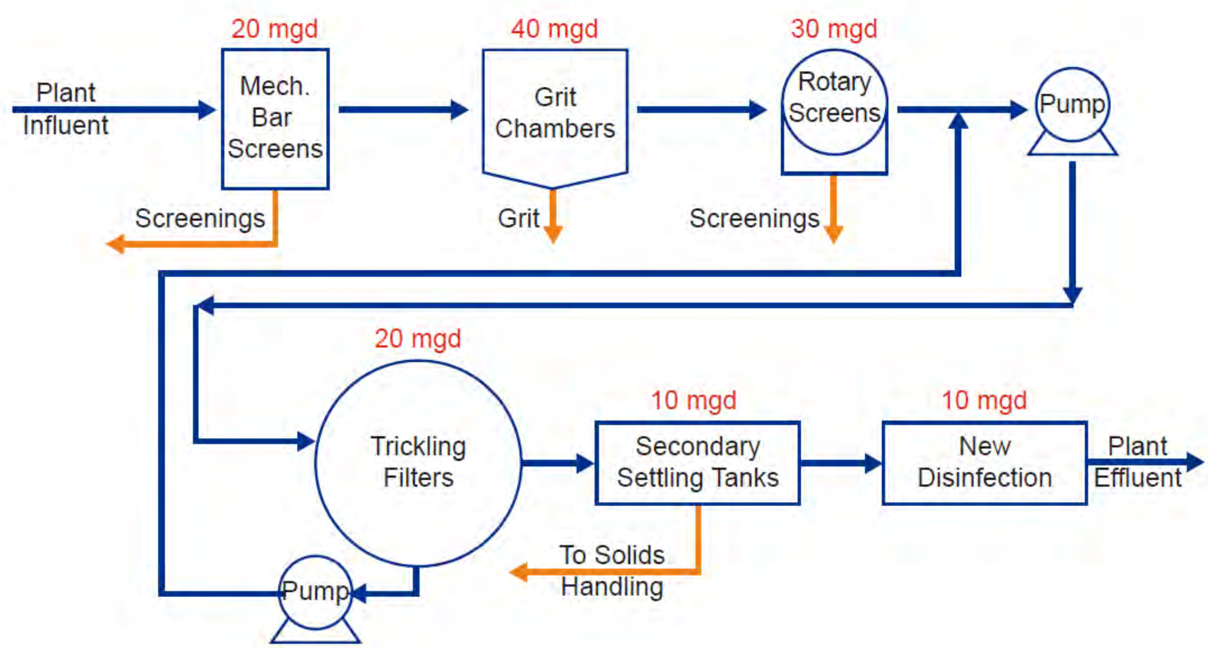
6 River Road Wastewater Treatment Plant

6.1 Wastewater Treatment Plant Overview

The River Road WWTP is located at 6400 Anthony M. Defino Way in West New York. The WWTP was constructed as a primary treatment plant in 1953 with a design capacity of 10 mgd and 20 mgd peak flow. In 1992, an upgrade to the plant was completed to provide secondary treatment using the trickling filter biological treatment process. The plant treats the sewage from the Town of West New York and from a section of Union City and Weehawken covering an area of approximately 1.4 square miles and three communities. The average flow to the facility has approached the plant capacity of 10 mgd in the past, but has been decreasing in recent years with aggressive I/I reduction efforts. Effluent is discharged to the Hudson River in accordance with the NJPDES permit NJ0025321.

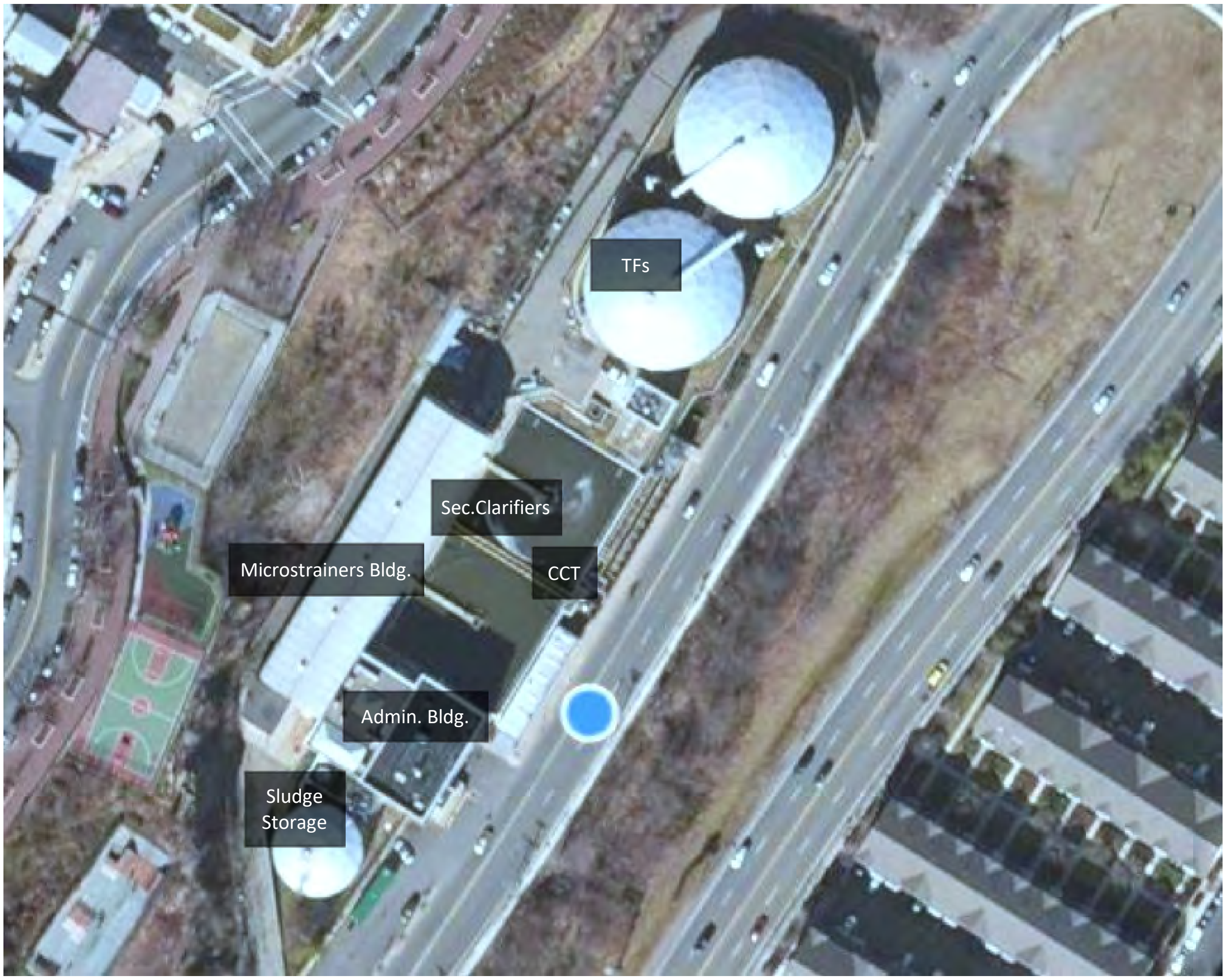
The treatment process at the plant includes preliminary treatment consisting of influent screening and grit removal using vortex type units, micro-strainers in lieu of primary clarifiers, trickling filters, secondary clarification, effluent disinfection using sodium hypochlorite and de-chlorination using sodium bisulfite, solids handling including sludge storage and sludge thickening using two belt presses and odor control. The process flow diagram for the River Road WWTP is provided on Figure 6-1. An aerial photograph of the site is provided on Figure 6-2.

Figure 6-1. River Road WWTP Process Flow Diagram



The capacities shown in the figure above indicate the hydraulic capacity of the plant, however are not necessarily representative of the biological capacity and may not reflect regular plant operations. For the purposes of this alternatives analysis, based on discussions with operating staff, it has been assumed that a maximum of 20 MGD would be conveyed through the trickling filters. The alternatives analyzed for JOSO and WNY1 in previous sections assumed the existing capacity at the treatment plant. The increased capacity analyzed in the following sections would be implemented concurrently with those alternatives at JOSO and WNY1 which convey more flow to the plant and will be decided at that time.

Figure 6-2. Aerial View of River Road WWTP



It is known that the treatment bottlenecks at the River Road WWTP are the capacities of the rotary screens, the secondary clarifiers and the chlorine contact chamber. In order to identify improvements at these points in the treatment train, available space was evaluated through the plant. A site visit to the WWTP was conducted on January 18, 2019 to obtain addition details on space availability and flexibility.

The preliminary treatment building houses the bar screens, grit vortex chamber, rotary strainers and intermediate pumping station. It can be seen on Figure 6-3 and Figure 6-4 that there is very limited space in this building to add additional treatment capacity.

Figure 6-3. Preliminary Treatment Building – facing northwest from southeast corner

Figure 6-4. Preliminary Treatment Building – Facing Southeast from Northwest End

The only available space in the pretreatment building is a small elevated area at the northwest end of the building adjacent to the rotary screens (shown in Figure 6-5), which is approximately 12-ft x 20-ft, and is not large enough for any of the evaluated treatment methods and their ancillary equipment, discussed further below. As such, any proposed improvements to the preliminary treatment building have not been considered further.

Figure 6-5. Open Area in Preliminary Treatment building

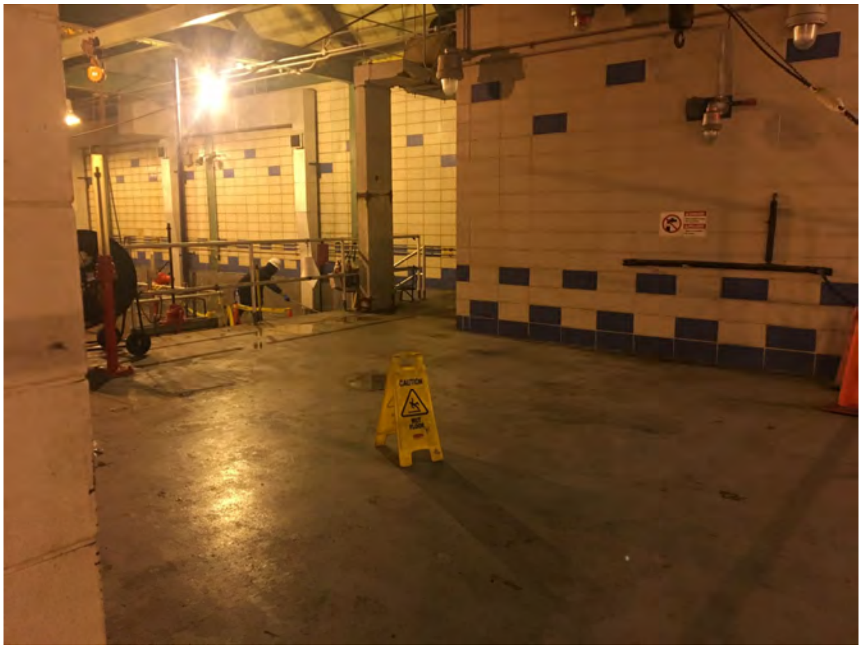
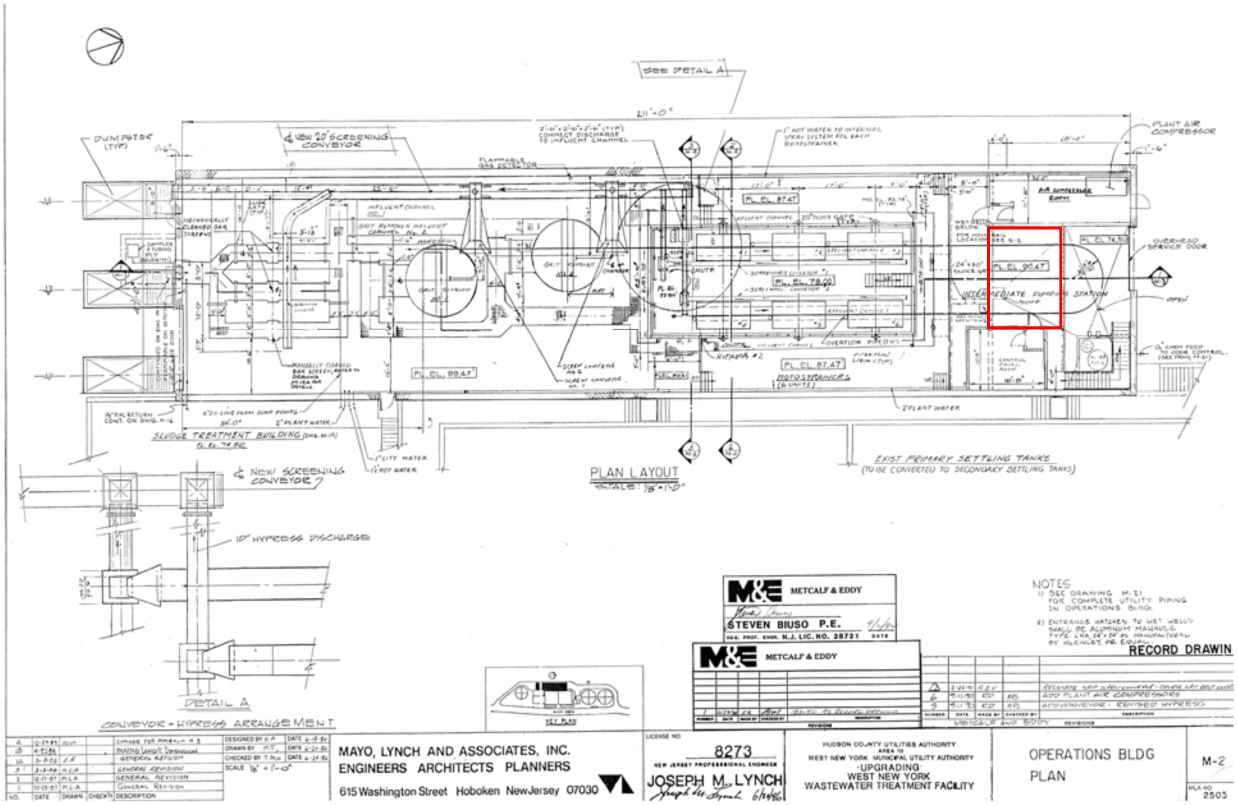


Figure 6-6. Plant Plan Drawing showing open area in preliminary treatment building



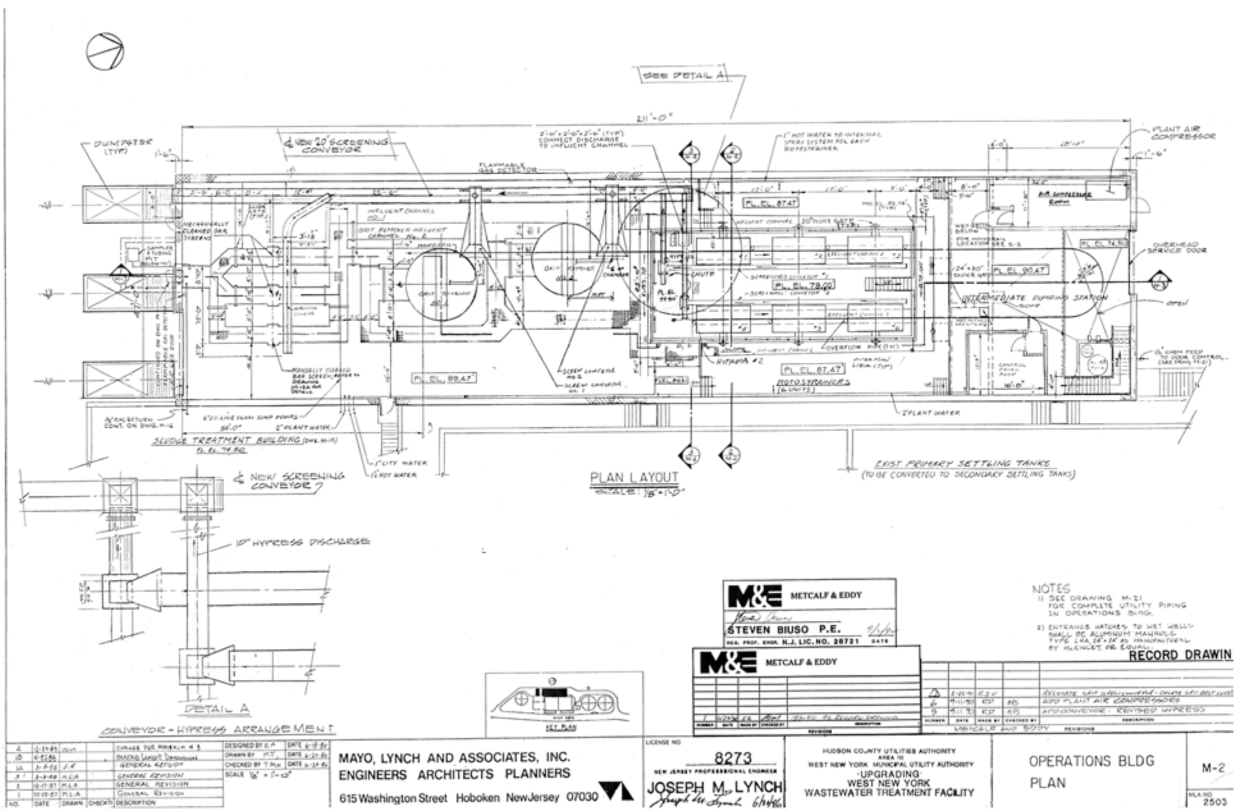
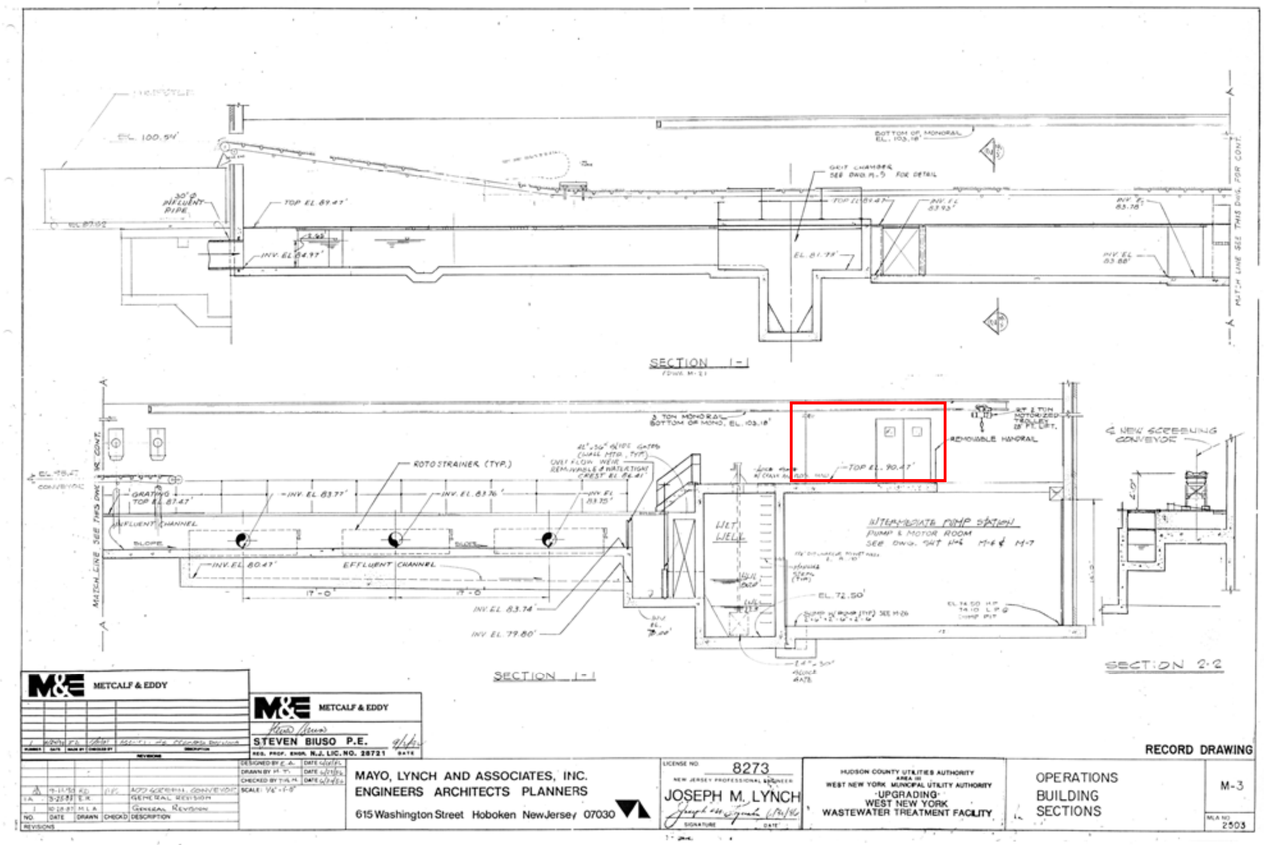
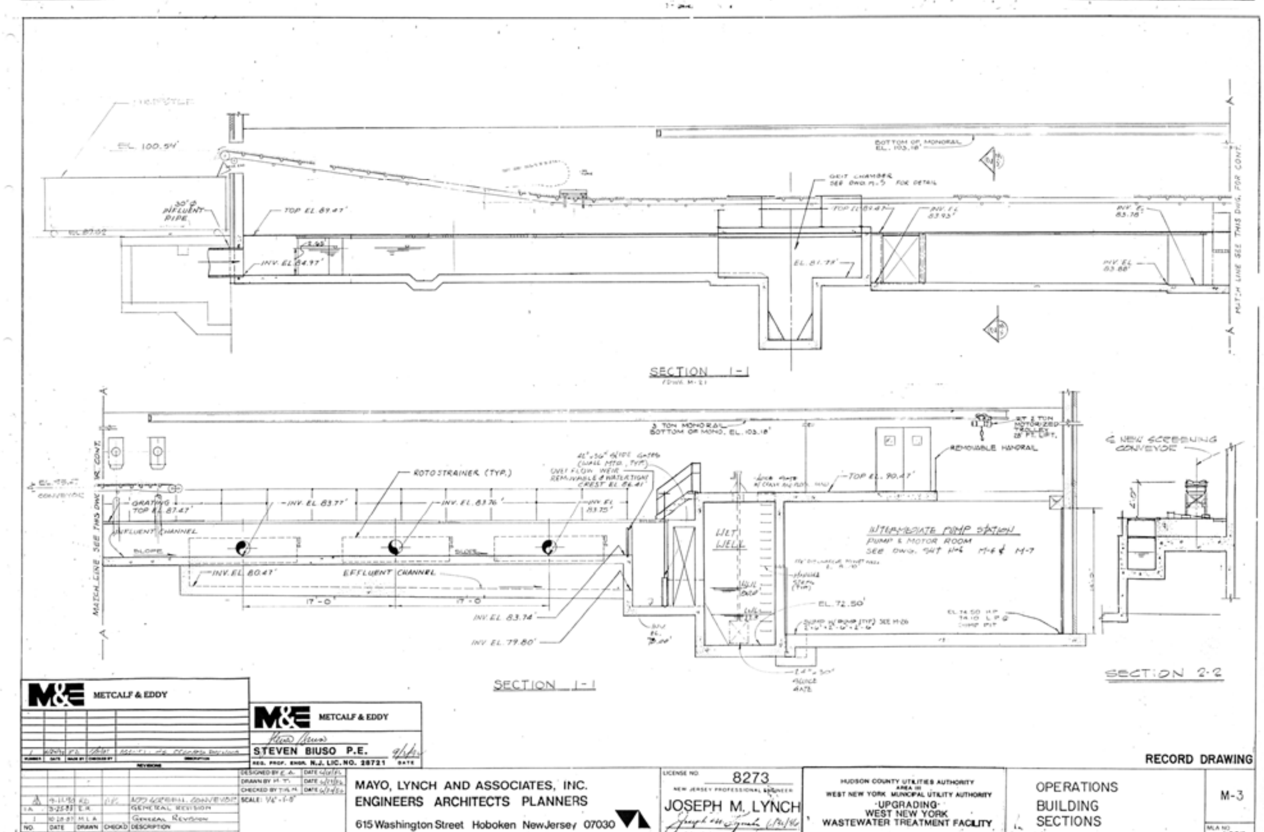


Figure 6-7. Plant Profile Drawing showing open area in preliminary treatment building





The plant has an existing bypass that conveys flow from the vortex grit chambers to the trickling filters, bypassing the rotary screens. It is proposed that the bypass be retrofitted to split flows, bypassing wet weather flow from the rotary screens and conveying it from the vortex grit chambers towards the location of the existing secondary clarifiers.

During dry weather, up to 20 mgd would continue to be conveyed through the rotary screens and trickling filters, and to a new higher capacity treatment unit located in the footprint of the existing secondary clarifiers, which would be decommissioned. During wet weather, the modified bypass would convey additional wet weather flows up to 15 mgd from the vortex grit chambers directly to the new higher capacity treatment unit located in the footprint of the decommissioned secondary clarifiers. Flows from the trickling filters and the bypass from the vortex grit chamber would be blended and conveyed to an upsized chlorine contact tank. The location of the secondary clarifiers and chlorine contact tank is shown in Figure 6-8.

Figure 6-8. Secondary Clarifiers and Chlorine Contact Tank

The proposed modification to the process flow schematic in order to increase plant capacity is shown in Figure 6-9 and the location of the proposed bypass is shown in Figure 6-10. It is noted that this configuration provides an additional 15 MGD of wet weather treatment capacity at the plant. If the bending weirs alternative was implemented, an additional 65 MG would be diverted from the JOSO basin during the typical year, requiring additional upgrades to the River Road WWTP for increased treatment capacity.

Figure 6-9. Proposed Modifications to Existing Plant Flow

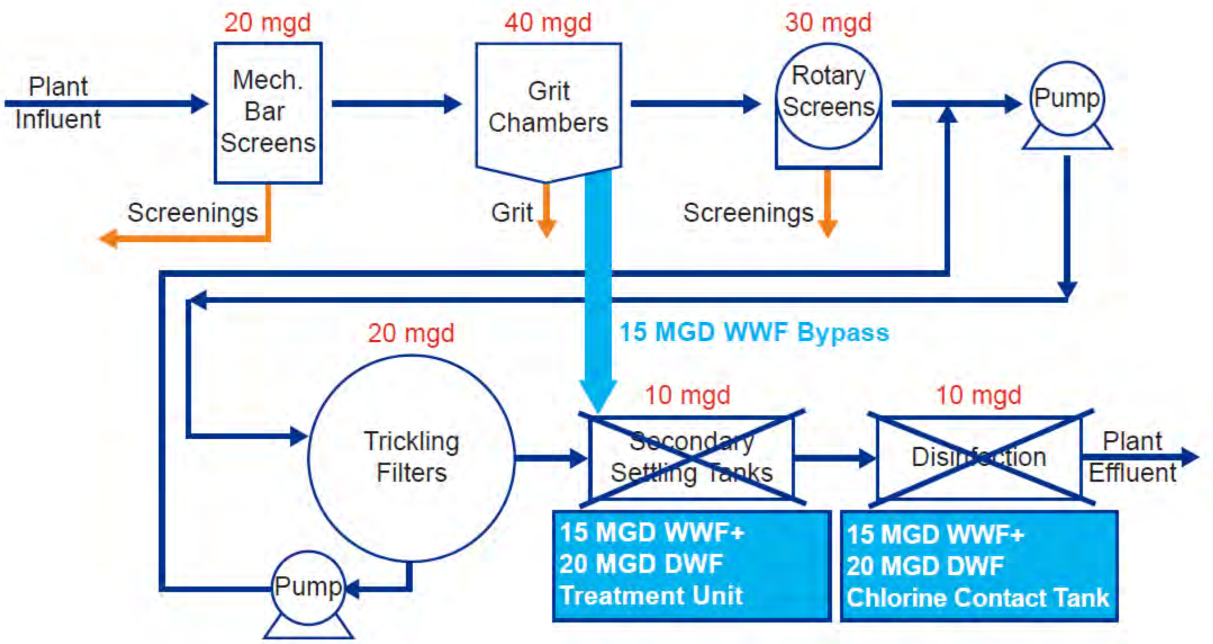
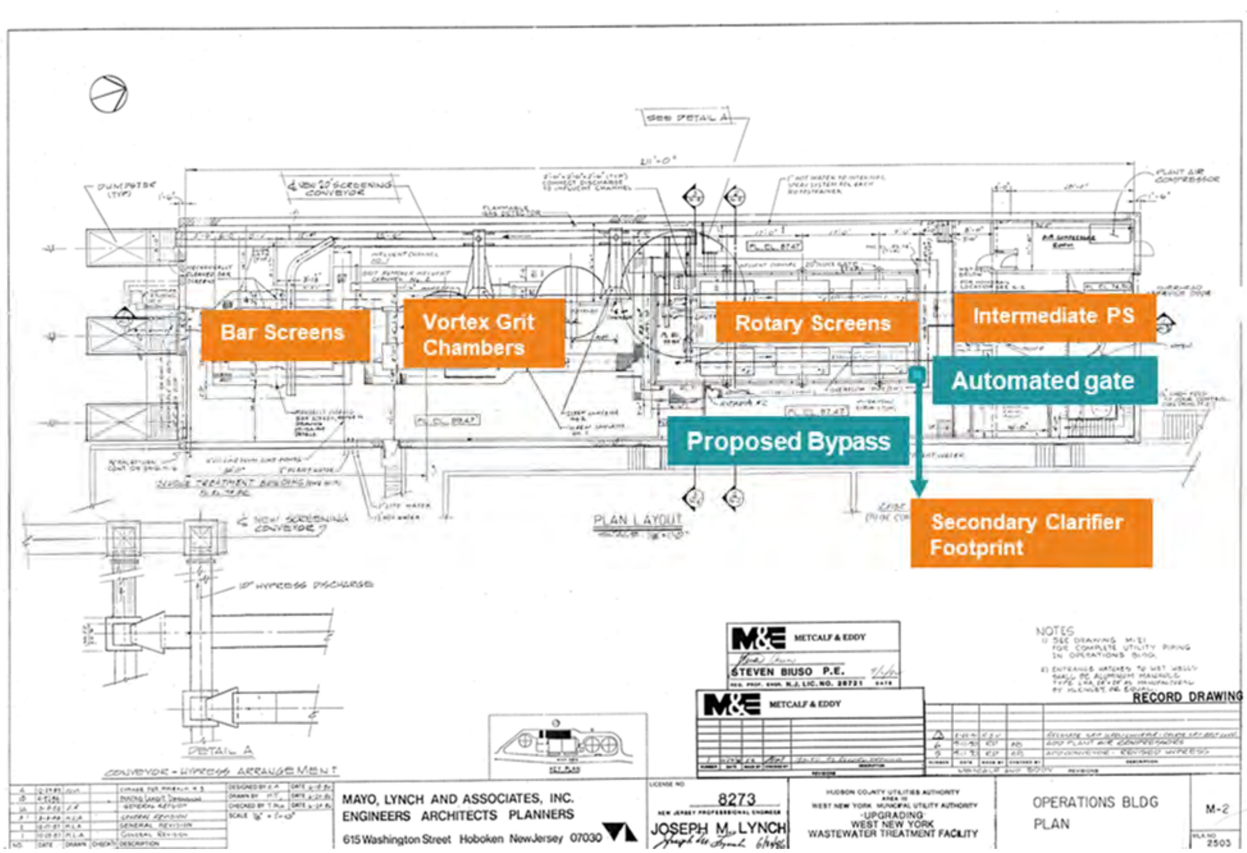


Figure 6-10. Proposed Bypass Location



It is proposed that chemical dosing of the southern secondary clarifier will be implemented to improve treatment performance by up to 50% while the northern secondary clarifier tank is decommissioned and replaced with the new treatment unit and upsized chlorine contact tank. While the southern secondary clarifier is decommissioned, the new treatment unit in the footprint of the northern clarifier will have a

20 mgd capacity which is sufficient to treat the current peak flows received at the plant. An additional treatment unit can be installed in the footprint of the southern clarifier if required.

Treatment alternatives to be located in the footprint of the secondary clarifier and chlorine contact area are thus evaluated in the next section below.

6.1.1 Construction Narrative

If making improvements at the treatment plant site, consideration will need to be given to how the new treatment unit will be installed and the secondary clarifiers decommissioned while keeping the plant in operation. The following construction sequence is proposed. It is noted that the construction sequence will be the same, regardless of the treatment alternative that is selected:

1. Retrofit bypass in preliminary treatment building so WWF (up to 15 mgd) bypasses rotary screens to flow from vortex grit chamber toward secondary clarifier. Up to 20 mgd still goes through rotary screens and trickling filters to secondary treatment.
2. Implement chemical dosing of southern secondary clarifier.
3. If required, install temporary secondary treatment unit to supplement chemical dosing.
4. Decommission northern secondary clarifier tank and replace with new treatment unit and upsized 9-foot-deep chlorine contact tank in the same footprint.
5. If required, decommission southern secondary clarifier tank and replace with treatment unit and upsized chlorine contact tank.

It is noted that this strategy is contingent upon the assumption that temporary chemical dosing of the clarifier will provide adequate secondary treatment. Alternatively, approval will be sought from NJDEP to receive approval for this intermediary treatment approach until construction has been completed.

6.1.2 Modelling Results

The River Road WWTP ICM model was adjusted to increase the capacity of the plant to 35 mgd. It was found that while there was no change to the overflows at JOSO, the River Road overflows dropped from 60 to 42 events in Typical Year and from 190.4 MG to 90.9 MG total overflow volume. The CSO volumes and events are summarized in Figure 6-11 through Figure 6-14.

Figure 6-11. Change in Volume at JOSO due to Treatment Plan Modifications

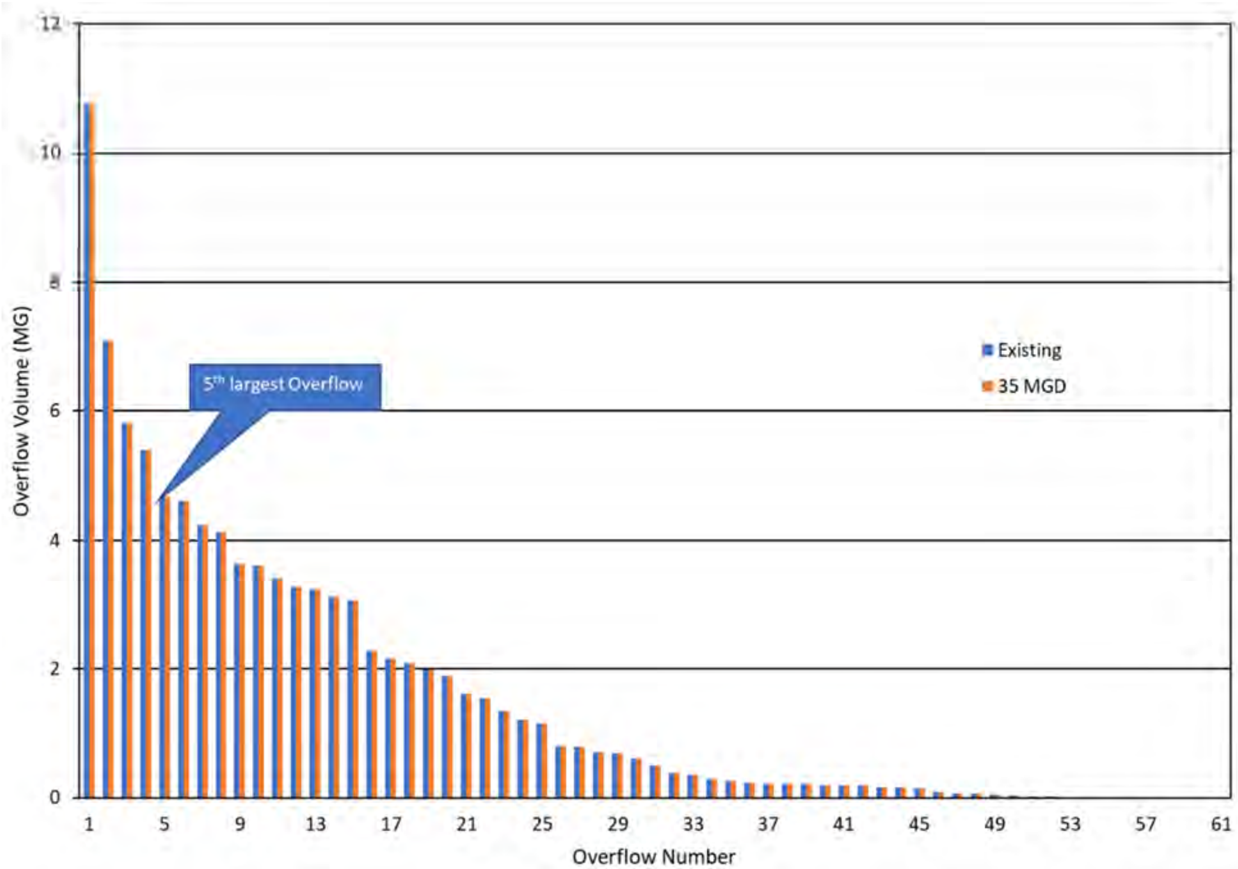


Figure 6-12. Change in Volume at River Road due to Treatment Plan Modifications

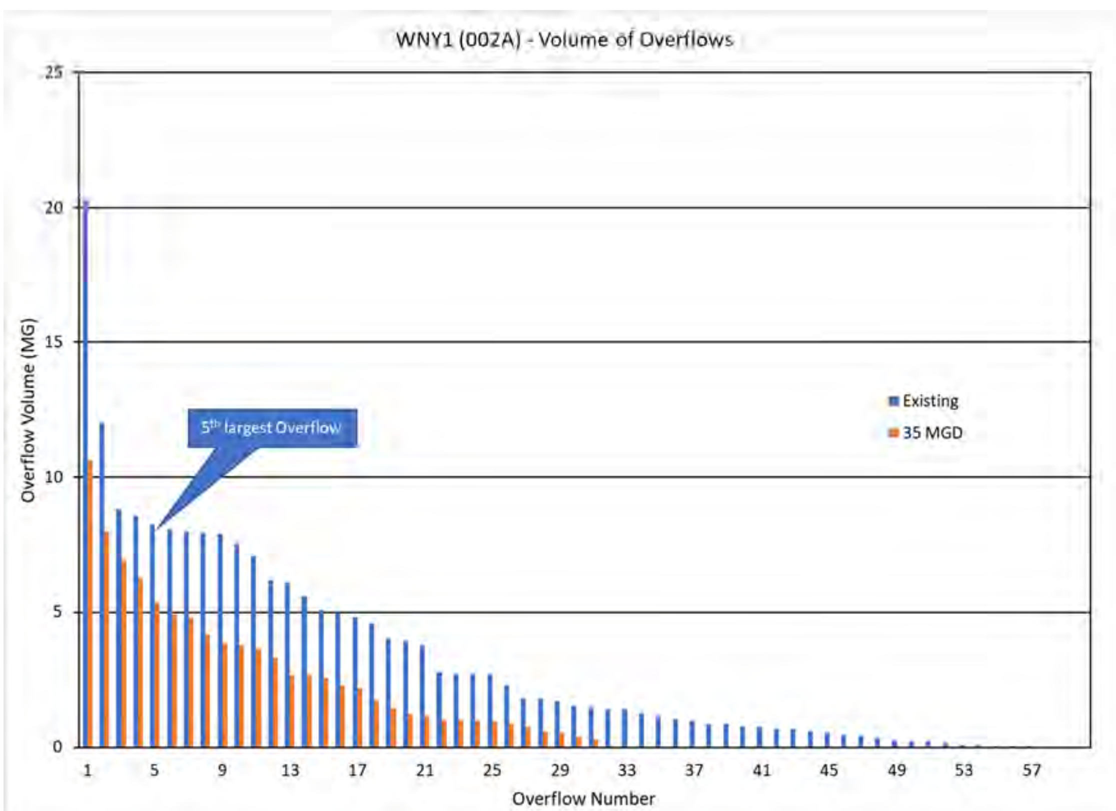


Figure 6-13. Change in Peak Flow at JOSO due to Treatment Plan Modifications

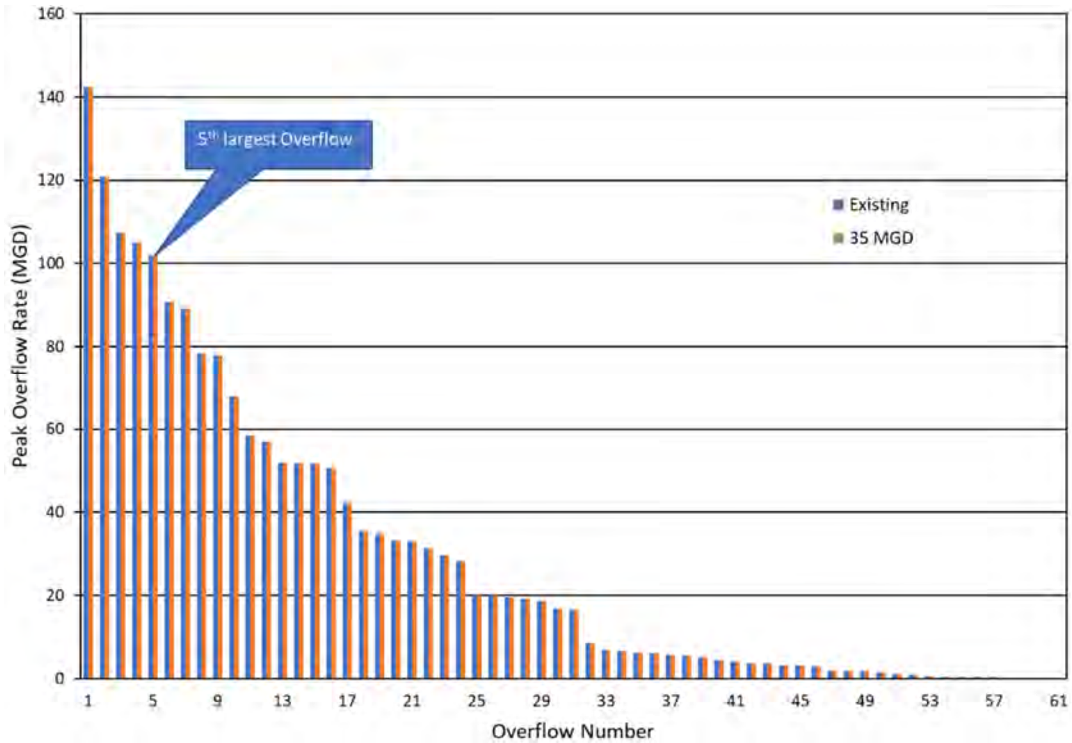
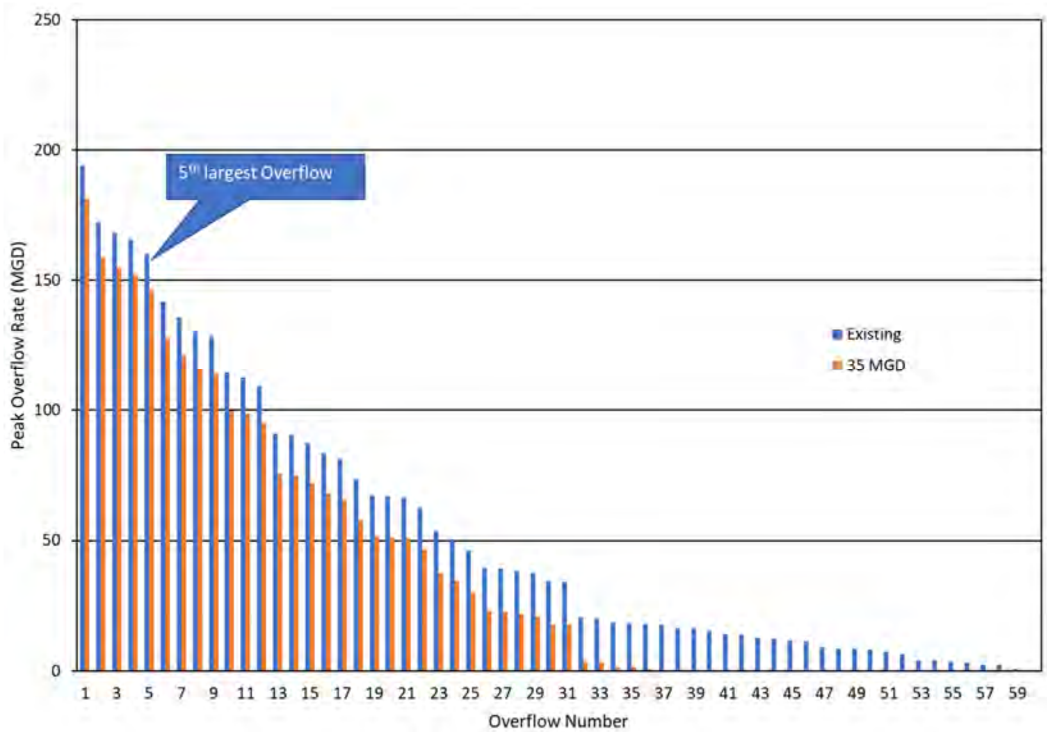


Figure 6-14. Change in Peak Flow at River Road due to Treatment Plan Modifications



6.2 Alternatives

Four treatment alternatives were evaluated as alternatives to the existing secondary clarifiers based on site limitations and feasibility of technology at the River Road WWTP.

ActiFLO
CoMag

- Cloth Media Filtration
- Compressed Media Filtration

6.2.1 ActiFLO

6.2.1.1 Identification and Preliminary Screening

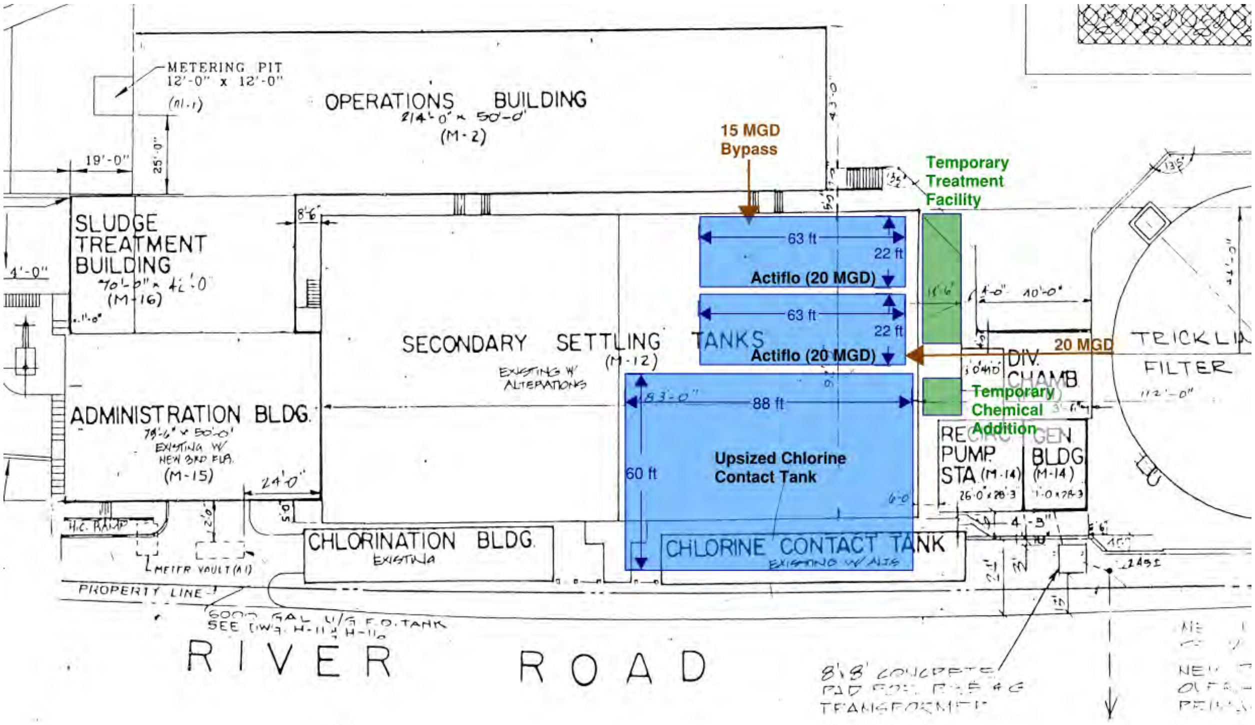
The addition of ACTIFLO® technology to bypass the strainers is considered as an alternative to increase treatment capacity to the River Road WWTP. ACTIFLO® is an established ballasted flocculation technology for CSO and wet weather treatment.

- Anticipated Constraints and Site Limitations:
  - As noted in the construction sequence, existing equipment would need to be relocated and reconfigured to accommodate the addition of the ACTIFLO® system. It is anticipated that the system may also require coarse as well as fine screening upstream to ensure that larger debris does not impact the functionality of the system. The ACTIFLO® also requires space for support systems such as a coagulant, polymer, and sand storage systems. In order to achieve a total treatment capacity of at least 35 mgd, two 20 mgd units are proposed, which would require a footprint of approximately 63 feet-3 inches by 22 feet each. Installation of an ACTIFLO facility to increase treatment capacity may also require upgrades to downstream processes such as disinfection and the outfall to treat and discharge the additional flow.
  - A significant constraint in the use of ACTIFLO® technology in end of pipe applications is the startup time, which is in the range of 15-30 minutes. However, at the WWTP the system would be in continuous operation and would be able to treat the first flush, which carries the greatest pollutant loading. As such it is recommended that the ACTIFLO system be left on all the time, and a wet weather operational procedure developed to bring additional train on-line with increasing flow. The system requires significant operation and maintenance attention and there is some complexity in determining the appropriate chemical dosage, which must be controlled by the flow rate.
- Functionality and Feasibility:
  - Performance efficiency - ActiFLO is known to provide TSS removal rates of 80-95% and fecal coliform removal rates of 85-95%. It is very effective in removing pollutants, particularly because the addition of coagulant and polymer helps to remove smaller particles.
  - Performance of the ACTIFLO® system is believed to deteriorate quickly for surface loading rates higher than 60 gallons per minute per square foot. The system is gravity fed, compatible with previously developed site layouts, and there is some flexibility in the system because the units can be added modularly. The amount of head loss must be considered in fitting it into the hydraulic grade line of the plant.
  - The system requires weekly inspections and preventive maintenance. If the system is being used intermittently, maintenance will be required to ensure that it is in working condition. These commitments would need to be agreed upon by plant staff. The ACTIFLO® system has significant operational and maintenance requirements, as well as complexity in chemical dosage, as such the Authority will need to take on the additional operational and upkeep duties.

6.2.1.2 Conceptual Network Layout

Figure 6-15 shows a conceptual layout of the ACTIFLO system.

Figure 6-15. ActiFlo Conceptual Layout



6.2.1.3 Cost

Table 6-1 lists the associated costs for this alternative.

Table 6-1. River Road WWTP ActiFLO- Conceptual Cost Estimate	
Construction Cost Estimate	$11,923,000
Project Annual Operations and Maintenance	$1,175,000
Project Capital Cost Estimate	$15,500,000
Project 50 Year Present Worth Estimate	$38,533,000

6.2.2 CoMag

6.2.2.1 Identification and Preliminary Screening

CoMag® is a ballasted settling process that could be implemented to increase treatment capacity. Modification of the current treatment works with CoMag® technology is considered as an alternative to add additional treatment capacity to the River Road WWTP.

- Anticipated Constraints and Site Limitations:
  - Existing equipment would need to be relocated and reconfigured to accommodate the addition of the CoMag® system. It is anticipated that a CoMag® system may also require coarse screening and possibly fine screening upstream to ensure that larger debris does not impact the functionality of the system. The CoMag® system also requires space for support systems such as a coagulant storage system and a feed storage system.
  - A significant constraint in the use of CoMag® technology in end of pipe applications is the startup time, which is in the range of 15-30 minutes. However, at the River Road WWTP the system would be in continuous operation and would be able to treat the first flush, which carries the greatest pollutant loading. As such it is recommended that the CoMag® system be

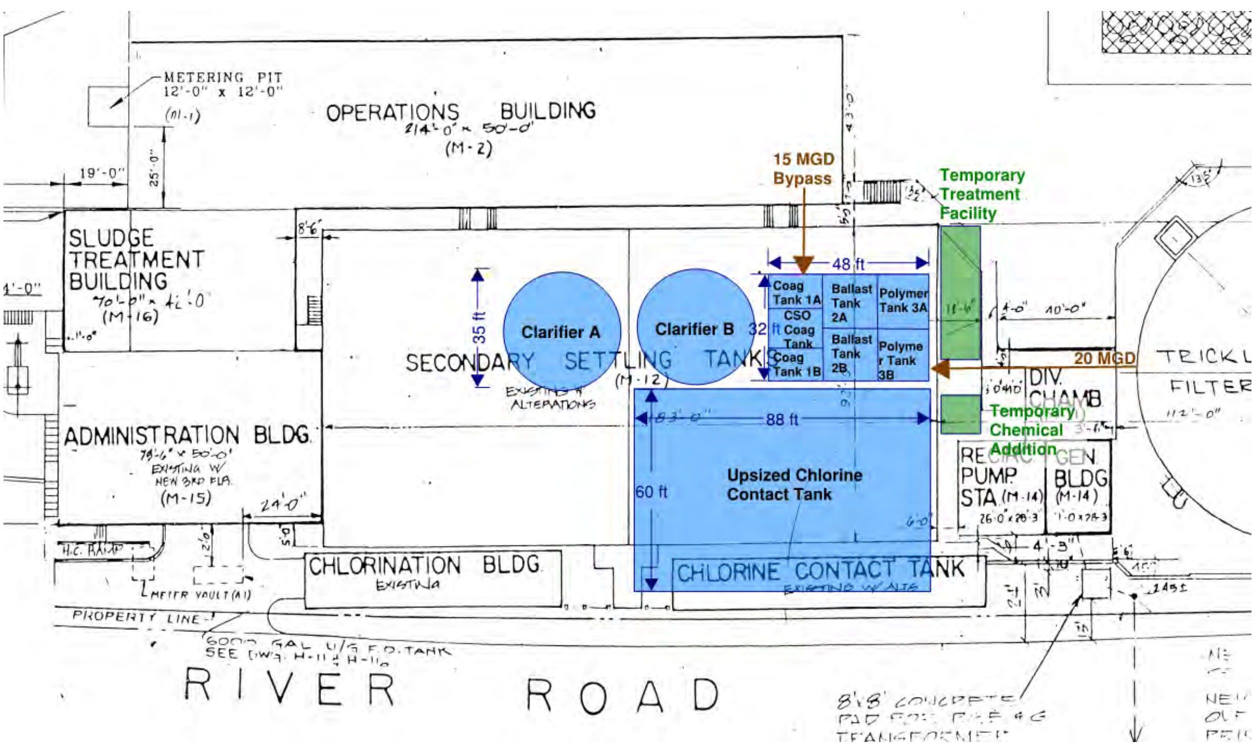
left on all the time, and a wet weather operational procedure developed to bring additional train on-line with increasing flow.

- Functionality and Feasibility:
  - Performance efficiency - the system is known to provide TSS removal rates of 75-95% and fecal coliform removal to < 200 Col/100 mL. CoMag® is not as widely used as other technologies for CSO and wet weather treatment applications as such site-specific pilot testing is recommended.
  - The amount of headloss must be considered in fitting it into the hydraulic grade line of the plant. The CoMag® system is able to provide settling rates which are faster than conventional treatments.
  - CoMag® is considered a flexible process because of its ability to treat widely fluctuating flows and loads. In addition, magnetite is denser than the sand used in other ballasted flocculation processes, readily available (iron ore commodity), fully inert, not abrasive (particle size is 40-50 microns) and magnetically retrievable (high recovery rates). Because the recovery rates of magnetite are high, the daily consumption is very low.
  - The system requires significant operation and maintenance attention and there is some complexity in determining the appropriate chemical dosage, which must be controlled by the flow rate. As such the Authority will need to take on the additional operational and upkeep duties.

6.2.2.2 Conceptual Network Layout

A conceptual layout of the CoMag system.

Figure 6-16. CoMag Conceptual Layout



6.2.2.3 Cost

Table 6-2 lists the costs associated to this alternative.

Table 6-2. River Road WWTP CoMag- Conceptual Cost Estimate	
Construction Cost Estimate	$12,191,000
Project Annual Operations and Maintenance	$409,000
Project Capital Cost Estimate	$15,849,000
Project 50 Year Present Worth Estimate	$23,860,000

6.2.3 Cloth Media Filtration

6.2.3.1 Identification and Preliminary Screening

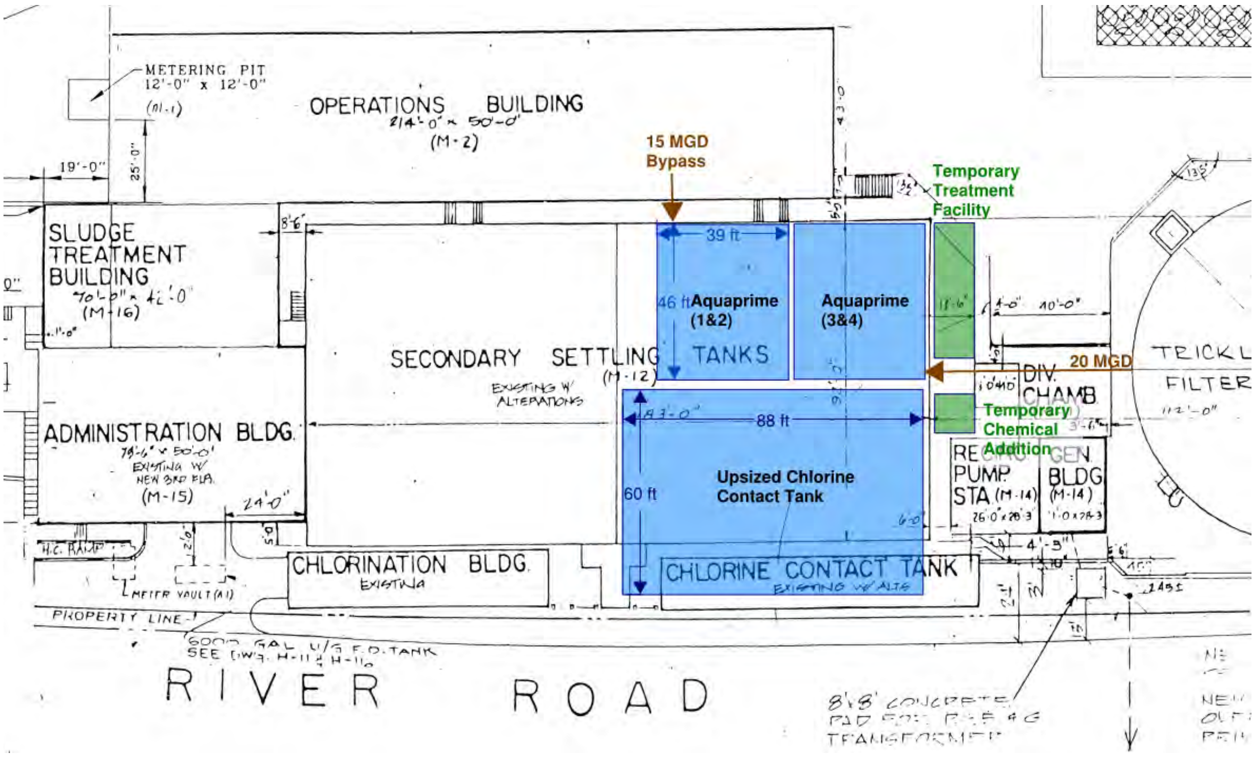
A high rate cloth media filtration system such as Aquaprime is considered as an alternative at the WWTP to increase treatment capacity and provide removal of total suspended solids (TSS). This application would require four Model 108 AquaPrime® Cloth Media Filters with 24 disks each in concrete basins.

- Anticipated Constraints and Site Limitations:
  - Existing equipment may need to be relocated and reconfigured to accommodate this system. A filtration system may also require space for support systems such as blowers and backwash pumps.
- Functionality and Feasibility:
  - Cloth media filters such as AquaPrime® for wet weather treatment is a relatively new application of an older technology that is being more widely adopted in recent years. They are gravity fed but are able to remain in filtration mode during backwashing meaning standby units are necessarily required. A significant benefit of this system is the short startup time. Performance efficiency with the AquaPrime® is about 75% to 85% TSS removal and 45% to 60% for CBOD removal. The amount of headloss required must be considered in fitting it into the hydraulic grade line of the plant.
  - Onsite piloting is required to determine the achievable effluent quality. AquaPrime has been successfully tested on filtering trickling filter effluent, however the maximum loading was only about 60 milligrams per liter (mg/L), and a pilot study is needed to confirm the treatability of higher solids wastewater, which based on historical data has an average TSS loading of about 110 mg/L and maximum of 668 mg/L.

6.2.3.2 Conceptual Network Layout

Figure 6-17 shows a conceptual layout of the Aquaprime system.

Figure 6-17. AquaPrime Conceptual Layout



6.2.3.3 Cost

Table 6-3 lists the costs associated to this alternative.

Table 6-3. River Road WWTP Cloth Media Filtration- Conceptual Cost Estimate	
Construction Cost Estimate	$14,961,000
Project Annual Operations and Maintenance	$330,000
Project Capital Cost Estimate	$19,450,000
Project 50 Year Present Worth Estimate	$25,927,000

6.2.4 Compressible Media Filtration

6.2.4.1 Identification and Preliminary Screening

Compressible media filtration (CMF) is a process that uses a synthetic, porous filter media for removal of turbidity and total suspended solids. The WWETCO FlexFilter compressible media filtration system has been considered as an alternative at the River Road WWTP to increase treatment capacity and provide removal of total suspended solids (TSS). The FlexFilter uses synthetic fiber spheres as filter media. This application would require 8 filter cells in two trains (4 cells per train) that can treat 35 mgd at an average TSS of 127 mg/L (average dry and wet TSS concentration).

- Anticipated Constraints and Site Limitations:
  - The system would fit into the footprint of one of the two 90-ft x 90-ft square clarifier structures with additional space required for the upgraded chlorine contact tank. The layout concept would include room for backwash transfer pumping and low head effluent pumping. This layout would treat the 35 mgd plus recycle and backwash return (approximately 46 mgd total). One train can be used for dry weather and one for wet weather, or both operating as a combined system. The capacity of the existing grit and trickling filter systems should be confirmed as to

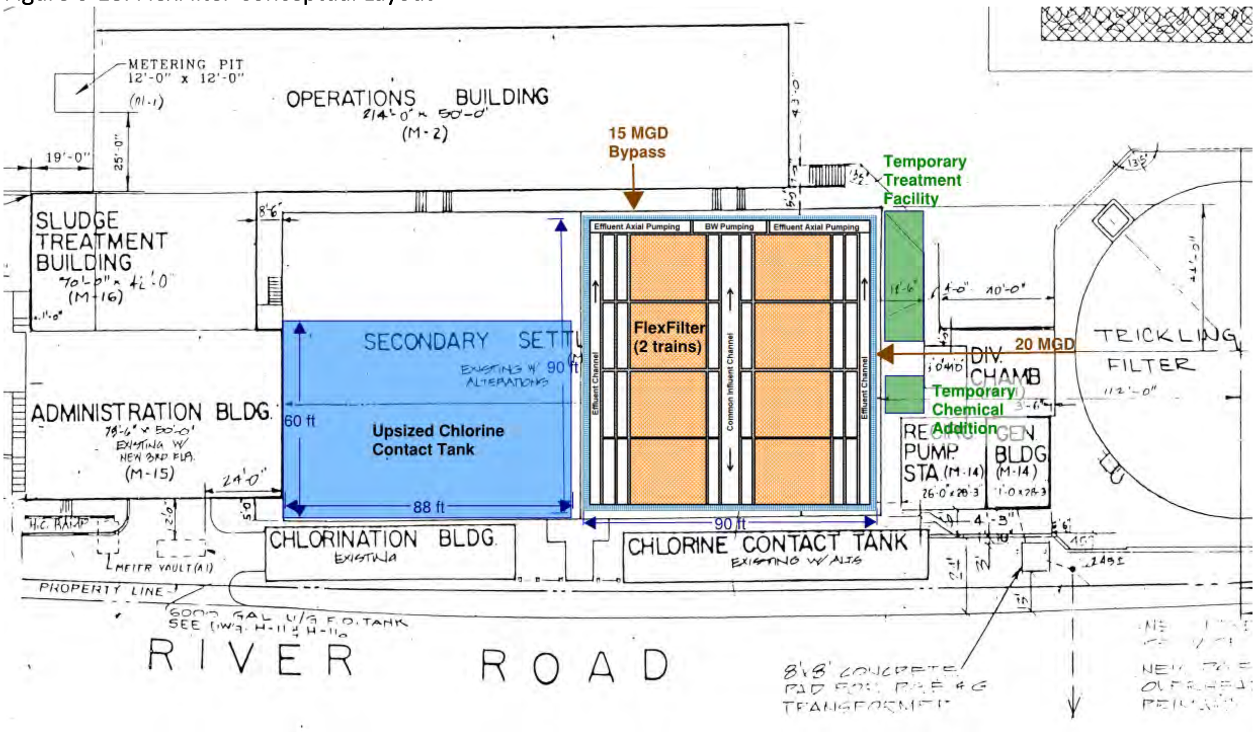
whether they can accommodate the increased flow as well as the extra flow from the backwash and grit loading.

- Functionality and Feasibility:
  - Performance of CMF is similar to other more conventional filters, however the filtration rate is more than 3 to 6 times the rate of other filters and the startup time is instantaneous. percent backwash water required is significantly less than that used in conventional filtration technologies. The manufacturer indicates that the contaminants removal efficiency of WWETCO FlexFilter in CSO application ranges from 73% to 94% for TSS removal and 16% to 69% for CBOD removal.
  - It is known from the Bayonne Municipal Utilities Authority pilot study that the FlexFilter units may experience operating issues related to the pumps and the time needed to backwash. Shorter filter run times and frequent backwashing were experienced when testing at the higher end of the filter loading rate recommended for CSO treatment. The compressed media filter is effective in removing finer and organic suspended solids. The FlexFilter utilizes low head air to accomplish the media scrubbing while lifting the backwash water to waste, thus minimizing backwash waste volumes. The influent TSS concentration to the FlexFilter is limited to less than 100 mg/L, and higher TSS concentrations increase the backwash time resulting in overall reduced performance of the units.
  - Operational and maintenance considerations include power costs for the blowers, recycle pumps, and backwash pumps as well as media change-out cost, labor for preventative and routine maintenance, and labor for post event clean-out. The FlexFilter system is relatively complex to operate due to automated valves, hydraulically operated porous plate, air injection into the beds during backwashing, and the monitoring needed for the flow and headloss conditions. The valves can be an issue during outdoor operation in freezing weather conditions. Chlorine dose of 5 mg/L to backwash is needed to control biological growth. This system is not designed for continuous backwash or continuous TSS of 300 mg/L at 35 mgd.

6.2.4.2 Conceptual Network Layout

Figure 6-18 shows a conceptual layout of the FlexFilter system.

Figure 6-18. FlexFilter Conceptual Layout



6.2.4.3 Cost

Table 6-4 lists the costs associated to this alternative.

Table 6-4. River Road WWTP Compressible Media Filtration (FlexFilter) - Conceptual Cost Estimate	
Construction Cost Estimate	$15,425,000
Project Annual Operations and Maintenance	$351,000
Project Capital Cost Estimate	$20,053,000
Project 50 Year Present Worth Estimate	$26,931,000

6.3 Alternatives Comparison

Each alternative was assigned a score based on the evaluation criteria identified in Task 1. Table 6-5 shows the weighted point total and weighted average of each alternative for the JOSO drainage basin. The full breakdown of the scoring for each alternative can be found in Appendix B.

Table 6-5. River Road WWTP Alternatives Score Comparison

Alternative	Weighted Point Total	Weighted Percent
ActiFLO	121	87%
CoMag	121	87%
Cloth Media Filtration	122	88%
Compressible Media Filtration	122	88%

SECTION 7

Summary

The Development and Evaluation of Alternatives report can be applied to the following phase of the LTCP, Selection and Implementation of Alternatives in the River Road Service Area. Table 7-1 shows the comparison of the alternatives based on the evaluation criteria. The details of each alternative listed in the report apply under the specific conditions stated here and any deviations to the assumptions listed may result in a change in the overall result of implementation, cost and evaluation score.

Table 7-1. River Road Service Area-CSO Control Alternatives Comparison

Drainage Basin	Alternatives	Weighted Point Total	Weighted Percent	Class 5 Conceptual Construction Cost Estimate
JOSO	Combined Sewer Overflow Storage Structure In Water	66	47%	$82,160,000.00
	Raise Regulator Weirs at UC1, UC2 and WNY2	105	76%	$120,000
	Replace Existing JOSO Sideflow Weirs with Bending Weirs	119	86%	$352,000
WNY1	Combined Sewer Overflow Storage Tank near WNY1 Outfall	65	47%	$60,333,000.00
	Linear Storage Tunnel at Anthony Defino Way	63	46%	$171,450,000.00
	Cloth Media Filtration[1]	-	-	$27,700,000-$86,500,000
	Compressible Media Filtration[2]	-	-	$92,000,000
Systemwide	Inflow/Infiltration Rehabilitation	107	77%	$13,788,000
	Green Infrastructure	99	71%	$42,310,000.00
River Road WWTP	ActiFLO	121	87%	$11,923,000
	CoMag	121	87%	$12,191,000
	Cloth Media Filtration	122	88%	$14,961,000
	Compressible Media Filtration	122	88%	$15,425,000

1. Alternative not scored due to potential range of costs
2. Alternative not scored due to potential range of costs; cost shown assumes max TSS concentration of 320 mg/L

SECTION 8

8 References

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Appendix A
Evaluation Criteria

Evaluation Criteria-Disinfection/Treatment Alternatives

Category	Criteria	1	2	3	4
CSO Reduction	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges of effluent	-	Alternative results in reduction of bacteria discharges of effluent	Alternative eliminates bacteria discharges of effluent
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in the Hudson River with help of another alternative	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary contact recreation and fishing)	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of Hudson River with help of another alternative	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective treatment under variety of operating conditions.	Need for supplemental steps in the treatment process – compatibility with disinfection process.	-	-	Limited number of steps in the treatment process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Relies on chemicals that are subject to degradation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater from interaction with agency	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

Evaluation Criteria-Storage/Conveyance Alternatives

Category	Criteria	1	2	3	4
CSO Reduction	CSO Volume Reduction	Greater than 4 overflows per year	-	-	Maximum of 4 overflows per year
	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges at outfall	-	Alternative results in reduction of bacteria discharges at outfall	Alternative eliminates bacteria discharges at outfall
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in Hudson River with help of another alternative	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary conta	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial	Will attribute to improved water quality to support partial	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of the alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective operation under variety of operating conditions.	Need for supplemental steps in the operation process – compatibility with disinfection process.	-	-	Limited number of steps in the storage process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response or positive public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

Appendix B
Evaluation Scores

JOSO Drainage Basin-Replace Existing Weirs with Bending Weirs

Category	Criteria	1	2	3	4
CSO Reduction	CSO Volume Reduction	Greater than 4 overflows per year	-	-	Maximum of 4 overflows per year
	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges at outfall	-	Alternative results in reduction of bacteria discharges at outfall	Alternative eliminates bacteria discharges at outfall
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in Hudson River with hel	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary conta	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial	Will attribute to improved water quality to support partial	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of the alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective operation under variety of operating conditions.	Need for supplemental steps in the operation process – compatibility with disinfection process.	-	-	Limited number of steps in the storage process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response or positive public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

JOSO Drainage Basin-In-Water CSO Storage Tank and Route Flow to Adams Street WWTP

Category	Criteria	1	2	3	4
CSO Reduction	CSO Volume Reduction	Greater than 4 overflows per year	-	-	Maximum of 4 overflows per year
	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges at outfall	-	Alternative results in reduction of bacteria discharges at outfall	Alternative eliminates bacteria discharges at outfall
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in Hudson River with hel	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary conta	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial	Will attribute to improved water quality to support partial	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of the alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective operation under variety of operating conditions.	Need for supplemental steps in the operation process – compatibility with disinfection process.	-	-	Limited number of steps in the storage process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Lack of performance history in application.	-	Alternative provides marignal performance while operating intermittently. Ability to operate after long idle periods.	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response or positive public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

JOSO Drainage Basin-Raise Regulator Weirs at UC1, UC2, and WNY2

Category	Criteria	1	2	3	4
CSO Reduction	CSO Volume Reduction	Greater than 4 overflows per year	-	-	Maximum of 4 overflows per year
	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges at outfall	-	Alternative results in reduction of bacteria discharges at outfall	Alternative eliminates bacteria discharges at outfall
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in Hudson River with hel	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary conta	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial	Will attribute to improved water quality to support partial	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of the alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective operation under variety of operating conditions.	Need for supplemental steps in the operation process – compatibility with disinfection process.	-	-	Limited number of steps in the storage process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Lack of performance history in application.	-	Alternative provides marignal performance while operating intermittently. Ability to operate after long idle periods.	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response or positive public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

WNY1 Drainage Basin-Storage Tunnel

Category	Criteria	1	2	3	4
CSO Reduction	CSO Volume Reduction	Greater than 4 overflows per year	-	-	Maximum of 4 overflows per year
	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges at outfall	-	Alternative results in reduction of bacteria discharges at outfall	Alternative eliminates bacteria discharges at outfall
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in Hudson River with hel	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary conta	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial	Will attribute to improved water quality to support partial	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of the alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective operation under variety of operating conditions.	Need for supplemental steps in the operation process – compatibility with disinfection process.	-	-	Limited number of steps in the storage process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
egulatory Complian	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response or positive public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

WNY1 Drainage Basin-In-Water CSO Storage Tank

Category	Criteria	1	2	3	4
CSO Reduction	CSO Volume Reduction	Greater than 4 overflows per year	-	-	Maximum of 4 overflows per year
	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges at outfall	-	Alternative results in reduction of bacteria discharges at outfall	Alternative eliminates bacteria discharges at outfall
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in Hudson River with hel	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary conta	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial	Will attribute to improved water quality to support partial	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of the alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective operation under variety of operating conditions.	Need for supplemental steps in the operation process – compatibility with disinfection process.	-	-	Limited number of steps in the storage process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Lack of performance history in application.	-	Alternative provides marginal performance while operating intermittently. Ability to operate after long idle periods.	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response or positive public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

Category	Criteria	1	2	3	4
CSO Reduction	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges of effluent	-	Alternative results in reduction of bacteria discharges of effluent	Alternative eliminates bacteria discharges of effluent
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in the Hudson River with help of another alternative	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary contact recreation and fishing)	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of Hudson River with help of another alternative	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective treatment under variety of operating conditions.	Need for supplemental steps in the treatment process – compatibility with disinfection process.	-	-	Limited number of steps in the treatment process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Relies on chemicals that are subject to degradation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater from interaction with agency	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

River Road WWTP-ActiFlo

Category	Criteria	1	2	3	4
CSO Reduction	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges of effluent	-	Alternative results in reduction of bacteria discharges of effluent	Alternative eliminates bacteria discharges of effluent
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in the Hudson River with help of another alternative	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary contact recreation and fishing)	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of Hudson River with help of another alternative	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective treatment under variety of operating conditions.	Need for supplemental steps in the treatment process – compatibility with disinfection process.	-	-	Limited number of steps in the treatment process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Relies on chemicals that are subject to degradation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater from interaction with agency	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on secondary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	Greater than $80,000,000	$50,000,000-$80,000,000	$20,000,000-$50,000,000	Less than $20,000,000
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	Greater than $200,000	$100,000-$200,000	$75,000-$100,000	Less than $75,000
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
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River Road WWTP-FlexFilter CMF

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Appendix C
Alternatives Analysis Workshop Memorandum

WORKSHOP SUMMARY

CSO Alternatives Analysis Concept Workshop

DATE:	June 14-15, 2018
ATTENDEES:	See attached attendance roster
PREPARED BY:	Jacobs Engineering Group
PROJECT:	Long Term Control Plan October 5,
ISSUED:	2018

The North Hudson Sewerage Authority (the Authority or NHSA) is developing its combined sewer overflow (CSO) Long Term Control Plan (LTCP) to comply with its permits. The Authority held a CSO Alternatives Analysis Concept Workshop on June 14 and 15, 2018. The workshop served as a brainstorming session to identify strategies and alternatives for maximizing wastewater treatment and reducing CSOs in the NHSA systems. The output from the workshop will be used by the Authority to further develop and evaluate CSO control alternatives, culminating in preparation of LTCP Evaluation of Alternatives Reports. This document describes the purpose of this summary, conceptual discussions for reducing and/or eliminating Adams Street and River Road CSOs, and action items.

Purpose of this Workshop Summary

The purpose of this summary is to document the discussions at the Authority's CSO Alternatives Analysis Concept Workshop held on June 14 and 15, 2018. The first day of the workshop focused on the Adams Street WWTP system, and the second day focused on the River Road WWTP system. Sign in sheets showing those in attendance over both days are provided in Attachment 1. The agenda detailing the schedule for discussion on each day is provided in Attachment 2. Handouts from the workshop are provided as Attachment 3.

Adams Street CSOs

Adams Street - Brief Overview of WWTP system

The Adams Street WWTP system is a combined sewer system owned and operated by the Authority. A few private developments have separate systems within the area, but they are not operated by NHSA. The Authority's "Sewer Atlas", developed using GIS, shows sewers, regulators and facilities featured on maps. NHSA has been using the maps to keep an accurate record of all sewers. The entire GIS was updated in 2015 and is continually updated. The GIS was used as the basis of the updated hydraulic collection system model. Summaries of the modeled CSO activations and volumes for the typical year for each regulator are provided in the handouts in Attachment 3.

The typical year rainfall data referenced in the table and charts showing the CSO activation frequencies and volumes in Attachment 3 was obtained from the NJ CSO Group. The typical year is based on hourly rain volumes at Newark Airport in 2004. The InfoWorks ICM collection system hydraulic/hydrologic model was calibrated and validated to six months of flow monitoring data collected in 2016. The flow monitoring data was collected from flow monitors placed upstream of each regulator. The Authority also installed Mission sensors at the elevation of the weirs within each regulator. These sensors were connected to a cellular device to indicate that a CSO is activated when the water elevation in the sewer is greater than the height of the weir. The model does not include future projections for additional flows because the Authority considers the system to be built out and does not anticipate that redevelopment will significantly increase dry weather flows. The Authority's new connection requirements are proactive and minimize peak wet weather flows into the systems.

It was noted that in Hoboken, tidal impacts can prevent the regulators from opening at high tides. On the system schematics included in the handouts, the number of days of overflow exceeds the number of events, since overflows can sometimes occur over two or more days. It was noted that overflows typically do not correlate directly with higher flows at the WWTP but when flows rise at the WWTP, CSOs are likely occurring. When severe wet weather events and high tides occur simultaneously, CSOs are pumped to river to prevent street flooding. In general, the West New York regulators (in the River Road WWTP service area) are the first to activate, and Hoboken regulators are the last to activate. The regulators then stop activating from north to south. Regulators W1, W2, W3 and W4 are operated manually. All outfalls currently have solids/floatables (S/F) controls (except W1234 - under construction) with TideFlex valve tide gates. It was suggested to show overflow volumes by storm for each outfall to determine if there are patterns in system-wide overflows or if overflows occur at some outfalls but not others at threshold-sized events.

Flushing chambers were originally provided in the upstream reaches of several drainage basins in Hoboken. These flushing chambers provide hydraulic connections between adjacent drainage basins, but the flushing chambers are no longer used by the Authority. The Authority desires to eliminate these interconnections between the drainage basins. The interconnections are included in the InfoWorks model and are assumed to be open but can be removed when changes are made to the system. The Authority has been removing these chambers when opportunities arise. The Authority is developing a drainage plan for areas H1 through H5 (a CH2M HILL/Mott MacDonald project) that will likely address this issue. The project will also investigate improving dry weather flow conveyance with new booster pump stations. It was noted that small-diameter pipes embedded in the inverts of the combined sewers were originally intended to feed the flushing chambers. The potential to repurpose these pipes for enhanced conveyance was discussed.

A brief overview of the status of the Rebuild by Design-Hudson River project was discussed. Funds from the U.S. Department of Housing and Urban Development (HUD) were given to the New Jersey Department of Environmental Protection (NJDEP) for two projects in the Meadowlands and the Hudson River. The Hudson River project has the goal of increasing flood resilience for Hoboken and Weehawken. The ongoing design is to raise flood protection to the 100-year flood elevation by integrating natural topography with new permanent and mobile barriers. During a storm with surge, the barriers will be closed, and wet weather flow will be held in the collection system. The H1 and H5 wet weather pump stations are critical to pumping out the collection system under high tide or storm surge conditions, but those pump stations will not protect parts of the H5 and H7 drainage areas. Future planning for the LTCP needs to consider the impact of the resilience program and if possible, seek to leverage the improvements where they can be coordinated to compliment the flood barrier project. Although likely a minor contributor to wet weather flows, the Authority should include in its LTCP model scenarios with the removal of areas that will be drained by the new stormwater systems outside the barrier.

The Authority's ongoing H6/H7 CSO Project is planning and designing high level storm sewers and a pump station in the H7 area alongside Hoboken's Northwest Resiliency Park project, which will have a one million gallon (MG) stormwater tank designed by Hoboken. The tank will be located under the new park. The tank will be emptied by the pump station via a force main connected to the existing Adams Street WWTP outfall. Runoff from both buildings and the street will be diverted to the stormwater tank. Planning takes into consideration Hoboken's long-term redevelopment plans for northwest Hoboken as well as the Authority's progressive requirements for new connections that would be applied in the area to limit wet weather flows in the existing combined sewers and maximize flows in the new high-level storm sewers.

It was noted that no bathing areas are located along the shoreline, but boating is popular, and a boat club is located near outfall 006A.

The intended level of CSO control was discussed. In general, the target will be 4 OF/yr. The NJ CSO group will conduct water quality modeling. CSO control may not result in a big change in attainment of water quality standards (WQS). Current data show WQS are being attained. AECOM noted that Hudson River data collected by the New York City Department of Environmental Protection shows similar findings.

Adams Street System-wide Alternatives

Green Infrastructure

Green infrastructure (GI) implementation would involve coordinating with all city departments although the different municipalities have different interests in CSO controls including GI. Hoboken is proactive but has poor infiltration and high ground water. Hoboken has a GI plan that includes Southwest Park and other GI projects and initiatives. A porous pavement project is located within the Police parking lot. The Authority may want to incorporate and quantify what Hoboken is doing into its LTCP now. But the Authority would need to coordinate with City and its various departments to determine what each will be doing and when. The Authority is constructing three GI projects in the other cities on its own. An overview of these projects is provided in Attachment 3.

GI projects done by others could be included as part of the NHSA LTCP, but the projects would have to be put into the LTCP implementation schedule and the expected performance would have to be established. If the Authority includes GI projects done by others in the LTCP, the Authority would have to partner with others on these installations to assure implementation and continual long-term operation that ensures the intended performance. This may be difficult as the technologies would need to be maintained and kept in service. One municipal administration may agree but the next may not, and instead limit/stop maintenance and/or remove a swale or porous pavement.

The Authority worked with Hoboken to implement GI at Southwest Park located in drainage area H1. The site includes the use of bioswales, rain gardens and permeable pavers. In addition, the site utilizes OPTI technology that involves automated valves with cloud-based technology to hold 70,000 gallons of runoff in storage and release it into the combined sewer system after a storm has passed. The Authority is implementing this technology at several other locations that are in planning and design stages in cooperation with developers. This is a combination of green/gray infrastructure. Because of this, agencies are viewing OPTI as more of a storage opportunity since operators/software monitor and control flows. In general, the OPTI technology allows for capture of stormwater from smaller storms that would otherwise pass through the orifices on stormwater tanks. The use of the OPTI technology may provide a factor of safety in the performance of the recommended CSO control plan.

The Authority requires a sewer connection application and significant stormwater attenuation for each sewer connection applicant. Grey infrastructure is common, however in some cases the owner looks for alternative solutions such as GI. The Authority offers credits for GI and has worked with applicants to promote green roof systems when there are challenges to installing conventional grey infrastructure. The Authority is incorporating all GI sites into the development review database to track all new developments with GI features and ensure GI maintenance. The owner is responsible for maintaining onsite GI. The Authority also noted that an inspection program for all stormwater management systems (gray and green) was recently approved by three of the four municipalities, and it is now being implemented.

The discussion noted how GI could be incorporated into the InfoWorks model. It was suggested that the model can be run with multiple control scenarios – 100% grey, 90% grey/10% green, 80% grey/20% green, etc.

Incorporating GI on private property was noted as an alternative to incorporating more GI in public spaces. Two concepts were identified for this approach: official projects are completed as part of stormwater management rules, and initiatives to have the community voluntarily contribute to stormwater control. This is a challenge for NHSA currently because opportunities are limited, and it is anticipated that developers will be the prime decision makers for applying GI. The developers will tend to look at GI in terms of cost-benefit for themselves, and their decisions will not necessarily be aligned with the Authority's LTCP goals. Individual homeowner GI initiatives with incentives may be a possible strategy to reduce wet weather flows. Agreements would be required to ensure perpetual maintenance of the GI on private property and this could be a hinderance. One suggestion was developing a menu of projects and selecting the project that captures the largest volume. Involving developers in this stage with the ability to quantify reductions in wet weather flows may be beneficial to the LTCP. This may entice developers to reduce flows and achieve LEED certifications.

It would make sense to use the model to conduct sensitivity runs of the impact of private GI on CSO volumes. If the impact on CSO volumes is minimal, it would not likely be worth the risk to commit to a level of private GI implementation.

Although the City of Hoboken is implementing various GI improvements as per its plan, the overall impact on reductions in CSO activations and volumes has yet to be quantified. A representative of AECOM indicated that in other cities, GI generally does not have a major impact on CSO volumes, perhaps on the order of 5% reduction in volume. GI may not be cost effective in terms of CSO reduction, but GI does have other community benefits that could be considered in a triple-bottom-line evaluation. NJDEP representatives noted that Rutgers did a GI study for Newark and it revealed only a minor CSO reduction if GI was implemented city-wide in all potential areas.

It was noted that the LTCP needs to be flexible to enable NHSA to make changes over time as new technologies may be introduced. An example cited was D.C. Water, George Hawkins, who has noted in presentations that when GI concepts were introduced, original grey infrastructure plans (such as tunnels) were subsequently modified to reflect reduction in the need for grey infrastructure. NJDEP indicated that the LTCP would be integrated into the NJPDES in 5-year increments aligned with milestones in the LTCP, which would provide for future flexibility.

Grey I/I Reduction

An effective approach to reduce infiltration and inflow (I/I) may be to build new stormwater systems to reduce flows in the combined sewers. However, the Authority indicated that providing separate storm drains would only pick up about 25% of the drainage, as 75% comes from private sources. The Authority noted that within its service area, I/I accounts for a significant portion of the flows at the WWTPs. The combined sewer systems may have been designed for conveying a 5-year/24-hour storm. However, some parts of Hoboken flood at high tide and then drain when the tide drops. Street flooding is not an issue in Union City, Weehawken and West New York. It was noted that the concept of sewer separation, even if feasible, does not necessarily result in water quality improvements. In some cases, such as when the CSO discharge frequency and volume is relatively low, sewer separation can degrade receiving water quality. The Authority noted that the NJDEP has indicated on the H6/H7 CSO Project that constructing new high-level storm sewers must result in the same or reduced solids discharges to surface waters, overall, between the new storm system and remaining CSOs.

The priority of reducing I/I was discussed. While I/I reductions do not contribute as much to CSO control as reducing runoff entering combined systems during wet weather, it was noted that I/I must be addressed to lower dry weather flows (DWF) in Hoboken and provide more capacity for wet weather flows. Within the River Road system, water leaks from drinking water distribution systems significantly contribute to I/I. The Authority works with United Water (Suez) to identify and reduce leaks, with noticeable benefits in the past. However, flows are rising again, and those flows may be attributable to new leaks. The Authority may be able to reduce its DWF to 7 or 8 million gallons per day (mgd) via continual focus on I/I reduction and sewer lining. Alternative evaluations should include model calculations of incremental I/I reductions to identify if appreciable benefits may be realized and compare I/I reduction to other alternatives for cost-effectiveness.

Private sources of rainfall-derived I/I from existing downspouts and sump pumps are sources of wet weather flow. The general opinion is that the opportunity to remove these sources is limited due to a number of factors, including the costs to homeowners for making changes to existing structures, the lack of separate storm sewer systems, and the density of development. New development is required to store flow from rooftops and surfaces to delay flows where the combined sewer system serves the area. New waterfront development has no combined sewers. Redevelopment in the H7 area will be required to connect storm flow to the future high-level storm sewer system being designed by the Authority's H6/H7 CSO Project.

The Authority indicated that they get some tidal inflow, but don't see high salinity at the WWTPs.

Storage at Regulators and Outfalls
Opportunities for 'system optimization' were discussed. Profiles reviewed during the meeting generally indicate that the interceptors run at capacity or surcharged conditions during the largest event of the typical year. It was suggested that similar graphics be prepared for 'the fifth largest' event to determine if in-system storage may be available for smaller storms.

Storage may be a possibility at several locations under streets, parks and parking lots (Observer Highway in H1, Stevens Park at H3/H4/HSI, under Sinatra Drive for H3/H4/HIS and H5, along waterfront at 18th Street Pump Station outfall). Alternatives to be considered could include locating storage offshore at existing/abandoned piers, or constructing a new pier, where storage (or treatment) could be located at or beneath the pier, with some potential recreation use at the surface. Permitting may be very difficult, and although the Authority was successful in permitting the W1234 S/F facility as an end-of-pipe facility in the Hudson River, the Authority should verify the feasibility of gaining regulatory approvals for end-of-pipe storage facilities that may encroach on surface waters.

Box culverts used in Elizabeth were raised as an example for discussion. In Elizabeth, a box culvert was constructed to store runoff to address flooding issues. This facility served as offline storage to capture the volume associated with storm peaks., and then to return the flow to the system when the storm recedes. For Hoboken, a box culvert may be difficult to site due to utility conflicts. It is important to note these structures were intended specifically for flood control.

Storage systems will likely require post-event flushing to remove floatables, solids and grit accumulations if no pre-treatment is constructed. In a tunnel or tank, 800 feet is typically the maximum length of scour effectiveness for a flushing gate. Odor generation and the need for odor control also can be a significant issue for the remnant solids.

Siting for storage facilities will be challenging. Property acquisition costs can be as high as $1 million for 2,500 square feet. It was noted that with above-grade storage, the need for influent pumping can increase the cost and risk. Contaminated soil handling costs could increase costs for below-grade storage.

High rate treatment at remote facilities was discussed. Challenges related to disinfection and de-chlorination of CSO discharges. Newport's facilities were mentioned as examples where high rate treatment has been used to supplement satellite storage facilities.

Increase Conveyance to WWTP and Expanded WWTP Capacity
System-wide alternatives to increase conveyance to the Adams Street WWTP were discussed. The Adams Street WWTP characteristics provided in the handout were reviewed (Attachment 3), including average and peak design flows. A consensus was that increasing wet weather flow to the WWTP may be potentially more cost-effective as opposed to in-system storage or end-of-pipe storage/treatment. The

WWTP was originally constructed in 1958, and since then has been expanded to increase hydraulic capacity and upgraded in terms of treatment processes. The annual average dry weather flow (AADF) has decreased from 20 mgd to 13 mgd. This reduction in flow was suggested to be a result of water conservation and targeting leaks in the system. The primary and secondary capacities are described in detail in the handout.

Possible updates to the WWTP processes and how they would benefit increased flows were discussed. Currently the primary clarifiers have a low overflow rate and some capacity is available to increase flow. It may be worth obtaining data on PST removals and overflow rates. One of the primary clarifiers is currently being used to store initial wet weather volumes during events as a standard procedure. The Authority is considering covering the primary clarifiers for odor control. Three trickling filters are installed and there are rare instances when all three are required for operation. It was suggested that one of the trickling filters could be replaced with a wet weather flow storage tank providing approximately 7 MG of storage. The existing sludge handling facility building was also mentioned as a potential location use for wet weather storage/treatment. However, potentially only half of this building would be readily available as the building currently houses the main electrical switch gear, which was recently upgraded. The dissolved air flotation (DAF) filters are currently the limiting factor for reaching the peak capacity of 40 mgd. The DAF filters are being replaced in an ongoing project that should enable 40 mgd peak capacity. The plant outfall may have an additional 7 to 12 mgd of storage.

It was noted that the Authority does not own any additional property adjacent to the Adams Street WWTP.

Increases in overall WWTP flow also brought up the topic of how this would affect the regulators and siphon that feed the WWTP. The siphon needs to be inspected and the construction of a parallel siphon may be necessary to enable the inspection. This would create an opportunity to increase flows to the WWTP. The suggestion of moving the W1, W2 and W3 regulators from their present locations to the top of the hill in their drainage areas was discussed. It was noted that the current manual operation of these regulators is a critical function, as failure to throttle the regulators under certain storm conditions could cause flooding that would affect the Lincoln Tunnel. Moving the regulators to the top of the hill could provide the opportunity for automation and better control of the flow as it drops in elevation. There was discussion of the significant technical challenges associated with this hydraulic control. Disinfection of the W1234 outfall may be the only viable control alternative for this outfall.

Approximately 22 MG of storage would be needed for all outfalls to reduce all overflows to four per typical year. If the Adams Street WWTP accepted typical dry weather flow, plus the additional volume from 22 MG of storage, it would take approximately three days to empty all the storage with the WWTP running at full capacity the entire time. Sidestream- treatment, blending, and/or a wet weather flow treatment facility at the WWTP would likely be required to drain 22 MG of storage in one day through the WWTP. The cost-effectiveness of this approach would need to be compared to end-of-pipe solutions.

Increasing flow through the WWTP would necessitate increasing the capacity of the effluent pump station and constructing a new WWTP outfall. The existing outfall capacity is limited and will also need to account for the H7 stormwater that will be pumped from the new Northwest Resiliency Park stormwater pump station. A new WWTP outfall could potentially be constructed from the northeast corner of the WWTP in a straight line to Weehawken Cove.

The Park Avenue siphon provides approximately 30% of the flow to the Adams Street WWTP. Pump station peak flows are as follows:

- Baldwin Ave PS: 0.65 mgd
- 5th Street PS: 5.5 mgd

- 11th Street PS: 2.5 mgd
- 18th Street PS: 5.5 mgd

The wet weather SOP calls for throttling W1 to W4, and the 5th Street and 11th Street Pump Stations as needed.

Regional Tunnel

The concept of a tunnel to capture wet weather flows from multiple regulators was discussed. It would make sense to first investigate what upgrades to flow capacity at the WWTP could be achieved and then move on to how a tunnel could be integrated. Tunneling would require land for shaft construction. Typically two to three acres is required for the mining operation at one end of the tunnel, while less area would be needed for the tunnel boring machine (TBM) removal shaft. The mining shaft is typically the downstream shaft, and a dewatering pump station would typically be located on the downstream shaft site. Acquiring access to properties during construction and for long-term operation at the shafts may be problematic in the service areas. Once constructed, the tunnel will require air shafts, which will require additional property.

Two tunnel concepts were discussed. In Weehawken, the overall concept was 'Hold, Release and Treat' for W1234 while in Hoboken the overall concept was 'Convey, Treat, Release.' The construction of a tunnel could be coordinated with resiliency work; data from geotechnical investigations by the Rebuild by Design project may be helpful in determining where and how to construct the tunnel. Additional use of the tunnel as an alternate means of conveyance to the WWTP to allow for system maintenance was discussed. It is also not ideal to have varying densities in material (combination of soft material and rock) as this may cause a tunnel boring machine to veer off course. Hard rock exists in the rock formations of the Palisades, while soft material exists along the waterfront. Deep rock tunnels minimize the settlement risk associated with shallower, soft ground tunnels.

The depths and sizes of tunnels were discussed. It was noted that a tunnel constructed within the Palisades may drain by gravity. Tunnels 100 feet below the surface and 300 feet below the surface were also suggested, noting that a tunnel at a depth of 100 feet would require one-stage pumping while a tunnel at 300 feet depth would most likely require two-stage pumping. A diameter range of eighteen to twenty feet is ideal to allow for efficient construction of the tunnel. A 2,000-foot tunnel at twenty feet in diameter can store approximately 4.7 MG. The ability to dewater the tunnel in a timely manner must also be considered to maximize capacity to accept multiple storms. Solids captured in a tunnel would have to be managed.

An example of a tunnel in another municipality was discussed for similarities. Milwaukee has had a tunnel system for 20 years. They hired a contractor to inspect the tunnel because deep tunnel inspection is specialized work and done infrequently. The tunnel itself generally requires little maintenance. The tunnel dewatering pump station maintenance can be challenging due to the depth of the pump station and the difficulty of access for personnel and equipment. Keeping the pump station dry can be another challenge, and it is usually necessary to dehumidify a pump station to keep it dry. Locating the mining shaft/dewatering pump station near the WWTP facilitates access to the facility and reduces the length of the dewatering pump station discharge force main.

It was noted that a tunnel could potentially help address surface flooding issues, if volume is available in the tunnel. If not operated properly, a tunnel could back up near surface piping.

Disinfection at Outfalls

Disinfection may be a viable option at existing facilities such as the H1 and H5 Wet Weather Pump Stations (outfalls 002A and 006A) and the 18th Street Pump Station (outfall 012A). Sufficient contact time will be needed for effective dosing systems. Disinfection may be the only viable option for W5 (outfall 015A). Peracetic acid may not be worth the chemical expense, difficulty in handling and design/construction costs to use at an outfall. It is currently used at the Adams Street WWTP to augment UV disinfection processes that are problematic due to DAF sand leaching. Peracetic acid is not widely used for CSO disinfection, so operating data on full-scale installations is limited. The Authority would prefer to not use peracetic acid. If sodium hypochlorite is used for disinfection, then dechlorination facilities would likely be required near the ends of the outfalls. It was noted that end-of-pipe treatment systems would likely require above-grade facilities to house a control room, an electrical room, chemical storage and feed equipment, etc.

Adams Street Outfall-specific Alternatives
The table provided in Attachment 4 summarizes the discussions for alternatives of specific outfalls for the Adams Street drainage area. Points were made regarding the estimated volume to control, available nearby open space for design, and key design points that may affect implementation.

River Road CSOs

River Road - Brief Overview of WWTP System

Attachment 3 is the handout provided during the workshop describing the River Road WWTP service area and providing the calculated CSO performance for the typical year. Like the Adams Street service area, the InfoWorks ICM model of the River Road service area is based on the Authority's GIS and was calibrated and validated to data collected in 2016.

There were some questions regarding the high flows calculated for Regulator WNY1. It was noted that the hydraulic profiles showed the peak hydraulic grade lines generally below the crown of the interceptor upstream of regulator WNY1 in the typical year, due to the elevation of the UC1, UC2 and UC3 weirs. The outfall downstream of Regulator WNY1 was shown to be surcharged. The regulators are located on the interceptor. Regulators UC1, UC2 and UC3 are side-overflow weirs. The top half of the interceptor has a hanging baffle to drive the flow over the weirs. At UC2 there appears to be only 4 inches of available freeboard during dry weather flow. WNY1 has a transverse weir and a gate. One of the weirs is up to 27 feet in length. The potential benefits of raising weirs to utilize the interceptor's capacity and 'maximize' flow to the WWTP should be evaluated during the planning effort.

General characteristics of the WWTP were discussed. It was noted that approximately half of the AADF may be I/I. The Authority noted the I/I is more closely connected to water main leaks as opposed to groundwater infiltration. I/I due to watermain leaks has been a challenge to eliminate but as noted earlier, the Authority proactively works with SUEZ to identify and eliminate leaks while also relining its sewers.

Overall WWTP capacity was discussed, noting that the current WWTP capacity is limited. Both clarifiers, both trickling filters and all six rotostrainers must run at all times. The two clarifiers are presently a bottleneck. The chorine contact tanks for disinfection are another bottleneck. Currently there is no space to expand at the WWTP. Expansion would be possible by excavating into the rock that abuts the facility. Space can also be made if the new treatment units are stacked.

It is currently not feasible to expand capacity within the existing unit processes described in Attachment 3, however replacements were discussed. CoMag® or Biomag® for clarifiers may enhance treatment. Replacing one clarifier with a cloth media filter or with a more efficient settling process may increase WWTP capacity. It was also suggested to replace the micro-strainers with a high-rate treatment system like Actiflo® to run at a higher rate during wet weather and lower rate during dry weather. Increasing WWTP capacity will likely necessitate increasing the capacity of the WWTP/WNY1 outfall to the Hudson River. The WWTP outfall drops from 90-inch to 54-inch diameter.

A concept of diverting some of the DWF to the Adams Street WWTP was discussed. The NHSA noted that this has been considered previously. It was also noted this could have permitting implications as the system would then be hydraulically connected. Another option discussed was constructing a tunnel connecting the Adams Street and River Road systems and equalizing flows between the two WWTPs.

This alternative would most likely require significant SCADA controls and optimization. It can be investigated to send sanitary/CSO flow to Adams Street and use River Road for stormwater treatment only.

River Road Outfall-specific Alternatives

WNY1

It was noted that the overflow volume for the largest storm in the typical year is significantly larger than the next-largest storm. Constructing approximately 2,000 feet of linear storage beneath Anthony M Defino Way between Regulator WNY1 and the WWTP was discussed. The Authority has also been investigating available lots near the River Road WWTP to locate storage and/or treatment for WNY1 overflows. A strip of land approximately 95 feet in width below the WWTP between Anthony M Defino Way and Port Imperial Blvd. was discussed as a potential site. The slope on the property is steep and it would be challenging to construct a facility cost-effectively. It was noted that this swath is owned by a developer. Creating storage here would require the flow to be pumped to the WWTP. Constructing a treatment system on the site would likely be more cost-effective than storage and pumping to the WWTP. A final alternative suggested was creating a new WWTP outfall altogether. This however would create permitting and constructability issues.

JOSO

The JOSO outfall is a box culvert taking overflows from multiple regulators above the Palisades, then dropping down to the Hudson River waterfront via a drop shaft and conveyance to the S/F facility on the waterfront. The top ten feet of the drop shaft is precast concrete, but the shaft then transitions to unlined rock. This location creates a very high-energy drop. The culvert is an irregular shape due to the surrounding rock. The available space for control alternatives along the outfall is minimal. No space is available for storage tanks and also no ideal space for linear storage through the use of a tunnel. A suggested alternative was to divert JOSO flows to either the Adams Street system or to WNY1. Diverting to WNY1 would necessitate a larger or additional outfall at WNY1.

River Road System-wide Alternatives

There was a consensus that I/I reduction and GI should be considered but may not be the most cost-effective alternatives due to the smaller size of the system and limited space available for GI. The Authority will continue to be proactive with United Water (Suez) in working to eliminate their leaks. The Authority estimates that the cost of relining sewers in the River Road service area is likely $20 to $25M. It was suggested that increased capacities and storage with diverted flow elsewhere should be considered with greater weight for this system. Bending weirs should be considered for the existing regulators to maximize flow in the system, especially where modeling indicates that sewer capacities are not maximized during wet weather. It was suggested that additional modeling runs should be conducted as well to further analyze system flows and evaluate how the timing of the peaks compares with a view towards opportunities to maximize storage and conveyance to the WWTP.

Disinfection may be considered for both outfalls, but the dosing point may need to be as far upstream as possible in the outfalls to achieve the proper contact time. An outfall disinfection system may also need a dechlorination facility. There were additional discussions on peracetic acid since it would not have a residual. It was noted that peracetic acid is five times more expensive than conventional chlorination, so even without the need for de-chlorination peracetic acid is not always cost-effective. As noted earlier, there are few full scale wet weather applications of peracetic acid with operational and performance histories. Other disinfection alternatives were discussed. The City of Newport, RI has two high rate chlorination/de-chlorination facilities. These facilities find it difficult to hit target kills because flow rates change rapidly.

Recommended Modeling Scenarios

The following modeling scenarios and evaluations were recommended for better understanding existing performance and starting evaluations of control alternatives:

For baseline conditions:

- Tabulate overflow volumes by storm, to help identify threshold rainfall characteristics for the various outfalls and assessment of system-wide overflows/year
- Plot all overflow hydrographs on common axes for selected storms based on the tabulation in the first bullet, to better characterize the relative timing of peaks and overflows and identify trends.
- Check whether storms that have the highest or 5th-largest volumes in the typical year also have the highest/5th largest peak flows
- Characterize flows through flushing chambers between drainage areas.
- Look at peak hydraulic profiles for smaller events in the typical year, to see if optimization may be effective during smaller storms

To begin control alternative evaluations:

- Include the H6/H7 CSO Project Plan
- Maximize Adams Street WWTP flows (simulate free discharge at the WWTP; may need to follow up with increased capacities of influent siphons and upstream pump stations)
- Equalization storage at Adams Street WWTP
- Maximize River Road WWTP flows (simulate free discharge at WWTP)
- Incremental I/I reduction scenarios
- Incremental GI scenarios
- Reroute H1 Housing Authority runoff to surface water
- Increase flow from 18th Street Pump Station to eliminate overflows
- Add parallel siphon to existing siphon
- Raise weirs at JOSO regulator weirs
- Add bending weirs to JOSO regulator weirs
- Relocate W1-W4 regulators
- Add sanitary pump stations in Hoboken
- Evaluate interconnections at flushing chambers
- Evaluate using flushing water lines for additional conveyance

Action Items

- ☐ CH2M to draft a meeting summary and distribute to the consultants.
- ☐ Consultants to review the draft meeting summary and return to the Authority (Fred Pocci) and the LTCP Program Manager (Bill McMillin).
- ☐ CH2M will finalize the meeting summary.
- ☐ The LTCP Program Manager will distribute the final meeting summary to all attendees.

Attachment 1
Workshop Attendance Sheets

NHSA Long Term Control Plan CSO Alternatives Analysis Workshop
Friday June 15, 2018

Sheraton Lincoln Harbor Hotel
8:00 AM – 5:00 PM

Sign in Sheet

Name	Affiliation	Email
Karen Karvazy	MM	Karen.Karvazy@hotmail.com
JOE MANNICK	NJDEP	joe.mannick@dep.nj.gov
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Phil Reeve	Jacobs	
Fred Pocci	NHSA	

Kevin Wynn	Mott MacDonald	
Tony Costello	Gannett Fleming	
Chris Pizarro	Ganett Fleming	
John Denning	Mott MacDonald	

NORTH HUDSON SEWERAGE AUTHORITY

NHSA Long Term Control Plan CSO Alternatives Analysis Workshop
Thursday June 14, 2018

Sheraton Lincoln Harbor Hotel
8:00 AM – 5:00 PM

Sign in Sheet

Name	Affiliation	Email
PETER LONZWECK	JACOBS	PETER.LONZWECK@JACOBS.COM
Mike Wilson	Jacobs	Mike.Wilson1@jacobs.com
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NORTH HUDSON SEWERAGE AUTHORITY

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Nancy Kempel	"	nancy.kempel@dep.nj.gov
Fred Pocci	NHSA	
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Armando Alfonso	NJDEP	armando.alfonso@dep.nj.gov
Moriah Kinberg	NJ Future	mkinberg@NJFuture.org
Susan Rosenwinkel	NJDEP	susan.rosenwinkel@dep.nj.gov

Attachment 2
Workshop Agendas

MEETING AGENDA

CSO Alternatives Analysis Concept Workshop

PROJECT:	North Hudson Sewerage Authority CSO LTCP Program
MEETING DATE:	June 14 – 15, 2018
MEETING TIME:	8:00 am – 5:00 pm
LOCATION:	Sheraton Lincoln Harbor Hotel, 500 Harbor Boulevard, Weehawken, NJ 07086
INVITED ATTENDEES:	Fredric Pocci, Richard Wolff, Don Conger, Phil Reeve, Bill McMillin, Don Walker, Greg Heath, Kevin Wynn, John Dening, Karen Karvazy, Mike Wilson, Peter von Zweck, Eugene DeStefano, Tony Costello, Chris Pizarro, Joe Mannick, Susan Rosenwinkel, Nancy Kempel, Armando Alfonso, Breana Whittaker

Objectives

This meeting will be a brainstorming session to identify strategies and alternatives for maximizing wastewater treatment and reducing CSOs in the NHSA system. The output from the workshop will be used by NHSA's LTCP program to further develop and evaluate CSO control alternatives, culminating in preparation of Evaluation of Alternatives Reports. The first day of the workshop will focus on the Adams Street WWTP system, and the second day will focus on the River Road WWTP system.

Schedule for both days:

8:00 am – 9:00 am: Breakfast
9:00 am – 12:30 pm: Working Session
12:30 pm – 1:15 pm: Lunch Break
5:00 pm (or sooner): Conclude

Agenda Items

Thursday, June 14, 2018

1. **Welcome and Introductions**
2. **Meeting Objectives**
3. **Brief Overview of Adams Street WWTP System**
    a. System schematic/overview of tributary area
    b. CSO Activations/volumes
    c. Recent CSO/wet weather projects implemented
    d. Target level(s) of CSO control
    e. Other wet weather issues in the collection system (flooding)
    f. Overview of Adams Street WWTP
        i. Capacity
        ii. Current/projected design flows
        iii. Physical layout and constraints

4. **System-wide Alternatives**
    a. Green Infrastructure
    b. Grey I/I reduction
    c. Increase conveyance to WWTP
    d. Regional tunnel
5. **Outfall-specific alternatives**
    a. Outfalls 002A, 003A, 005A
    b. Outfalls 006A, 008A
    c. 18^{th} Street PS Outfall 012A
    d. Outfalls 013A, 015A
6. **Summary/recap of Alternatives for Adams Street WWTP System**

<u>Friday June 15, 2018</u>

1. **Brief Overview of River Road WWTP System**
    a. System schematic/overview of tributary area
    b. CSO Activations/volumes
    c. Recent CSO/wet weather projects implemented
    d. Target level(s) of CSO control
    e. Other wet weather issues in the collection system (flooding)
    f. Overview of River Road WWTP
        i. Capacity
        ii. Current/projected design flows
        iii. Physical layout and constraints
2. **System-wide Alternatives**
    a. Green Infrastructure
    b. Grey I/I reduction
    c. Increase conveyance to WWTP
    d. Regional tunnel
3. **Outfall-specific alternatives**
    a. WNY1 Outfall 002A
    b. JOSO Outfall 003A
4. **Summary/recap of Alternatives for River Road WWTP System**
5. **Summary and Concluding Remarks**
6. **Action Items Review**

Attachment 3
Workshop Handouts

North Hudson Sewerage Authority
Long Term Control Plan
CSO Alternatives Analysis Workshop

Adams Street WWTP

NJPDES Permit: NJ0026085

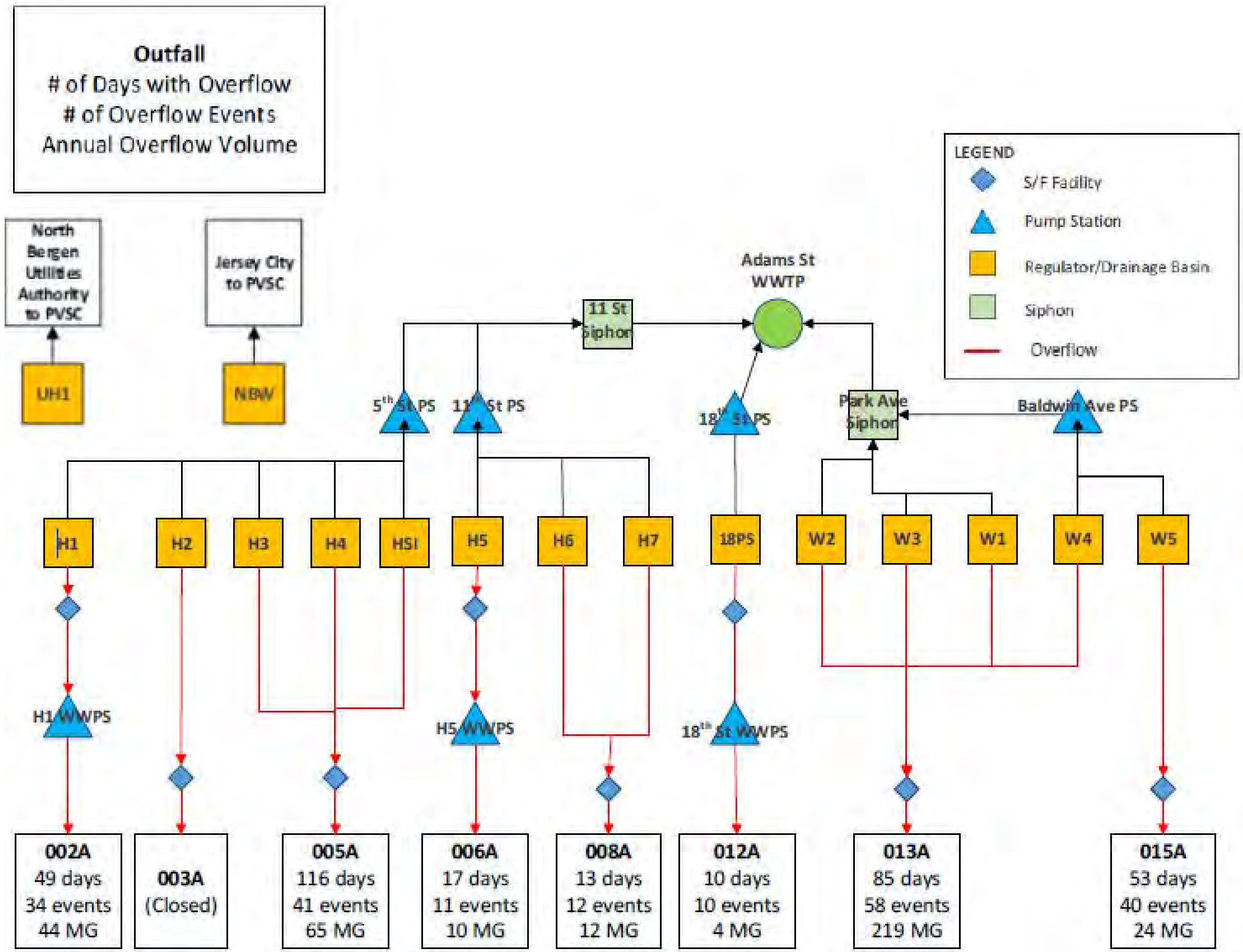
Date:June 14, 2018

North Hudson Sewerage Authority

1600 Adams Street
Hoboken, NJ 07030
(201) 963-6043

www.nhudsonsa.com

Adams Street STP Collection System Schematic Diagram



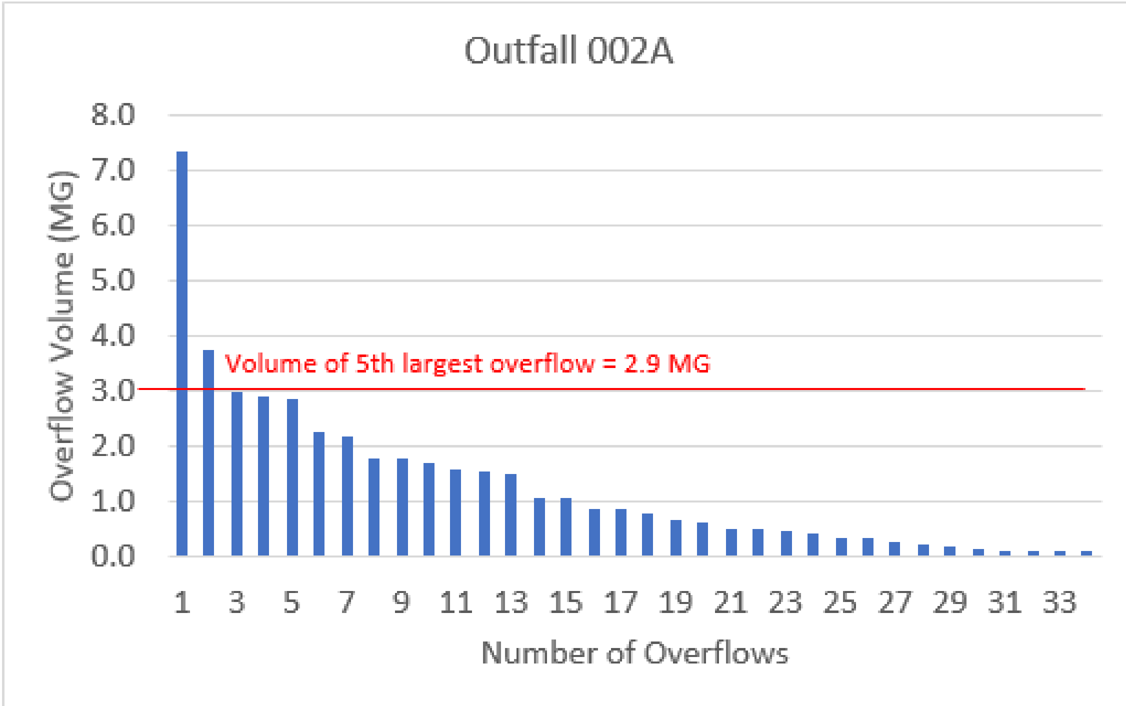
Summary Table - CSO Frequency, and Total Overflow Volume per Year

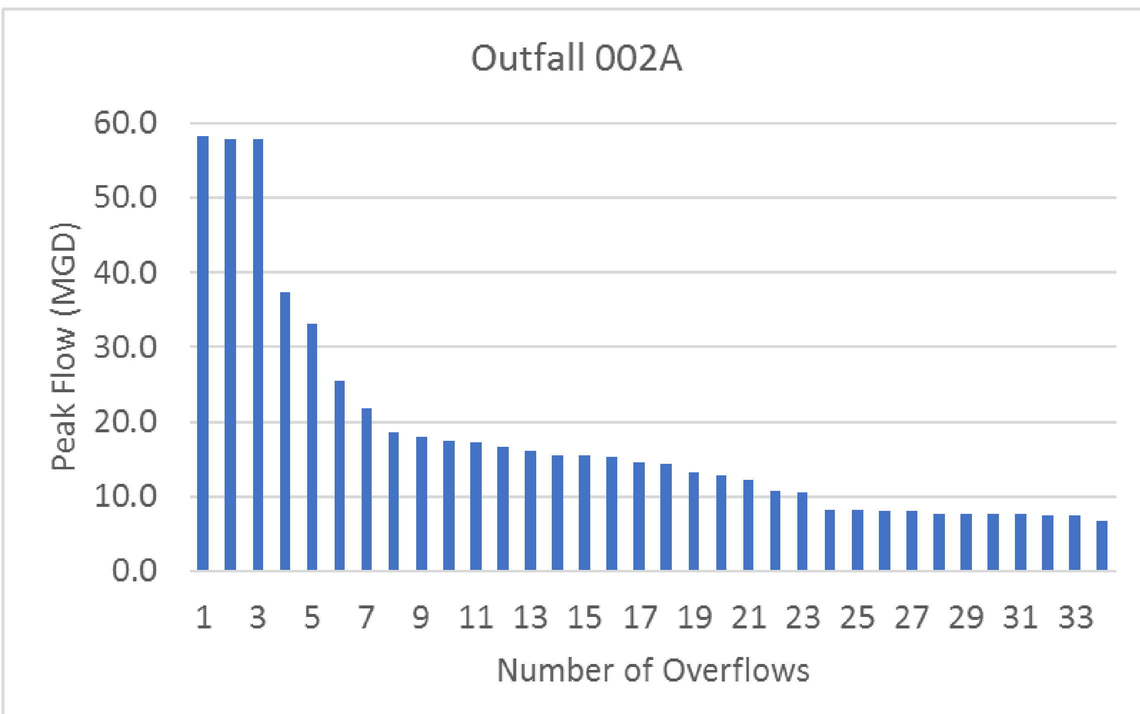
Outfall	CSO Frequency	Volume per year (MG)
002A	34	44
005A	41	65
006A	11	9.5
008A	13	12
012A	10	3.6
013A	58	219
015A	40	24
	Total volume, MG	377

Outfall 002A CSO Frequencies (Volumes and Peak Flows) in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	7.32	58.28
2	3.75	57.93
3	2.99	57.79
4	2.89	37.29
5	2.88	33.04
6	2.26	25.40
7	2.17	21.92
8	1.80	18.65
9	1.77	18.02
10	1.72	17.51
11	1.57	17.24
12	1.56	16.64
13	1.52	16.10
14	1.08	15.51
15	1.05	15.47
16	0.88	15.24
17	0.86	14.51
18	0.80	14.31
19	0.67	13.14
20	0.61	12.77
21	0.52	12.27
22	0.51	10.69
23	0.46	10.44
24	0.43	8.28
25	0.35	8.21
26	0.34	8.02
27	0.25	8.00
28	0.23	7.71
29	0.17	7.71
30	0.15	7.67
31	0.12	7.63
32	0.10	7.51
33	0.10	7.49
34	0.09	6.69

Volumes and Peak Flows were sorted separately

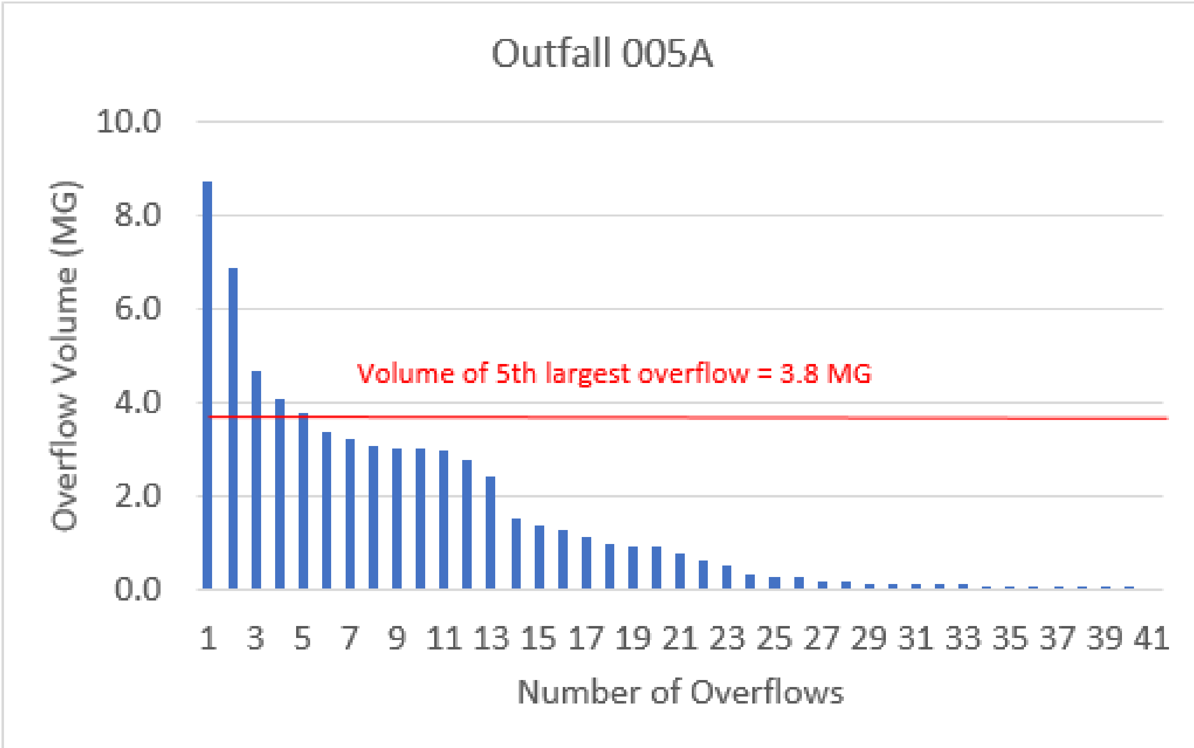

Outfall 002A
Overflow Volume (MG)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Volume of 5th largest overflow = 2.9 MG
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
Number of Overflows


Outfall 002A
Peak Flow (MGD)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
Number of Overflows

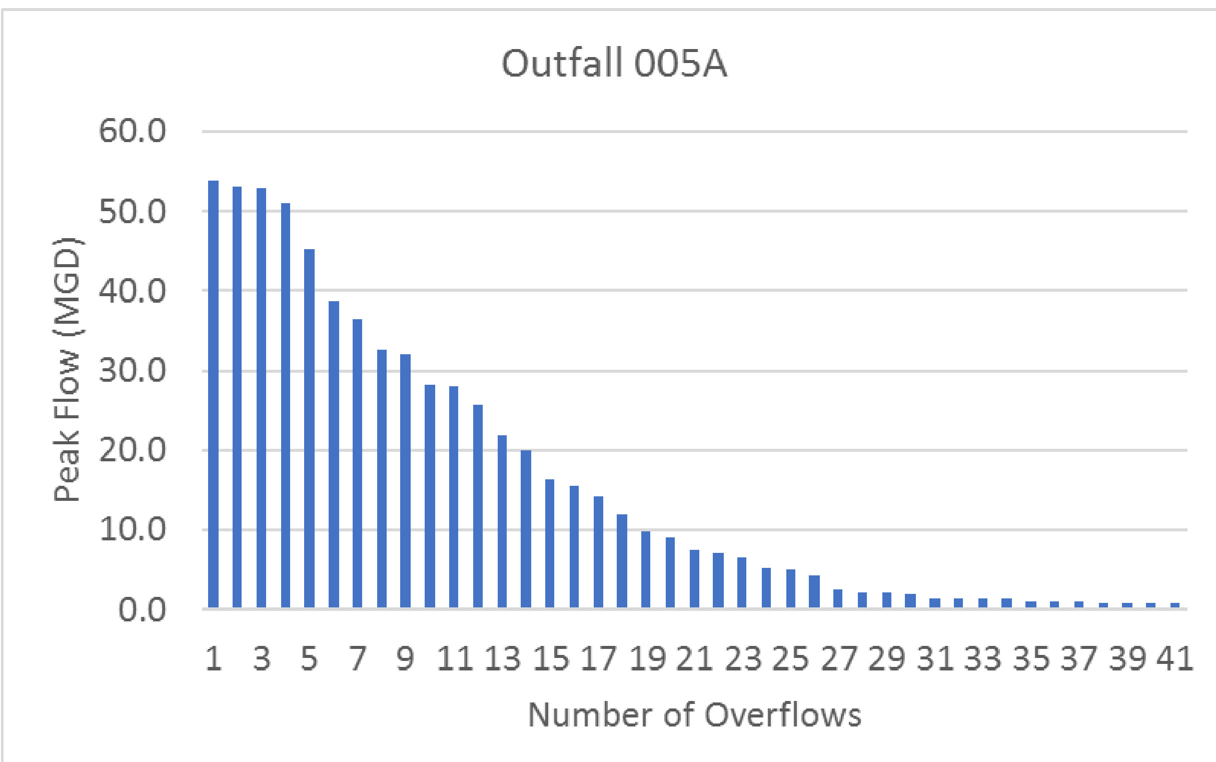
Outfall 005A CSO Frequencies (Volumes and Peak Flows) in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	8.73	53.96
2	6.85	53.12
3	4.67	52.91
4	4.09	50.94
5	3.79	45.20
6	3.36	38.70
7	3.23	36.41
8	3.08	32.54
9	3.05	32.01
10	3.02	28.19
11	3.00	28.01
12	2.80	25.63
13	2.42	21.92
14	1.54	20.06
15	1.36	16.29
16	1.31	15.53
17	1.14	14.28
18	0.99	11.89
19	0.95	9.79
20	0.92	9.02
21	0.80	7.62
22	0.62	7.21
23	0.55	6.49
24	0.33	5.26
25	0.30	5.06
26	0.27	4.30
27	0.21	2.63
28	0.17	2.26
29	0.13	2.20
30	0.13	1.91
31	0.13	1.42
32	0.13	1.37
33	0.13	1.36
34	0.10	1.32
35	0.10	1.09
36	0.09	1.02
37	0.08	1.02
38	0.07	0.88
39	0.06	0.87
40	0.06	0.86
41	0.05	0.81

Volumes and Peak Flows were sorted separately



Outfall 005A
Overflow Volume (MG)
10.0
8.0
6.0
4.0
2.0
0.0
Volume of 5th largest overflow = 3.8 MG
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
Number of Overflows

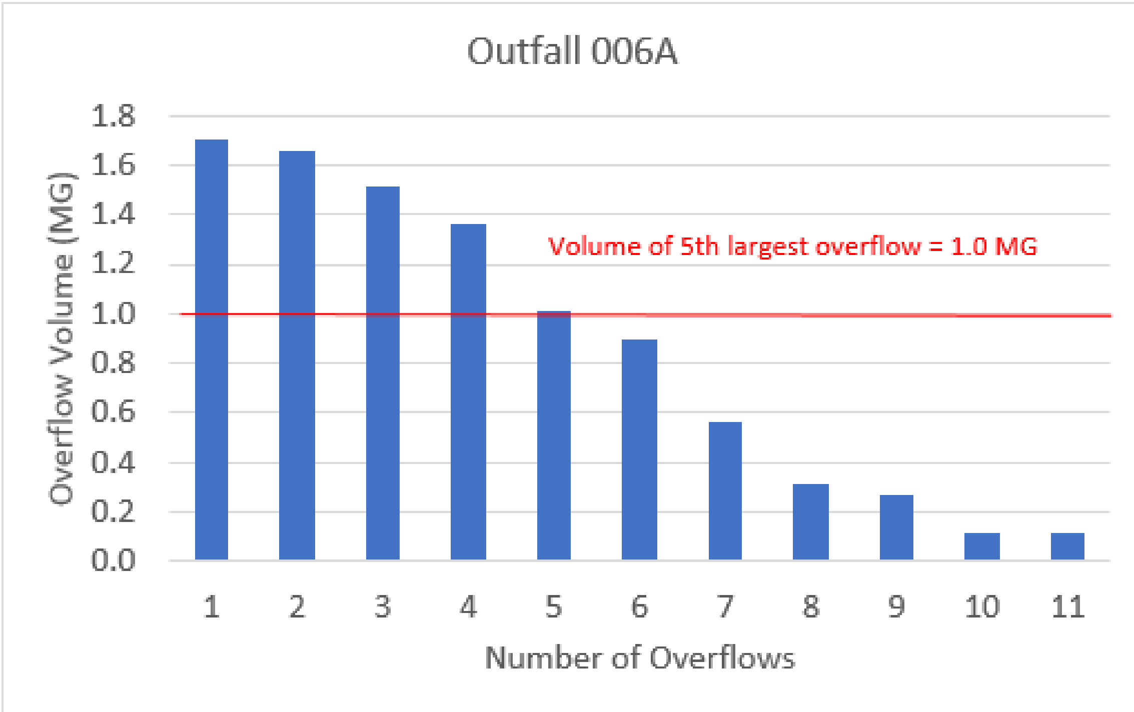


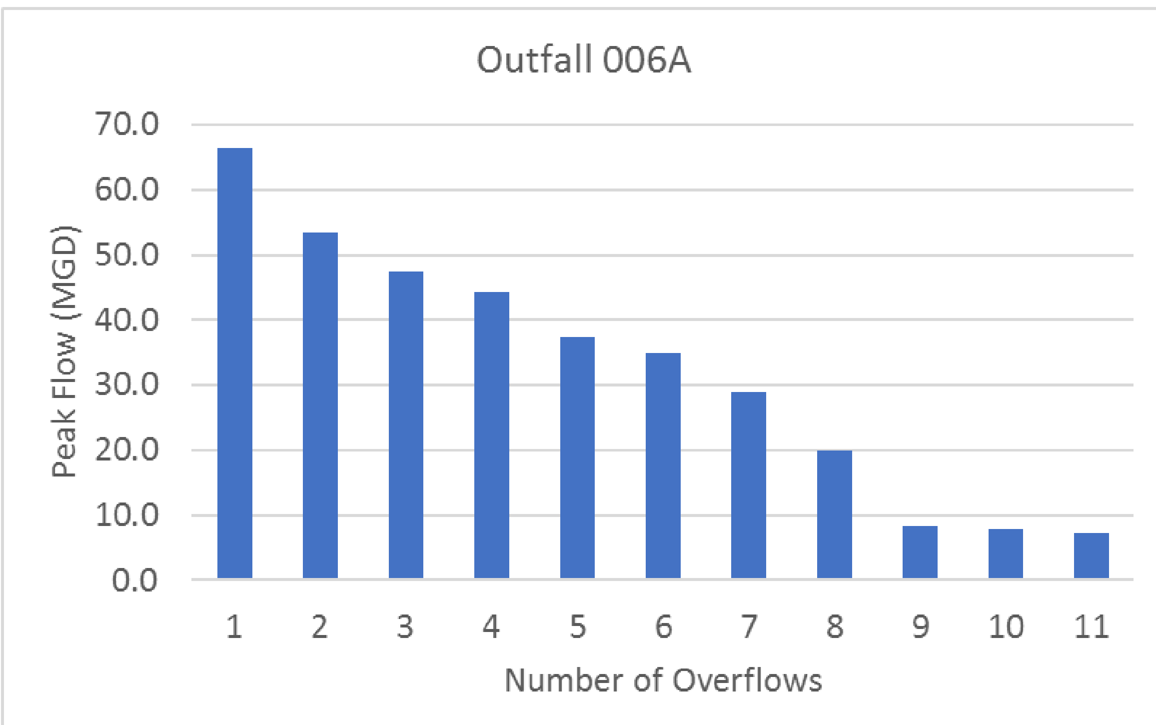
Outfall 005A
Peak Flow (MGD)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
Number of Overflows

Outfall 006A CSO Frequencies (Volumes and Peak Flows) in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	1.70	66.38
2	1.66	53.44
3	1.51	47.49
4	1.36	44.41
5	1.01	37.29
6	0.90	34.95
7	0.57	28.97
8	0.31	19.93
9	0.27	8.32
10	0.11	7.83
11	0.11	7.17

Volumes and Peak Flows were sorted separately

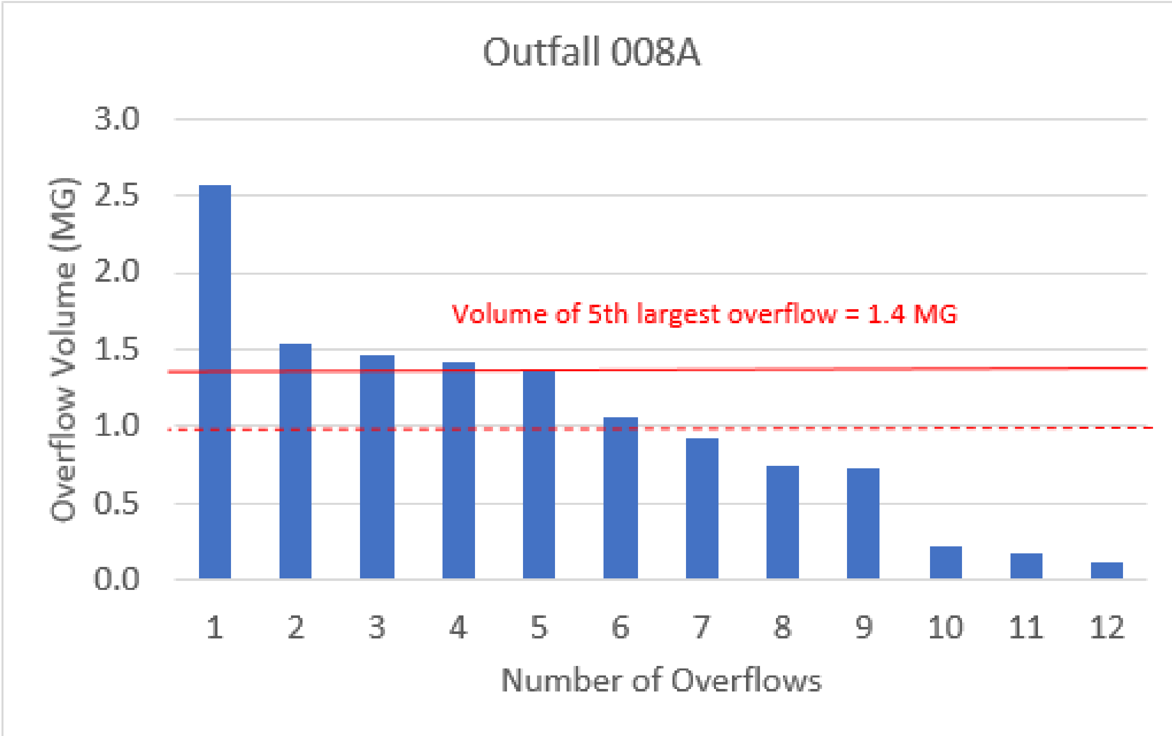

Outfall 006A
Overflow Volume (MG)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Volume of 5th largest overflow = 1.0 MG
1
2
3
4
5
6
7
8
9
10
11
Number of Overflows

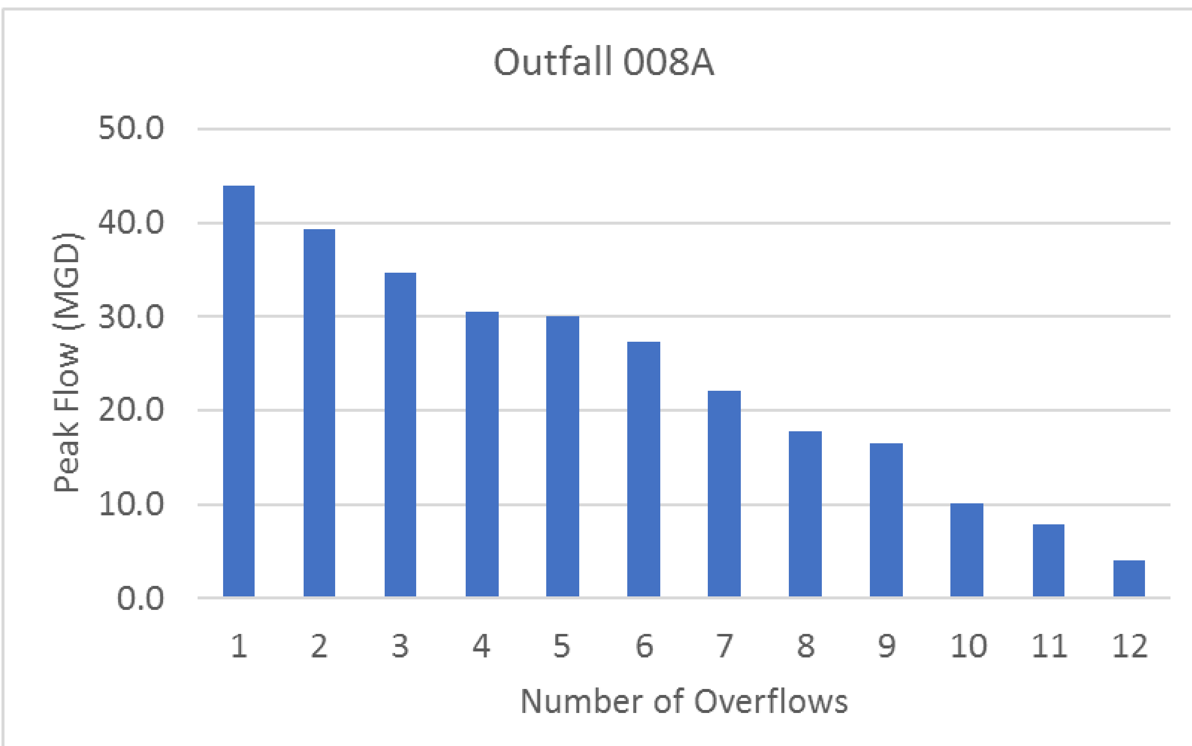

Outfall 006A
Peak Flow (MGD)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1
2
3
4
5
6
7
8
9
10
11
Number of Overflows

Outfall 008A CSO Frequencies (Volumes and Peak Flows) in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	2.56	43.99
2	1.53	39.34
3	1.45	34.66
4	1.41	30.50
5	1.36	30.04
6	1.06	27.42
7	0.92	22.08
8	0.75	17.76
9	0.74	16.47
10	0.22	10.04
11	0.18	7.86
12	0.11	4.11

Volumes and Peak Flows were sorted separately

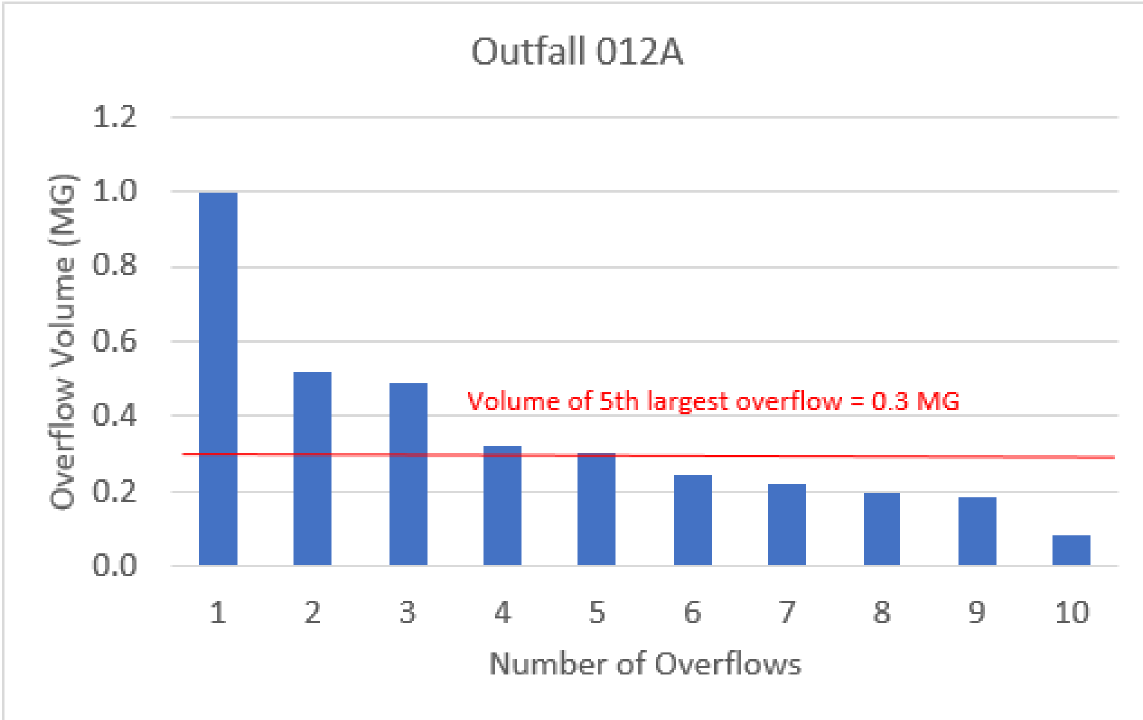

Outfall 008A
Overflow Volume (MG)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Volume of 5th largest overflow = 1.4 MG
1
2
3
4
5
6
7
8
9
10
11
12
Number of Overflows

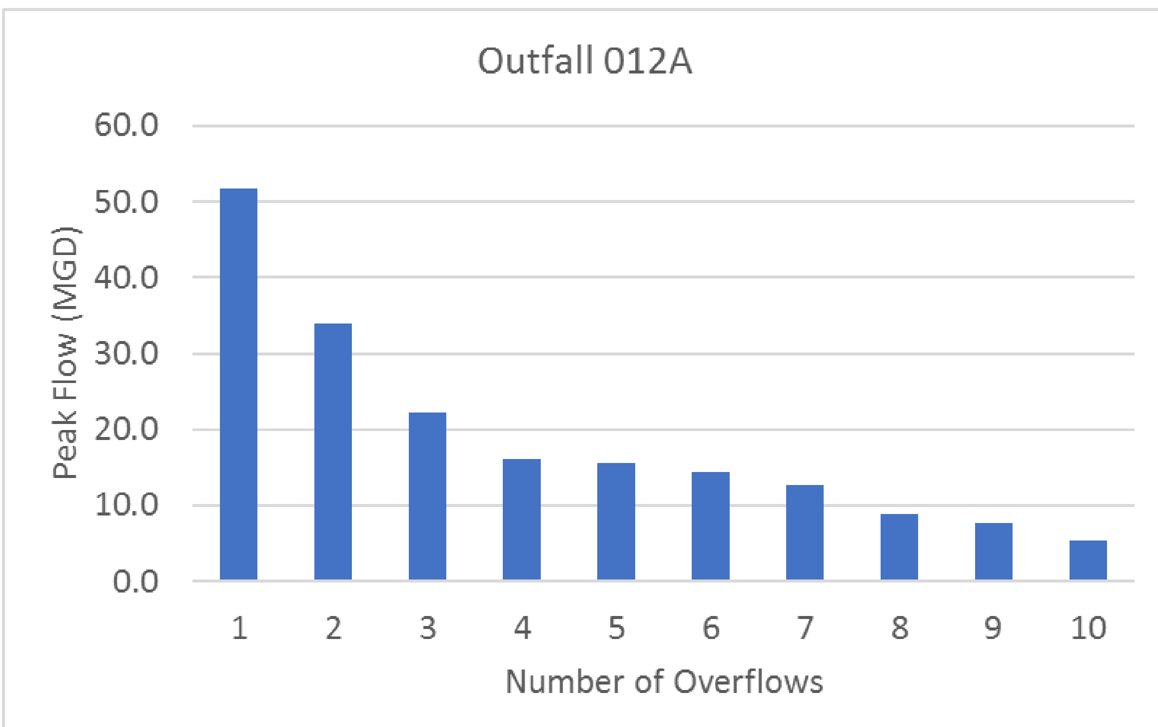

Outfall 008A
Peak Flow (MGD)
50.0
40.0
30.0
20.0
10.0
0.0
1
2
3
4
5
6
7
8
9
10
11
12
Number of Overflows

Outfall 012A CSO Frequencies (Volumes and Peak Flows) in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	1.00	51.81
2	0.52	33.98
3	0.49	22.23
4	0.32	16.18
5	0.30	15.49
6	0.25	14.47
7	0.22	12.69
8	0.20	8.94
9	0.18	7.65
10	0.08	5.43

Volumes and Peak Flows were sorted separately


Outfall 012A
Overflow Volume (MG)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Volume of 5th largest overflow = 0.3 MG
1
2
3
4
5
6
7
8
9
10
Number of Overflows

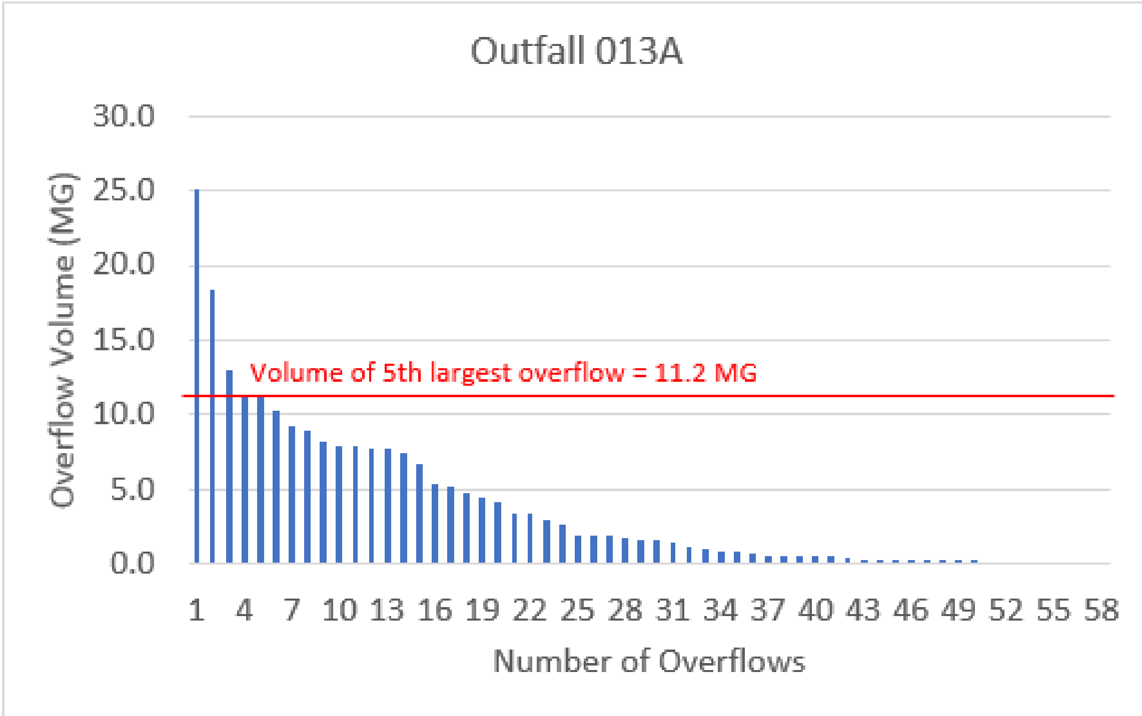

Outfall 012A
Peak Flow (MGD)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1
2
3
4
5
6
7
8
9
10
Number of Overflows

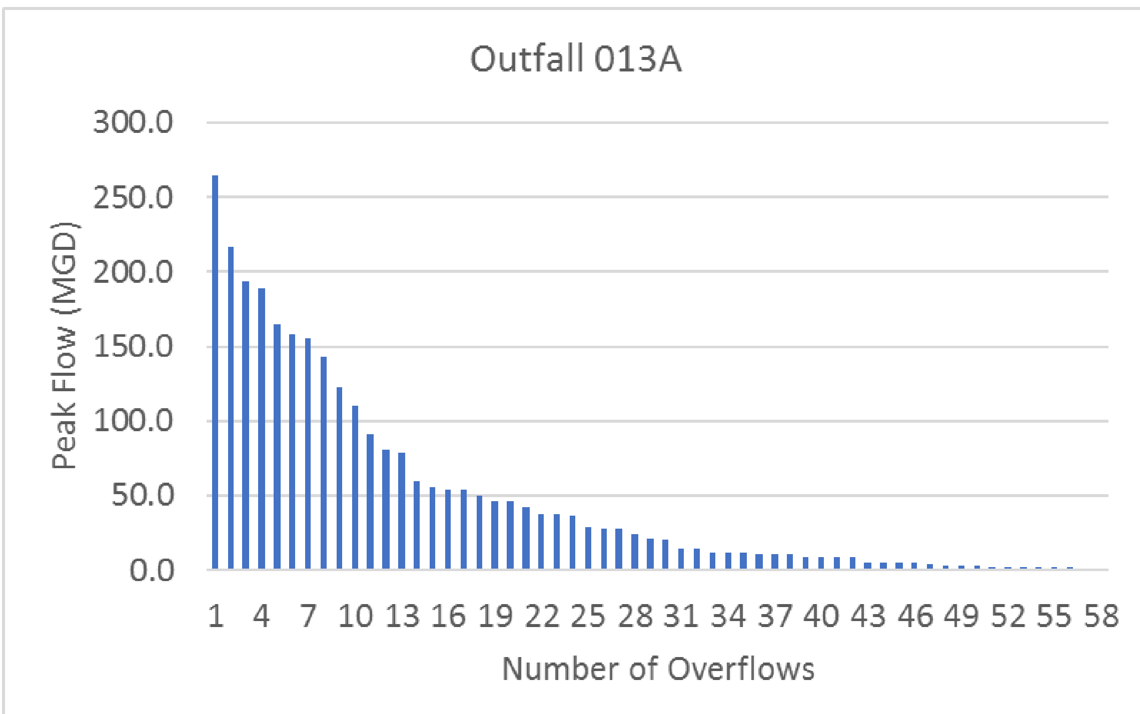
Outfall 013A CSO Frequencies (Volumes and Peak Flows) in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	25.06	264.33
2	18.33	216.37
3	12.91	194.19
4	11.21	188.52
5	11.21	165.14
6	10.30	158.63
7	9.26	154.96
8	8.90	142.51
9	8.24	123.24
10	7.89	110.76
11	7.85	91.29
12	7.70	80.97
13	7.68	79.24
14	7.36	59.72
15	6.76	55.79
16	5.35	54.06
17	5.15	53.84
18	4.74	49.82
19	4.39	46.06
20	4.11	45.93
21	3.40	42.34
22	3.39	38.00
23	2.96	37.87
24	2.71	36.75
25	1.89	28.65
26	1.86	28.48
27	1.86	27.87
28	1.82	23.97
29	1.60	21.63
30	1.53	20.20
31	1.43	14.65
32	1.12	14.37
33	0.93	12.23
34	0.83	11.94
35	0.81	11.49
36	0.71	10.54
37	0.61	10.47
38	0.57	10.36
39	0.57	8.92
40	0.50	8.80
41	0.49	8.60
42	0.36	8.53
43	0.33	5.50
44	0.32	4.97
45	0.27	4.90
46	0.25	4.63

Overflow Number	Volume (MG)	Peak Flow (MGD)
47	0.24	3.92
48	0.20	3.56
49	0.20	3.46
50	0.19	2.93
51	0.16	2.62
52	0.16	2.53
53	0.13	2.45
54	0.12	2.44
55	0.12	2.14
56	0.09	1.82
57	0.09	1.55
58	0.05	0.78

Volumes and Peak Flows were sorted separately

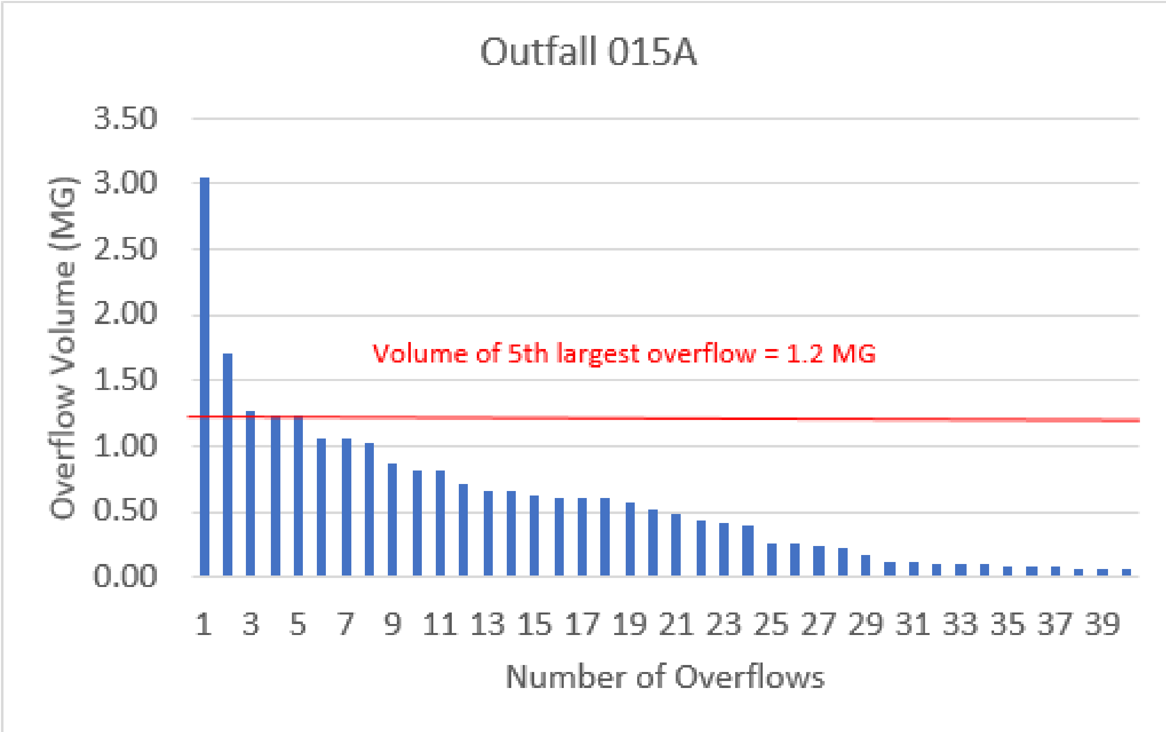

Outfall 013A
Overflow Volume (MG)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Volume of 5th largest overflow = 11.2 MG
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58
Number of Overflows


Outfall 013A
Peak Flow (MGD)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58
Number of Overflows

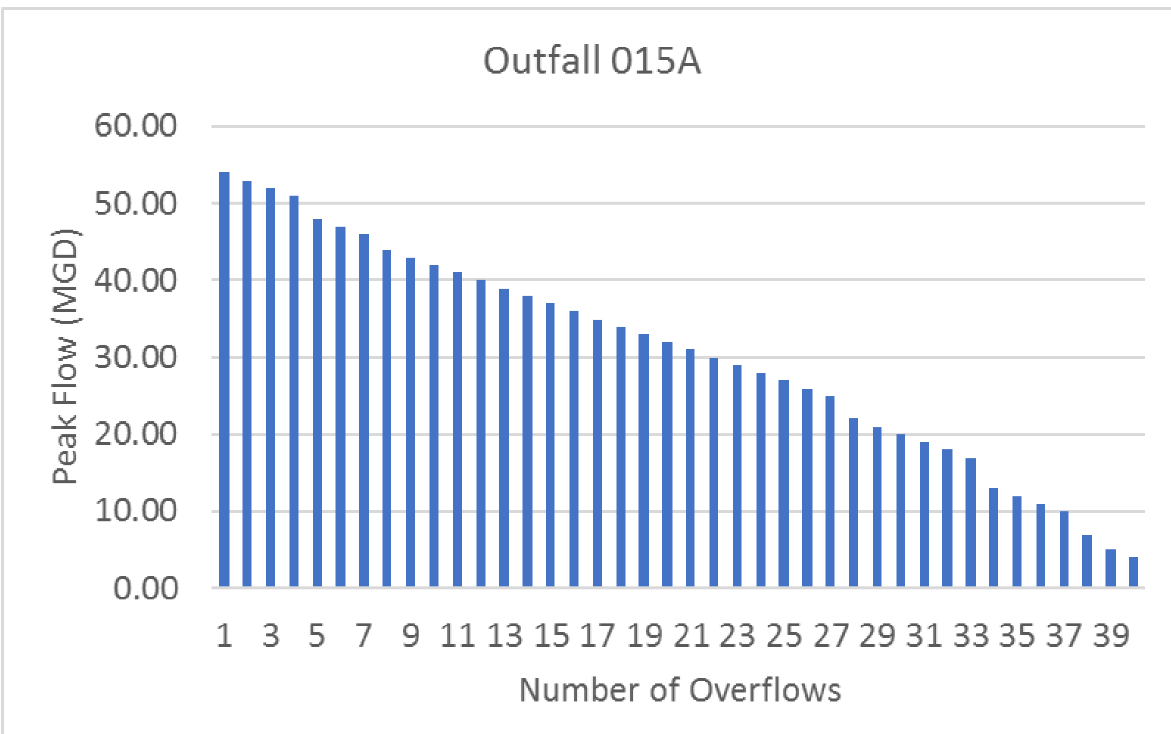
Outfall 015A CSO Frequencies (Volumes and Peak Flows) in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	1.06	47.00
2	1.06	46.00
3	1.03	44.00
4	0.87	43.00
5	0.82	42.00
6	0.82	41.00
7	0.70	40.00
8	0.66	39.00
9	0.66	38.00
10	0.62	37.00
11	0.61	36.00
12	0.60	35.00
13	0.60	34.00
14	0.57	33.00
15	0.52	32.00
16	0.48	31.00
17	0.43	30.00
18	0.42	29.00
19	0.39	28.00
20	0.26	27.00
21	0.25	26.00
22	0.25	25.00
23	0.22	22.00
24	0.16	21.00
25	0.12	20.00
26	0.12	19.00
27	0.10	18.00
28	0.10	17.00
29	0.09	13.00
30	0.09	12.00
31	0.08	11.00
32	0.08	10.00
33	0.07	7.00
34	0.06	5.00
35	0.06	4.00
36	1.06	47.00
37	1.06	46.00
38	1.03	44.00
39	0.87	43.00
40	0.82	42.00

Volumes and Peak Flows were sorted separately



Outfall 015A
Overflow Volume (MG)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Volume of 5th largest overflow = 1.2 MG
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
Number of Overflows

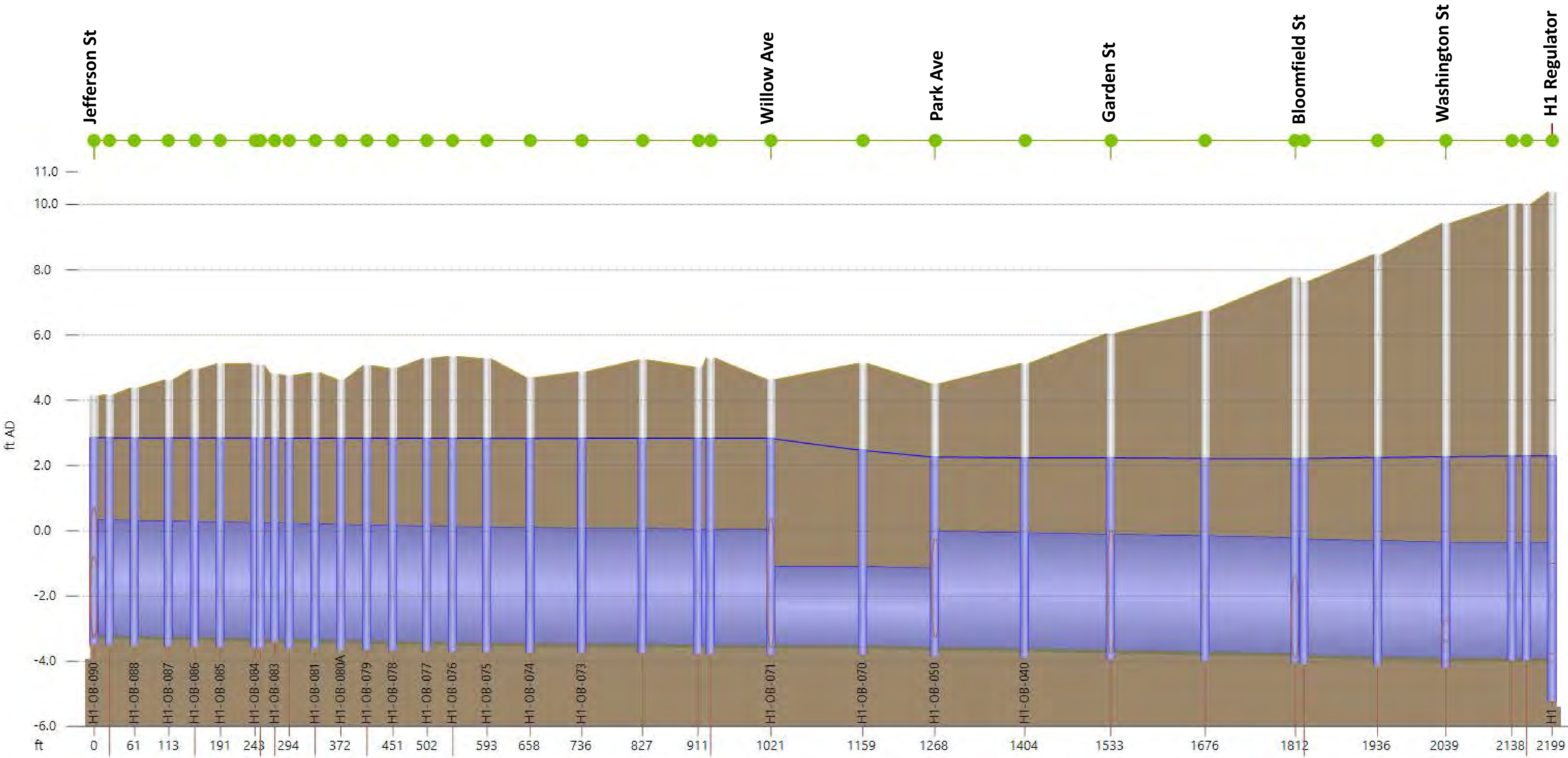


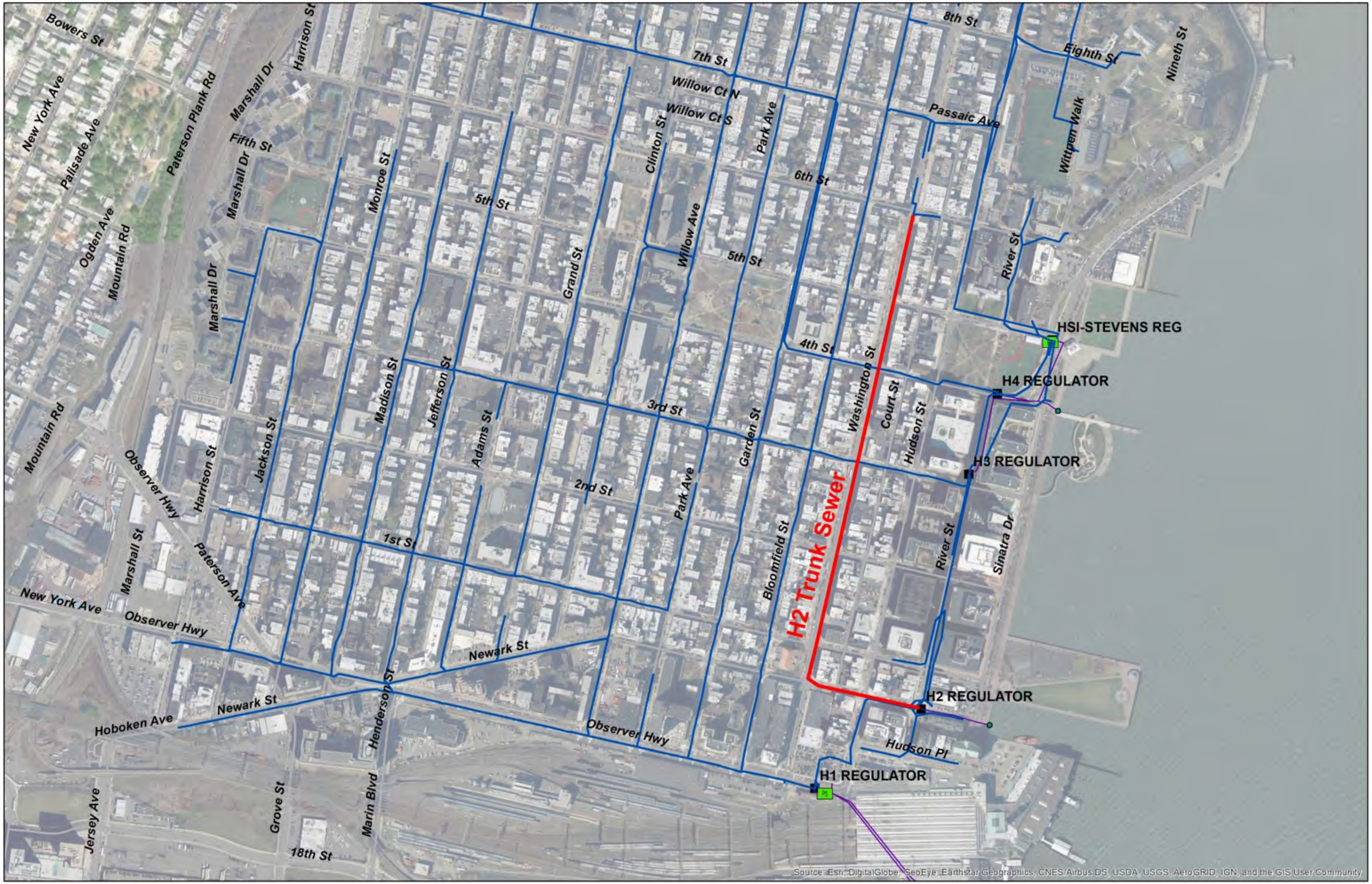
Outfall 015A
Peak Flow (MGD)
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
Number of Overflows

Marshall St
Jackson St
Paterson Ave
Harrison St
Monroe St
Madison St
Jefferson St
Adams St
Grand St
Clinton St
Willow Ave
Park Ave
2nd St
3rd St
Court St
Garden St
Bloomfield St
Washington St
Hudson St
Sinatra Dr
1st St
Observer Hwy
Newark St
Henderson St
H1 Trunk Sewer
Observer Hwy
Newark St
River St
H3 REGULATOR
H2 REGULATOR
H1 REGULATOR
PS
Hudson Pl
18th St
Marin Blvd
Grove St
16th St
Erie St
15th St
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H1 Trunk Sewer

Max Typical Year

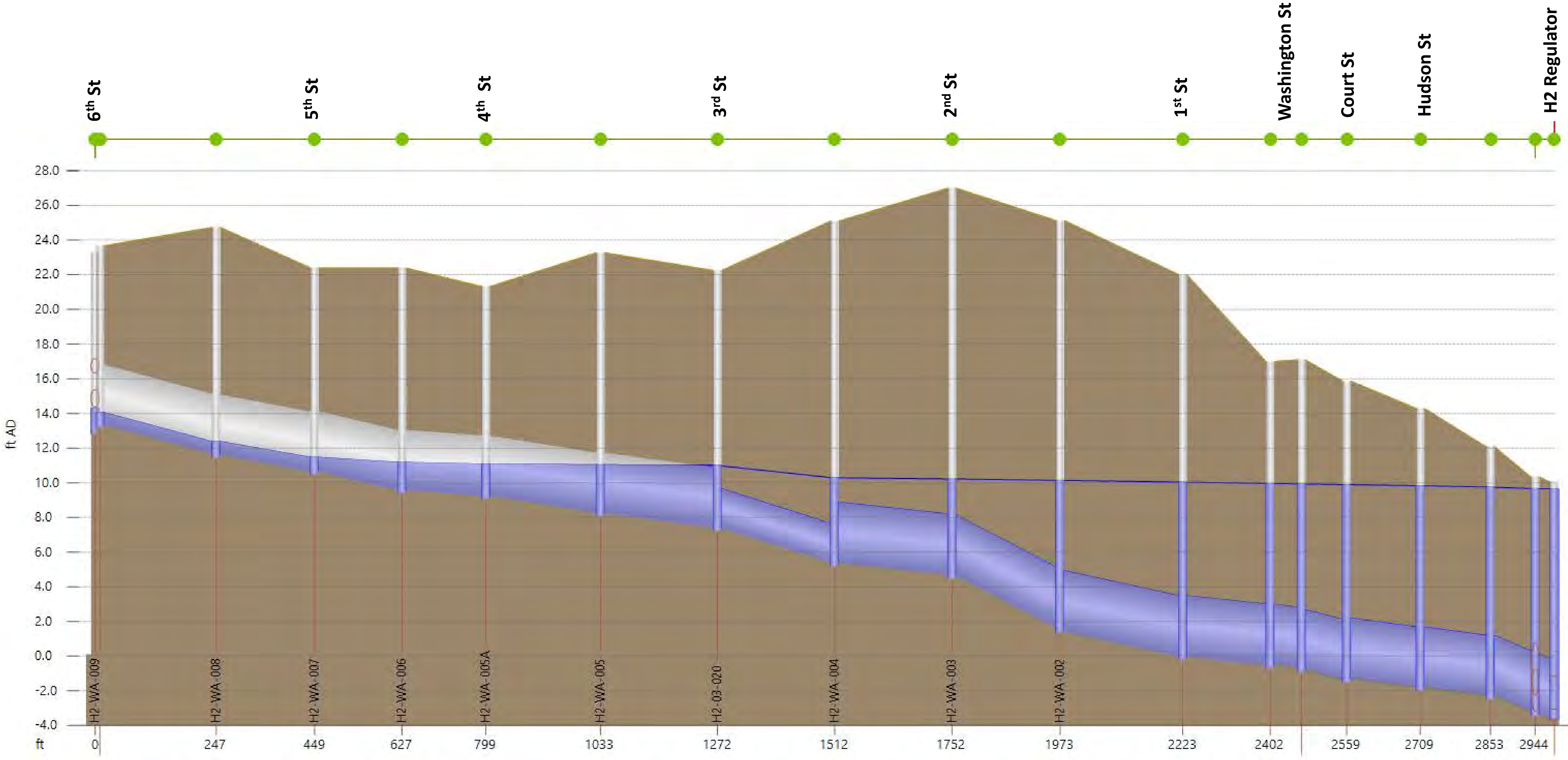


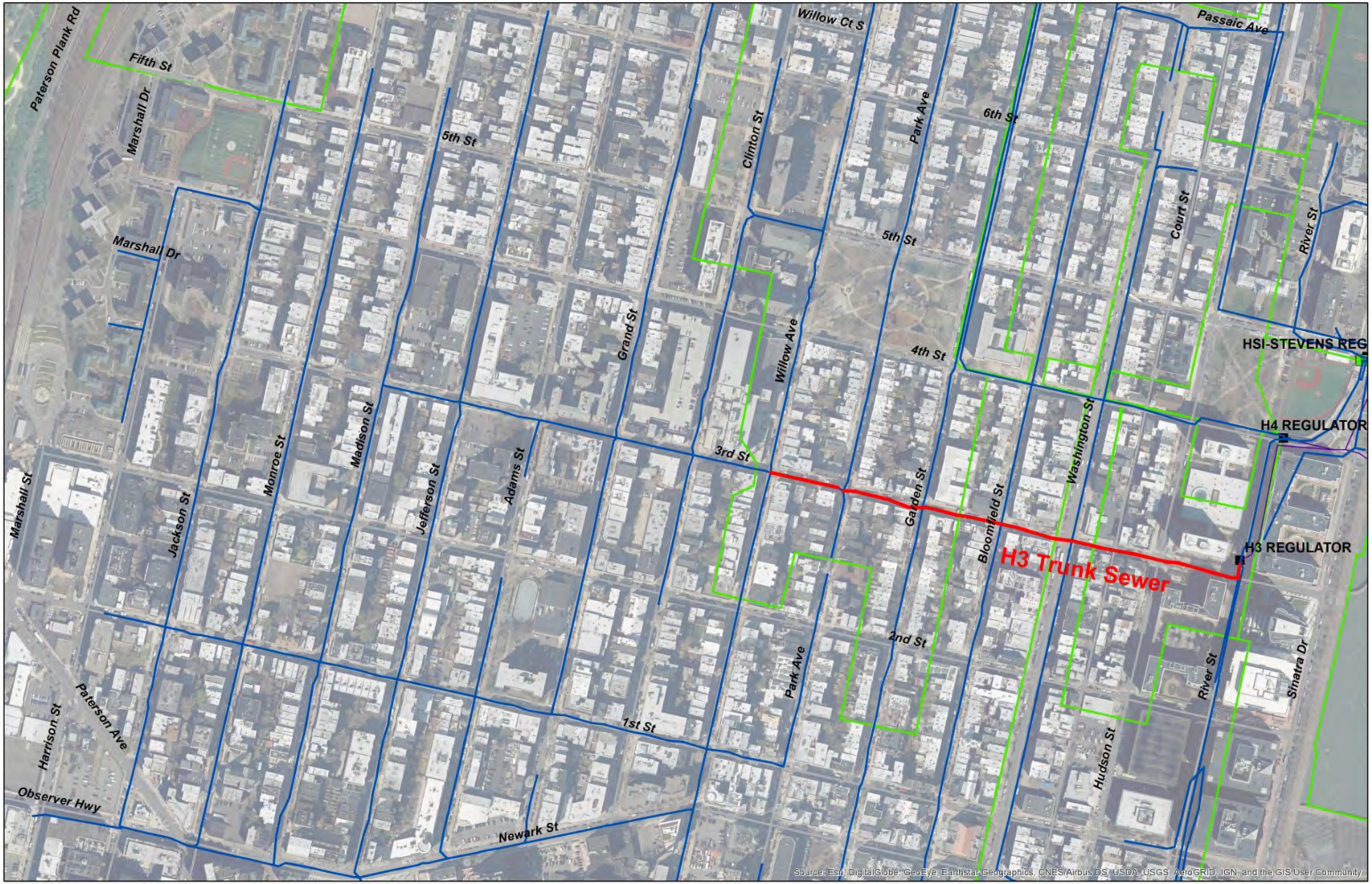


H2 Trunk Sewer
HSI-STEVENS REG
H4 REGULATOR
H3 REGULATOR
H2 REGULATOR
H1 REGULATOR
Bowers St
Harrison St
8th St
7th St
Eighth St
Nineth St
Willow Ct N
Willow Ct S
Passaic Ave
Wittpen Walk
New York Ave
Palisade Ave
Paterson Plank Rd
Marshall Dr
Fifth St
Clinton St
Park Ave
6th St
Monroe St
5th St
Ogden Ave
Mountain Rd
Willow Ave
River St
Grand St
4th St
Washington St
Madison St
Jefferson St
Court St
Hudson St
3rd St
Adams St
Garden St
Jackson St
Observer Hwy
2nd St
Sinatra Dr
1st St
Bloomfield St
Marshall St
Paterson Ave
New York Ave
Newark St
Hoboken Ave
Henderson St
Hudson Pl
Jersey Ave
Grove St
Marin Blvd
18th St
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H2 Trunk Sewer

Max Typical Year

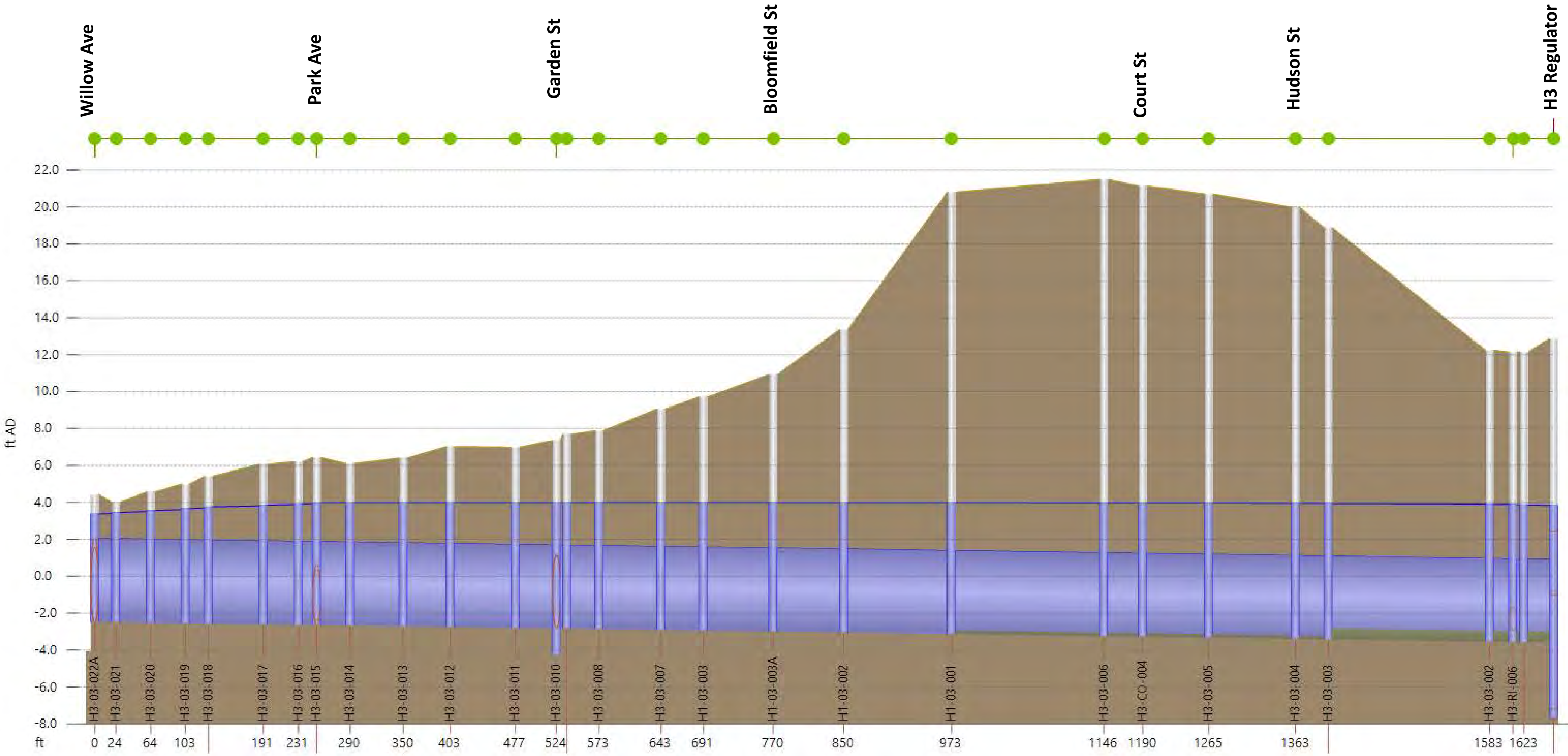


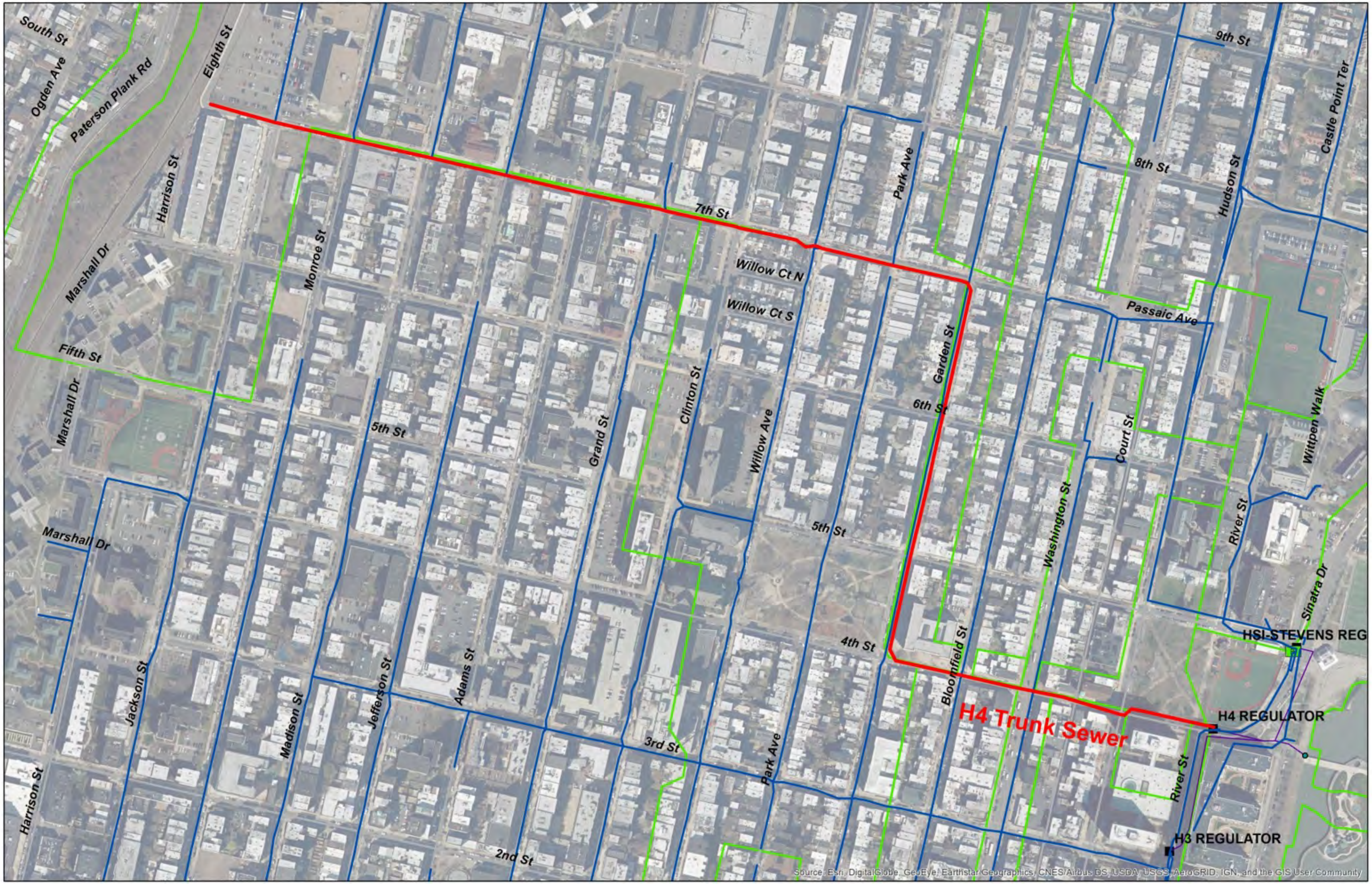


Paterson Plank Rd
Fifth St
Marshall Dr
Willow Ct S
Passaic Ave
6th St
5th St
Clinton St
Park Ave
Court St
River St
Marshall Dr
5th St
Grand St
Willow Ave
4th St
HSI-STEVENS REG
H4 REGULATOR
3rd St
Madison St
Monroe St
Adams St
Jefferson St
Garden St
Bloomfield St
Washington St
Marshall St
Jackson St
H3 REGULATOR
H3 Trunk Sewer
2nd St
Park Ave
River St
Sinatra Dr
Paterson Ave
Harrison St
1st St
Hudson St
Observer Hwy
Newark St
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H3 Trunk Sewer

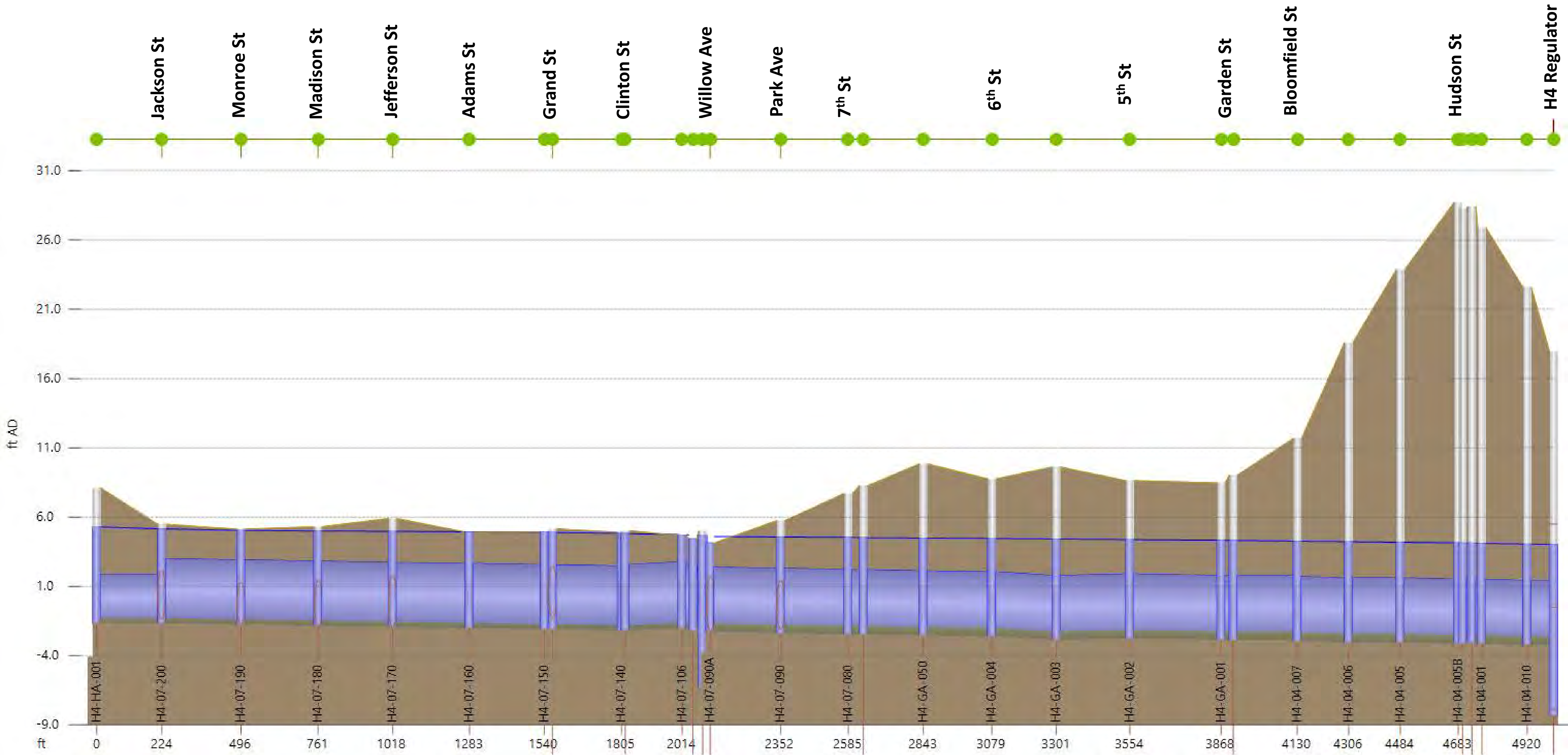
Max Typical Year




H4 Trunk Sewer
H4 REGULATOR
H3 REGULATOR
HSI-STEVENS REG
South St
Ogden Ave
Paterson Plank Rd
Eighth St
Harrison St
Marshall Dr
Fifth St
Monroe St
5th St
Grand St
Clinton St
Willow Ave
7th St
Willow Ct N
Willow Ct S
Park Ave
Garden St
6th St
5th St
4th St
3rd St
2nd St
Jackson St
Madison St
Jefferson St
Adams St
Bloomfield St
Washington St
Court St
River St
Hudson St
8th St
9th St
Castle Point Ter
Passaic Ave
Wittpen Walk
Sinatra Dr
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H4 Trunk Sewer

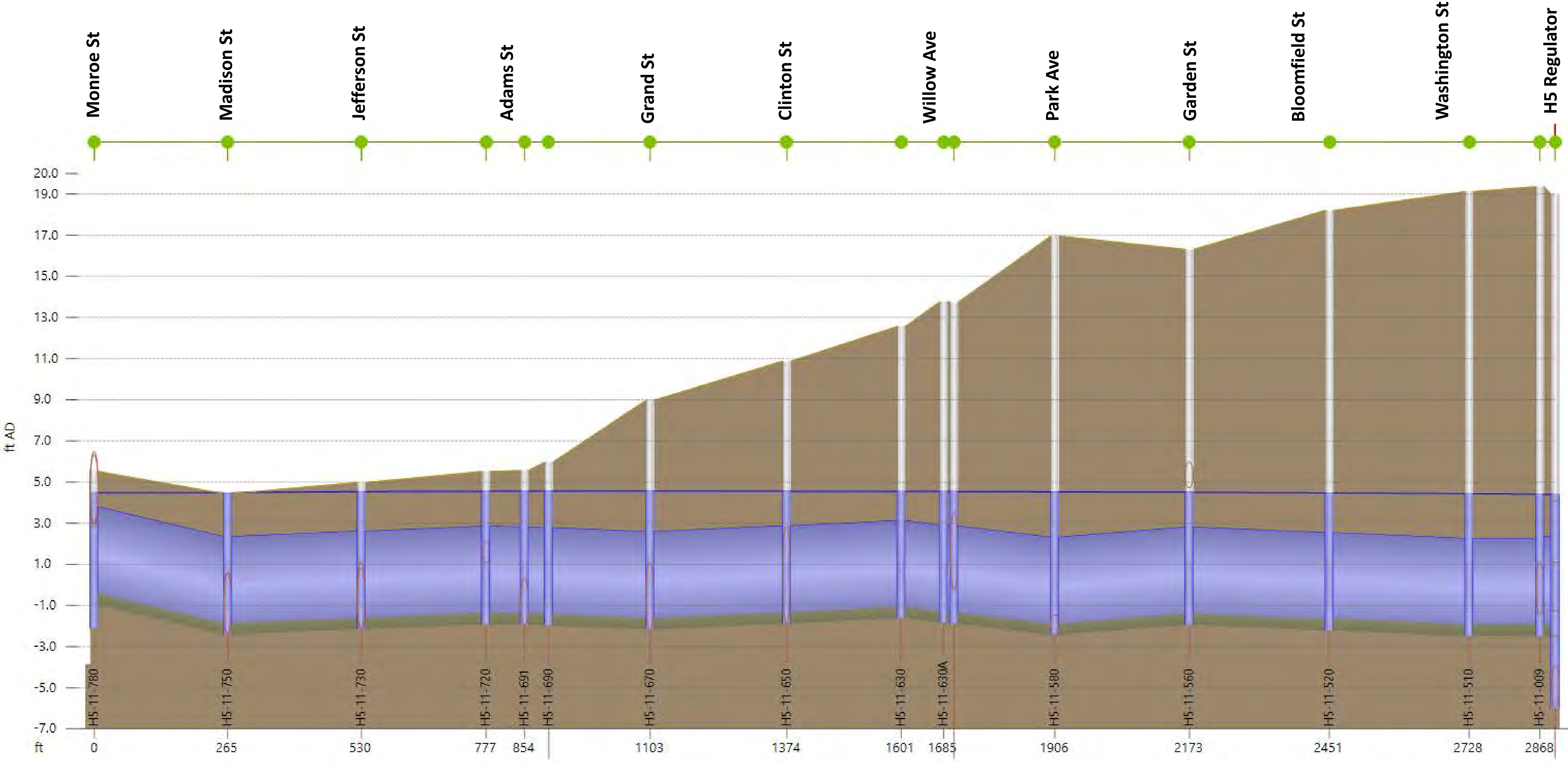
Max Typical Year

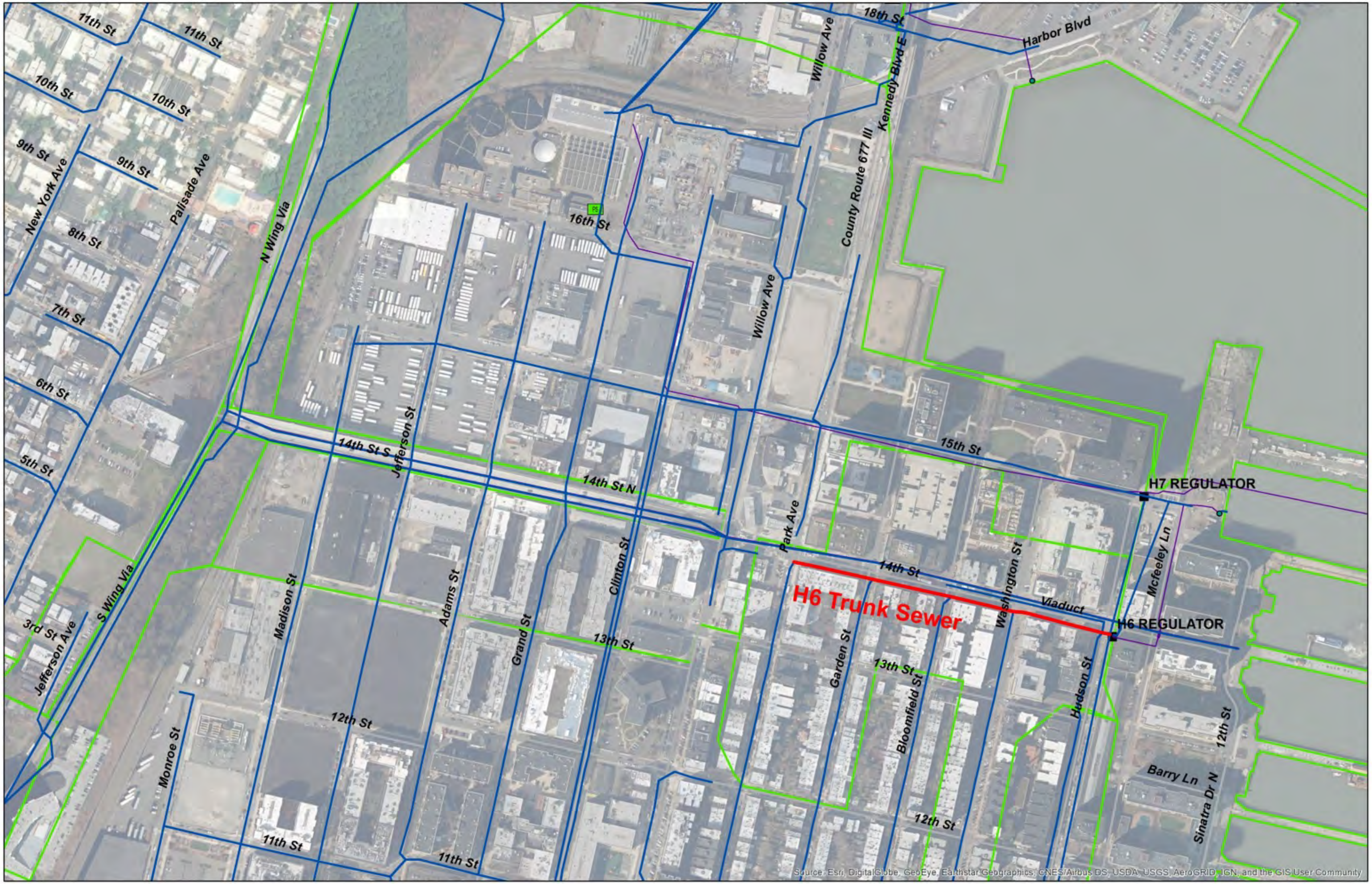


H5 Trunk Sewer
H5 REGULATOR
H6 REGULATOR
14th St
Viaduct
13th St
12th St
11th St
10th St
9th St
8th St
7th St
Nineth St
New York Ave
3rd St
2nd St
Jefferson Ave
S Wing Via
Paterson Plank Rd
Palisade Ave
Ogden Ave
Eighth St
Jackson St
Monroe St
Madison St
Jefferson St
Adams St
Grand St
Clinton St
Willow Ave
Park Ave
Garden St
Bloomfield St
Washington St
Hudson St
Castle Point Ter
Mcfeeley Ln
Barry Ln
Maxwell Ln
Sinatra Dr
Sinatra Dr N
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H5 Trunk Sewer

Max Typical Year

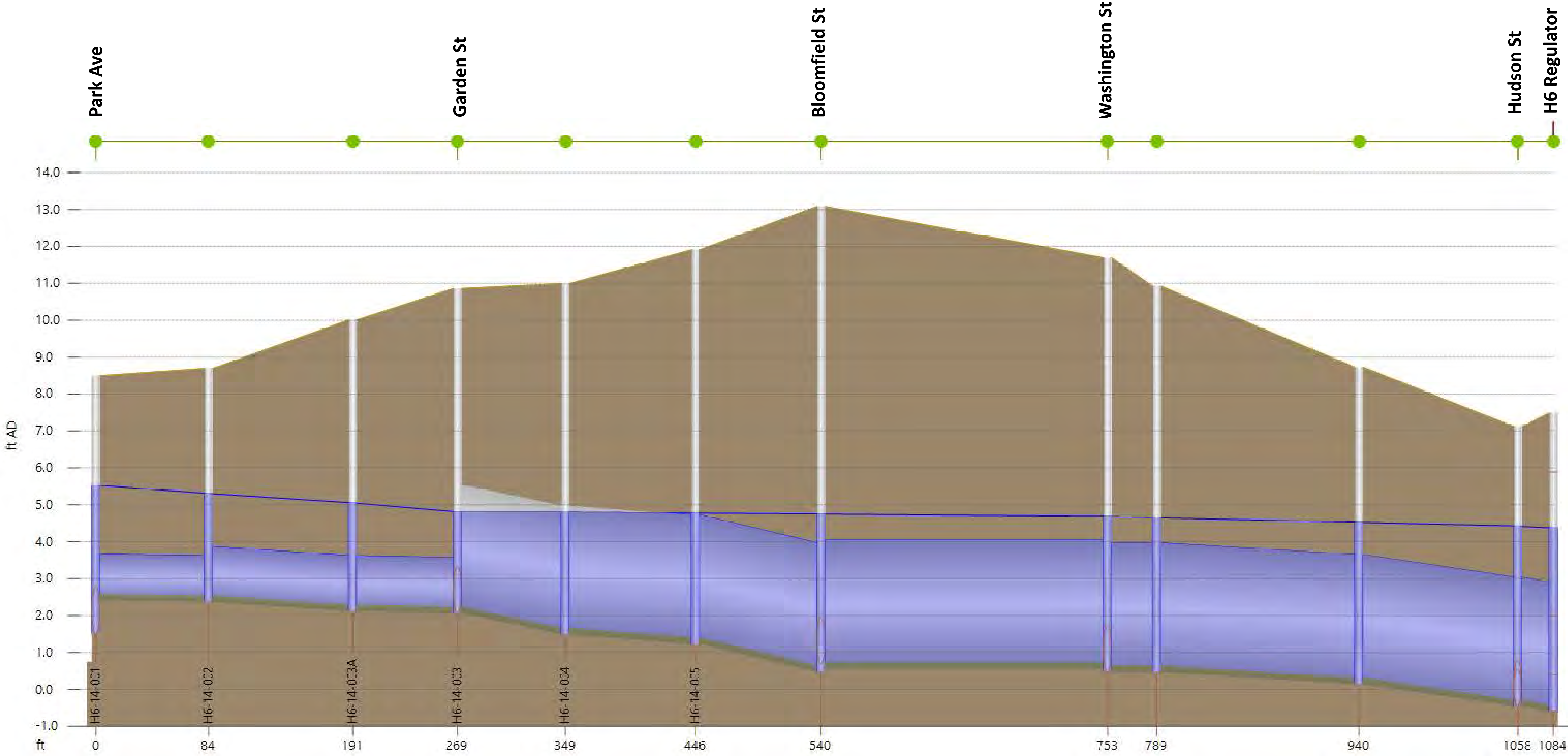


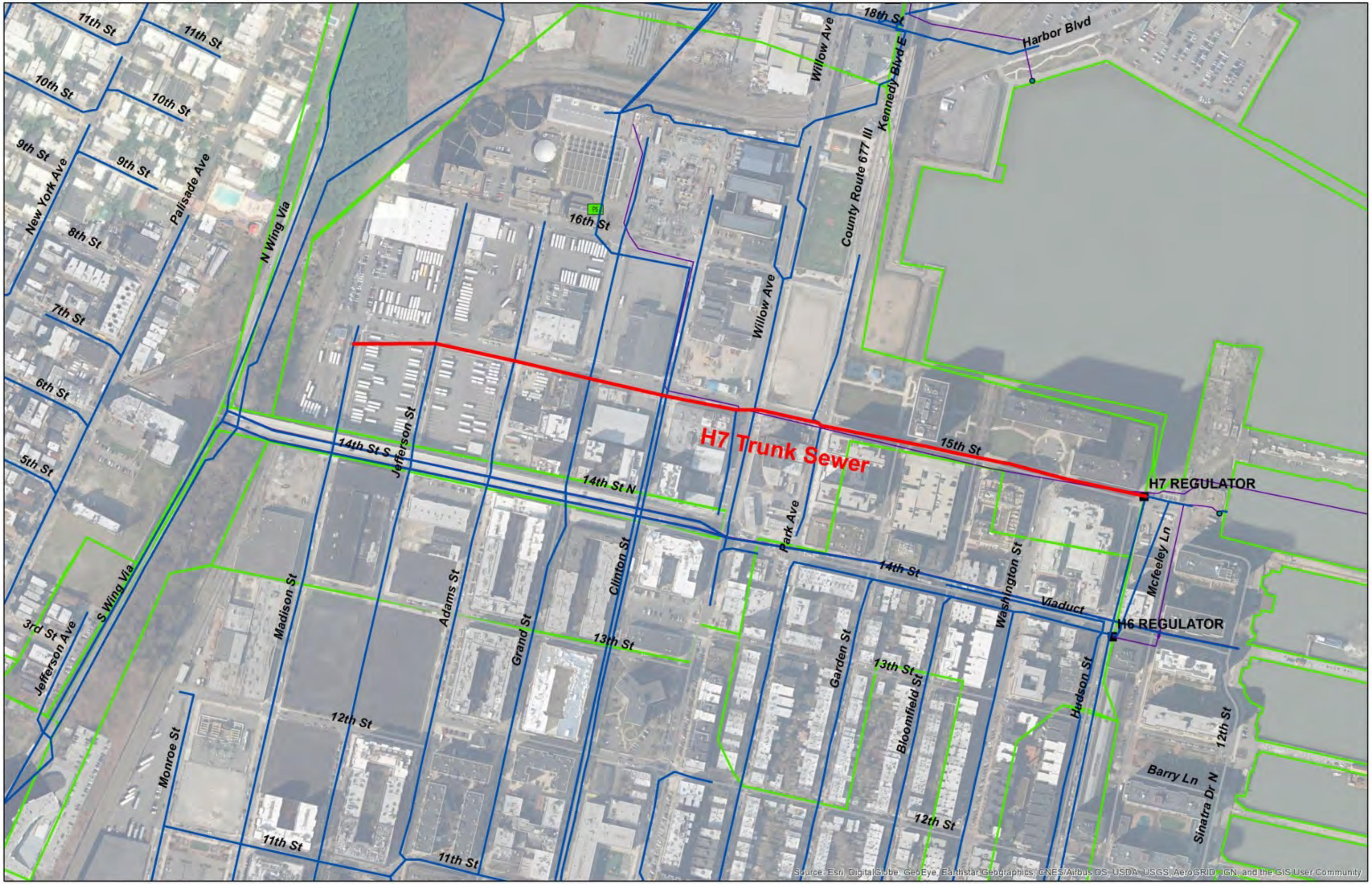


H6 Trunk Sewer
H6 REGULATOR
H7 REGULATOR
14th St
Viaduct
15th St
14th St N
14th St S
16th St
18th St
Harbor Blvd
Willow Ave
Kennedy Blvd E
County Route 677 II
Park Ave
Washington St
Mcfeeley Ln
Hudson St
Garden St
Bloomfield St
13th St
12th St
11th St
10th St
9th St
8th St
7th St
6th St
5th St
3rd St
New York Ave
Palisade Ave
N Wing Via
S Wing Via
Jefferson Ave
Jefferson St
Madison St
Monroe St
Adams St
Grand St
Clinton St
Barry Ln
Sinatra Dr N
PS
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H6 Trunk Sewer

Max Typical Year

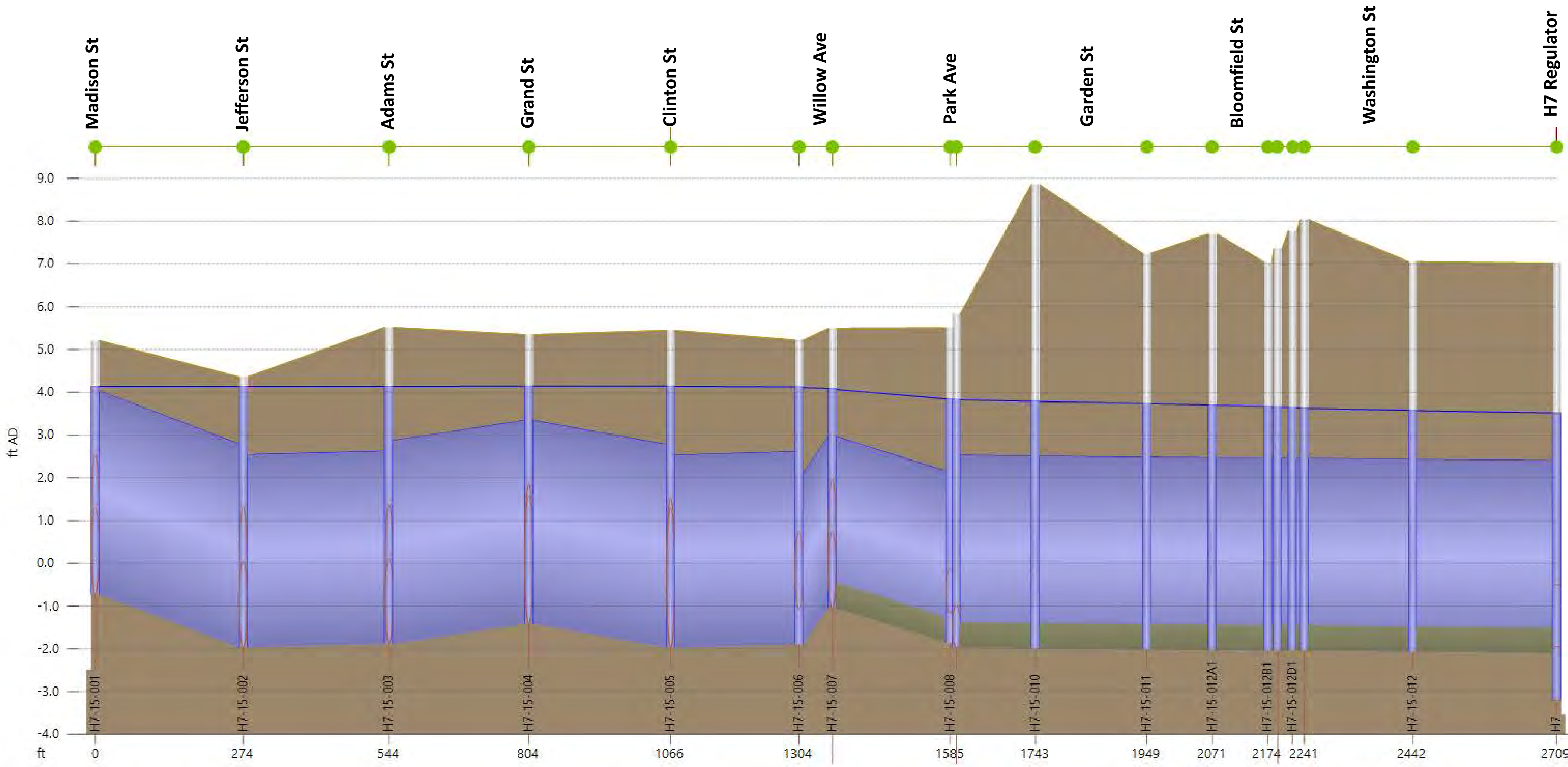




H7 Trunk Sewer
H7 REGULATOR
H6 REGULATOR
15th St
14th St S
14th St N
14th St
Viaduct
13th St
12th St
11th St
16th St
18th St
Harbor Blvd
Willow Ave
Park Ave
County Route 677 II
Kennedy Blvd E
Jefferson St
Madison St
Adams St
Grand St
Clinton St
Monroe St
Garden St
Bloomfield St
Washington St
Hudson St
Mcfeeley Ln
Sinatra Dr N
Barry Ln
N Wing Via
S Wing Via
Palisade Ave
New York Ave
Jefferson Ave
10th St
9th St
8th St
7th St
6th St
5th St
3rd St
PS
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H7 Trunk Sewer

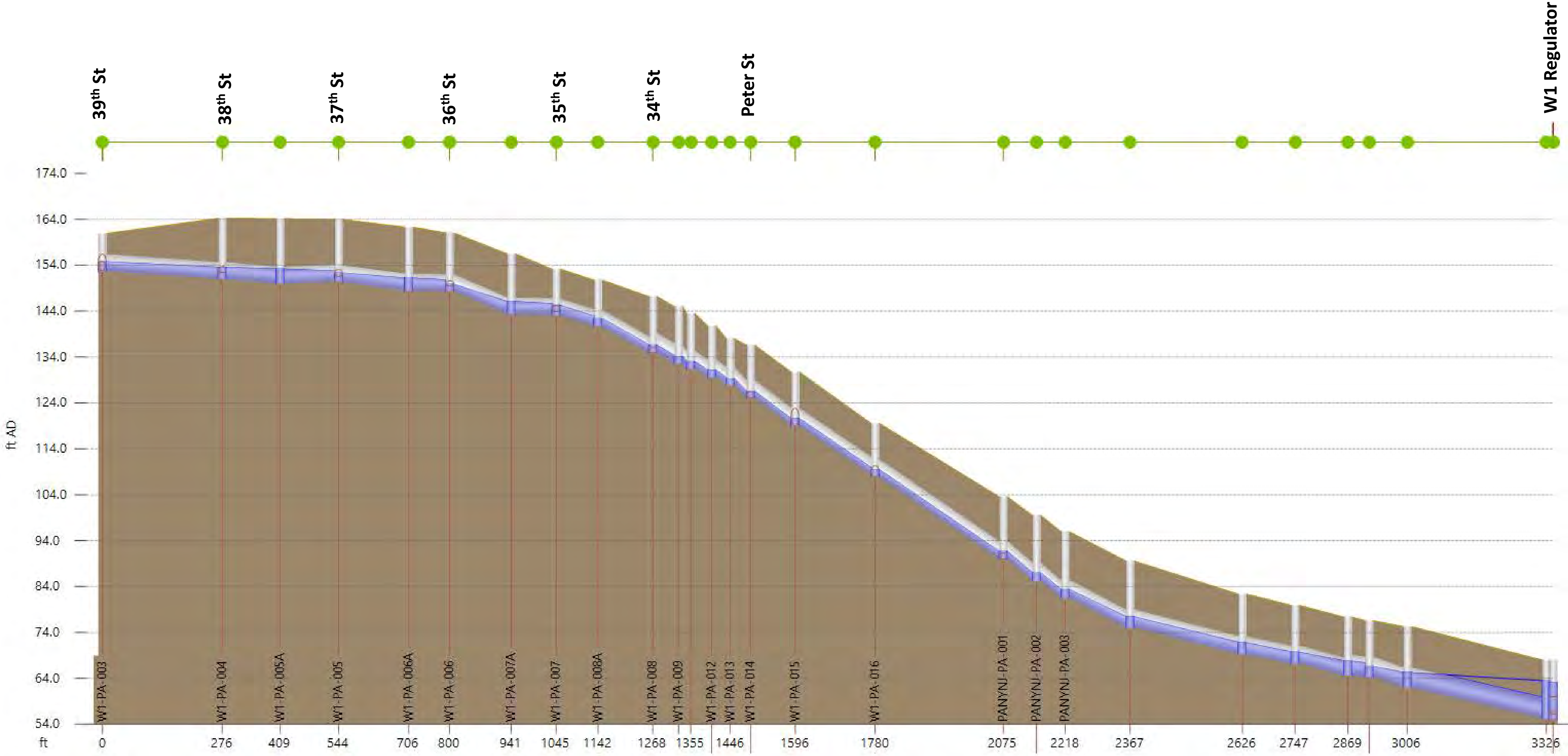
Max Typical Year

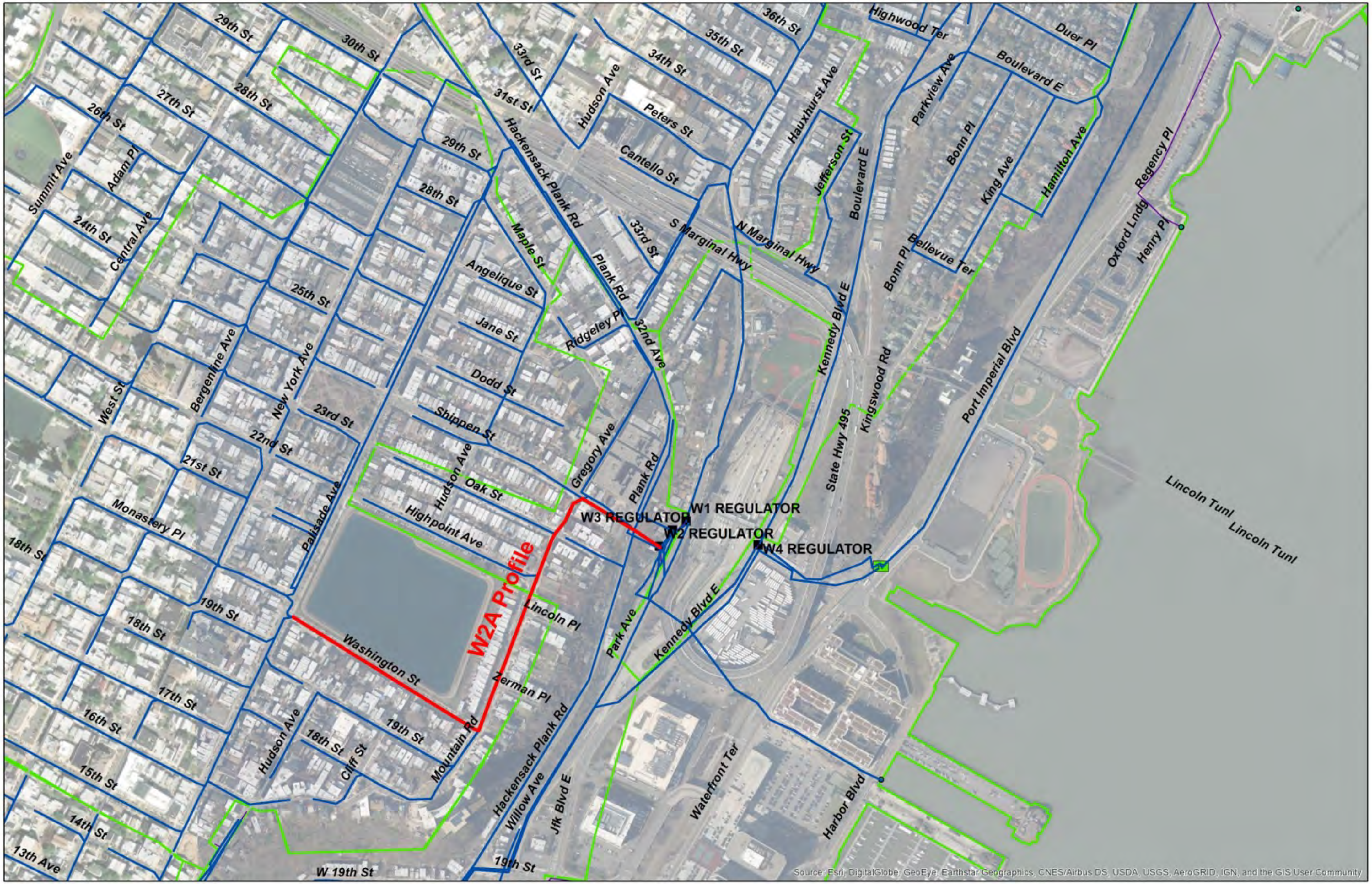



W1 Profile
W1 REGULATOR
W2 REGULATOR
W3 REGULATOR
W4 REGULATOR
John F Kennedy Blvd
Hackensack Plank Rd
Palisade Ave
Bergenline Ave
Hudson Ave
New York Ave
Summit Ave
Central Ave
Boulevard E
Kennedy Blvd E
Port Imperial Blvd
State Hwy 495
S Marginal Hwy
N Marginal Hwy
Lincoln Tunl
Harbor Blvd
Pershing Rd
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

W1 Trunk Sewer

Max Typical Year

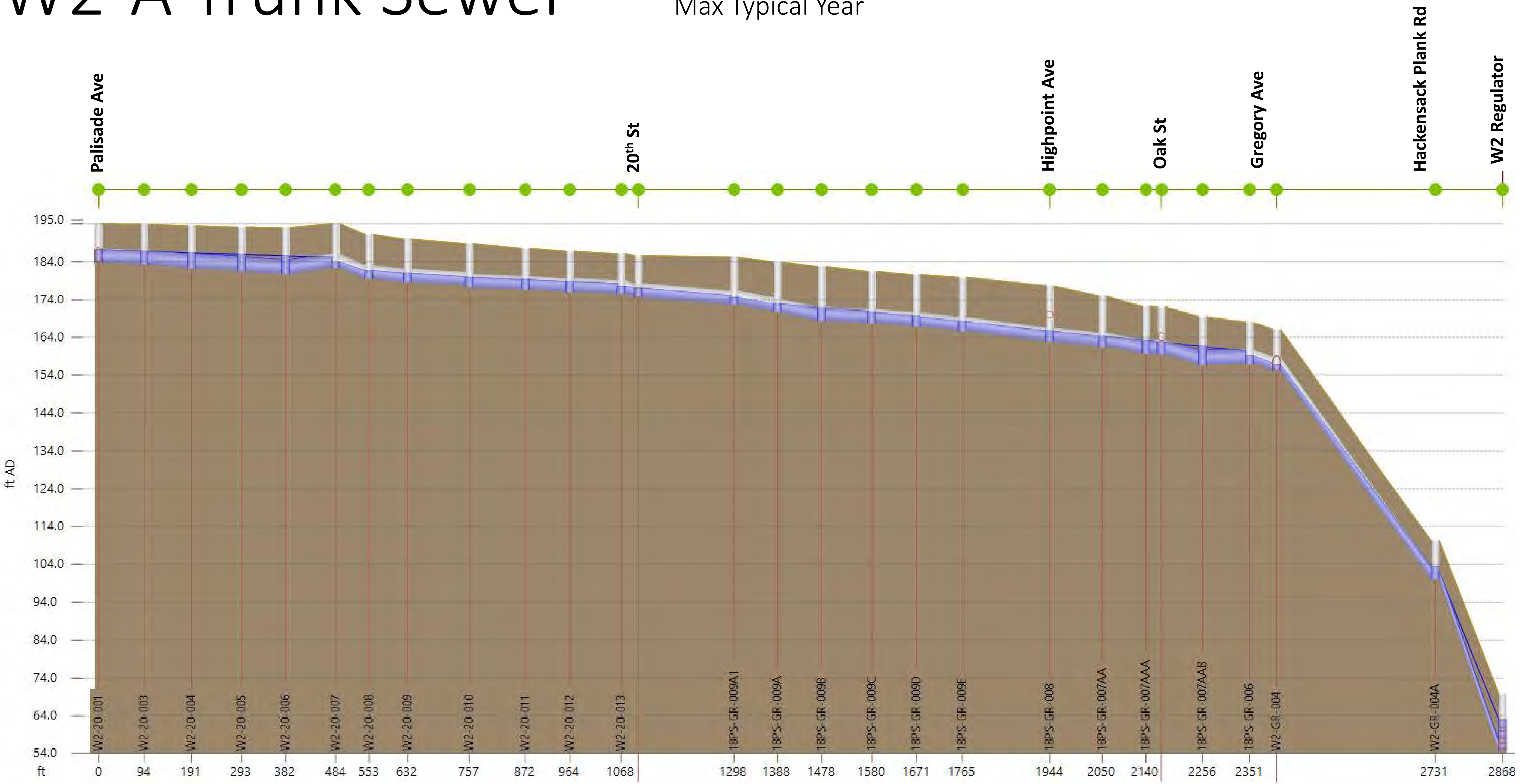


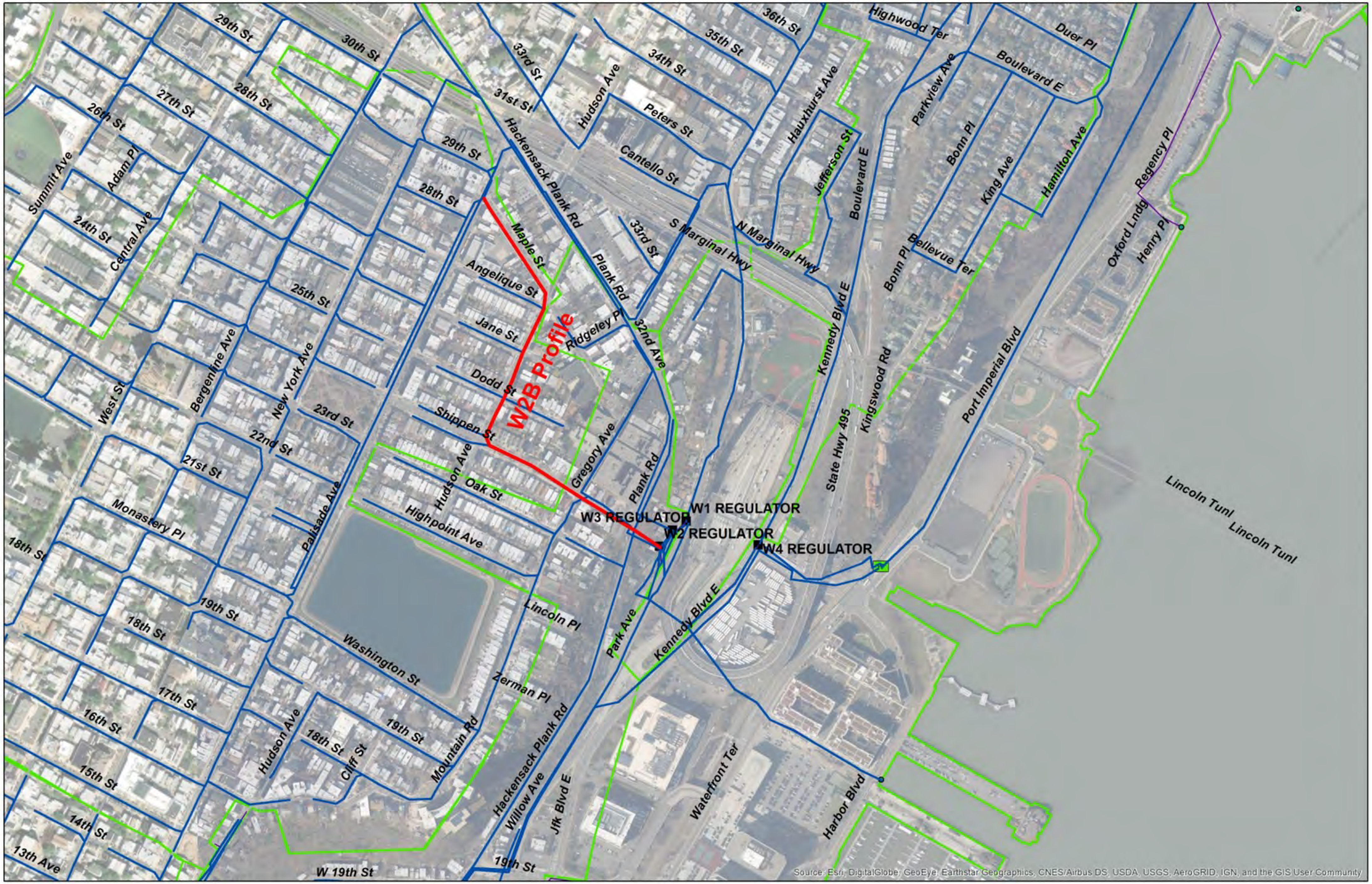


W1 REGULATOR
W3 REGULATOR
W2 REGULATOR
W4 REGULATOR
W2A Profile
Washington St
Mountain Rd
Lincoln Pl
Zerman Pl
Highpoint Ave
Oak St
Gregory Ave
Plank Rd
Hudson Ave
Palisade Ave
Kennedy Blvd E
Park Ave
Hackensack Plank Rd
Willow Ave
Jfk Blvd E
Waterfront Ter
Harbor Blvd
Port Imperial Blvd
State Hwy 495
Kingswood Rd
Lincoln Tunl
S Marginal Hwy
N Marginal Hwy
Boulevard E
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

W2-A Trunk Sewer

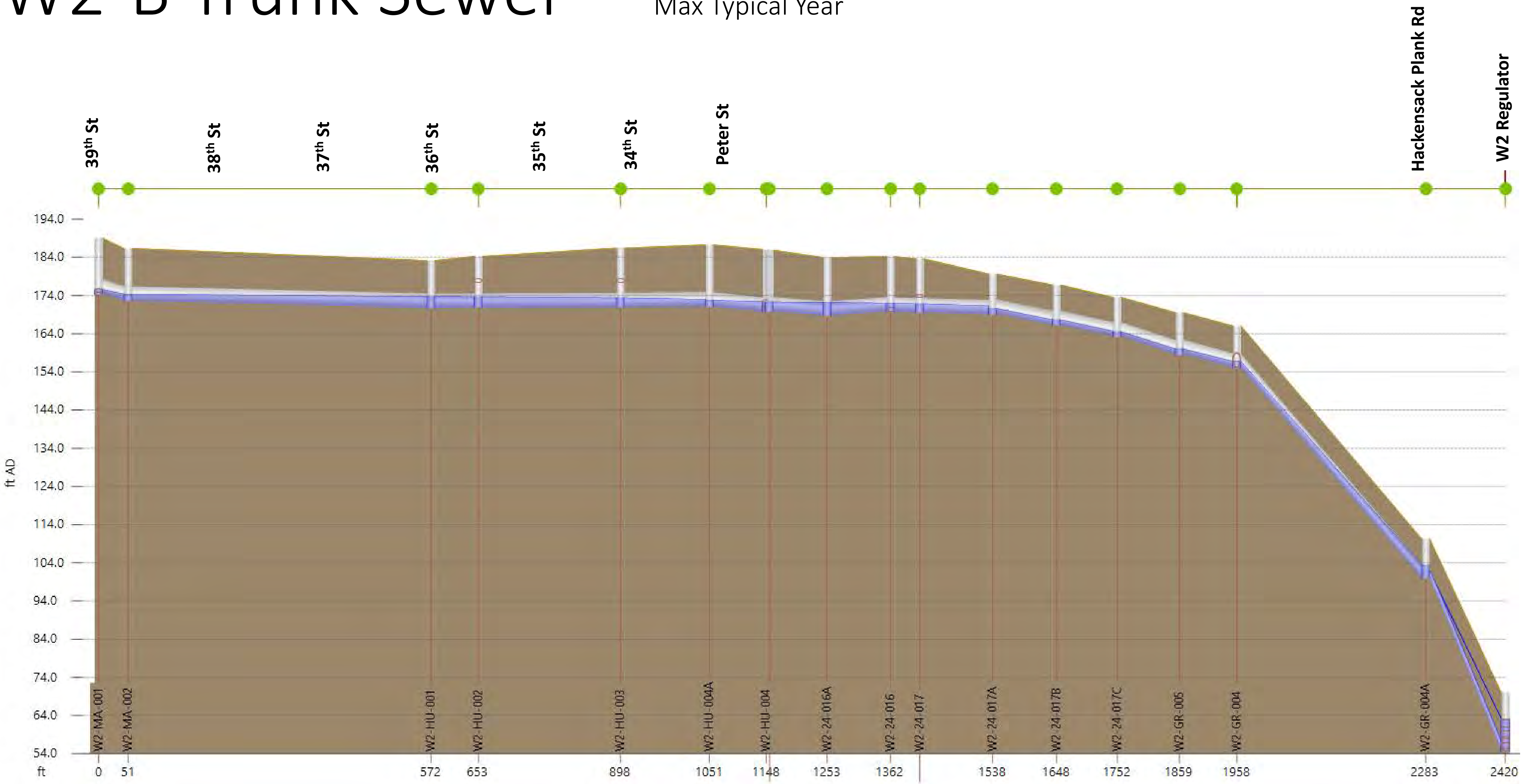
Max Typical Year

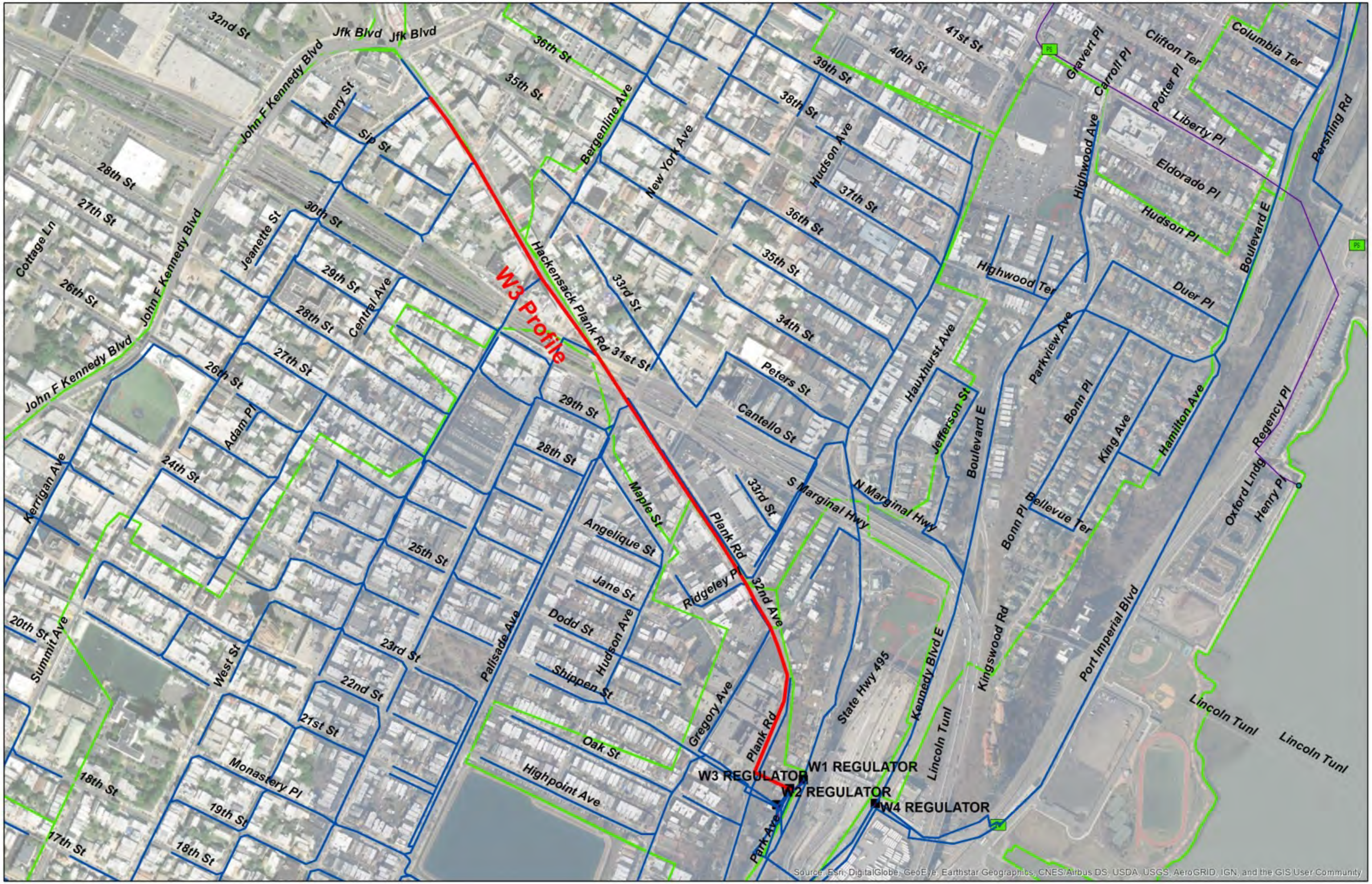



W2B Profile
W1 REGULATOR
W2 REGULATOR
W3 REGULATOR
W4 REGULATOR
Hackensack Plank Rd
Plank Rd
Maple St
Angelique St
Jane St
Dodd St
Shippen St
Oak St
Highpoint Ave
Hudson Ave
Gregory Ave
Ridgeley Pl
32nd Ave
Park Ave
Kennedy Blvd E
Boulevard E
State Hwy 495
Kingswood Rd
Port Imperial Blvd
Lincoln Tunl
Lincoln Pl
Washington St
Zerman Pl
Mountain Rd
Palisade Ave
New York Ave
Bergenline Ave
West St
Central Ave
Summit Ave
Adam Pl
Monastery Pl
S Marginal Hwy
N Marginal Hwy
Cantello St
Peters St
Hauxhurst Ave
Jefferson St
Parkview Ave
Bonn Pl
King Ave
Hamilton Ave
Bellevue Ter
Boulevard E
Duer Pl
Highwood Ter
Regency Pl
Oxford Lndg
Henry Pl
Willow Ave
Jfk Blvd E
Waterfront Ter
Harbor Blvd
Cliff St
W 19th St
13th Ave
14th St
15th St
16th St
17th St
18th St
19th St
21st St
22nd St
23rd St
24th St
25th St
26th St
27th St
28th St
29th St
30th St
31st St
33rd St
34th St
35th St
36th St
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

W2-B Trunk Sewer

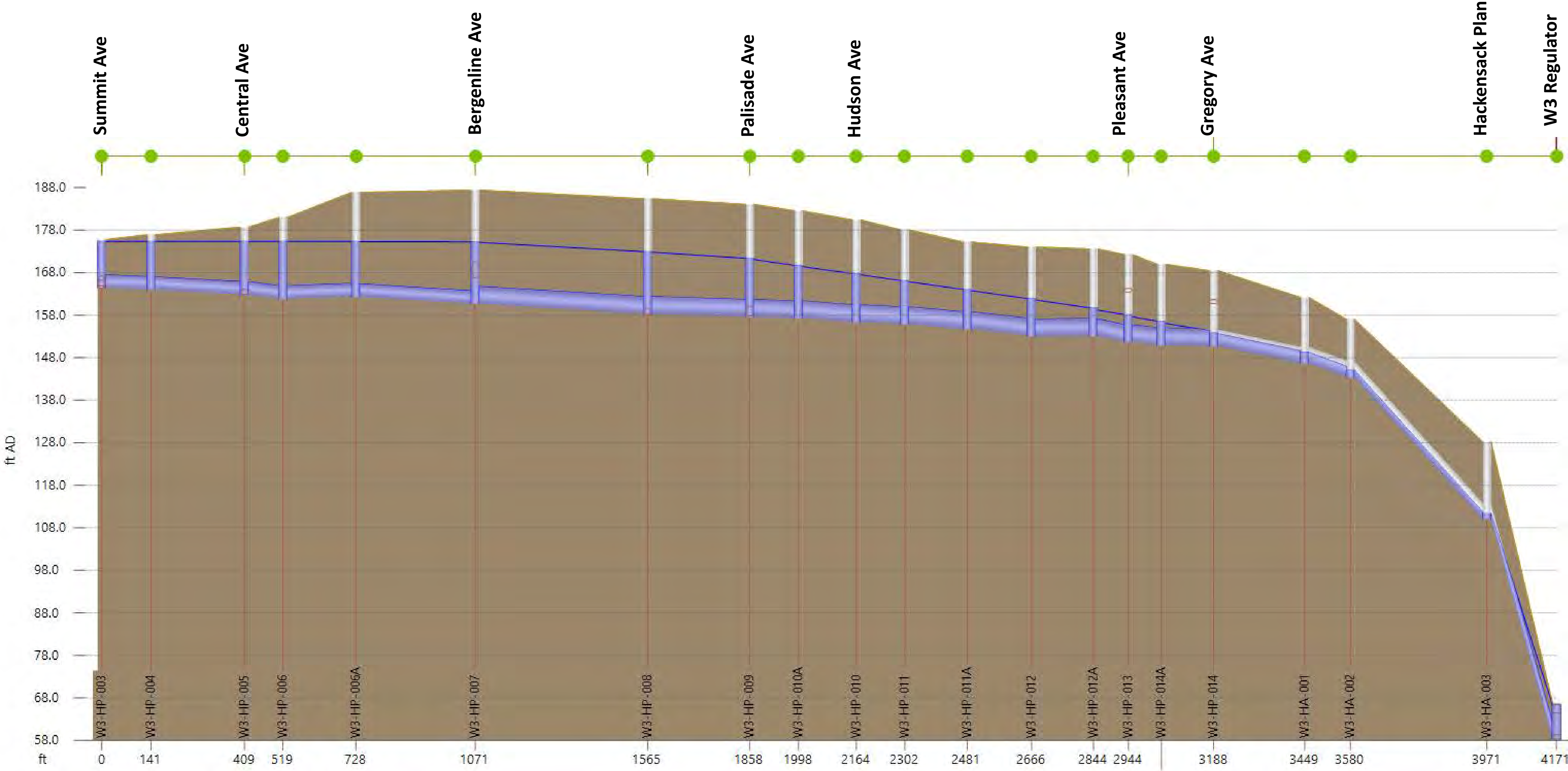
Max Typical Year

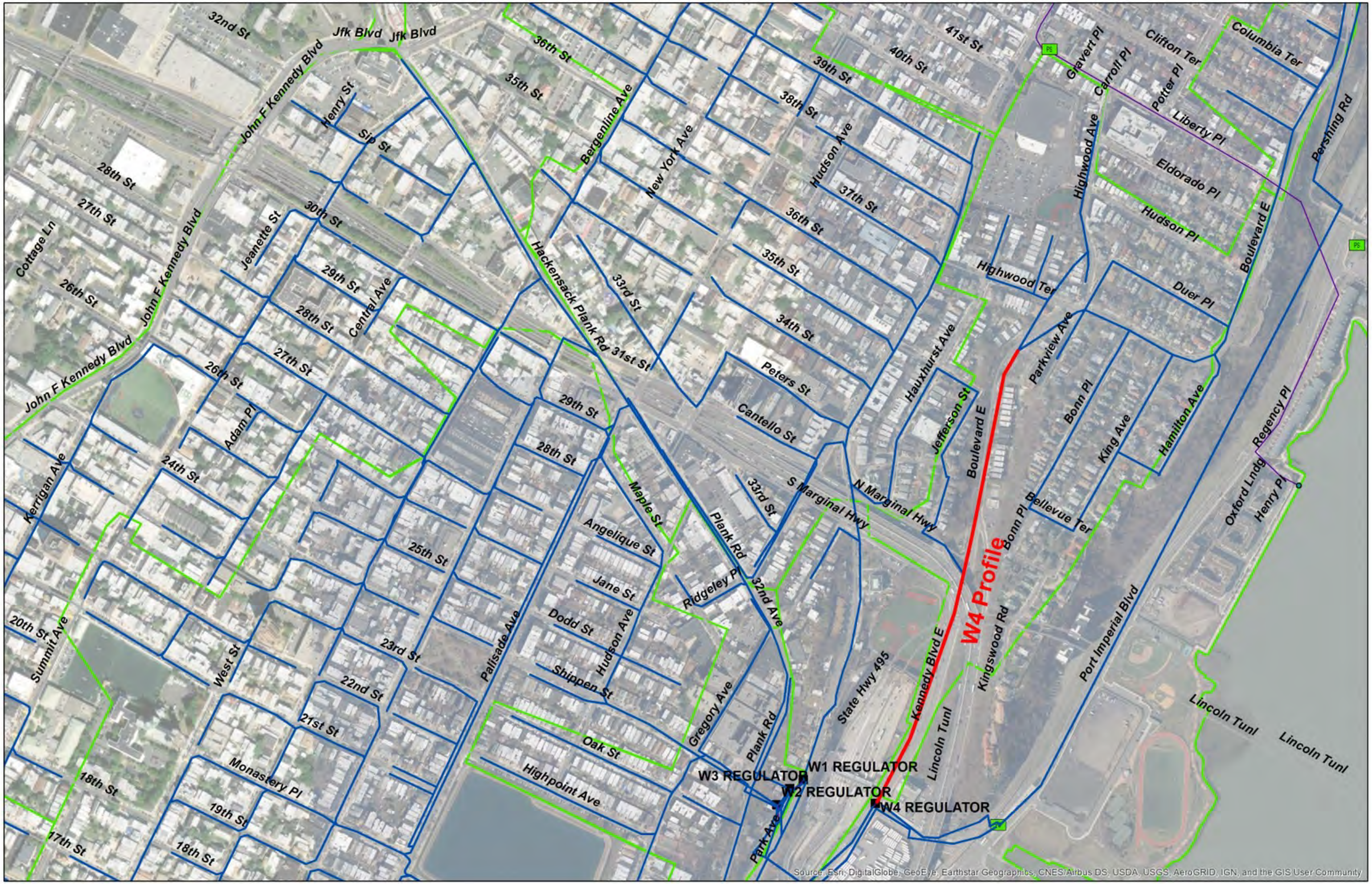



W3 Profile
W1 REGULATOR
W2 REGULATOR
W3 REGULATOR
W4 REGULATOR
Jfk Blvd
John F Kennedy Blvd
32nd St
36th St
35th St
Henry St
Sip St
28th St
27th St
26th St
Cottage Ln
30th St
Jeanette St
29th St
Central Ave
Hackensack Plank Rd
33rd St
31st St
Bergenline Ave
New York Ave
Hudson Ave
39th St
40th St
41st St
38th St
37th St
34th St
Peters St
Cantello St
Gravert Pl
Carroll Pl
Clifton Ter
Columbia Ter
Potter Pl
Liberty Pl
Eldorado Pl
Hudson Pl
Highwood Ave
Highwood Ter
Duer Pl
Boulevard E
Pershing Rd
Parkview Ave
Hauxhurst Ave
Jefferson St
Bonn Pl
King Ave
Hamilton Ave
Regency Pl
Oxford Lndg
Henry Pl
S Marginal Hwy
N Marginal Hwy
Bellevue Ter
Adam Pl
24th St
Kerrigan Ave
Maple St
Angelique St
Plank Rd
32nd Ave
Ridgeley Pl
Jane St
Dodd St
25th St
23rd St
22nd St
21st St
20th St
Summit Ave
West St
Palisade Ave
Shippen St
Gregory Ave
Oak St
Highpoint Ave
Monastery Pl
18th St
19th St
17th St
Park Ave
State Hwy 495
Kennedy Blvd E
Lincoln Tunl
Kingswood Rd
Port Imperial Blvd
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

W3 Trunk Sewer

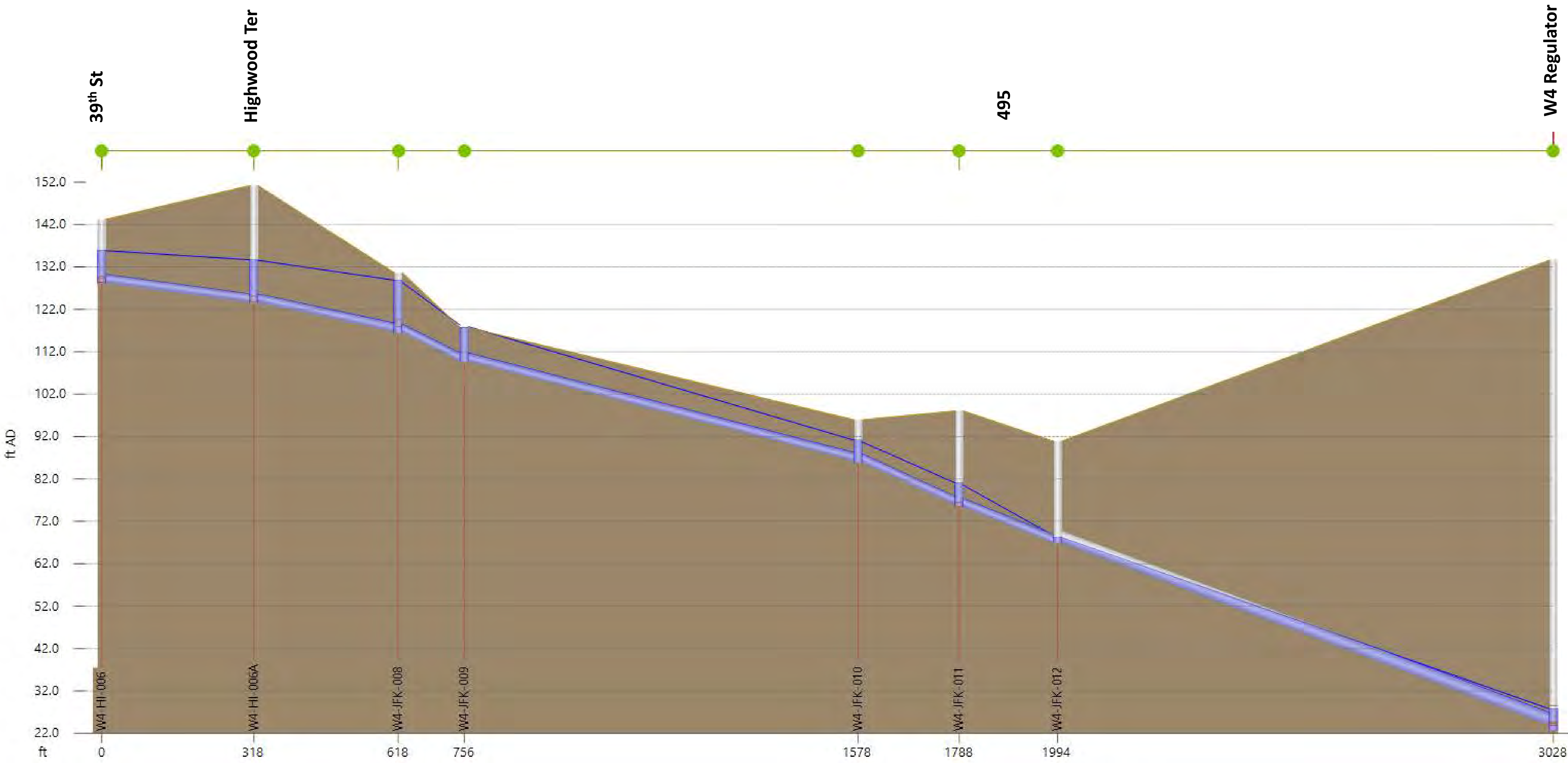
Max Typical Year




W4 Profile
W1 REGULATOR
W2 REGULATOR
W3 REGULATOR
W4 REGULATOR
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

W4 Trunk Sewer

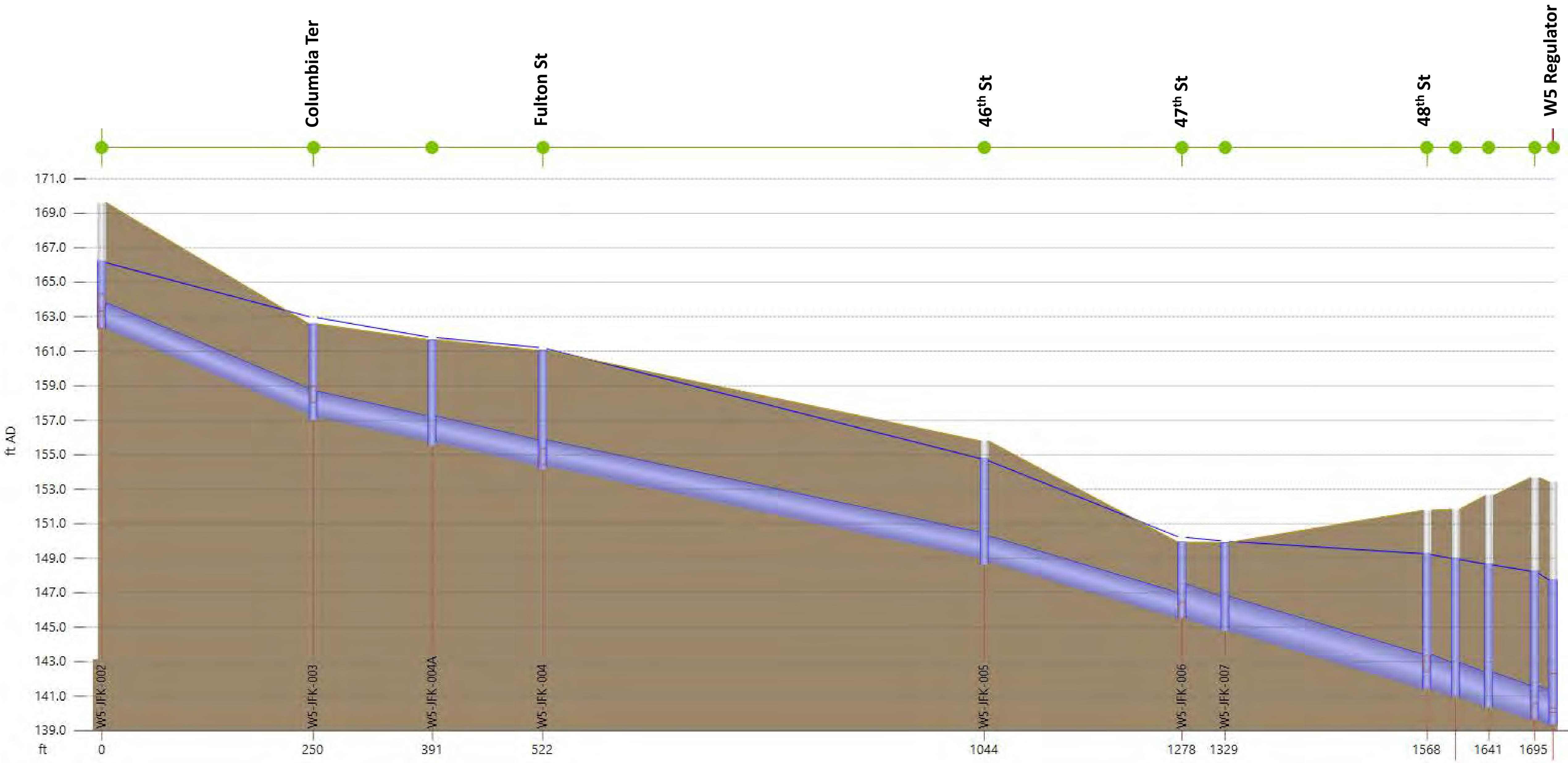
Max Typical Year




UC2-Regulator
W5 REGULATOR
UC1-Regulator
W5 Profile
43rd St
Hillside Ave
Cottage Pl
Golden Ln
46th St
47th St
48th St
49th St
50th St
51st St
J F Kennedy Blvd E
Port Imperial Blvd
John F Kennedy Blvd
44th St
45th St
Lincoln St
Roosevelt St
Brown St
Broadway
Park Ave
43rd St
44th St
42nd St
Cooper Pl
46th St
Ave At Port Imperial Ave
40th St
Fulton St
Louisa Pl
Palisade Ave
Hudson Ave
39th St
41st St
Clifton Ter
Columbia Ter
36th St
Bergenline Ave
Gravert Pl
Carroll Pl
Potter Pl
38th St
Liberty Pl
Port Imperial Blvd
35th St
New York Ave
Highwood Ave
Eldorado Pl
37th St
36th St
Hudson Pl
Boulevard E
Pershing Rd
35th St
Carlyle Ct
Highwood Ter
Duer Pl
33rd St
34th St
Parkview Ave
Hauxhurst Ave
31st St
30th St
Peters St
Bonn Pl
Hamilton Ave
Regency Pl
Hackensack Plank Rd
State Hwy 495
29th St
Cantello St
State Hwy 495
Jefferson St
King Ave
Boulevard E
28th St
S Marginal Hwy
Maple St
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

W5 Trunk Sewer

Max Typical Year



Adams Street STP Layout and Facilties

Adams Street STP Simplified Process Flow Diagram

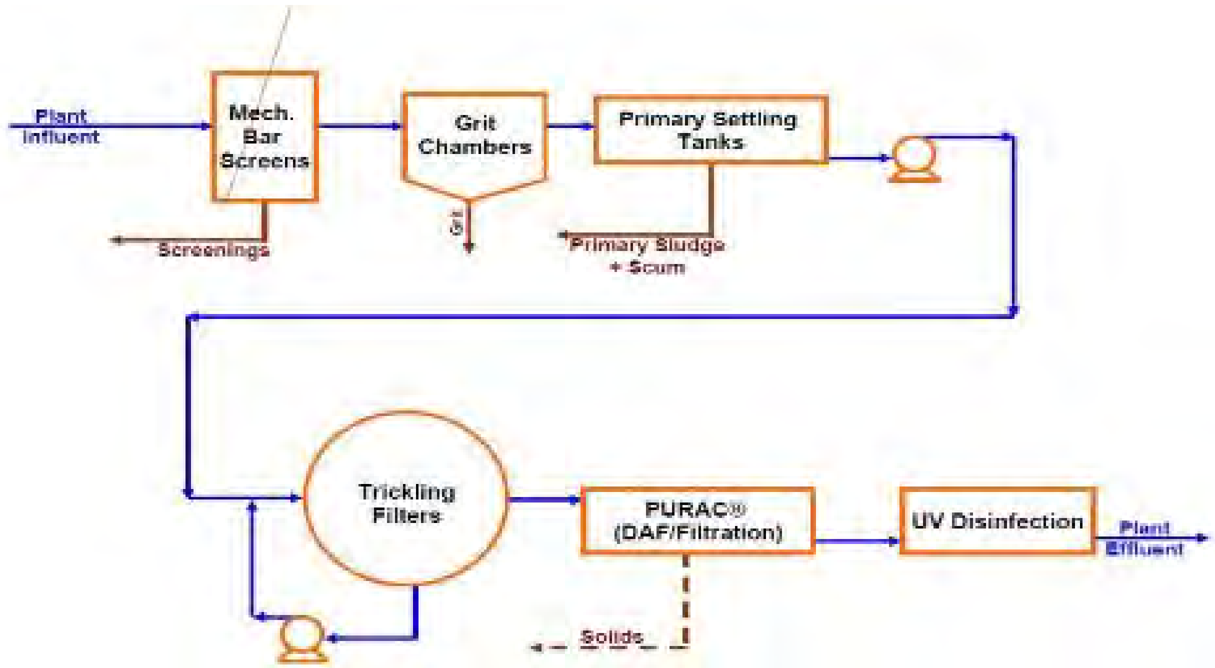


Figure 2: Adams Street WWTP Simplified Process Flow Diagram

Adams Street STP Fact Sheet

Plant Design Capacity

Parameter	Units	Annual Average (Projected)	Max. Month (Design)	Peak(Design)
Flow	mgd	20	24	40/48
BOD_5	mg/l	253	253	
	lbs/d	42,200	50,640	
TSS	mg/l	193	193	
	lbs/d	32,190	38,631	

1. 40 mgd represents peak hydraulic flow handled by all process units
2. 48 mgd represents peak hydraulic flow through plant (portion of flow will bypass the gravity sand filters
3. NJPDES Permit allows the Adams Street WWTP to treat up to 20.8 mgd on an average daily basis.

Plant Historical Data 2017-2018

	MGD									
	Average	Median	Max. Month	Peak Week	Peak Day[1]					
Plant Influent Flow	**12.98**	**12.15**	**15.95**	**19.61**	**29.18**					
	mg/L					lb/day				
	Average	Median	Max. Month	Peak Week	Peak Day[1]	Average	Median	Max. Month	Peak Week	Peak Day[1]
Plant Influent										
TSS	145	138	177	199	145	15,702	14,006	19,330	26,570	35,220
BOD	149	146	178	193	114	15,813	15,697	16,837	18,291	27,635
Primary Effluent										
TSS	102	97	124	140	101					
BOD	63	69	87	96	75					
Primary Clarifier Performance										
HLR (gpd/ft2)	371	348	456	561	835					
%TSS Removed[2]	30%	30%	30%	30%	30%					
%BOD Removed	58%	53%	51%	50%	34%					
Trickling Filters										
THL (gpm/mgd)	1.02	0.95	1.26	1.50	2.28					
SLR (lb/day/1000ft3)	47	43	57	70	105					
DAF/Flofilter Secondary Treatment Performance										
HLR (gpm/ft2)	1.02	0.96	1.26	1.55	2.30					
SLR (lb/day*ft2)[3]	1.376	1.224	2.054	2.853	3.082					
Final Effluent										
TSS	17	16	22	39	18	1,820	1,598	2,406	4,169	6,975
BOD	19	18	25	36	18	2,033	1,903	2,823	3,787	5,598
%TSS Removed	87.1%	87.0%	85.9%	82.1%	87.6%					
%BOD Removed	87.4%	87.7%	86.1%	81.5%	84.2%					

1 Wet Weather BOD and TSS averages for Flows Greater Than 16 mgd Used for Peak Day

2 Assumed 30 % Removal

3 Assumes Nine Flofilters in Service

Adams Street STP Treatment Capacity

Primary and Secondary Treatment Capacity is as follows:

- **Primary Treatment Capacity:** There are three (3) primary clarifiers each with a surface area of 11,100 sf. The average overflow rate for the existing clarifiers is 371 gpd/sf at approximately 13 mgd whereas the recommended design average overflow rate is typically 1200 gpd/sf for most tanks deeper than 12 feet. The primary clarifiers at the Adams Street WWTP are only 10 feet deep and relatively shallow and therefore derating the overflow rate to 1000 gpd/sf is a reasonable design criteria. **At an overflow rate of 1000 gpd/sf the primary clarifiers are rated for 33 mgd average flow. For peak hour flow the recommended design overflow rate is approximately 1800 gpd/sf. At 1800 gpd/sf the capacity of the clarifiers is 59 mgd with all three units in service. When one unit is out of service the capacity is approximately 40 mgd.**
- **Secondary Treatment Capacity:** There are ten (10) dissolved air floatation/filters in the secondary treatment system. The hydraulic capacity of each unit is limited to approximately 4 gpm/sf which equates to **32 mgd with one unit in backwash or out of service.** However, if the flow across the filters is allowed to bypass the filters by opening the emergency bypass valve it will allow up to 40 mgd capacity with one unit out of service. The use of this bypass feature is not currently allowed in the plants permit as it is a blended effluent. The historical effluent quality for BOD5 ranges between 19 mg/l at average flows of 13 mgd and 36 mg/l at peak week flows of 19.6 mgd. The TSS effluent quality ranges from 17 mg/l at average daily flows of 13 mgd and 39 mg/l at 19.6 mgd. Since the wet weather flows are much more dilute during peak hour periods the influent solids and BOD5 are much more dilute and effluent quality is better than the peak week condition. However, removals are typically degraded when the wastewater is too dilute.

Limiting factors in STP Capacity include:

- The capacity of the **grit removal system** is the limiting process in the Preliminary Treatment Building. There are two grit chambers and each is rated at 24 mgd. This capacity limits the preliminary treatment capacity to approximately 24 mgd when one unit is out of service.
- The **secondary treatment process (PURAC)** is currently planned for a major rehabilitation. The disinfection capacity and performance has been impacted due the recent performance degradation of the PURAC DAF/Flofilters.
- There are three (3) channels of **UV disinfection.** The hydraulic capacity of each channel is limited 15 mgd due to headlosses in the UV banks, baffles and control gates. When one channel is out of service the capacity is 30 mgd. However, the disinfection capacity is currently significantly below the required design capacity and is impacted due to the sand that has migrated through the failed underdrains in several DAF/Flofilter cells. Once the DAF/Flofilters are rehabilitated the UV disinfection capacity should be restored to the design flows.

Adams Street System Recent/Ongoing Projects

1. W1234 Solids/Floatables Screening Facility, Weehawken
2. Design Services H6/H7 Hydraulic Modeling Study, H8 Stormwater System Design for the Long Term Control Plan, Hoboken
3. St Augustine School, Union City

W1234 Solids/Floatables Screening Facility Factsheet

- Combined flow from the W1, W2, W3, and W4 drainage basins (38% of the Adams Street WWTP service area)
- S/F Facility
    - 2 parallel hydraulically connected discharges in the Hudson River
    - 2 netting structures located under a public access park pier facility
        - 6 nets per structure (3 below and 3 above) to capture solids/floatables greater than ½”
    - Facility Flow capacity = 480 mgd (240 mgd per netting structure)
        - Twice the 2-year storm flow of 238 mgd
        - 50% greater than 10-year storm flow of 318 mgd
        - 100% screening back-up capacity and 50% screening back-up capacity at the 2 year and 10 year storm flows

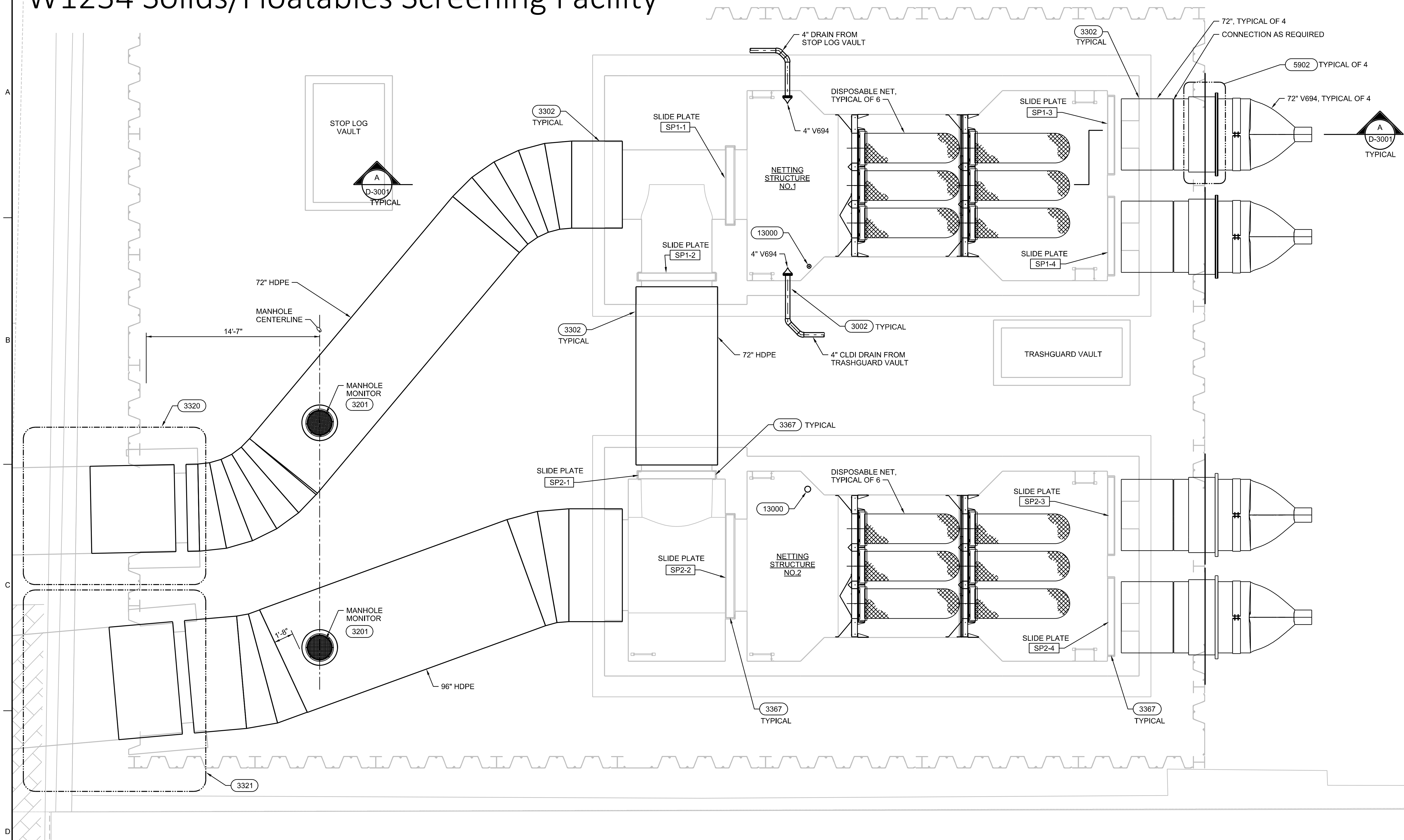
MELILLO+BAUER
ASSOCIATES
Landscape Architecture

CONCEPT PERSPECTIVE 2
WEEHAWKEN PIER
WEEHAWKEN, NJ

DATE: 05.30.2018 **SCALE**: NTS

DRAFT

W1234 Solids/Floatables Screening Facility



PIPING AND EQUIPMENT PLAN

1/4"=1'-0"

SHIVANI PATEL

N.J. PROFESSIONAL ENGINEER No. 24GE05092500

S PATEL

NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
	M MOORE	J HALEC	J TOBIA

NORTH HUDSON SEWERAGE AUTHORITY

W1234 SOLIDS/FLOATABLES SCREENING FACILITY

WEEHAWKEN, NEW JERSEY

CH2MHILL®

PROCESS MECHANICAL

PIPING AND EQUIPMENT PLAN

VERIFY SCALE

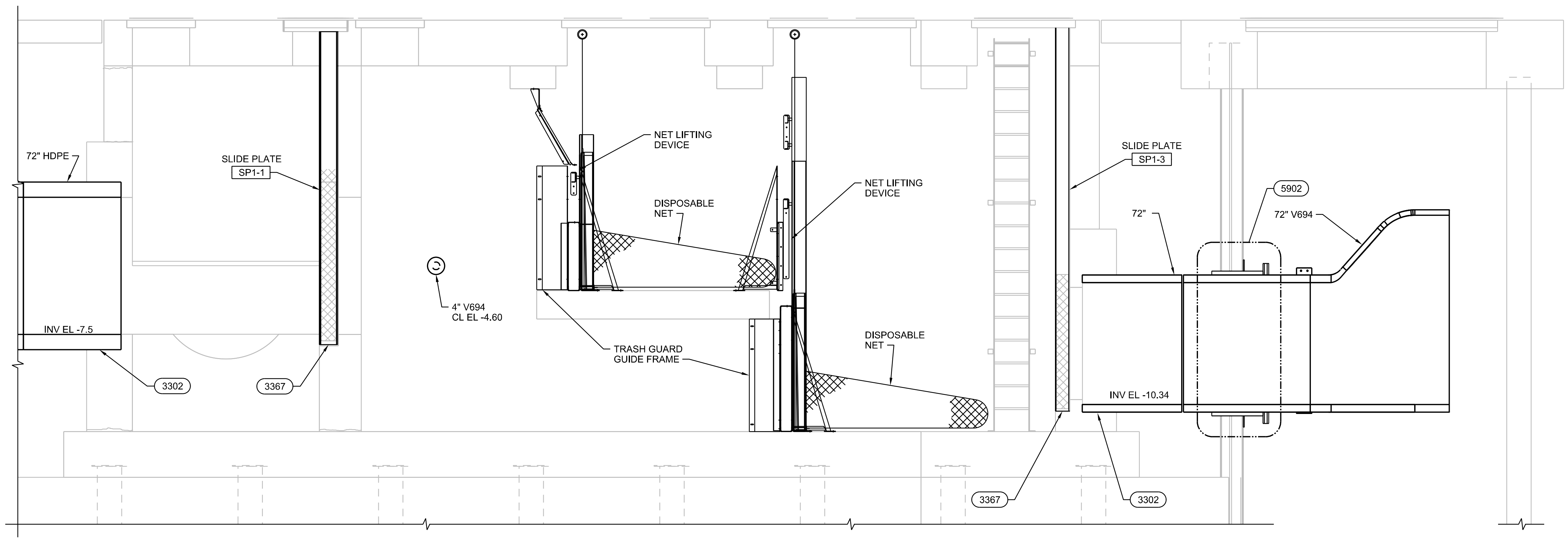
BAR IS ONE INCH ON ORIGINAL DRAWING.

0 1"

DATE	AUGUST 2016
PROJ	491076
DWG	M-2001
SHEET	53 of 57

FILENAME: M-2001_491076.dgn PLOT DATE: 2016\07\21 PLOT TIME: 3:18:34 PM

W1234 Solids/Floatables Screening Facility



A SECTION
3/8"=1'-0"
D-2001

SHIVANI PATEL

N.J. PROFESSIONAL ENGINEER No. 24GE05092500

NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
M MOORE	J HALEO	J TOBIA	S PATEL

NORTH HUDSON SEWERAGE AUTHORITY
W1234 SOLIDS/FLOATABLES SCREENING FACILITY
WEEHAWKEN, NEW JERSEY

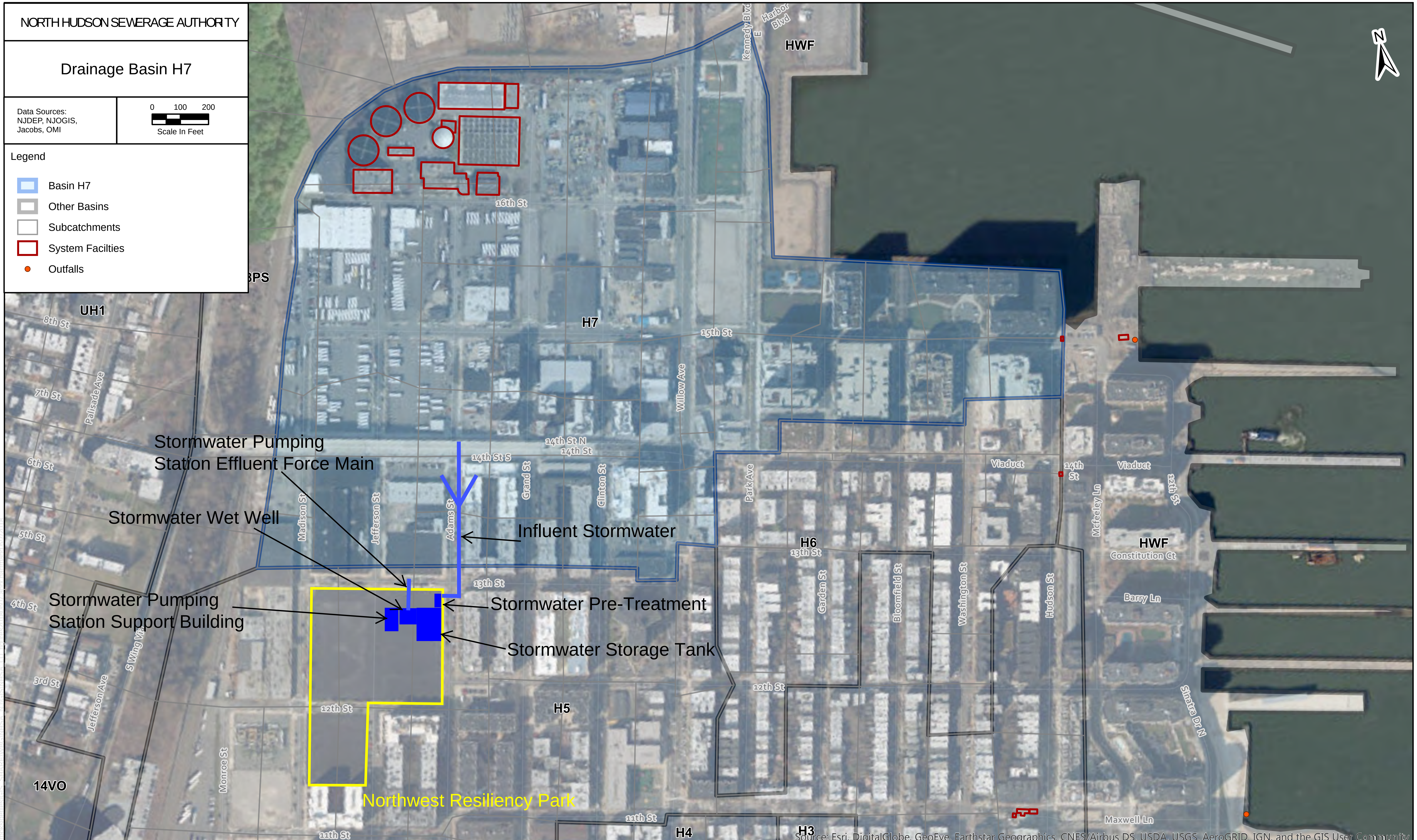
CH2MHILL®

PROCESS MECHANICAL

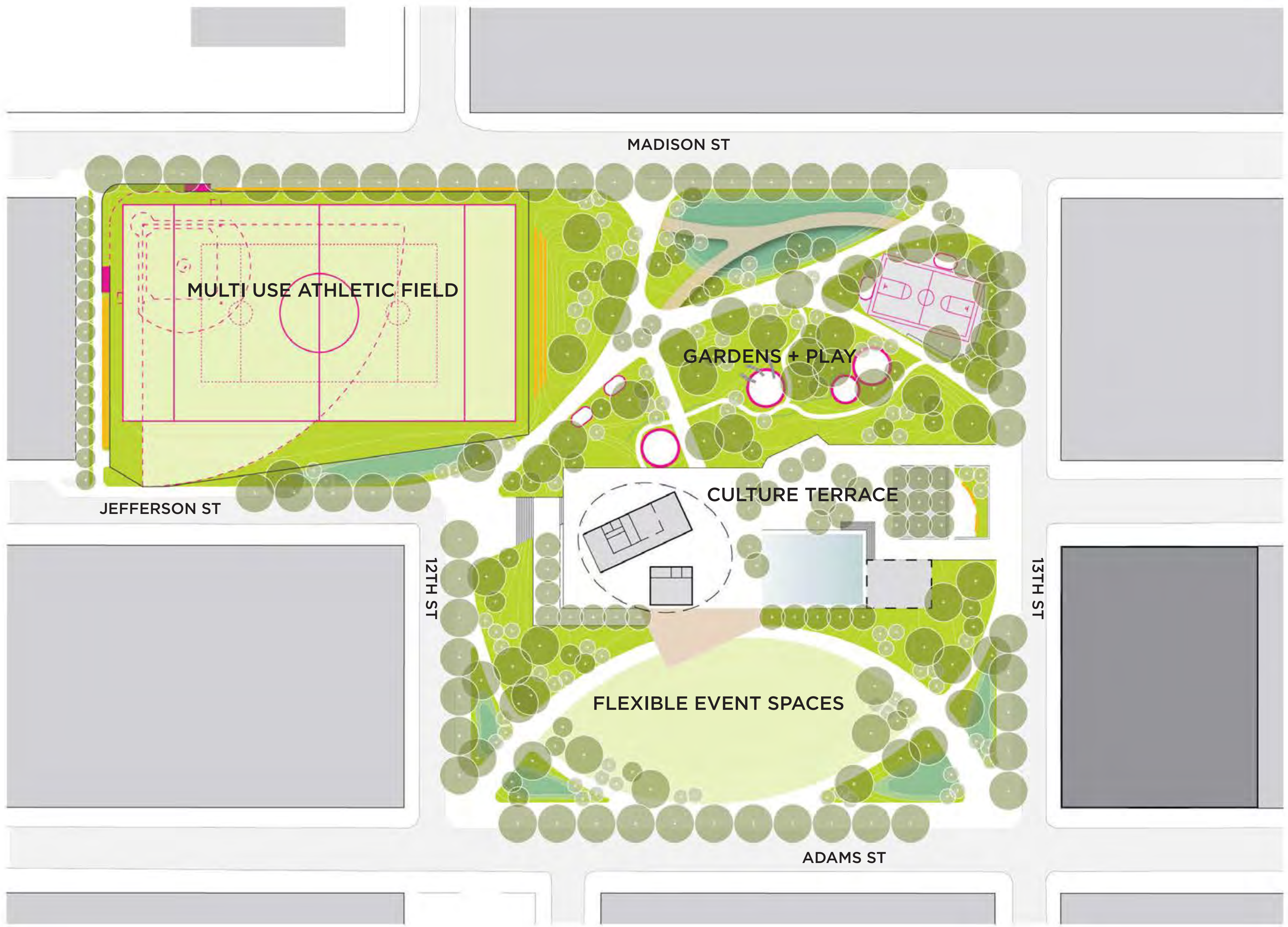
SECTION I

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	AUGUST 2016
PROJ	491076
DWG	M-3001
SHEET	54 of 57


NORTH HUDSON SEWERAGE AUTHORITY
Drainage Basin H7
Data Sources: NJDEP, NJOGIS, Jacobs, OMI
0 100 200
Scale In Feet
Legend
Basin H7
Other Basins
Subcatchments
System Facilties
Outfalls
Stormwater Pumping Station Effluent Force Main
Stormwater Wet Well
Influent Stormwater
Stormwater Pumping Station Support Building
Stormwater Pre-Treatment
Stormwater Storage Tank
Northwest Resiliency Park
H7
H6
H5
H4
H3
HWF
UH1
14VO
16th St
15th St
14th St S
14th St N
13th St
12th St
11th St
Madison St
Jefferson St
Adams St
Grand St
Clinton St
Willow Ave
Park Ave
Garden St
Bloomfield St
Washington St
Hudson St
Viaduct
Constitution Ct
Barry Ln
Maxwell Ln
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Northwest Resiliency Park Concept Design



CROSS-PARK CONNECTIVITY

MULTI-USE LOOP TRAIL

MULTI-USE ATHLETIC FIELD:
- High school soccer field (165ft x 300ft)
- Little league baseball field (200ft oufield)
- Youth lacrosse (35yds x 60yds and 40yds x 90yds)

BASKETBALL BASIN
- Youth court (42ft x 74ft)

NATURE + ECOLOGY

COLLECTS PARK + STREET STORMWATER

MULTIPLICITY OF SPACES + EXPERIENCES

12TH ST CLOSED
MADISON, JEFFERSON, 13TH ST NARROWED
1/4 acre added to park

PARK BUILDING:
2,465 SF Large Interior (Cafe)
930 SF Small Interior (Community Room)
9,425 SF Covered Area

SAINT AUGUSTINE SCHOOL

Subwatershed: Hackensack River

Site Area: 54,169 sq. ft.

Address: 3920 New York Ave
Union City, NJ 07087

Block and Lot: Block 151, Lots 1-9,
5-24, & 26-28

A bioretention system can be installed to capture, treat, and infiltrate rooftop runoff. Parking spaces can be replaced with pervious pavement to capture and infiltrate stormwater. Two tree filter boxes can be installed along the street to treat runoff. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
85	46,044	2.2	23.3	211.4	0.036	1.26

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.031	5	2,244	0.08	370	$1,850
Pervious pavement	0.085	14	6,201	0.23	1,270	$31,750
Tree filter box	n/a	6	n/a	n/a	32	$20,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Saint Augustine School

- bioretention system
- pervious pavement
- tree filter box
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 30' 60'

North Hudson Sewerage Authority

Long Term Control Plan

CSO Alternatives Analysis Workshop

River Road WWTP

NJPDES Permit: NJ0025321

Date: June 15, 2018

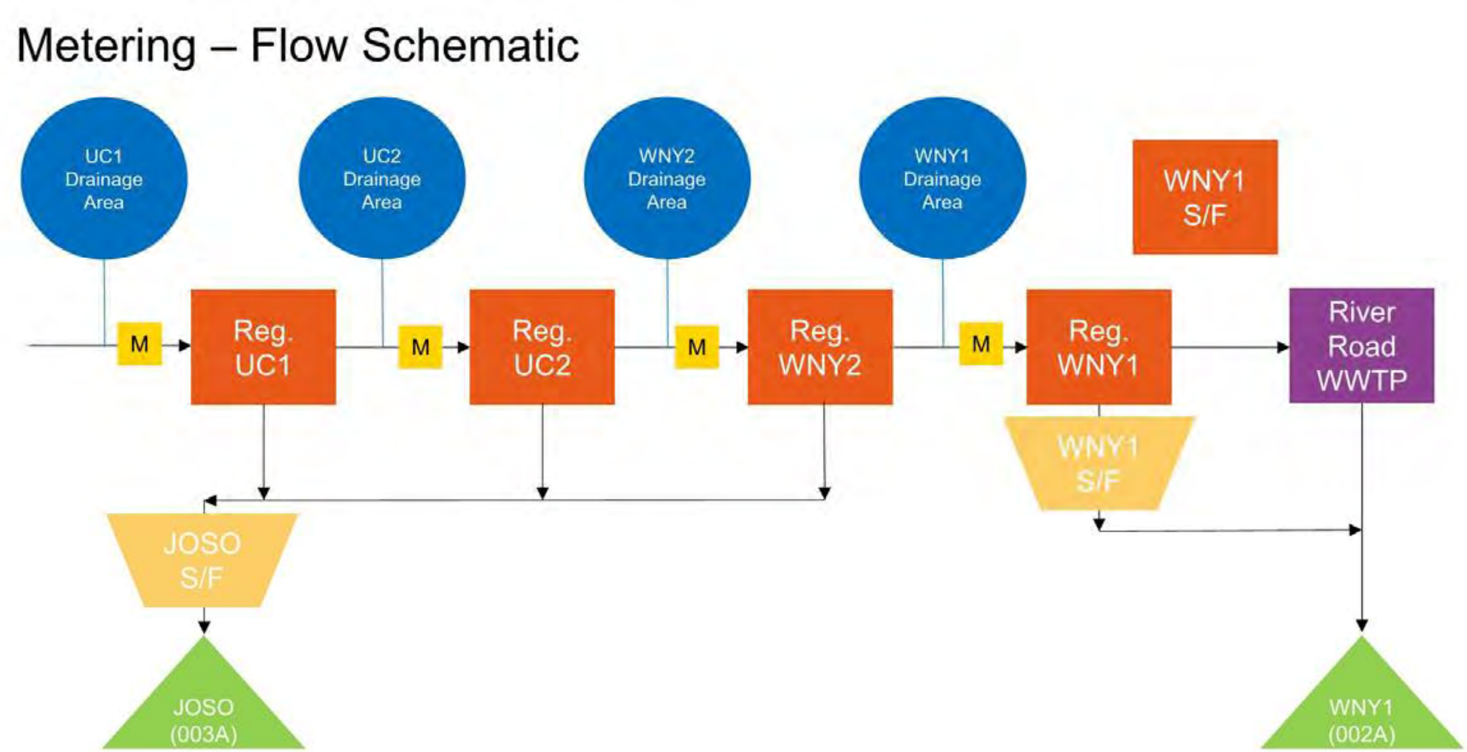
North Hudson Sewerage Authority

1600 Adams Street
Hoboken, NJ 07030
(201) 963-6043

www.nhudsonsa.com

1. **Collection system schematic**

Figure 1: River Road Collection System Schematic



2. CSO Frequencies (Volumes and Peak Flows) by Outfall in the Typical Year

Table 1: CSO Frequency and Total Overflow Volume in Typical Year

Outfall	CSO Frequency	Volume per Year (MG)
JOSO (003A)	**32**	**49.8**
WNY1 (002A)	**56**	**238.4**
	Total, MG	

Table 2 JOSO (003A) Overflows in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	5.25	128.71
2	5.02	109.07
3	4.83	98.64
4	3.78	98.48
5	3.29	94.35
6	3.25	84.35
7	2.76	76.17
8	2.51	72.43
9	2.41	58.51
10	1.98	55.05
11	1.97	49.92
12	1.96	44.70
13	1.44	42.81
14	1.13	38.16
15	1.11	35.27
16	1.04	35.03
17	0.95	23.67
18	0.88	21.68
19	0.87	19.81
20	0.50	17.97
21	0.49	17.38
22	0.38	16.64
23	0.35	15.56
24	0.33	12.97
25	0.32	7.53
26	0.31	7.02
27	0.24	6.12
28	0.16	5.73
29	0.14	5.49
30	0.12	5.10
31	0.05	3.26
32	0.00	0.07

Volumes and Peak Flows were sorted separately

Figure 2: JOSO (003A) Volume of Overflows

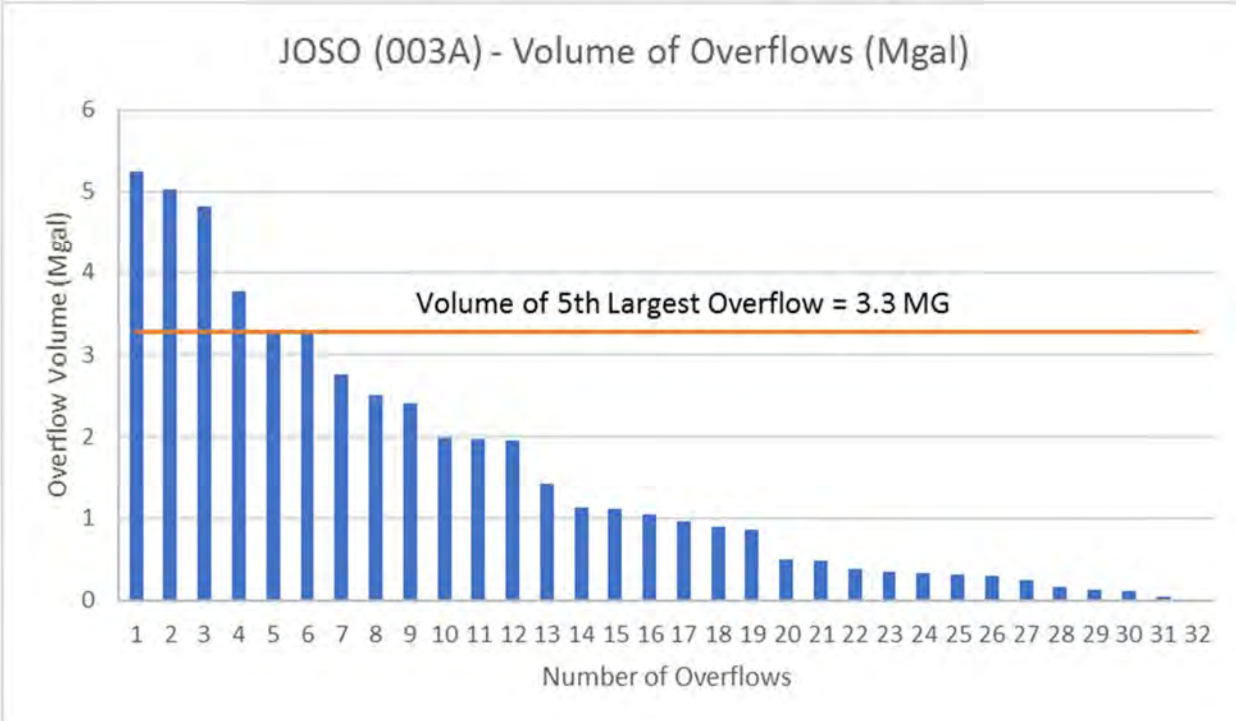


Figure 3: JOSO (003A) Peak Flow of Overflows

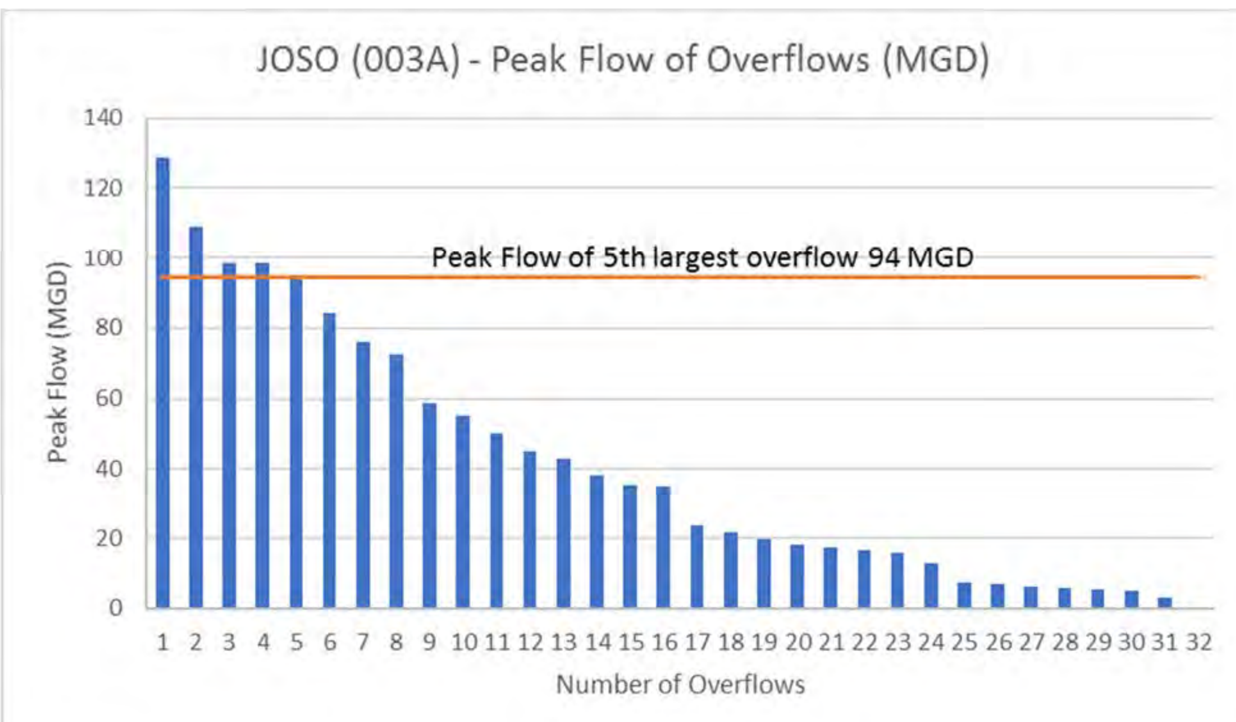


Table 3: WNY1 (002A) Overflows in Typical Year

Overflow Number	Volume (MG)	Peak Flow (MGD)
1	26.73	198.13
2	14.18	169.17
3	11.67	167.32
4	11.01	166.09
5	10.97	161.59
6	10.45	145.42
7	10.32	138.47
8	9.73	136.14
9	9.65	126.02
10	8.88	125.25
11	8.60	119.94
12	7.98	108.50
13	7.15	93.53
14	7.04	93.03
15	6.68	92.26
16	6.65	91.77
17	5.26	89.42
18	5.21	78.81
19	5.06	72.66
20	4.84	71.11
21	4.56	67.00
22	4.02	65.23
23	3.49	64.07
24	3.26	61.59
25	3.20	50.70
26	2.67	50.36
27	2.55	46.28
28	2.43	46.02
29	2.33	45.31
30	2.29	43.63
31	1.89	34.90
32	1.85	23.62
33	1.67	22.04
34	1.62	20.79
35	1.43	20.24
36	1.32	19.41
37	1.17	19.03

Volumes and Peak Flows were sorted separately

Overflow Number	Volume (MG)	Peak Flow (MGD)
38	0.97	18.10
39	0.92	17.73
40	0.89	17.44
41	0.86	16.09
42	0.80	14.80
43	0.80	14.46
44	0.72	13.76
45	0.64	11.65
46	0.52	11.53
47	0.41	11.48
48	0.38	8.71
49	0.17	7.95
50	0.16	7.70
51	0.15	7.01
52	0.14	4.05
53	0.02	1.65
54	0.02	1.60
55	0.02	1.32
56	0.01	0.79

Volumes and Peak Flows were sorted separately

Figure 4: WNY1(002A) Volume of Overflows

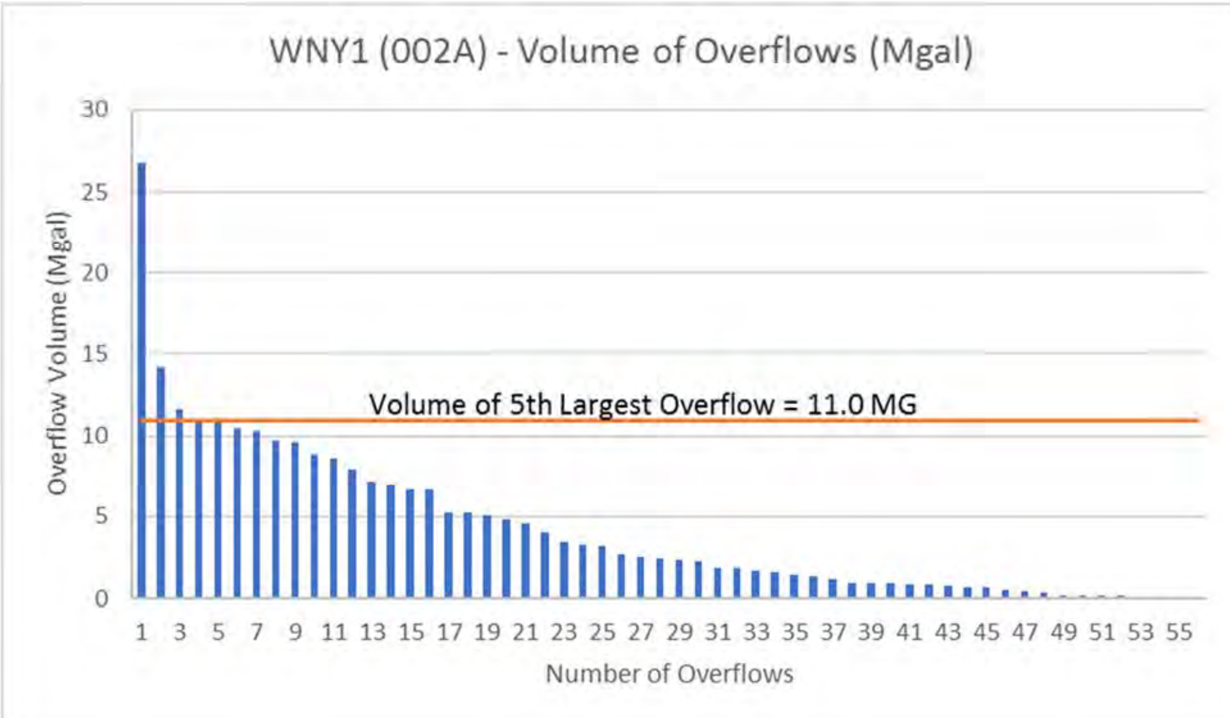
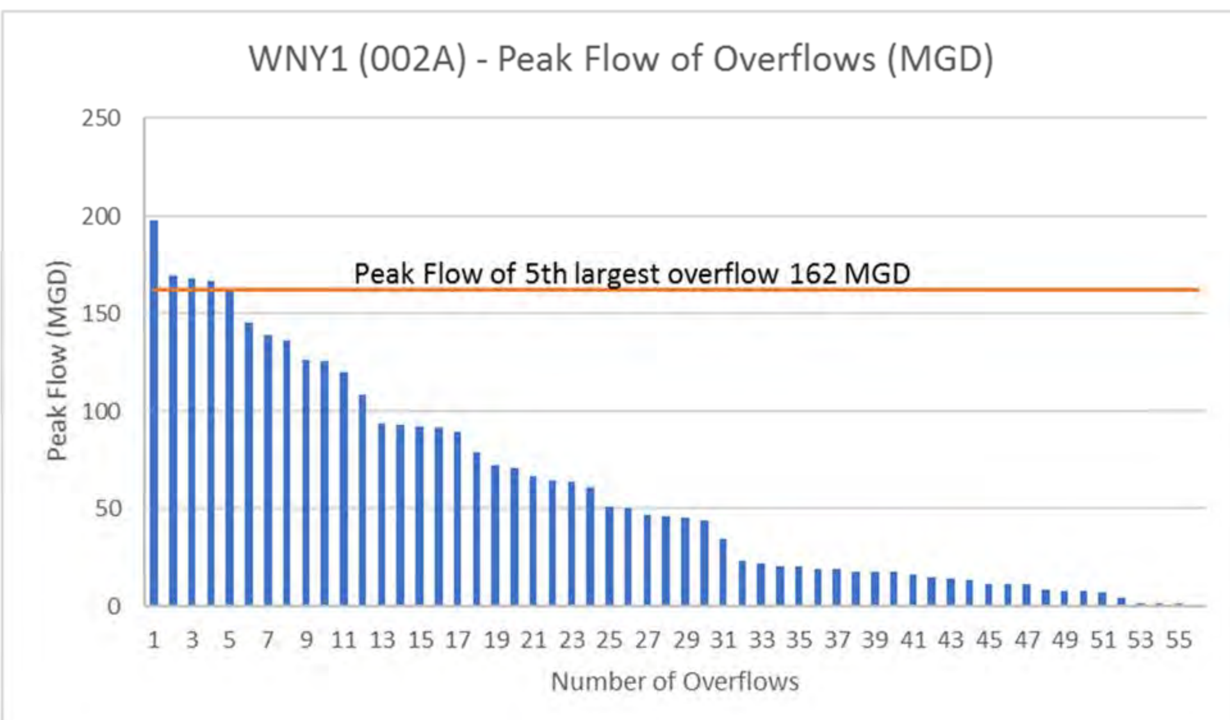


Figure 5: WNY1 (002A) Peak Flow of Overflows



3. Hydraulic Profiles in Major Interceptors and Combined Sewer Trunks

Figure 6: Trunk Sewer from UC1 to WNY1

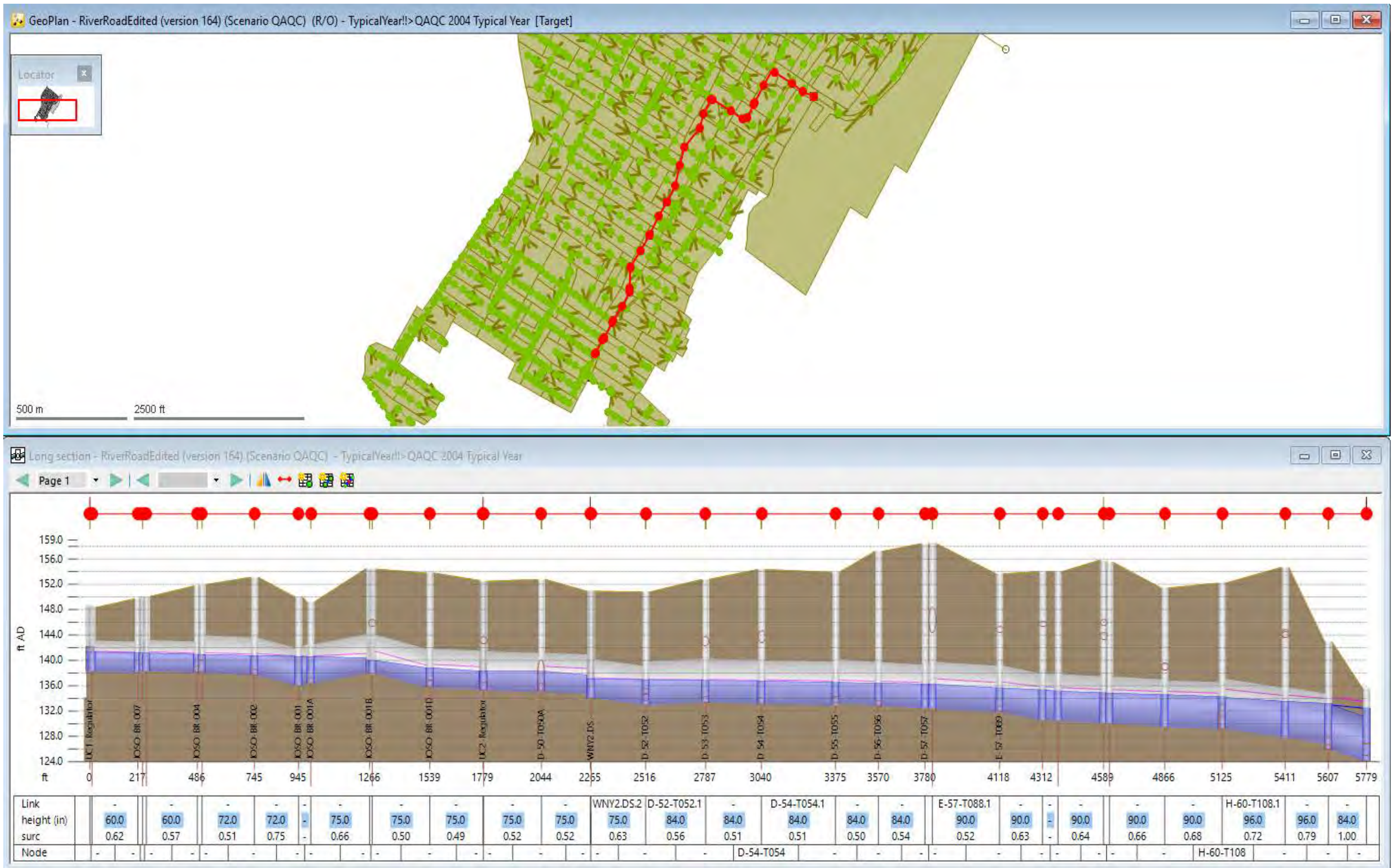


Figure 7: Interceptor Sewer from UC1 to WNY2

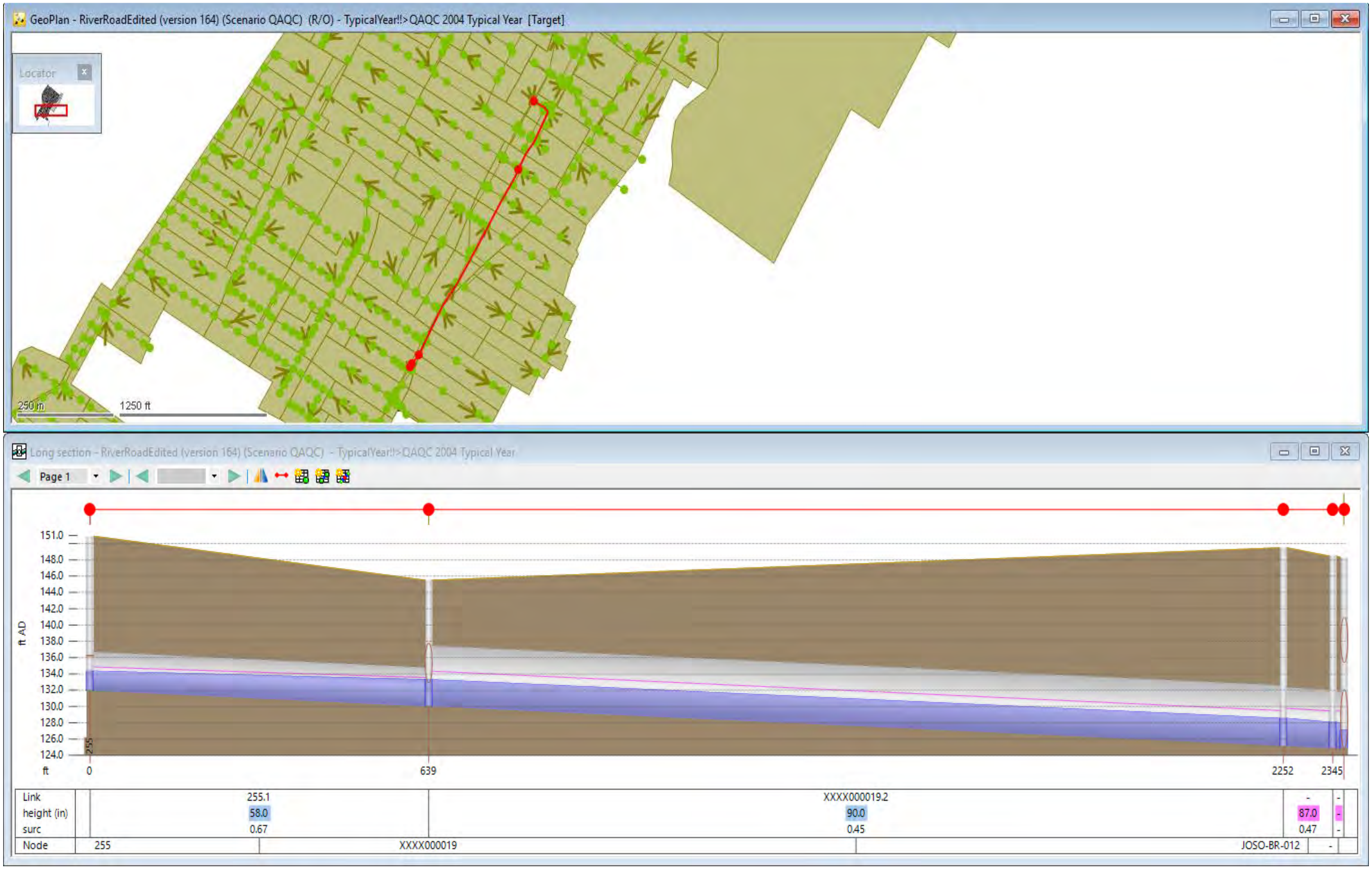


Figure 8 JOSO (003A) Outfall Sewer - UC1 to Outfall

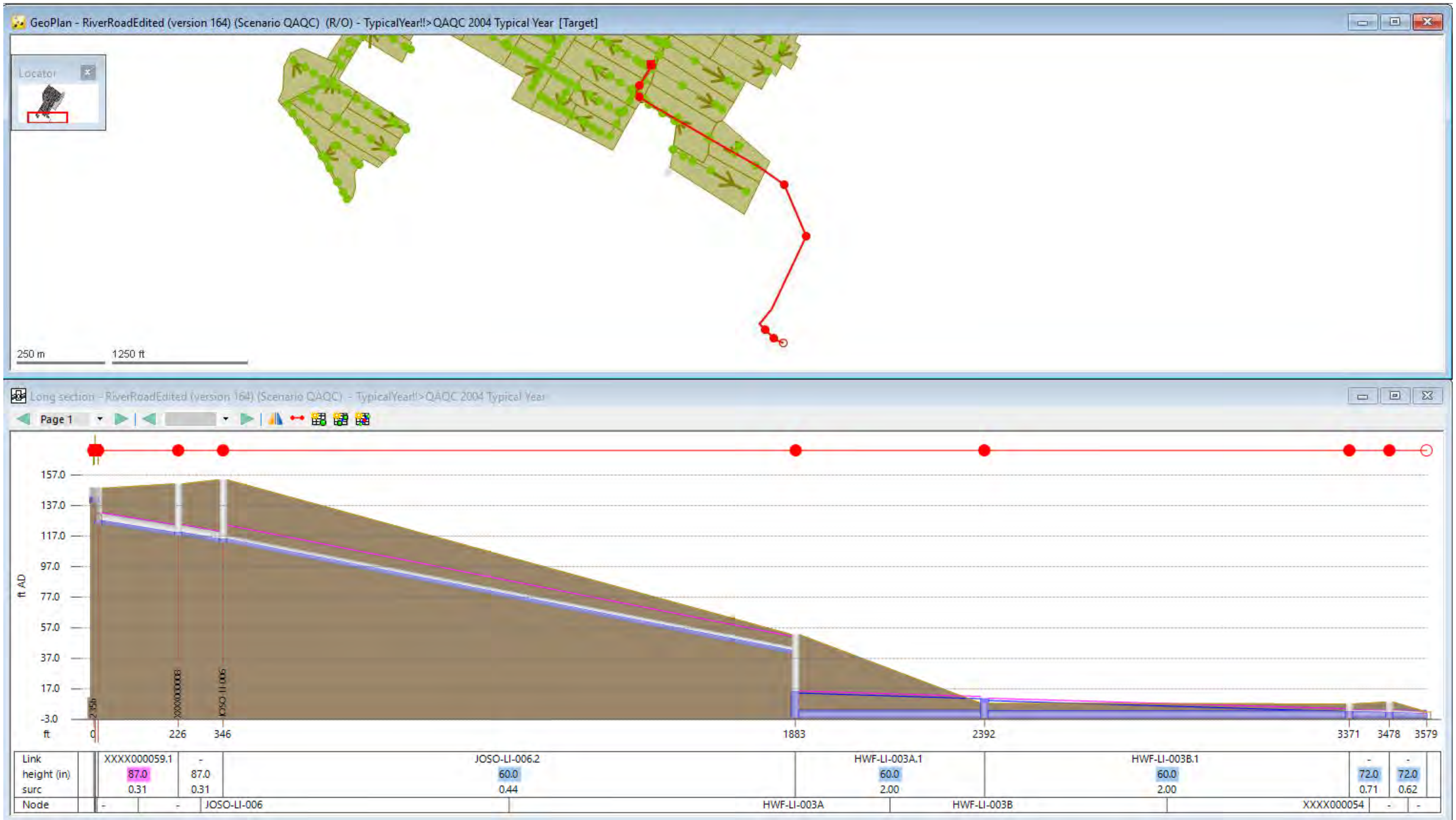


Figure 9: WNY1 Outfall Sewer - Overflow line from WNY 1 to Outfall (002A)

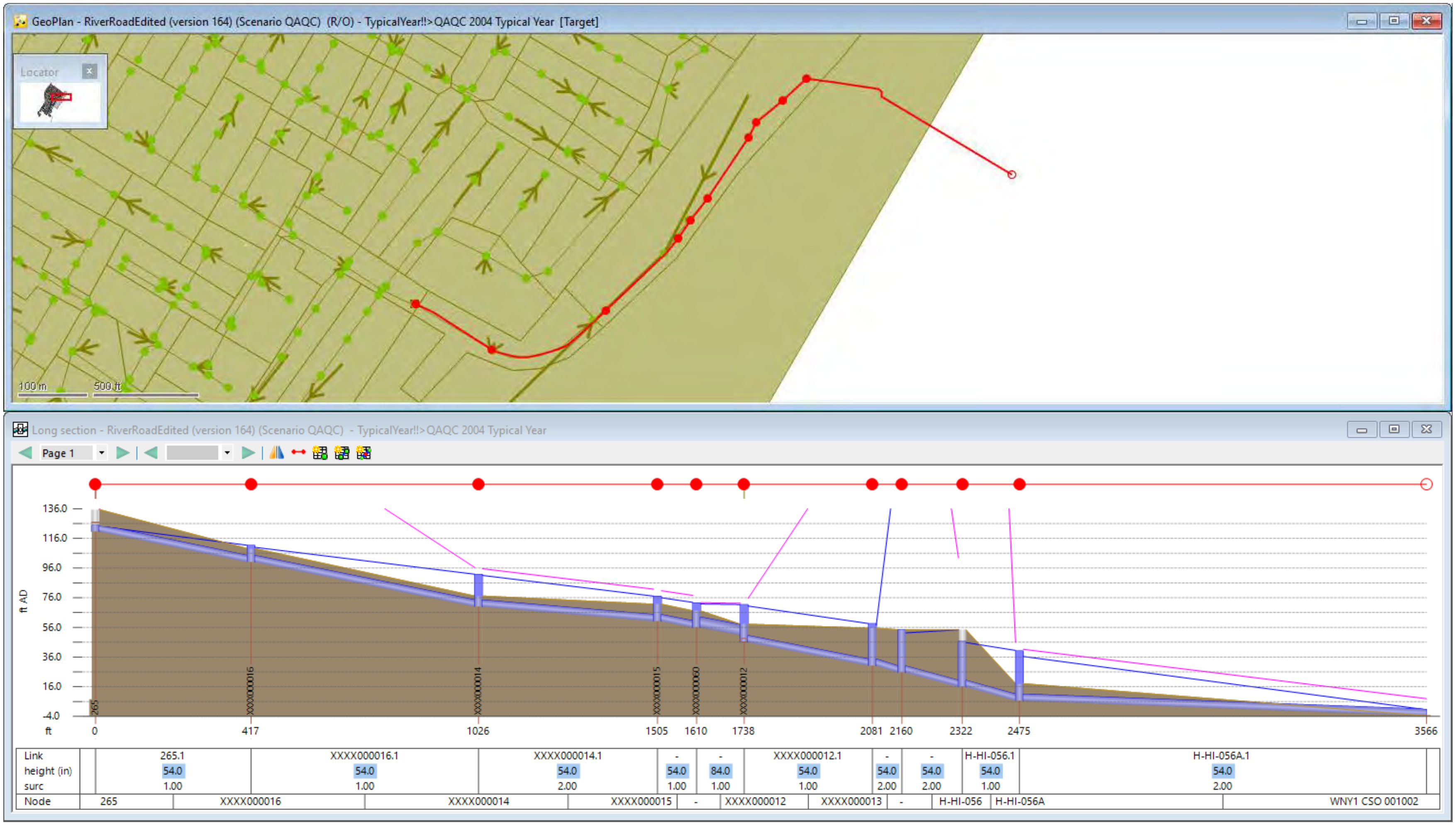
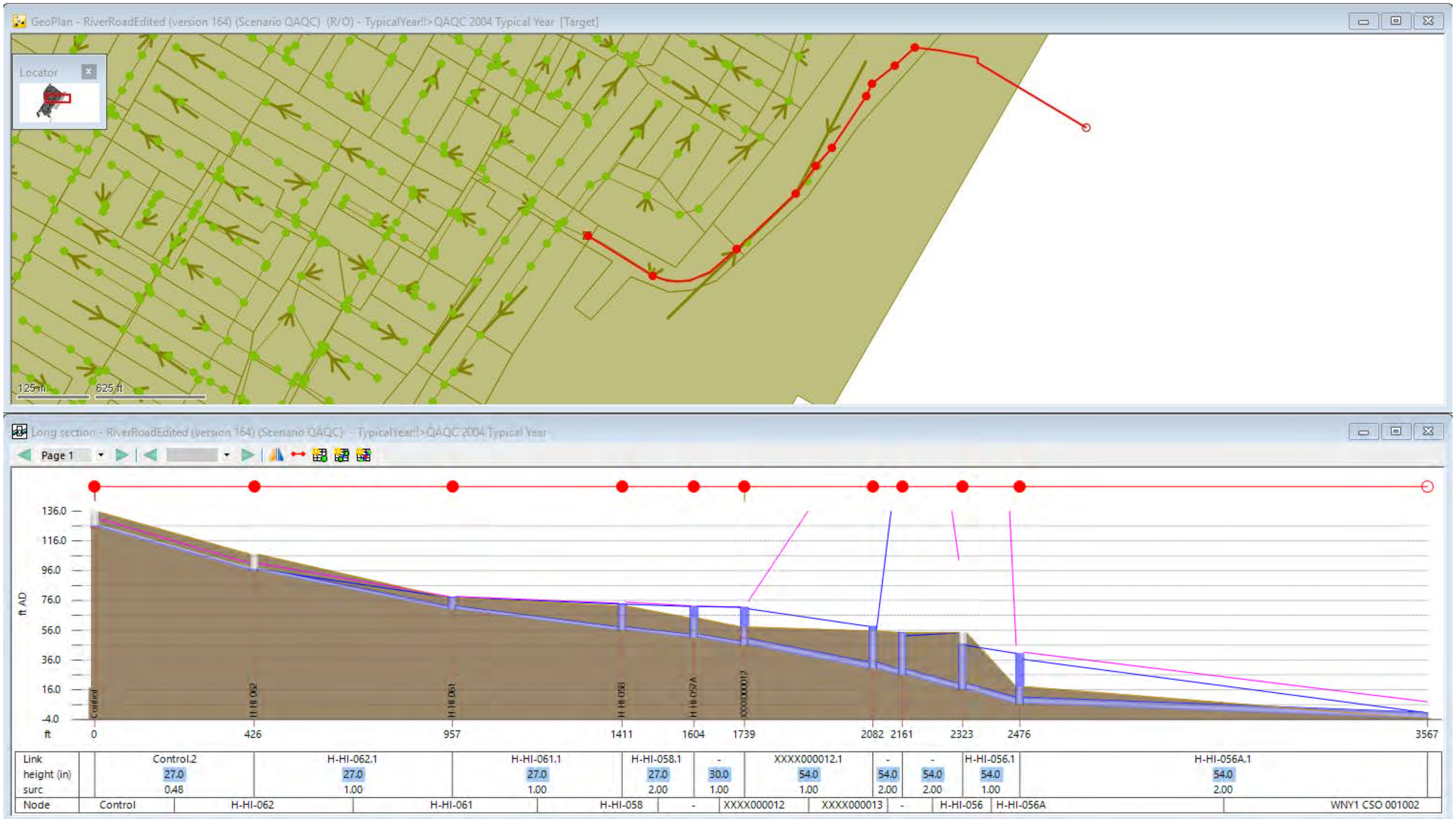


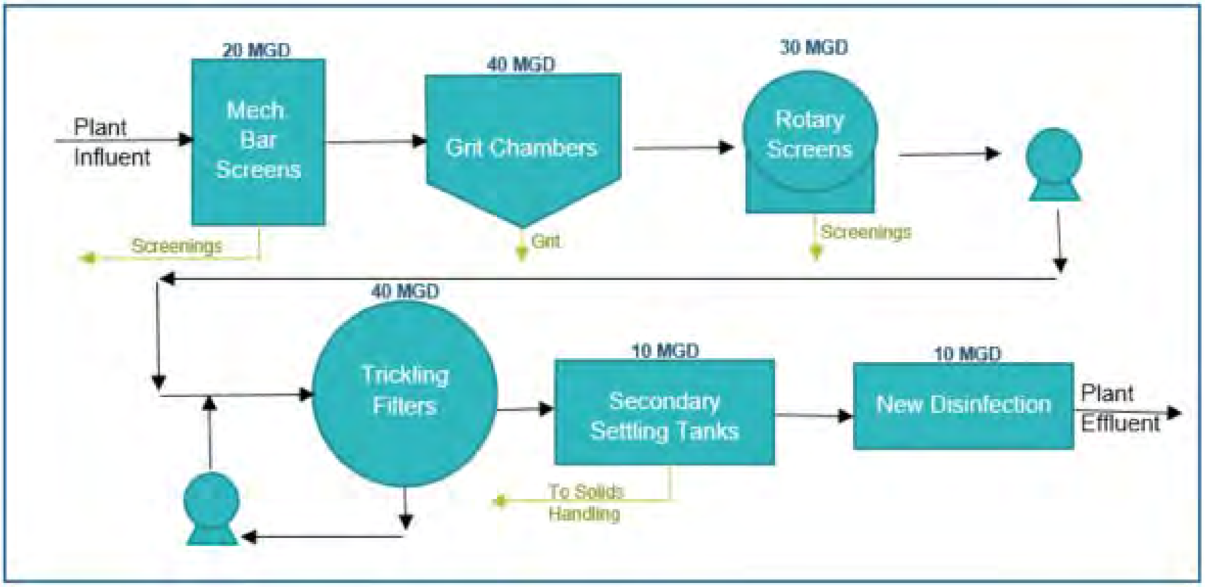
Figure 10: River Road Outfall Sewer – Main Line to/from Plant to WNY1 (002A)



4. River Road Wastewater Treatment Plant Characteristics

A. Plant Capacity:

Figure 11: River Road Treatment Plant Schematic



- Design dry weather flow = 10 MGD
- Min DWF = approx. 3 MGD
- Max Plant Flow = 24 MGD
- Primary treatment capacity = 0 MGD
    - Primary treatment capacity is defined as "the maximum flow i.e. daily, weekly or monthly that can receive primary treatment at the existing primary treatment facilities". Currently, there are no existing primary settling tanks at the River Road WWTP. Micro-screens that are designed for 10% BOD removal and 18% TSS removal are provided. Typical removal efficiencies for primary treatment facilities when treating municipal wastewater are 50 to 70% TSS removal and 25 to 40% BOD removal. Consequently, the micro-screens are not considered to be equivalent to primary treatment facilities, therefore primary treatment capacity = 0 MGD.
        - Mechanical bar screens = 20 MGD
        - Grit chambers = 40 MGD
        - Rotary screens = 30 MGD
        - Trickling Filters = 40 MGD
- Secondary treatment capacity = designed for 10 MGD, actual 8.1 MGD
- Disinfection capacity = 10 MGD
- Limiting factors in WWTP capacity:
    - Plant is limited by the capacity of its secondary settling tanks (8.1 MGD). Secondary settling tanks were designed as primary settling tanks and have a shorter sidewall depth than is typically used for secondary settling tanks. Settling tanks are also overloaded and when an average loading rate is used their capacity would be 8.1 MGD.

B. Flow Rates and Performance:

Figure 12: Historic Flow Rates 2013-January 2017, River Road Wastewater Treatment

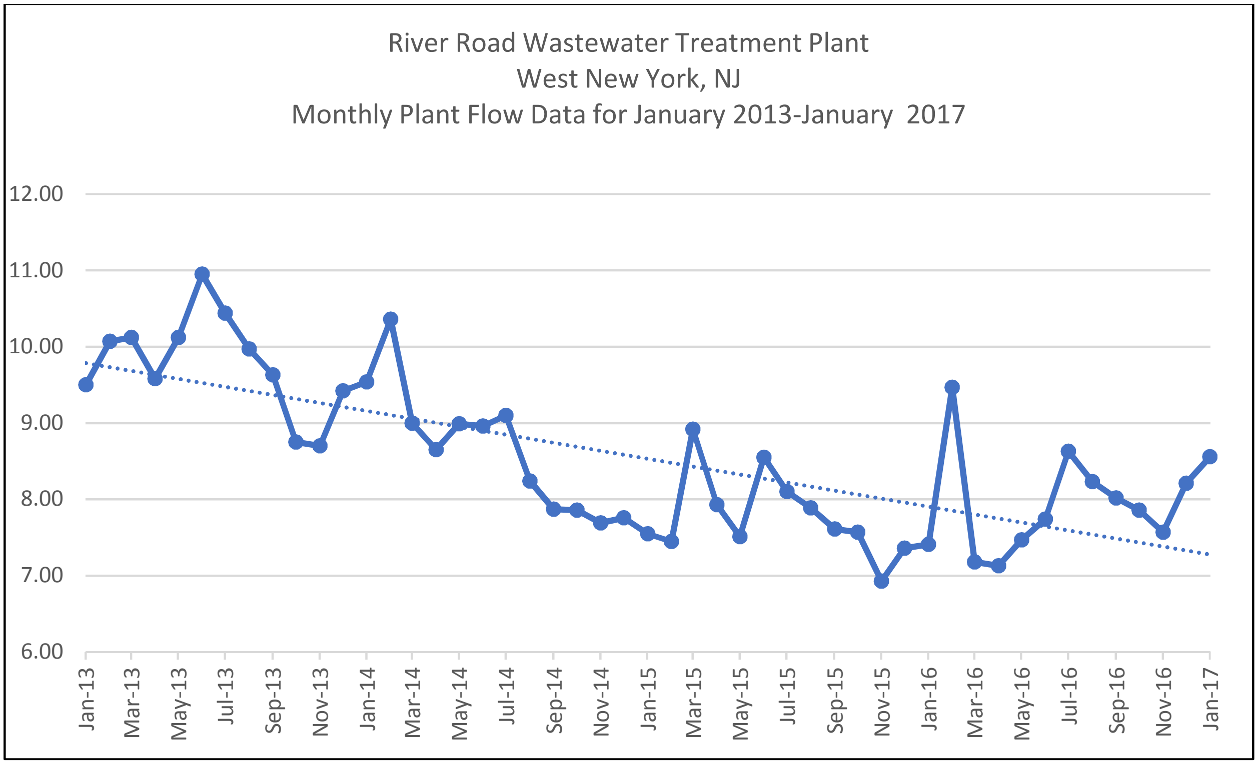


Table 4: River Road WWTP Performance Summary, FY2017

Parameter	Permit Limit	WWTP Operation Data		
		Annual	Minimum	Maximum
Flow	Report Only	8.01	7.13	9.47
pH Influent, Maximum	Report Only	8.42	8.1	8.9
pH Influent, Monthly Minimum	Report Only	7.1	6.8	8.9
pH Effluent, Monthly Maximum	9.00 SU	7.6	7.4	7.9
pH Effluent, Monthly Minimum	6.00 SU	6.85	6.4	7.3
TSS Effluent	30 MG/L Monthly Ave.	16.4	11	23
	85 Percent Removal Monthly Ave.	90.5	86	93
CBOD Effluent	25 mg/L Monthly Ave.	17.58	13	22
	85 Percent Removal Monthly Ave.	88.9	83	92
Oil and Grease	10 mg/L Monthly Ave.	4.66	0.70	9.8
Fecal Coliform	200 CFU Monthly Geometric Mean	11.83	1	30
	400 CFU Weekly Geometric Mean	76	3	442
Chlorine	0.13 MG/L Daily Max	0.07	0.02	0.29
Dissolved Oxygen, Minimum Weekly Average	4 MG/L Weekly Ave. Min	8.02	6.34	10.91

5. Green Stormwater Infrastructure Projects

WEST NEW YORK PARKING AUTHORITY: 63RD STREET PARKING LOT

RUTGERS New Jersey Agricultural Experiment Station

Subwatershed:	**Hudson River**
Site Area:	**14,271 sq. ft.**
Address:	**6305 Bergenline Avenue West New York, NJ 07093**
Block and Lot:	**Block 151, Lot 8**

Parking spaces can be replaced with pervious pavement to capture and infiltrate stormwater. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
94	13,483	0.7	6.8	61.9	0.011	0.37

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.177	30	13,001	0.49	4,900	$122,500

6.

GREEN INFRASTRUCTURE RECOMMENDATIONS

West New York Parking Authority: 63rd Street Parking Lot

- pervious pavement
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 30' 60'

MOTT MACDONALD 111 Wood Avenue South Iselin NJ 08830-4112 United States of America Certificate No. 24GA28018500 T +1 (800) 832 3272 F +1 (973) 376 1072 W www.mottmacamericas.com	Client NORTH HUDSON SEWERAGE AUTHORITY HUDSON COUNTY, NEW JERSEY	Rev / Date / Drawn / Description / Ch'kd / App'd	Title PARK AVE AND 48TH STREET WEEHAWKEN, NEW JERSEY STORMWATER PLANTER CONCEPTUAL PLAN Drawing Number CONCEPT-01

Drawn	KWG
Checked	KPW
Approved	KWG
Scale at ANSI B	1" = 20'
Security	STD
Status	APR
Rev	REV. 0

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Attachment 4
Adams Street Outfall Alternatives

Outfall	General Information	Available Open Space	Key Takeaways, Design Points and Control Alternatives
002A	• Typical year current conditions: 44 MG/yr, 34 activations/yr • Regulator H1 located near intersection of Observer Highway and Hudson Street; screening facility and wet weather pump station located on outfall adjacent to Regulator H1. • Dry weather flow travels through interceptor to 5th Street Pump Station. • Estimated 3 MG of storage needed for 4 overflows/typical year. • Twin 48-inch outfalls run under the NJ Transit Station. The outfalls were relined during the H1 wet weather pump station project. • H1 pump station capacity is 50 mgd and pumps at high tide. The outfall can discharge by gravity during low tide; the pump station operations are in the model. Monroe Street project is removing flow from H1. • Regulator H0 was eliminated. • Fats, oil and grease (FOG) issues on the collection system being partially addressed with new NHSA inspection program.	• Limited amount of open space near 002A; building on NJ Transit property is not possible. • Potential for linear storage under Observer Highway. • Parking lot on south side of Hoboken is an opportunity to store approximately 1 MG, but this parking lot is targeted for development. • Storage tank or sodium hypochlorite disinfection possibly could be constructed in parking lot north of H1 wet weather pump station.	• Evaluate sensitivity of diverting stormwater from housing authority area into a transit authority drainage ditch. • More opportunity to build exists in the south side of Hoboken. • Outfall length is approximately 630 feet. This would not provide enough detention time for disinfection. Would need to dose at the pump station and de-chlorinate at downstream end. There is the potential to dose with chlorine upstream. A study at West New York WWTP determined that the Hudson River has a chlorine demand, noting that de-chlorination may not be necessary.
003A	• NHSA intends to close Regulator H2 and remove from NJPDES.	• N/A	• NHSA intends to provide outfall for use by the Rebuild by Design Hudson River Project for discharging stormwater from new storm sewer system that is planned in this area outside the barrier.
005A	• Typical year current conditions: 65 MG/yr, 41 activations/yr • Three regulators feed the outfall: H3, H4 and HSI. Solids/floatables facility located on outfall downstream of the three regulators. • Dry weather flow travels through interceptor to 5th Street Pump Station. • Estimated 4 MG of storage needed for 4 overflows/typical year. • It is desired to catch all the flow from H4 as well because it is the majority of the overflow along with H3. • Evaluate if H4 flushing chambers are closed and test different scenarios in model. It is important to note if they are not closed.	• Potentially more cost effective to build out into the Hudson River instead of constructing a storage tank under Stevens Park. • Consider Sinatra Drive as a route for consolidating outfalls and work on the Hudson River farther down. Outfall 006A was measured at approximately 0.62 miles away from outfall 005A. Investigation on possible existing piles would be required.	• Attempt to mirror Pier C Park or make another park with a tank under the walkway. • Storage/treatment under Stevens Park may be viable option. One option may be a disinfection tank with contact time within/under Stevens Park. • Reconstructing Stevens Park is an opportunity to store flow. Could also consider tunnelling under the park without demolishing the park itself and interrupting public use.
006A	• Typical year current conditions: 10 MG/yr, 11 activations/yr • Regulator H5 located at intersection of Hudson and 11th Streets; screening facility located on outfall adjacent to Regulator H5. • Dry weather flow goes to 11th Street Pump Station. • Estimated 1 MG of storage needed for 4 overflows/typical year.	• Parcel of open land possibly available near a dry dock for construction, although the State and the City are arguing over uses they have already identified. • Sinatra Drive was mentioned as a potential route for consolidation/storage conduit, however there may be piles in that area. • Consider storage or treatment facility in the water.	• Peak flows are relatively high in relation to the overflow volumes, so it may be more cost-effective to store compared to end-of-pipe treatment. • H5 is a sensitive area due to kayak launch on other side of peninsula.
008A	• Typical year current conditions: 12 MG/yr, 11 activations/yr • Two regulators feed the outfall: H6 and H7. Solids/floatables facility located on outfall downstream of the two regulators. • Dry weather flow goes to 11th Street Pump Station. • Estimated 1.4 MG of storage needed for 4 overflows/typical year. • NHSA's H6/H7 CSO Project planning and design is ongoing. • HLSS being designed for H7, eliminating street runoff, conveyed to tank under the new park. Will optimize Regulators H6 and H7 to reduce overflows. • Need to assess whether the H6/H7 project reduces overflows to four per typical year. • Regulators H6 and H7 will be outside the Rebuild by Design barrier.	• Northwest Resiliency Park will be used for storage. • Developer wants to build on pier near outfall. • Limited available sites for storage.	• Regulators H6 and H7 will have to be optimized to reduce overflows after HLSS and tank are online. • Project may require new Adams Street WWTP outfall to provide capacity in existing WWTP outfall to discharge H7 stormwater flows. • Consider opportunities for stormwater reuse from storage tank.

Outfall	General Information	Available Open Space	Key Takeaways, Design Points and Control Alternatives
012A	• Typical year current conditions: 4 MG/yr, 10 activations/yr • 18th St PS regulator located near intersection of Park Avenue and 18th Street; • Dry weather flow goes to 18th Street Pump Station. • Estimated 0.3 MG of storage needed for 4 overflows/typical year. • 18th Street Pump Station force main was recently replaced. • The water quality impact of CSO is very little; water quality in Weehawken Cove is poor but is not driven by CSOs.	• Parking lot on north side of outfall is being developed and not available. • Limited land under park and parking lot to the south of the outfall along Weehawken Cove waterfront. • Possibility of letting new WWTP outfall create more flushing in Weehawken Cove.	• Maximize flow to WWTP with increased capacity and larger/second force main from 18th Street Pump Station. • Disinfect at 18th Street Pump Station. • 300,000 gallons may be stored at identified open spaces.
013A	• Typical year current conditions: 219 MG/yr, 58 activations/yr • Four regulators feed the outfall: W1, W2, W3 and W4. Solids/floatables facility is being constructed in the Hudson River at the end of outfall downstream of the four regulators. • Dry weather flow from W1, W2, W3 goes directly to Park Ave. siphon; dry weather flow from W4 goes to Baldwin Ave. PS, and is then pumped to the Park Ave. siphon head box. • Estimated 11 MG of storage needed for 4 overflows/typical year. • Drainage area is almost completely impervious with a large amount of wet weather flow generated. • Regulators W1, W2 and W3 are manually closed during high wet weather flows. • Single outfall pipe is aligned under bus lot and light rail. A junction box divides the flow through parallel outfalls to new end-of-pipe net S/F. • Storage at the top of the hill in drainage areas is unlikely. • Opportunity for GI in drainage areas is limited due to existing land uses. • Tank or tunnel storage taking overflows from W1, W2 and W3 may be possible to hold and release when WWTP can accept flows. Although advised to avoid construction on Park Avenue.	• Brownfields sites to the north. • Open lot on 44th St & Hudson Avenue. • Storage under Hackensack Plank Road and Park Avenue may be possible but construction on Park Avenue may want to be avoided. • Pathmark parking lot is potential site for storage (may also divert flow from River Road's JOSO to site). • Sufficient space for a chlorine contact tank with 15 minutes of detention time does not appear to be available at the bottom of the Palisades. A short detention time, high-rate disinfection system would perhaps need smaller space.	• Relocating regulators would require dry weather flow connections running from the top of the hill and down the steep rock cliff. This would allow for flow control upstream of the high-energy drop. Biggest issue would be constructing new dry weather flow connections. Benefit would be elimination of the need for manual control of dry weather flow at these locations. • Drop shaft at the top of the hill under Park Avenue to tunnel gently sloped and directed towards Adams Street WWTP. • New drop shafts will likely require vertical flow control. • Overflow detention can include disinfection upstream of the W1234 S/F. • Currently 24-inch and 12-inch siphon on backside of the WWTP. Can increase capacity of the siphon with a third barrel. That would take more flow from the north as a benefit. • Consider targeting an 85% solids capture for a storage/treatment facility
015A	• Typical year current conditions: 24 MG/yr, 40 activations/yr • Regulator W5 located along John F. Kennedy Bouldevard, between 48th and 49th Streets. Vortex separator facility located along outfall downstream of the regulator • Dry weather flow goes to Baldwin Avenue Pump Station. • Estimated 1 MG of storage needed for 4 overflows/typical year. • Metered flows and modelled overflows are much higher than expected for this drainage area compared to other areas of comparable size and drainage area characteristics.	• No existing space on top of Palisades at Regulator W5. • No existing space at vortex – would require excavation/hill removal. • No existing space along outfall to waterfront.	• NHSA intends to further investigate drainage area and possibly meter flows again to better characterize wet weather flows and overflows. • Add disinfection at vortex. • Confirm overflows through vortex and analyse the amount of chlorine contact time needed. Replace/upsize vortex if necessary to achieve required contact time.

Appendix D
Preliminary Screening Memorandum

North Hudson Sewerage Authority

Long Term Control Plan

Preliminary Screening of CSO Control Technologies: JOSO, WNY1, and River Road WWTP

NJPDES Permit: NJ0026085

Date: November 13, 2018

Prepared by:
Jacobs Engineering Group
412 Mt. Kemble Avenue, Suite 100
Morristown, NJ 07960

North Hudson Sewerage Authority

1600 Adams Street
Hoboken, NJ 07030
(201) 963-6043

www.nhudsonsa.com

Preliminary Screening of CSO Control Technologies

DATE: November 13, 2018

PREPARED BY: Jacobs Engineering Group

PROJECT: North Hudson Sewerage Authority Alternatives Analysis-River Road

Executive Summary

Under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit for the River Road Wastewater Treatment Plant (WWTP), as part of the Long Term Control Plan, the North Hudson Sewerage Authority (Authority) must conduct an evaluation of alternatives for combined sewer overflow (CSO) technologies at the River Road WWTP and its outfalls. This technical memorandum presents the findings of the preliminary screening of these identified control technologies for the River Road drainage area. The purpose of this screening is to provide an initial evaluation on the alternatives by identifying anticipated constraints, site limitations, functionality and feasibility of the control technologies identified. The evaluation criteria presented in the Identification of Alternatives and Evaluation Criteria memorandum dated October 29, 2018 were used as a guide to summarize this analysis, which can be found at the end of this memo. Based on this preliminary screening, alternatives that would not allow compliance with the Final Permit will not be included in the next phase of evaluation ('Not for This Contract) in which conceptual layouts of the alternatives are presented and the Authority's InfoWorks ICM model is used to simulate the expected benefits of the alternatives.

Table 1 summarizes the results from the preliminary screening and indicates the alternatives that will proceed to the next phase of evaluation.

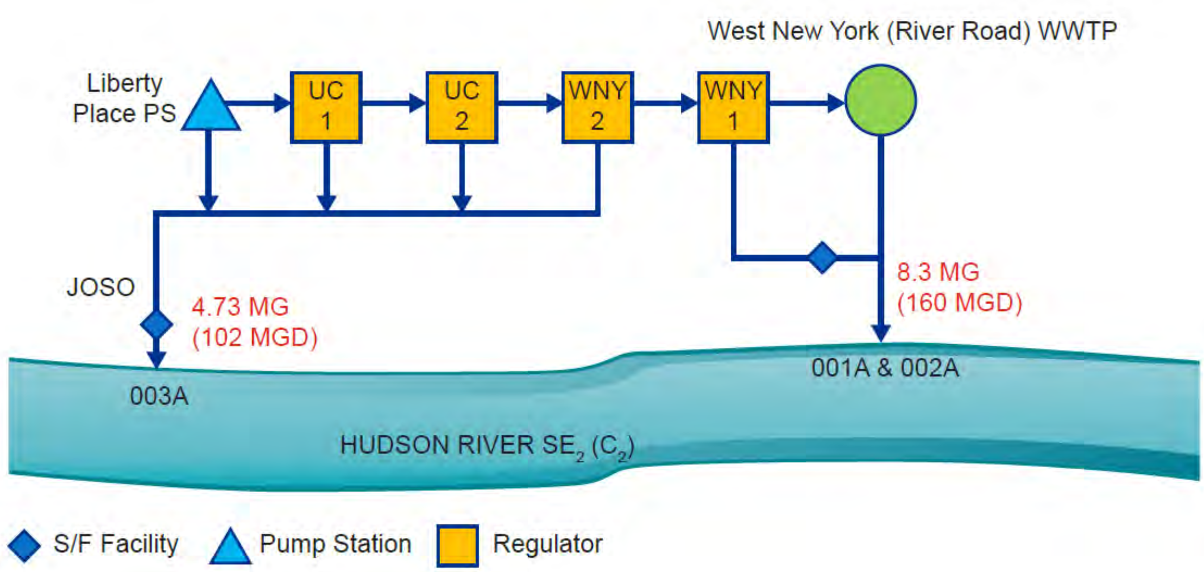
Table 1 - Preliminary Screening Alternatives Summary

Service Area	Alternative	Proceed to full evaluation?
JOSO	Raise regulator weirs at UC1, UC2 and/or WNY2	Yes
	Replace existing JOSO side-flow weirs with bending weirs	Yes
	CSO storage structure constructed in River	Not for this contract
WNY1	Linear Storage Along Anthony Defino Way	Yes
	CSO storage structure constructed in River	Yes
River Road WWTP	CSO Storage Adjacent to River Road WWTP	Not for this contract
	Replace Treatment Works with CoMag®/BioMag® Technology	CoMag® – Yes BioMag® - Not for this contract
	Replace microstrainers with ACTIFLO® technology	Yes
	Incorporate Cloth Media Filtration to Increase Treatment Capacity and Provide TSS Removal	Yes
	Gravity Storage Tank with Primary Level BOD and TSS Removal	Not for this contract
System-wide Alternatives	Green Infrastructure	Yes
	Inflow/Infiltration-Sewer Lining and Rehabilitation	Yes

Introduction

This technical memorandum presents the preliminary screening of control technologies listed in the Identification of Alternatives and Evaluation Criteria memorandum dated October 29, 2018 for the River Road System. Control technologies include flow control (e.g. storage) and treatment. It is noted that treatment alternatives are meant to be partial solutions which would be incorporated with upstream solutions such as storage or weir optimization. The objective of the treatment alternatives is to expand treatment capacity to accommodate dewatering from storage or improve percent capture in treating higher flows to the WWTP. The purpose of this memorandum is to identify the anticipated constraints, functionality and feasibility of all identified alternatives for the specified site. The intention is to refine the list of technologies to those that would fit the site-specific needs and would allow compliance with the Final Permit. Those final identified alternatives would then undergo the evaluation method defined in the Evaluation Criteria memo. This memorandum is an interim step towards producing the Development and Evaluation of Alternatives Report to be submitted to the New Jersey Department of Environmental Protection (NJDEP) by July 1, 2019. Figure 1 below depicts the System Block Diagrams of the River Road WWTP outfalls. This Figure provides an understanding of the relative locations and configuration of the Authority's infrastructure along the Hudson River based on the wastewater treatment plant service area as well as the volume of the 5th largest overflow developed from the model that will be used as a target to evaluate storage, capacity and treatment alternatives.

Figure 1 – River Road WWTP Service Area



Preliminary Screening

The following section details the preliminary screening of the alternatives from the Identification of Alternatives and Evaluation Criteria memorandum dated October 29, 2018 by drainage basin. The screening includes identifying the anticipated constraints, site limitations, functionality, and feasibility of each alternative. The evaluation criteria provided in Attachment 1 were used as a guide to describe any anticipated constraints, site limitations, functionality and feasibility of the alternatives.

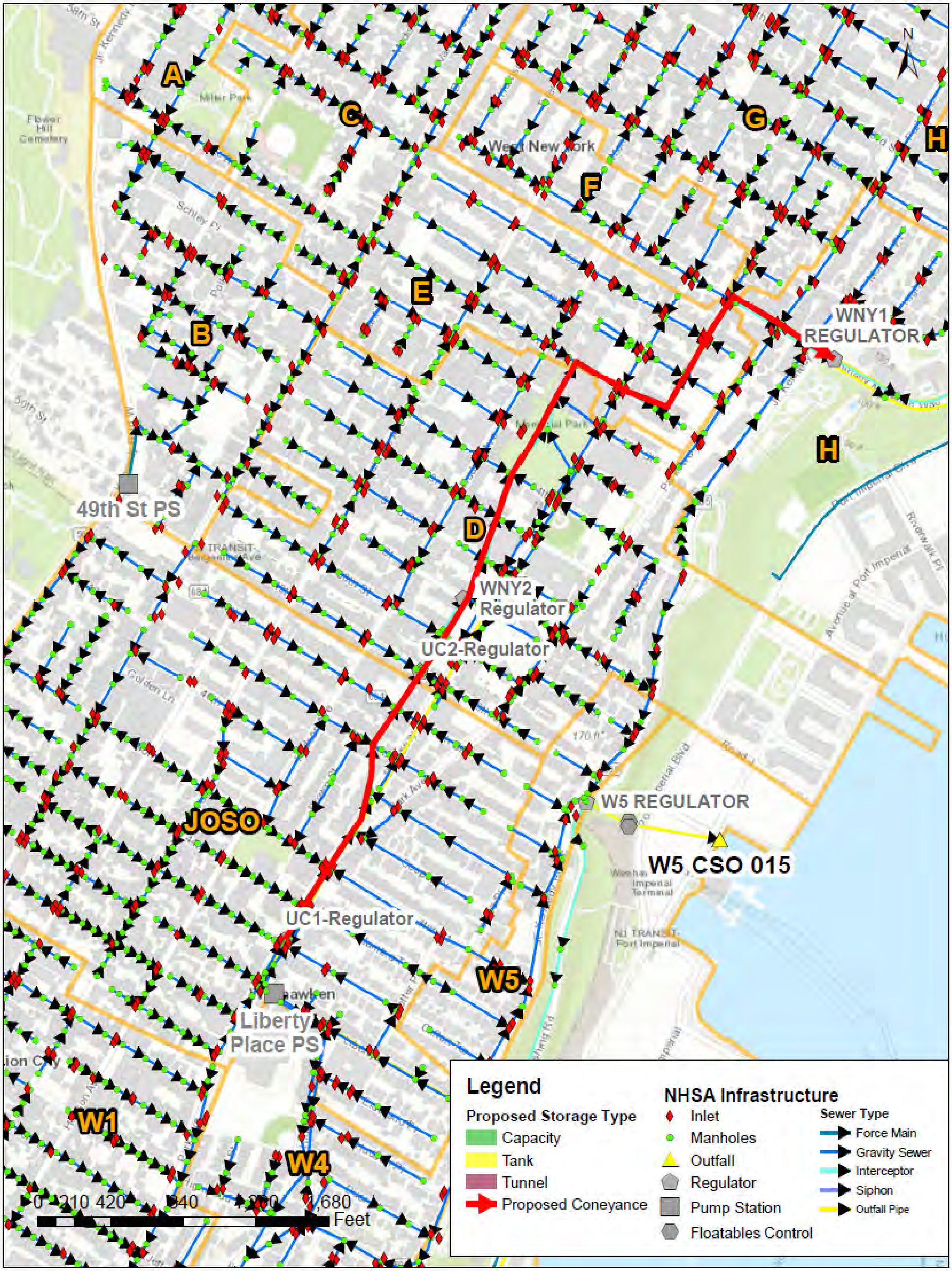
JOSO Basin

Raise Regulator Weirs at UC1, UC2 and/or WNY2

Diverting flows from the JOSO network to the WNY1 outfall is proposed. Figure 2 shows the approximate path of the diverted flow from the UC1, UC2 and WNY2 regulators thorugh the JOSO interceptor. The JOSO outfall currently has 3 regulators (UC-1, UC-2 and WNY2) in the network that direct wet weather flow to the JOSO relief sewer as needed. To avoid expensive, disruptive and challenging in-rock construction, an option is to raise these overflow weirs regulators to direct more flow to WNY1 (and less overflow to JOSO). This could be accomplished with minimal construction and/or break in service, and without the hassles of in-rock construction.

- *Anticipated Constraints and Site Limitations*:
  - Capacity at River Road WWTP - Diverting additional flow to the WNY1 regulator alone may not result in CSO reduction to the desired level; the River Road WWTP needs to have sufficient capacity to treat the increased flow, otherwise, it may result in a larger or an additional WNY1 outfall with solids/floatables reduction. Since discharge from the JOSO outfall already receives solids/floatables (S/F) reduction, its mere diversion to WNY1 may not be an improvement. To ensure the desired level of CSO reduction, diverting additional flow to the WNY1 regulator should be supplemented by increased capacity at the River Road WWTP to treat additional flow.
- *Functionality*:
  - The level of CSO reduction expected would need to be verified as well as the capacity of the WNY1 trunk sewer by modeling or other theoretical means. Modeling could also help determine which regulators need their weir raised, the additional weir height necessary and any unintended consequences. No additional hiring/training is anticipated to be required for the function of this alternative. This alternative is anticipated to reduce CSOs to the desired level by improving on existing conveyance methods while avoiding challenging in-rock construction and conveying increased flow to an existing WWTP for complete treatment.
- *Feasibility*:
  - Managing impact on traffic and the neighborhood during construction is anticipated to be limited because these improvements would be within existing structures owned by the Authority. Relatively small capital and O&M costs are expected compared to other storage or disinfection alternatives. These improvements are also anticipated to work effectively under a variety of flow conditions and during intermittent operation. This alternative is considered feasible.

Figure 2 – Proposed Conveyance from JOSO Regulators to WNY1 Regulator Site Plan



Replace existing JOSO side-flow weirs with bending weirs

It is proposed to replace the existing JOSO weirs with bending weirs to convey more flow to the River Road WWTP. The objective is to maximize upstream collection system storage and capacity during smaller storms to reduce CSOs, while allowing flows to be diverted to the CSO outfalls during larger storms.

- *Anticipated Constraints and Site Limitations:*
    - Plant Capacity - Like the alternative to raise regulator weirs, it is necessary to verify that the River Road WWTP has sufficient capacity to treat and discharge the additional flow that is diverted from JOSO. To ensure the desired level of CSO reduction, diverting additional flow to the River Road should be supplemented by increased capacity at the WWTP to treat the additional flow.
    - Construction - This alternative requires replacement of the existing side overflow weirs, which would result in temporary traffic disruption on Park Avenue, 49th Street and 51st Street. The duration of work would be shorter than the other alternatives listed within this memo.
- *Functionality:*
    - This alternative does not require any SCADA automation or external controls for operation, thus there is minimal complexity in operation. However, bending weirs are prone to clogging/jamming with debris such as aluminum cans. A top-opening bending weir would be preferable to a bottom-opening weir, as a top-opening weir provides easier access for cleaning. The capacity of the WNY1 trunk sewer will also need to be determined through modeling iterations.
- *Feasibility:*
    - If more flow is diverted from JOSO to the River Road WWTP as a result of the weir replacement, it may be necessary to upgrade the treatment components at the River Road WWTP to provide capacity to treat this additional flow, and to upgrade the River Road outfall to discharge the additional flow. As such, there may be additional potential for sewer backups and flooding, or the relocation of the CSO discharge elsewhere in the watershed or to an adjacent watershed. This alternative is anticipated to work effectively under a variety of flow conditions and during intermittent operation. This alternative is considered feasible.

CSO Storage Structure constructed in River

A storage alternative constructed in the Hudson River is proposed for the JOSO Basin. This may include a public/private partnership with a residential development that will ultimately utilize platform facility. Figure 3 shows the approximate available footprint of where the storage facility would be constructed. Based on the target volume of 4.7 MG and an assumed depth of 10 feet for a storage structure, an approximate area of 63,000 sq. ft. would be required. The overall dimensions of the structure can be modified to yield a larger or smaller area by adjusting the depth of the structure.

- *Anticipated Constraints and Site Limitations:*
    - Foundation - If the proposed structure would include a pier, achieving the proper foundation stability would require the use of multiple piles which can require complex methods and coordination.
    - Construction in Navigable Waters and Boat Traffic -
        - The proposed structure would extend beyond the current edge of all nearby existing structures with the exception of Days Point. Extending beyond the existing shoreline will require extensive permitting and would be required to meet stringent impact design criteria for boat and barge traffic so as to not disrupt currents and tides in the River. Permitting the structure as an "end of pipe" structure may allow for approval of surface water encroachments but the adjacency would need to be confirmed.
        - This alternative would require the use of a Cofferdam and dewatering during construction would present challenges and have significant costs
    - Sea Level Rise - This alternative being located on the shoreline presents design challenges to accommodate sea level rise. The designing of pumping system power and controls will need to meet flood damage protection criteria and sea level rise criteria which may conflict with the desire to not limit lines of sight for residents.
- *Functionality*:
    - The proposed storage structure would need to be at the water level equal with the surrounding grade to allow for a pedestrian park/development to be extended over the top of the structure. The required pumping system would also need to be enclosed in an architecturally consistent structure that does not limit lines of sight from residents. The access for structure maintenance would be from the existing lot along Henley Place
- *Feasibility*:
    - The proposed structure is adjacent to a new high end residential complex (Henley on Hudson). Not only will design and construction efforts need to be heavily structured and regulated, odor control measures taken after construction would be paramount. It is anticipated that the local residents along the shoreline would be difficult to gain approval as public stakeholders. While this alternative provides flexibility in the overall size of a structure, it is not considered feasible.

Figure 3 – Proposed CSO Storage Site Plan

WNY1 Basin

Linear Storage along Anthony Defino Way

Linear storage in the form of a tunnel between the WNY1 regulator and the outfall is proposed. Figure 4 shows the approximate alignment of the proposed tunnel at this stage. The available area allows for a 2,200 ft long tunnel which would require a diameter of 26 ft to achieve the required 8.3 MG of storage. Construction of the tunnel would require installation of a launching shaft and a receiving shaft at either end of the alignment. Filling of the tunnel would require some form of drop shaft to dissipate energy and emptying the tunnel would require the installation of a pump station.

- *Anticipated Constraints and Site Limitations:*
    - Available Space - The effectiveness of the tunnel hinges on the ability to provide the required storage within the available tunnel alignment. While the tunnel does not utilize surface space, large areas are required for laydown and construction. Following construction, permanent facilities are required for odor control, grit handling, screening and dewatering. The most convenient site for the tunnel is along the open space area south of Anthony Defino Way since it is adjacent to the River Road WWTP and is currently not utilized. The location introduces a number of site constraints.

      The launching shaft would be located at the base (northern end) of the open space area downstream of the River Road WWTP, thus flow would be pumped backwards (south) to the plant for treatment. Space is required in this area for laydown of equipment and materials, which may be challenging considering the steep slope. A drop shaft will be required at the downstream end of the tunnel, which will also require above grade facilities for odor control, grit removal, and possibly screenings. Air release will also be required along the tunnel.
    - Terrain - The steep ground surface (upstream end approximate ground elevation of 135 ft, and at the downstream the approximate ground elevation is 50 ft, a change of 85 feet) requires that the receiving shaft and storage tunnel be very deep to function properly.
    - Land Use - There are buildings on the north side of Anthony Defino Way that may impact the allowable methods for constructing the shaft including additional monitoring during construction, representing an additional risk to the project.
- *Functionality -*
    - This alternative requires a pump station to prevent deposition of solids, which increases cost, energy requirements, and operational considerations. It would also require SCADA monitoring and controls to level sensors, flow monitors, and overflow detectors. There is a risk of potential sewage backups in service laterals due to surcharging the system above previous hydraulic grades.
- *Feasibility -*
    - Tunnels have been shown to be a feasible alternative to provide temporary storage for a CSO. The feasibility of a tunnel for this application would depend on several factors. First is the cost, not just of the tunnel, but also the ancillary odor control, dewatering, screening and grit handling facilities. Extensive geotechnical investigations are required to determine the tunneling or mining methods to be used. Poor quality rock, excessive

groundwater and other factors can increase the price. In order to capture the volume of the 5th largest storm, a tunnel of about 2,200 feet in length with a diameter of about 26 feet would be required as shown in Figure 4. A tunnel of this diameter would require a tunnel boring machine (TBM) for construction and may need to be buried up to 60 feet below the surface to avoid utilities. Also, in order to remain within the public right-of-way the TBM must be able to follow the curve of Anthony Defino Way which would require a turning radius of approximately 250 ft. It may not be possible to obtain a TBM or the required diameter that would make the turn, and the cost of acquisition at about $20M for this TBM may be cost prohibitive for this length of tunnel.

Deep tunnels require specialized equipment, personnel and training to maintain and operate. While some tasks could be carried out by Authority personnel, periodic tunnel inspection and various maintenance tasks would require tunnel entry.

In order to discharge flow from the tunnel in an acceptable period of time expanding of the River Road WWTP may be required. As complex as this alternative may be it is considered feasible.

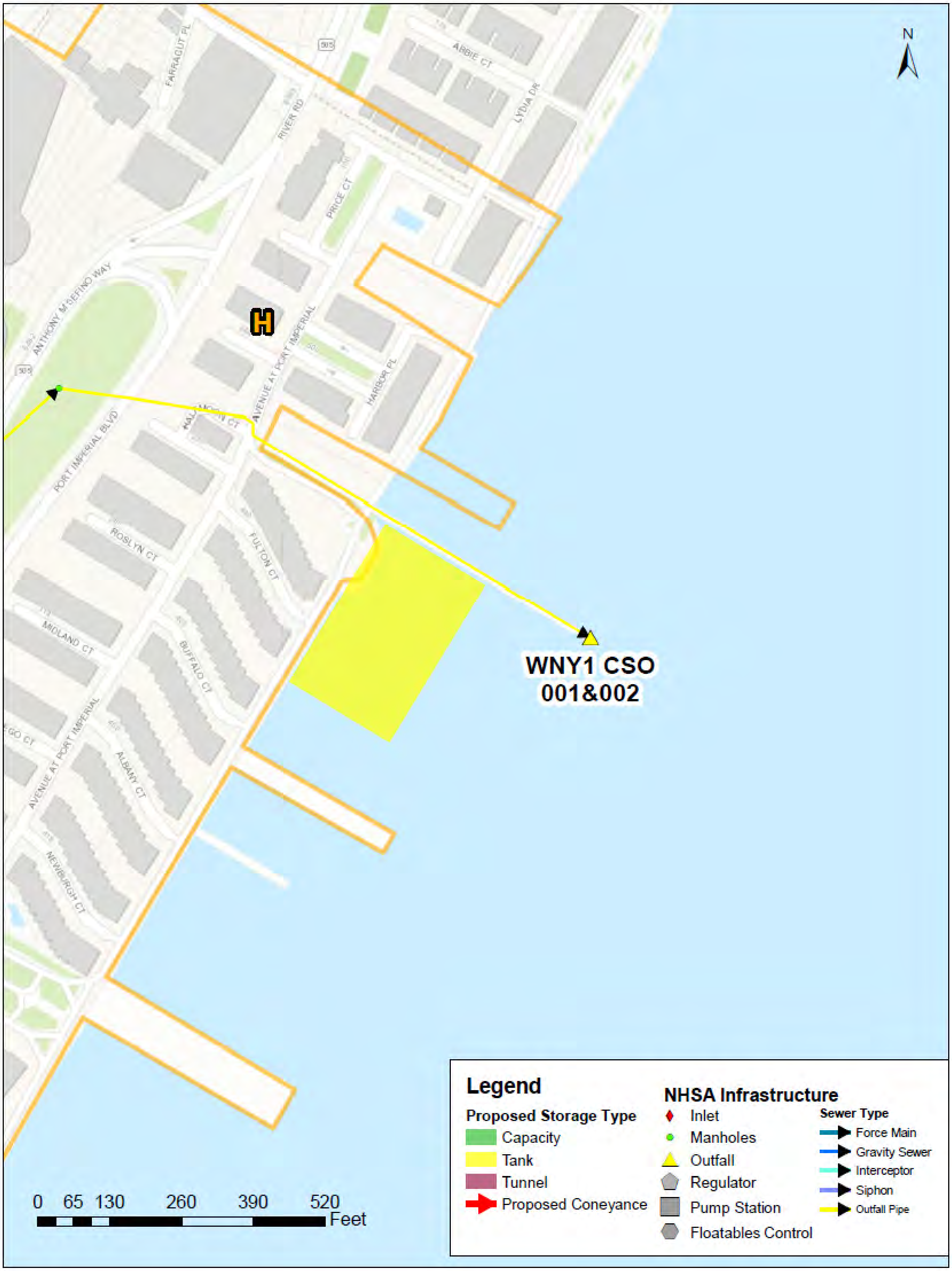
Figure 4 – Antony Defino Way Storage Tunnel Site Plan

CSO Storage Structure Constructed in River

A storage alternative constructed in the water is proposed for WNY1. This may include a public/private partnership with a residential development that will that will ultimately utilize platform facility. Figure 5 shows the approximate available footprint of where the storage practice would be constructed. Based on the target volume of 8.3 MG and an assumed depth of approximately 30 feet (height of the existing pier) the required area for a structure would be approximately 37,000 sq. ft. The overall dimensions of the structure can be modified to yield a larger or smaller area by adjusting the depth of the structure .

- *Anticipated Constraints and Site Limitations:*
  - Foundation - If the proposed structure would include a pier, achieving the proper foundation stability would require the use of multiple piles which can require complex construction methods and coordination.
  - Construction in Navigable Waters -
    - Permitting the structure as an “end of pipe” structure may allow for approval of surface water encroachments, but the adjacency would need to be confirmed.
    - This alternative would require the use of a Cofferdam and dewatering during construction which would present challenges and have significant costs.
  - Sea Level Rise - This alternative being located on the shoreline presents design challenges to accommodate sea level rise. The designing of pumping system power and controls will need to meet flood damage protection criteria and sea level rise criteria which may conflict with the desire to not limit lines of sight for residents.
- *Functionality:*
  - The proposed storage structure would need to be at high water level equal with the surrounding grade to allow for a pedestrian park/development to be extended over the top of the structure. The required pumping system would also need to be enclosed in an architecturally consistent structure that does not limit lines of sight from residents. The access for structure maintenance would be from the existing lot along Fulton Court which is private property.
- *Feasibility:*
  - The proposed structure is adjacent to a residential complex (The Landings at Port Imperial). Not only will design and construction efforts need to be heavily structured and coordinated, odor control measures taken after construction would be paramount. It is anticipated that the local residents along the shoreline would be difficult to gain approval as public stakeholders. However, due to the proximity to the River Road WWTP and the existing outfall, incorporating a park structure or other pier as an extension of the existing pier that houses the WNY1 outfall is an option that should be tested. This alternative is considered feasible.

Figure 5 – Proposed WNY1 CSO Storage Site Plan


N
WNY1 CSO
001&002
RIVER RD
PORT IMPERIAL BLVD
ANTHONY M DEFINO WAY
AVENUE AT PORT IMPERIAL
PRICE CT
HARBOR PL
LYDIA DR
ABBIE CT
FARRAGUT PL
ROSLYN CT
FULTON CT
MIDLAND CT
BUFFALO CT
ALBANY CT
NEWBURGH CT
0 65 130 260 390 520
Feet
Legend
Proposed Storage Type
Capacity
Tank
Tunnel
Proposed Coneyance
NHSA Infrastructure
Inlet
Manholes
Outfall
Regulator
Pump Station
Floatables Control
Sewer Type
Force Main
Gravity Sewer
Interceptor
Siphon
Outfall Pipe

River Road WWTP

CSO Storage Adjacent to River Road WWTP

Storage at an open space near the WWTP is proposed for this alternative. Figure 6 shows the approximate location of the open space for investigation. The available footprint of the site shown in the figure is approximately 30,000 sq ft. The location of this space is subject to change pending the next stage of evaluation.

- *Anticipated Constraints and Site Limitations:*
    - Terrain - There is an extremely large difference in gradient between the River Road WWTP and the Landings PS, and the River Road WWTP and JF Kennedy Blvd E. Excavating and constructing a storage tank in this location would be extremely challenging and expensive.
    - Available Space - Access to this site is very limited and traffic impacts could be significant as this site is wedged between JF Kennedy Blvd E and the River Road WWTP with no direct roadway access. Anthony M Defino Way serves the east side River Road WWTP and consists of single lanes in both directions. There is a small parking lot in front of the plant.
- *Functionality:*
    - The site location and resulting tank depth does not allow for a typical storage tank design. Access to the tank for maintenance vehicles and/or cranes would be very challenging at this location.
- *Feasibility:*
    - Hydraulically this alternative is not feasible because the existing terrain of the site forces the storage tank to be located at an elevation above the River Road WWTP. Excavating deeper and locating the tank at a lower elevation below the River Road WWTP is not considered feasible at this location.

Figure 6 – Proposed River Road WWTP CSO Storage Site Plan

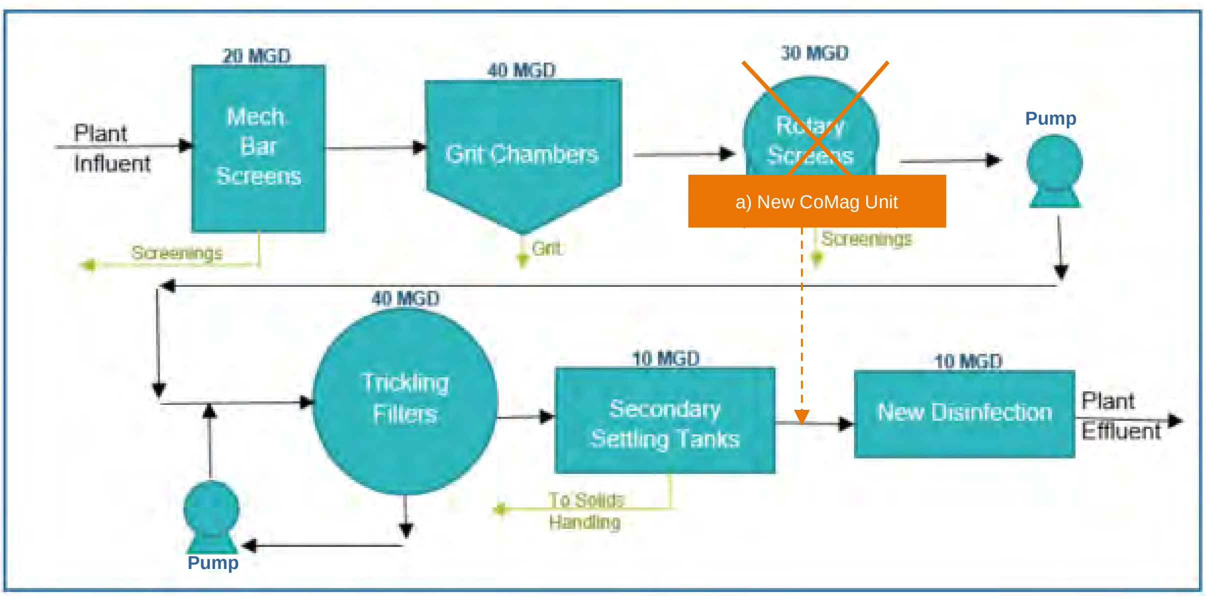
Treatment - CoMag® or BioMag®

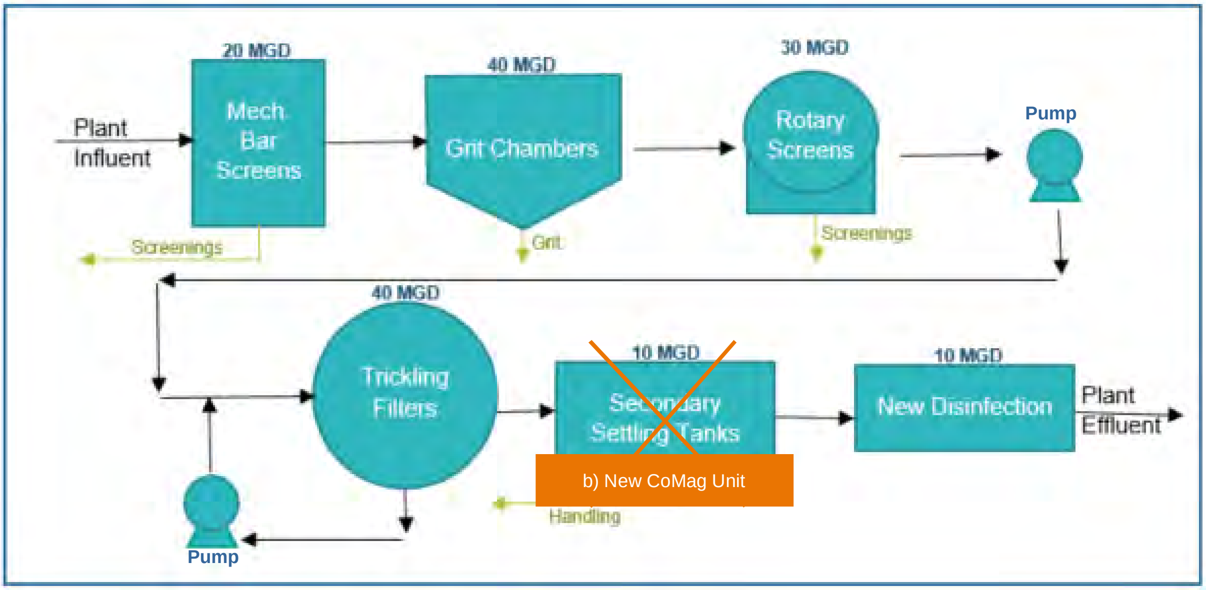
Modification of the current treatment works with CoMag® or BioMag® technologies is considered as an alternative to add additional treatment capacity to the WWTP. This capacity may be used to increase the percent capture of combined sewage or to treat dewatering flows from storage facilities. It is noted that this increased capacity may also necessitate a larger outfall and possible upgrades/modifications to the existing downstream disinfection system.

BioMag® is not typically used in a fixed film activated sludge process application (trickling filter plants) such as the River Road WWTP. As such, there are fewer pilot studies to provide design guidance. In order to use BioMag® in a typical application in conjunction with activated sludge treatment, significant space for additional facilities such as a suspended growth system, aeration basins, final clarifiers, blowers and associated facilities would be required. This is considered an impractical addition to the River Road WWTP, which has neither the available space nor the applicable treatment process to incorporate a BioMag® system, as such BioMag® is removed from further consideration for this application.

CoMag® is a ballasted settling process that could be implemented as a main stream or side-stream process to increase primary treatment capacity for bypass purposes. It could also be considered to replace the existing secondary settling tanks to increase overall plant capacity. If implemented as part of secondary treatment, it would be also necessary to consider an increase in disinfection capacity before discharge. Additional equipment/footprint is needed for the supplemental systems needed for the CoMag® process.

The figures below show where CoMag® could be added to the treatment train in the WWTP.





- *Anticipated Constraints and Site Limitations:*
  - Available Space- Installing a CoMag® system on the existing site will be a challenge due to the limited space available at the WWTP site, specifically in the existing headworks building where the proposed system would be located. Existing equipment would need to be relocated and reconfigured to accommodate the addition of the CoMag® system. It is anticipated that a CoMag® system may also require coarse screening and possibly fine screening upstream to ensure that larger debris does not impact the functionality of the system. More space is available if CoMag® is installed to replace the secondary settling tanks, however this may be limited by the capacity of the trickling filter. The CoMag® system also requires space for support systems such as a coagulant storage system and a feed storage system. A benefit of the CoMag® system is that the clarification tank size can be limited, thus it may be appropriate for applications in a small footprint. Installation of a CoMag® facility to increase treatment capacity may also require upgrades to downstream processes and the outfall to treat and discharge the additional flow.
  - Start Up Time- A significant constraint in the use of CoMag® technology in end of pipe applications is the startup time, which is in the range of 15-30 minutes. However, at the WWTP the system would be in continuous operation and would be able to treat the first flush, which carries the greatest pollutant loading. As such it is recommended that the CoMag® system be left on all the time, and a wet weather operational procedure developed to bring additional train on-line with increasing flow. The system requires significant operation and maintenance attention and there is some complexity in determining the appropriate chemical dosage, which must be controlled by the flow rate.
- *Functionality:*
  - CoMag® is not as widely used as other technologies for CSO and wet weather treatment applications. In terms of performance efficiency, the system is known to provide TSS removal rates of 75-95% and fecal coliform removal to < 200 Col/100 mL, site specific pilot testing is recommended. The system is gravity fed, compatible

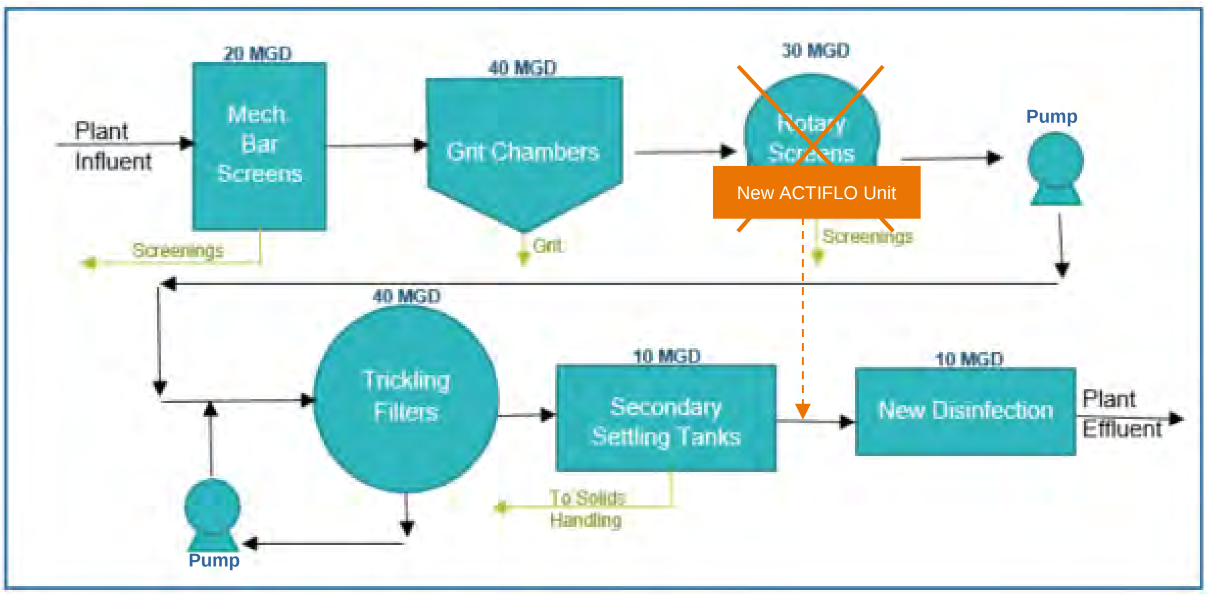
with previously developed site layouts, and there is flexibility in the system because the units can be added modularly. The amount of headloss must be considered in fitting it into the hydraulic grade line of the plant. The CoMag® system is able to provide settling rates which are faster than conventional treatments. They are considered a flexible process because of their ability to treat widely fluctuating flows and loads. In addition, magnetite is denser than the sand used in other ballasted flocculation processes, readily available (iron ore commodity), fully inert, not abrasive (particle size is 40-50 microns) and magnetically retrievable (high recovery rates). CoMag® systems have significant operational and maintenance requirements, as well as complexity in chemical dosage. As such the Authority must be willing to take on the additional operational and upkeep needs.

- *Feasibility:*
  - Consideration will need to be given to how the CoMag® system will be installed while keeping the plant in operation. Magnetite, which is used to settle chemical floc in the CoMag® system, is relatively inexpensive, ranging from $0.20 USD to $0.50 USD per pound delivered. Because the recovery rates of magnetite are high, the daily consumption is very low. If the treatment capacity of the WWTP is further increased in the future, an CoMag® system with higher capacity and cost may be required. While the BioMag® process is not considered to be feasible due to the current configuration of the plant as a trickling filter process, CoMag® is considered a feasible possible treatment alternative.

Replace Microstrainers with ACTIFLO®

Increasing the capacity of the WWTP by replacing the current microstrainers with ACTIFLO® technology is considered as an alternative to increase treatment capacity to the WWTP. Stacking the proposed units would also potentially allow for the increased capacity. This capacity may be used to increase the percent capture of combined sewage or to treat dewatering flows from storage facilities. Like CoMag, it could be implemented as a mainstream process to increase primary treatment to allow for bypass, which may also necessitate improvements to the disinfection system as well as a larger outfall.

The figure below shows where the ACTIFLO® unit could be added to the treatment train in the WWTP.



- *Anticipated Constraints and Site Limitations:*
  - Available Space- Installing an ACTIFLO® system on the existing site will be a challenge due to the limited space available at the WWTP site, specifically in the existing headworks building where the proposed system would be located. Existing equipment would need to be relocated and reconfigured to accommodate the addition of the ACTIFLO® system. It is anticipated that the system may also require coarse as well as fine screening upstream to ensure that larger debris does not impact the functionality of the system. The ACTIFLO® also requires space for support systems such as a coagulant, polymer, and sand storage systems. Based on the existing capacity of downstream processes, the ACTIFLO would likely be sized to a capacity of about 25 MGD. As such, based on the Updated Technical Guidance Manual, it may require footprint of approximately 60’9” x 22’. Installation of an ACTIFLO facility to increase secondary treatment capacity may also require upgrades to downstream processes such as disinfection and the outfall to treat and discharge the additional flow.
  - Start Up Time- A significant constraint in the use of ACTIFLO® technology in end of pipe applications is the startup time, which is in the range of 15-30 minutes. However, at the WWTP the system would be in continuous operation and would be able to treat the first flush, which carries the greatest pollutant loading. As such it is recommended that the CoMag system be left on all the time, and a wet weather operational procedure

developed to bring additional train on-line with increasing flow. The system requires significant operation and maintenance attention and there is some complexity in determining the appropriate chemical dosage, which must be controlled by the flow rate

  - O&M- The system requires weekly inspections and preventive maintenance. If the system is being using intermittently, maintenance will be required to ensure that it is in working condition. These commitments would need to be agreed upon by plant staff.

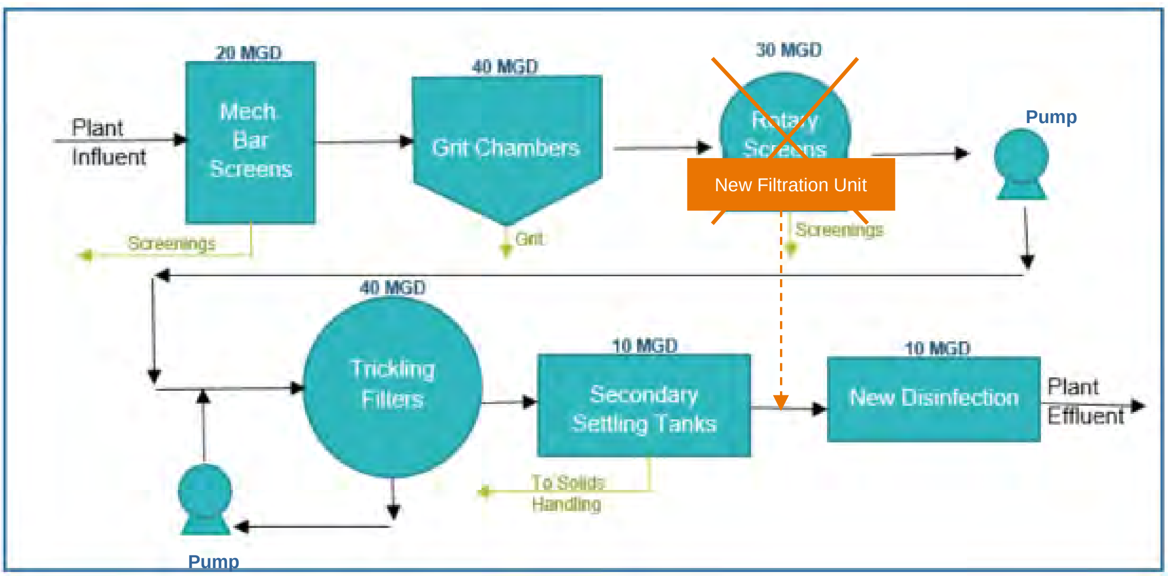
- *Functionality:*
  - ACTIFLO® is an established technology for CSO and wet weather treatment. In terms of performance efficiency, it is known to provide TSS removal rates of 80-95% and fecal coliform removal rates of 85-95%. It is very effective in removing pollutants, particularly because the addition of coagulant and polymer helps to remove smaller particles. It is noted that performance of the ACTIFLO® system deteriorates quickly for surface loading rates higher than 60 gallons per minute per square foot. The system is gravity fed, compatible with previously developed site layouts, and there is flexibility in the system because the units can be added modularly. The amount of headloss must be considered in fitting it into the hydraulic grade line of the plant. However, the system requires weekly inspections and preventive maintenance. If the system is being using intermittently, maintenance will be required to ensure that it is in working condition. The ACTIFLO® system has significant operational and maintenance requirements, as well as complexity in chemical dosage, as such the Authority must be willing to take on the additional operational and upkeep duties.

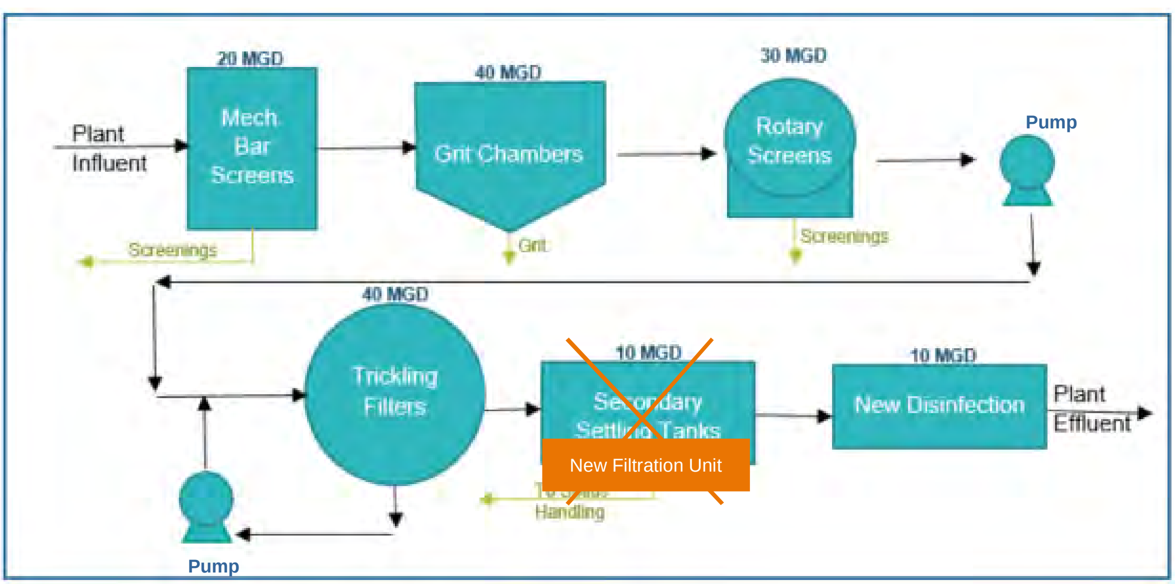
- *Feasibility:*
  - Consideration will need to be given to how the ACTIFLO® system will be installed while keeping the plant in operation. In order to provide treatment for 25 MGD, based on the Updated Technical Guidance Manual, the system is estimated to have a capital cost of approximately $10.1M. The annual cost of the system would be approximately $50,000 for energy and chemical costs and $38,000 for operation and maintenance labor costs. If the treatment capacity of the WWTP is further increased in the future, an ACTIFLO® system with higher capacity and cost may be required. Should these considerations be taken into account and the space be available, this alternative is considered feasible based on the plant's current need for additional TSS removal.

Incorporate High Rate Filtration to Increase Treatment Capacity and Provide TSS Removal

A high rate filtration system is considered as an alternative at the WWTP to increase treatment capacity and provide removal of total suspended solids (TSS). This capacity may be used to increase the percent capture of combined sewage or to treat dewatering flows from storage facilities. The filtration system may be a compressible media filtration process such as FlexFilter® or a cloth media filtration system such as AquaPrime® disk system.

The figures below show where filtration could be added to the treatment train in the WWTP. Filtration could be installed downstream of the existing mechanical bar screens to increase overall plant capacity. A system such as AquaPrime® or FlexFilter® could be in place of the rotary screens, with additional units brought on-line to blend with the trickling filter effluent prior to disinfection. Alternately, if implemented as part of secondary treatment, it would be necessary to increase capacity of the downstream disinfection system.





- *Anticipated Constraints and Site Limitations:*
  - Available Space- Installing a new filtration system on the existing site will be a challenge due to the limited space available at the WWTP site. Existing equipment may need to be relocated and reconfigured to accommodate this system. A filtration system may also require space for support systems such as blowers and backwash pumps. Based on the existing capacity of downstream processes, a filtration system would likely be sized to a capacity of about 25 MGD. As such, based on the Updated Technical Guidance Manual, a FlexFilter® may require dimensions of approximately 1,800 SF. AquaPrime® units are not included in the updated TGM but will provide some footprint efficiencies when compared with the FlexFilter®. If the treatment capacity of the WWTP is increased, upgrades to downstream processes and the outfall to treat and discharge the additional flow may be required.
  - Plant Operation-Consideration will need to be given to how a filtration system will be installed while keeping the plant in operation. The filters could be installed as standby units for wet weather service. Filtered effluent could be disinfected and blended with trickling filter plant effluent prior to discharge. Additionally, the AquaPrime® technology could replace the existing rotary (micro) screen units, and additional AquaPrime standby units could be provided to increase wet weather capacity.
  - Capacity at the WWTP-Based on the Updated Technical Guidance Manual a FlexFilter® may require dimensions of approximately 1,800 SF. AquaPrime® units are not included in the updated TGM but will provide some footprint efficiencies when compared with the FlexFilter®. If the treatment capacity of the WWTP is increased, upgrades to downstream processes such as disinfection and the outfall to treat and discharge the additional flow may be required.
- *Functionality:*
  - Compressible media filters such as the FlexFilter® are an established technology for CSO and wet weather treatment for plants of this size. The FlexFilter® is a simple gravity system requiring no moving parts. According to the Updated Technical Guidance Manual, it is typically operated at 4 gpm/sq. ft. hydraulic loading rate during the first flush portion of a CSO event and gradually increases the operating hydraulic loading rate as the CSO flow rate increases and solids concentration decrease. In terms of performance efficiency, FlexFilter® is known to provide TSS removal rates of 73% to 94% and 16% to 69% for BOD removal. Time is needed during operation for backwashing, especially at the higher end of the recommended filter loading rate as well as standby units for operation during backwash. A waste stream is produced which must be treated or disposed of. The FlexFilter is also noted for its operational complexity due to automated valves, hydraulically operated porous plate, air injection into the beds during backwashing, and monitoring needed for flow and headloss conditions. The amount of headloss required must be considered in fitting it into the hydraulic grade line of the plant.

    Cloth media filters such as AquaPrime® for wet weather treatment is a relatively new application of an older technology that is being more widely adopted in recent years. They are also gravity fed, but unlike the FlexFilter are able to remain in filtration mode during backwashing meaning standby units are necessarily required. Performance efficiency with the AquaPrime® is listed as slightly higher than the FlexFilter® with about 75% to 85% TSS removal and 45% to 60% for CBOD removal. The footprint of a cloth media filtration system is generally 50% smaller than an equivalent compressible media filtration system. The amount of headloss required must be considered in fitting it into the hydraulic grade line of the plant.

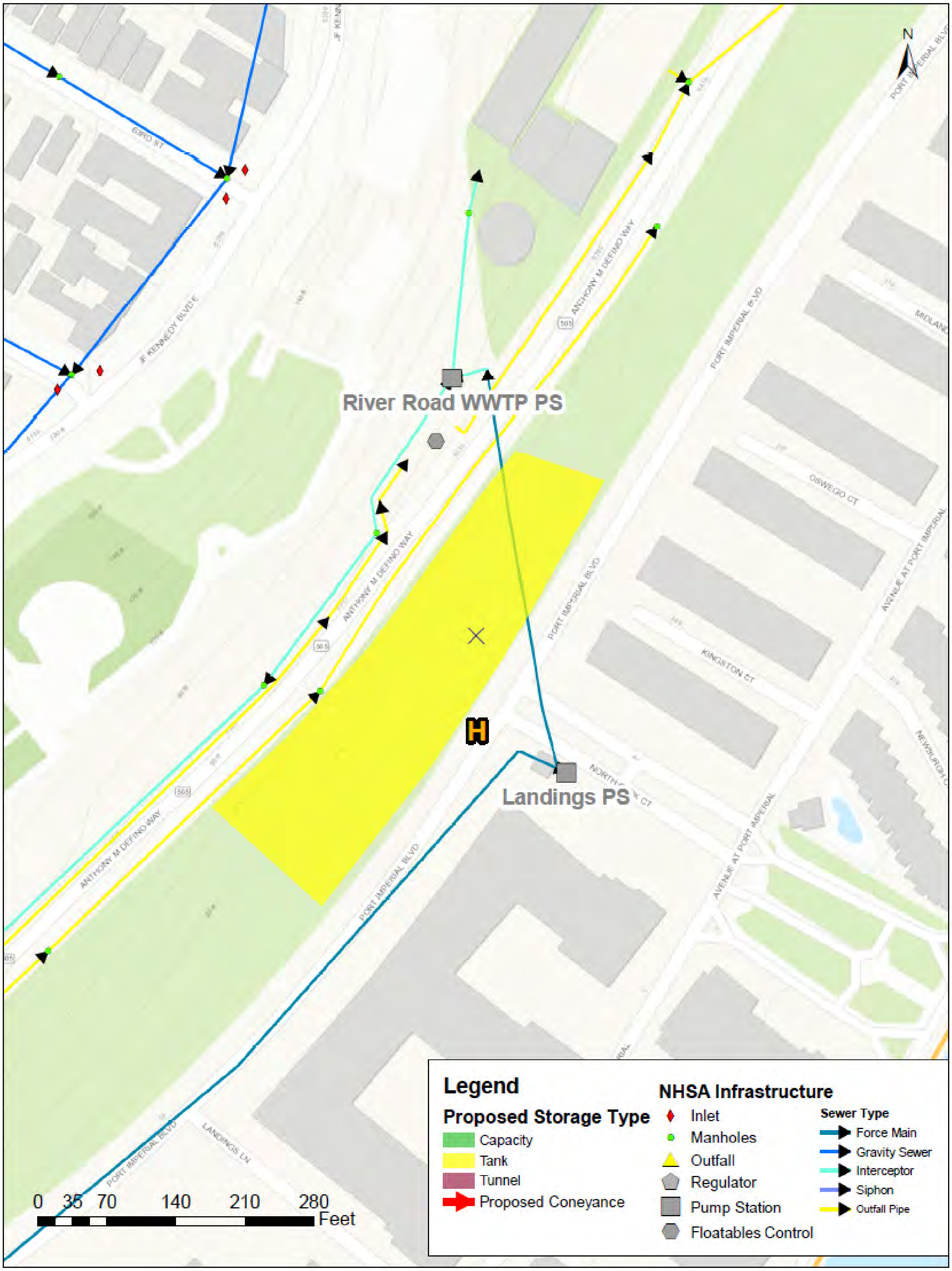
- *Feasibility:*
  - In order to provide treatment flow 25 MGD, based on the Updated Technical Guidance Manual, a FlexFilter system is estimated to have a capital cost of approximately $6.3M and annual cost of $33,000. Based on the plant's current need for additional TSS removal in order to aid the treatment plant with TSS removal, this alternative is considered feasible.

Gravity Storage Tank with Primary Level BOD and TSS Removal

A gravity storage tank with primary level BOD and TSS removal is recommended at the River Road WWTP for this alternative. Figure 10 shows the footprint of the identified open space. Based on the target volume of 11 MG, the storage tank would have a depth of approximately 20 feet and a length with an irregular curvature of approximately 515 feet.

- *Anticipated Constraints and Site Limitations:*
    - Available Space - There is very limited open space for a storage tank in the vicinity of the River Road WWTP. The only possible above ground storage location would be the 9.22 acre property located at Block 168, Lot 4 in West New York, immediately south of the River Road WWTP between Anthony M. Defino Way and Port Imperial Boulevard. There would be lead time as well as cost in acquiring the property, especially if it must be acquired via imminent domain.
- Terrain:
    - The site noted above is an irregularly shaped property (long and thin) with a steep slope ranging between 25% and 40%, and elevation drop of 80 feet across the southwestern end of the site and 20 feet elevation drop near the treatment plant. The underlying material is likely rock, thus there would be additional challenges as well as cost in partially burying this storage tank or making it a sub-surface tank. There may also be utilities underground which may need to be relocated if subsurface work is required. In order to provide storage for the 5th largest storm, the storage tank would have a footprint of approximately 20 feet in height, offset of 10 feet from the northern and southern adjacent roads, and an irregularly shaped tank with walls following the curvature of the parcel with an approximate tank length of 515 feet. An additional footprint of about 50 feet x 50 feet would be required to locate a pumping station and odor control facility.
- *Functionality:*
    - A storage tank will require a pump station and control system to empty the solids deposited in the tank for periodic cleanout. SCADA monitoring such as level sensors, rain gauges, flow monitors, and overflow detectors will be required to monitor flow depth in the tank. There may also be odor concerns in storing this flow in the tank. A benefit of using a storage tank is that it would have the capability to handle high flow and water quality variations, and can act as a sedimentation tank.
- *Feasibility:*
    - There are limitations in constructing a tank at the above noted site, due to the slope and space constraints, as well as subsurface rock material. Vertical shaft storage has also been considered. While it does have lower above ground site requirements than the other storage alternatives, vertical shaft storage would likely require a deep dewatering pump station as well as site challenges with tunneling down into the rock, and with sediment deposition in the shaft. Another challenge would be that O&M is in deep, confined spaces. There are a limited number of vertical shafts, thus this alternative is less widely understood and adopted. Due to the irregularity of the structure of the tank lending to decreased reliability, this alternative is not considered feasible.

Figure 10 – Proposed Primary Treatment Storage Structure Site Plan



System-Wide Alternatives

Green Infrastructure

Green Infrastructure (GI) is one type of source control technology that can help to manage stormwater, reduce CSOs, and improve water quality. GI technologies most common in urban areas like the River Road drainage basins include bioretention, bioswales, stormwater planters, permeable pavement, subsurface infiltration/storage, and stormwater tree pits. For less constrained sites with additional space, GI technologies such as infiltration basins, ponds, and constructed wetlands can prove to be effective, as well as cost-efficient. Conversely, for more constrained sites with limited at-grade opportunities, green (vegetated) roofs may be the only viable GI technology. When properly designed, constructed, and maintained, these technologies can provide significant levels of control over the course of a year through their performance in small to moderate-sized storms.

- *Anticipated Constraints and Site Limitations:*
    - Land Use -The overall River Road study area is divided into the following land uses:
        - Medium Density Residential/Mixed Use 0%
        - High Density Residential 65%
        - Commercial/Industrial/Transportation 27%
        - Open Space/Park/Other: 8%
        - Overall Imperviousness: 78%

    Based on a high-level assessment of these identified land uses in the study area, the following percentages of each land use area that can be feasibly managed by GI were assumed to be:

        - Up to 40% of the Medium Density Residential/Mixed Use area
        - Up to 15% of the High Density Residential area
        - Up to 30% of the Commercial/Industrial/Transportation area
        - Up to 60% of the Open Space/Park/Other area
        - Up to 23% of the overall study area

    From this assessment, a significant constraint of implementing GI within the service area is land use which includes limited open space. High Density Residential, which is the most limiting land use for GI implementation, represents the largest percentage of land use in this study area and also the one that has the least percentage of space to be feasibly managed by GI practices. Because of this, large, regional public GI projects/programs will likely be difficult to implement.
- *Functionality:*
    - The available types of GI that would function most effectively within the service area were analyzed. For the overall study area, the following assumed levels of implementation by GI technology were based on a high-level investigation of the various land uses and site conditions:

- Infiltration Basins/Ponds: 9%
- Constructed Wetlands: 11%
- Bioretention/Bioswales/Stormwater Planters: 43%
- Stormwater Tree Pits: 8%
- Subsurface Infiltration/Storage: 23%
- Permeable Pavements: 4%
- Green Roofs: 2%

In general, the most applicable GI technologies for the overall study area are Bioretention / Bioswales / Stormwater Planters, Subsurface Infiltration/Storage, and Constructed Wetlands, with lesser applicability for the other common types of GI. For the next phase, modeling scenarios will be conducted to estimate the possible CSO reduction from these methods of GI implementation based on different design storms.

- *Feasibility:*
  - The feasibility of implementing GI depends on multiple factors, including site conditions/usage, topography, the configuration of the collections system, land availability, property ownership, anticipated pollutant load, utility conflicts, size of drainage area, contaminated soils, and localized flooding. The slopes of the various drainage basins are generally favorable for GI implementation, as they range primarily from 0% to 6%, with only a few steeply sloped area (12.5% and 39.3%) at the northwest end of the service area where there are steep drops in elevation. These aspects will all be considered for locations recommended for green infrastructure. In addition to these estimated amounts of GI that can be feasibly managed for the service areas, sites that have previously been identified in a study for the Authority as opportunities for GI within West New York and Union City will be further evaluated for the evaluation as these are within the River Road service area.

Inflow/Infiltration

The Authority has reported increasing issues with dry weather flows at the River Road WWTP in recent years. This can be attributed to issues with inflow and infiltration (I/I) due to aging infrastructure. CCTV data that was conducted for all of the River Road drainage area indicated the severity of aging infrastructure within the service area. The analysis categorized each pipe, with a 4 or 5 on the PACP rating scale indicating that they are more susceptible to failure. Tables 2 and 3 analyze the results of the RedZone investigations to quantify the level of required rehab.

Table 2 - RedZone Results by Basin, Percentage of Sewer Aging Based on Total Length of RedZone Pipes

Drainage Basin	PACP Category				
	1	2	3	4	5
A*	-	-	-	100%	-
B*	12%	29%	31%	28%	-
C*	7%	-	6%	55%	32%
D*	8%	18%	17%	24%	32%
E*	22%	-	-	78%	-
G*	11%	4%	15%	58%	13%
H*	-	-	-	100%	-
JOSO	3%	11%	16%	47%	24%

*Sub Basin within the WNY1 Drainage Area

Table 3 - RedZone Results by Basin, Percentage of Sewer Aging Based on Total length of Pipes in Basins

Drainage Basin	PACP Category				
	1	2	3	4	5
A	-	-	-	2%	-
B	12%	4%	4%	3%	-
C	1%	-	1%	6%	3%
D	3%	8%	7%	10%	13%
E	1%	-	-	3%	-
G	2%	1%	3%	13%	3%
H	-	-	-	1%	-
JOSO	3%	11%	15%	46%	23%

*Sub Basin within the WNY1 Drainage Area

Based on the above information, scenarios will be run in the hydraulic collection systems model to remove the estimated amount of baseflow (dry weather flow) resulting from the pipes categorized as a 4 or 5. These results will provide an estimate of the effects of sewer lining or overall replacement for the aging infrastructure and provide a representative metric that shows improvements that sewer lining will have on the system

Summary

In Summary, Table 4 below identifies the final list of alternatives that will undergo the full evaluation process to simulate the conditions as they are expected to exist after construction and operation of the alternative. Those identified alternatives will also have a Class 5 conceptual cost estimate developed to provide the overall cost benefits for the anticipated amount of CSO control.

Table 4 - Preliminary Screening Alternatives Summary

Service Area	Alternative	Proceed to full evaluation?
JOSO	Raise regulator weirs at UC1, UC2 and/or WNY2	Yes
	Replace existing JOSO side-flow weirs with bending weirs	Yes
	CSO storage structure constructed in River	Not for this contract
WNY1	Linear Storage Along Anthony Defino Way	Yes
	CSO storage structure constructed in River	Yes
River Road WWTP	CSO Storage Adjacent to River Road WWTP	Not for this contract
	Replace Treatment Works with CoMag®/BioMag® Technology	CoMag® – Yes BioMag® - Not for this contract
	Replace microstrainers with ACTIFLO® technology	Yes
	Incorporate Cloth Media Filtration to Increase Treatment Capacity and Provide TSS Removal	Yes
	Gravity Storage Tank with Primary Level BOD and TSS Removal	Not for this contract
System-wide Alternatives	Green Infrastructure	Yes
	Inflow/Infiltration-Sewer Lining and Rehabilitation	Yes
	Inflow/Infiltration-Sewer Lining and Rehabilitation	Yes

Attachment 1

Evaluation Criteria

Table-Evaluation Criteria Summary

Category	Criteria	1	2	3	4
CSO Reduction	CSO Volume Reduction	Greater than 4 overflows per year	-	-	Maximum of 4 overflows per year
	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges at outfall	-	Alternative results in reduction of bacteria discharges at outfall	Alternative eliminates bacteria discharges at outfall
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in the Hudson River with help of another alternative	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary contact recreation and fishing)	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of Hudson River with help of another alternative	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of the alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of alternative to provide effective operation under variety of operating conditions.	Need for supplemental steps in the operation process – compatibility with disinfection process.	-	-	Limited number of steps in the treatment process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on primary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Physical Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas

Category	Criteria	1	2	3	4
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	(Range of prices to be defined once costs start being developed)			
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.	(Range of prices to be defined once costs are developed)			
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response or positive public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

North Hudson Sewerage Authority

Long Term Control Plan

Preliminary Screening of CSO Control Technologies: End of Pipe

NJPDES Permit: NJ0026085

Date: November 13, 2018

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Preliminary Screening of CSO Control Technologies

DATE: November 13, 2018

PREPARED BY: Jacobs Engineering Group

PROJECT: North Hudson Sewerage Authority Alternatives Analysis-End of Pipe

Executive Summary

Under the New Jersey Pollutant Discharge Elimination System (NJPDES) permit for Adams Street and River Road, as part of the System Characterization Report for the Adams Street Wastewater Treatment Plant (WWTP) and the River Road WWTP, the North Hudson Sewerage Authority (the Authority) must conduct an evaluation of alternatives for combined sewer overflow (CSO) technologies at all of the Authority's outfalls. This technical memorandum presents the findings of the preliminary screening of these identified end-of-pipe control technologies for all of the Authority's outfalls. The purpose of this screening is to provide an initial evaluation on the alternatives by identifying anticipated constraints, site limitations, functionality and feasibility of the control technologies identified. The evaluation criteria presented in the Identification of Alternatives and Evaluation Criteria memorandum dated October 29, 2018 were used as a guide to summarize this analysis, which can be found at the end of the memo. Based on this preliminary screening, alternatives that would not fit the site-specific needs or not allow compliance with the Final Permit will not be included in the next phase of evaluation in which conceptual layouts of the alternatives are presented and the Authority's InfoWorks ICM model is used to simulate the expected benefit of the alternatives.

Table 1 summarizes the results from the preliminary screening and indicates the alternatives that will proceed to the next phase of evaluation.

Table 1 – Preliminary Screening Results

Service Area	Alternative	Proceed to full evaluation?
H1	Disinfect at H1 WWPS	Yes
	Combine flows with Jersey City CSO in Long Slip Canal	Not for this contract
H3/H4/HSI	Chemical Storage and Feed at 5th Street Pump Station and route chemical to H3 CSO	Yes
	Disinfection under Stevens Park	Not for this contract
H5	Incorporate disinfection with structure in water	Yes
	Disinfect at H5 regulator adjacent to 11th Street PS	Yes
W1234	Disinfect at W1234 Outfall Manholes on Waterfront Terrace	Yes
	Disinfect at Junction Structure under the Lincoln Tunnel Helix	Yes
	Disinfect at one of the W1234 regulators on Park Avenue	Not for this contract
	Disinfect at W1234 S/F facility	Not for this contract
	Install chlorine contact tank at the bottom of the Palisades	Not for this contract
18th Street	Disinfect at 18th Street Pump Station	Yes
W5	Disinfect at at W5 S/F vortex facility	Yes
JOSO	Disinfect at Liberty Place Pump Station	Yes
	Disinfect at JOSO drop shaft	Not for this contract
WNY1	Disinfect at WNY1 S/F facility	Yes

Introduction

This technical memorandum identifies the end of pipe control technologies discussed at the Authority's Alternatives Analysis Workshop for all outfalls and defines the proposed evaluation criteria to apply to the overall implementation of each alternative. The purpose of this memorandum is to present the evaluation criteria and all identified alternatives for the specified site with only technologies that would fit the site-specific needs and would allow compliance with the Final Permit. Those final identified alternatives would then undergo further evaluation defined in the Evaluation Criteria memo. This memorandum is the initial step towards the Development and Evaluation of Alternatives Report to be submitted to the New Jersey Department of Environmental Protection by July 1, 2019. Figures 1 and 2 below depict the System Block Diagrams for the Authority's outfalls. These figures provide an understanding of the relative locations and configuration of the Authority's infrastructure along the Hudson River based on the WWTP service area.

Figure 1 – Adams Street WWTP Service Area

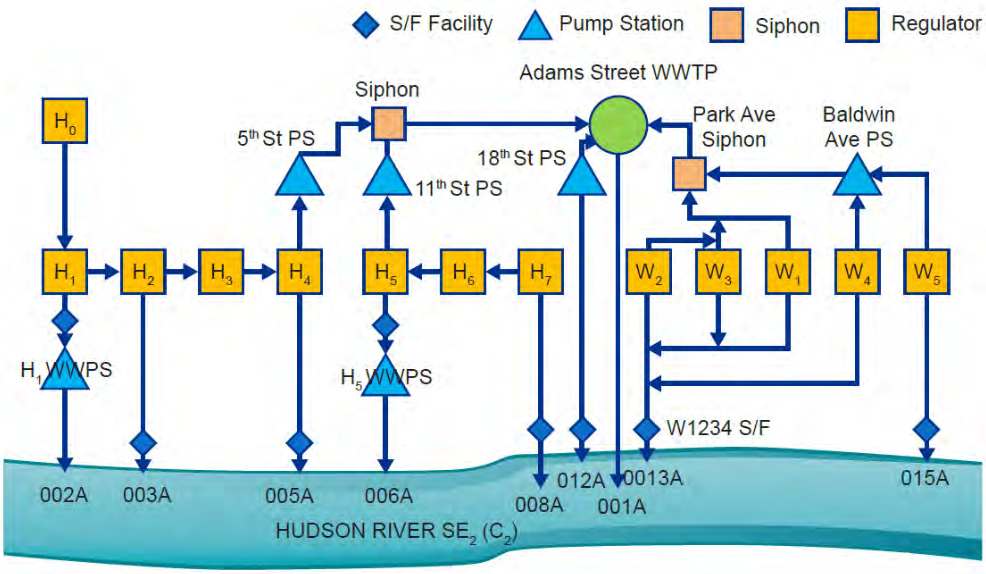
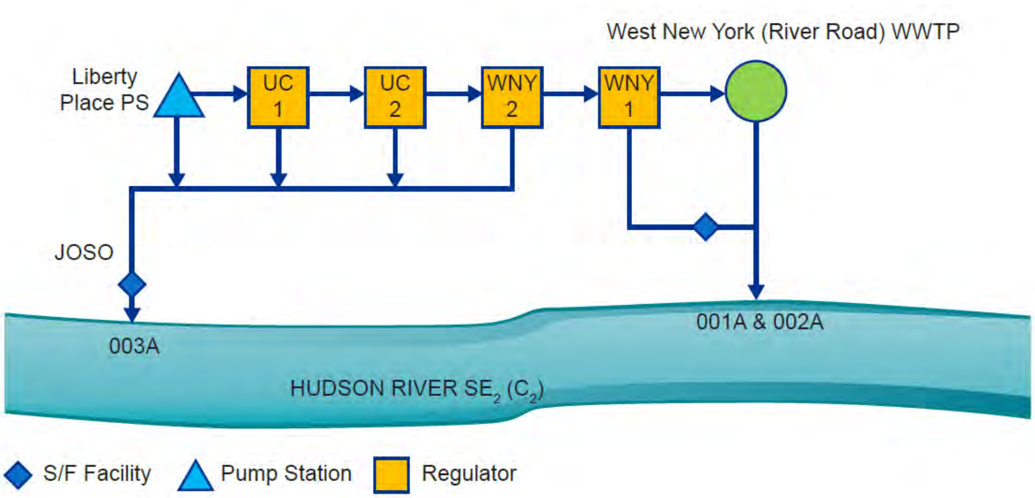


Figure 2- River Road WWTP Service Area



Preliminary Screening

The following section details the preliminary screening of the alternatives from the Identification of Alternatives and Evaluation Criteria memorandum dated October 29, 2018. The screening includes identifying the anticipated constraints, site limitations, functionality, and feasibility of each alternative. The evaluation criteria that will be used in the final evaluation are provided in Attachment 1 and were used as a guide to identify anticipated constraints, site limitations, functionality and feasibility of the alternatives.

Disinfection

As summarized in Table 1, disinfection was reviewed for the following service areas: H1, H3/H4/HSI, H5, W1234, 18th Street, W5, JOSO, and WNY1. Below is the evaluation for all of the facilities that is the same for each alternative. Deviations for each individual alternative is noted in the alternative.

- *Anticipated Constraints and Site Limitations:* Siting the disinfection building and the required contact time are the anticipated constraints for this alternative.
    - Available Space - A disinfection building to house disinfectant bulk storage tank, metering pumps, and electrical room would need be needed on site.
    - Land Acquisition - A land acquisition may be required to house the proposed facilities and is noted in each individual alternative.
    - Contact Time - The available contact time would need to be evaluated.
    - Traffic/Public Access – Consideration to the public is noted for each individual alternative.
- *Functionality*
    - Chemical Dose - The required sodium hypochlorite dose increases as the available contact time decreases. Available detention times in the existing system would need to be determined. However, as an example detention times of 15 minutes and 5 minutes and an assumed required CT of 225 mg/L minutes, sodium hypochlorite doses of 15 mg/L and 45 mg/L would be required.
    - Chemical Storage and Feed - The annual volumes to be treated are sufficiently large and a bulk storage tank would be preferred over totes or drums. The bulk storage tank size would be based on a single standard bulk delivery volume (e.g., 1.5 x a standard delivery volume of approximately 6,000 gallons) unless otherwise noted, however, if space constraints are present totes may be the recommended option. A building to house a single bulk storage tank, chemical metering pumps, and associated electrical room is assumed for preliminary screening. A second chemical to dechlorinate, or to neutralize an alternative disinfectant such as peracetic acid (PAA), may be required if the residual will be greater than the allowable permit limit. Available space for a second chemical addition at or near the outfall would be required.

      Involvement from plant staff will likely require periodic monitoring of sodium hypochlorite strength due to degradation and corresponding adjustment of dose and being present during chemical deliveries. Adjustment of dose can be automated based on analysis results monitored through the SCADA system. Caution should be taken as sodium hypochlorite has potential to degas and requires careful design provisions. Sodium hypochlorite disinfection has a proven reliability/functionality while PAA is less proven but is in use at some operating facilities. Should PAA be selected for disinfection, it would need to be tested to determine the required dose and expected residual versus time to determine the need for a neutralization chemical.

- *Feasibility*
    - While sodium hypochlorite is a proven disinfectant in a contact tank, it is not common practice to provide the disinfection at pump stations and outfalls. The available contact time would need to be verified and may be the limiting factor in implementing this alternative. There are also potential corrosive impacts of sodium hypochlorite on the existing facilities.

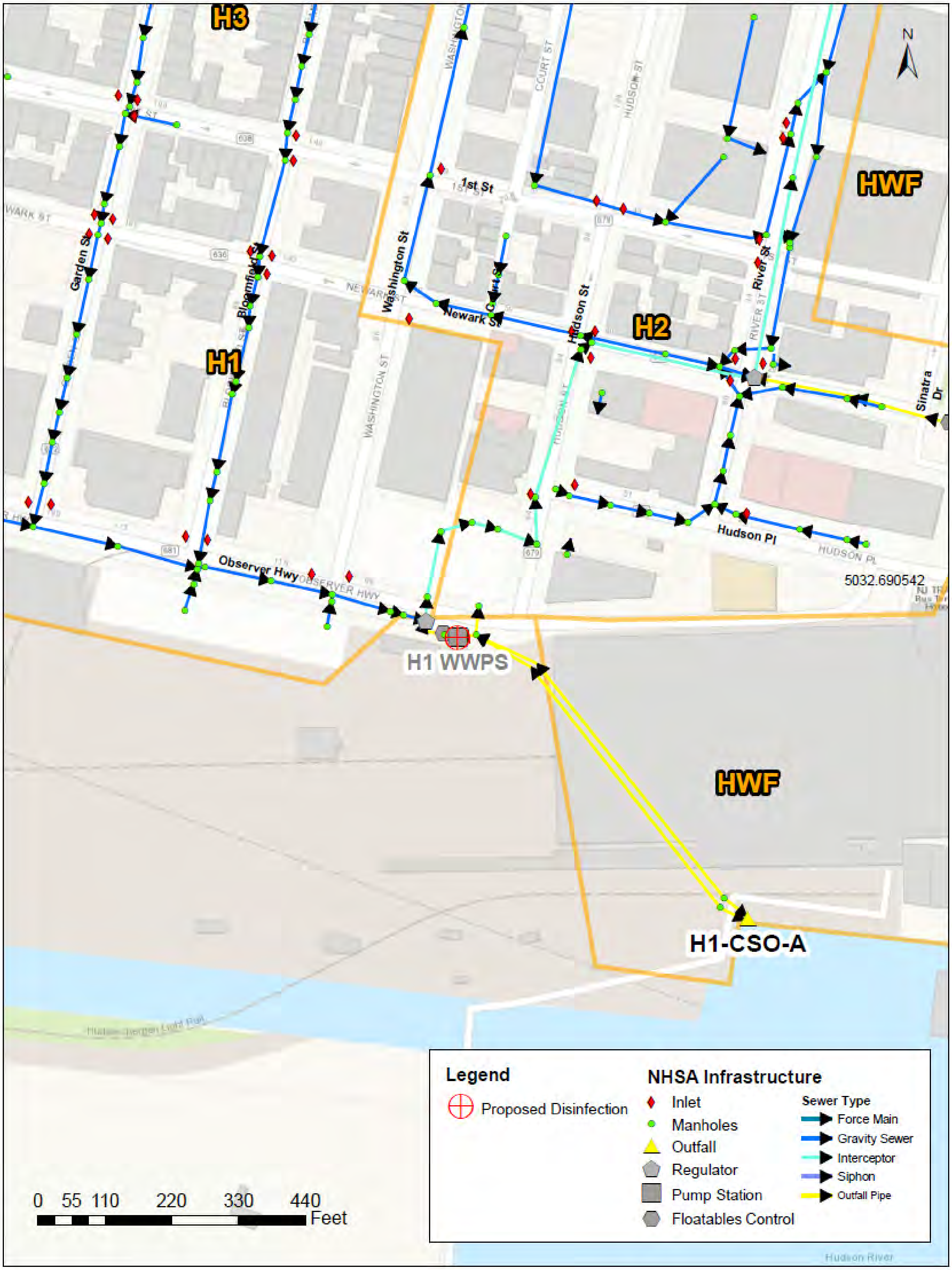
H1 Basin

Disinfect at H1 WWPS

Disinfection is proposed at the existing H1 Wet Weather Pump Station to meet the permit limitations for outfall 002A. Figure 3 shows the proposed location of this alternative. According to the System Characterization Report dated July 1, 2018 for the Adams Street WWTP, Outfall 002A has 34 CSO events and an annual CSO volume of 44 MG in a typical year. The H1 Wet Weather Pump Station has two low head pumps each rated for 50.4 MGD. The largest typical year CSO event is 7.32 MG with a corresponding peak flow rate of 58.28 MGD.

- *Anticipated Constraints and Site Limitations:* Siting the disinfection building and the required contact time are the anticipated constraints for this alternative.
    - Available Space – A 25 ft. x 36 ft. disinfection building would be required. There is very limited space downstream for a second chemical facility if required for dechlorination or neutralization.
    - Land Acquisition - A disinfection facility at this location would require an easement as part of the adjacent parking lot is on NJ Transit property.
    - Rebuild By Design - The Rebuild by Design program currently has plans to construct a floodwall on the south side of Observer Highway that will continue on the east side of Washington Street, stopping before Newark Street. Construction and overall design would need to be considered should construction of a tunnel proceed. Additional information on the Rebuild by Design plans can be found in the final section of this report.
    - Contact Time - The available contact time in the pump station and outfall pipeline would need to be evaluated.
    - Traffic/Public Access - Observer Highway at this location is highly congested and staging construction along this road over an extended period of time may create scheduling issues. This would require the project to be on a strict timeline.
- *Functionality-*
    - Chemical Dose - Available detention times in the pump station wet well and discharge pipe to the outfall would need to be determined.
- *Feasibility*
    - This alternative appears to be feasible provided there is sufficient contact time and the facilities can be sited.

Figure 3 - H1 WWPS Site Plan

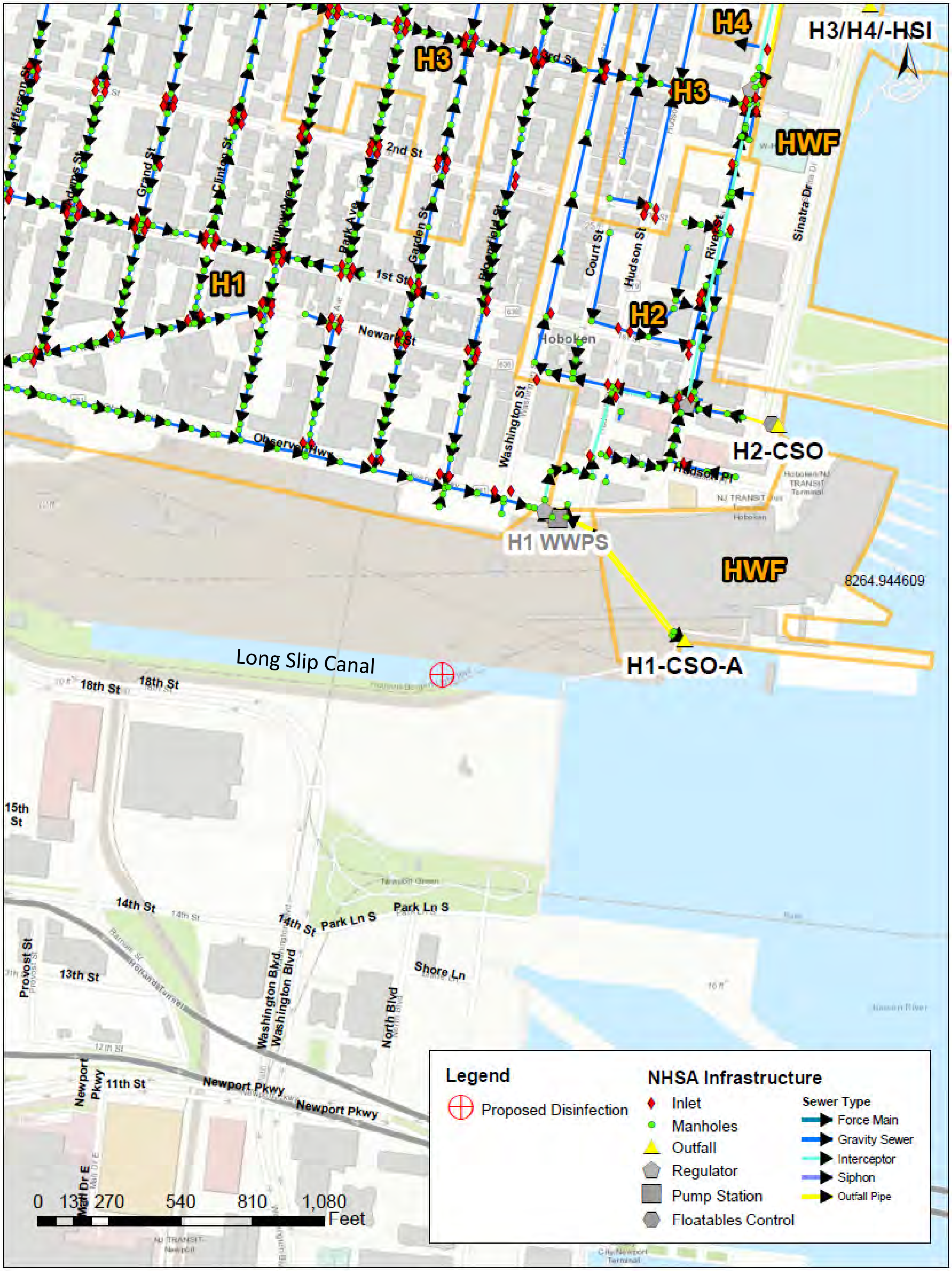


Combine Flows with Jersey City CSO in Long Slip Canal

As part of the NJ Transit Resilience Program, the Long Slip Fill and Rail Enhancement project will allow NJ Transit to operate train service longer and recover more quickly form storm events. The Long Slip canal is a 2000-foot former barge canal adjacent to the Hoboken Terminal. A CSO from Jersey City discharges at the end of this canal. It is proposed to combine this discharge with the discharge from H1 and utilize a contact basin or treatment facility to reach the required level of disinfection for the outfall. The following figure shows the outline of the canal in relation to the H1 outfall.
From the NJ Transit Resilience Program website, the canal will be filled to an elevation above the Federal Emergency Management Agency (FEMA) base flood elevation, and six new tracks will be constructed on the filled area to serve three high-level ADA-accessible boarding platforms. This project will advance as a result of a grant awarded by the Federal Transit Administration (FTA) through the Emergency Relief Program for resiliency projects in response to Superstorm Sandy. It is proposed to construct a disinfection treatment technology atop of a portion of the filled in canal that would allow two large CSO outfalls to be combined.

- Anticipated Constraints and Site Limitations-
    - Available Space-The specific plans for filling in the canal are unknown. Once the plans are finalized, the NJ Tranist Resilience program may have plans that do not allow for an adequate capacity disinfection treatment facility for this site.
    - Transit Coordination-To combine the flows, the existing route of the piping will need to be modified by either extending the Jersey City outfall pipe or routing the H1 piping back to the Jersey City outfall. For the latter choice, construction would be at or near NJ Transit facilities which may limit the available routes of pipes.
- Functionality-
    - Applying disinfection in a contact basin is favorable compared to applying disinfection in a pipeline. With the appropriate system, the approved methods of disinfection by hypochlorite could be an effective alternative.
- Feasibility-
    - Without information on the flows from the Jersey City CSO, it is difficult to determine if this alternative is feasible. Without knowing the current flows, it will not be possible to determine the benefits of implementing this alternative and for this reason, this alternative is not considered feasible for this contract. Should this method be considered in the future, it could show to be an ideal method of disinfection and create an effective method to treat a large amount of flow within permit compliance through collaboration with regional sewerage agencies.

Figure 4 – Long Slip Canal Site Plan



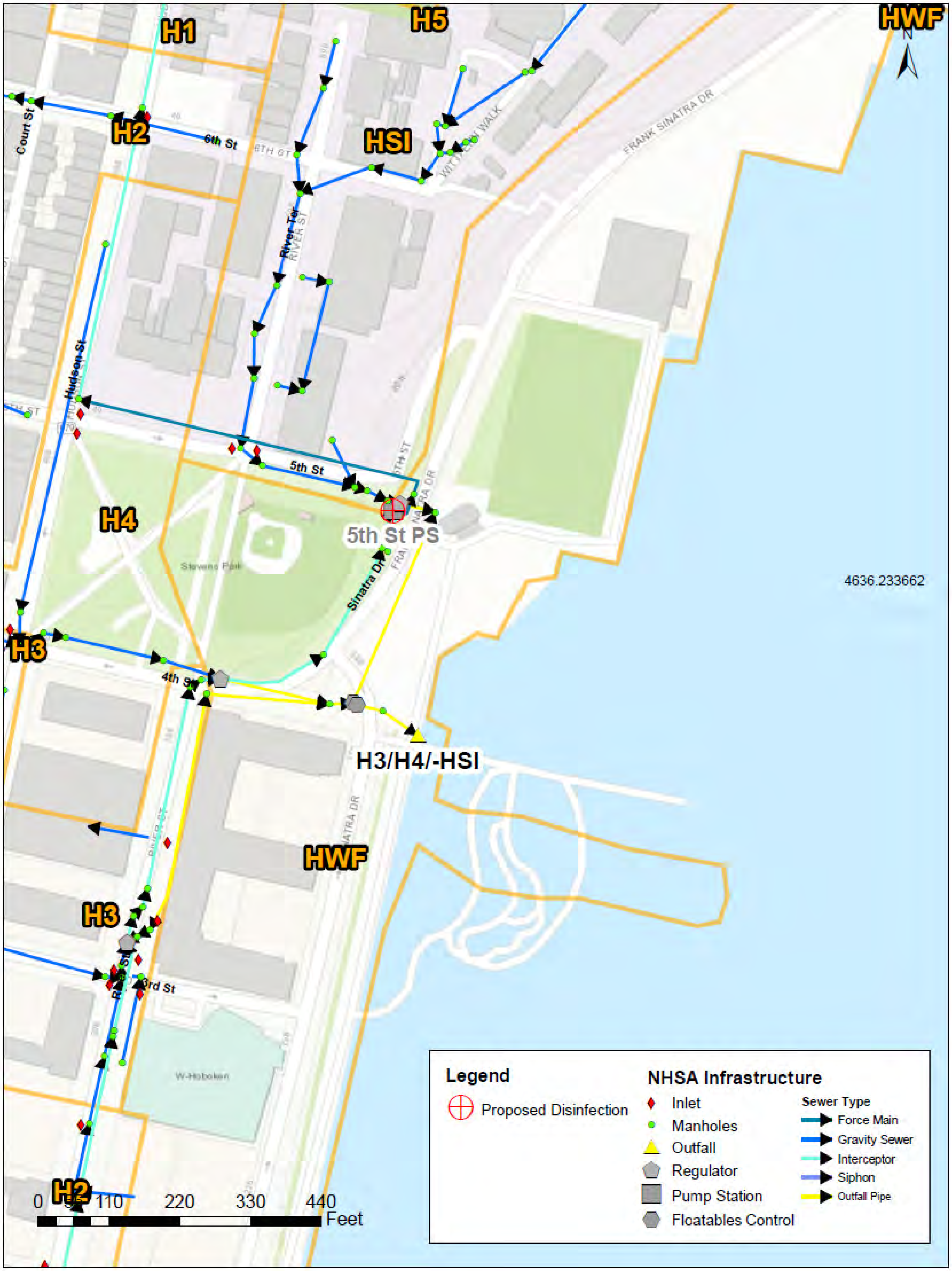
H3/H4/HSI Basin

Chemical Storage and Feed at 5th Street Pump Station and route chemical to H3 CSO

Disinfection is proposed between the existing H3 regulator and the junction with the H4 regulator, or after the two systems combine to meet the permit limitations for outfall 005A. The chemical disinfection storage and feed facility would be located at the 5th Street Pump Station and the disinfectant pumped to the CSO conveyance pipe. Figure 5 shows the proposed location of this alternative. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 005A has 41 CSO events and an annual CSO volume of 65 MG in a typical year from a combination of H3, H4, and HSI regulators. The largest typical year CSO event is slightly under 9 MG (combined H3, H4, and HSI) with a corresponding peak flow rate of slightly less than 55 MGD.

- *Anticipated Constraints and Site Limitations*- Construction impacts on traffic, the required contact time, and the need for a second chemical at the outfall are the anticipated constraints for this alternative:
  - Available Space – A 25 ft. x 36 ft. disinfection building would need to be sited adjacent to the 5th Street Pump Station, however, if there is room for powering the metering pumps and instruments from an existing electrical room then the building size could be reduced.
  - Land Acquisition - There is a small amount of space available to the south of the pump station, however, it would need to be confirmed if this property belongs to the Authority or would need to be acquired.
  - Contact Time - The available contact time in the outfall pipeline and S/F facility would need to be evaluated.
  - Traffic/Public Access - Installing a chemical feed pipeline along Frank Sinatra Drive could be disruptive to traffic and could require the project to be on a strict timeline. Alternatively, it may be possible to route the buried chemical pipe along the perimeter of Steven's Park to minimize traffic disruption.
- *Functionality*:
  - Chemical Dose - Available detention times in the H3 CSO discharge pipe that combines with regulator H4 and runs through the H3/H4/HSI S/F facility to the outfall would need to be determined.
- *Feasibility:*
  - This alternative appears to be feasible provided there is sufficient contact time.

Figure 5 – 5th Street Pump Station Site Plan



Disinfection under Stevens Park

The CSO from the existing H3 regulator would be diverted into an underground contact tank in Steven's Park. The chemicals (disinfection and dechlorinating/neutralizing agent) storage and feed facility could be located adjacent to the 5th Street Pump Station, or if there is space it could be located on the perimeter of Stevens Park adjacent to one of the bordering roads to provide the necessary truck access for chemical unloading. A contact tank would allow the dechlorination or neutralization of PAA if required, to occur in a small partitioned area at the effluent end of the contact tank. If located at the 5th Street Pump Station the chemicals would be pumped through the park to the contact tank. Figure 6 shows the proposed location of the alternative. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 005A has 41 CSO events and an annual CSO volume of 65 MG in a typical year from a combination of H3, H4, and HSI regulators. The largest typical year CSO event is slightly under 9 MG (combined H3, H4, and HSI) with a corresponding peak flow rate of slightly less than 55 MGD.

- *Anticipated Constraints and Site Limitations:*
  - Land Use - Construction would involve excavation and construction of an underground contact tank which would make a portion of the park unavailable for public use during construction. While the contact tank can be below grade and grass planted above it, hatches or manways would need to be provided for access to various components in the tank and the removal of existing mature trees in the area is not favored. Additionally, if the chemical feed facilities were installed at the perimeter of the park, there would be a permanent building consuming a portion of the park which may not be received well by the public.
  - Available Space – A maximum area of 80 ft. x 80 ft. would be required for a contact tank. Additionally, a 25 ft. x 60 ft. disinfection building to house two bulk storage tanks, metering pumps, and electrical and mechanical rooms would need to be sited adjacent to the 5th Street Pump Station or in the park adjacent to one of the roads for chemical unloading, however, if there is room for powering the metering pumps and instruments from an existing electrical room then the building size could be reduced. Additionally, the length of the building could be reduced somewhat if using a smaller tank or totes for the dechlorination/neutralization chemical.
  - Traffic/Public Access - Most of the pipe routing would be across the park. This would have less public impact than alternatives involving pipe routing following a road.
- *Functionality:*
  - Chemical Dose and Contact Tank Sizing - Peak 15 minute flow volume for the design storm would be required to determine the required contact volume. A 15 minute detention time at peak CSO flow would require 500,000 gallon contact tank. For a maximum 80 ft. x 80 ft. contact tank, a water depth of 10 ft would be required. Increasing the depth of the water would ultimately minimize the footprint of the tank.
- *Feasibility:*
  - The inclusion of a contact tank makes this alternative a proven approach to disinfection. It also eliminates the need for a remote dechlorination/neutralization chemical storage and feed facility near the end of the outfall. However, due to the existing mature trees in the area and the potential for roots to interfere with the disinfection facilities, this alternative is not considered feasible.

Figure 6 – Stevens Park Site Plan

H5 Basin

Incorporate Disinfection with Structure In Water

Disinfection is proposed by constructing a pier with a disinfection chamber below to meet the permit limitations for outfall 006A. The pier is expected to be located at a slightly different location to the existing Outfall 006A to facilitate the addition of a pier which would require the relocation of the outfall discharge point. Figure 7 shows the location of this proposed alternative. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 006A has 11 CSO events and an annual CSO volume of 9.5 MG in a typical year. The largest typical year CSO event is about 1.75 MG with a corresponding peak flow rate of about 67 MGD.

- *Anticipated Constraints and Site Limitations:* The spatial requirements for a contact basin and getting approval to build into the water are the primary anticipated constraints for this alternative.
  - Construction in Navigable Waters - As this alternative would be located in the river approvals by more than one governmental agency would be required.
  - Water Classification - The river near this discharge point is classified as a Category 1 water due to the kayak launch near the outfall which will likely create construction limitations in the area and increased coordination with the city and other agencies.
  - Available Space and Land Use – A maximum 6,400 sq-ft pier could be required for a maximum contact tank that has a maximum area of 80 ft. x 80 ft with a 10 ft. water depth that is located below the pier. Increasing the depth of the water would ultimately minimize the footprint of the tank. A 25 ft. x 54 ft. disinfection building would need to be sited on the pier or adjacent shoreline. While there is open space near the shoreline, the existing kayak launch may limit total available open space. The length and width of the building could be reduced if using totes., in lieu of storage tanks.
  - Conveyance - This alternative would require an updated alignment from the outfall that is currently located north of Maxwell Place and re-routing the outfall under the park would likely have significant setback that may not be well received by the public.
- *Functionality:*
  - Chemical Dose and Contact Tank Sizing - Peak 15 minute flow volume for the design storm would be required to determine the required contact volume. A 15 minute detention time at peak CSO flow would require 500,000 gallon contact tank. For a maximum 80 ft. x 80 ft. contact tank, a water depth of 10 ft would be required. Increasing the depth of the water would ultimately minimize the footprint of the tank.
  - Chemical Storage and Feed - The annual volume to be treated is small enough that either a small tank sized for partial loads or totes could be used. While this will increase unit cost compared to a bulk delivery, smaller delivered volumes are preferred at the anticipated consumption rates. While this is true for either PAA or sodium hypochlorite, the benefit of storing smaller volumes is especially relevant to sodium hypochlorite given degradation. The required dosing of sodium bisulfite for dechlorination or neutralization of PAA if required could be achieved with a small tank or totes as well.

- *Feasibility:*
  - The inclusion of a contact tank makes this alternative a proven approach to disinfection. It also eliminates the need for a remote dechlorination/neutralization chemical storage and feed facility at the outfall. Adequate space in the river and approval from governing agencies are the primary concerns with the feasibility of this alternative. A smaller building would be required on the pier or adjacent shoreline for dechlorination or PAA neutralization if required. The feasibility of this alternative depends on the acceptability of building a facility of this size in the river.

Figure 7 – H5 In Water Site Plan

Disinfect at H5 regulator adjacent to 11th Street Pump Station

Disinfection is proposed at the existing H5 regulator which is adjacent to the 11th Street Pump Station to meet the permit limits at outfall 006A. Figure 8 shows the location of this proposed alternative. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 006A has 11 CSO events and an annual CSO volume of 9.5 MG in a typical year. The H5 Wet Weather Pump Station has a capacity of 80 MGD with both 40 MGD pumps in service. The largest typical year CSO event is about 1.75 MG with a corresponding peak flow rate of about 67 MGD.

- *Anticipated Constraints and Site Limitations:* Construction impacts on traffic, being able to position the disinfection building in the median, the required contact time, and the need for a second chemical at the outfall are the anticipated constraints for this alternative.
    - Available Space - A 25 ft. x 36 ft. disinfection building that would be required can be located in the center median of 11th Street adjacent to the 11th Street Pump Station. If there is room for powering the metering pumps and instruments from an existing electrical room then the building size could be reduced. The length and width of the building could also be reduced by using totes.
    - Land Acquisition - A disinfection facility at this location would require acquisition or approvals from the City of Hoboken.
    - Contact Time - The available contact time in the pump station wet well and outfall pipeline would need to be evaluated. If the achievable contact time is insufficient this may be the limiting factor in this alternative.
- *Functionality*:
    - Chemical Dose - Available detention times in the H5 Wet Weather Pump Station and outfall pipe would need to be determined.
    - Chemical Storage and Feed - The annual volumes to be treated are small enough that either a small tank sized for partial loads or totes could be used. While this will increase unit cost compared to a bulk delivery, smaller delivered volumes are preferred at the anticipated consumption rates. While this is true for either PAA or sodium hypochlorite, the benefit of storing smaller volumes is especially relevant to sodium hypochlorite given degradation.
- *Feasibility:*
    - This alternative appears to be feasible provided there is sufficient contact time.

Figure 8 – H5 Regulator Site Plan

W1234 Basin

Disinfect at W1234 Outfall Manholes on Waterfront Terrace

Disinfection is proposed at the manholes on both the existing and new W1234 outfalls on Waterfront Terrace. Figure 9 shows the proposed dosing point. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 013A has 58 CSO events and an annual CSO volume of 219 MG in a typical year. The largest typical year CSO event is 25 MG with a corresponding peak flow rate of about 263 MGD.

- *Anticipated Constraints and Site Limitations:* Land acquisition and the required contact time are the anticipated constraints for this alternative.
    - Available Space and Land Use - A 25 ft. x 86 ft. disinfection building would be required and can be located at an adjacent parking lot and this would be a challenge. Given the proximity to the outfall, a common chemical storage feed facility is assumed.
    - Land Acquisition - Land acquisition would be required from the owner of the parking lot where the disinfection facilities are proposed.
    - Construction - Traffic on Riverview Drive may be affected if it is necessary to route chemical piping underneath it. Traffic on Waterfront Terrace will only be affected if the injection point is in or very close to the road.
    - Contact Time - The available contact time in the outfall pipeline would need to be evaluated. If the achievable contact time is insufficient this may be the limiting factor in this alternative.
- *Functionality*:
    - Chemical Dose - Available detention times in the discharge pipe to the outfall would need to be determined.
    - Chemical Storage and Feed- The annual volumes to be treated and the design storm events are sufficiently large to assume two 6000 gallon bulk storage tanks for screening purposes. A single tank may be possible with PAA since it does not degrade but testing would be required to determine the required dose. The outfall is close enough that the dechlorinating or neutralizing chemical storage and feed would also be assumed to be in the same building.
- *Feasibility:*
    - There appears to be available space within the nearby parking lot to site a common chemical and storage building, however acquiring this land would be a challenge. This alternative appears to be feasible if there is adequate contact time for disinfection.

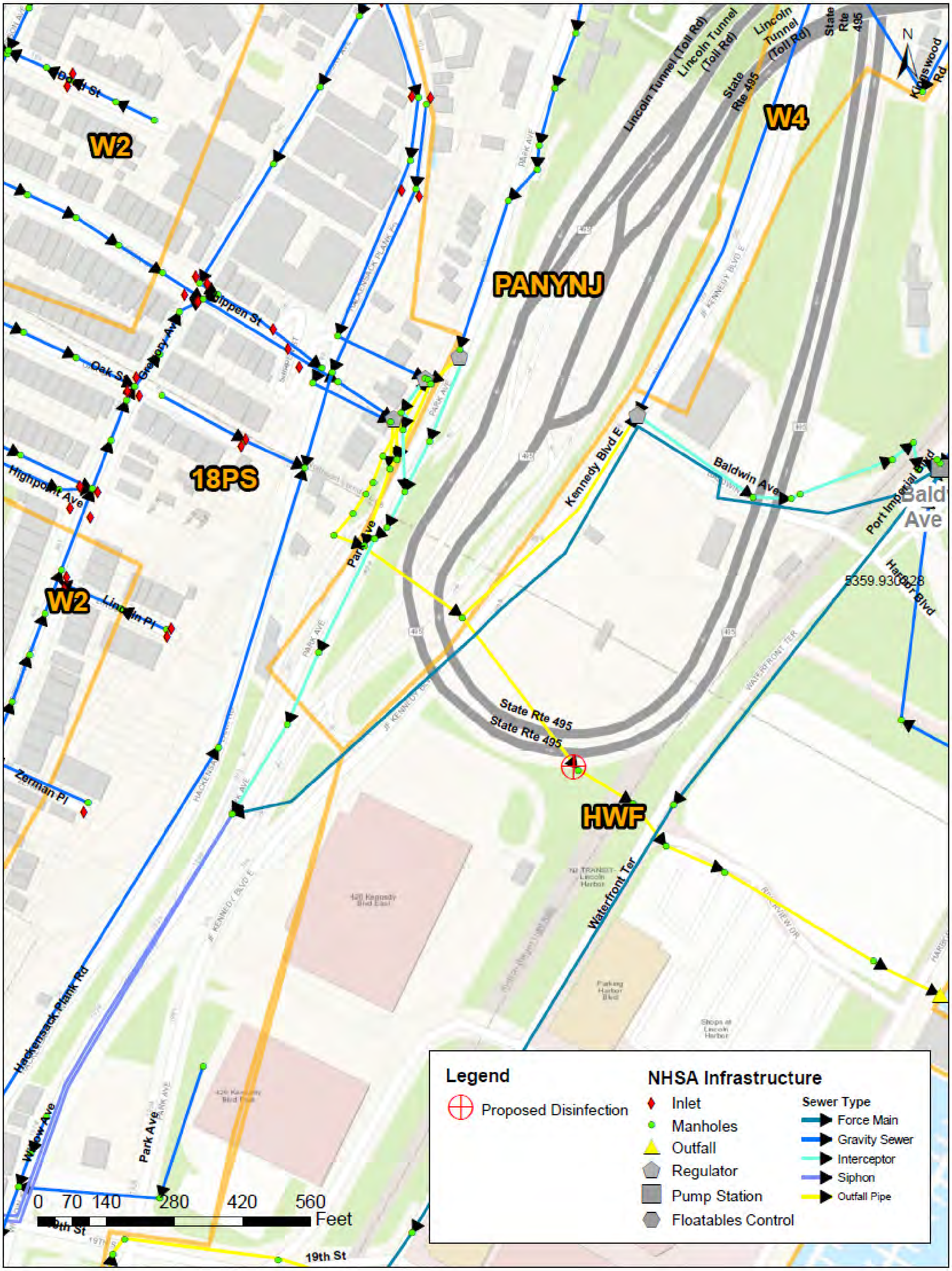
Figure 9 – W1234 Outfall Manholes Site Plan

Disinfect at Junction Structure under the Lincoln Tunnel Helix

Disinfection is proposed at the junction structure under the Lincoln Tunnel Helix in the existing New Jersey Transit bus parking lot. Figure 10 shows the approximate location of the dosing point. This alternative is very similar to applying disinfection at the W1234 outfall manholes on Waterfront Terrace except the proposed siting of the disinfection building would be approximately 225 feet northwest on the other side of Waterfront Terrace and the light rail line. Only the differences from disinfecting at the W1234 outfall manholes are noted below.

- *Anticipated Constraints and Site Limitations:*
  - Available Space and Land Use - A 25 ft. x 61 ft. disinfection building would be required.
  - Agency Coordination - The dosing point for this alternative is adjacent to the west border of the NJ Transit Bus parking lot, under the Lincoln Tunnel helix, and adjacent to the light rail train tracks. Design and construction near the facilities may be met with numerous challenges related to flexibility of the alignment, position of the alternative, and coordination with NJ Transit and the Port Authority of New York New Jersey (Port Authority).
  - Land Acquisition – An easement would be required with the Port Authority to obtain the land necessary to house the proposed facilities.
  - Existing Utilities - The presence of utilities in this area would need to be verified to ensure there are no interferences that would prevent siting at this location.
- *Functionality:*
  - Dosing further upstream could be advantageous if it is determined that there is inadequate contact time in the conveyance pipe for disinfection downstream at the outfall junction box. However, the light rail and road crossing could favor a separate building at the outfall for dechlorination/neutralization if that is required.
- *Feasibility:*
  - This alternative appears to be feasible if there is adequate contact time for disinfection.

Figure 10 – W1234 Junction Structure Site Plan



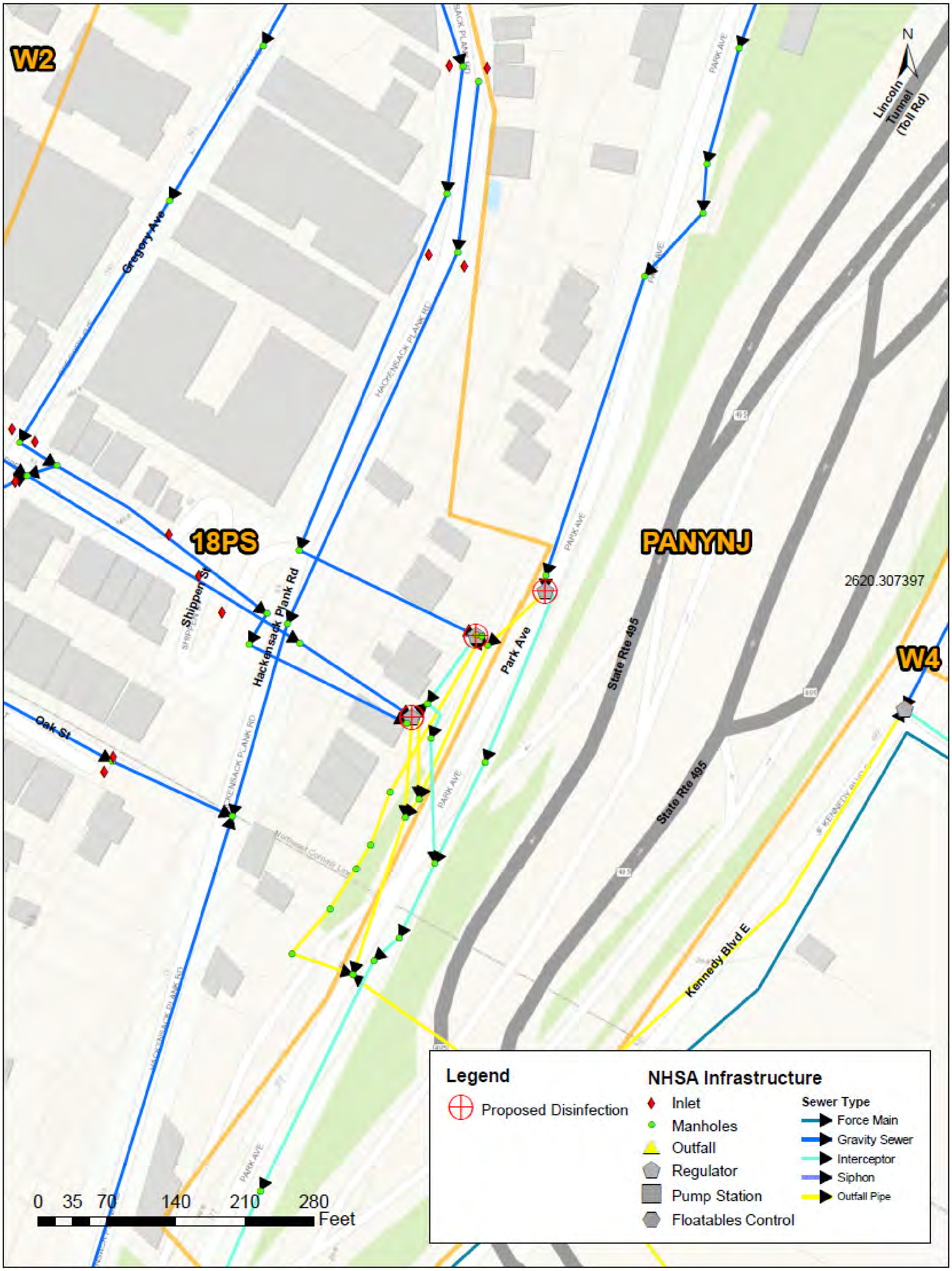
Disinfect at One of the W1234 Regulators on Park Avenue

Disinfection is proposed at one of the regulators along Park Avenue within the W1234 drainage area. Currently there are 3 regulators in close proximity to each other. Figure 11 shows the locations of these regulators and the approximate dosing point(s). This alternative is similar to applying disinfection at the 2 other W1234 options except the proposed siting of the disinfection building would be approximately 860 feet northwest of the junction structure under the Lincoln Tunnel helix if located along the west side of Park Avenue.

- *Anticipated Constraints and Site Limitations:*
  - Available Space - There is an undeveloped lot located 170 feet downstream of the regulators but near the outfall pipe on Park Avenue, however, building a 25 ft. x 61 ft. disinfection building on the west side of Park Avenue in this residential strip is not desirable. Alternatively, there is a narrow strip of forested land on the east side of Park Avenue at the southwest corner of the Highway 495 horseshoe bend, which appears to have enough room for the building with 10 foot setbacks from the bordering roads. This location is on an embankment which would complicate construction and the proximity to the roads would be disruptive to traffic during construction. Additionally, chemical unloading would obstruct one lane of Park Avenue.
  - Terrain - The west side of Park Avenue where W1, W2, and W3 regulators are located is dense residential units on a steep hillside. The only undeveloped space on the west side in the immediate vicinity of the regulators appears to be behind the SSG John D. Linde Fallen Soldiers Memorial which is a steep hillside. Chemical unloading at this location would need to be through a parking lot and would require a wider entrance gate.
  - Construction - Park Avenue is a main artery connecting Weehawken to Hoboken. Construction in this area would need to be on a strict timeline most likely conducted in phases to disrupt local traffic.
- *Functionality:*
  - This alternative involving dosing further upstream could be advantageous if it is determined that there is inadequate contact time in the conveyance pipe for applying disinfection at the helix structure or outfall junction box.

    Should there be a wet weather event resulting in a CSO from regulator W4 but not concurrently from one of the regulators W1, W2, or W3 then this alternative would not disinfect a CSO from W4 as the W4 regulator connection to the outfall is downstream of the potential chemical feed and storage facilities and injection points for this alternative.
- *Feasibility:*
  - Due to the undesirable terrain to construct the disinfection facilities, this alternative is not considered feasible.

Figure 11 – W1234 Regulators Site Plan



Disinfect at W1234 S/F Facility

Disinfection is proposed in the Solids/Floatables Screening Facility on the Hudson River that is currently under construction. The Solids/Floatables screening at this location will be accomplished with nets. Figure 12 shows the proposed dosing point. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 013A has 58 CSO events and an annual CSO volume of 219 MG in a typical year. The largest typical year CSO event is 25 MG with a corresponding peak flow rate of about 263 MGD.

- *Anticipated Constraints and Site Limitations:* The required contact time is the driving force for this alternative. Space for chemical storage is also too large to be located on the public access pier above the screening facility and would need to be located on shore.
  - Contact Time - A minimum acceptable contact time of 5 minutes is assumed to be required for adequate disinfection. At the design peak flow rate this would require a volume of 913,200 gallons. The volume in the netting facility is roughly estimated to be less than 90,000 gallons. Therefore, there would not be sufficient contact time in the facility.
  - Available Space and Land Use - A 25 ft. x 86 ft. disinfection building would be required and there does not appear to be room for this on the public access pier above the screening facility which would require locating the building on land.
  - Construction- Traffic on Riverview Drive may be affected if it is necessary to route chemical piping underneath the street. Traffic on Waterfront Terrace will only be affected if the injection point is in or very close to the road.
- *Functionality*:
  - Chemical Dose – A higher dose would not be expected to be effective to compensate for the lack of 5 minutes detention time.
  - Chemical Storage and Feed- The annual volumes to be treated and the design storm events are sufficiently large to assume two 6000 gallon bulk storage tanks for screening purposes. A single tank may be possible with PAA since it does not degrade but testing would be required to determine the required dose.
- *Feasibility:*
  - There is inadequate detention time in the screening facility for this alternative to be feasible and there is inadequate space for the disinfection building on the pier and siting the building in the parking lot across the street may be a challenge. Additionally, there are also potential corrosive impacts of hypochlorite in the S/F facility. Therefore, this alternative is not considered feasible.

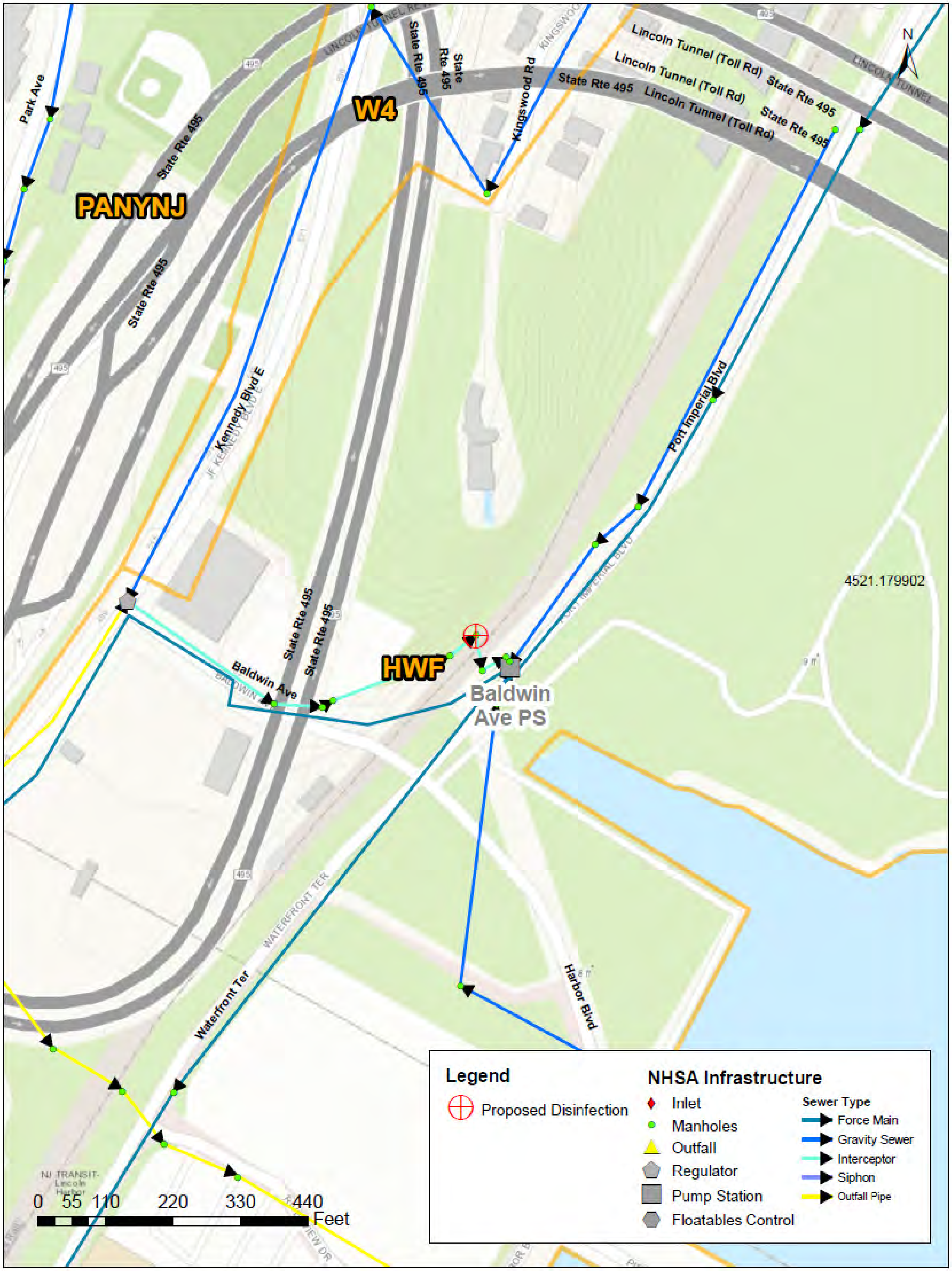
Figure 12 – W1234 Solids/Floatables Facility Site Plan

Install a chlorine contact tank at the bottom of the Palisades

A chlorine contact tank is proposed for the W1234 outfall at the bottom of the Palisades. Figure 13 shows the proposed dosing point. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 013A has 58 CSO events and an annual CSO volume of 219 MG in a typical year. The largest typical year CSO event is 25 MG with a corresponding peak flow rate of about 263 MGD

- *Anticipated Constraints and Site Limitations:*
  - Available Space - At the bottom of the Palisades there is limited space for a disinfection facility due to the active parking lot adjacent to the light rail tracks.
  - Contact Time - A minimum acceptable contact time of 5 minutes is assumed to be required for adequate disinfection. At the design peak flow rate this would require a volume of 913,200 gallons. The approximate area of the open space at the bottom of the Palisades is 10,000 square feet which would require a contact basin with a depth of approximately 12 feet.
  - Agency Coordination - The dosing point for the alternative is adjacent to the Hudson Bergen Light Rail and within the Port Authority parking lot. Construction to reach the outfall pipe to effectively provide disinfection would not be ideal. Design and construction near the facilities may be met with numerous challenges related to flexibility of the alignment and position of this alternative.
- *Functionality:*
  - An existing interceptor owned by the Authority crosses the parking lot sited for this alternative which may aid in acquiring additional easements. However, a connection from the interceptor would then be required to the outfall pipe which would cross the Hudson Bergen Light Rail overpass.
- *Feasibility:*
  - A contact tank is favorable to disinfection within a pipeline. However, due to the limited space to construct a contact tank that will provide adequate contact time and required construction to route this flow to the outfall, this alternative is not considered feasible.

Figure 13-Proposed Dosing Point, Palisades



18th Street Basin

Disinfect at 18th Street Pump Station

Disinfection is proposed at the 18th Street pump station to meet the permit limits of Outfall 012A. Figure 14 shows the approximate location of the dosing point. The wet weather side of the pump station has two pumps each rated for 47.5 MGD. The largest typical year CSO event is 1 MG with a corresponding peak flow rate of about 52 MGD and an annual CSO volume of 3.6 MG.

- *Anticipated Constraints and Site Limitations:*
  - Available Space - There is limited space available for a 12 ft. x 25 ft. disinfection building adjacent to the 18th Street Pump Station. If the electrical equipment can be housed in an existing electrical room then the building size can be reduced. Dechlorination would require additional space downstream of the dosing point near the outfall which appears to be available but may require multiple approvals.
  - Contact Time - The available contact time in the pump station wet well and outfall pipeline would need to be evaluated. If the achievable contact time is insufficient this may be the limiting factor in this alternative.
- Functionality and Feasibility:
  - Chemical Dose – Available detention times in the pump station wet well and discharge pipe to the outfall would need to be determined.
  - Chemical Storage and Feed - The annual volumes to be treated are small enough that either a small tank sized for partial loads or totes could be used. While this will increase unit cost compared to a bulk delivery, smaller delivered volumes are preferred at the anticipated consumption rates. While this is true for either PAA or sodium hypochlorite, the benefit of storing smaller volumes is especially relevant to sodium hypochlorite given degradation.
  - This alternative appears to be feasible provided there is sufficient contact time and the facilities can be sited.

Figure 14 – 18th Street Pump Station Site Plan


W2
18PS
HWF
H7
18th St PS
W 19th St
Hackensack Plank Rd
St Lawrence Street Pl
Clinton St
18th St
Willow Ave
19th St
Park Ave
Harbor Blvd
3069.96996
N
Legend
Proposed Disinfection
NHSA Infrastructure
Inlet
Manholes
Outfall
Regulator
Pump Station
Floatables Control
Sewer Type
Force Main
Gravity Sewer
Interceptor
Siphon
Outfall Pipe
0 40 80 160 240 320
Feet

W5 Basin

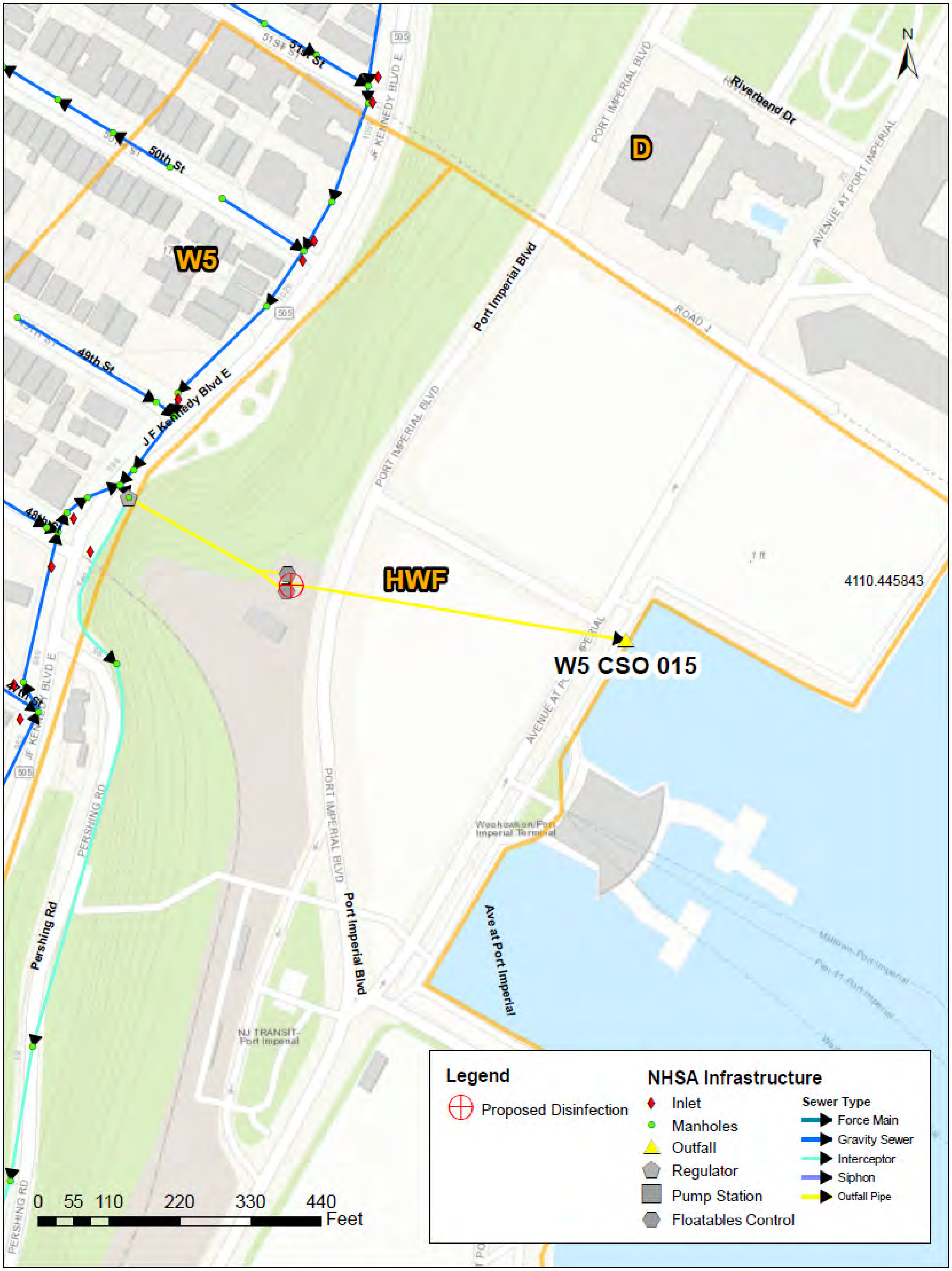
Disinfection at the W5 S/F vortex facility

Disinfection is proposed at the existing vortex facility to meet the permit limitations for outfall 015A. Figure 15 shows the location of the proposed alternative. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 015A has 40 CSO events and an annual CSO volume of 24 MG in a typical year. The largest typical year CSO event is under 3.1 MG with a corresponding peak flow rate of about 54 MGD.

- *Anticipated Constraints and Site Limitations:* The required contact time is the primary anticipated constraint for this alternative.
  - Available Space - A 25 ft. x 54 ft. disinfection building north of the W5 S/F Vortex Facility would be required. The length and width of the building could be reduced if using totes in lieu of storage tanks.
  - Land Acquisition - There is a space available to the north of the W5 S/F Vortex Facility, however, it would need to be confirmed if this property belongs to the Authority or would need to be acquired.
  - Contact Time - The available contact time in the S/F facility and outfall would need to be verified.
  - Traffic/Public Access - Obstruction of traffic would be expected to be limited to construction vehicles and equipment entering and leaving the site.
- *Functionality*:
  - Chemical Dose - Available detention times in the vortex facility and discharge pipe to the outfall would need to be determined.
  - Chemical Storage and Feed - The annual volumes to be treated are small enough that either a small tank sized for partial loads or totes could be used. While this will increase unit cost compared to a bulk delivery, smaller delivered volumes are preferred at the anticipated consumption rates. While this is true for either PAA or sodium hypochlorite, the benefit of storing smaller volumes is especially relevant to sodium hypochlorite given degradation. The required dosing of sodium bisulfite for dechlorination or neutralization of PAA if required could be achieved with a small tank or totes as well.

    The dechlorination/neutralization chemical could be stored in the same facility and piping routed the approximate 500 feet to the outfall or it could be separately located adjacent to the outfall. A small tank or totes would be appropriate for it as well.
- *Feasibility:*
  - This alternative appears to be feasible provided there is sufficient contact time and the facilities can be sited.

Figure 15 – W5 S/F Vortex Facility Site Plan



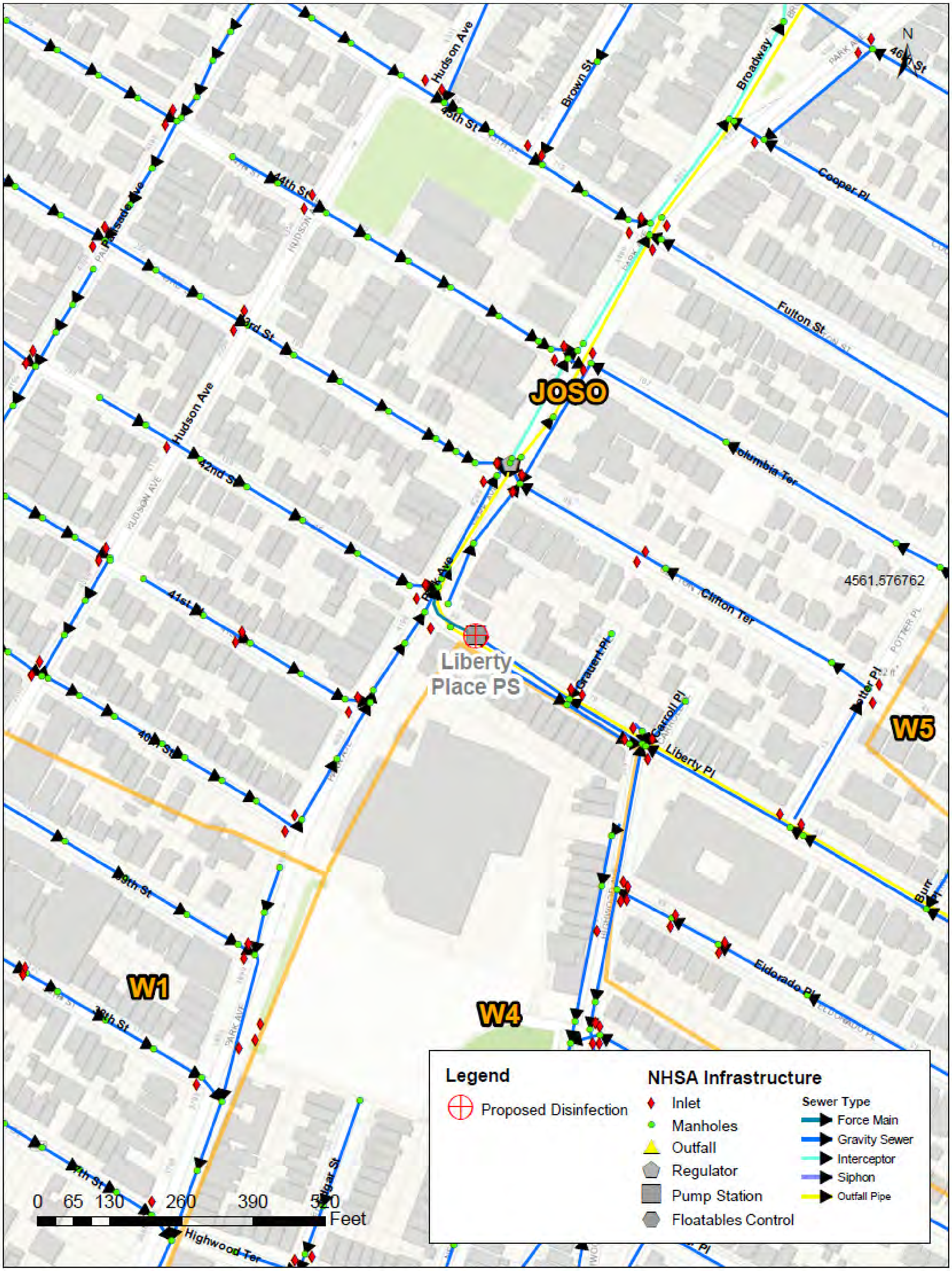
JOSO

Disinfect at the Liberty Place Pump Station

Disinfection is proposed at the Liberty Place pump station for the JOSO drainage area. Figure 16 shows the proposed dosing point. According to the System Characterization Report for the River Road WWTP dated July 1, 2018, Outfall 003A has 61 CSO events and an annual CSO volume of 95.2 MG in a typical year. The largest typical year CSO event is 10.8 MG with a corresponding peak flow rate of 142.5 MGD.

- *Anticipated Constraints and Site Limitations:* Construction staging at the corner parking lot adjacent to the pump station, the required contact time, and the need for a second chemical at the outfall are the anticipated constraints for this alternative.
    - Available Space - A 25 ft. x 36 ft. disinfection building would need to be sited adjacent to the pump station. There appears to be adequate space for the building behind 4204 Park Avenue although a longer narrower building layout appears to be required. Access to the building for construction and chemical unloading would be from Liberty Place via the parking lot behind the building at the northeast corner of Park Avenue and Liberty Place intersection. This would interfere with use of this parking lot during construction. Alternatively, the disinfection building could be located in this parking lot if the necessary portion of this parking lot is not needed by the corner building. Additionally, available space would need to be verified for a second chemical addition at or near the outfall to dechlorinate, or neutralize an alternative disinfectant such as PAA, if the residual will be greater than the allowable permit limit.
    - Land Acquisition - Property acquisition would be required for this.
    - Contact Time - The available contact time in the outfall and screening facility would need to be evaluated. If the achievable contact time is insufficient this may be the limiting factor in this alternative.
    - Traffic/Public Access- Construction staging would need to occur in the corner parking lot. This would limit obstruction of traffic to construction vehicles and equipment entering and leaving the site. Chemical unloading may need to be scheduled during non-business hours to not interfere with public use of the parking lot.
- *Functionality*:
    - Chemical Dose - Available detention times in the discharge pipe to the outfall and JOSO screening facility would need to be determined.
- *Feasibility:*
    - This alternative appears to be feasible provided there is sufficient contact time and the facilities can be sited.

Figure 16 – Liberty Place Pump Station Site Plan

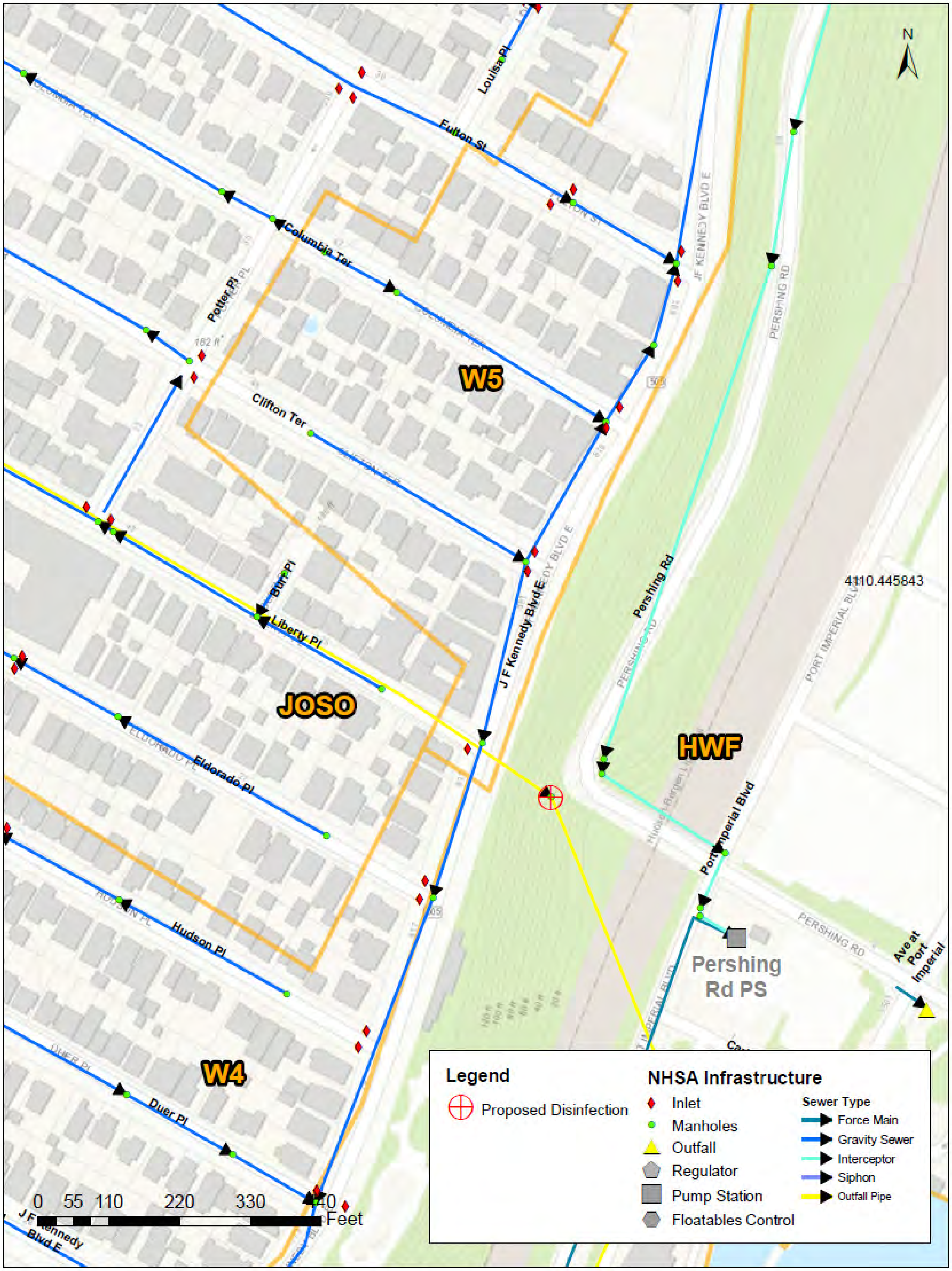


Disinfection at JOSO drop shaft

Disinfection is proposed at the JOSO drop shaft for the JOSO drainage area. Figure 17 shows the location of the proposed dosing point. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, Outfall 003A has 61 CSO events and an annual CSO volume of 95.2 MG in a typical year. The largest typical year CSO event is 10.8 MG with a corresponding peak flow rate of 142.5 MGD.

- *Anticipated Constraints and Site Limitations:* Siting and constructing a building on a constrained site, the required contact time, and the need for a second chemical at the outfall are the anticipated constraints for this alternative.
    - Available Space - A 25 ft. x 36 ft. disinfection building would need to be sited near the drop shaft. The drop shaft exists because of the major elevation change from Liberty Street down to Pershing Road and Port Imperial Boulevard. There does not appear to be any available land to site the facility at the top of the shaft. Therefore, it would be necessary to site the building at the bottom of the shaft. The chemical could be injected at a turbulent point near the bottom of the shaft near the bend in Pershing Road. The closest available land on a flat surface is over 300 feet to the east and would require pipe crossings under light rail train tracks and Port Imperial Boulevard.
      Field inspection would be required to determine if there is sufficient buildable area in the heavily forested area at base of the hillside near the bottom of the drop shaft. Suitable access would be required from Pershing Road near the Liberty steps for construction equipment and for chemical delivery.
    - Contact Time - The available contact time in the outfall pipeline from the JOSO drop shaft would need to be verified.
    - Traffic/Public Access - Construction could impede traffic on Pershing Road. Chemical unloading could also impede traffic on Pershing Road unless there is adequate area for the delivery truck to pull off the road during unloading.
- *Functionality*:
    - Chemical Dose - Available detention times in the discharge pipe to the outfall would need to be determined.
- *Feasibility:*
    - This alternative is not considered feasible due to the possible construction beneath train tracks and minimal space for the disinfection facility.

Figure 17 – JOSO Drop Shaft Site Plan



WNY1 Basin

Disinfect at the WNY1 S/F Facility

Disinfection is proposed at the existing WNY1 solids/floatables facility. Figure 18 shows the location of the proposed dosing point. According to the System Characterization Report for the Adams Street WWTP dated July 1, 2018, WNY1 with Outfall 002A has 60 CSO events and an annual CSO volume of 190.4 MG in a typical year. The largest typical year CSO event is 20.3 MG with a corresponding peak flow rate of 194 MGD.

- *Anticipated Constraints and Site Limitations:* Construction staging adjacent to Anthony M Defino Way and the WNY1 Screening facility, the required contact time, and the need for a second chemical at the outfall are the anticipated constraints for this alternative.
    - Available Space - A nominal 25 ft. x 61 ft. disinfection building with 2 bulk storage tanks would need to be sited adjacent to the screening facility.
        - The screening facility is located against a rock cliff. A significant amount of rock blasting would be required to widen the available area to the south of the screening facility. A lesser amount of rock blasting would be required if a single bulk tank were determined to be sufficient.

      A 25 ft. x 61 ft. disinfection building would not fit to the north of the existing screening facility. However, if the parking lot area could be used, it appears that there is just enough room for a single bulk tank facility without blocking the service roads.
    - Contact Time - The available contact time in the outfall pipeline and screening facility would need to be evaluated.
    - Traffic/Public Access - Construction staging could require a lane closure on Anthony M Defino Way. The project may cause similar traffic constraints to those experienced during the construction of the WNY1 screening facility although the screening facility limits of road access to the north thereby requiring all construction equipment to access the site from the road. Chemical unloading could require lane closure although this would only be required a few times per year.
- *Functionality*:
    - Chemical Dose - Available detention times in the discharge pipe to the outfall and WNY1 screening facility would need to be determined.
    - Chemical Storage and Feed - The annual volumes to be treated and the design storm events are sufficiently large to assume two nominal 6000 gallon bulk storage tanks for screening purposes. A single tank may be possible with PAA since it does not degrade but testing would be required to determine the required dose.
- *Feasibility:*
    - Due to the proximity to the WWTP and the distance from residential areas, this alternative is considered feasible.

Figure 18 – WNY1 S/F Facility Site Plan

Summary

In Summary, Table 2 below identifies the final list of alternatives that will undergo the full evaluation process to simulate the conditions as they are expected to exist after construction and operation of the alternative.   Those identified alternatives will also have a Class 5 conceptual cost estimate developed to provide ithe overall cost benefits for the anticipated amount of CSO control.

Table 2 - Preliminary Screening Alternatives Summary

Service Area	**Alternative**	**Proceed to full evaluation?**
H1	Disinfect at H1 WWPS	Yes
	Combine flows with Jersey City CSO in Long Slip Canal	Not for this contract
H3/H4/HSI	Chemical Storage and Feed at 5th Street Pump Station and route chemical to H3 CSO	Yes
	Disinfection under Stevens Park	Not for this contract
H5	Incorporate disinfection with structure in water	Yes
	Disinfect at H5 regulator adjacent to 11th Street PS	Yes
W1234	Disinfect at W1234 Outfall Manholes on Waterfront Terrace	Yes
	Disinfect at Junction Structure under the Lincoln Tunnel Helix	Yes
	Disinfect at one of the W1234 regulators on Park Avenue	Not for this contract
	Disinfect at W1234 S/F facility	Not for this contract
	Install chlorine contact tank at the bottom of the Palisades	Not for this contract
18th Street	Disinfect at 18th Street Pump Station	Yes
W5	Disinfect at at W5 S/F vortex facility	Yes
JOSO	Disinfect at Liberty Place Pump Station	Yes
	Disinfect at JOSO drop shaft	Not for this contract
WNY1	Disinfect at WNY1 S/F facility	Yes

Attachment 1

Evaluation Criteria

Table 1- Evaluation Criteria Summary

Category	Criteria	1	2	3	4
CSO Reduction	Bacteria Reduction	Alternative does not eliminate or reduce bacteria discharges of effluent	-	Alternative results in reduction of bacteria discharges of effluent	Alternative eliminates bacteria discharges of effluent
	Water Quality Benefits	Will not meet water quality standards in the Hudson River	-	Will meet water quality standards in the Hudson River with help of another alternative	Will meet water quality standards in the Hudson River standing alone
	Support designated uses in Hudson River (Secondary contact recreation and fishing)	Will not attribute to improved water quality to support designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of the Hudson River	Will attribute to improved water quality to support partial designated uses of Hudson River with help of another alternative	Will support all designated uses of the Hudson River standing alone
Feasibility	Availability of validation on main technology for the alternative	Scientific basis largely unproven/untested	Limited data provided, but technology claims cannot be corroborated using conventional scientific/engineering principles	Significant data to corroborate technology claims available but lacks consensus of the scientific community	Uses well known and accepted scientific principles or the Authority already uses technology with success
	Flexibility of alternative to be adjusted or optimized with future changing flows	Alternative cannot be adjusted after initial implementation	Alternative can be adjusted with significant additional construction/cost in conjunction with adjustment to related alternative	Alternative can be adjusted with significant additional construction/cost	Alternative can be altered without significant additional construction/cost
	Flexibility of the alternative to provide effective treatment under variety of operating conditions.	Need for supplemental steps in the treatment process – compatibility with disinfection process.	-	-	Limited number of steps in the treatment process. Effective performance under a variety of operating conditions. Tolerance of the alternative to variable loading conditions (flow, pollutant load) and compatibility with influent.
	Anticipated Operations from the Authority's personnel	Capabilities and/or staff resources are not readily available and require hiring	Capabilities and/or staff partially available and require training. Some hiring may be required.	Capabilities can be accomplished with existing staff, with additional training	No additional hires/training required
	Reliability	Alternative struggles with intermittent operation. Relies on chemicals that are subject to degradation. Lack of performance history in application.	-	-	Alternative provides consistent performance while operating intermittently. Ability to operate after long idle periods.
Regulatory Compliance	Anticipated effects on project timeline through coordination with other agencies or the Authority's projects	High probability of project delay of one year or greater from interaction with agency	Moderate potential for project delay	Minor probability or project delay of one year or greater	No anticipated cause for delay of this project or other projects
	Anticipated lead time for permitting	Permit lead time > 6 months	-	-	Permit lead time < 6 months
	Requirement of USACOE Permit	USACOE permit required for construction	-	-	USACOE permit not required for construction
	Requirement of NJPDES Permit	Requires a new NJPDES permit	-	Requires revision of an existing NJPDES Permit	New NJPDES permit or revisions to existing NJPDES permit not required
Location Constraints	Anticipated Land Acquisition	Permanent acquisition of publicly or privately owned land with owner known to be strongly resistant	Temporary acquisition of land for construction purposes where owner is known to be strongly resistant	Temporary acquisition of land for construction where owner is known to be compliant	Sufficient access is likely available at low cost and resistance, or land is already owned by the Authority
	Anticipated Traffic Impacts	Significant adverse impacts on primary road	Significant adverse impacts on primary road	Minor adverse impacts lasting more than 6 months on smaller road	Minor adverse impacts lasting less than 6 months
	Compatibility with Existing Infrastructure	Requires utility relocating for 1000 feet or counteracts previous investment	Requires utility relocating for less than 1000 feet	Localized/minor consequences-Utility relocation at spot locations	No impact/positive impact
	Anticipated Noise and Odor Impacts	Noise and odor impacts are significant or unable to be measured or mitigated	Noise and odor impacts are significant but are able to be mitigated with additional services	Noise and Odor Impacts are minor but able to be mitigated with additional services	Noise and Odor impacts are minimal or non-existent
	Alternative Characteristics	Size or footprint of the alternative will significantly impact surrounding area	Size or footprint of the alternative will significantly impact surrounding area but can be mitigated	-	Size or footprint of the alternative will not impact surrounding areas
Cost	Capital (Includes New Equipment, staffing during and after wet weather events, and Design Costs and Present Worth)	(Range of prices to be defined once costs are developed)			

Category	Criteria	1	2	3	4
	Operations and Maintenance (Includes chemicals, labor to maintain equipment, power cost and need for staffing during and after wet weather events.)	(Range of prices to be defined once costs are developed)			
Community Impact	Public Acceptance	Public concerns expected	Moderate public concerns anticipated	Minor public concerns anticipated	No public response anticipated
	Impact to Businesses	Permanent interruption to businesses with no mitigation	Permanent interruption with mitigation strategy	Temporary interruption with mitigation strategy	No interruption
	Quality of life after construction	Significant adverse impact on use of parks or public spaces for more than 6 months	Significant adverse impact on use of parks or public spaces for less than 6 months	Minor adverse impacts on parks or public spaces for less than 6 months	Negligible or no adverse impacts on use of parks or public spaces

Appendix C
Public Participation Materials

NHSA CSO LTCP Public Meeting #1

February 25, 2019

North Hudson Sewerage Authority
CSO Long Term Control Plan

Public Meeting #1

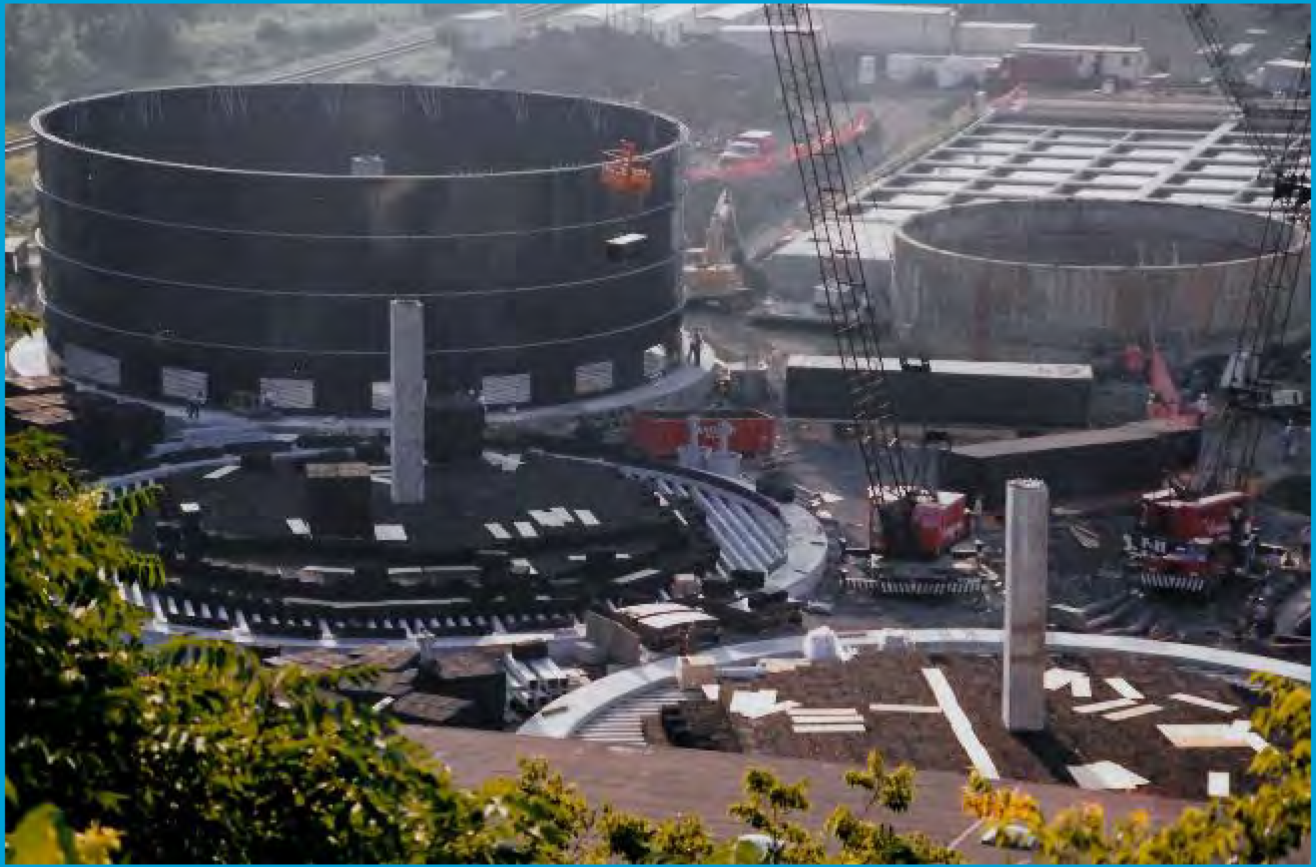
1. Introduction to North Hudson Sewerage Authority
2. Combined Sewer Overflows Explained
3. North Hudson Combined Sewer System and Facilities
4. NJDEP Long Term Control Plan Requirements
5. Ongoing LTCP Project Activities
6. Next Steps

February 25, 2019

Introduction to the North Hudson Sewerage Authority

NHSA History - Establishment

- 1985 – Sewer Ban put into effect
- 1988 – Tri-City Sewerage Authority established



NHSA History - Establishment

- 1989 - The Authority privatizes operations, hires CH2M Hill OMI.

NHSA History - Enabling the Development of the Gold Coast

- 1993 – Adams Street WWTP is opened

Photo from Hoboken Historical Museum - http://www.hobokenmuseum.org

NHSA History - Enabling the Development of the Gold Coast

- 1994 – Sewer Ban is lifted

State of New Jersey
Department of Environmental Protection and Energy
Environmental Regulation
CN 401
Trenton, NJ 08625-0401

Jeanne M. Fox
Acting Commissioner

John K. Weingart
Assistant Commissioner

January 13, 1994

Richard J. Wolff, Chairman
Hoboken-Union City-Weehawken Sewerage Authority
1600 Adams Street
Hoboken, New Jersey 07030

Re: Sewer Connection Ban Rescission
HUCWSA Sewage Treatment Plant Service Area

Dear Mr. Wolff:

I am writing in reference to two letters, dated November 19, 1993, and January 7, 1994, both from Fredric J. Pocci, P.E., HUCWSA Engineer, requesting the rescission of the existing sewer connection ban imposed upon the sewer service area of the HUCWSA Sewage Treatment Plant (STP). This ban was imposed on August 12, 1985 due to inadequate treatment capability at said treatment facility.

The Department of Environmental Protection and Energy had issued a Treatment Works Approval permit (89-2220-4), dated July 28, 1989, for the upgrade of the HUCWSA STP. Construction of the STP upgrade was completed and the Department has received an executed WQM 105 Certification for Approval form. Included with the January 7, 1994 letter from Mr. Pocci was a letter from Patrick J. Lawler, P.E., of Lawler, Matusky and Skelly Engineers, the design engineers for the STP upgrade, which certifies that the upgraded HUCWSA STP is designed to meet and is capable of meeting all the final effluent limitations and terms of its NJPDES permit No. NJ0026085.

Therefore, based on the above, the sewer connection ban imposed on the HUCWSA STP is hereby vacated as of the date of this letter. It needs to be noted, however, that if at any time in the future a sewer connection ban is required, as per N.J.A.C. 7:14A-12.21 et seq., it must be immediately imposed.

If you have any additional questions concerning this matter, please contact Nicholas Koribies, Principal Environmental Specialist, Bureau of Construction and Connection Permits, at (609) 984-4429.

Sincerely,

Narinder K. Ahuja, P.E., P.P.
Assistant Director
Division of Water Quality

JAN 1 8 1994

WF3317
c: Fredric J. Pocci, P.E., HUCWSA
City of Hoboken
City of Union City
Township of Weehawken
Bureau of Watershed Permitting
Metro Bureau of Water and Hazardous Waste Enforcement
Mike Maganacki, BCCP

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NHSA History - Establishment

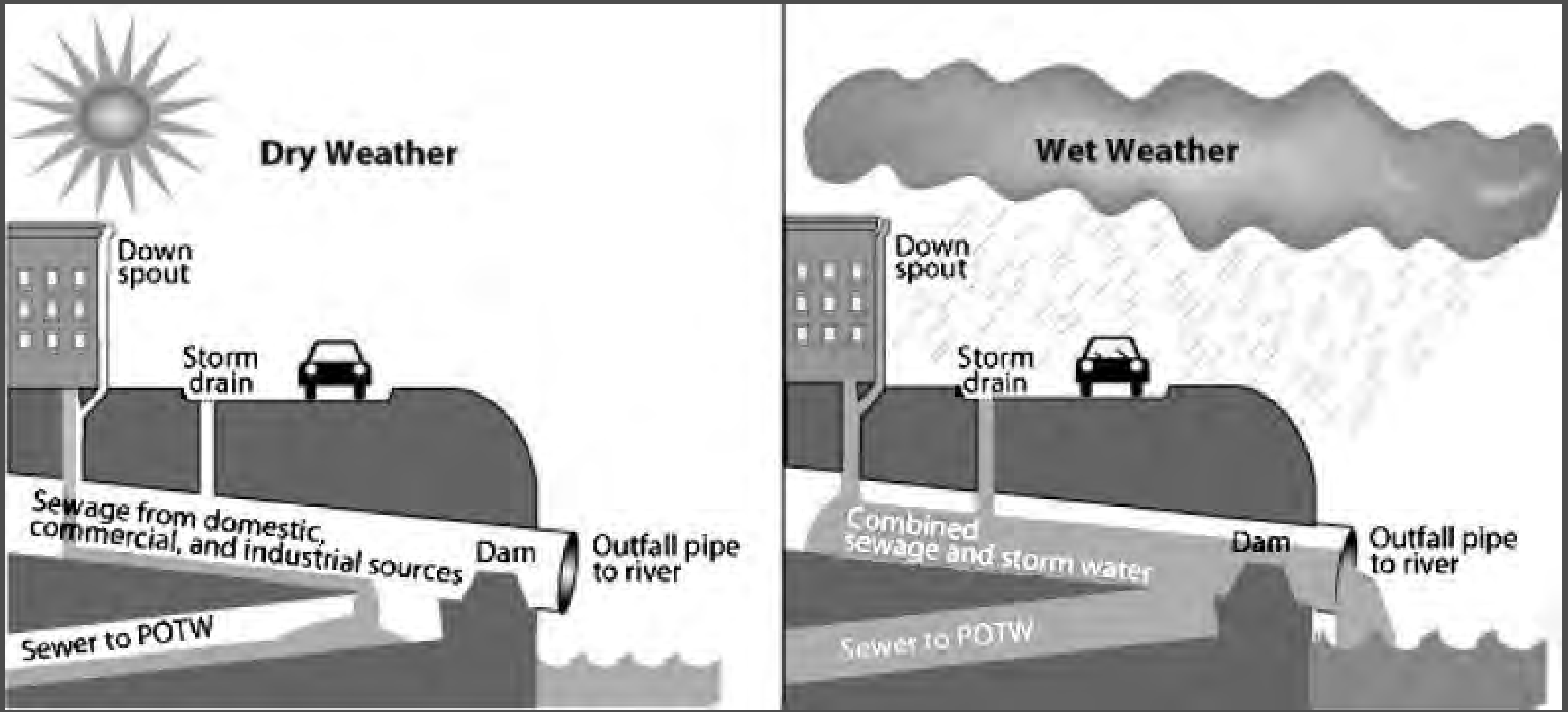
- 1996 - The Authority acquired the West New York Municipal Authority. The North Hudson Sewerage Authority is formed.

Combined Sewer Overflows Explained

Combined Sewer Systems

- Not all systems combine sanitary flow and stormwater in the same sewer pipe.
- A combined sewer system is normal in older urban areas, like Hudson County, where sewer infrastructure can date from the Civil War.
- In newer communities, there are separate sewer pipes for sanitary and storm flow.
- During dry weather, combined sewer systems work just fine. The problem is when it rains.

Combined Sewer System and CSOs



A combined sewer system (CSS) collects rainwater runoff, domestic sewage, and industrial wastewater into one pipe. Under normal conditions, it transports all of the wastewater it collects to a sewage treatment plant for treatment, then discharges to a water body. The volume of wastewater can sometimes exceed the capacity of the CSS or treatment plant (e.g., during heavy rainfall events or snowmelt). When this occurs, untreated stormwater and wastewater, discharges directly to nearby streams, rivers, and other waterbodies.

So, why reduce CSO discharges?

To continue the rehabilitation of the Hudson River until it is virtually swimmable again!

What's it Going to Take?

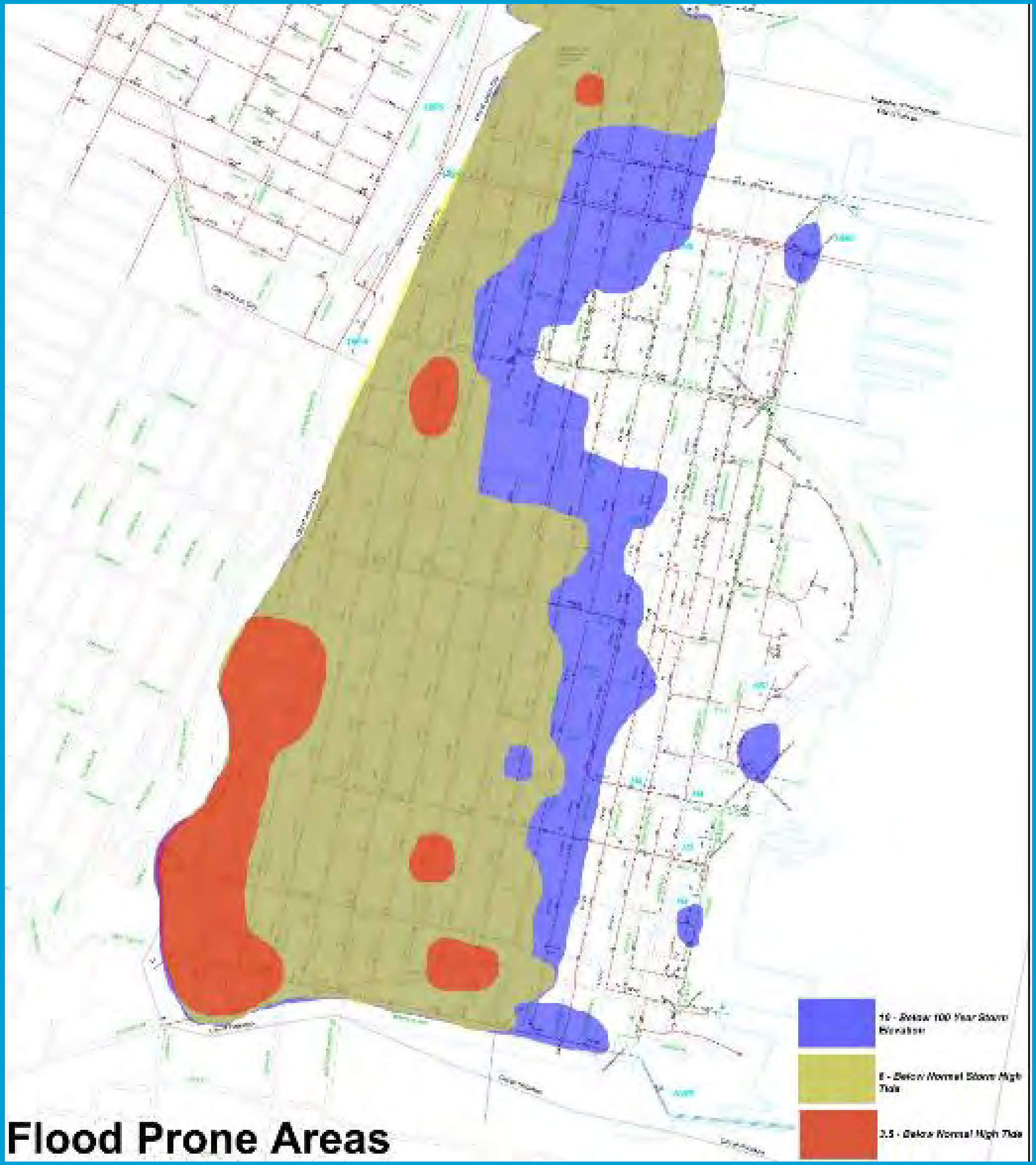
- Controlling CSOs requires significant investment in infrastructure, some of which is over 100 years old.
- North Hudson has stayed ahead of the curve by making substantial capital investments in infrastructure and maintenance for the last 25 years.
- Relative to other sewer systems around the State, North Hudson is in a strong position to successfully develop and implement its LTCP.
- To do so takes not only engineering expertise, but also considerable capital.
- The infrastructure costs will be spread over decades which will minimize the impact on current customers.

What have we done so far?

- The work to reduce CSOs goes back many years, before the current 2015 Federal and State mandate.
- Over the last 20 years, North Hudson has eliminated three CSOs that discharge into the Hudson River.
- Over 5.5 miles of sewers have been relined, replaced and rehabilitated to increase capacity and flow to the treatment plants during rain events.
- Treatment systems have been upgraded.
- End-of-pipe controls have been put into place to provide basic treatment at the outfalls.
- Green infrastructure projects have been undertaken throughout the entire service area.
- Detention tanks have been built under public parks.
- Wet weather pump stations have been constructed to prevent flooding.

NHSA History - Combating Flooding in Hoboken

- Hoboken has faced flooding throughout its history.
- Several areas in the city are located below storm tides.
- H-1 Wet Weather Pump Station Commissioned October 17, 2011, and has reduced street flooding in Southern Hoboken.



NHSA History - Combating Flooding in Hoboken

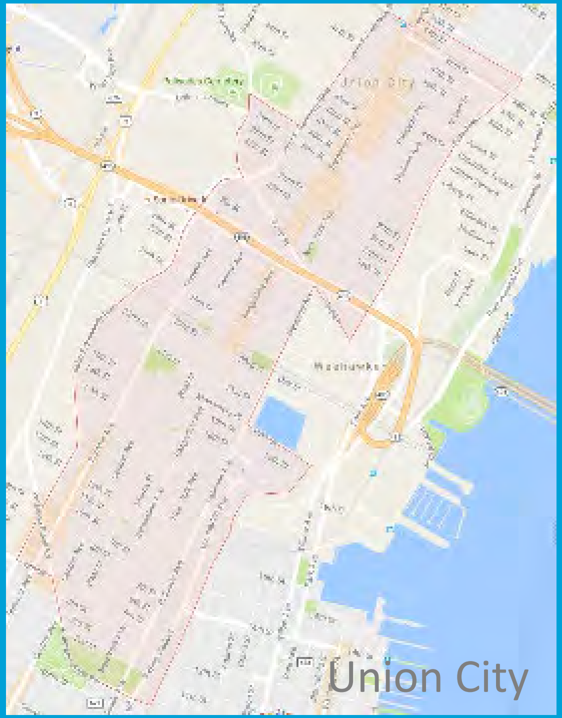
- H-5 Wet Weather Pump Station on 11th Street.
- Construction completed October 2016.
- This pump station has reduced flooding in the northwest section of Hoboken.

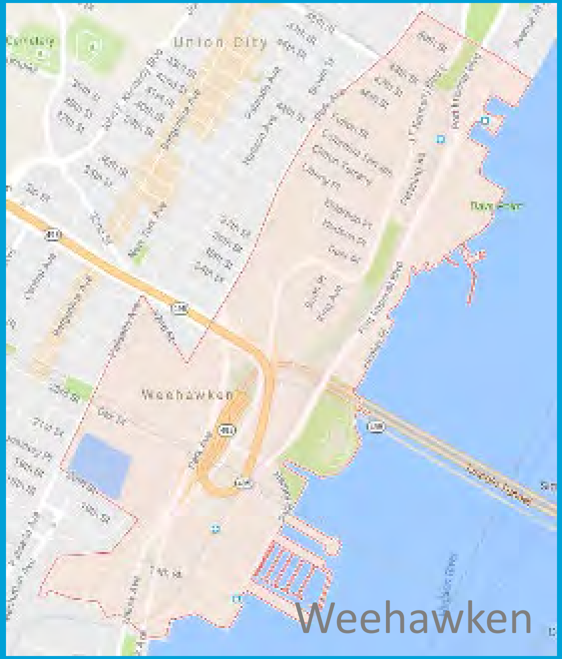
9th and Madison Before & After Pump Station Constructed

North Combined Sewer System and Facilities

North Hudson System

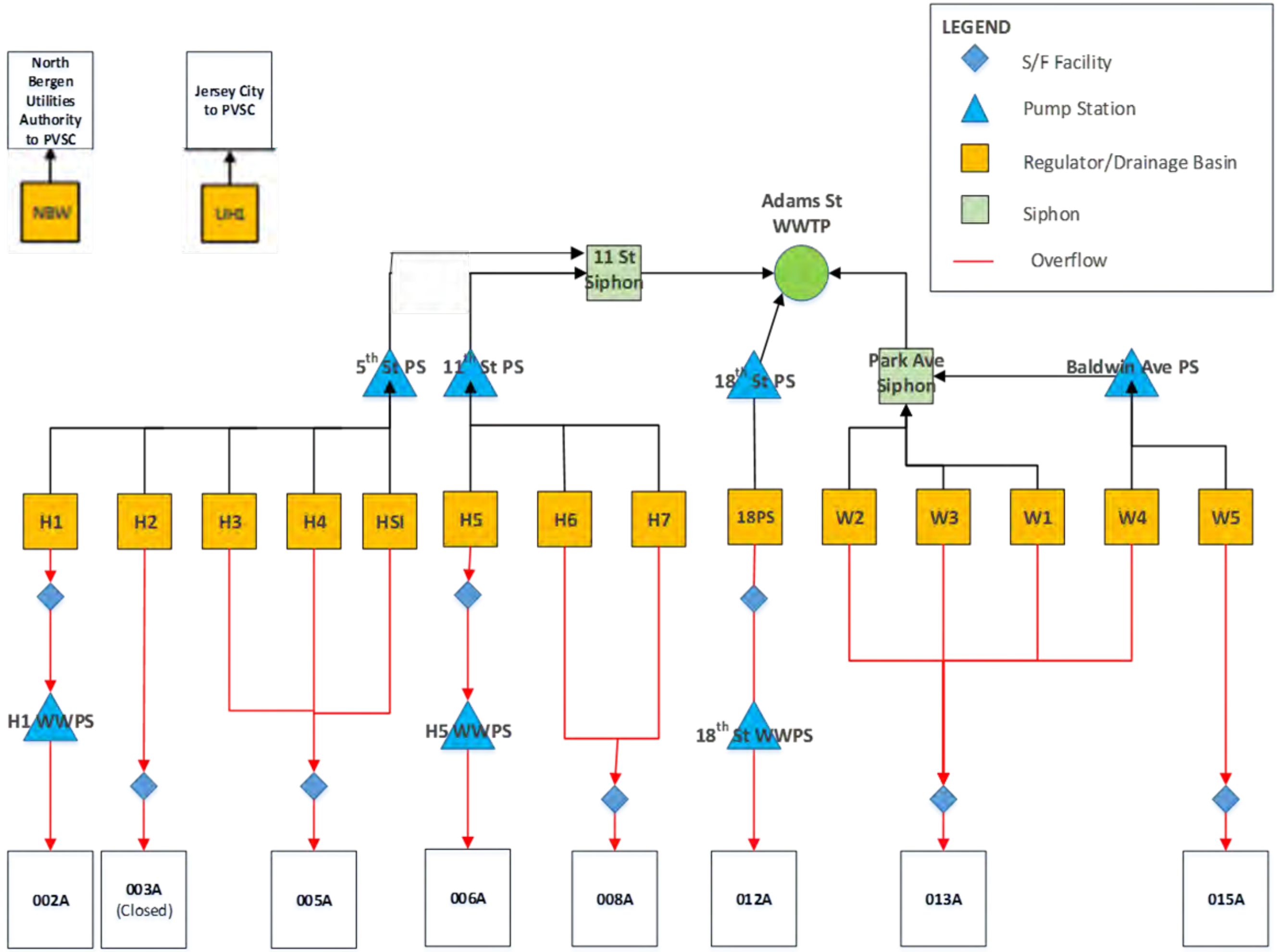
- Services
  - Hoboken
  - Weehawken
  - West New York
  - Union City
- NHSA Infrastructure Includes:
  - 107 miles of combined sewers
  - 10 Pump Stations
  - 16 Combined Sewer Overflow (CSO) Regulators
  - 10 CSO Outfalls with solids/floatables treatment
  - 2 Wastewater Treatment Plants (WWTP)

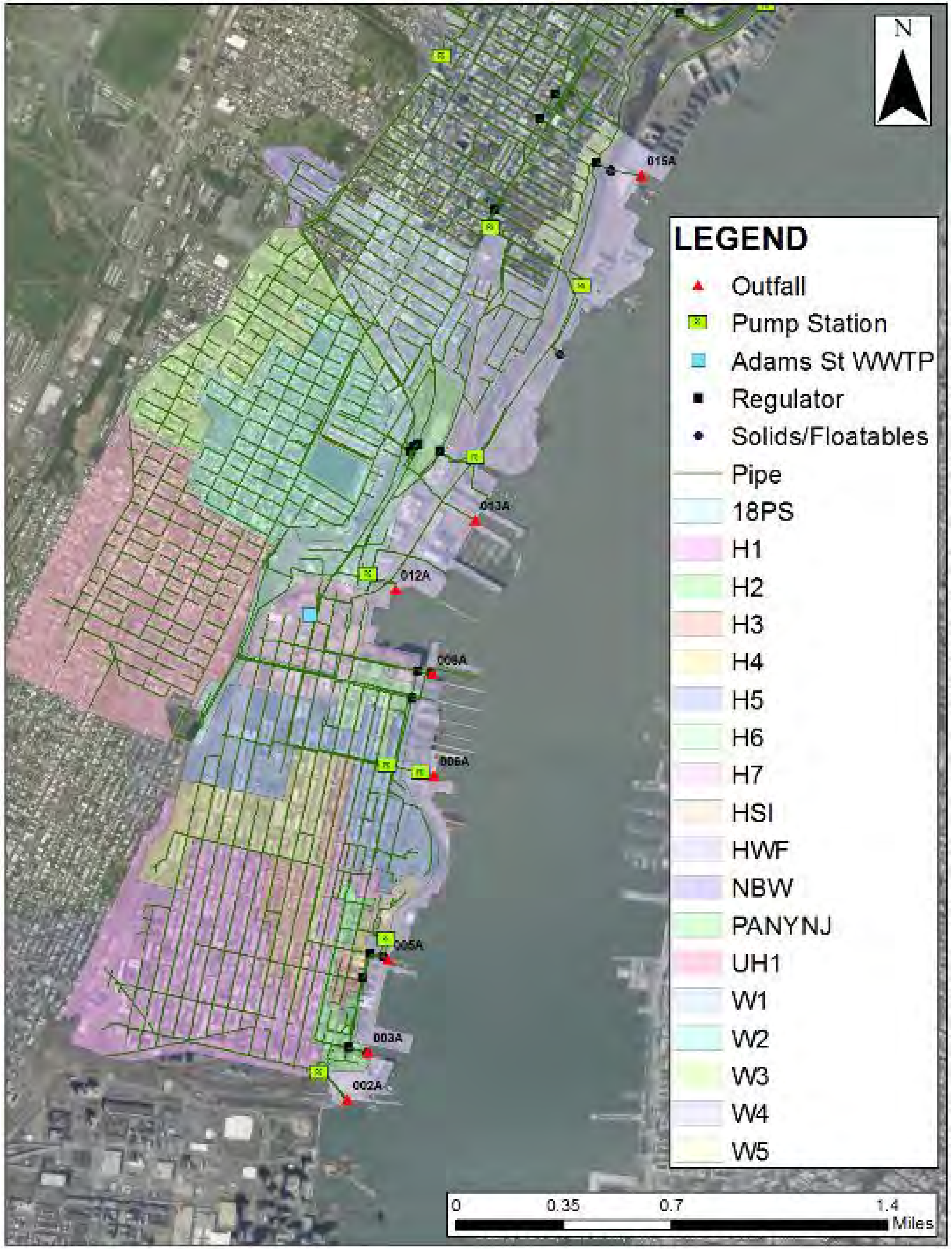




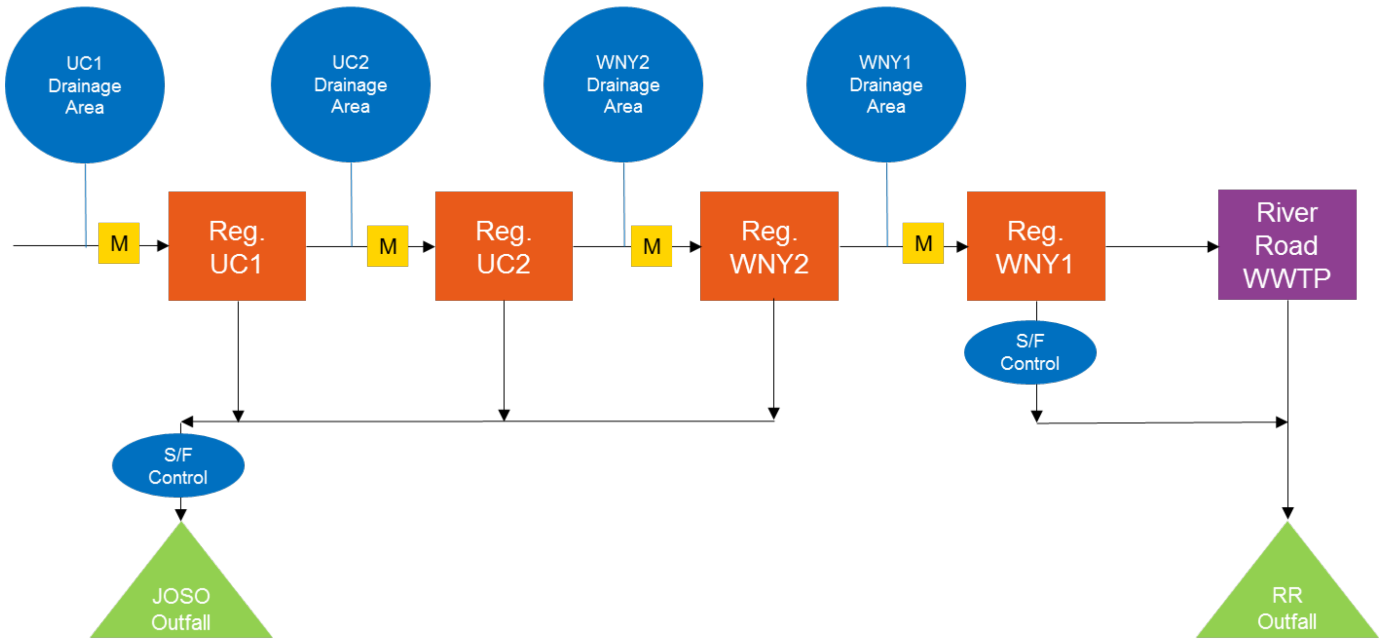
Images from Google Maps - http://maps.google.com

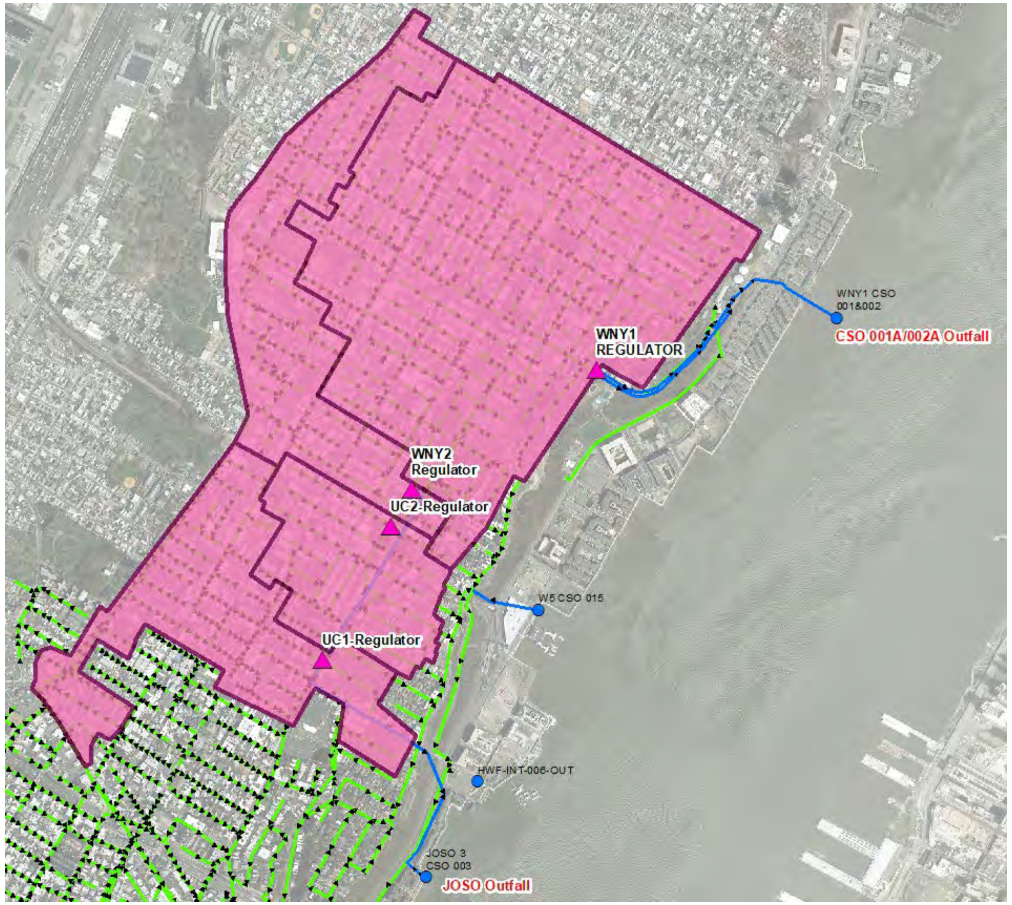
Adams Street Combined Sewer System





River Road Combined Sewer System





Wastewater Treatment Plants

Adams Street Wastewater Treatment Plant
1600 Adams Street, Hoboken
20 million gallons per day (MGD)

River Road Wastewater Treatment Plant
6400 Anthony M Defino Way, West New York
10 MGD

NHSA Today

- NHSA is one of the largest wastewater entities in the State, serving a population of over 190,000
- Pride in Maintenance
- Since 2006, NHSA has spent over $112 Million on Capital Improvement Projects.
- Current ongoing Capital Improvement Projects Include:
  – Adams Street WWTP Improvements
  – W1234 Solids/Floatables Facility at Lincoln Harbor
  – H6/H7 CSO LTCP Project in northwest Hoboken
  – Sewer lining and wood sewer removal

2006 – 2015 Capital Investments	
Adams Street WWTP	$26,510,776
River Road WWTP	$11,611,278
Pumping Stations	$32,550,174
Hoboken Sewer System	$13,971,563
Union City Sewer System	$7,556,027
Weehawken Sewer System	$4,230,980
West New York Sewer System	$15,684,515
TOTAL	$112,115,313

NJDEP Long Term Control Plan Requirements

New Jersey Pollution Discharge Elimination System (NJPDES) Permits have 2 Major Requirements for Wastewater Treatment Plants with CSOs

- Nine Minimum Controls

  Nine (9) “low” cost measures to improve flows getting to the treatment plant, improve public notification, and update Operation and Maintenance procedures

- Long Term Control Plans (LTCP)

  A complex engineering, hydraulic analysis of wastewater collection systems, pumping stations, combined sewer overflows, regulators and sewage treatment facilities, to provide the most cost effective manner to regulate CSO’s so that the CSO National Policy can be met.

  Develop a plan over 5 years to determine what system improvement projects will be needed over the next several decades to reduce the frequency, volume and impacts of CSOs.

NJPDES Nine Minimum Controls Permit Requirements Met via a Series of Activities and Submittals to the NJDEP by July 1, 2016:

- ☑ Update Operation & Maintenance Manuals, Emergency Plans, CSO Standard Operating Procedures, and Asset Management Plans
- ☑ Submit Discharge Monitoring Reports (DMR) for monthly solids/floatables, precipitation, and duration of CSO discharges
- ☑ System Characterization including GPS location of all pump stations, regulators and outfalls
- ☑ Review all Rules/Ordinances/Sewer Use Agreements to require infiltration/inflow (I/I) removal, submit schedule for revisions
- ☑ Delineate all combined sewer and separate sewer areas in the system
- ☑ Install new public information signs at all outfalls with a NJDEP hotline number to call.
- ☑ Create telephone hot line or website to inform public of when CSOs are discharging

NJPDES LTCP Permit Requirements Met via a Series of Activities and Submittals to the NJDEP by June 1, 2020:

- System Characterization (Work Plans and Reports) – July 1, 2018 ✓
- Baseline Compliance Monitoring (Work Plans and Reports) – July 1, 2018 ✓
- Public Participation Process (Report) – July 1, 2018 ✓
- Identification and Consideration of Sensitive Areas (Report) – July 1, 2018 ✓
- Develop and Evaluate CSO Control Alternatives (Report) – July 1, 2019
- Select Alternatives and Plan Implementation of the LTCP (Report) – June 1, 2020

Performed as a LTCP Program with a Consultant Program Manager and a series of projects performed by the Authority's Engineering Consultants

Ongoing LTCP Project Activities

Where Are We on Developing the LTCP?

Characterization	Engineering Alternative Evaluation	Long Term Control Planning

Characterization

- ☑ Work Plans
- ☑ Field Work
  - ☑ Condition Assessment
  - ☑ Sewer Flow Monitoring
  - ☑ CSO Water Quality (WQ) Monitoring
  - ☑ Hudson River WQ Monitoring
- ☑ Identify Sensitive Areas
- ☑ Engineering
  - ☑ Land Use and Drainage Analyses
  - ☑ Hydraulic Sewer Modeling
  - ☑ Hudson River WQ Modeling
- ☑ Public Participation
- ☑ Reports

Engineering Alternative Evaluation

- ❑ Establish CSO Reduction Targets
- ❑ Identify Opportunities with Communities to Reduce CSOs
- ❑ Identify and Evaluate CSO Control Strategies and Technologies
- ❑ Estimate Potential Project Costs
- ❑ Assess Cost/Performance for Potential Projects
- ❑ Assess Financial Capability
- ❑ Identify Funding Mechanisms
- ❑ Report

Long Term Control Planning

- ❑ Select Strategies and Controls
- ❑ Select Funding Mechanisms
- ❑ Develop Schedule for Implementation
- ❑ Finalize LTCP
- ❑ Report

CSO Tasks
What have we done so far in operations?

1. Outfall Signs are installed.
2. Operations and Maintenance Manual, SOPs, Asset Management Plan, and Emergency Plan are all in place and are continuously being updated.
3. Update of the system infrastructure characterization is in progress.
4. GIS Map is complete.
5. Telephone Hotline has been online since 2012.
6. Website is in the process of being updated.
7. Updated Discharge Monitoring Reports are being submitted Monthly.

NHSA CSO Waterbody Advisory System

- Real-time status of CSO activity on the NHSA website.
- Inform the public of CSO activities.
- Uses level sensors and a cellular communication system.
- Live and online NOW!
- Visit: www.nhudsonsa.com

NJDEP required the Authority to form a “Supplemental CSO Team” to:

- 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.

North Hudson formed its “CSO Community Advisory Board”

Convening the North Hudson CSO Community Advisory Board

- The Authority:
  - solicited recommendations from the mayors of the four municipalities,
  - reached out to community organizations and environmental organization representatives, and
  - sought developers and other business community representatives via the chambers of commerce in the municipalities for members of the Board.
- The CSO Community Advisory Board includes members from and representing Hoboken, West New York, Weehawken, and Union City.
- Board members are a diverse group representing all aspects of life in the community it serves.
- Board members represent the business community, environmental groups, and community citizen action groups.

North Hudson CSO Community Advisory Board Members

- Brian Battaglia - Battaglia's Home and Hoboken Chamber of Commerce, Hoboken resident
- Larry Bijou - Bijou Properties (Hoboken business), Weehawken resident
- Jason Capizzi - Port Imperial Homeowners Association, West New York resident
- Carter Craft - Hoboken Cove Community Boathouse Board, Rebulid-by-Design Hudson River Citizens' Advisory Group (RBBD), Hoboken resident
- Mary Kelly - Hoboken Quality of Life/Nature Conservatory Committees, Hoboken resident
- Frank Raia - Raia & Sirignano LLC, Long time member of HOPES, former NHSA Commissioner, Hoboken resident
- Robert Sosa - Weehawken Parking Authority, Weehawken Resident
- Anthony Squire - Union City resident
- Debra Tantleff - New Jersey Committee of the Regional Plan Association and the Board of Directors for Downtown New Jersey, New Jersey Future and New Jersey Mixed-Use, Developers, West New York resident

CSO Tasks
What have we done so far in planning?

- System Characterization Work Plan and Report
  - A work plan described how NHSA would asses the condition and performance of its combined sewer systems.
  - Work efforts included surveying, CCTV sewer inspection, sewer flow monitoring and modeling, and CSO discharge water quality monitoring.
  - Updated the Authorities information on combined sewer system characteristics and performance. The plan is essential to properly evaluate mitigation alternatives. A final report of the findings will be presented at the end of the project.
- Public Participation Process Plan and Report
  - A plan to assure that representatives of the public are aware of the CSO issues and have input into the CSO reduction projects.

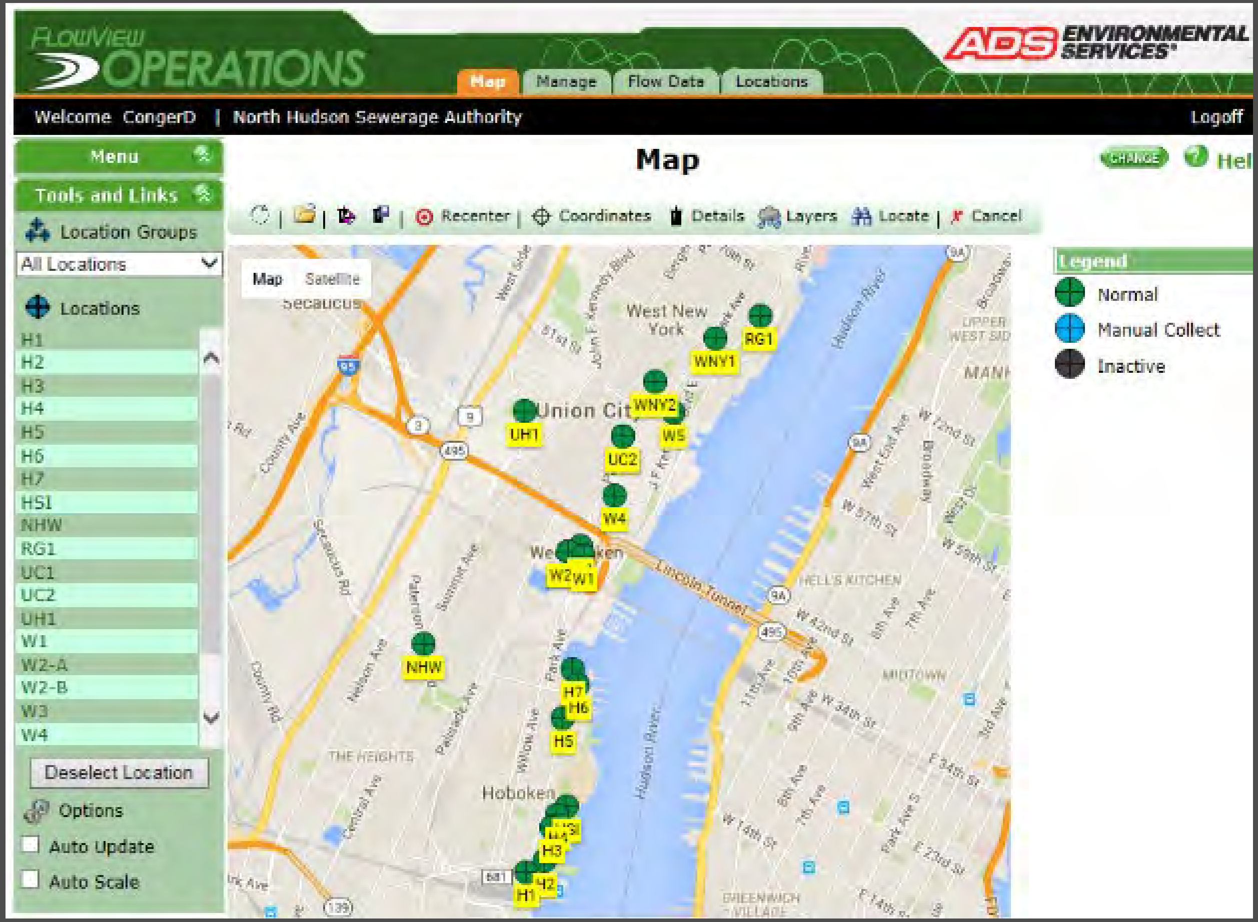
Sewer Video Inspection and Condition Assessment

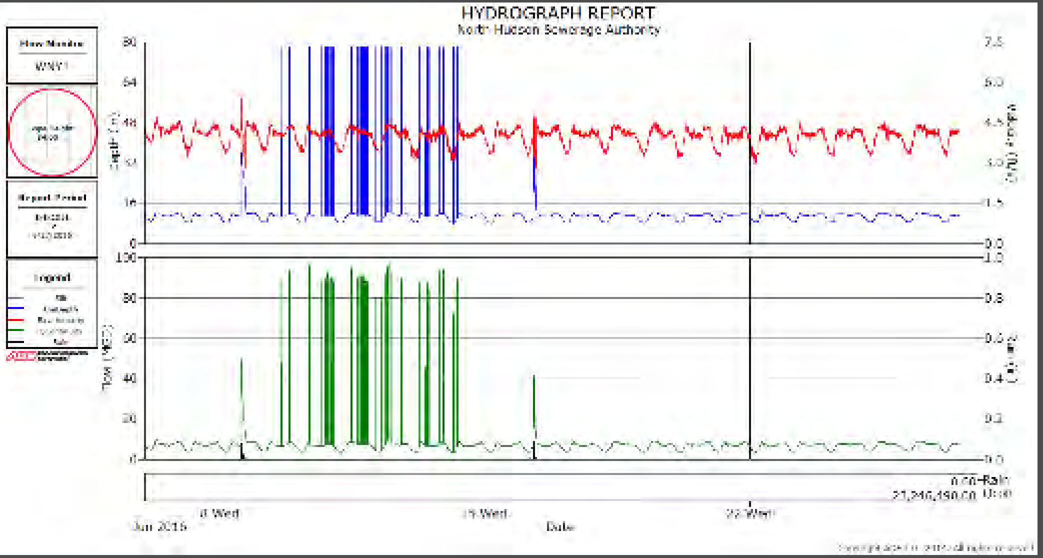
- CCTV camera inspection of pipes in the sewer system.
- Condition assessments are performed based on the videos.
- We rate and rank the sections of sewer for repair or replacement.
- We identify where water is entering the pipes through cracks due to trees roots, illegal connections, street pipe failures and leaks from water main leaks and breaks.
- The more groundwater and water main leaks removed from the system, the more space the system has for stormwater, and this will reduce CSOs.

Sewer Lining Eliminates Leaks into the Sewers

Collection System Flow Monitoring

- Flow and rain measurement devices were installed in the sewer pipes in 2016.
- We collected flow data for both dry and wet weather days for 6 months.
- The data was used to calibrate computer models of the combined sewer systems.





CSO Water Quality Sampling

- Project Need: Better understand the quality of CSO discharges and the impacts they have on the Hudson River
- Project Goal: Collect water quality data representing CSO discharges to the Hudson River
- Project Approach:
  - Collected water samples from the sewer system where overflows occur during wet weather.
  - Tested for bacteria only.
  - Executed a NJDEP-approved project plan
- Schedule:
  - Started April 2016
  - Completed in Summer 2017.

H3 - 3rd St. at River St.

18th Street Pump Station – W 18th St.

WNY1 - JF Kennedy Blvd. at Anthony Delfino Way

CSO Tasks
What have we done so far in planning?

Consideration of Sensitive Areas Report

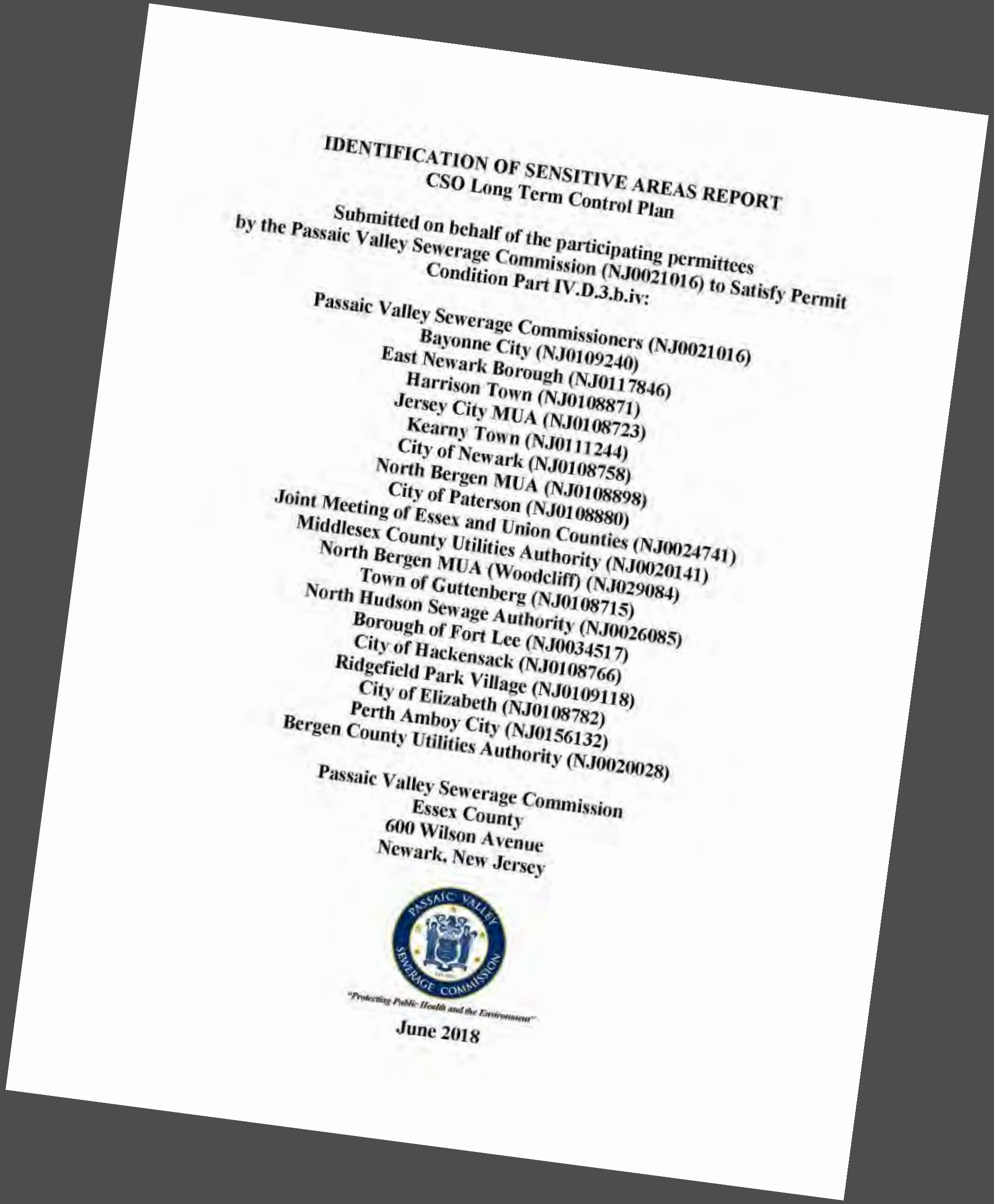
- Identified aquatic and shoreline areas that the federal government defines as sensitive to CSO discharges to be used in planning and decision making.
- The Authority also identified areas along the waterfront that are used for recreational access to the Hudson; such as marinas, beaches, and kayak launch points.

• Compliance Monitoring Program Work Plan and Report

- A plan to sample water quality in the Hudson River and adjacent waters where CSO discharges occur.
- The final report documented the findings of water quality sampling throughout the NY/NJ harbor estuary in 2016-2017 and compared the findings to water quality standards.
- The findings will serve as a baseline for planning efforts and to evaluate accomplishments as CSO controls are constructed in the future.

Identification of Sensitive Areas

- Submitted reports to NJDEP on June 28, 2018
- No:
  - Outstanding National Resource Waters
  - National Marine Sanctuaries
  - Public drinking water intakes
  - Primary contact recreation
  - Shellfish beds
- Threatened or endangered species and habitat
  - Atlantic and shortnose sturgeon – sufficiently protected
- NJDEP posted the reports on its CSO website:
  - https://www.nj.gov/dep/dwq/cso-ltcpsubmittals.htm



IDENTIFICATION OF SENSITIVE AREAS REPORT
CSO Long Term Control Plan

Submitted on behalf of the participating permittees by the Passaic Valley Sewerage Commission (NJ0021016) to Satisfy Permit Condition Part IV.D.3.b.iv:

Passaic Valley Sewerage Commissioners (NJ0021016)
Bayonne City (NJ0109240)
East Newark Borough (NJ0117846)
Harrison Town (NJ0108871)
Jersey City MUA (NJ0108723)
Kearny Town (NJ0111244)
City of Newark (NJ0108758)
North Bergen MUA (NJ0108898)
City of Paterson (NJ0108880)
Joint Meeting of Essex and Union Counties (NJ0024741)
Middlesex County Utilities Authority (NJ0020141)
North Bergen MUA (Woodcliff) (NJ029084)
Town of Guttenberg (NJ0108715)
North Hudson Sewage Authority (NJ0026085)
Borough of Fort Lee (NJ0034517)
City of Hackensack (NJ0108766)
Ridgefield Park Village (NJ0109118)
City of Elizabeth (NJ0108782)
Perth Amboy City (NJ0156132)
Bergen County Utilities Authority (NJ0020028)

Passaic Valley Sewerage Commission
Essex County
600 Wilson Avenue
Newark, New Jersey

June 2018

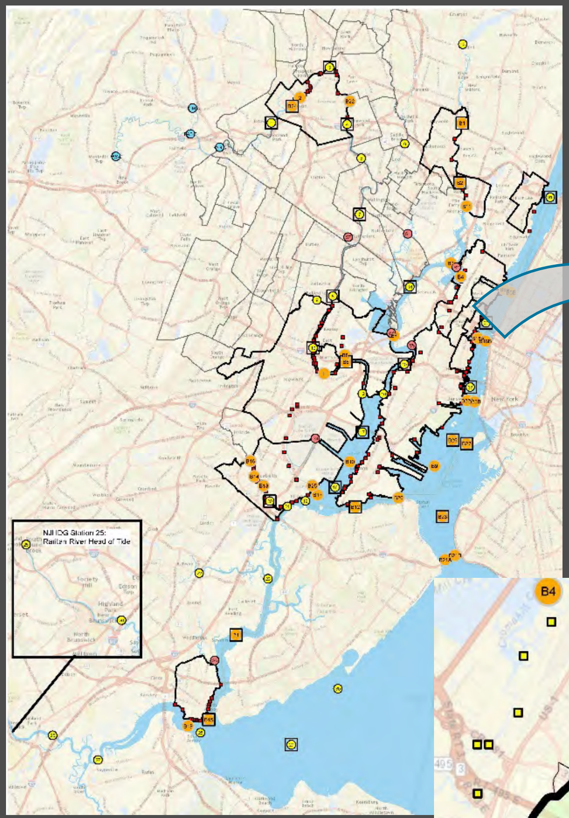
Example List of Sensitive Areas - Secondary Contact and Parks

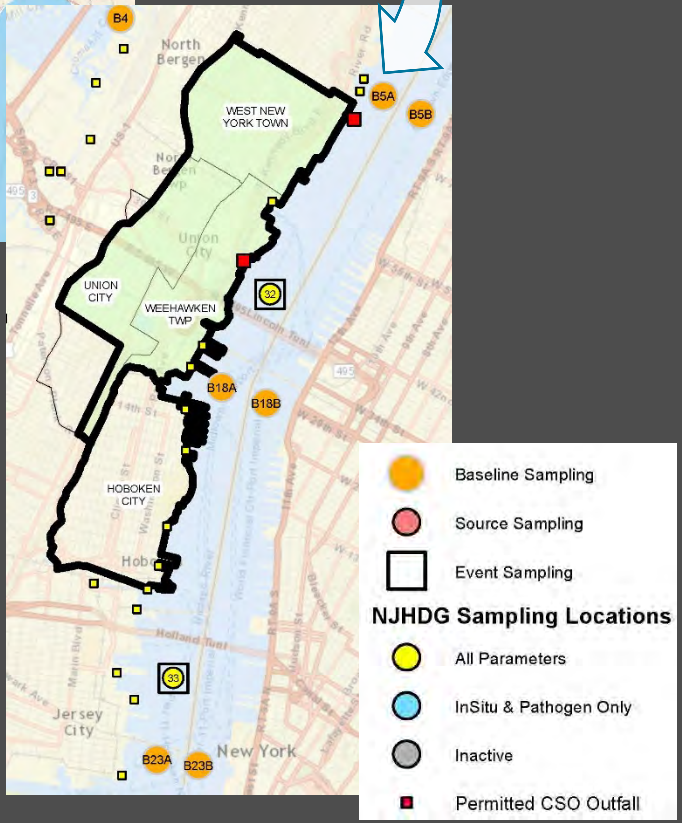
Adams Street WWTP Service Area			
Area	**Location**	**Activity**	**Nearby CSO Outfall**
Sinatra Park	Between 4^{th} & 5^{th} Streets, Hoboken	Kayak Launch	Adams Street 005A
Maxwell Place Park at Hoboken Cove	11^{th} Street, Hoboken	Kayak Launch	Adams Street 006A
Pier 13	13^{th} Street, Hoboken	Marina, kayaking, jet skiing, paddle boarding	Adams Street 008A
Lincoln Harbor Yacht Club	Harbor Boulevard, Weehawken	Marina	Adams Street 013A

River Road WWTP Service Area			
Area	**Location**	**Activity**	**Nearby CSO Outfall**
River Road Outfall Pier	Avenue at Port Imperial, West New York	Fishing	River Road 002A

Hudson River Water Quality Monitoring

- Project Need: Better understand water quality conditions in the Hudson River and how they are impacted by CSOs
- Project Goal: Collect water quality data representing Hudson River water quality during dry and wet weather
- Project Approach:
  - Partnered with other CSO Permittees in Northern New Jersey to pool resources, not duplicate efforts and save $
  - Executed a NJDEP-approved project plan
  - Dry and wet weather water quality samples collected by NJ CSO Group consultants by boat throughout the Harbor Estuary in 2016-2017
- Reports submitted June 26, 2018
- NJDEP posted the reports on its CSO website:
  - https://www.nj.gov/dep/dwq/cso-ltcpsubmittals.htm






NJCSO GROUP COMPLIANCE MONITORING PROGRAM REPORT

Prepared on behalf of the following participating Permittees by Passaic Valley Sewerage Commission (NJ0021016) to Satisfy Permit Condition Part IV.D.3.d:

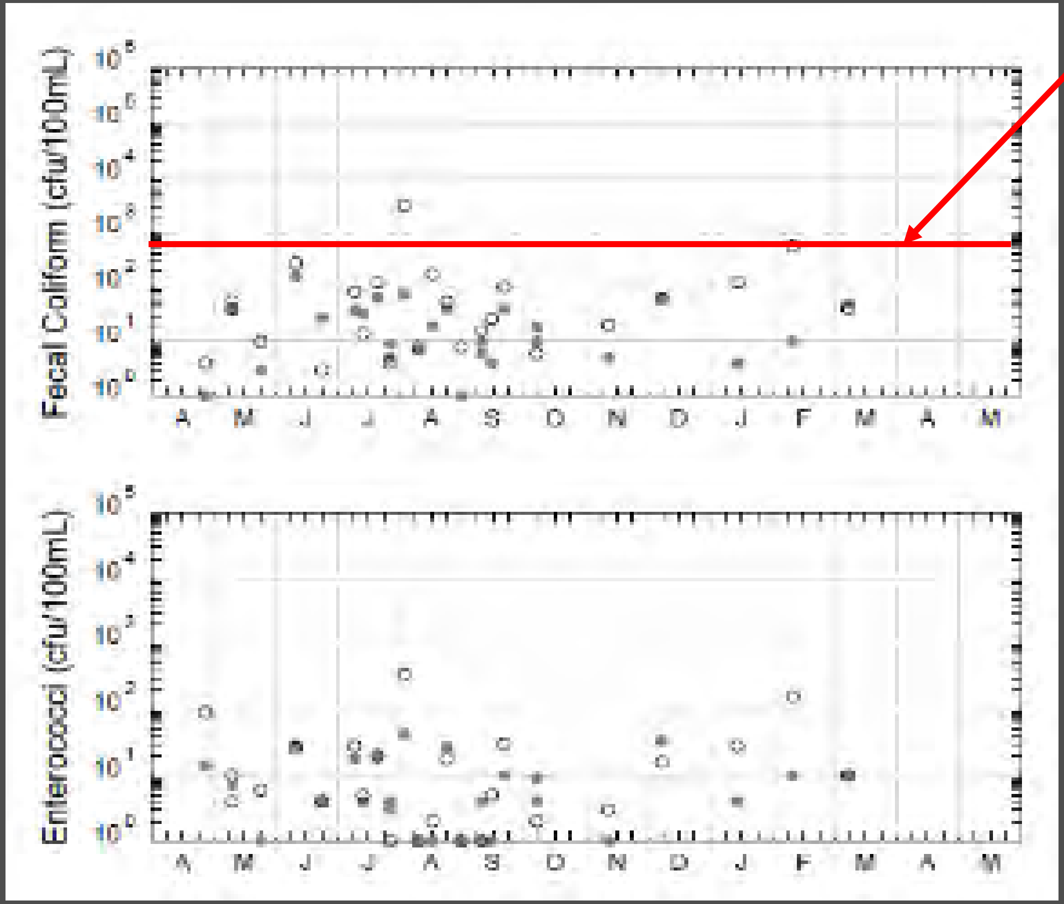
Bayonne City (NJ0109240) PVSC
East Newark Borough (NJ0117846) PVSC
Harrison Town (NJ0108871) PVSC
Jersey City MUA (NJ0108723) PVSC
Kearny Town (NJ0111244) PVSC
Newark City (NJ0108758) PVSC
North Bergen MUA (NJ0108898) PVSC
Paterson City (NJ0108880) PVSC
Joint Meeting of Essex and Union Counties (NJ0024741) JMEUC
Middlesex County Utilities Authority (NJ0020141) MCUA
North Bergen MUA (Woodcliff) (NJ0029084) NBMUA
Guttenberg Town (NJ0108715) NBMUA
North Hudson Sewage Authority - Adams Street STP (NJ0026085) NHSA
North Hudson Sewage Authority - River Road STP (NJ0025321) NHSA
Fort Lee Borough (NJ0034517) BCUA
Hackensack City (NJ0108766) BCUA
Ridgefield Park Village (NJ0109118) BCUA
Elizabeth City (NJ0108782) JMEUC
Perth Amboy City (NJ0156132) MCUA
Bergen County Utilities Authority (NJ0020028) BCUA

Passaic Valley Sewerage Commission
Essex County
600 Wilson Avenue
Newark, New Jersey

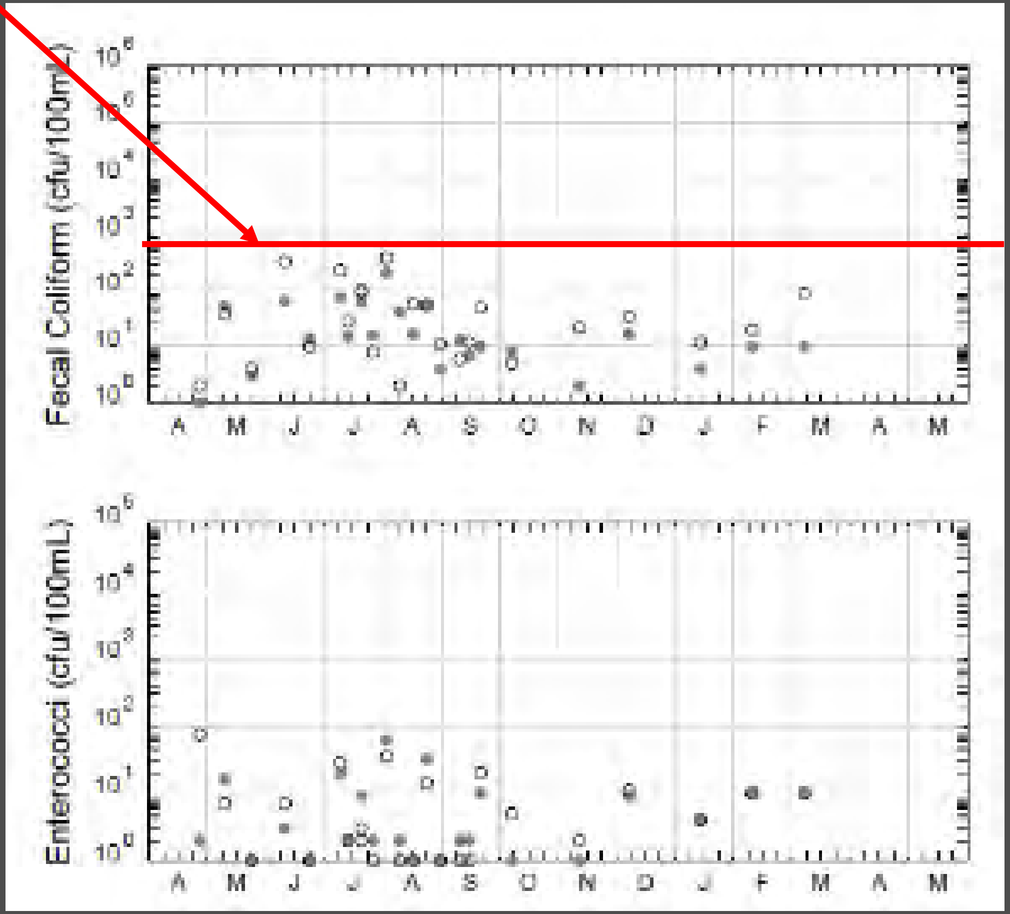
JUNE 30, 2018

2016-2017 Bacteria Data in the Hudson River

The bacteria water quality standard for fecal coliform is a geometric mean of 770 cfu/100mL.



Monitoring Stations B18A at Weehawken
Hudson River – New Jersey Side



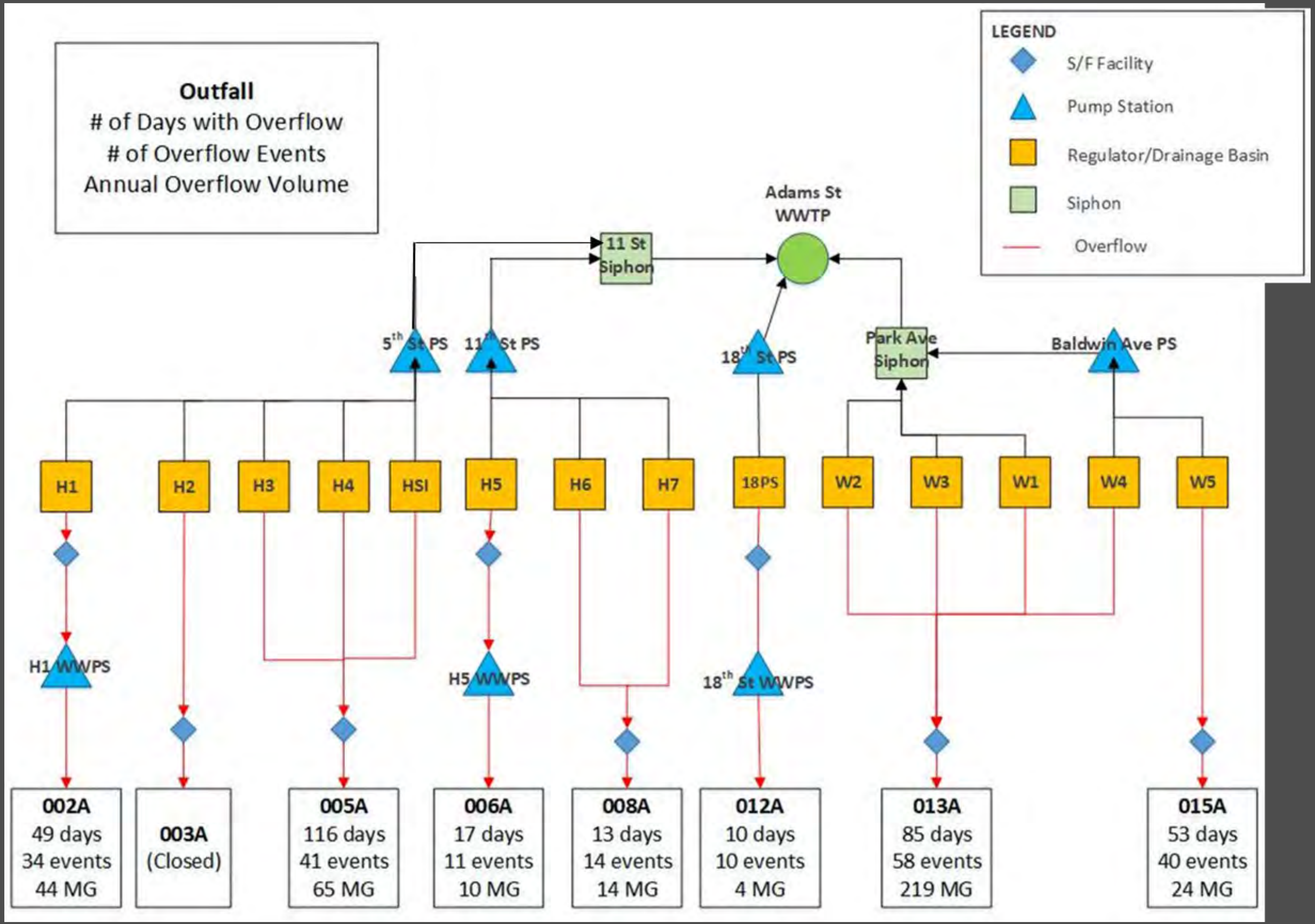
Monitoring Stations B18B at Weehawken
Hudson River – New York Side

Sewer System Characterization Reports

- NJPDES Requirements:
  - Establish the existing baseline conditions,
  - Evaluate the efficacy of the CSO technology based controls,
  - Determine the baseline conditions upon which the LTCP will be based.
- Reports submitted July 2, 2018
  - Adams Street WWTP
  - River Road WWTP
- NJDEP posted the reports on its CSO website:
  - https://www.nj.gov/dep/dwq/cso-ltcpsubmittals.htm

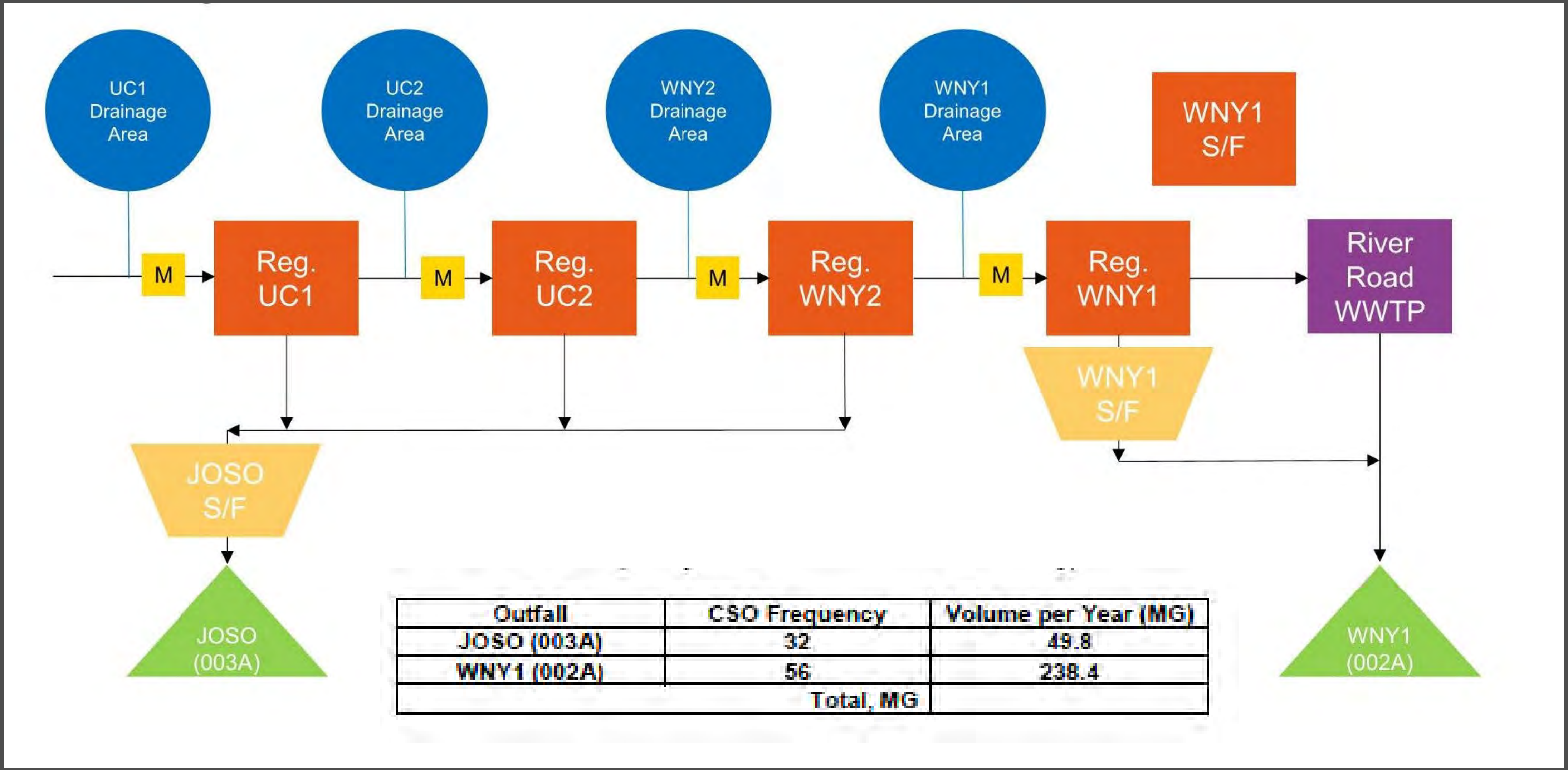
- NHSA Reports Described:
  - Collection System Investigations
  - Sewer System Inventory
  - Wastewater Treatment Plant
  - Service Area and Land Uses
  - Infiltration and Inflow Assessment
  - Hydraulic Collection System Modeling
  - Baseline Characterization

Adams Street Schematic Diagram with Overflow Calculations



Calculated with calibrated collection system hydraulic models for a typical year

River Road Schematic Diagram with Overflow Calculations



Outfall	CSO Frequency	Volume per Year (MG)
JOSO (003A)	32	49.8
WNY1 (002A)	56	238.4
	Total, MG	

Calculated with calibrated collection system hydraulic models for a typical year

Where Are We on Developing the LTCP?

Characterization → **Engineering Alternative Evaluation** → **Long Term Control Planning**

Characterization

- ☑ Work Plans
- ☑ Field Work
  - ☑ Condition Assessment
  - ☑ Sewer Flow Monitoring
  - ☑ CSO Water Quality (WQ) Monitoring
  - ☑ Hudson River WQ Monitoring
- ☑ Identify Sensitive Areas
- ☑ Engineering
  - ☑ Land Use and Drainage Analyses
  - ☑ Hydraulic Sewer Modeling
  - ☑ Hudson River WQ Modeling
- ☑ Public Participation
- ☑ Reports

Engineering Alternative Evaluation

- ☑ Establish CSO Reduction Targets
- ☑ Identify Opportunities with Communities to Reduce CSOs
- ◔ Identify and Evaluate CSO Control Strategies and Technologies
- ◔ Estimate Potential Project Costs
- ◔ Assess Cost/Performance for Potential Projects
- ☐ Assess Financial Capability
- ☐ Identify Funding Mechanisms
- ☐ Report

Long Term Control Planning

- ☐ Select Strategies and Controls
- ☐ Select Funding Mechanisms
- ☐ Develop Schedule for Implementation
- ☐ Finalize LTCP
- ☐ Report

CSO Tasks
What have we done so far in planning?

- Development and Evaluation of Alternatives Report
  - Conducted a workshop to identify potential engineering controls to reduce CSOs.
  - Currently conceptualizing and identifying the benefits and the costs of potential CSO controls.

Summary

- The North Hudson Sewerage Authority has a long history of solving complex environmental challenges.
- Combined Sewer Overflows occur when the amount of rainfall exceeds the capacity of the sewer treatment system, and the diluted wastewater is discharged directly to the river.
- NHSA looks forward to being a leader in tackling the latest challenge of reducing Combined Sewer Overflows.
- NHSA is progressing through the five year study phase, and has completed several projects on the way to crafting a Long Term Control plan.

Next Steps

Thank You

NORTH
SEWERAGE
AUTHORITY
HUDSON

NHSA CSO LTCP Public Meeting #2

May 20, 2019

NORTH HUDSON SEWERAGE AUTHORITY
COMBINED SEWER OVERFLOW
LONG TERM CONTROL PLAN
PUBLIC MEETING #2

MEETING SIGN-IN SHEET

Meeting: NHSA CSO LTCP Public Meeting #2 **Meeting Date:** MAY 20, 2019

Name	Affiliation	E-Mail
S. Rosenwinkel	NJDEP	susan.rosenwinkel@dep.nj.gov
J. Lakhicharran	NJDEP	Johnathan.Lakhicharran@dep.nj.gov
J. CAPIZZI	WNY RESIDENT	jason.capizzi@gmail.com
Mo Kinberg	NJ Future	mkinberg@NJFuture.org
S. Chicoine	Hob. res.	sjcgotham@gmail.com
Don Conger	Jacobs	don.conger@jacobs.com
Steve Huduck	JAcobs	steve.huduck@jacobs.com
Ed Friedrich	NHSA commissioner	edfriedrich@gmail.com (A)
KAREN APPELL	AECOM	Karen.appell@aecom.com
CARTER CRAFT	HOBOKEN RESIDENT ~~RATEPAYER~~	CARTER@OUTSIDENEWYORK.NET
Noelle Thurlow	CAB & Resilience Paddlesports & Hoboken Resident	thurlow.noelle@gmail.com
Tiffanie Fisher	~~[illegible]~~ Hoboken City Council	HOBOKEN2ND@gmail.com
BILL MCMILLIN	JACOBS - NHSA	WILLIAM.MCMILLIN@JACOBS.COM

(A) = send me the presentation

North Hudson Sewerage Authority
CSO Long Term Control Plan

Public Meeting #2

1. Greetings and Introductions
2. NJDEP Long Term Control Plan Requirements and Ongoing Activities
3. Introduction to CSO Control Strategies and Alternatives
4. Development and Evaluation of Alternatives
5. Review of CSO Control Alternatives
6. Next Steps

May 20, 2019

Greetings and Introductions

(Please do sign in)

NJDEP Long Term Control Plan Requirements and Ongoing Activities

NJPDES LTCP Permit Requirements Met via a Series of Activities and Submittals to the NJDEP by June 1, 2020:

- System Characterization (Work Plans and Reports) – July 1, 2018 ✓
- Baseline Compliance Monitoring (Work Plans and Reports) – July 1, 2018 ✓
- Public Participation Process (Report) – July 1, 2018 ✓
- Identification and Consideration of Sensitive Areas (Report) – July 1, 2018 ✓
- Develop and Evaluate CSO Control Alternatives (Report) – July 1, 2019
- Select Alternatives and Plan Implementation of the LTCP (Report) – June 1, 2020

Performed as a LTCP Program with a Consultant Program Manager and a series of projects performed by the Authority's Engineering Consultants

Where Are We on Developing the LTCP?

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- ☑ Work Plans
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- ☑ Reports

Engineering Alternative Evaluation

- ☑ Establish CSO Reduction Targets
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Long Term Control Planning

- ❑ Select Strategies and Controls
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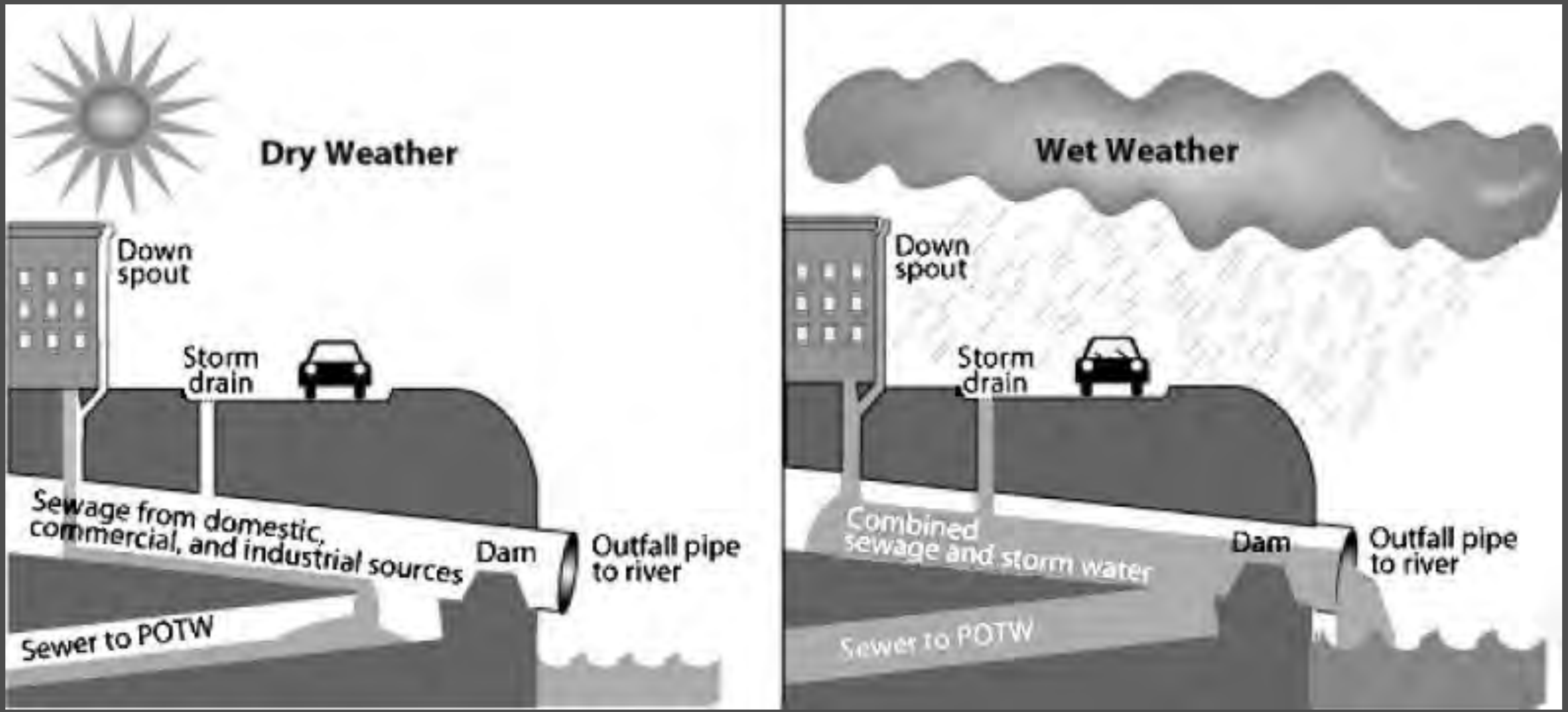
- ❑ Finalize LTCP
- ❑ Report

Introduction to CSO Control Strategies and Alternatives

Combined Sewer System and CSOs



A combined sewer system (CSS) collects rainwater runoff, domestic sewage, and industrial wastewater into one pipe. Under normal conditions, it transports all of the wastewater it collects to a sewage treatment plant for treatment, then discharges to a water body. The volume of wastewater can sometimes exceed the capacity of the CSS or treatment plant (e.g., during heavy rainfall events or snowmelt). When this occurs, untreated stormwater and wastewater, discharges directly to nearby streams, rivers, and other waterbodies.

Development and Evaluation of Alternatives

- As specified in the NJPDES permits from the New Jersey Department of Environmental Protection, an evaluation of combined sewer overflow (CSO) control technologies at each outfall in the service area is required.
- The goal of identifying, developing and evaluating CSO control technologies is to identify the best strategy to reduce the frequency of overflows to no more than 4 at each outfall in a typical year.
- An evaluation of alternatives for the Adams Street WWTP, River Road WWTP and the CSO outfalls in each service area has been developed.
- The purpose of this evaluation is to submit an approvable report to NJDEP in June that provides the information needed for the Authority to then develop the Long Term Control Plans by next summer.

NJDEP CSO Controls to Evaluate

- Green infrastructure
- Increased storage capacity in the collection system
- STP expansion and/or storage
- I/I reduction
- Sewer separation
- Treatment of the CSO discharge
- CSO related bypass of the secondary treatment portion of the STP

Alternatives Analysis

Storage: Subsurface Storage Tanks, In-Line Storage

Truman School in New Haven, CT

CSO Storage Tank beneath parking lot

Alternatives Analysis

Storage: Subsurface Storage Tanks, In-Line Storage

CSO Tunnel

Milwaukee, WI

Alternatives Analysis

Conveyance: Additional Pipeline to Convey to WWTP

Siphon

Alameda, CA

Alternatives Analysis

Green Infrastructure: Adding pervious area to collect stormwater prior to entering combined sewer system, preventing overflow

Rain Garden

Onondaga County

Green Roof

Onondaga County

Alternatives Analysis

Inflow/Infiltration: Lining aging sewers to prevent groundwater from infiltrating into the combined sewer system

H1 Outfall Lining
Hoboken, NJ

Alternatives Analysis

Sewer Separation: Construct storm sewers to collect stormwater that would otherwise enter combine sewer system and contribute to overflow

New York City constructing storm sewers in Coney Island
https://www1.nyc.gov/site/ddc/about/press-releases/2016/pr-080316-storm-sewers-coney-island.page

Alternatives Analysis

WWTP Upgrades: Increase capacity at WWTP and combine with conveyance

River Road WWTP
West New York, NJ

Development and Evaluation of Alternatives

Development and Evaluation of Alternatives

Development and Evaluation of Alternatives

- Alternatives Workshop
  - In June 2018, a Workshop was held by consultants and the Authority to conceptualize possible control technologies in each drainage area.
  - Results of the System Characterization (June 2018) were referenced to estimate the target volume in each drainage area. This provided a baseline for potential size, alignment, and cost of each alternative.

Development and Evaluation of Alternatives

Alternatives Workshop → Preliminary Screening → Evaluation

- Preliminary Screening
  - Based on results of the Alternatives Workshop and conversations with the Authority, a Preliminary Screening was conducted to eliminate alternatives that either would not meet the goal of 4 overflows per year or could not be constructed due to various obstacles including land ownership, disruptive construction, and high costs.

Development and Evaluation of Alternatives

Alternatives Workshop → Preliminary Screening → Evaluation

- Evaluation
  - After the list of alternatives for evaluation was finalized, the concept was constructed in the Infoworks model to simulate the potential amount of overflows expected with implementation of the alternative.
  - After reaching the target control, conceptual cost estimates were developed.
  - Accuracy range of costs: -20% to -50% on the low end, +30% to +100%
  - Costs presented here serve as an estimate and are subject to change based on required facilities

Review of CSO Control Alternatives

Alternatives Evaluations - Adams Street

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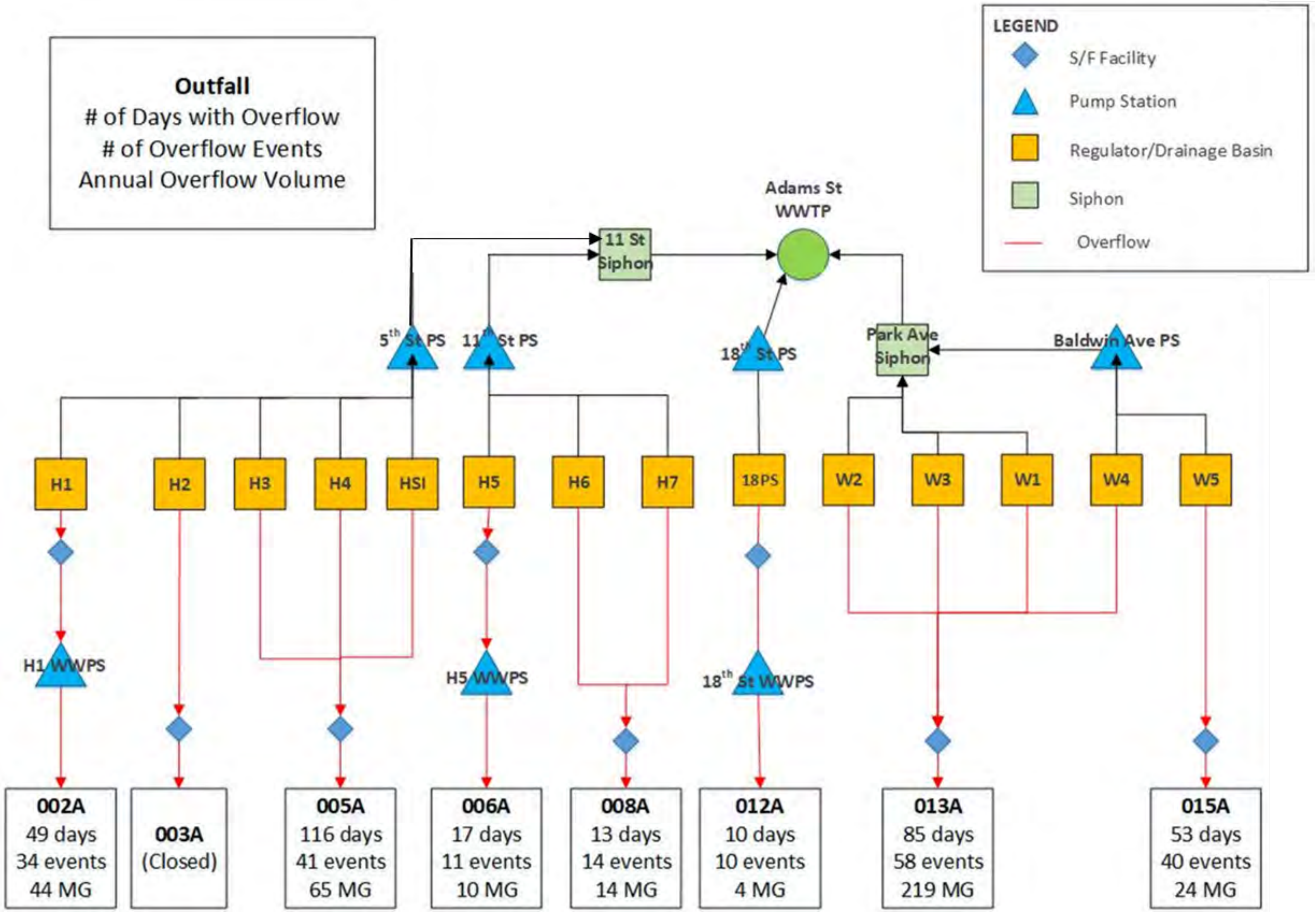
Adams Street Combined Sewer System Performance for a Typical Year



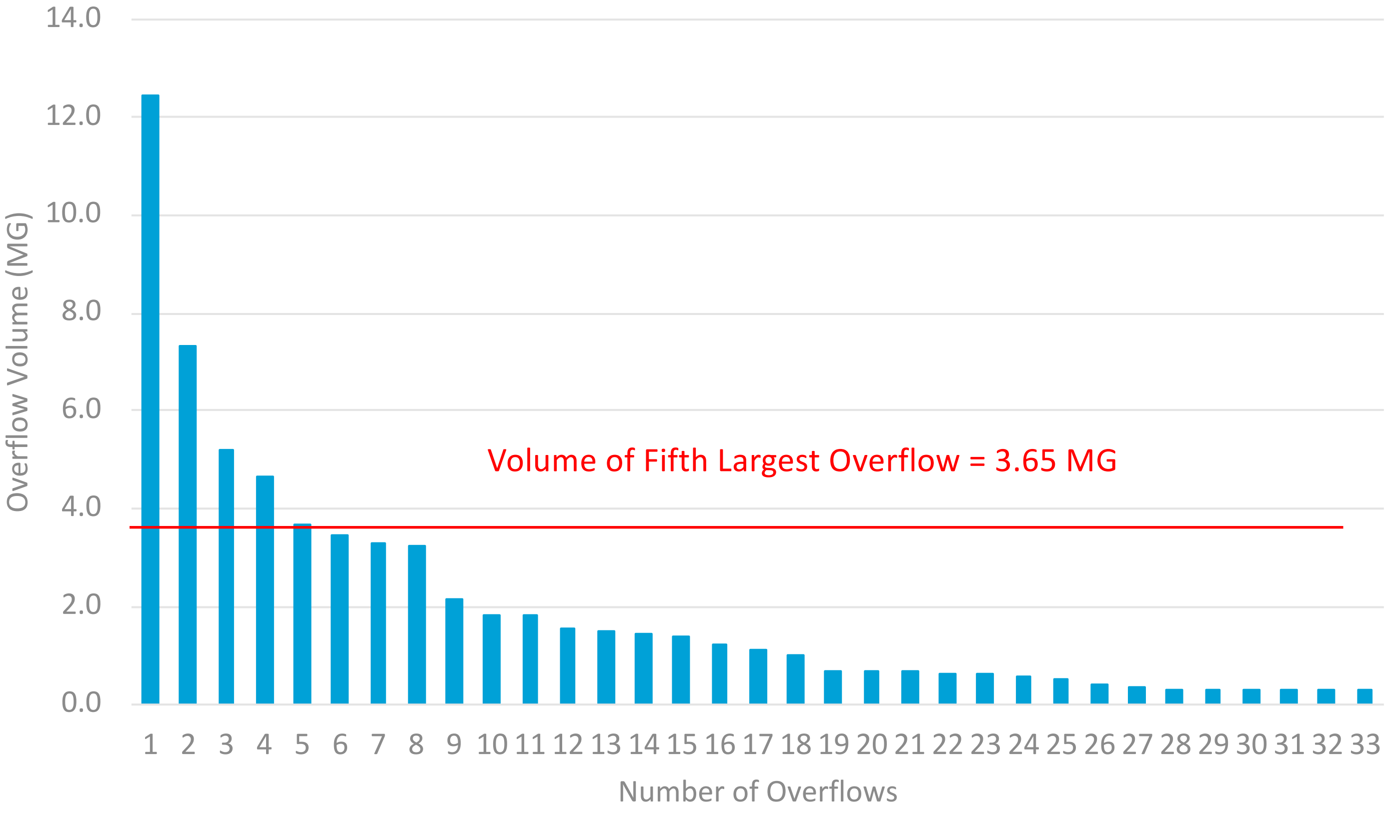
Outfall 002A (Southwest Hoboken)

Alternatives

- Storage:
  - CSO Storage Structure Lot at Observer Highway and Hudson Street
- Disinfection:
  - Combine Flows with Jersey City CSO in Long Slip Canal
  - Cloth/Compressible Media Filtration

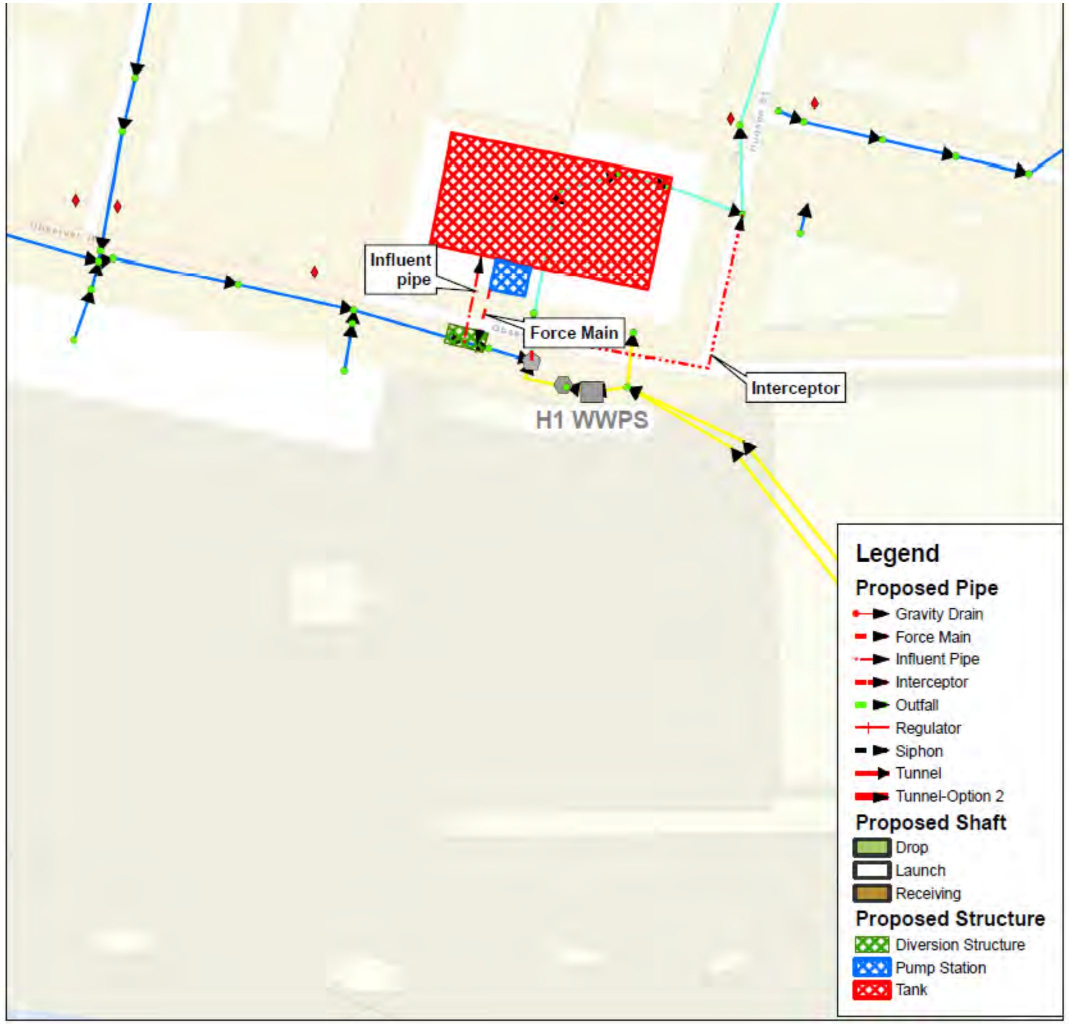
Outfall 002A (Southwest Hoboken)

Overflow Volume

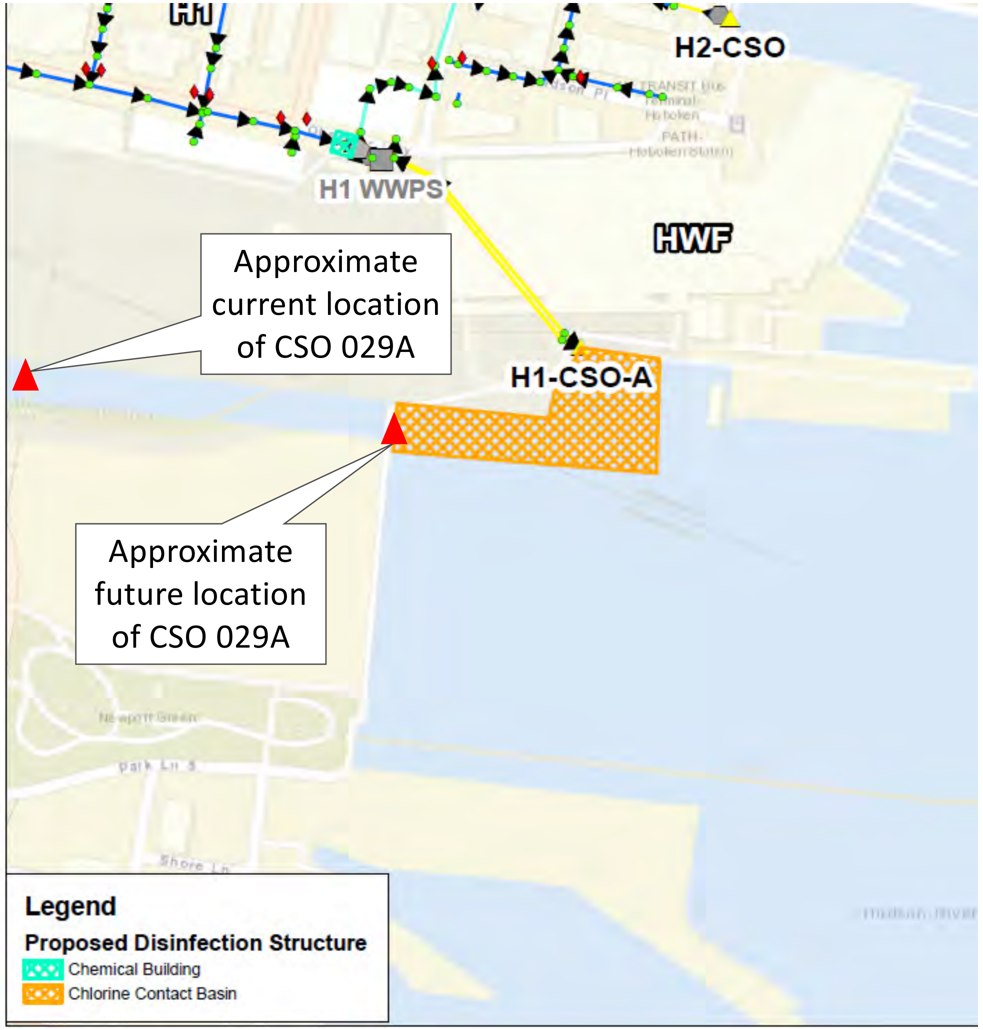


Outfall 002A

CSO Storage Structure at Lot at Observer Highway and Hudson Street



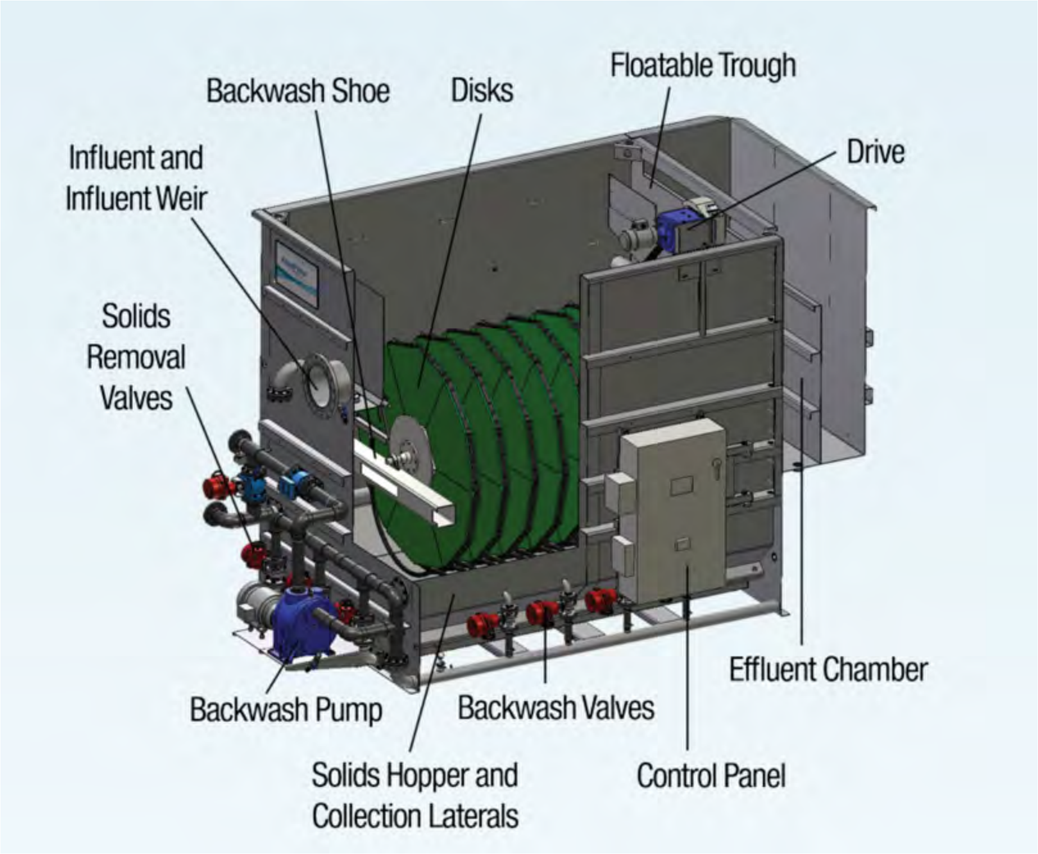
Combine Flows with Jersey City CSO in Long Slip Canal



Outfall 002A

Cloth Media Filtration

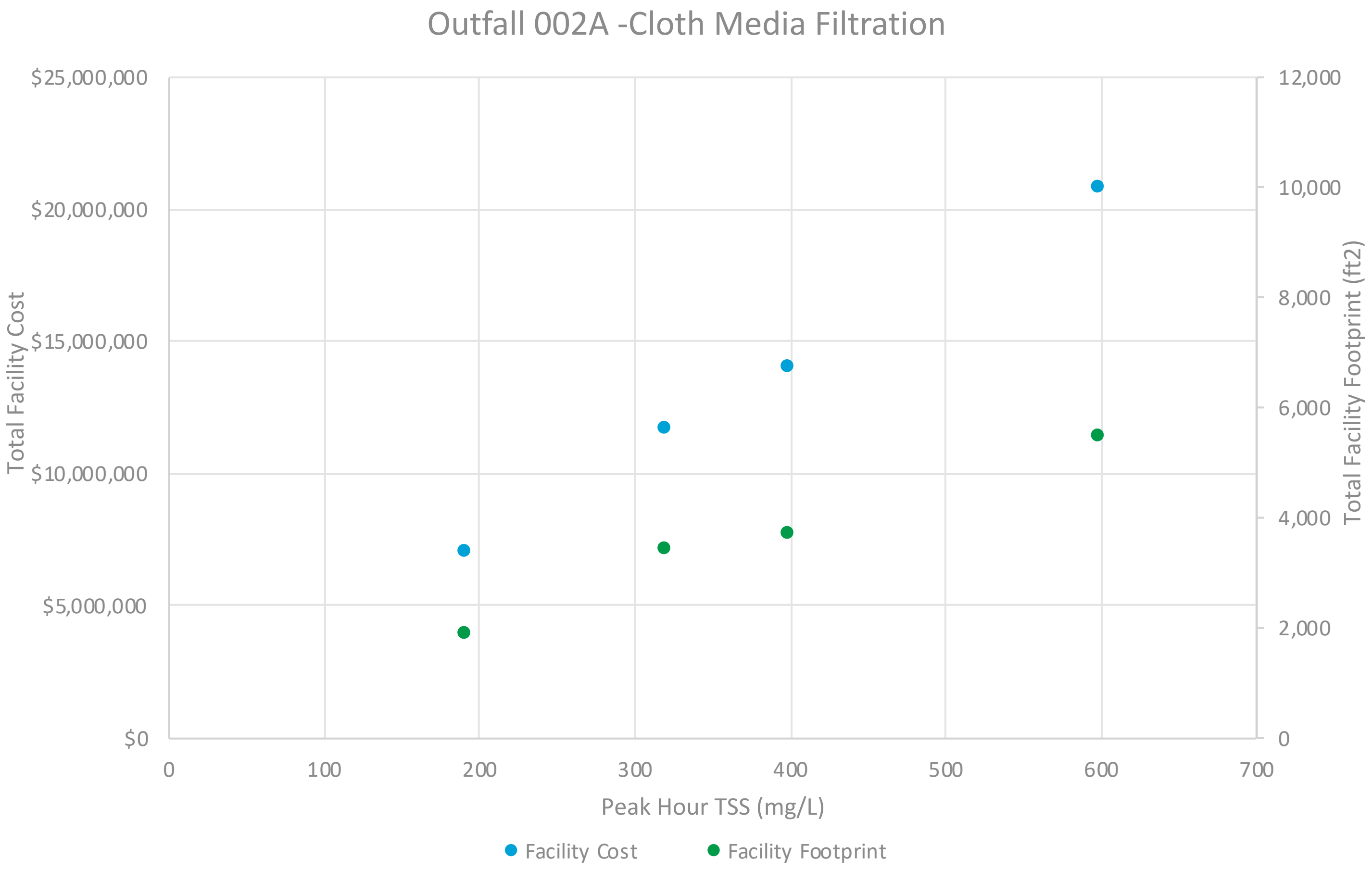
- **Aqua Prime**
  - Cloth media filtration utilizes cloth woven or fiber pile construction for 10 micron TSS removal
  - Benefits to this type of implementation is the discs are vertically oriented to reduce the required footprint and have higher solids and hydraulic loading rates than other technologies



Outfall 002A

Cloth Media Filtration

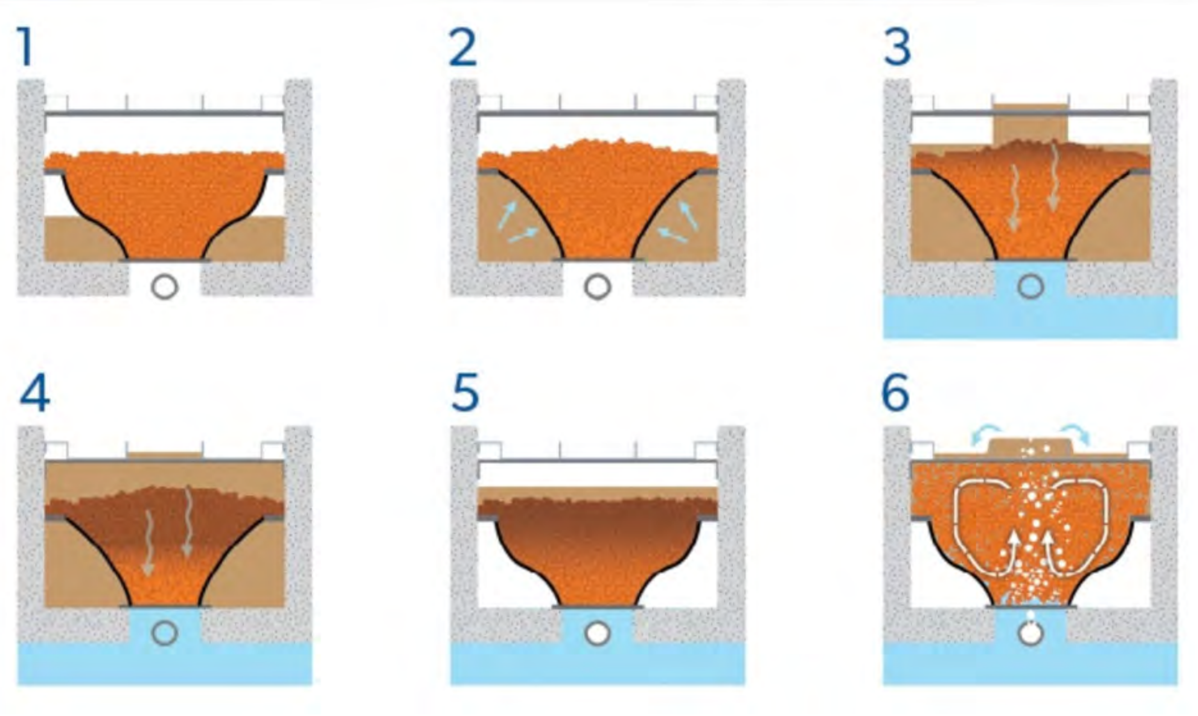
- Costs can vary dependent on TSS concentration which will be tested should this alternative be selected.



Outfall 002A

Compressible Media Filtration

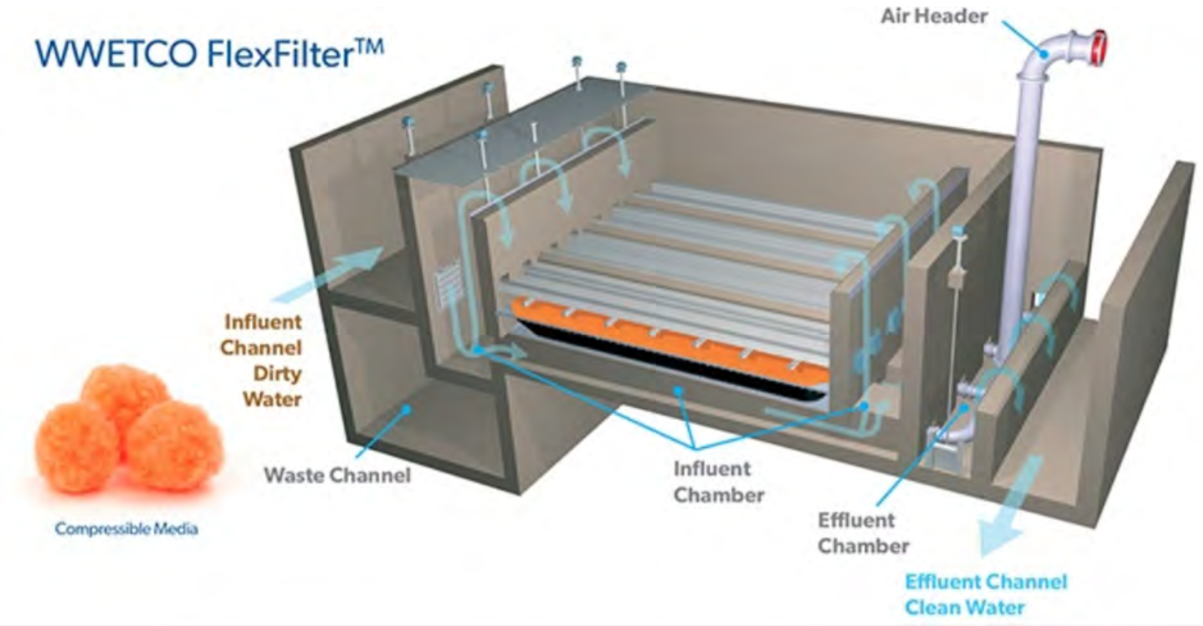
- **WWETCO Filters**
  - Durable synthetic balls which are compressed to create a porosity gradient resulting in the removal of large and small particles throughout the media bed
  - Benefits to this type of implementation are the small footprint and relatively simple operation. While this technology is ideal for solids removal, any application for this analysis will require disinfection to meet permit limits.



Outfall 002A

Compressible Media Filtration

- **WWETCO Filters**
  - Costs and footprint can vary greatly based on the peak TSS concentration. This will need to be verified should this alternative be implemented.
  - With an assumed peak TSS concentration of 320 mg/L, an approximate **footprint of 11,932 sf**



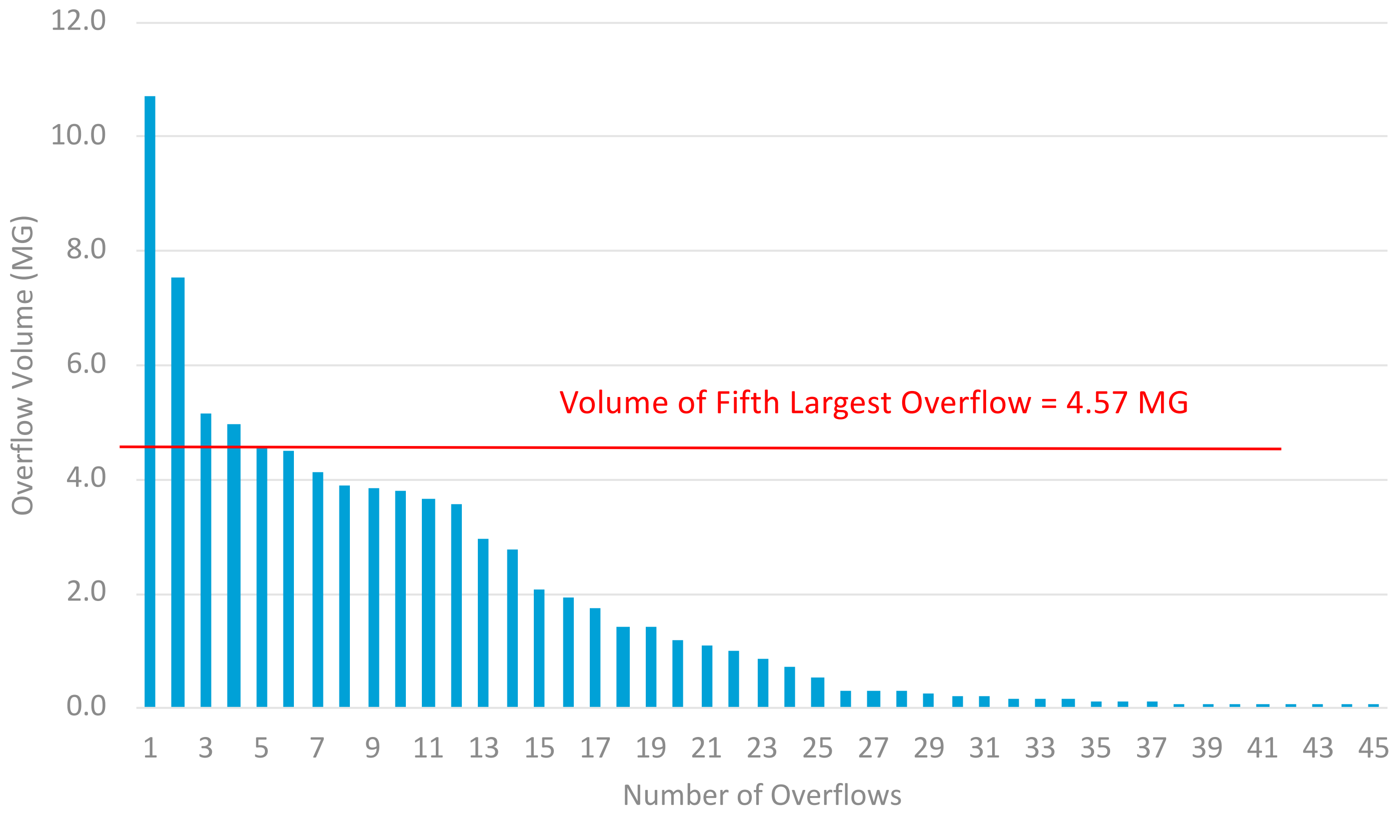
Outfall 005A (Central Hoboken)

Alternatives

- Disinfection:
  - Contact Basin in Water
- Storage:
  - CSO Storage Structure in the River
  - CSO Storage Structure at Stevens Park
  - CSO Storage Structure at Baseball Field
- Conveyance
  - Convey flows to plant through 5th Street pump station

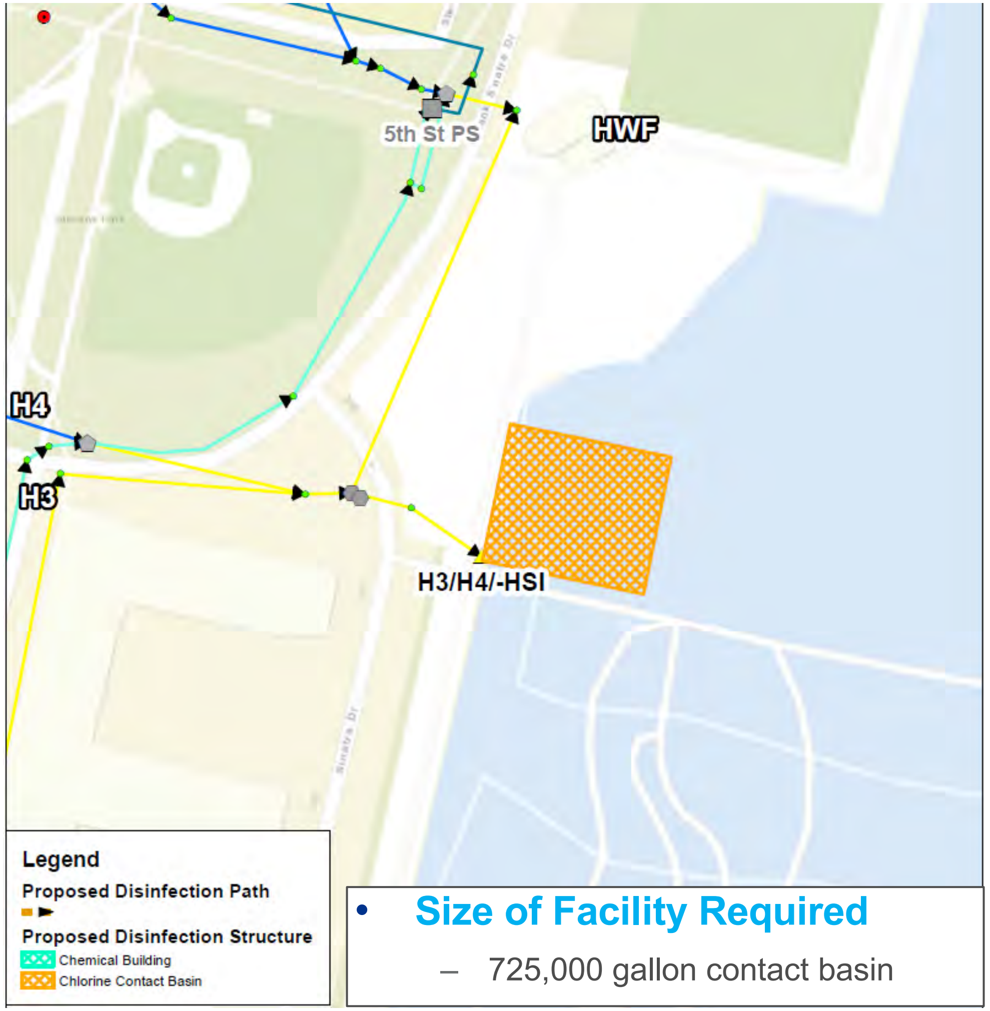
Outfall 005A (Central Hoboken)

Overflow Volume



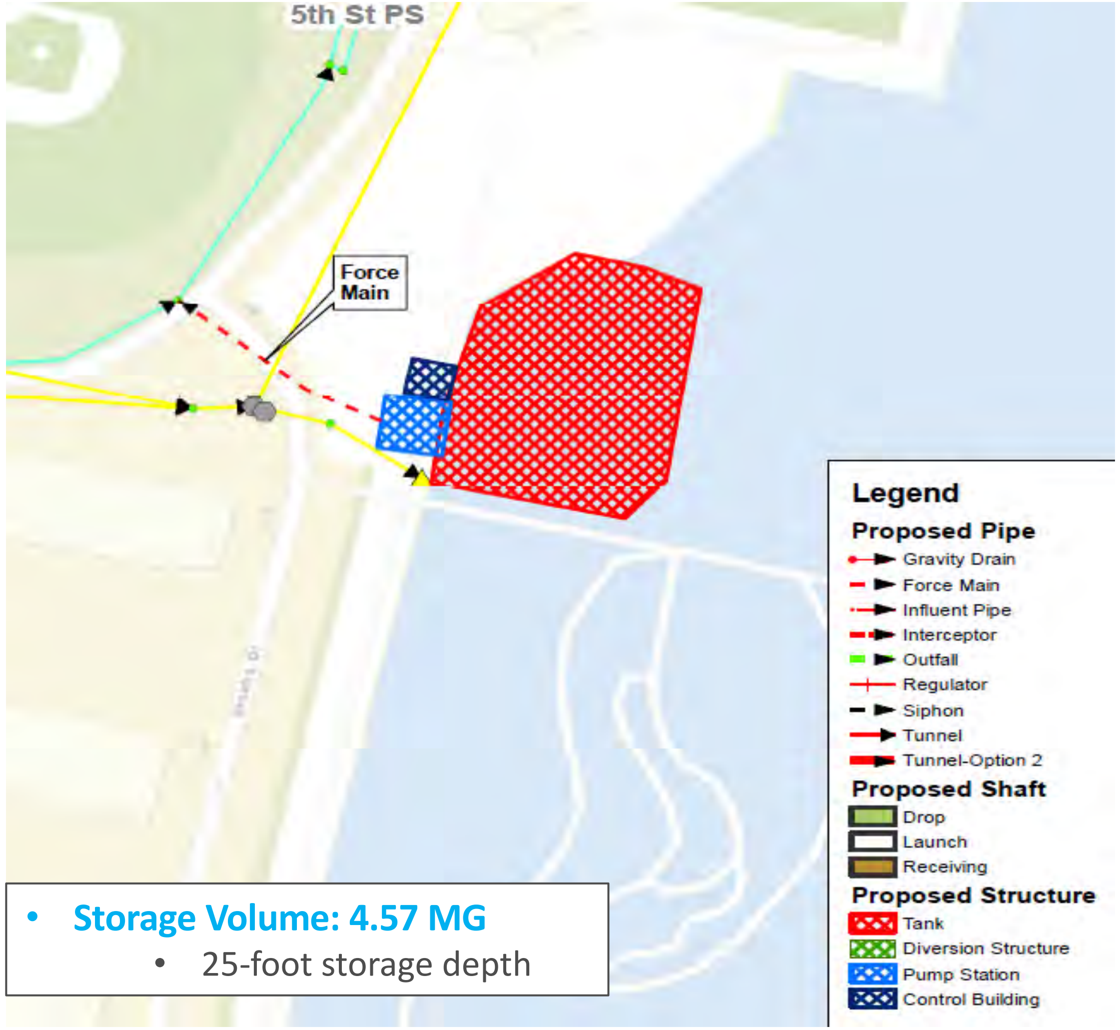
Outfall 005A

Treatment Facility in River



- **Size of Facility Required**
  - 725,000 gallon contact basin

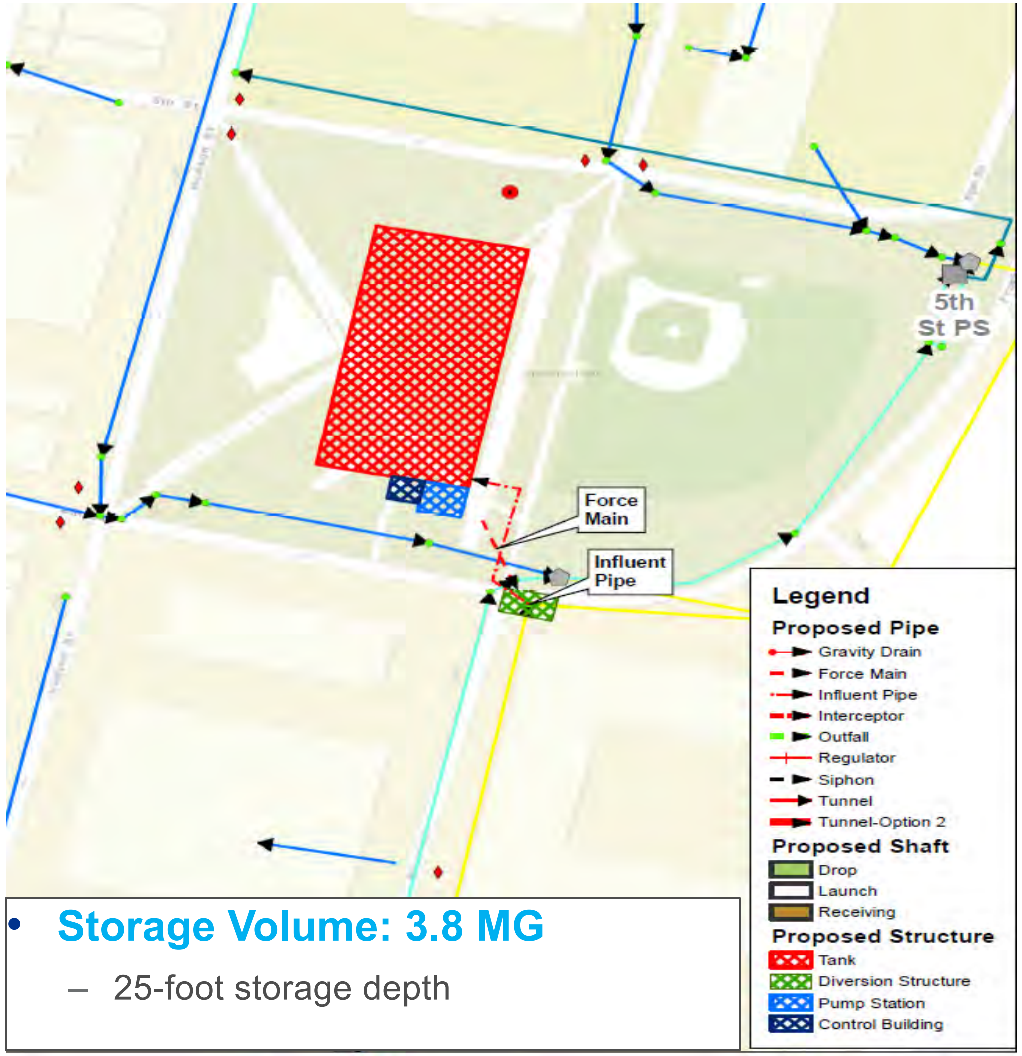
CSO Storage Structure In River



- **Storage Volume: 4.57 MG**
  - 25-foot storage depth

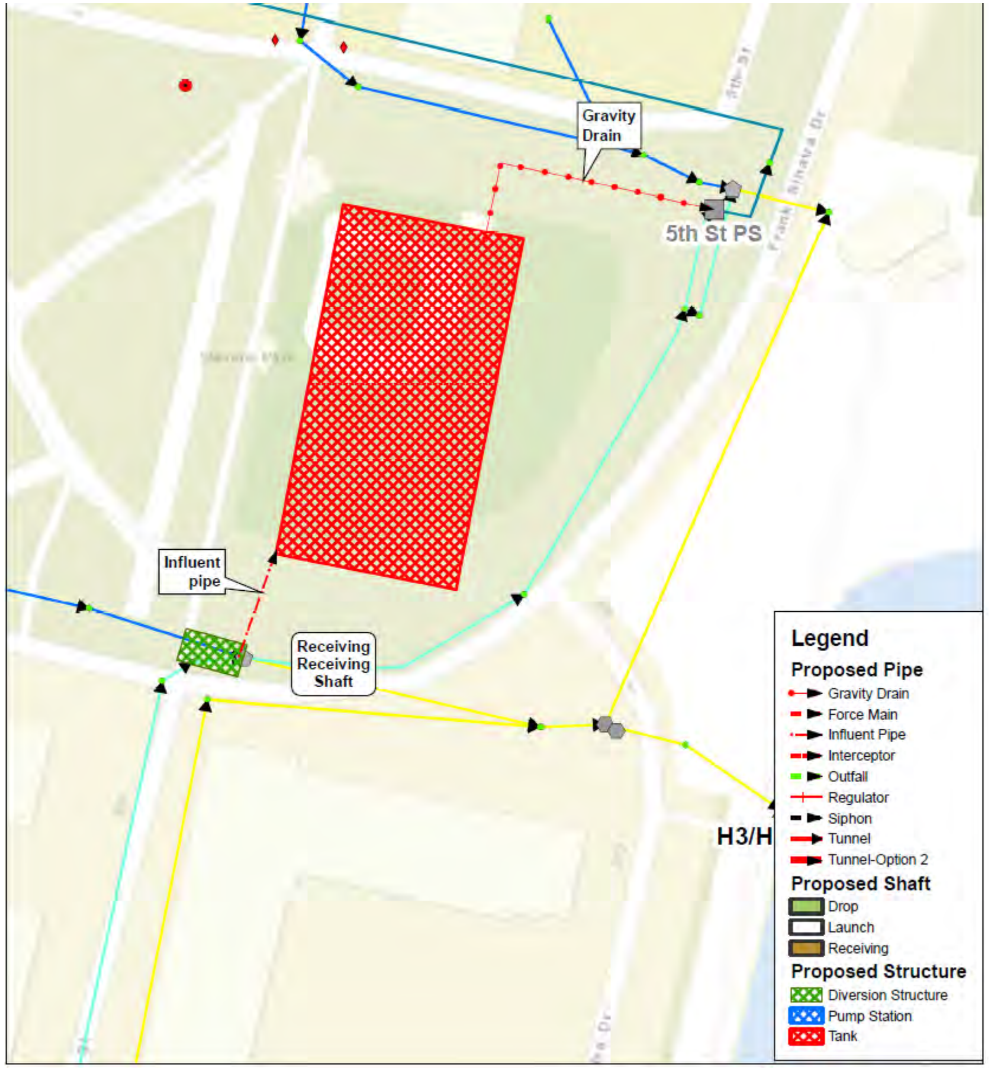
Outfall 005A

CSO Storage Structure at Stevens Park



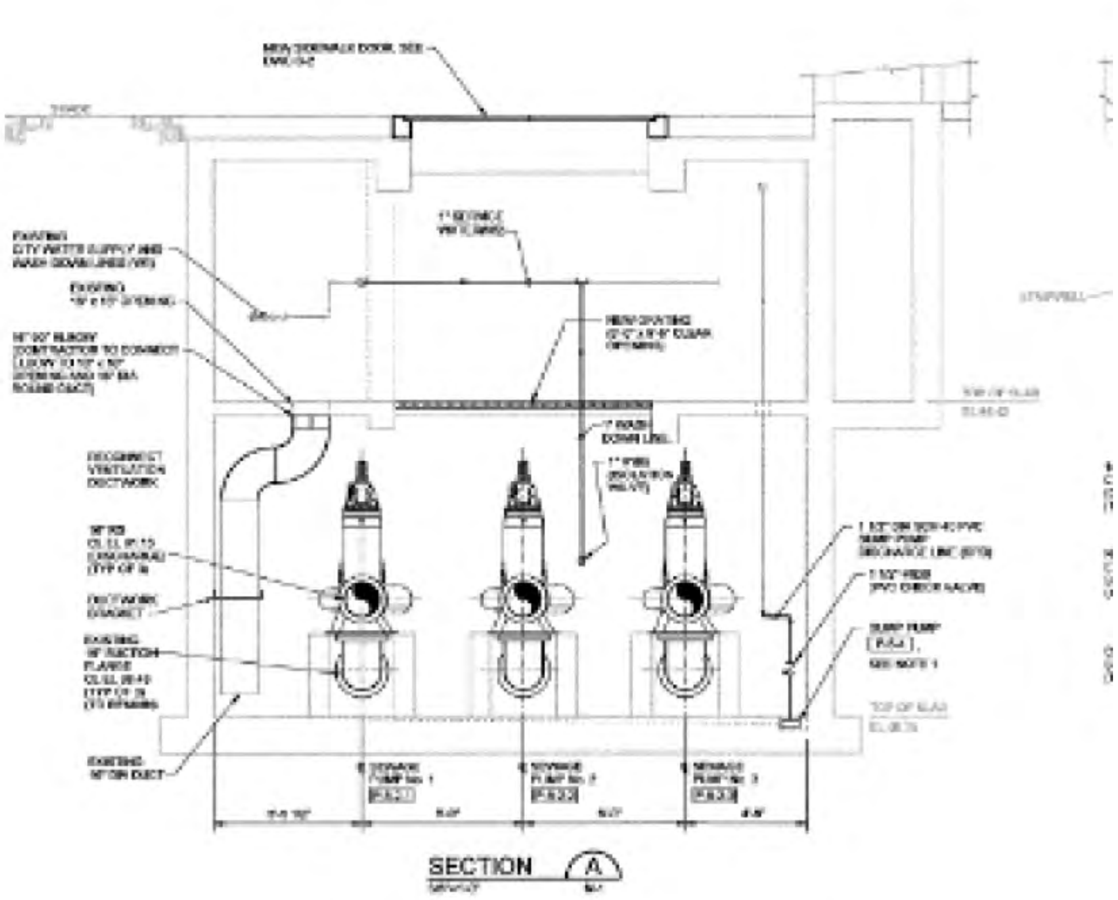
- **Storage Volume: 3.8 MG**
  - 25-foot storage depth

CSO Storage Structure at Baseball Field



Outfall 005A

Convey Flows to Plant through 5th Street Pump Station

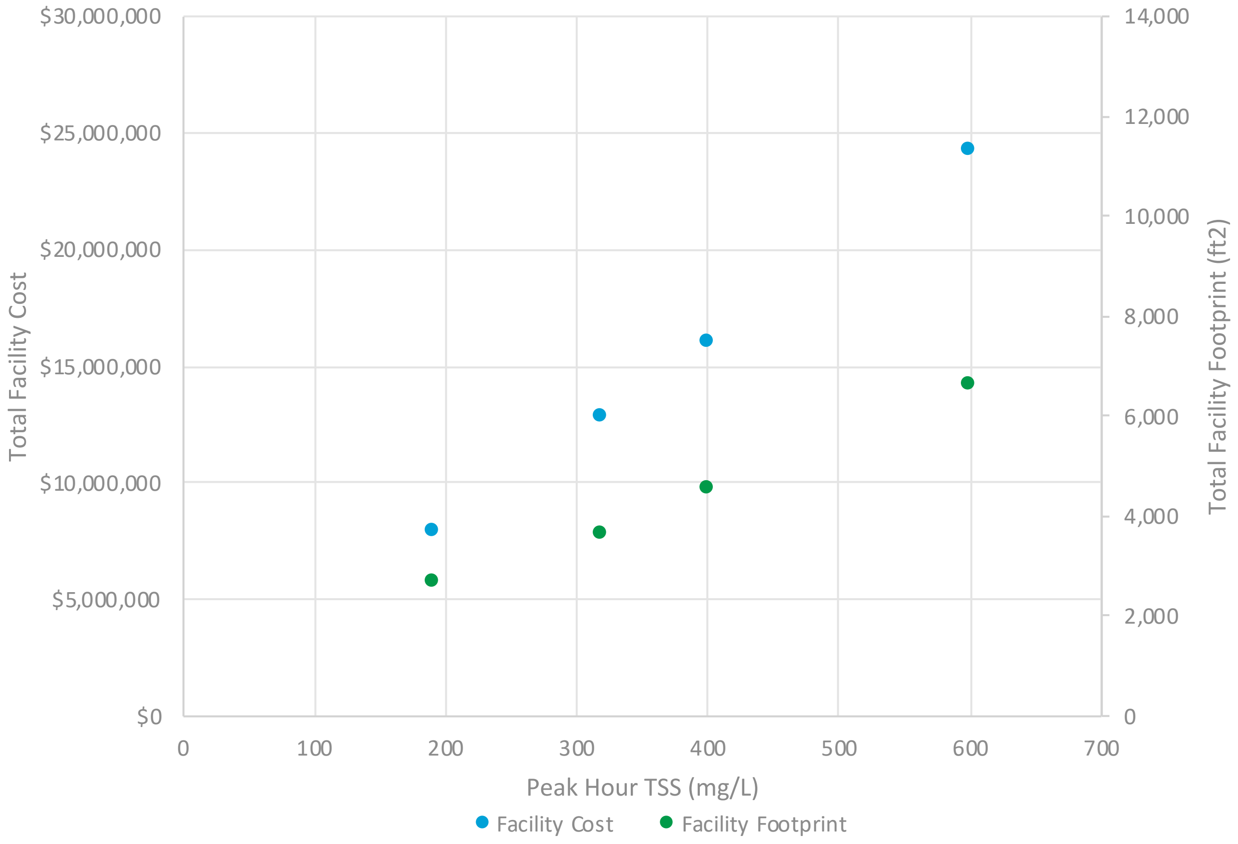


- **General**
  - Adjust H3 and H4 regulator weirs
  - Increased peak pumping rate to 31 MGD
  - Upstream capacity will need to be monitored

Outfall 005A

Cloth Media Filtration vs Compressible Media Filtration

Cloth Media Filtration



Compressible Media Filtration

- Costs and footprint can vary greatly based on the peak TSS concentration. This will need to be verified should this alternative be implemented
- With an assumed peak TSS concentration of 320 mg/L, an approximate **footprint of 14,318 sf**

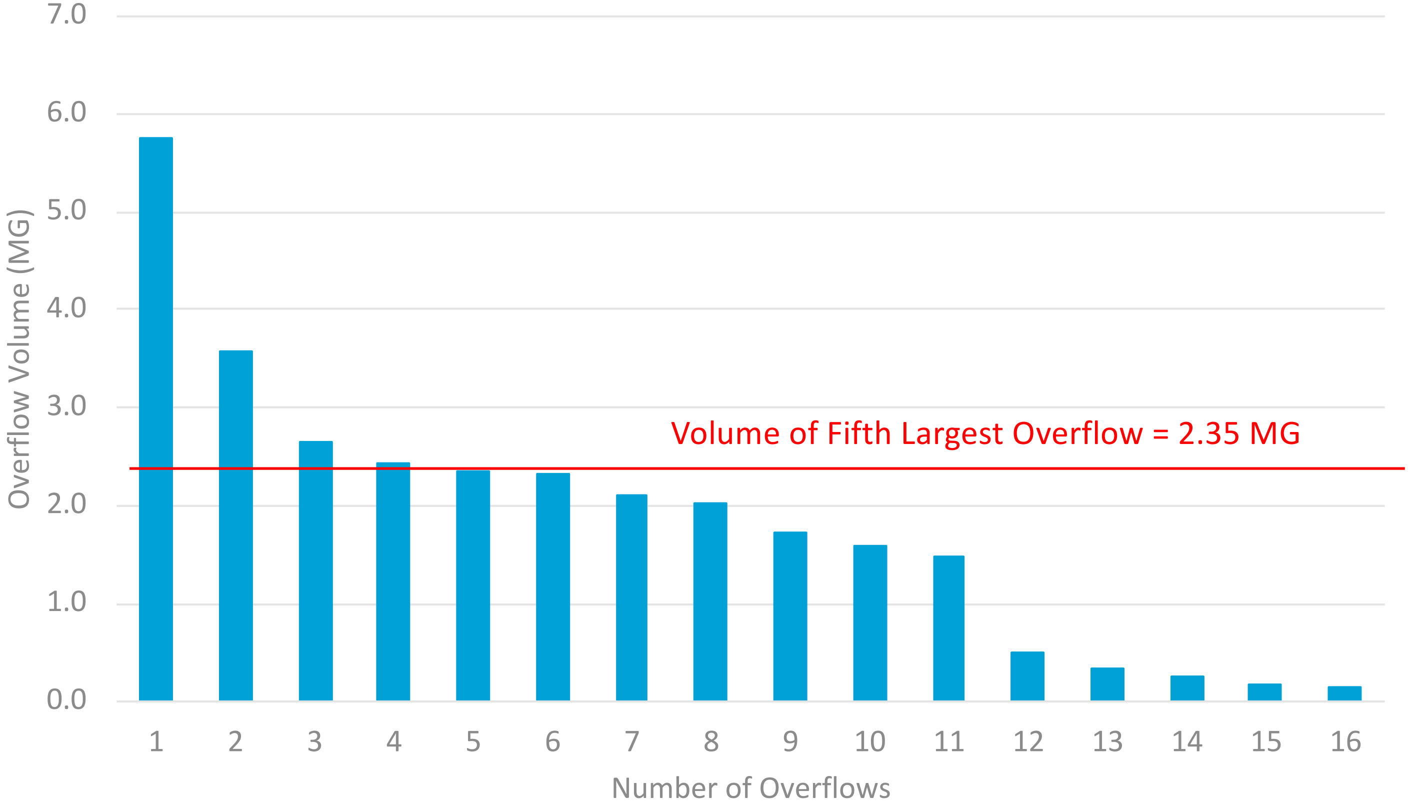
H5 Basin (Northeast Hoboken)

Alternatives

- Disinfection:
  - Incorporate Disinfection with structure at Maxwell Plaza
- Storage:
  - Linear Storage to H3 Regulator and pump flows back to plant
  - CSO Storage at Maxwell Plaza
- Conveyance
  - Convey Flows to H3/H4/HSI Drainage Basin

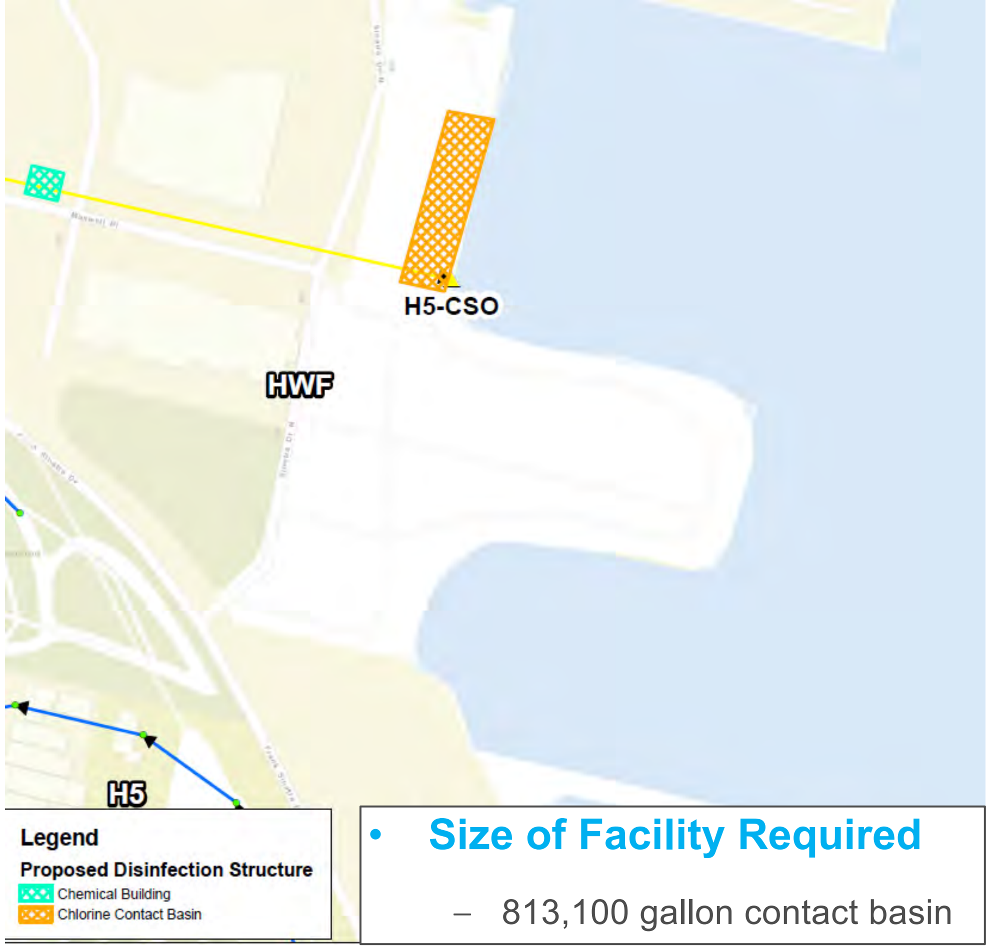
Outfall 006A (Northeast Hoboken)

Overflow Volume



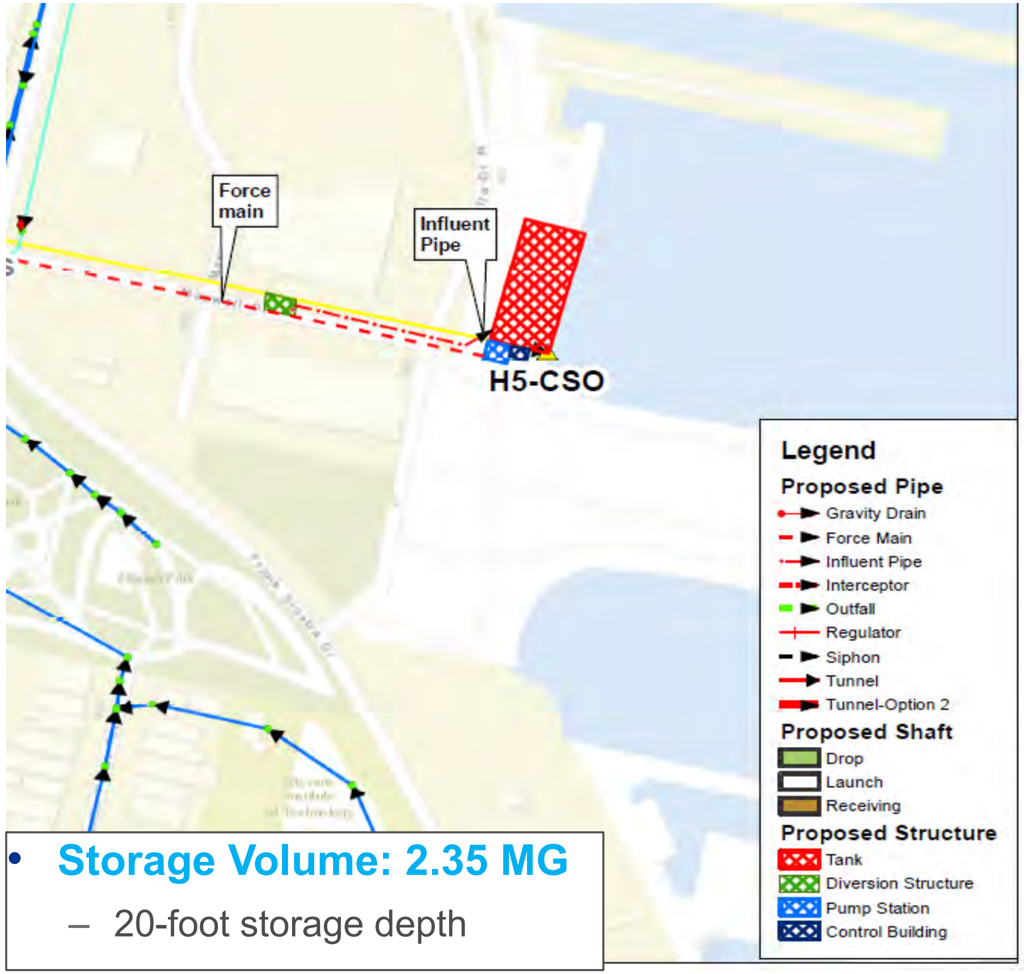
Outfall 006A

Contact Basin at Maxwell Place



- **Size of Facility Required**
  - 813,100 gallon contact basin

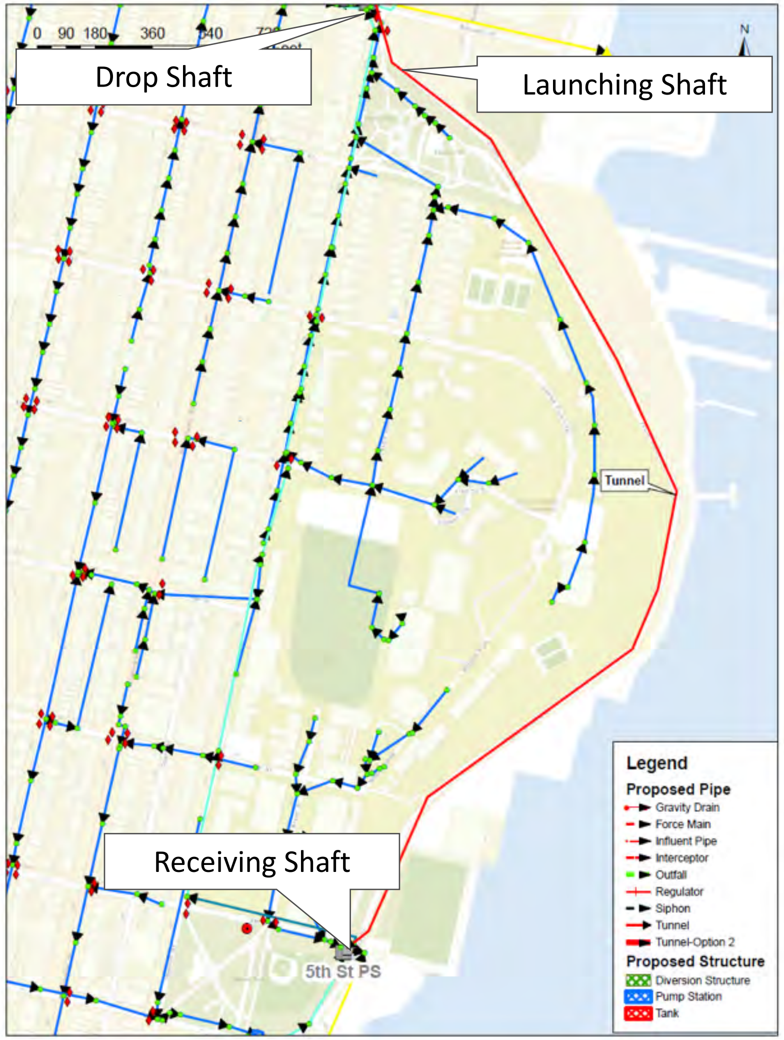
CSO Storage Structure At Maxwell Place



- **Storage Volume: 2.35 MG**
  - 20-foot storage depth

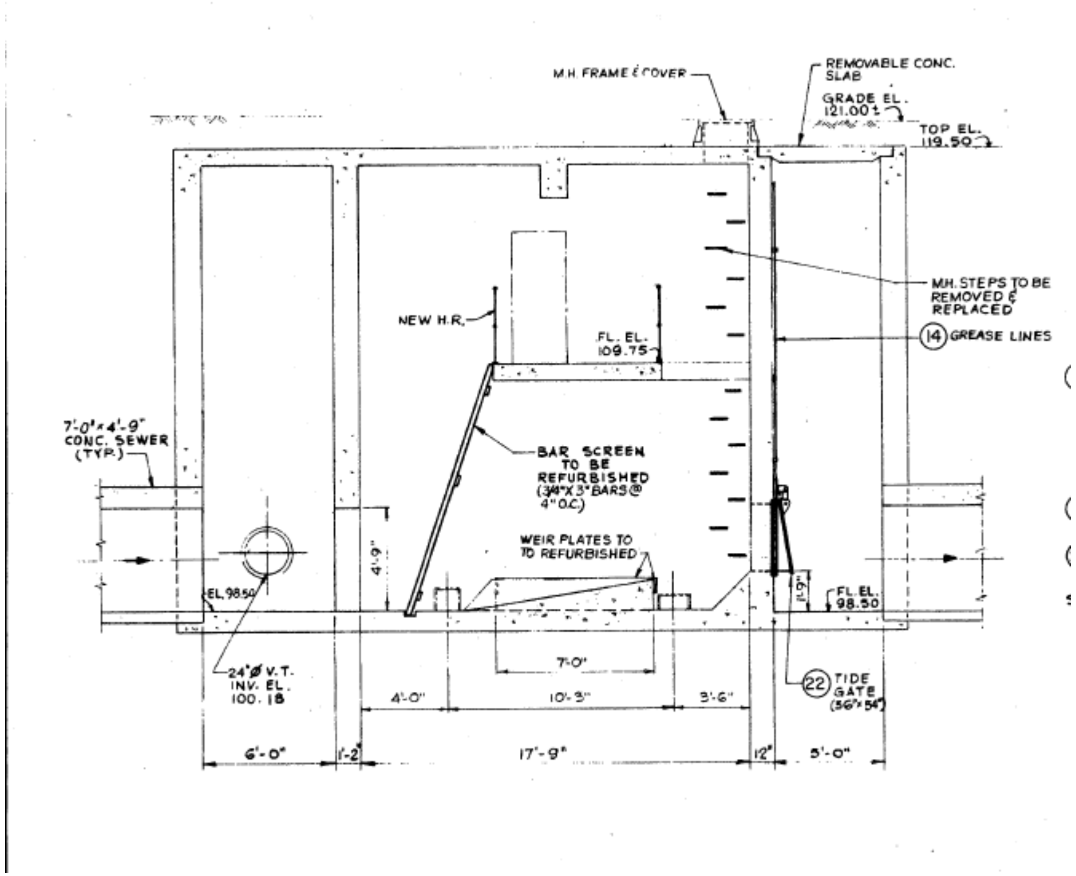
Outfall 006A

Convey Flows to H3/H4/HSI Outfall



- **Tunnel Volume: 2.35 MG**
  - 3730’ in length; 10’ ID
- **Structure**
  - 20 feet of cover

Modify the H5 Regulator to convey additional flow to the 11th St Pump Station

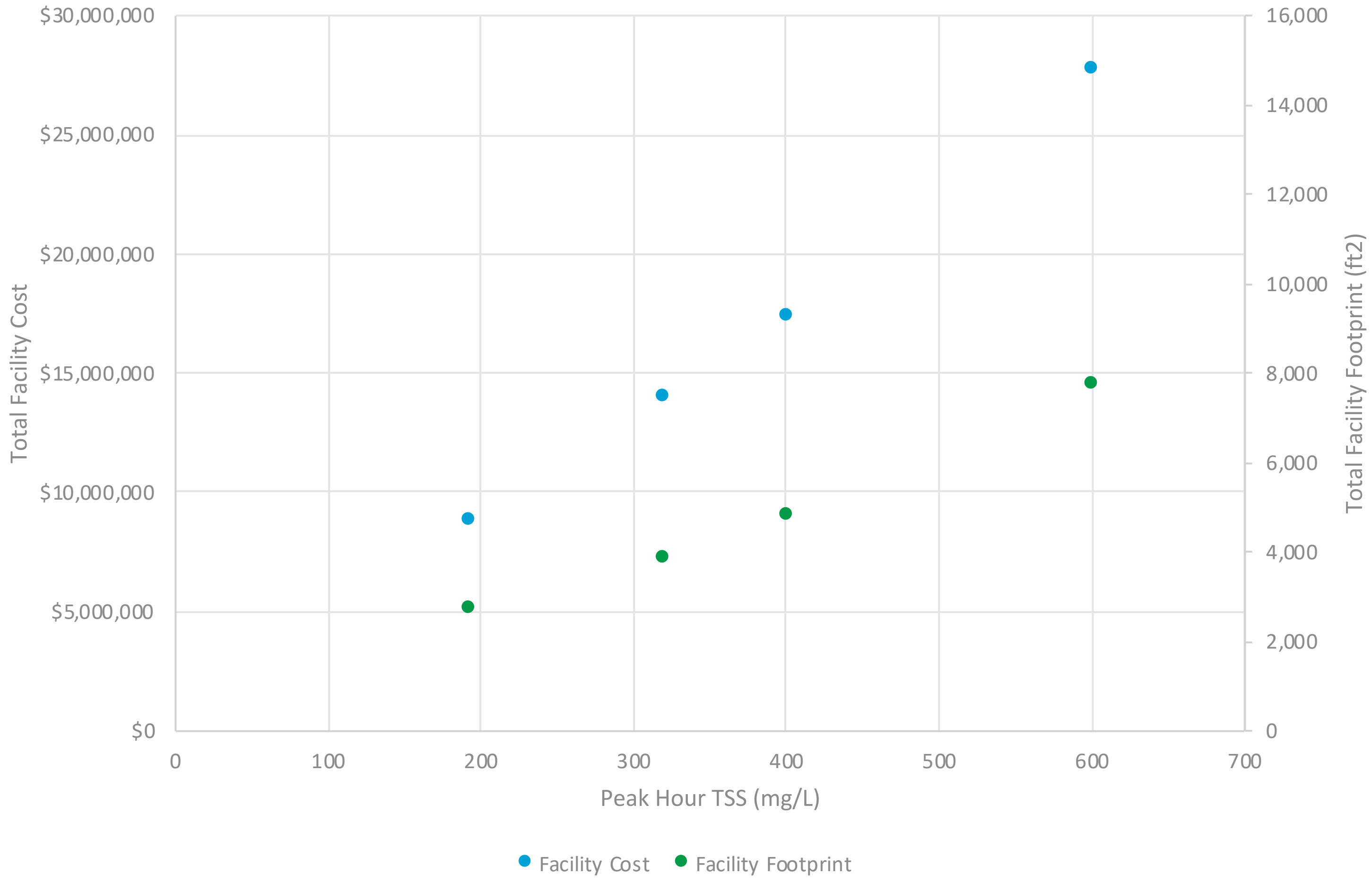


- General
  - Adjust H5 Regulator Weir
  - Increase pump station capacity from 10 to 31 MGD

Outfall 006A

Cloth Media Filtration vs Compressible Media Filtration

Cloth Media Filtration

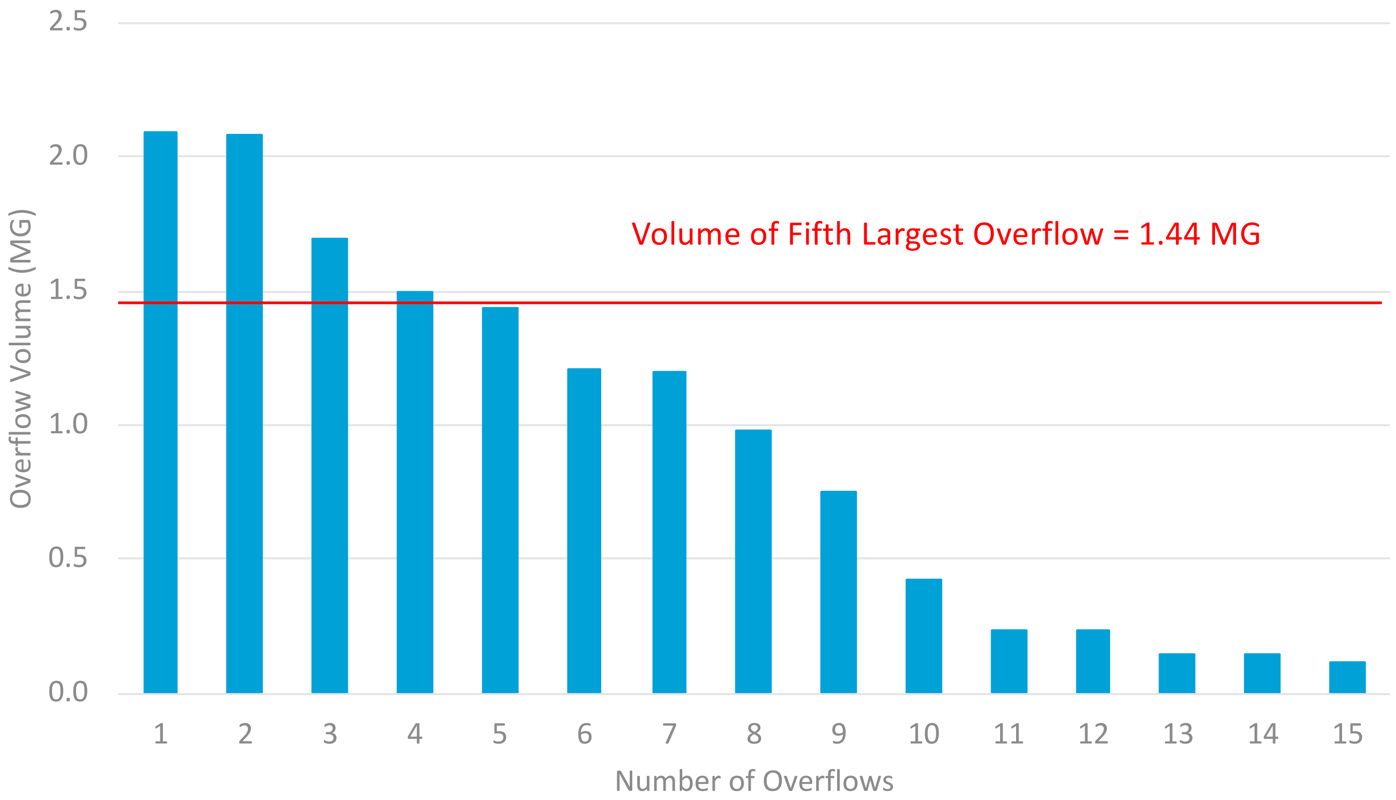


Compressible Media Filtration

- Costs and footprint can vary greatly based on the peak TSS concentration. This will need to be verified should this alternative be implemented
- With an assumed peak TSS concentration of 320 mg/L, an approximate **footprint of 14,646 sf**

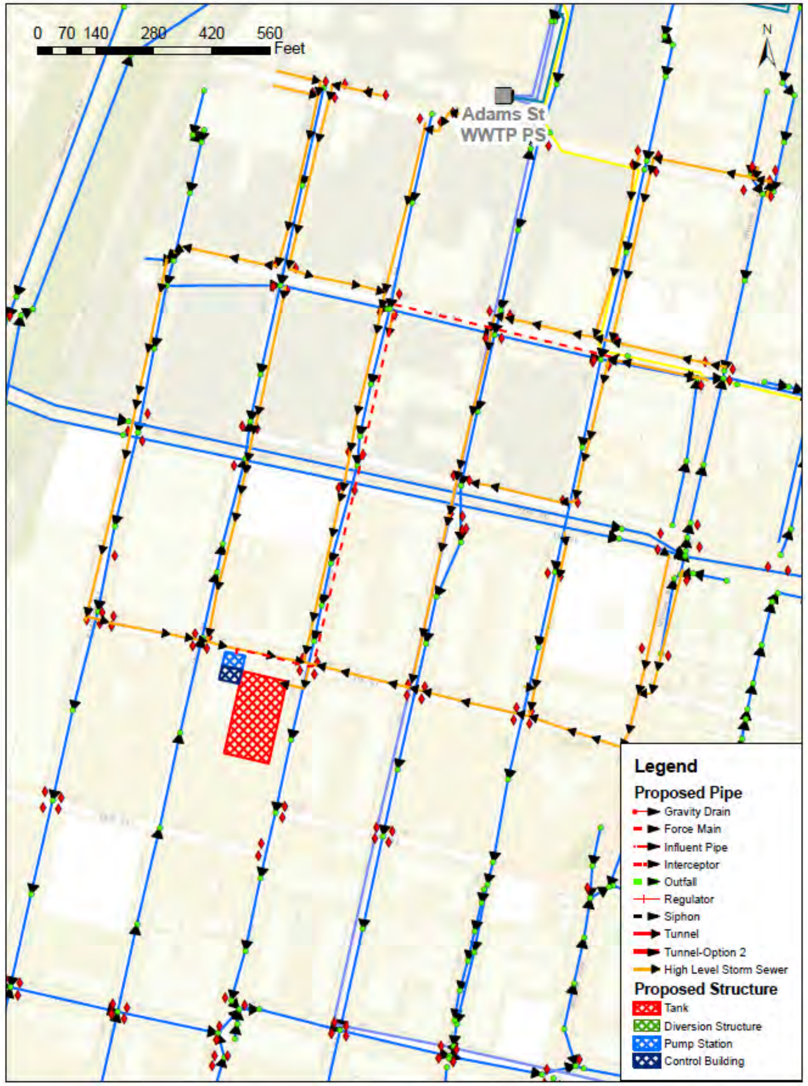
Outfall 008A (North Hoboken)

Overflow Volume



Outfall 008A (North Hoboken)

High Level Storm Sewer and Underground Storage



- **Structure**
  - Parallel system to existing system throughout roadway
  - Utilize existing inlets
  - 1 MG storage tank beneath New Northwest Resiliency park

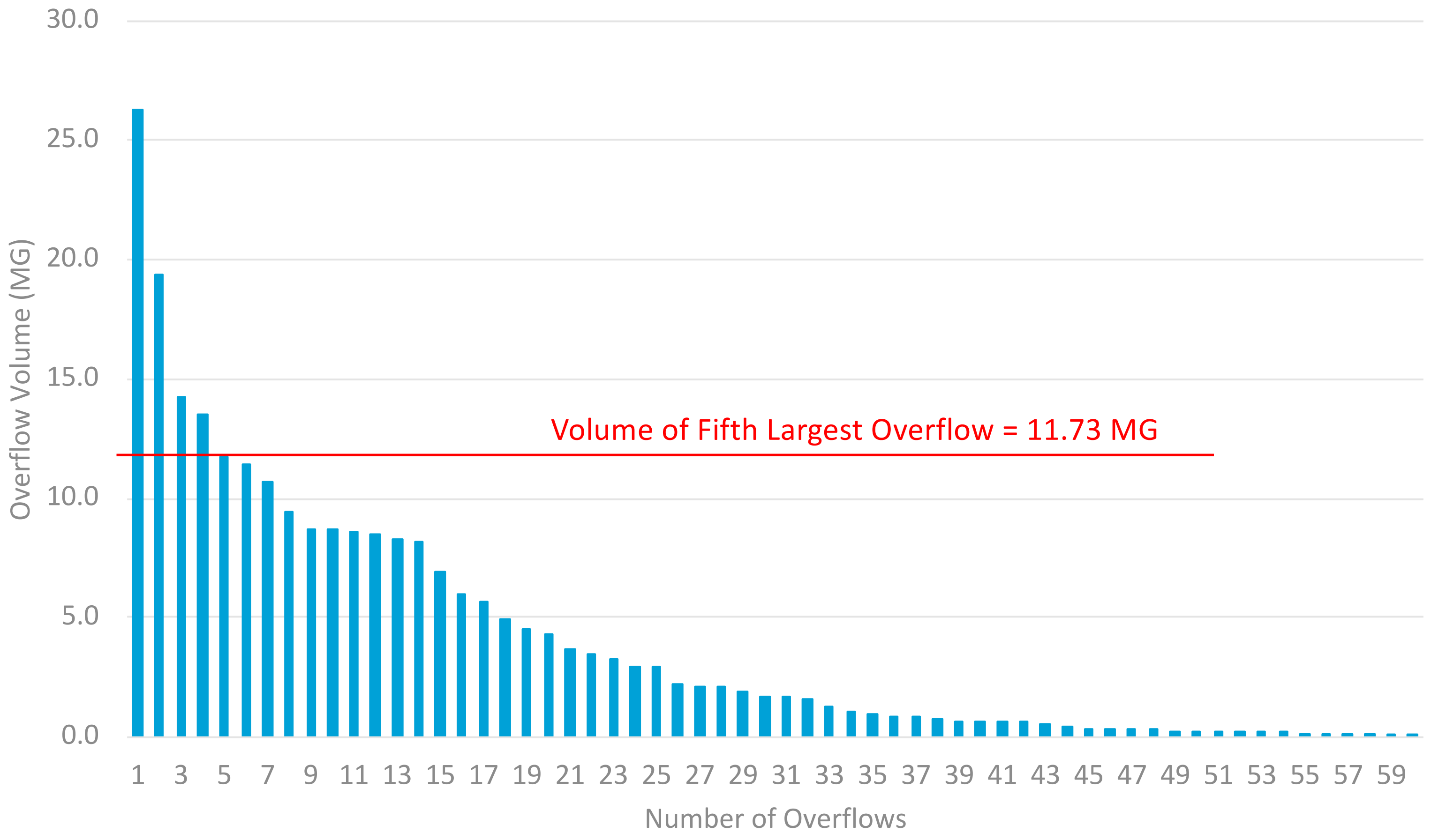
Outfall 013A (Weehawken)

Alternatives

- Disinfection:
  - Disinfect at W1234 S/F Facility
- Storage/Conveyance:
  - Install a 3rd barrel for the Park Avenue Siphon
  - Relocate Regulators W1, W2, and W3
  - Separate the W4 basin with above ground storage

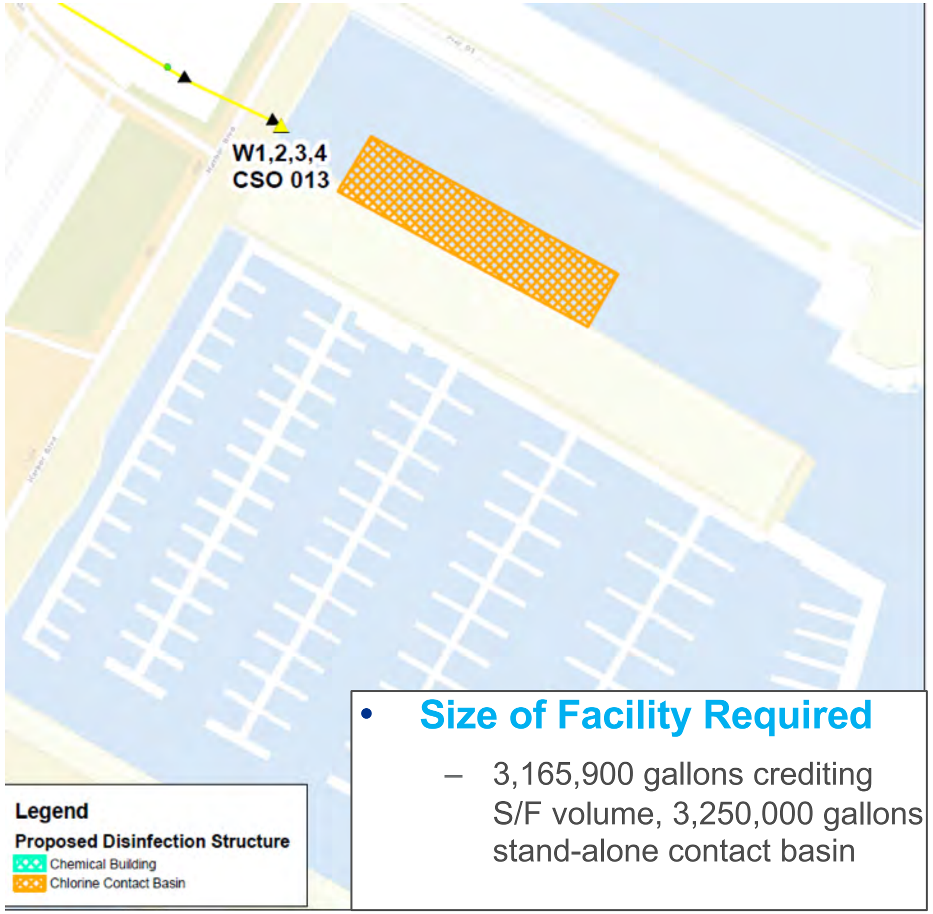
Outfall 013A (Weehawken)

Overflow Volume

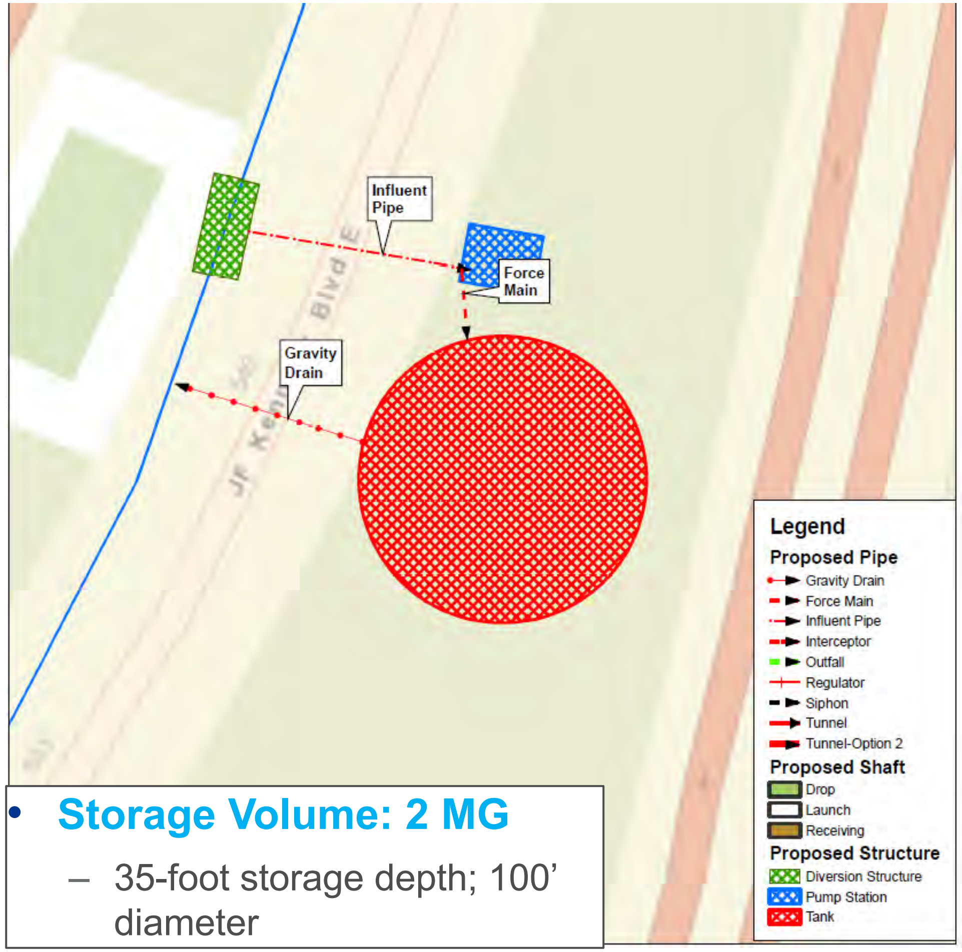


Outfall 013A

Disinfect at W1234 S/F Facility



- **Size of Facility Required**
  - 3,165,900 gallons crediting S/F volume, 3,250,000 gallons stand-alone contact basin



- **Storage Volume: 2 MG**
  - 35-foot storage depth; 100' diameter

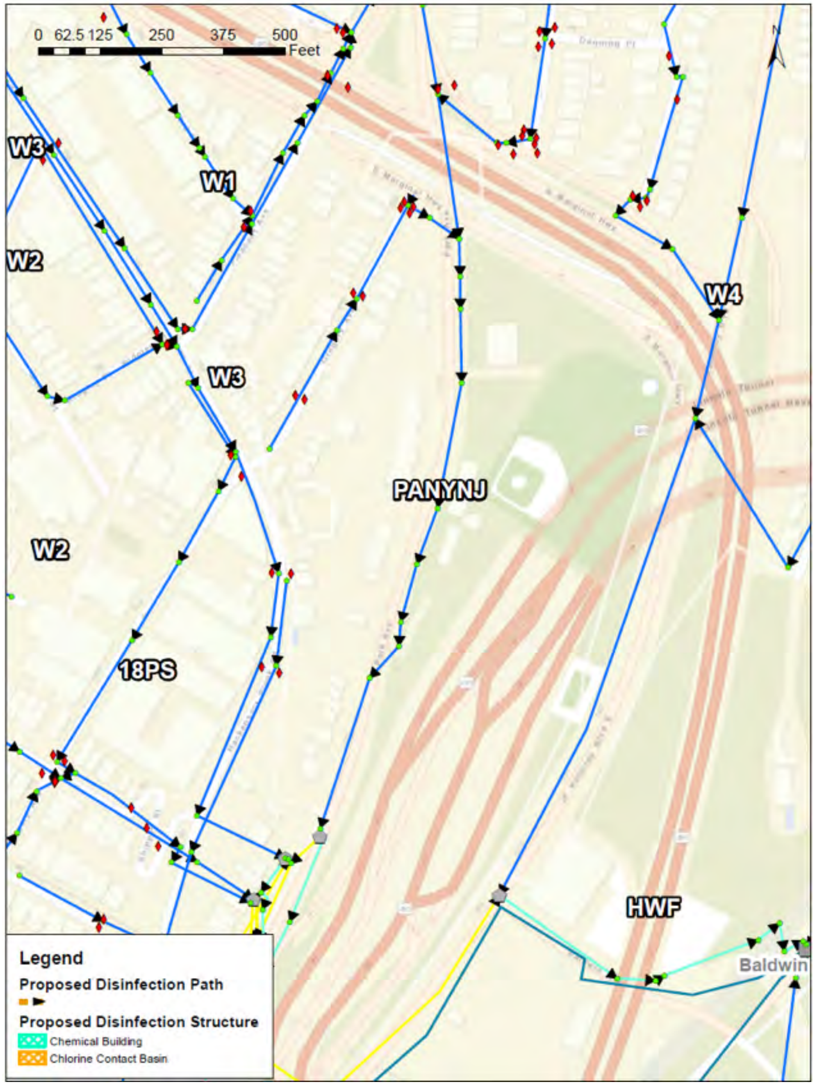
Outfall 013A

Install a 3rd barrel for the Park Avenue Siphon

- **Structure**
  - Parallel to existing Siphon
- **Piping**
  - 48” Pipe; next increment size from existing 24” and 12”

Outfall 013A

Relocate Regulators W1, W2, and W3

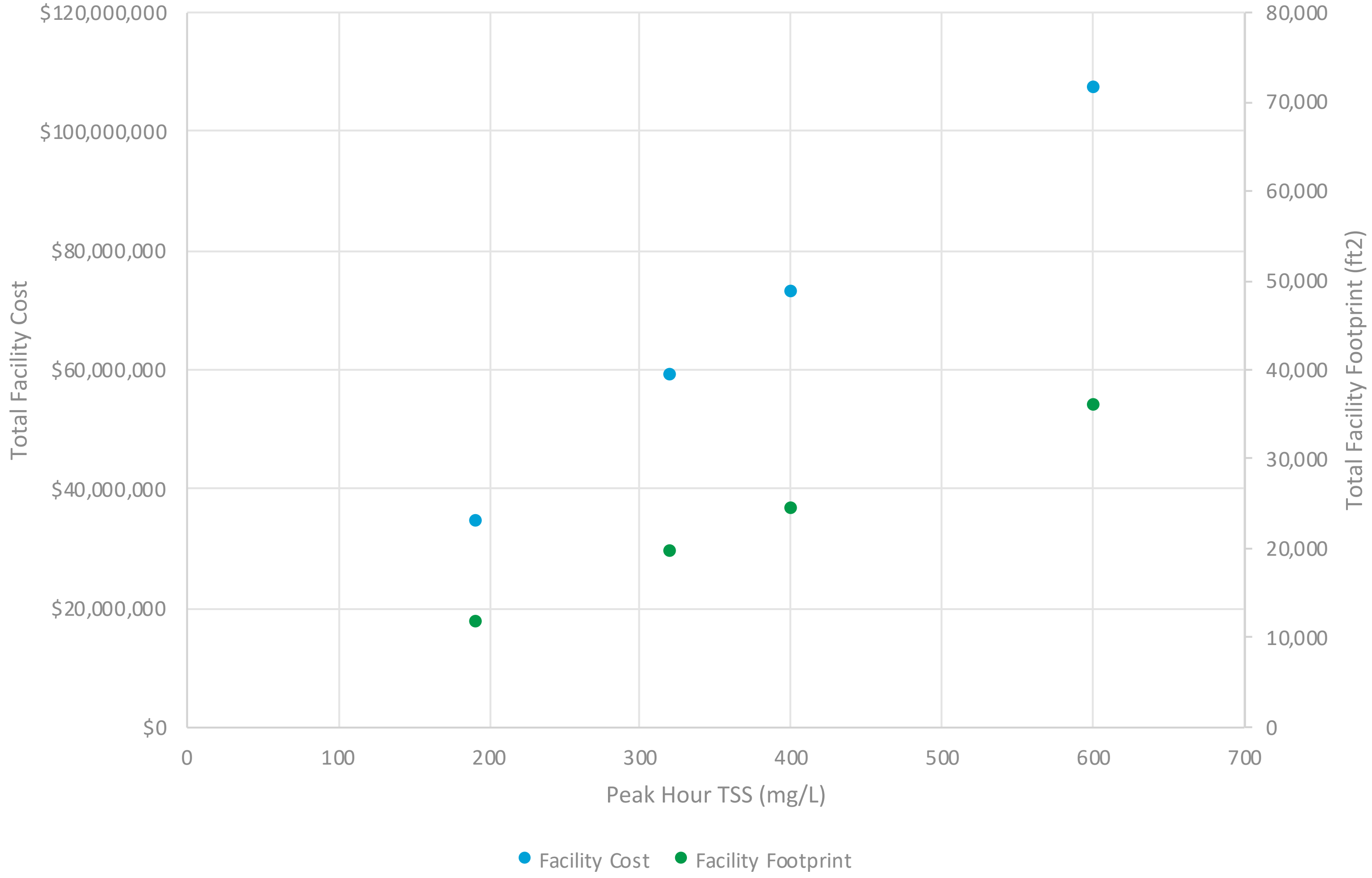


- Potential Construction
  - With potential work on proposed tunnel and increasing siphon capacity, this would provide an opportunity to relocate regulators to aid in decelerating flow to interceptor
  - This alternative is not expected to reduce flows significantly and will be combined with the other proposed alternatives for W1234 which convey flow to the plant for optimization

Outfall 013A

Cloth Media Filtration vs Compressible Media Filtration

Cloth Media Filtration



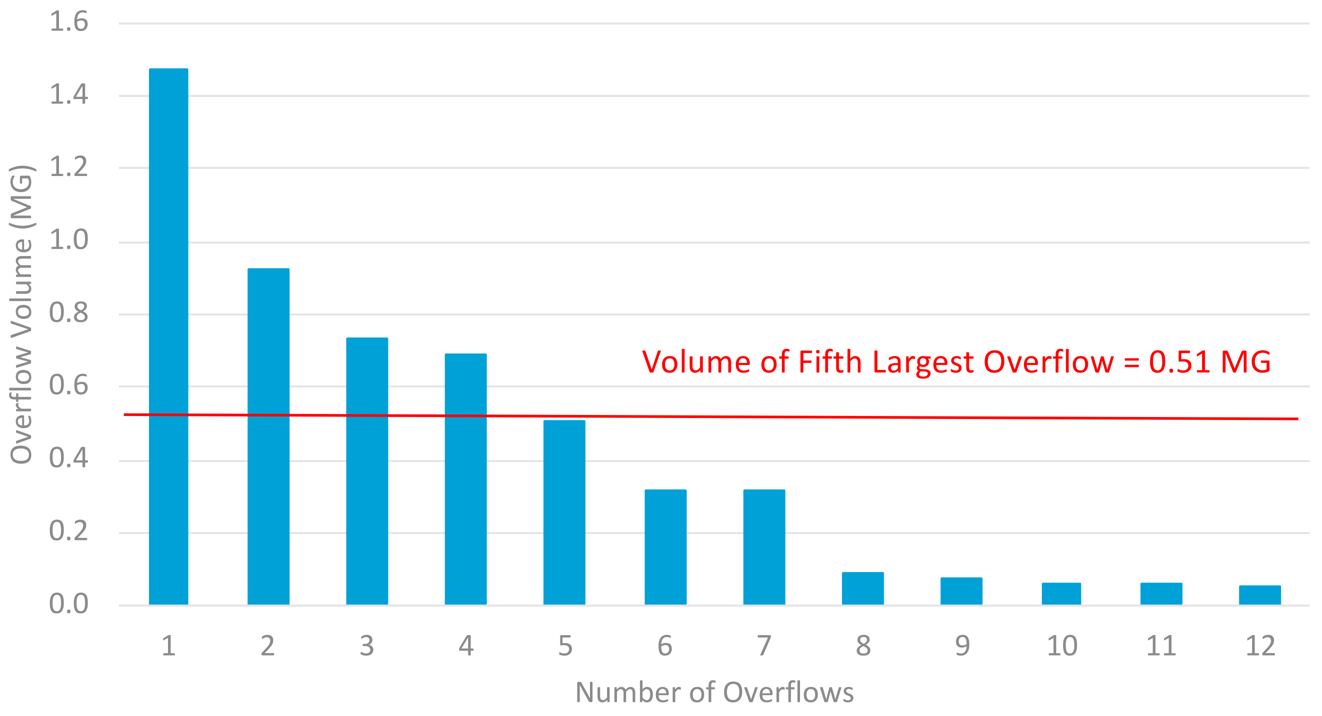
Compressible Media Filtration

- Costs and footprint can vary greatly based on the peak TSS concentration. This will need to be verified should this alternative be implemented
- With an assumed peak TSS concentration of 320 mg/L, an approximate **footprint of 59,659 sf**

Outfall 012A (South Weehawken)

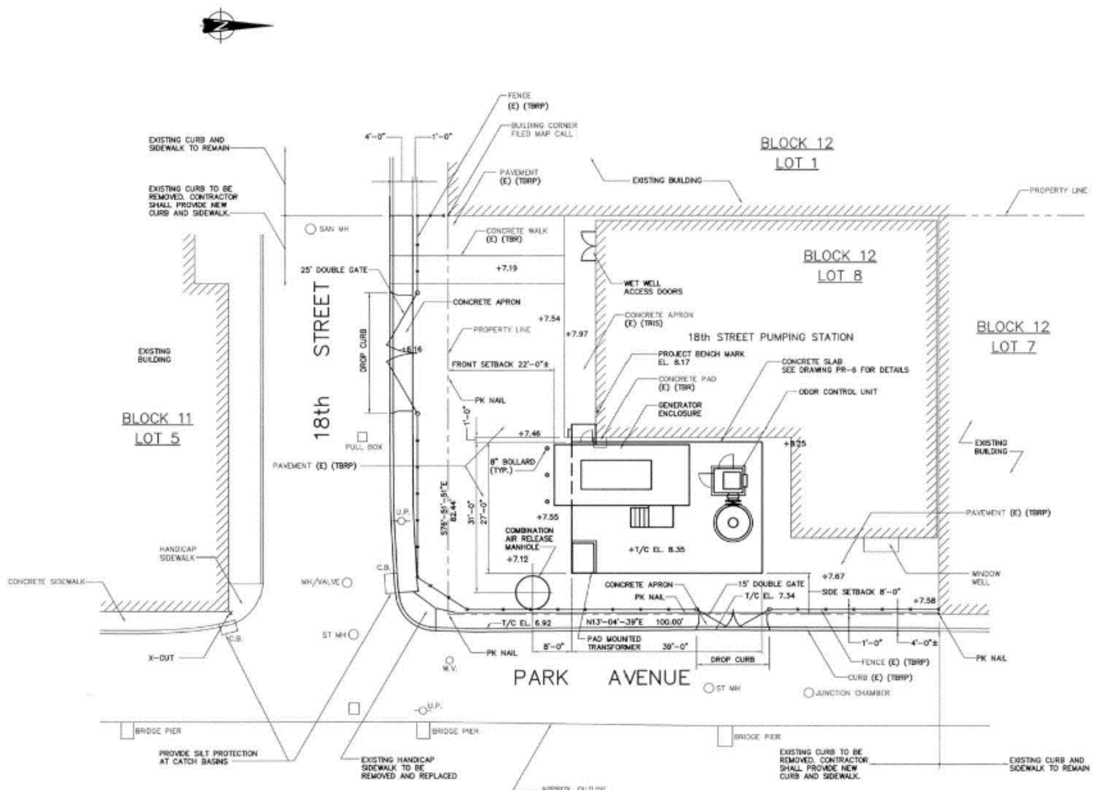
Alternatives

- Conveyance:
  - Increase Capacity of 18th Street Pump Station



Outfall 012A

Increase Capacity of 18th Street Pump Station

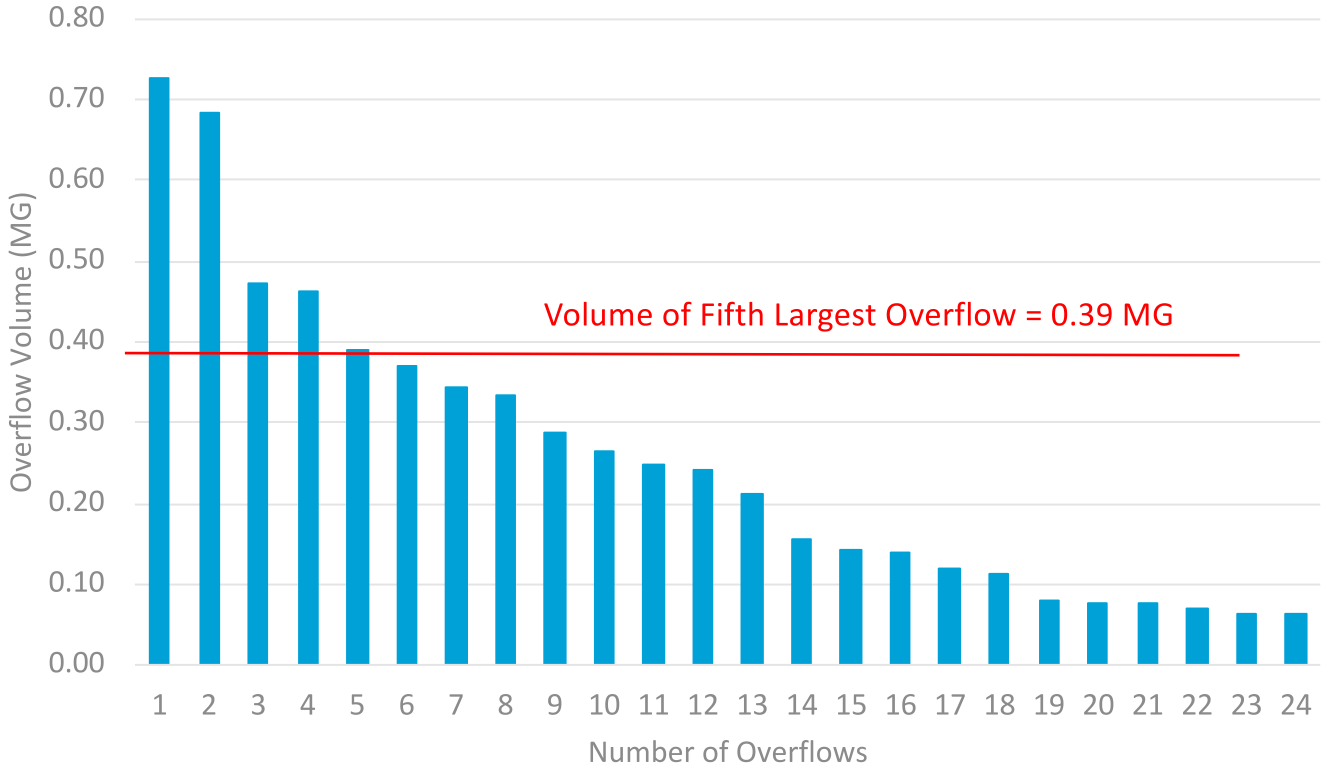


- General
  - Upgraded Capacity to 18 MGD

Outfall 015A (North Weehawken)

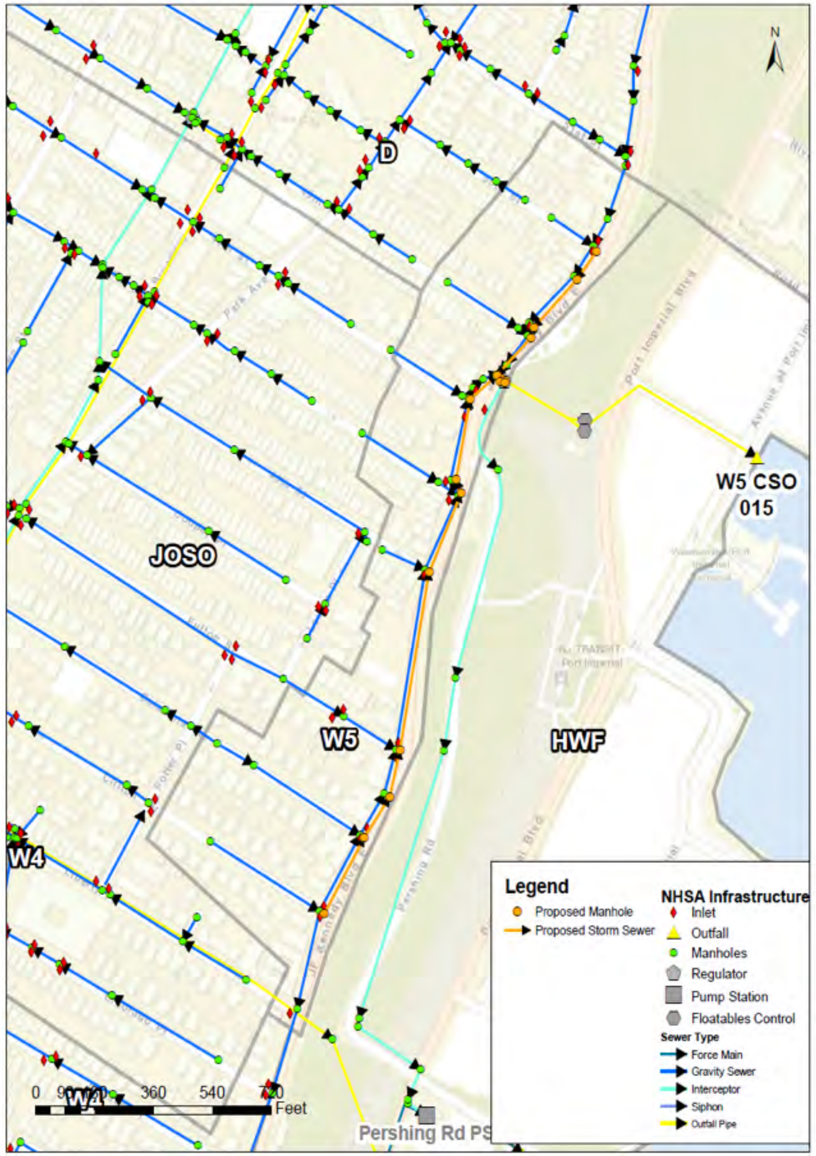
Alternatives

- Conveyance
  - Separate Storm Sewer System



Outfall 015A

High Level Storm Sewer



- **Structure**
  - Parallel system to existing system along John F Kennedy Blvd
  - Utilize existing inlets
  - Reconfigure regulator to direct sanitary flows to existing 12” Interceptor

Green Infrastructure

- Based on a land use analysis in the preliminary screening phase, it was estimated that an average of 20% of the total impervious area could be managed by green infrastructure within the Adams Street service area.
- A bioretention calculation was completed to estimate the total amount of capture within the subcatchments and the area of green infrastructure that would be required.

Adams Street Service Area

Inflow/Infiltration

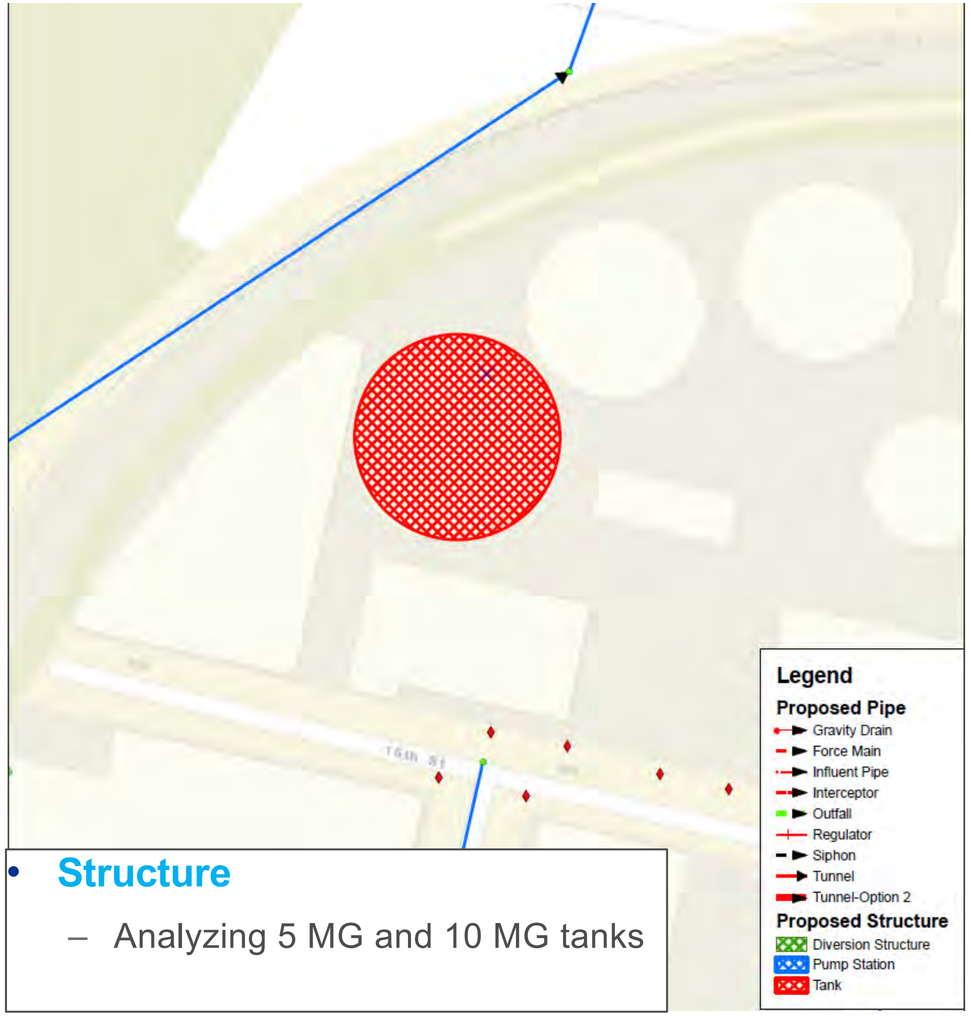
- Based on the EPA condition assessment of estimating infiltration (June 2014), the total inch diameter-miles of pipe is calculated for each drainage basin
- This unit of length is divided by the baseflow extracted from the model (mgd) and converted to a rate to represent the approximate infiltration per inch diameter-mile, or gpd/idm, of groundwater infiltration.
- In the Adams Street Service area, RedZone data was collected for the W1, W2, W3, W4, W5 and 18PS metersheds. It was assumed that pipes with a PACP score of at least 3 contributed to this infiltration

Adams Street WWTP Capacity Improvements

- Equalization of Peak Flow
  - Install Storage Tank at Trickling Filter
- Treatment
  - Blending to Allow for Increased Capacity at the WWTP
    1. Split peak flows around the filter portion of the PURAC system during wet weather to increase peak secondary capacity from 32 mgd to 40 mgd
    2. Provide up to 52 mgd total WWTP capacity by blending 20 mgd of disinfected primary effluent from Primary Clarifier No. 1 with 32 mgd receiving primary treatment in Primary Clarifiers Nos. 2 & 3, secondary treatment, and UV disinfection
- Conveyance
  - New Plant Outfall at Adams Street WWTP

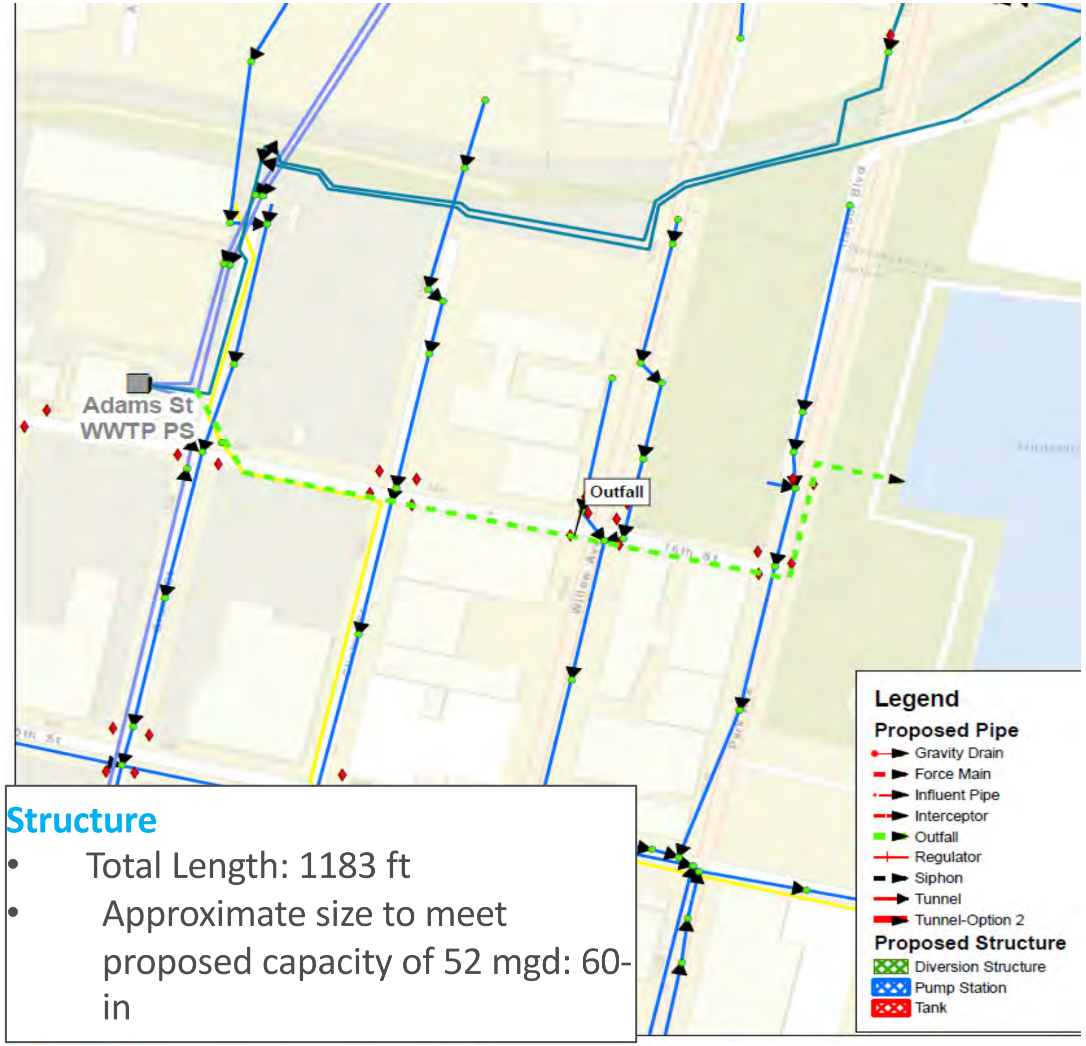
Adams Street WWTP

Install Storage Tank at Trickling Filter



- **Structure**
  - Analyzing 5 MG and 10 MG tanks

Construct New Plant Outfall



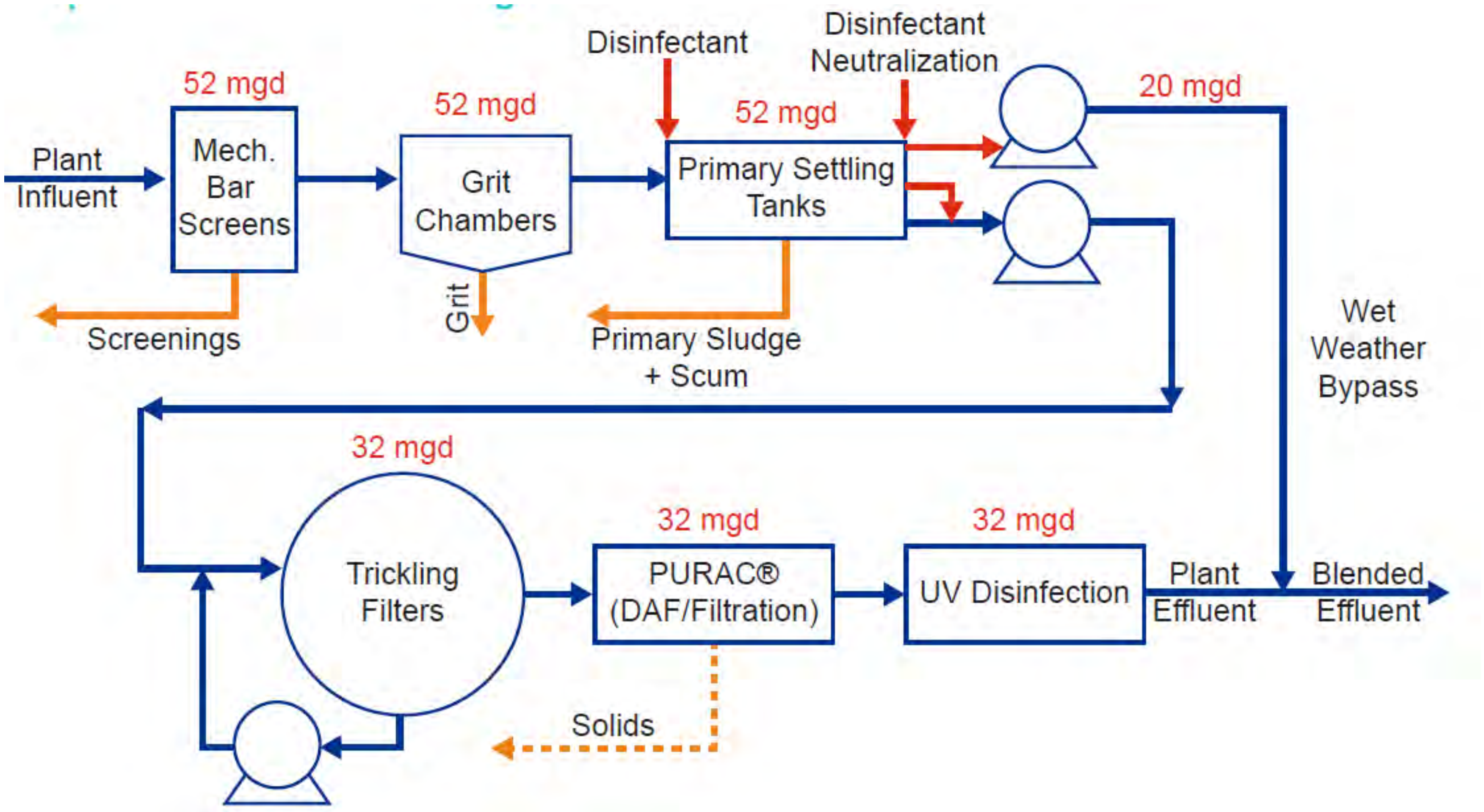
Structure

- Total Length: 1183 ft
- Approximate size to meet proposed capacity of 52 mgd: 60-in

Adams Street WWTP

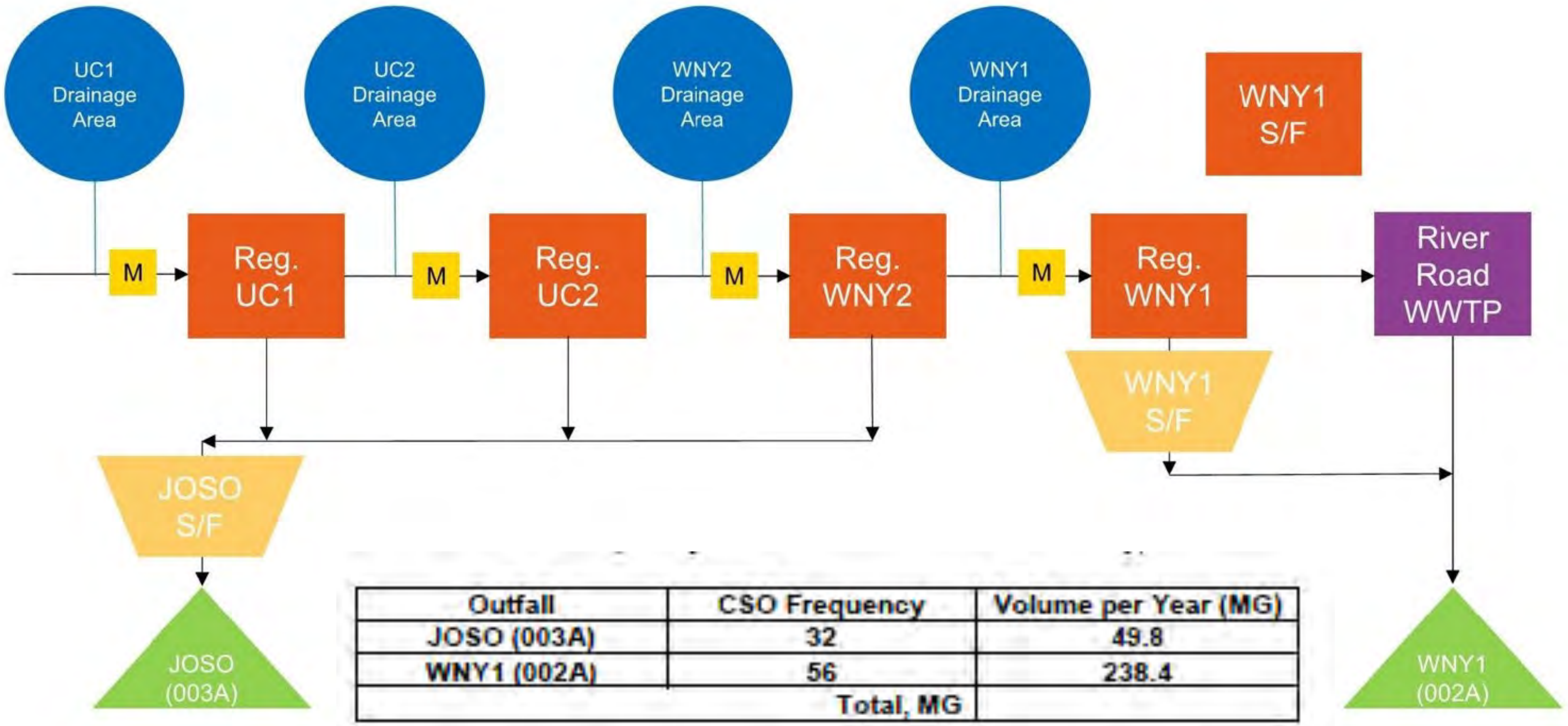
Blending Disinfected Primary Effluent with Secondary UV Disinfeced Effluent to Allow for Increased Capacity at the WWTP

Proposed Process Flow Diagram



Alternatives Evaluations - River Road

River Road Combined Sewer System Performance for a Typical Year



Outfall	CSO Frequency	Volume per Year (MG)
JOSO (003A)	32	49.8
WNY1 (002A)	56	238.4
	Total, MG	

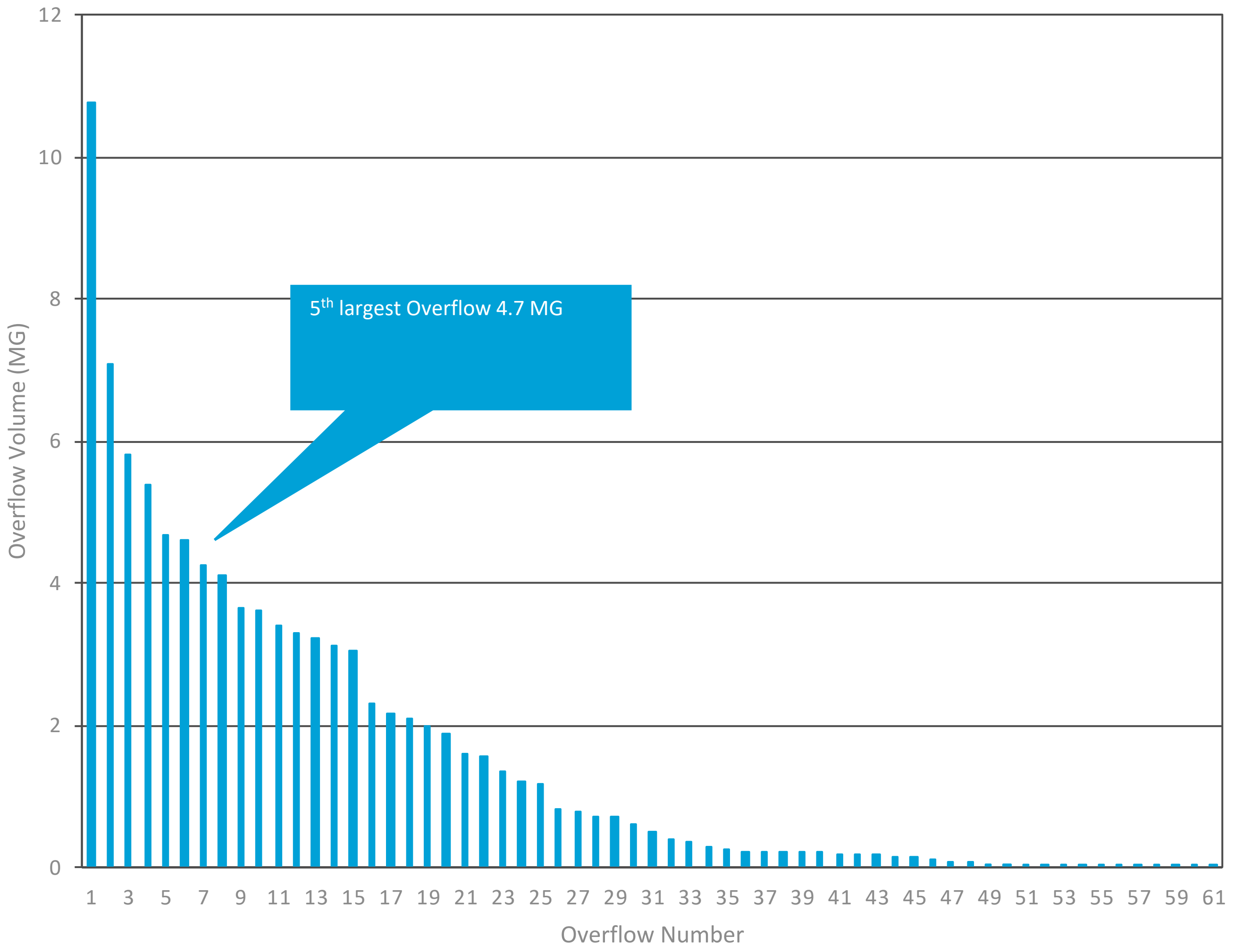
Outfall 003A (Weehawken)

Alternatives

- Conveyance:
  - Raise Regulator Weirs at UC1, UC2 and/or WNY2
  - Replace existing JOSO side-flow weirs with bending weirs
- Storage
  - CSO Storage Structure constructed in River

Outfall 003A (Weehawken)

Overflow Volume



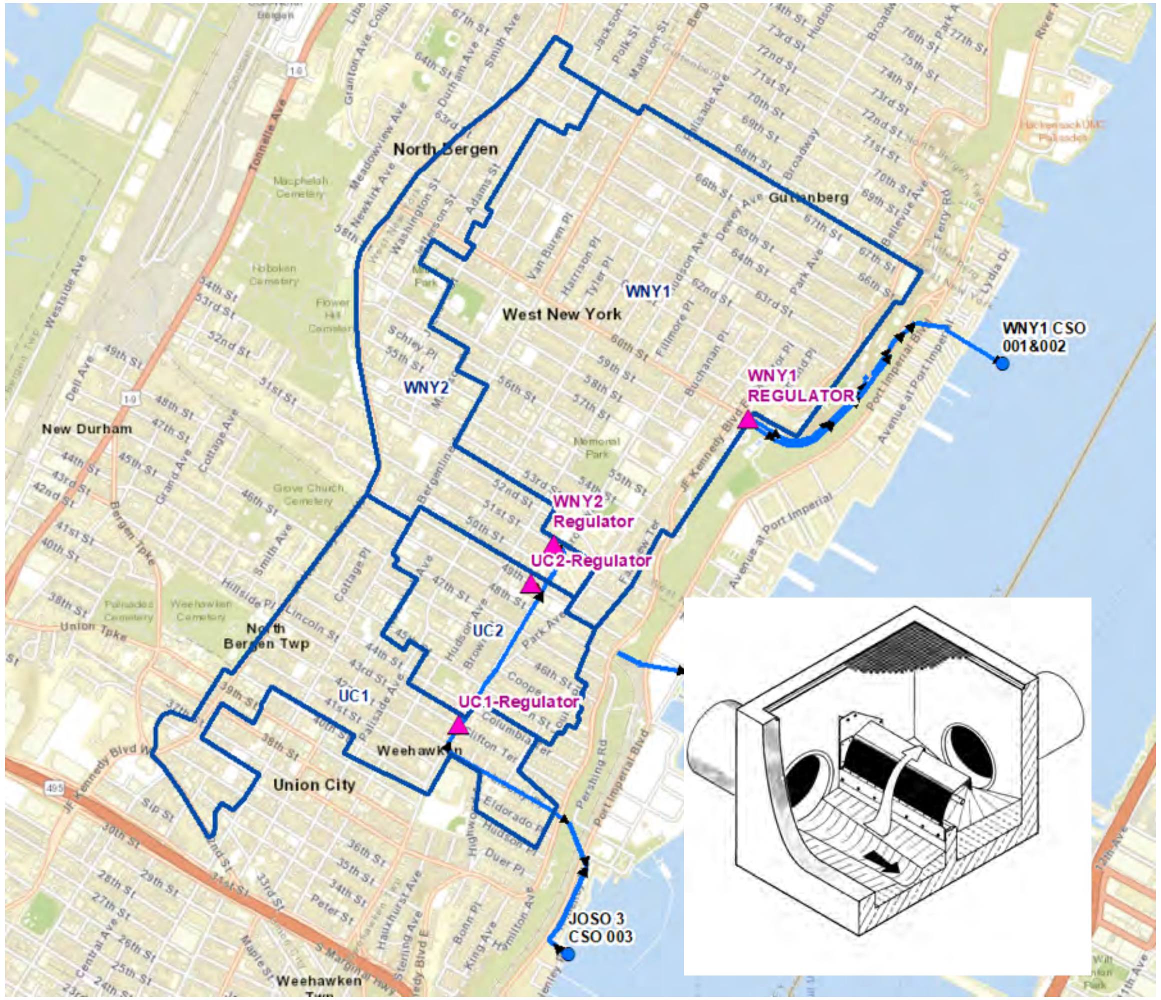
Outfall 003A

Raise Regulator Weirs at UC1, UC2 and/or WNY2

- General
  - Divert flows to WWTP and minimize amount routed to JOSO outfall
  - Iterate scenarios raising weirs and analyzing overflow amounts
- Next modeling phase
  - Model alternative with free outfall at River Road WWTP and analyze flows and volumes at plant to determine plant capacity required for alternative

Outfall 003A

Replace existing JOSO side-flow weirs with bending weirs



- Bending weir not available for WNY1
- Generates 0.08 MGD of storage along interceptor

	Number of Overflows		Total CSO Volume (Mgal)	
	Existing	Bending Weirs	Existing	Bending Weirs
JOSO (003A)	61	24	95	28
River Road (002A)	60	60	190	254

Outfall 003A

CSO Storage Structure constructed in River

- **Storage Volume: 4.7 MG**
  - 10-foot storage depth; 250'L x 250'W

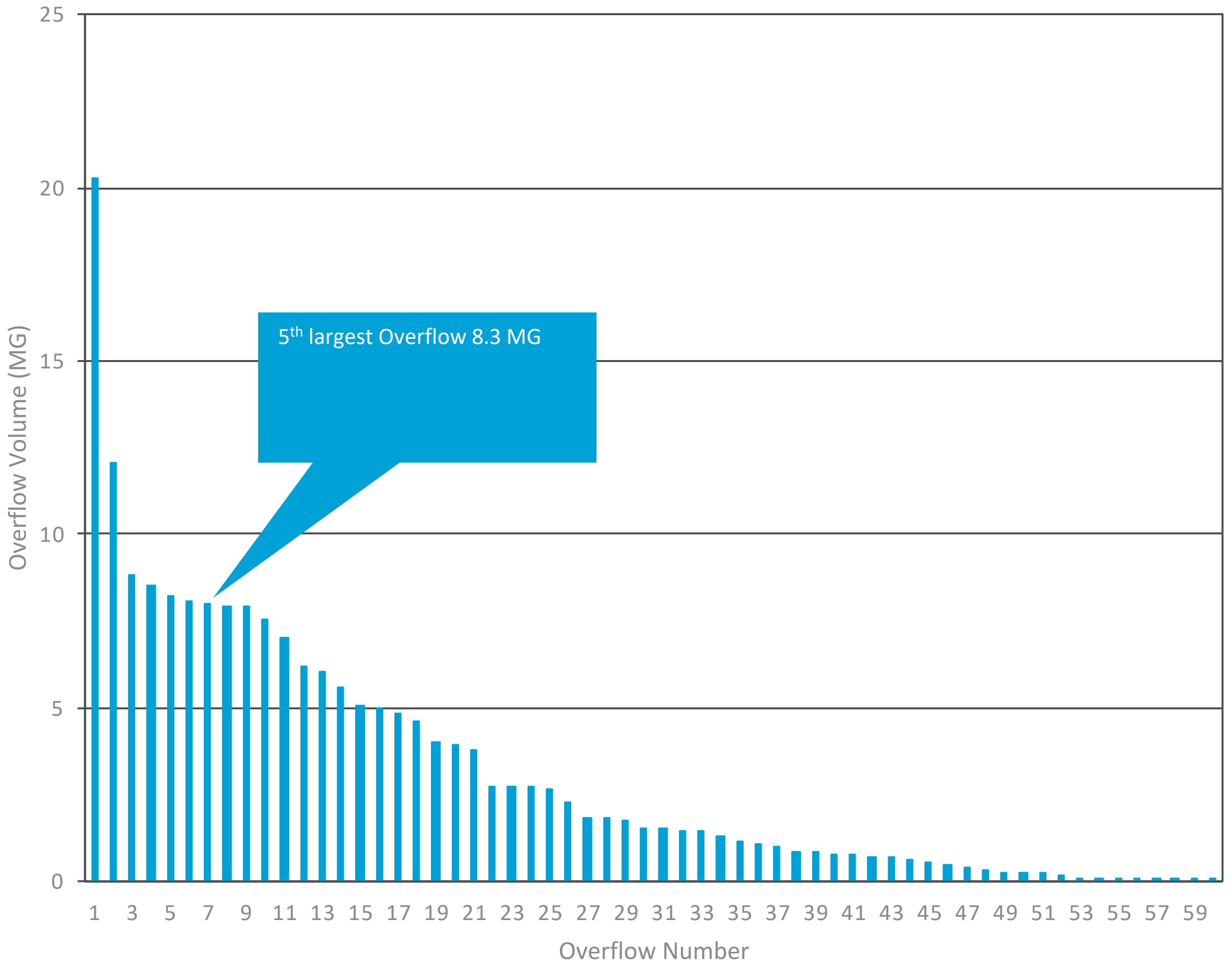
Outfall 001A/002A (West New York)

Alternatives

- Storage:
  - Linear Storage along Anthony Defino Way
  - CSO Storage Structure Constructed in River

Outfall 001A/002A (West New York)

Overflow Volume



Outfall 001A/002A

Linear Storage along Anthony M. Defino Way

- 2,200 ft long, 26 ft diameter = 8.3 MG storage
- Number of overflow events at River Road reduced from 60 to zero. No improvement at JOSO but can combine with weir optimization
- Site considerations: slope, existing infrastructure
- Vortex drop structure, WWPS, HRT, disinfection, new parallel outfall, tide gate

Outfall 001A/002A

CSO Storage Structure Constructed in River

- **Storage Volume: 8.3 MG**
  - 30-foot storage depth; 220'L x 170'W

Inflow/Infiltration

- Based on the EPA condition assessment of estimating infiltration (June 2014), the total inch diameter-miles of pipe is calculated for each drainage basin
- This unit of length is divided by the baseflow extracted from the model (mgd) and converted to a rate to represent the approximate infiltration per inch diameter-mile, or gpd/idm, of groundwater infiltration.
- In the River Road Service area, RedZone data was collected for the UC1, UC2, WNY2 and WNY1 metersheds. It was assumed that pipes with a PACP score of at least 3 contributed to this infiltration

Green Infrastructure

- Based on a land use analysis in the preliminary screening phase, it was estimated that an average of 20% of the total impervious area could be managed by green infrastructure within the River Road service area.
- A bioretention calculation was completed to estimate the total amount of capture within the subcatchments and the area of green infrastructure that would be required.

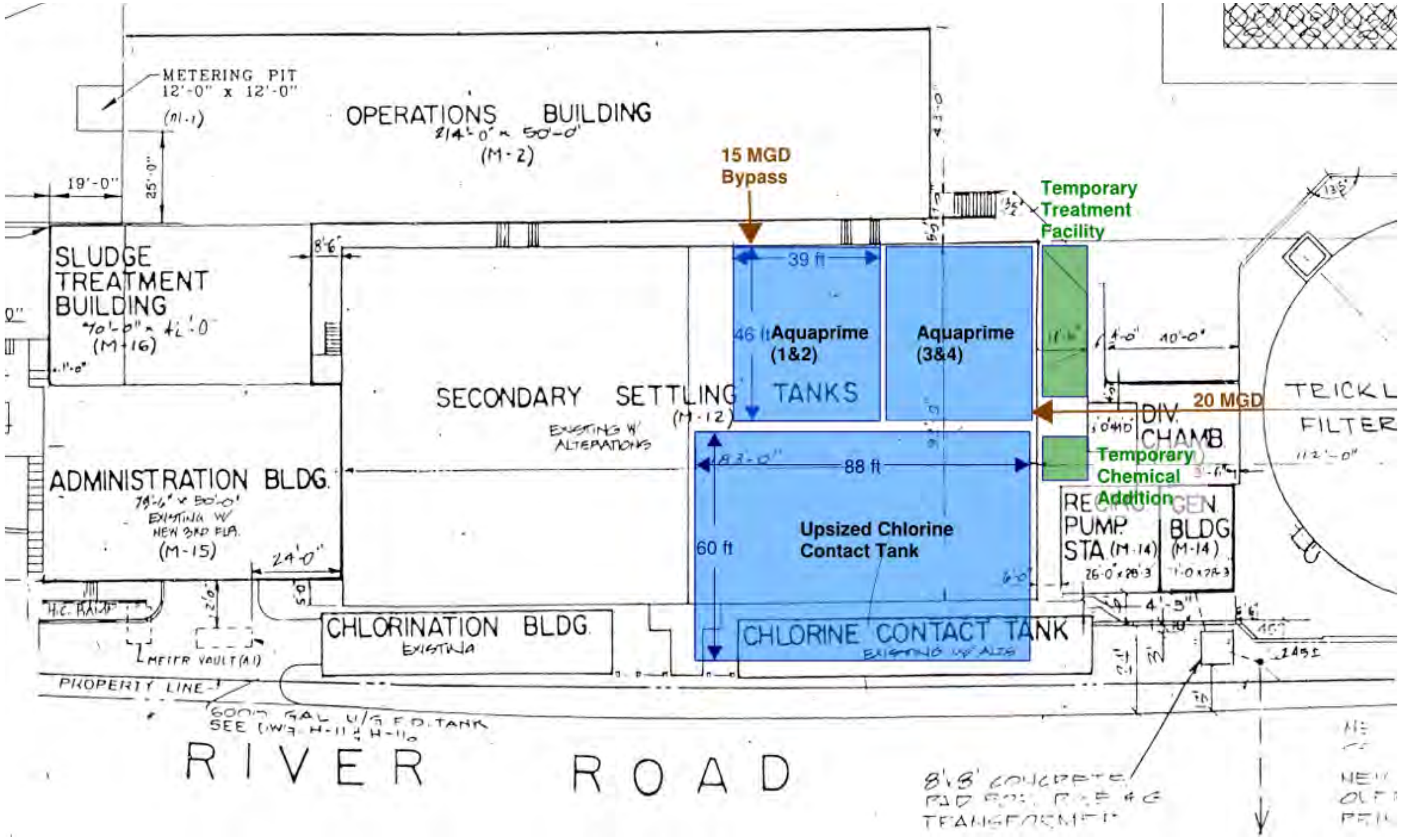
River Road WWTP

- Treatment alternatives:
  - CoMag®
  - ACTIFLO®
  - High Rate Filtration
- Increase plant capacity to 35 MGD:
  - Bypass WWF from rotary screens
  - Install new 35 MGD secondary treatment and chlorine contact tank in footprint of secondary clarifiers
  - Temporary chemical dosing of one secondary clarifier during construction

	Number of Overflows		Total CSO Volume (Mgal)	
	Existing	35 MGD Plant	Existing	35 MGD Plant
JOSO (003A)	61	61	95	95
River Road (002A)	60	42	190	91

River Road WWTP

AquaPrime



- Cloth media
- On-site jar/pilot testing required

Next Steps

Next Steps

- Finalize and submit Development and Evaluation of Alternatives Reports to NJDEP
- Proceed with developing Long Term Control Plans
- Continue ongoing dialogue and solicit feedback from the public

Thank You

NORTH
SEWERAGE
AUTHORITY
HUDSON

M E ETI NG M I N UT E S

NHSA Alternatives Analysis Public Meeting 2 Minutes

PROJECT:	North Hudson Sewerage Authority Alternatives Analysis
MEETING DATE:	May 20, 2019
MEETING TIME:	7:00 PM – 8:30 PM
LOCATION:	1600 Adams Street, Hoboken, NJ
INVITED ATTENDEES:	General Public

Objectives

This meeting will be present the Alternatives Analysis Process, the various types of alternatives being considered, and the work the Authority is doing to develop this phase of its CSO Long Term Control Plans (LTCPs).

Agenda Items

1. **Review of Previous Action Items**
2. **NJDEP Long Term Control Plan Requirements and Ongoing Activities**
    a. Required to reduce # of overflows per year into Hudson. In heavy rains the stormwater combines with the sanitary flow and bypasses the plant
    b. State and Federal Gvt expect to reduce # of overflows into River dramatically. About 70 discharges a year, reduce to 4
    c. Develop a long term plan
    d. Worked on first characterization to understand inner workings of the plan. Have a preliminary analysis in ways we can reduce the CSO outfalls
    e. Next public meeting in August, costs will be presented.
    f. Question: No costs included?
        i. We gave the state what they asked for for now
    g. 6 specific deliverables
        i. Need to be submitted to the state for each plant, so total of 12 submittals to the state
        ii. Alts needs to be submitted June 1st
        iii. Submittals given so far are online and can be accessed at NJDEP website
    h. Three phases
        i. Characerization
        ii. Alternatives Analysis
        iii. And plan
    i. Opportunities and current projects have been identified with all 4 cities
    j. Ongoing currently are strategies and estimating costs

k. Assessing financial capabilities

3. Introduction to CSO Control Strategies and Alternatives

a. Reduce when flow goes into the river

4. Development and Evaluation of Alternatives

a. Identifying strategies, developing how they would be implemented at a particular location, and then xxx

b. Looking at alternatives to treat at the plant to treat as much as possible and looking at the outfalls themselves

c. Question: Does at the outfall mean 'at the outfall'?

    i. Some occur in the collection system, others are at the end of the pipe

d. Review of those listed in the permit

e. Equivalent

f. Serious problem with infiltration which is mainly a source of Suez

g. Question: Will we see leakage technology in Hoboken?

    i. Leaks are so bad in Union City and WNY. We worked with Suez and they initially worked pretty closely with us. In the past 2 or 3 years

    ii. Spent approximately $4 million on

    iii. 407 miles of sewers. Sewers we identified using PACP system

h. Question: How did the number '4' come up for overflow?

    i. Other ways to show compliance, but this is simplest. Statistically is can be expected that this

i. Do other cities have this issue?

    i. 21 municipalities and only 1 is down to 4 or less. Trenton is the 1 city

    ii. In NYC, many places they are still getting overflows

    iii. Paerdegat Basin tank is ~330 million for 50 MG storage total (30 MG tank, 20 MG in line storage)

j. Sewer separation is not true sewer separation since each building still has sanitary sewer connected to our system. Ordinances are currently in place for new construction to go into storm sewers.

k. Footprint of West New York plant is very difficult

l. Alternatives workshop held back in 2018, brought in consultants and those from public entities

m. Preliminary Screening

n. Once we have a set number for costs, we will have a public meeting which will discuss the rates. Can't raise rates more than 2%

5. Review of CSO Control Alternatives

a. Adams Street has 8 total outfalls, 7 without H2

b. Disinfection has us focused on bacteria. Could be measured as total coliform, fecal coliform and enterococci

c. Question: How does 77 compare to those?

    i. This counts 'events'

d. Disinfection is when you'll use chlorine to disinfect the overflow. Will have an impact on fish and other types of water
e. Question: Everytime H1 WWPS works, is that a CSO?
    i. Yes
f. Have we spoken with property owners? Other developers have H1 site on their maps
    i. We have not be we have an easement with a sewer line below the parking lot
g. Does the state have any notion of special circumstances? What if we have 5 hurricanes?
    i. Policy is for typical year. In typical year, the state can decide how they evaluate that. State is working out how we will deal with that then.
h. Question: Aren't they filling in long slip?
    i. Yes
i. Treatment systems can require maintenance and is a permanent commitment
j. Almost 12000 sq ft?
    i. Yes
k. At h1, is this where jersey transit outfall goes?
    i. Jersey city at head end of Canal has major CSO outfall
    ii. Jersey city is not as specific in outfall by outfall, they are general concepts
    iii. The model will need to be redone eventually to account for the Jersey city
l. Making sure we're part of the dialogue to get some of the land ownership decided on
    i. As we start eliminating we will begin those talks
m. Don't want to be designed out
    i. At H1 they know we have an easement for the property
n. Is there an opportunity to do something at Stevens? Once they're complete the new development and the park are going to be subject to rebuilding, there may be a conversation there
    i. What we are trying to navigate in the feasibility of things, there is no way to convey flow to that side
o. Water quality monitoring is always worse in Hoboken cove and regularly is worse than other locations. Have not done tests yet to indicate which of these are waste from animals.
p. Do w know the average event period?
    i. We would design the pump station to empty within 24 hours, rule of thumb is to have enough storage and treatment capacity at the plant. Have to run that balance as well
q. Since some of these are right at the waterfront, can they withstand SLR and climate change?
    i. They are constructed outside the barrier, outside the 100 year flood zone
r. Is there any way to increase capacity at he plant?
    i. Yes we are looking at this alternative. We've started the discuss and had a meeting with the state last week to go from 10 MGD to 15 MGD to give us more capacity during dry weather.
s. Fred: Looking to effectively treat at 50 MGD at the Adams Street Plant
t. The 20 MGD bypass is new?

    i. Yes

u. Our goal systemwide wouold be treating 85% of the overflows. Right now wet weather capture is around 30%

v. If we maximized to plant, how many more alternatives wuld be need to do?

    i. Would be an iterative process

w. Could you make the treatment filters larger?

    i. Not to that extent. One of the trickling filters would be a tear down. Hopefully can go deep enough and high enough

x. Where is bottleneck at plant?

    i. Treatment wise, 32 mgd is our limit. Our actual dry weather is well below 32 mgd

y. What is typical wet weather flow?

    i. About 36 mgd. In small storms, flow will go up to 20-25 mgd. High intensity storms plant goes up to 36 mgd total.

z. Difference between 52 and 36 is capacity curing really bad storms?

    i. No 50 right now, only 36

aa. If we all have the same rainstorms (Bill responds could be sunny) what causes this one to have so much more flow?

    i. Velocity of the flow coming own the hill. Three regulators all spilling into one outfall

bb. Fred: Hoboken cove and Weehawken cove are natural jettys.

cc. How does the I/I work when these rpolems aren't our fault?

    i. Pursuing a number of tracks. First have made a formal complaint to the NJDEP commissioner. Filed complaint with BPU against suez. After finishing up calcs, have decided to bill them for the amount of water getting into our system. In River road getting minimum of 2 MG a day. If they start going above what they're budgeting for. Hoboken always owned the system, before suez kept all of it. When talking about potential liability, xxx. Hoboken literally signed a new contract if we're suddenly going to get a lawsuit we need to know that today. In Hoboken since we're below groundwater, all sewers need to be lined regardless.

dd. For that 20%, is that private property, combination of the 2?

    i. Primarily public property but looked at combination of them

6. Month Look Ahead

a. At the next meeting, if we get feedback, we will prioritize the options by then and incorporate that feedback. Final meeting in fall with focus on finances. We will have our rate advisor to see how these options will focus on the rates from then.

b. Feedback should be emailed to Fred. This presentation will be posted on the website.

c. Feedback: next time maybe consider doing separate meetings

    i. Devote 2 sessions to the alternatives. We could add another session but that seems xxx. Our rate is a blended rate, you're paying the same in Weehawken and in Hoboken. We want all our customers to feel they're in one service area. Sometimes we have to address spending more in one area vs another. We shy away from giving separate presentations, but we acknowledge that there is a lot of information.

NHSA CSO LTCP Public Meeting #3

August 19, 2019

Public Participation Meeting Sign In Sheet

DATE: 8/19/2019

PREPARED BY: JACOBS

Name	Affiliation	Email
MARIOLA KRUCZEK	CLIENT	KMARIOLA2003@YAHOO.COM
JASON CAPIZZI	NNY RESIDENT	jason.capizzi@gmail.com
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Stephen Hudock	JACOBS	steve.hudock@JAcobs.com
KAREN APPELL	AECOM	Karen.appell@aecom.com
Sahar Ghavami	Hoboken Resident	~~sahar@bb~~ saharbbt@gmail.com
Siyizg Wang	Jacobs	siyizg.wang@jacobs.com

North Hudson Sewerage Authority
CSO Long Term Control Plan

Public Meeting #3

Agenda:

1. Summary Overview/Status of LTCP Program
2. Ongoing LTCP Project Updates
3. LTCP Development
4. NHSA Social Media Update
5. Next Steps

August 19, 2019

Greetings and Introductions

(Please do sign in)

NJDEP Long Term Control Plan Requirements and Ongoing Activities

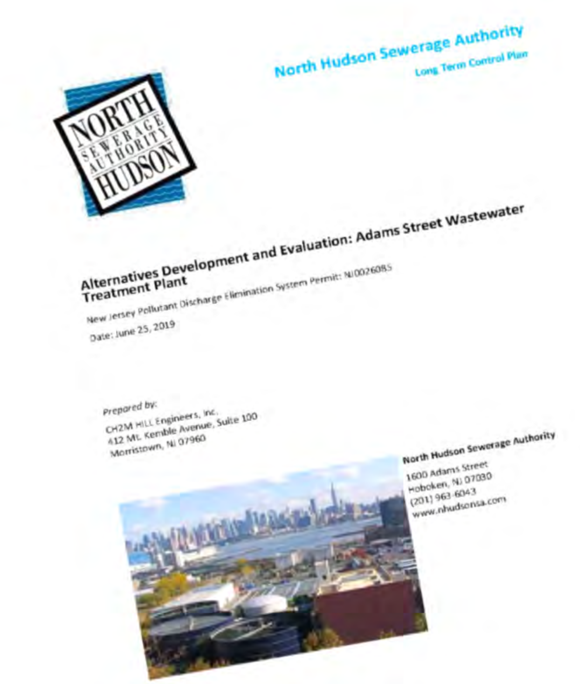
NJPDES LTCP Permit Requirements Met via a Series of Activities and Submittals to the NJDEP by June 1, 2020:

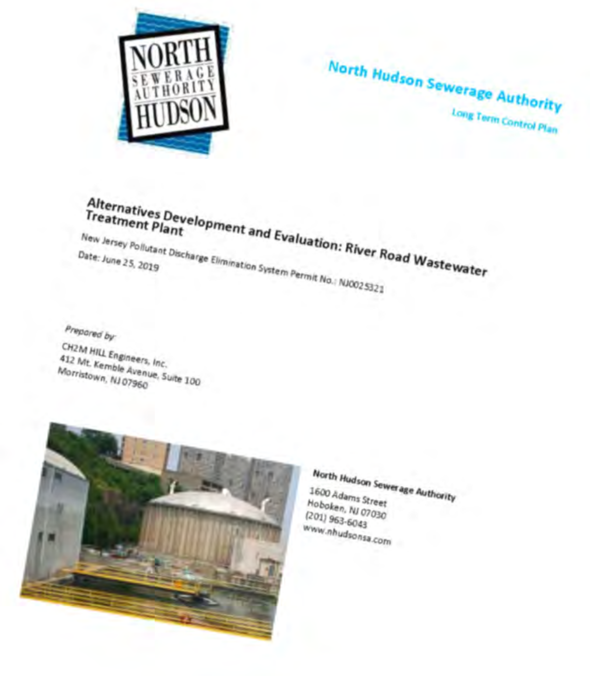
- System Characterization (Work Plans and Reports) – July 1, 2018 ✓
- Baseline Compliance Monitoring (Work Plans and Reports) – July 1, 2018 ✓
- Public Participation Process (Report) – July 1, 2018 ✓
- Identification and Consideration of Sensitive Areas (Report) – July 1, 2018 ✓
- Develop and Evaluate CSO Control Alternatives (Report) – July 1, 2019 ✓
- Select Alternatives and Plan Implementation of the LTCP (Report) – June 1, 2020

Performed as a LTCP Program with a Consultant Program Manager and a series of projects performed by the Authority's Engineering Consultants

Development and Evaluation of Alternatives Reports

Submitted to NJDEP June 26, 2019


North Hudson Sewerage Authority
Long Term Control Plan
NORTH SEWERAGE AUTHORITY HUDSON
Alternatives Development and Evaluation: Adams Street Wastewater Treatment Plant
New Jersey Pollutant Discharge Elimination System Permit: NJ0026085
Date: June 25, 2019
Prepared by:
CH2M HILL Engineers, Inc.
412 Mt. Kemble Avenue, Suite 100
Morristown, NJ 07960
North Hudson Sewerage Authority
1600 Adams Street
Hoboken, NJ 07030
(201) 963-6043
www.nhudsonsa.com


North Hudson Sewerage Authority
Long Term Control Plan
NORTH SEWERAGE AUTHORITY HUDSON
Alternatives Development and Evaluation: River Road Wastewater Treatment Plant
New Jersey Pollutant Discharge Elimination System Permit No.: NJ0025321
Date: June 25, 2019
Prepared by:
CH2M HILL Engineers, Inc.
412 Mt. Kemble Avenue, Suite 100
Morristown, NJ 07960
North Hudson Sewerage Authority
1600 Adams Street
Hoboken, NJ 07030
(201) 963-6043
www.nhudsonsa.com

Can be downloaded at: https://www.nj.gov/dep/dwq/cso-ltcpsubmittals.htm

Where Are We on Developing the LTCP?

Characterization

- Work Plans
- Field Work
  - Condition Assessment
  - Sewer Flow Monitoring
  - CSO Water Quality (WQ) Monitoring
  - Hudson River WQ Monitoring
- Identify Sensitive Areas
- Engineering
  - Land Use and Drainage Analyses
  - Hydraulic Sewer Modeling
  - Hudson River WQ Modeling
- Public Participation
- Reports

Engineering Alternative Evaluation

- Establish CSO Reduction Targets
- Identify Opportunities with Communities to Reduce CSOs
- Identify and Evaluate CSO Control Strategies and Technologies
- Estimate Potential Project Costs
- Assess Cost/Performance for Potential Projects
- Report

Long Term Control Planning

- Assess Financial Capability
- Select Strategies and Controls
- Select Funding Mechanisms
- Develop Schedule for Implementation
- Finalize LTCP
- Report

Key:

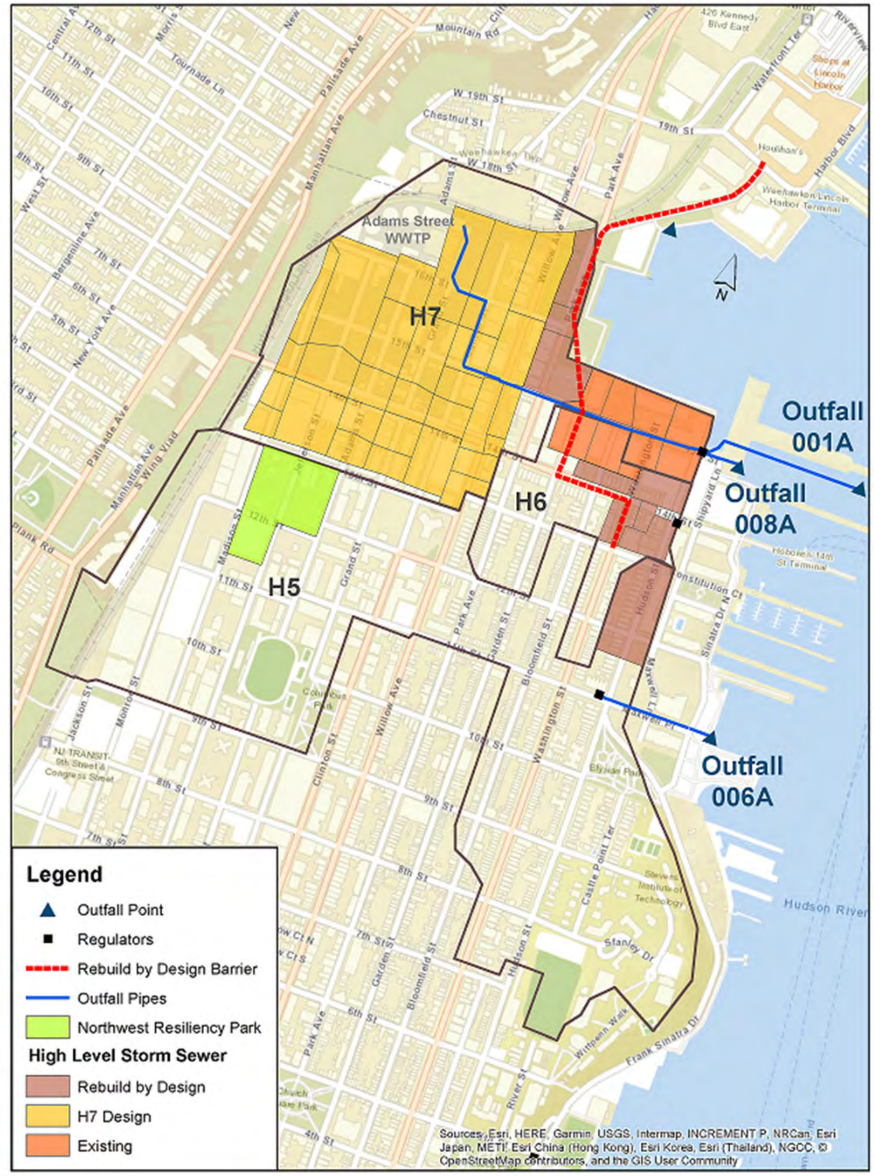
Ongoing

Completed

Ongoing Long Term Control Plan Project Updates

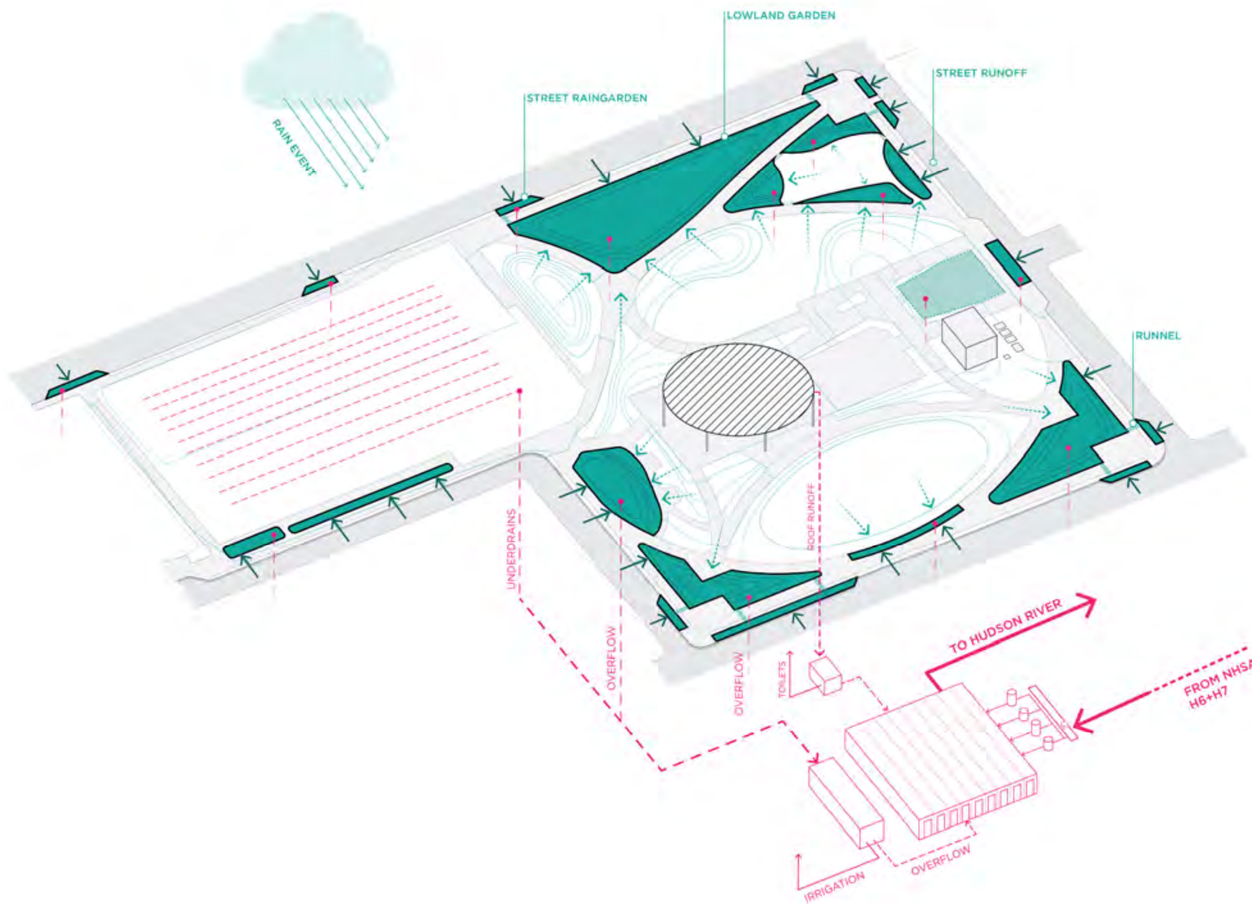
H6/H7 CSO LTCP Project

- Project Need:
  - Reduce CSOs at for LTCP
  - Improve long-term Resilience
- Project Goals:
  - Reduce CSOs at H6/H7 Outfall 008A
  - Reduce/eliminate street flooding
  - Integrate with Hoboken GI Plan
  - Integrate with Rebuild by Design
- Project Approach:
  - Work collaboratively with Hoboken on its Northwest Resiliency Park
  - New High-level Storm Sewers
  - CSO controls
- Status
  - Hoboken – Selected a Construction Contractor
  - NHSA 90% design, RFP Phase 1 Services During Construction, submitting permits



New High Level Storm Sewer System

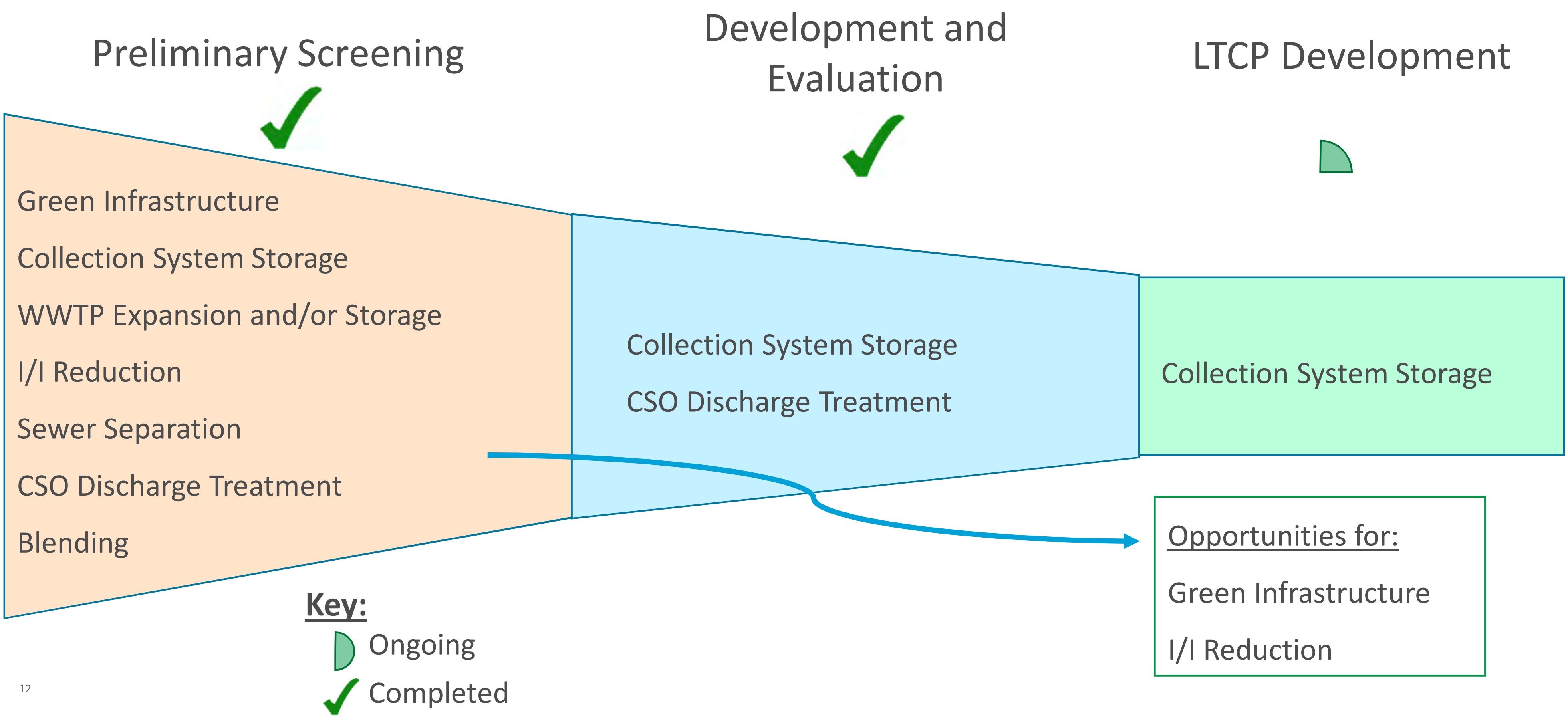
Northwest Resiliency Park Green Infrastructure, Storage and Conveyance



Source: Hoboken Northwest Resiliency Park website http://nwpark-cityofhoboken.opendata.arcgis.com/

Long Term Control Plan Development

CSO Control Identification, Evaluation and Selection Process Example

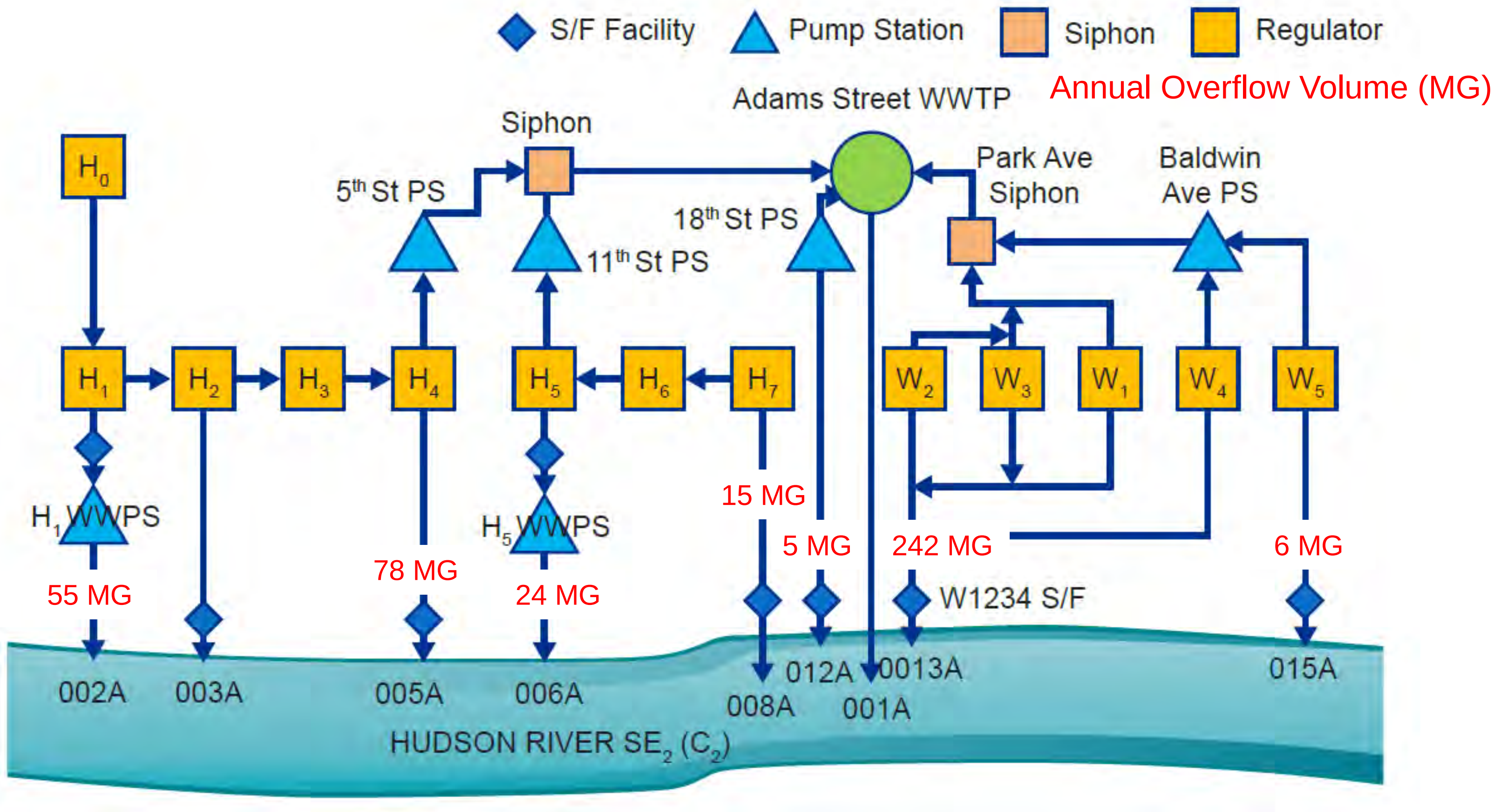


LTCP Development Approach

- Goal: Achieve 85% wet weather volume capture annually
- Planning Process:
    1. Build baseline condition with all committed projects (e.g. closing H2, H6/H7 project, GI, I/I)
    2. Optimize strategies to achieve maximum flow through the WWTPs
    3. Upgrade conveyance capacity to eliminate any bottlenecks for maximizing flow to the WWTPs
    4. Plan for storage in drainage areas to achieve capture

LTCP Development - Adams Street

NHSA Adams Street Collection System Schematic



Adams Street WWTP

Storage Tank at Trickling Filter

Add Ballasted Flocculation to PURAC

Add Storage Structure over Tanks

Blending via Sidestream Treatment

- Split flows
- Bypass secondary
- Add ACTIFLO treatment
- Add BioACTIFLO treatment

New WWTP Outfall

Storage Tank at Trickling Filter

Blending via Sidestream Treatment

- Split flows
- Bypass secondary
- Add ACTIFLO treatment
- Add BioACTIFLO treatment
- Cloth/Compressible Media Filtration

New WWTP Outfall

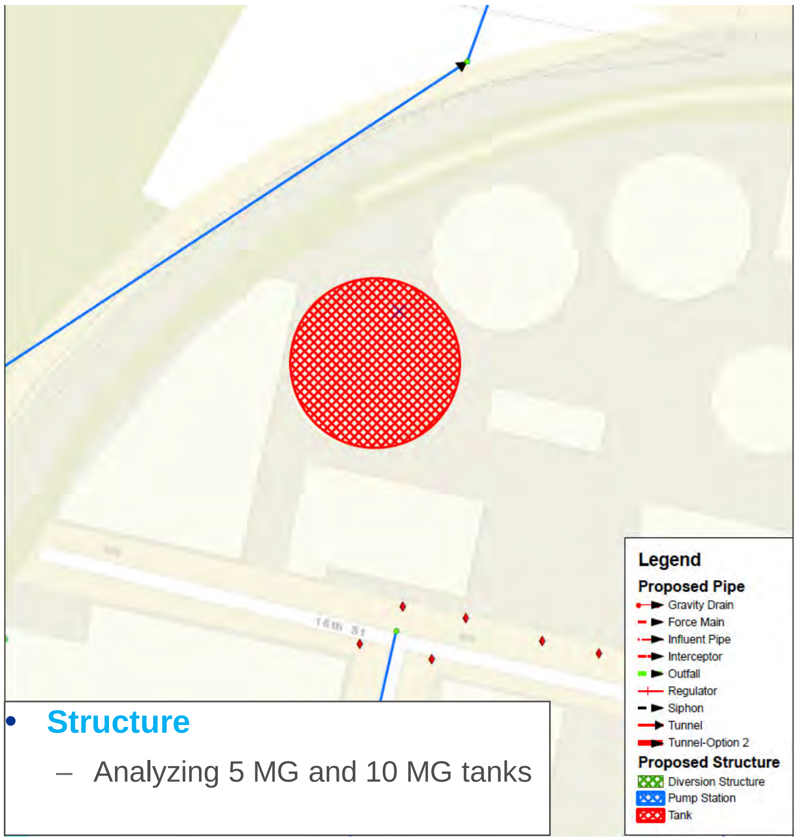
Replace 1 Trickling Filter with storage tank

Blending

New WWTP Outfall

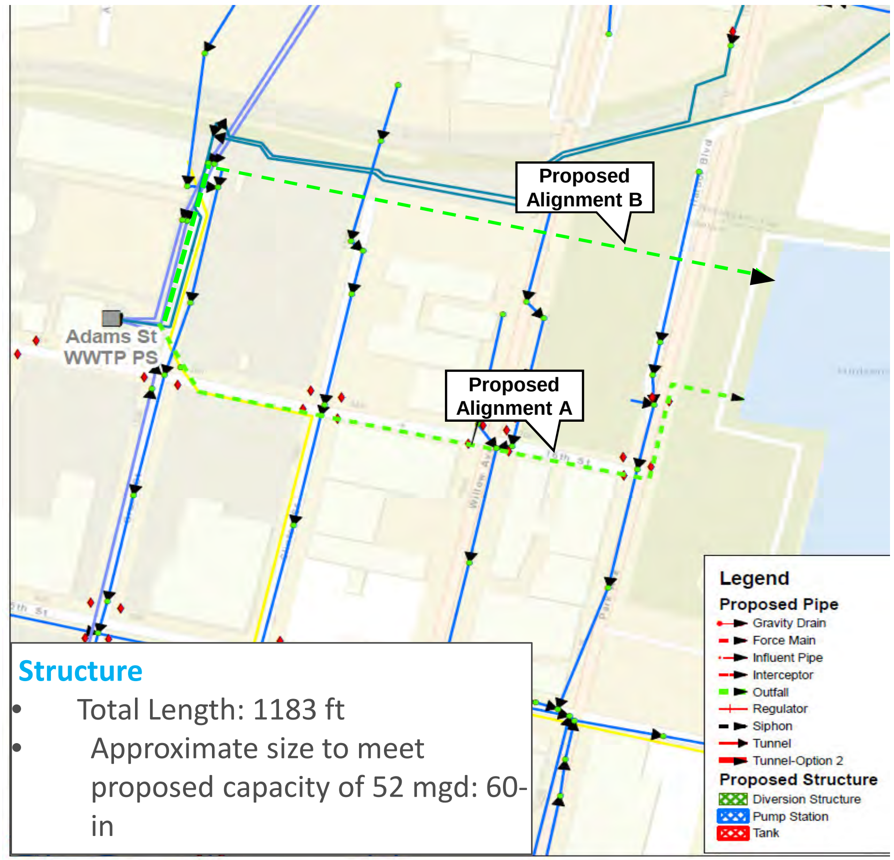
Adams Street WWTP

Install Storage Tank at Trickling Filter



- **Structure**
  – Analyzing 5 MG and 10 MG tanks

Construct New Plant Outfall



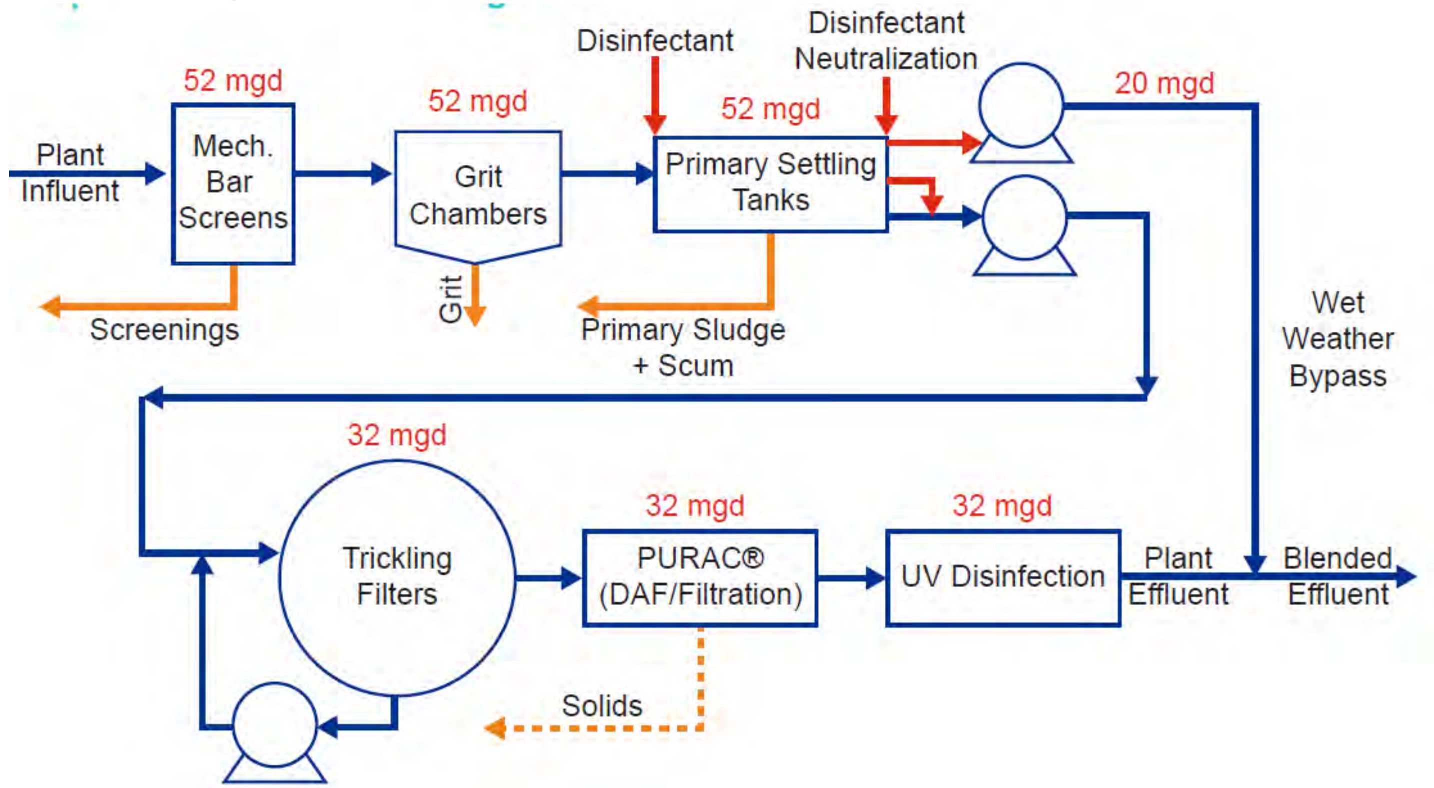
Structure

- Total Length: 1183 ft
- Approximate size to meet proposed capacity of 52 mgd: 60-in

Adams Street WWTP

Blending Disinfected Primary Effluent with Secondary UV Disinfected Effluent to Allow for Increased Capacity at the WWTP

Proposed Process Flow Diagram



Outfall 002A (H1 Drainage Area - South Hoboken)

Green Infrastructure

I/I Reduction

Sewer Separation

Storage under Observer Highway

Storage under parking lot

CSO Discharge Treatment

CSO Storage Structure under Lot at Observer Highway and Hudson Street

Combine Flows with Jersey City CSO in Long Slip Canal

Cloth/Compressible Media Filtration

Disinfection

CSO Storage Structure under Lot at Observer Highway and Hudson Street

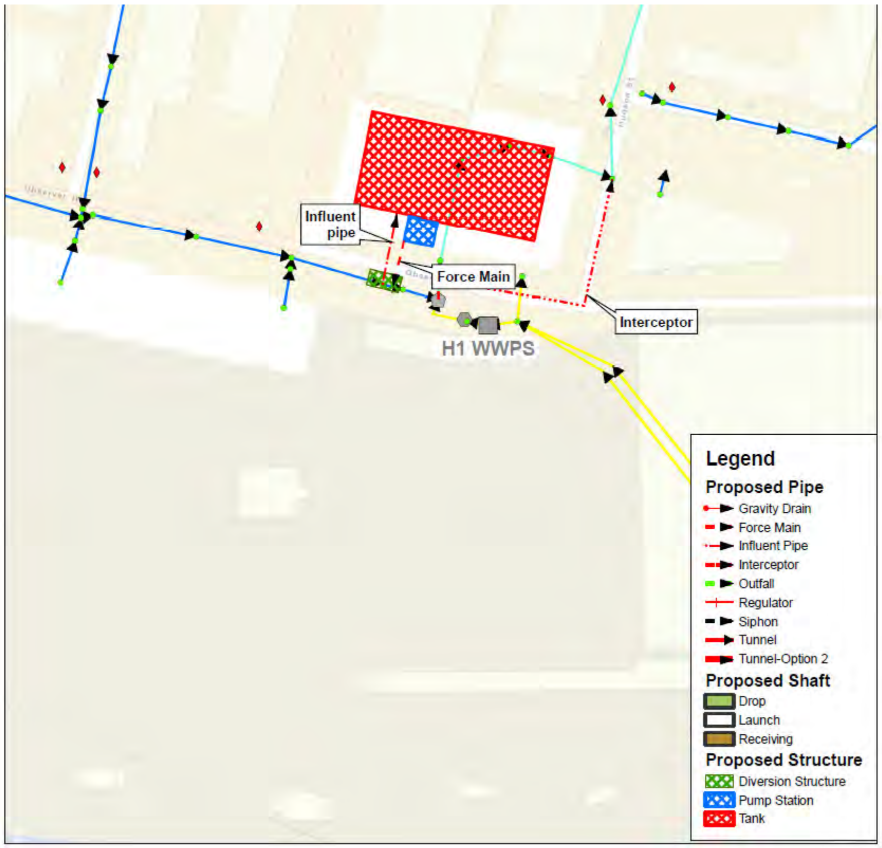
<u>Opportunities for:</u>

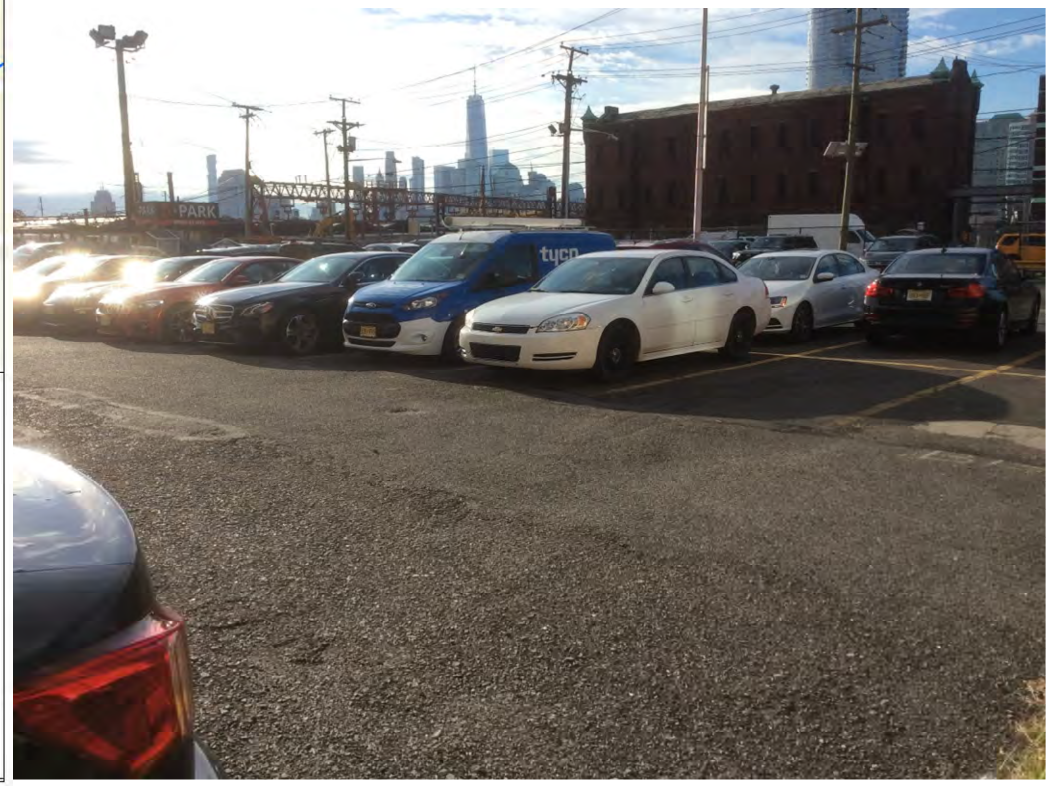
Green Infrastructure

I/I Reduction

Outfall 002A

CSO Storage Structure at Lot at Observer Highway and Hudson Street





Outfall 005A (H3/H4/HSI Drainage Area - Central Hoboken)

Green Infrastructure

I/I Reduction

Sewer Separation

Increase Flow to WWTP

CSO Storage under Parks/Fields

CSO Storage Structure in River

CSO Discharge Treatment

Pump more through 5th Street Pump Station

CSO Storage Structure in River
– Mirror Pier C Park

CSO Storage under Stevens Park and/or Baseball field

Cloth/Compressible Media Filtration

Disinfection

Pump more through 5th Street Pump Station

CSO Storage under Stevens Park or Baseball field

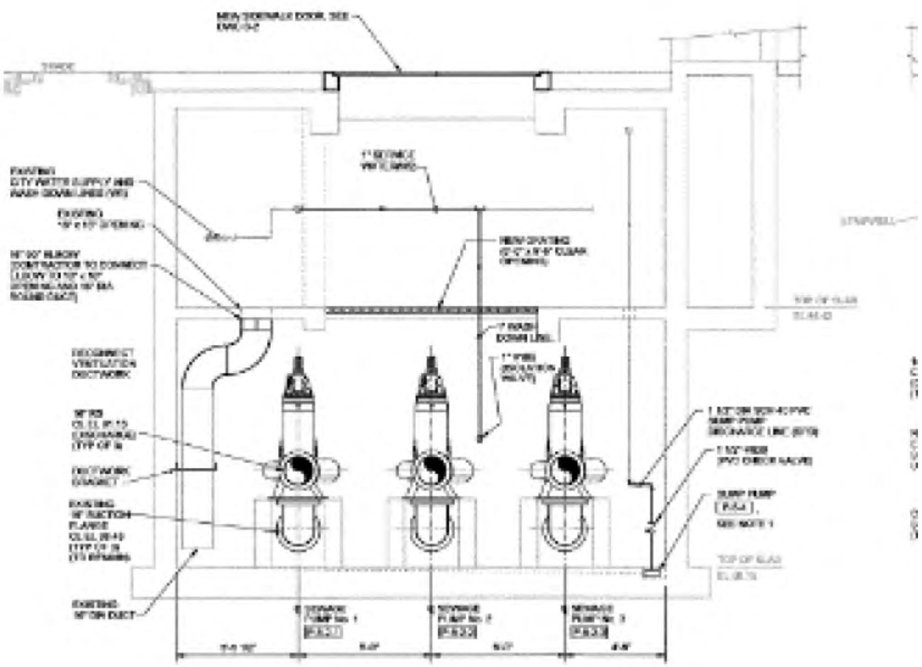
Opportunities for:

Green Infrastructure

I/I Reduction

Outfall 005A

Increase Flows to WWTP through 5th Street Pump Station

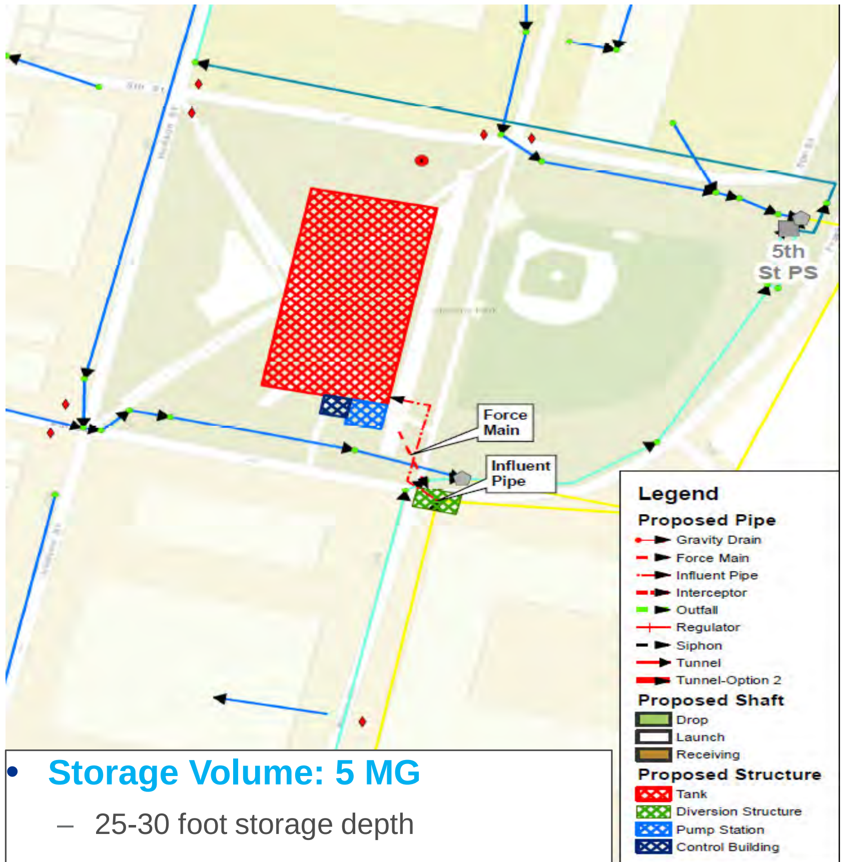


SECTION A

- **General**
  - Adjust H3 and H4 regulator weirs
  - Increased peak pumping rate from 15.8 MGD to 31 MGD
  - Upstream capacity and piing downstream of pump station will need to be monitored

Outfall 005A

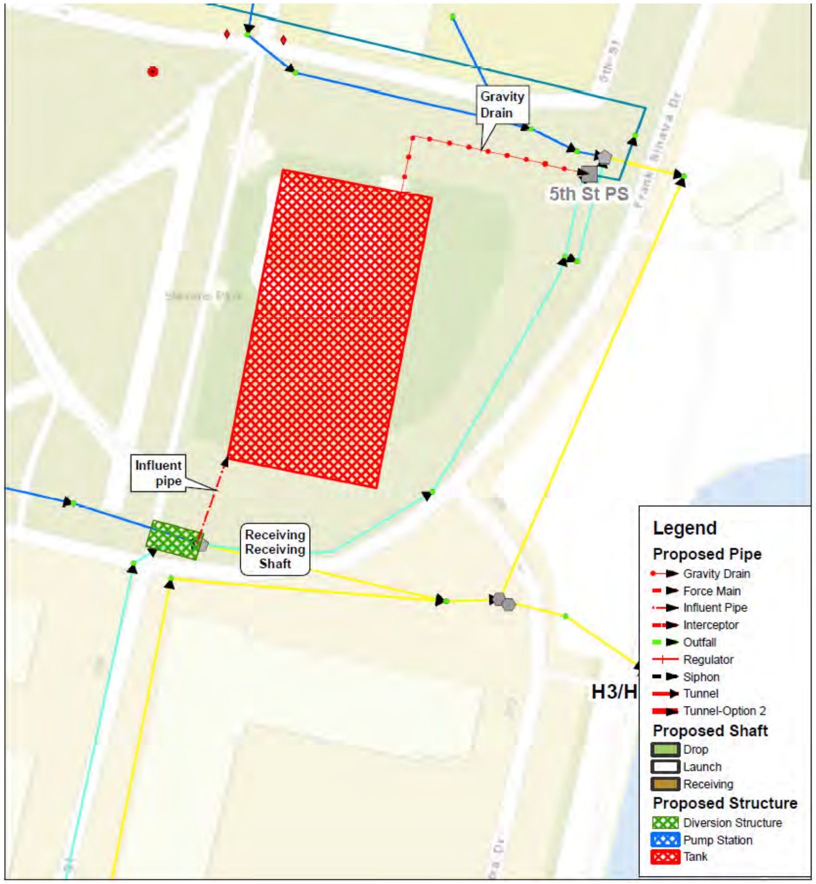
CSO Storage Structure at Stevens Park



- **Storage Volume: 5 MG**
  - 25-30 foot storage depth

Outfall 005A

CSO Storage Structure at Baseball Field



Outfall 006A (H5 Drainage Area - Central Hoboken)

Green Infrastructure

I/I Reduction

Sewer Separation

Increase flow to WWTP

Consolidate with H3/H4/HSI

CSO Storage

CSO Discharge Treatment

Modify H5 regulator to Convey More to WWTP

CSO Storage in River at Maxwell Place

Convey Flows to H3/H4/HSI via tunnel

Cloth/Compressible Media Filtration

Disinfection

Modify H5 regulator to Convey More to WWTP

CSO Storage in or near River at Maxwell Place

Convey Flows to H3/H4/HIS via Tunnel

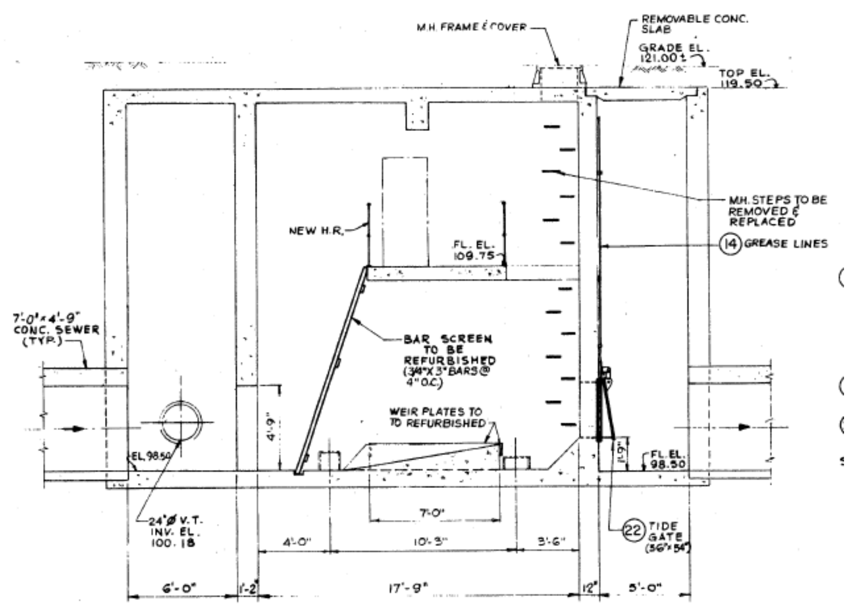
<u>Opportunities for:</u>

Green Infrastructure

I/I Reduction

Outfall 006A

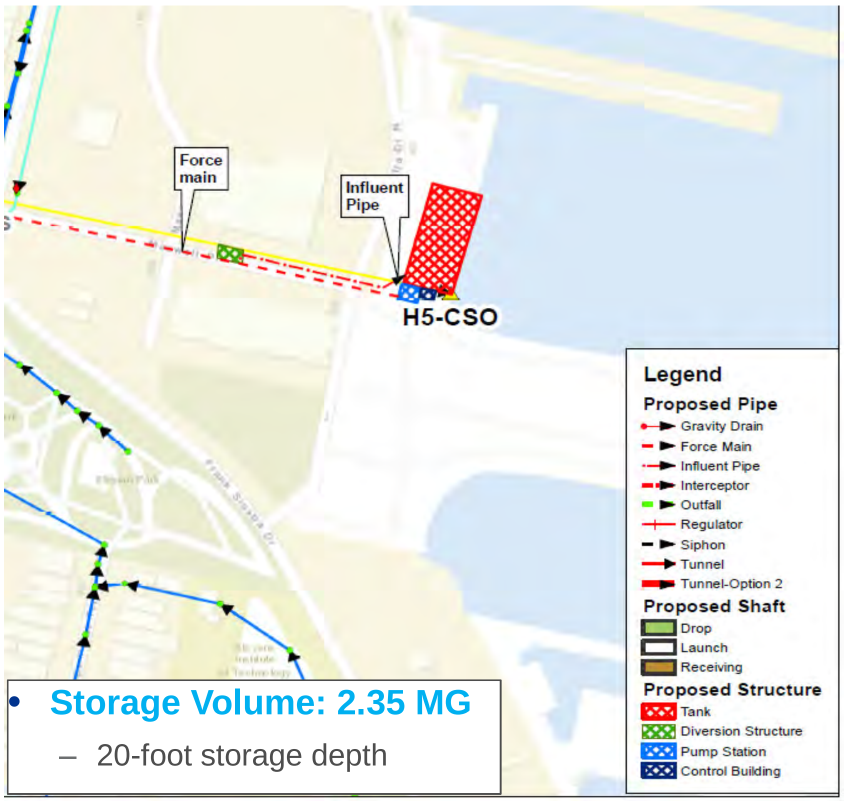
Modify the H5 Regulator to Convey More Flow to the 11th Street Pump Station



- General
  - Raise H5 Regulator Weir
  - Increase pump station capacity from 10 to 31 MGD

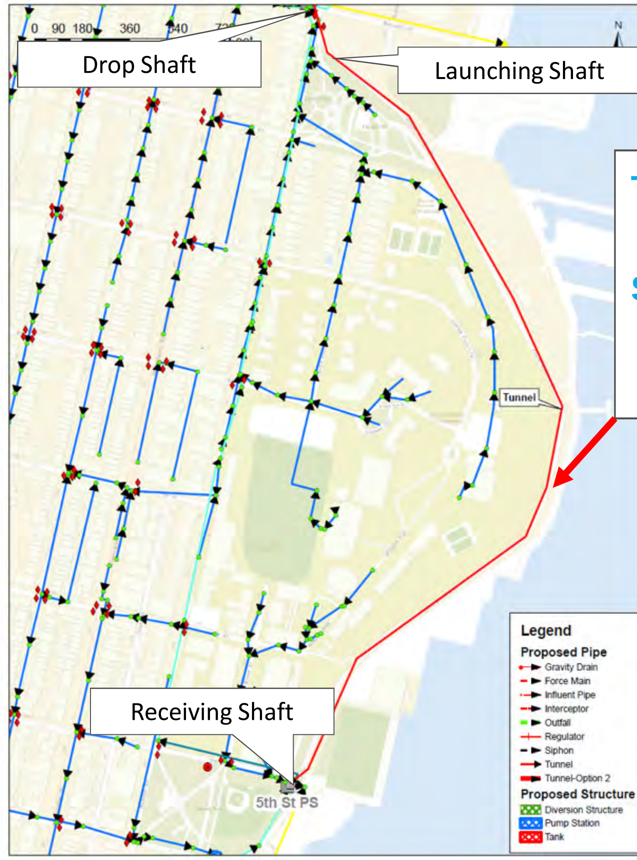
Outfall 006A

CSO Storage Structure At Maxwell Place



- **Storage Volume: 2.35 MG**
  - 20-foot storage depth

Convey Flows to H3/H4/HSI Outfall



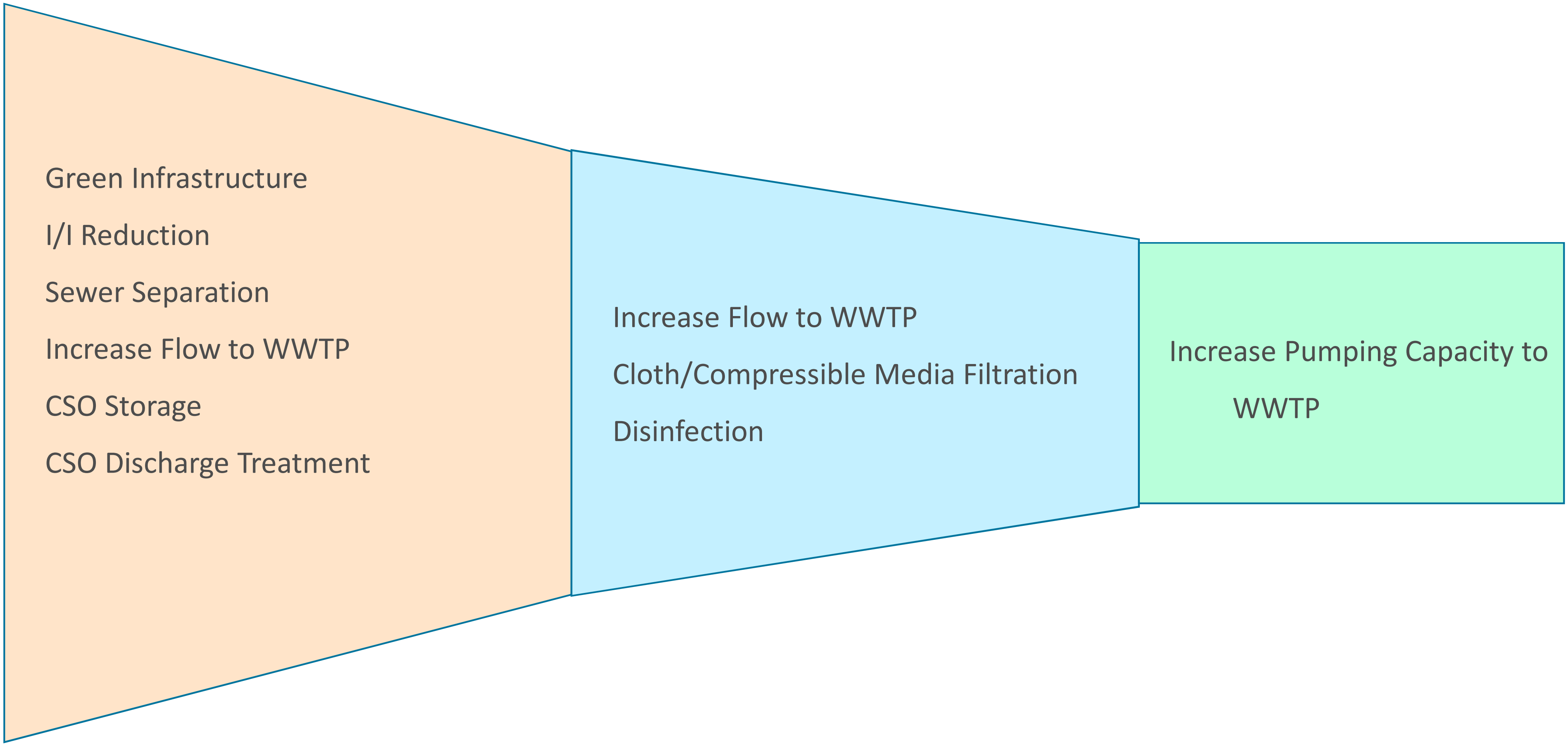
Tunnel Volume: 2.35 MG

3730' in length; 10' ID

Structure

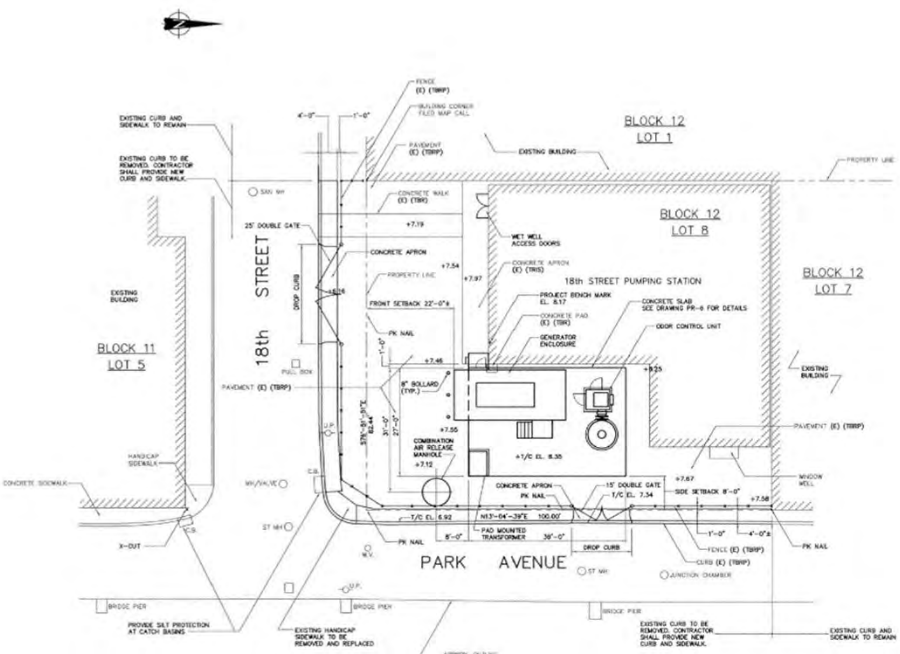
20 feet of cover

Outfall 012A (18th Street Pump Station – Weehawken)



Outfall 012A

Increase Pumping Capacity of 18th Street Pump Station



- General
  - Upgrade Capacity from 5 MGD to 18 MGD
  - Increase size of force main

Outfall 013A (W1234 Drainage Area - Weehawken)

Green Infrastructure

I/I Reduction

Sewer Separation

Increase Flow to WWTP

Relocate Regulators W1, W2 & W3

Tunnel to WWTP

CSO Storage

CSO Discharge Treatment

Increase Siphon Capacity

Relocate Regulators W1, W2 & W3

Tunnel to WWTP

CSO Storage at Regulator W4

Cloth/Compressible Media Filtration

Disinfection at S/F Facility

Relocate Regulators W1, W2 & W3

Increase Siphon Capacity

CSO Storage at Regulator W4

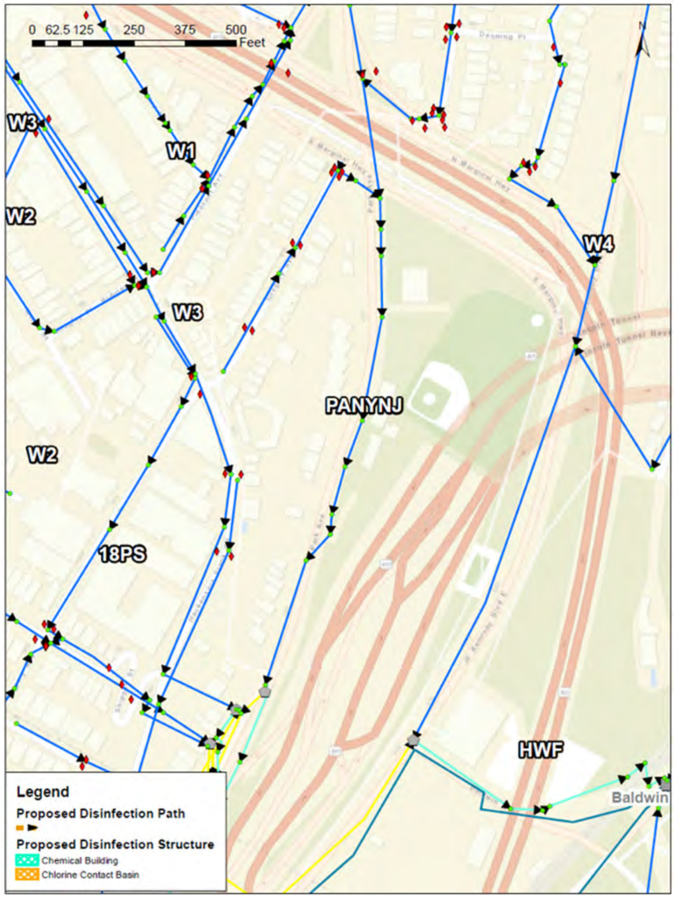
<u>Opportunities for:</u>

Green Infrastructure

I/I Reduction

Outfall 013A

Relocate Regulators W1, W2, and W3



- Potential Construction
  - With potential work on increasing siphon capacity, this would provide an opportunity to relocate regulators to aid in decelerating flow to interceptor
  - This alternative is not expected to reduce flows significantly and will be combined with the other proposed alternatives for W1234 which convey flow to the plant for optimization

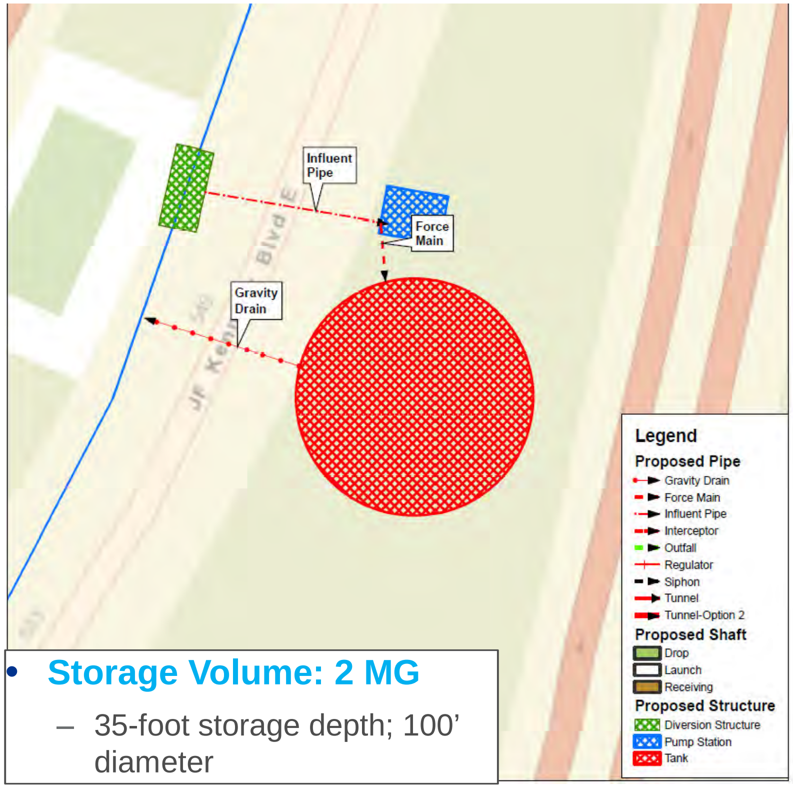
Outfall 013A

Install a 3rd Barrel for the Park Avenue Siphon to Increase Flow to WWTP

- **Structure**
  - Parallel to existing Siphon
- **Piping**
  - Existing siphons are 24” and 12”
  - Next increment is 36” pipe
  - Analyzing larger pipe sizes or additional barrel to target more flow

Outfall 013A

CSO Storage Tank at Regulator W4



- **Storage Volume: 2 MG**
  - 35-foot storage depth; 100' diameter

Outfall 015A (W5 Drainage Area – Weehawken)

Green Infrastructure

I/I Reduction

Sewer Separation

CSO Storage

CSO Discharge Treatment

Construct High Level Storm Sewers

Cloth/Compressible Media Filtration

Disinfection

High Level Storm Sewers

Disinfection Pilot Study

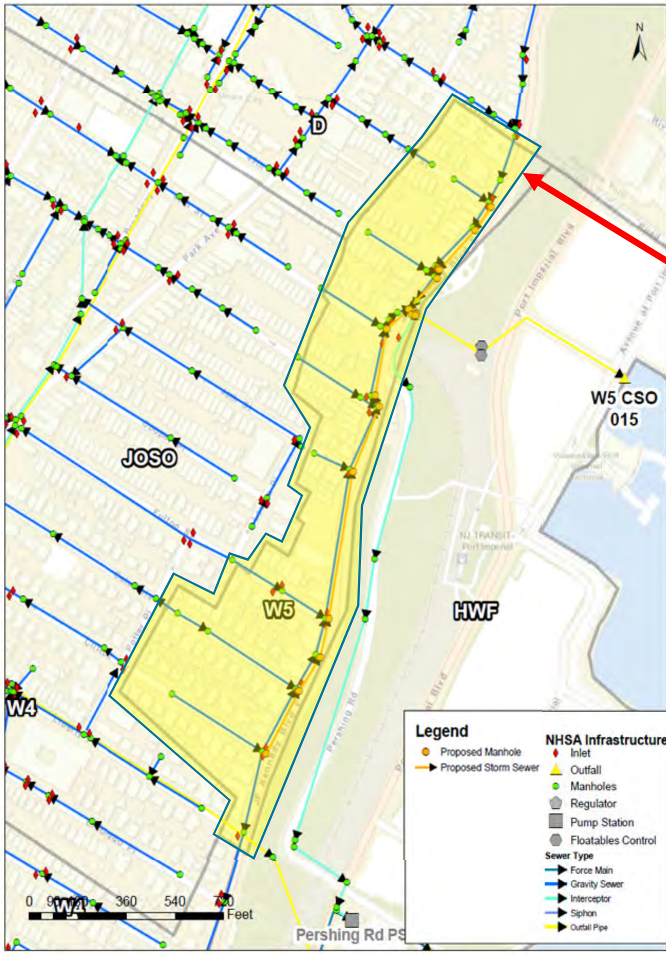
<u>Opportunities for:</u>

Green Infrastructure

I/I Reduction

Outfall 015A

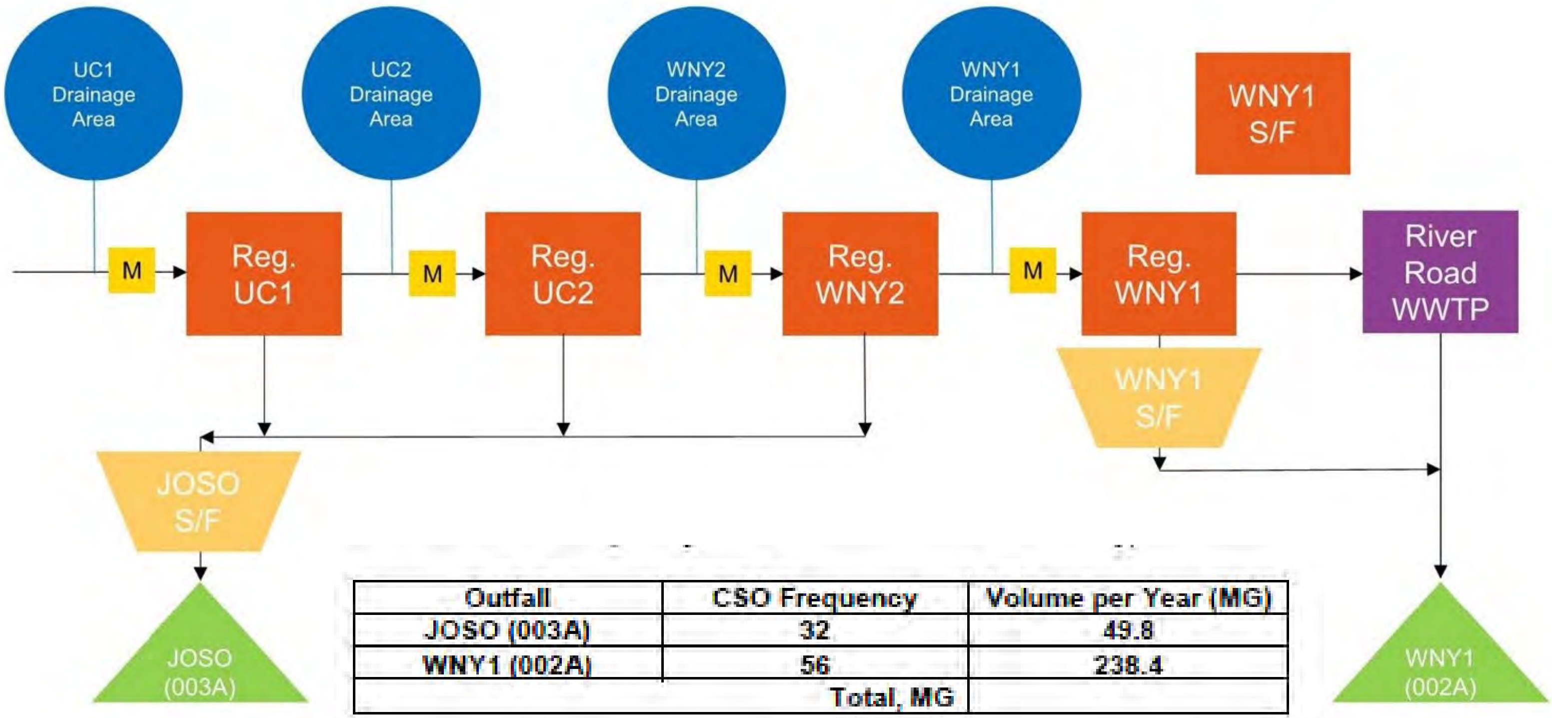
High Level Storm Sewer



- **Project Concept**
  - Construct stormwater system in parallel to existing combined system along Boulevard East
  - Disconnect catch basins from combined sewers and connect to new high level storm sewers
  - Reconfigure regulator to direct sanitary flows to existing 12” Interceptor

LTCP Development - River Road

River Road Combined Sewer System



Outfall	CSO Frequency	Volume per Year (MG)
JOSO (003A)	32	49.8
WNY1 (002A)	56	238.4
	Total, MG	

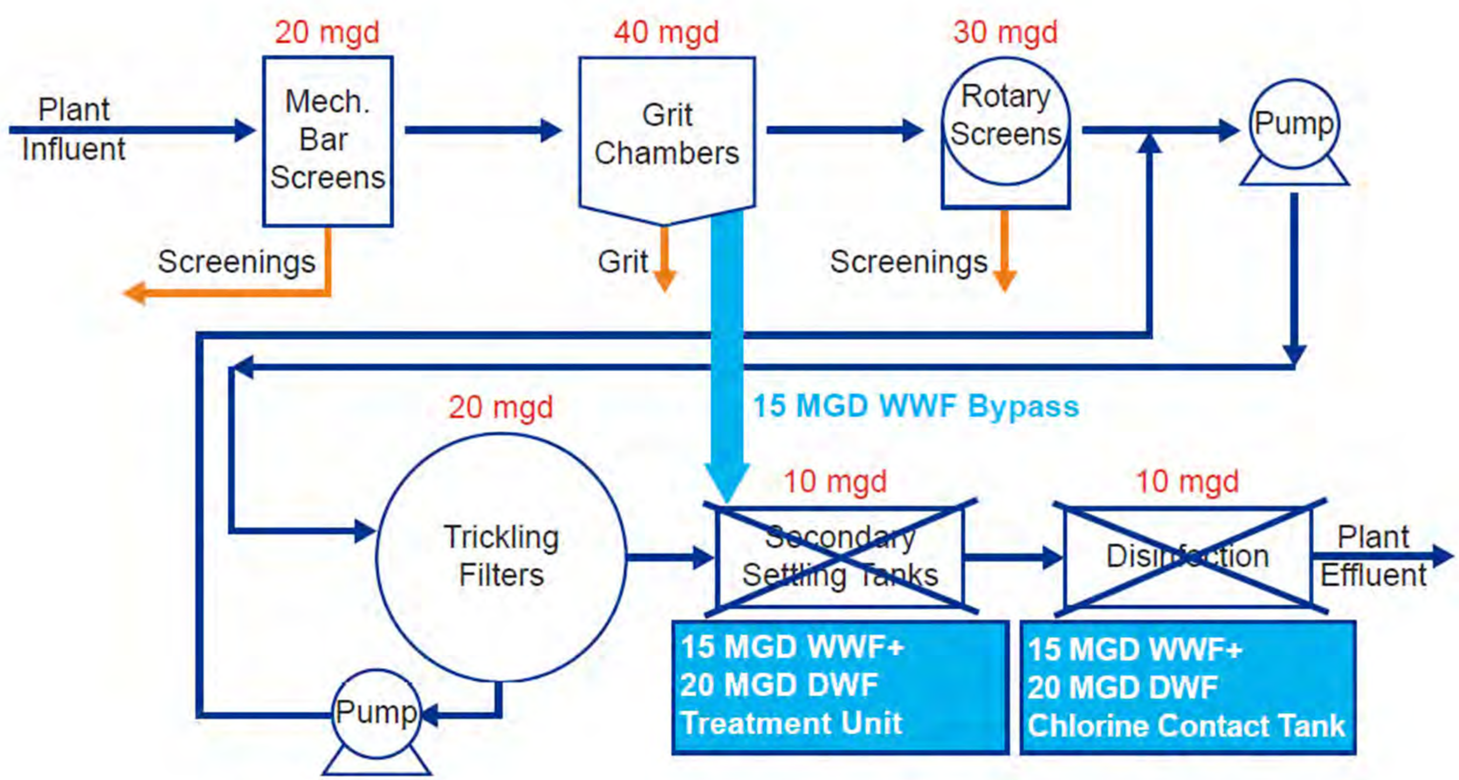
River Road WWTP

CSO Storage Adjacent to WWTP
Gravity Storage Tank with Primary-level BOD and TSS Removal
Change Treatment Process
- Replace microstrainers with ACTIFLO treatment
- Replace process with CoMag/BioMag treatment
- Add Cloth/Compressible Media Filtration for more TSS removal

CSO Storage Adjacent to WWTP
Gravity Storage Tank
Change Treatment Process

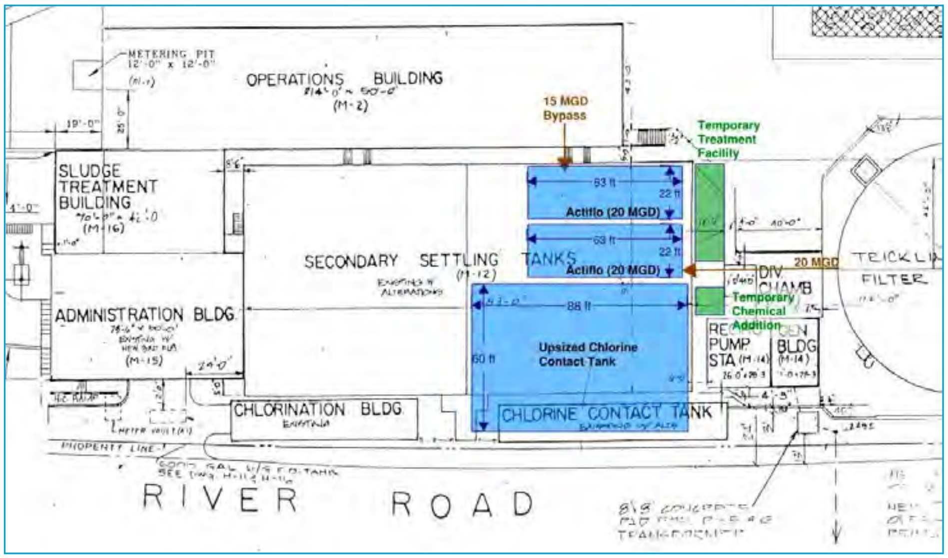
CSO Storage Adjacent to WWTP
Gravity Storage Tank
Change Treatment Process

River Road WWTP – Change Treatment Processes

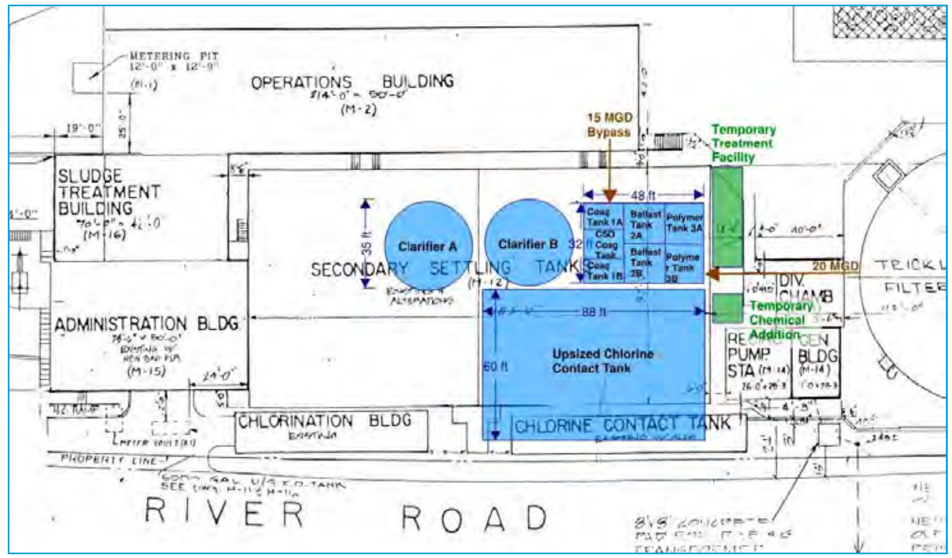


River Road WWTP – Change Treatment Processes

ACTIFLO Treatment



CoMag Treatment



Outfall 003A (JOSO Drainage Area – Union City & West New York)

Green Infrastructure

I/I Reduction

Sewer Separation

Raise Regulator Weirs

Add Bending Weirs to Regulators

CSO Storage Structure in River

CSO Discharge Treatment

Raise Regulator Weirs

Add Bending Weirs to Regulators

CSO Storage Structure in River

Cloth/Compressible Media Filtration

Disinfection

Raise Regulator Weirs

Add Bending Weirs to Regulators

CSO Storage Structure in River

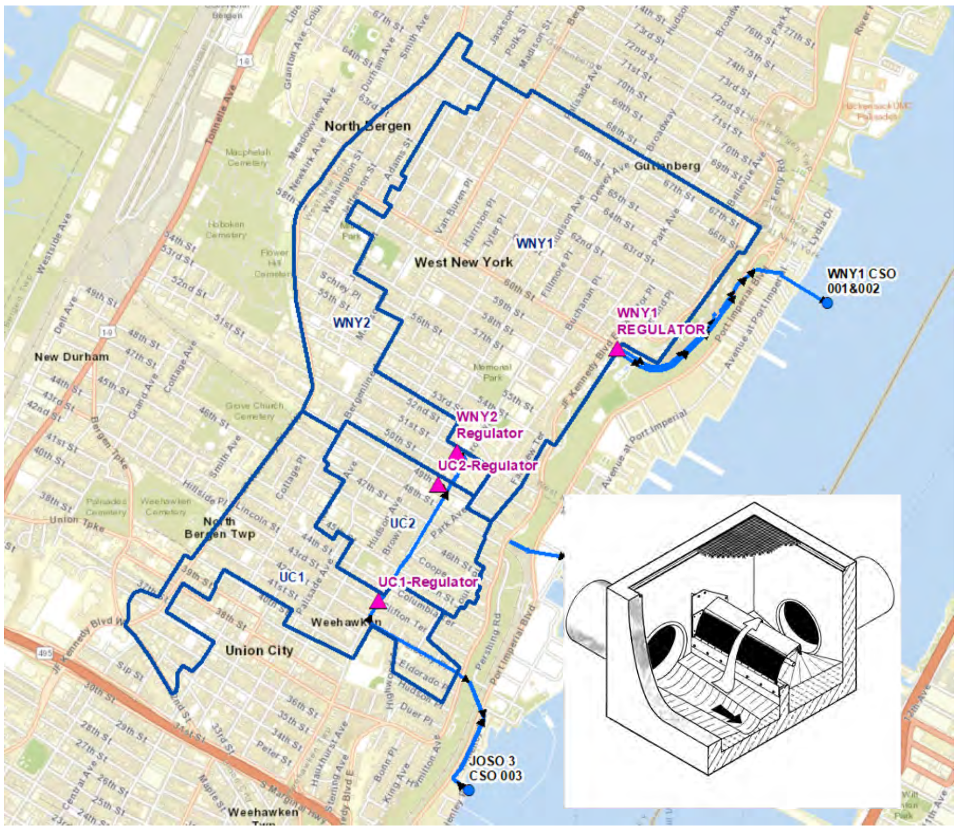
<u>Opportunities for:</u>

Green Infrastructure

I/I Reduction

Outfall 003A

Replace Existing JOSO Side-flow weirs with Bending weirs



	Number of Overflows		Total CSO Volume (Mgal)	
	Existing	Bending Weirs	Existing	Bending Weirs
JOSO (003A)	61	24	95	28
River Road (002A)	60	60	190	254

Raise Regulator Weirs at UC1, UC2 and/or WNY2

- Divert flows to WWTP and minimize amount routed to JOSO outfall
- Iterate scenarios raising weirs and analyzing overflow amounts

Outfall 003A

CSO Storage Structure constructed in River

- **Storage Volume: 5 MG**
  - 10-foot storage depth; 250’L x 250’W

Outfall 002A (WNY1 –West New York)

Green Infrastructure

I/I Reduction

Sewer Separation

CSO Storage Tunnel/Tank

Linear Storage under Anthony Defino Way

CSO Storage Structure in River

CSO Discharge Treatment

Linear Storage under Anthony Defino Way

CSO Storage Structure in River

Cloth/Compressible Media Filtration

Disinfection

Linear Storage under Anthony Defino Way

Opportunities for:

Green Infrastructure

I/I Reduction

Outfall 001A/002A

Linear Storage along Anthony M. Defino Way

- 2,200 ft long, 26 ft diameter = 8.3 MG storage
- Number of overflow events at River Road reduced from 60 to zero. No improvement at JOSO but can combine with weir optimization
- Site considerations: slope, existing infrastructure
- Vortex drop structure, WWPS, HRT, disinfection, new parallel outfall, tide gate

NHSA Social Media Update

Redesigned Website:

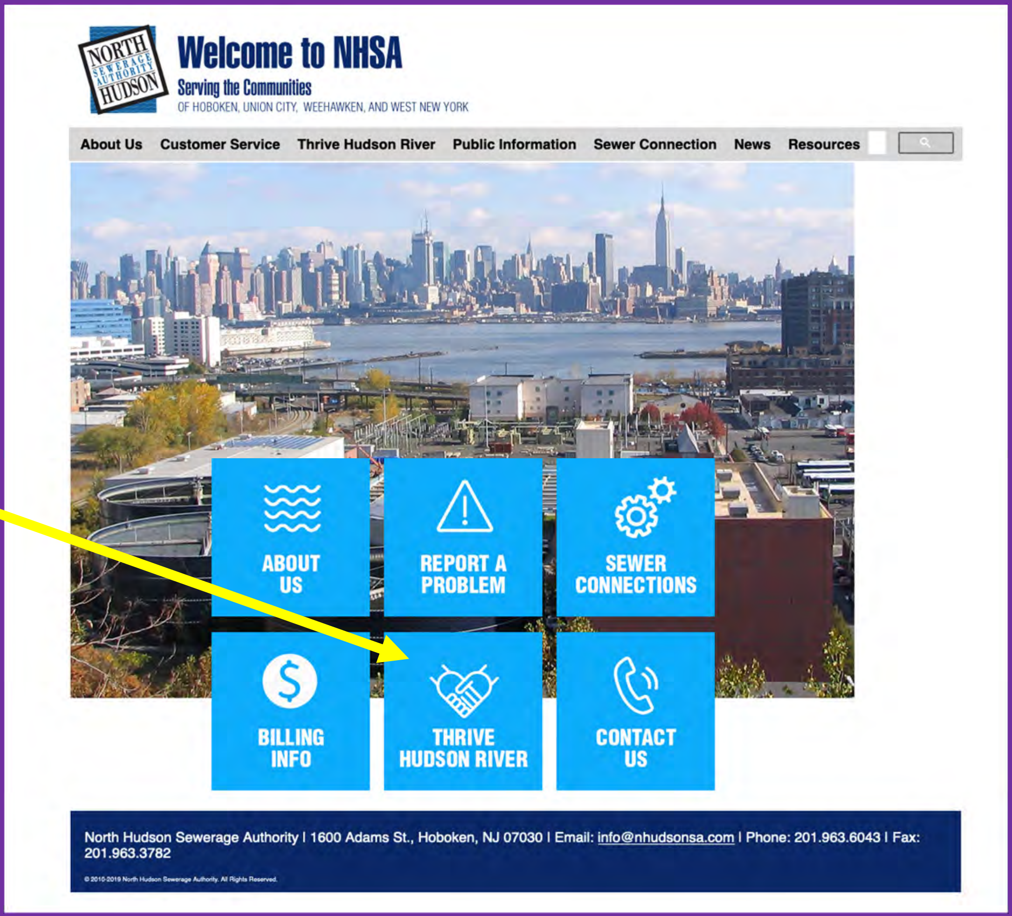
http://www.nhudsonsa.com

Dedicated LTCP Section with Waterbody Advisory System

Twitter

@NHSALTCP

or https://twitter.com/NHSALTCP



Next Steps

- Public Input on Remaining CSO Control Options
- Sequencing of CSO Control Construction
- Analysis of the Financial Implications of Implementing CSO Controls
- Develop Long Term Control Plans (LTCPs)
- June 2020: Submit LTCPs for NJDEP Approval

Next Public Meeting Date November 18, 2019

Thank You

NORTH SEWERAGE AUTHORITY HUDSON

North Hudson Sewerage Authority CSO Long Term Control Plan - Public Meeting Minutes

PROJECT:	North Hudson Sewerage Authority Alternatives Analysis
MEETING DATE:	August 19, 2019
MEETING TIME:	7:00 PM – 8:45 PM
LOCATION:	1600 Adams Street, Hoboken, NJ

The third public meeting regarding the Alternatives Analysis for development of the Long Term Control Plan (LTCP) for the North Hudson Sewerage Authority service areas was held on August 19th, 2019. Previously the meetings discussed the beginning stages of the Alternatives Analysis. The purpose of this meeting is to discuss the next steps after the preliminary screening of numerous alternatives at each drainage basin and to discuss the feasibility of the alternatives. The meeting began with a presentation on the alternatives selection process to date and potential alternatives. These slides can be seen on the Authority's website. A sign-in sheet for attendance was at the front desk. The following summarizes the questions and comments following the presentation.

Q: On the proposed tunnel alternative at River Road, treatment processes are indicated in the alternative. Is this an End of Pipe alternative?

A: These processes would attempt to mimic the processes currently at the plant as a 'mini' WWTP as the flow would be captured outside of the plant and would need to be treated prior to being discharged. This does not necessarily constitute as End of Pipe but the flow will be treated before being discharged to the River.

Q: Has sea level rise been considered in these alternatives?

A: Sea level rise was considered but more detailed analyses would be conducted further in the selection process.

Q: In Hoboken, which outfall is being eliminated?

A: H2 is being dedicated to Rebuild by Design. The existing Adams Street plant outfall will be dedicated to the Northwest Resiliency Park Project for drainage areas H6 and H7 and a new plant outfall will be constructed in the future for the treatment plant.

Q: What is the existing capacity of the H5 WWPS?

A: There are two (2) 40 MGD pumps (one Duty, One Standby), but both pumps can be operated at one time, should the need occur.

Q: For the H1 drainage basin, is there only one option?

A: Multiple alternatives analyzed at H1 are listed in the Draft Evaluation of Alternatives report (see Authority's website). However, the presented alternative of storage under the Observer Highway parking lot is technically feasible and is viable.

Q: For next steps in the alternative at H3/H4, how does the decision-making process happen? Will the stakeholders be engaged in the process?

A: Stakeholders will be identified and involved in the decision making for the elements of the H3/H4 alternative in the near future.

Q: When were these permits issued?

A: The NJDEP reissued the NJPDES Permits to municipalities with combined sewers. These additions to the permits were issued in 2014 for CSO LTCPs.

Q: Compared to Passaic Valley alternatives, what is the schedule like?

A: North Hudson is on a different schedule but we are complying with the NJPDES permit for the River Road and Adams Street plants. We must have a working plan to submit by July 2020.

Q: When are the alternatives going to be selected?

A: The permit states that a plan must be submitted by July 2020. The alternatives have not been selected but a preliminary screening has been conducted for numerous possible alternatives in all drainage basins. This involved feasibility analyses and overall return on the volume treated or captured compared with the estimated cost.

Q: Once the alternatives are selected to reach 85% capture, is there capacity at the Hoboken plant or will it need to be built out?

A: The 85% capture includes building out capacity at the WWTP and also a new outfall to convey the increased capacity.

Q: For the proposed storage at H3/H4, will there be two tanks? And will there be additional coordination?

A: For the alternatives analysis, one tank holding all of the volume required was analyzed and could be located at either of two different locations. The construction of two tanks is not required. The location of this storage tank is not something that the Authority is actively pursuing.

Q: On Maxwell Park, is this constructed on the boathouse? What is the depth? Is it to scale?

A: This is north of the boathouse. The approximate depth is 20-30 feet and is approximately to scale on the presentation.

Q: Describe locale of outfall

A: The potential locations of the new outfall extend beyond 16th Street to 17th Street. The alignment will be reviewed for technical feasibility but an alignment along 17th Street is the preferred choice. Additional analyses will be conducted to determine how deep and far the outfall must extend as compared to the current plant outfall.

Q: Was any data looked at of the fecal and entero data from the Citizen Water Plan? From what has been seen, it seems the samples have not been taken at the beach or cove.

A: PVSC conducts the water quality analysis and the data and it has been passing along the information. PVSC conducted the testing for all of the NY Harbor dischargers.

Q: How does LTCP, Land Use Plan, and Rebuild by Design programs plan to achieve synergy economically and productively?

A: The various organizations work together and are in communication. They are working together to look for improvements as well as keep the public informed.

(Comment: The City's Master Plan was completed but previously the master plan data was not available.)

(Comment: Church at 6th and Garden did not flood in Sandy. According to the Hoboken analysis, this is in the green/gray area. Incorporating green infrastructure into these plans is a possibility.)

Q: Are all the GI alternatives proposed those that Hoboken has done or is the alternatives analysis introducing new GI alternatives?

A: The alternatives analysis looked at a high-level implementation of green infrastructure system-wide but did not intend to overlap what has been done by Hoboken. The Authority continues to accept each new opportunity as they come. In Hoboken, Southwest Park has been outfitted with GI and 7th and Jackson has had a green roof outfitted. The Authority welcomes all feasible opportunities for GI but there are some instances where stakeholders inhibit implementation. In one municipality stormwater storage is available beneath an athletic field but the owner will not allow the Authority to operate. We have also looked at private property when public property is not available.

Q: How will this affect rates?

A: The Authority's goal is to push this out as bonds become paid and financing becomes available to not raise the rates. Additionally, they are looking at ways to subsidize different parts of the community.

(Comment: One resident stated they would prefer to raise rates if it would help the overall capture and new infrastructure goals.) It was pointed out that not all of the customer base can afford substantial rate increases.

Q: At Hudson and Observer [proposed H1 storage location], are there other property owners in the vicinity that discussions have been had with?

A: No, only the owners of the referenced property and the City of Hoboken.

Q: Since the implementation of the LTCP plan goes until 2042, maybe by then there is a new tunnel in the Hudson River and there could be some synergy with the tunnel project.

A: The potential LTCP plans will not be able to be constructed in 20 years so it will likely be later than that. The tunnel would be a NJ Transit project. The Authority's goal is to optimize any existing infrastructure. One example is the major outfall structure at the end of Long Slip Canal in South Hoboken. There were discussions with Jersey City to combine their CSO and ours in Long Slip but it was not pursued by Jersey City.

(Comment: For any in-water construction, there would need to be much more coordination. For options like H3/H4, down the line we would need to discuss this with the master plan and city planners. Building in the River is not an optimal solution nor is building in public parks unless it has been in the master plan like the Northwest Resiliency Park and Southwest Park)

The meeting ended at about 8:45 pm.

NHSA CSO LTCP Public Meeting #4

November 18, 2019

Public Participation Meeting Sign In Sheet

DATE: 11/18/2019

PREPARED BY: JACOBS

Name	Affiliation	Email
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Ed Friedrich	NHSA	edfriedrich@gmail.com

Public Participation Meeting Sign In Sheet

DATE: 11/18/2019

PREPARED BY: JACOBS

NORTH HUDSON SEWERAGE AUTHORITY

Name	Affiliation	Email
Phil Reeve	NHSA	philip.reeve@jacobs.com

North Hudson Sewerage Authority
Long Term Control Plan

Public Meeting

11.18.2019

Agenda

- Methodology
  - ➢ 4 Overflows/Year
  - ➢ 85% Capture
- 4 Overflows/Year Analysis
  - ➢ Adams Street WWTP Service Area Scenarios
  - ➢ River Road WWTP Service Area Scenarios
- 85% Percent Capture Analysis
  - ➢ Adams Street WWTP Service Area Scenarios
  - ➢ River Road WWTP Service Area Scenarios
- Summary
  - ➢ Adams Street WWTP Service Area
  - ➢ River Road WWTP Service Area

Methodology

- Requirements: Permit Compliance can be achieved in two methods
  - Reduce annual overflows to 4 per year systemwide
  - Capture 85% of wet weather volume annually

Methodology

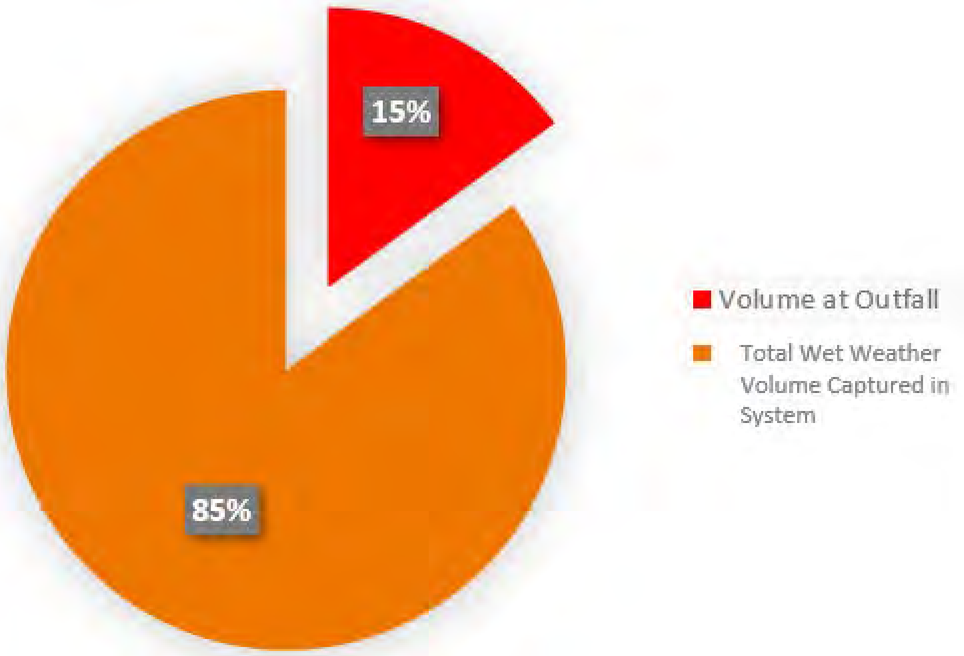
4 Overflows Per Year Systemwide

- Each outfall currently has a range of 12 to 60 overflows per year, ranging in volume.
- To achieve permit compliance through this plan, there is a maximum of 4 overflows allotted at all outfalls per year per service area.

Methodology

Percent Capture

- Percent Capture $= \dfrac{\boldsymbol{Total\ Wet\ Weather\ Volume\ Captured\ at\ WWTP\ (MG)}}{\boldsymbol{Total\ Wet\ Weather\ Volume\ in\ System, (Volume\ at\ WWTP\ plus\ Volume\ at\ Outfalls)(MG)}}$
- This method analyzes the system as a whole as opposed to by drainage basin, potentially reducing the need for extensive construction in one drainage basin over another
- Percent Capture Goal: 85%



Analysis in Adams Street WWTP Service Area

4 Overflows Per Year Systemwide

Methodology

4 Overflows Per Year Systemwide – Adams Street WWTP Service Area

- Each outfall currently has a range of 12 to 60 overflows per year, ranging in volume.
- To achieve permit compliance through this plan, there is a maximum of 4 overflows allotted at all outfalls per year.
- This would require an increase in capacity in all drainage basins whether through storage tanks, pump stations to convey flow back to the plant, and/or additional piping.

Drainage Basin	Outfall	Current Estimated Number of Overflows Per Year
H1	002A	33
H3/H4/HSI	005A	45
H5	006A	16
H6/H7	008A	15
18st. Pump Station	012A	12
W1234	013A	60
W5	015A	24

Analysis

4 Overflows Per Year Systemwide-Adams Street

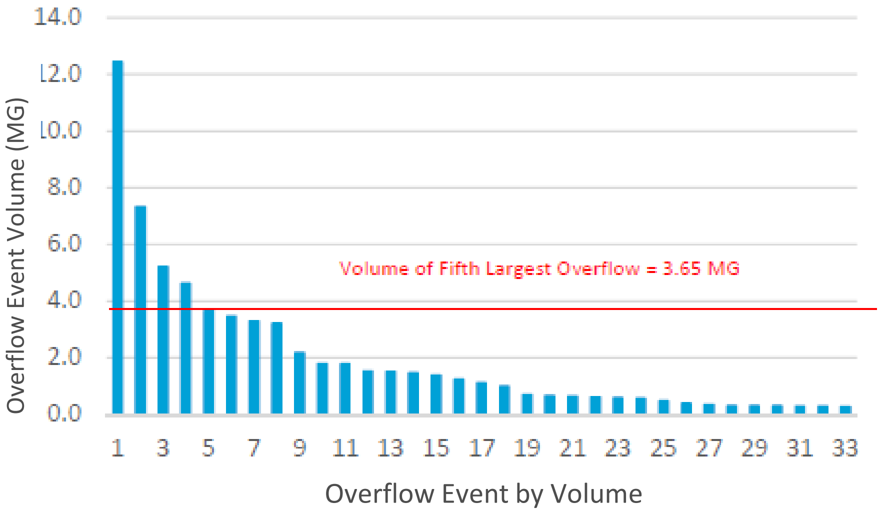
- To achieve no more than 4 overflows in the system annually, the storage tanks and red piping shown in Hoboken may be required
- These storage tanks would capture volume during a rainstorm. After the storm, the volume would be pumped to the treatment plant
- Yellow piping is the existing outfall pipe and outfall structure

Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: CSO Storage Structure at Lot at Observer Highway and Hudson Street

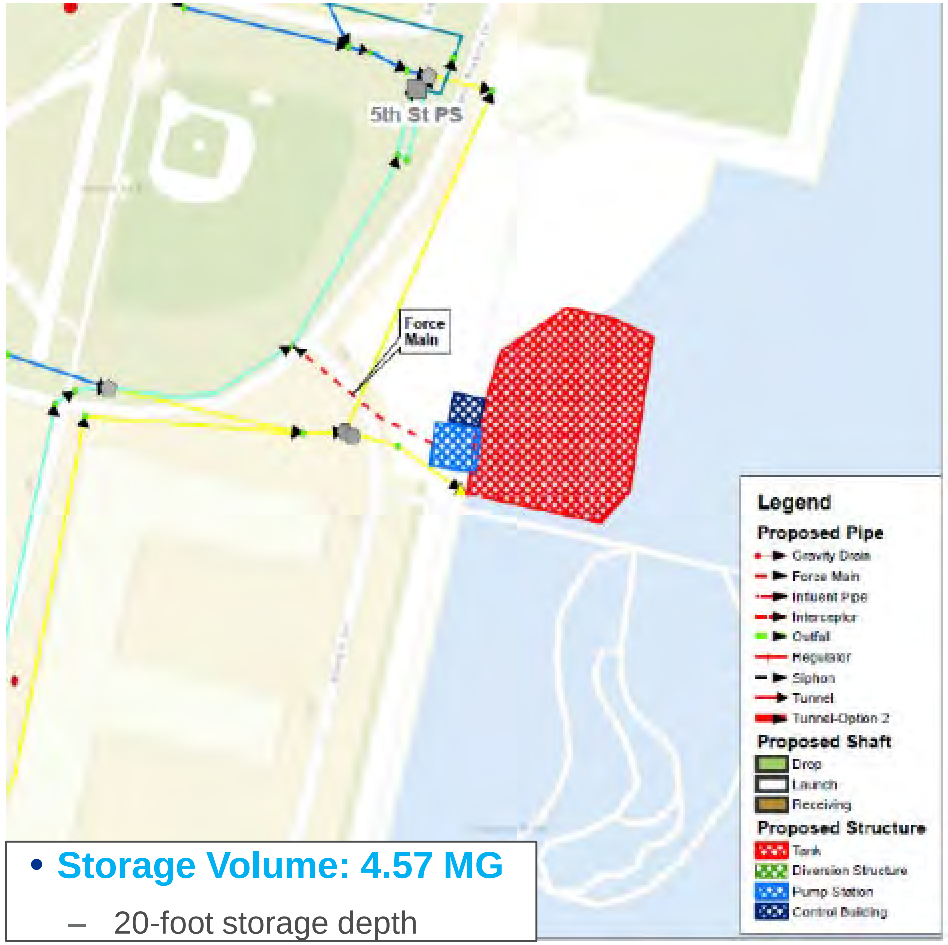
- **Storage Volume: 3.65 MG**
  - 30-foot storage depth



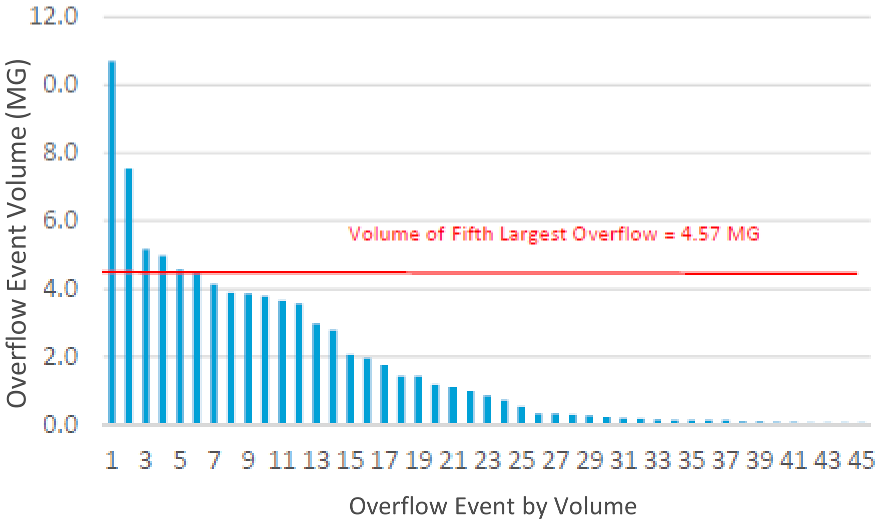
Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: In-Water CSO Storage Structure Near Pier C Park



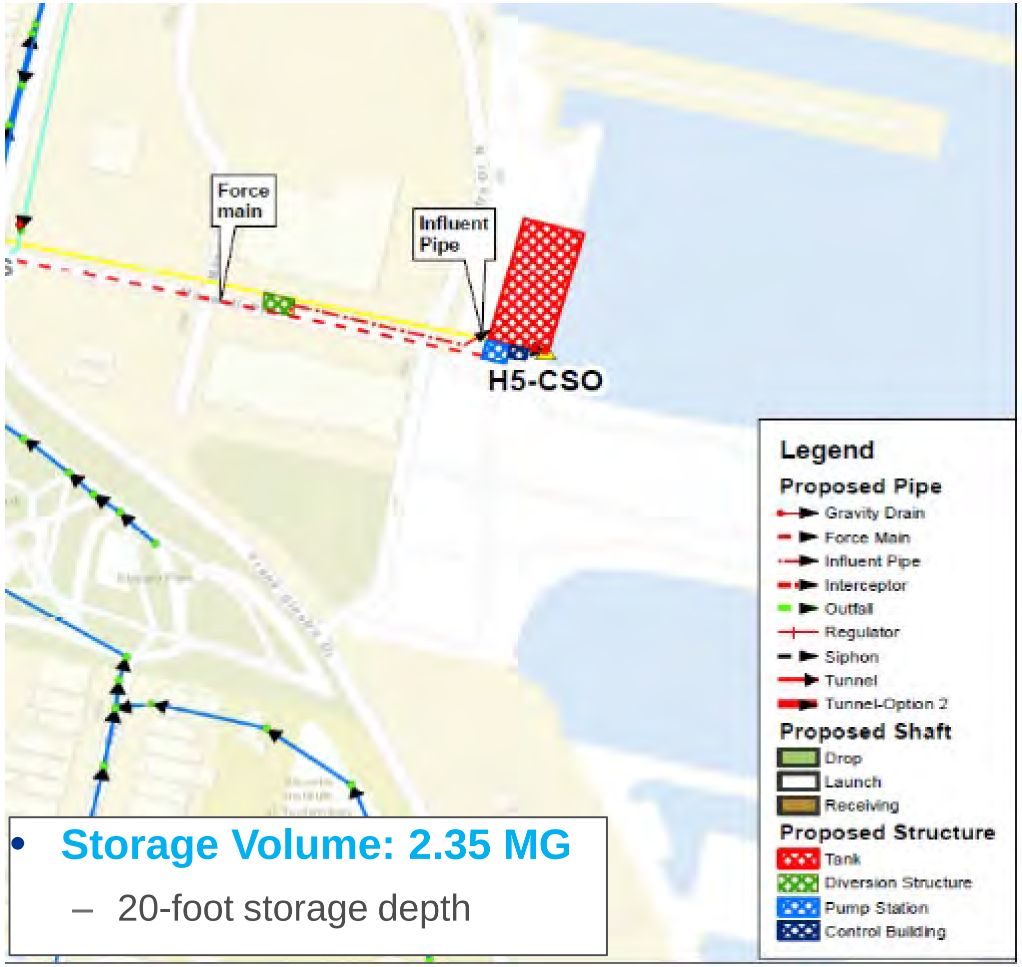
- **Storage Volume: 4.57 MG**
  - 20-foot storage depth



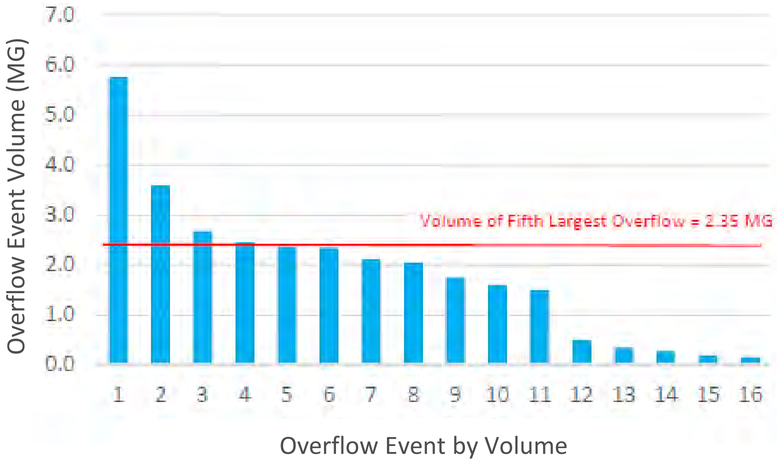
Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: CSO Storage Structure Near Maxwell Place



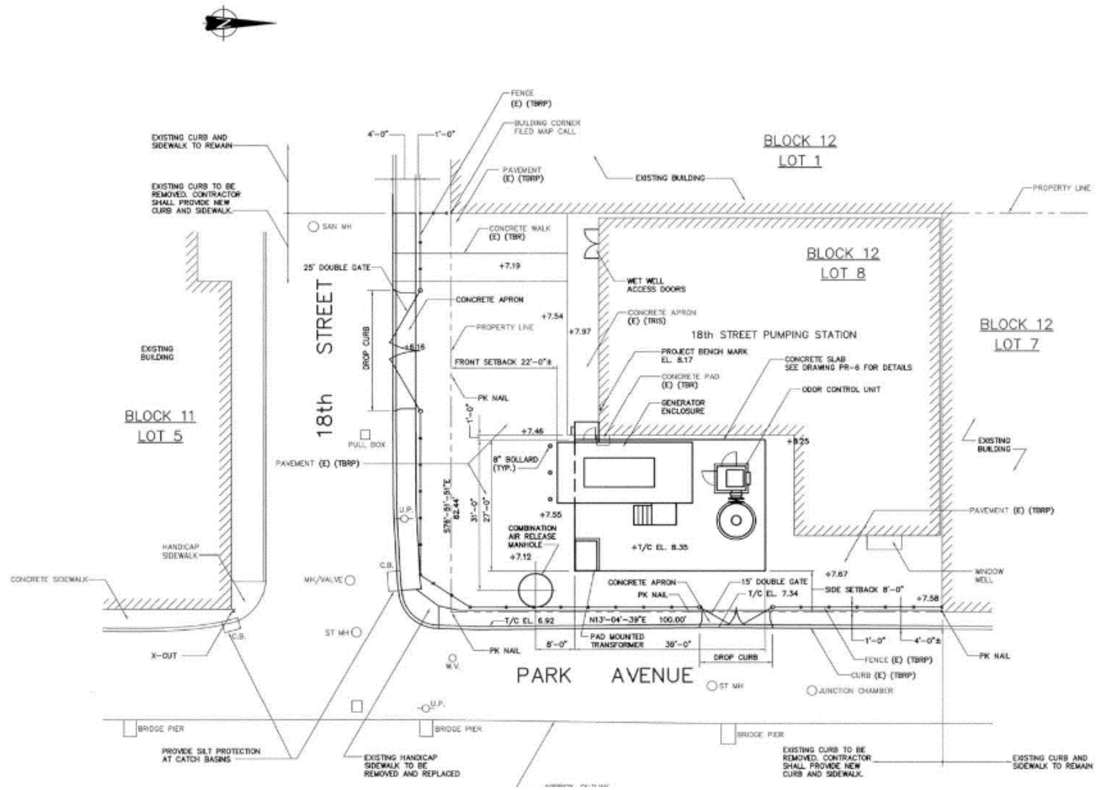
- **Storage Volume: 2.35 MG**
  - 20-foot storage depth

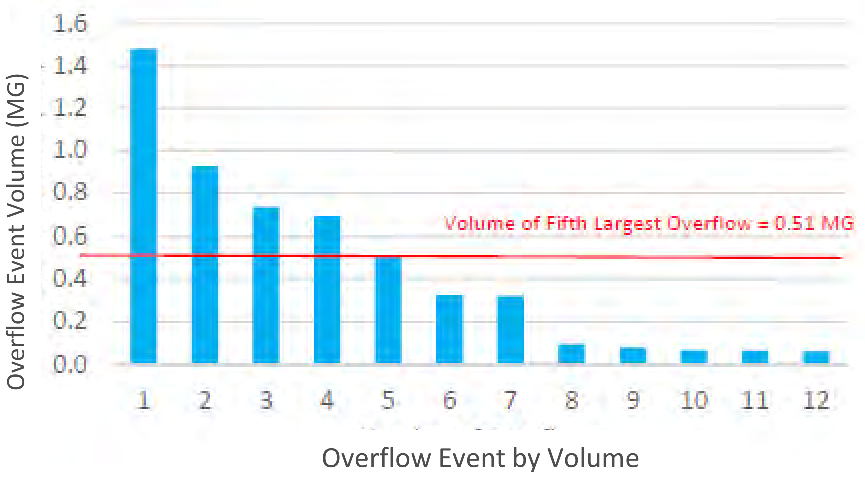


Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: Increase Capacity of 18th Street PS from 5 mgd to 18 mgd

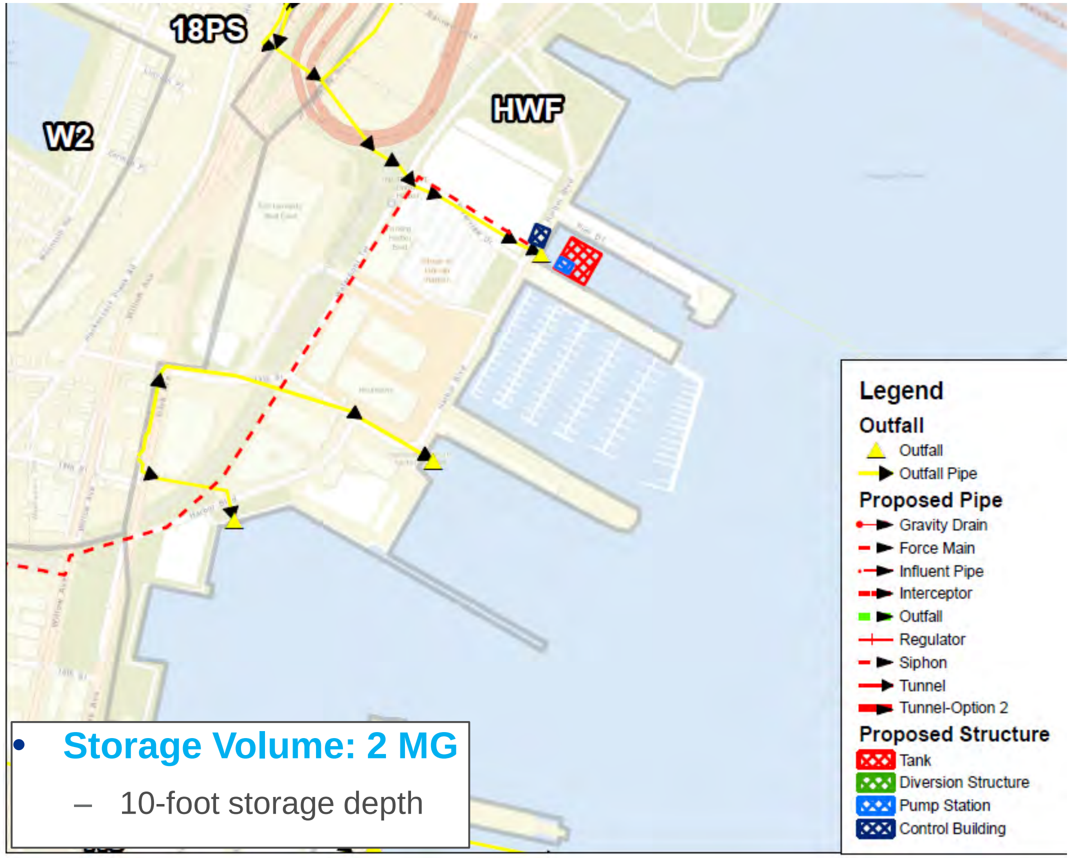




Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: New 72" Siphon Along Park Avenue and In-Water Storage at the Outfall

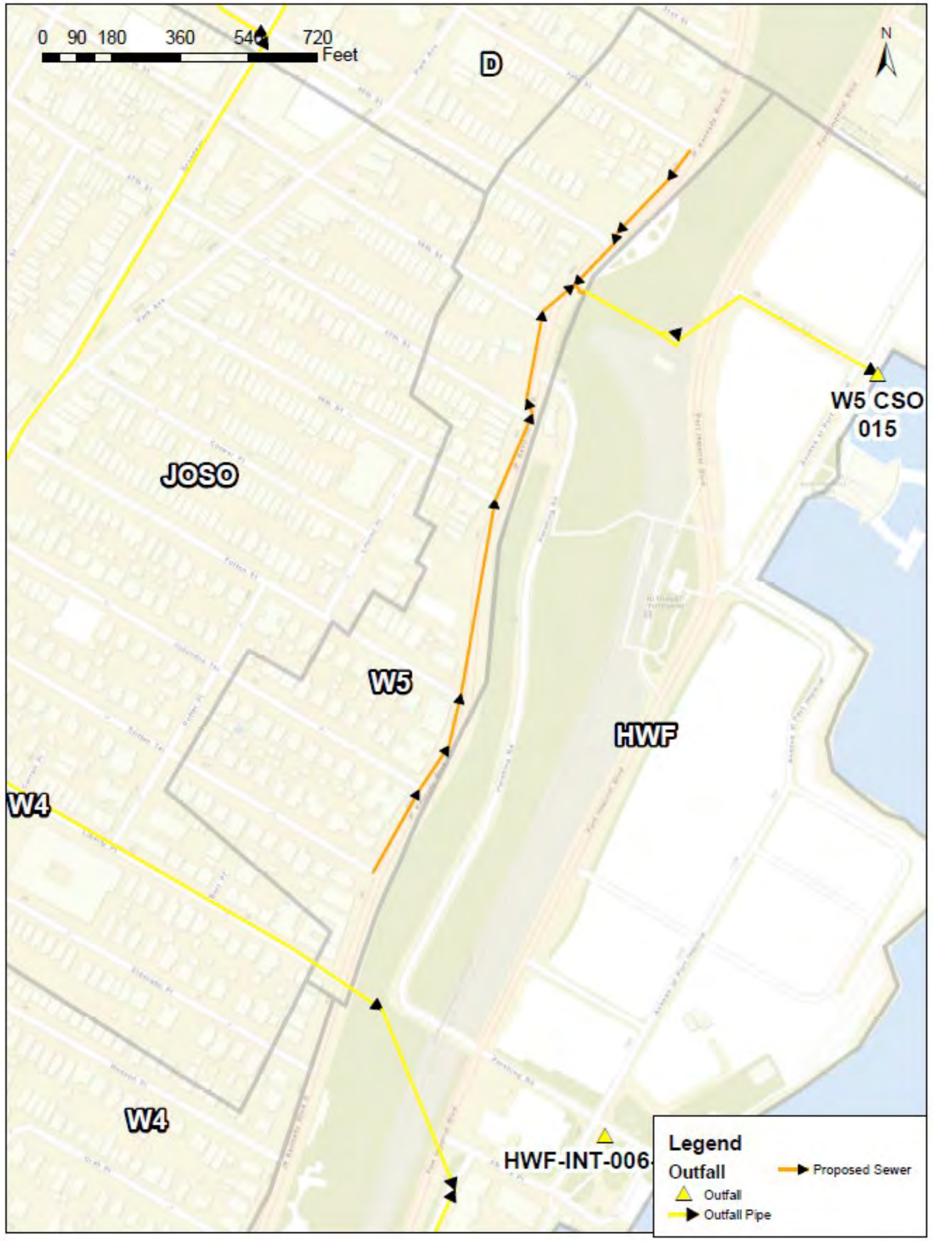


- **Storage Volume: 2 MG**
  - 10-foot storage depth

Analysis

4 Overflows Per Year Systemwide-Adams Street

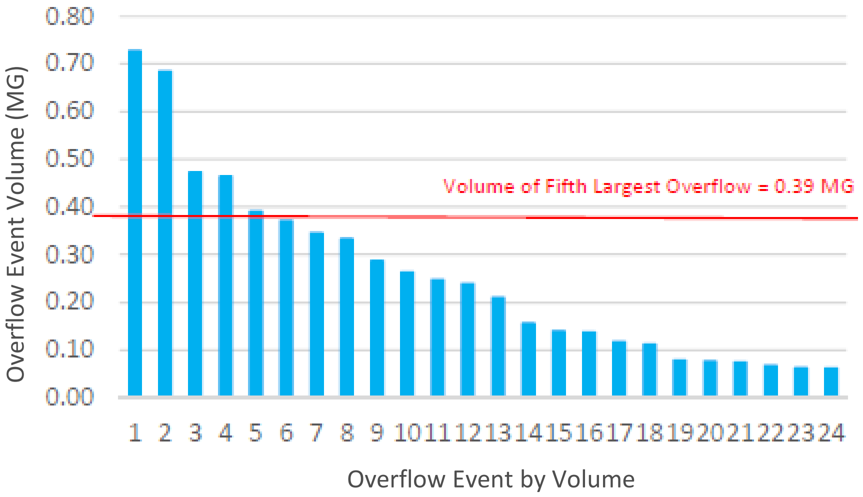
- To achieve no more than 4 overflows in the system annually, in addition to the proposed storage tanks in Hoboken and the piping, storage tank, and pump station upgrades in Weehawken , the proposed piping in Weehawken may also be required
- Yellow piping is the existing outfall pipe and outfall structure



Analysis

4 Overflows Per Year Systemwide-Adams Street

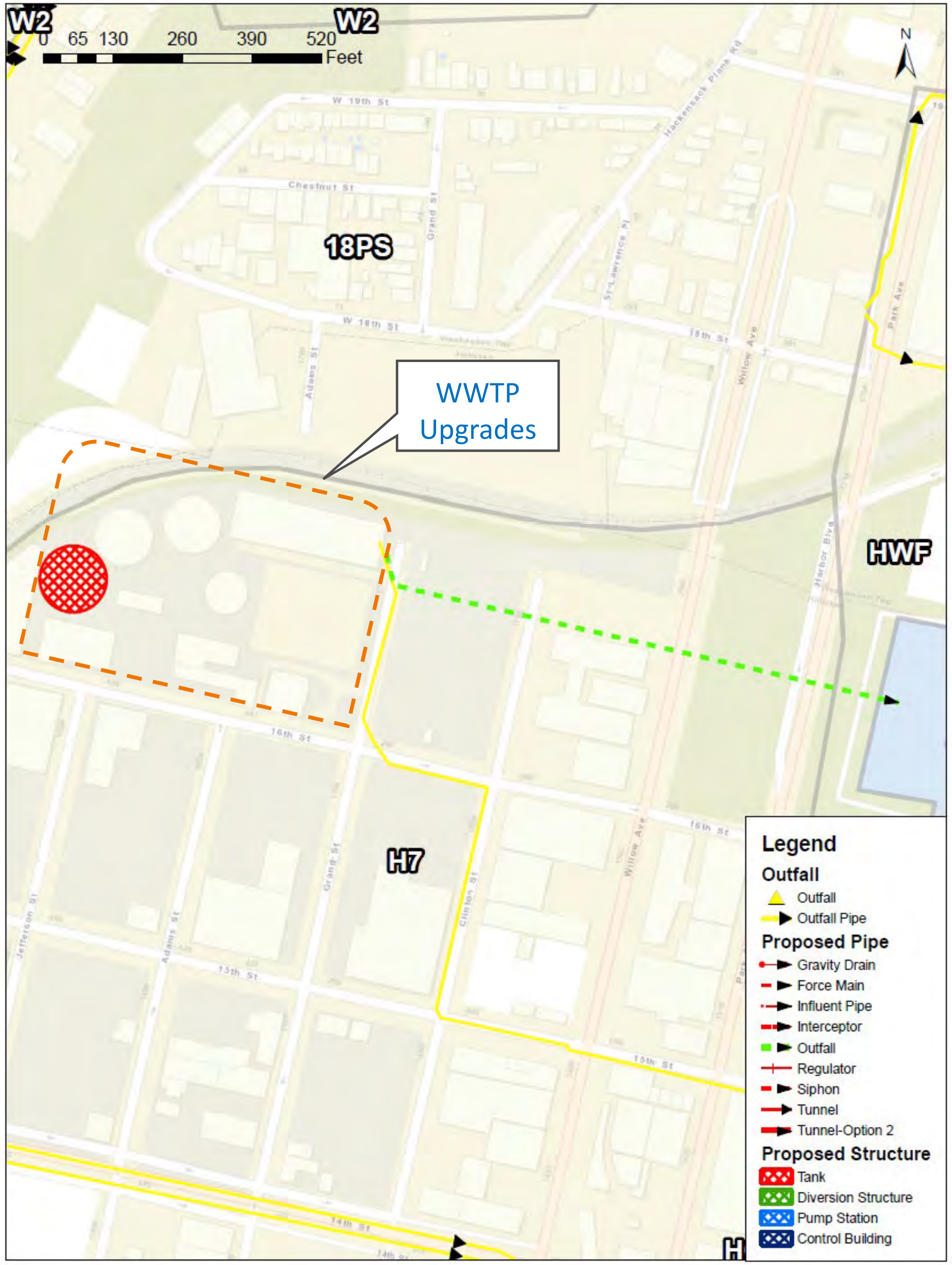
Example: Construct High Level Storm Sewer Along Blvd East



Analysis

4 Overflows Per Year Systemwide-Adams Street

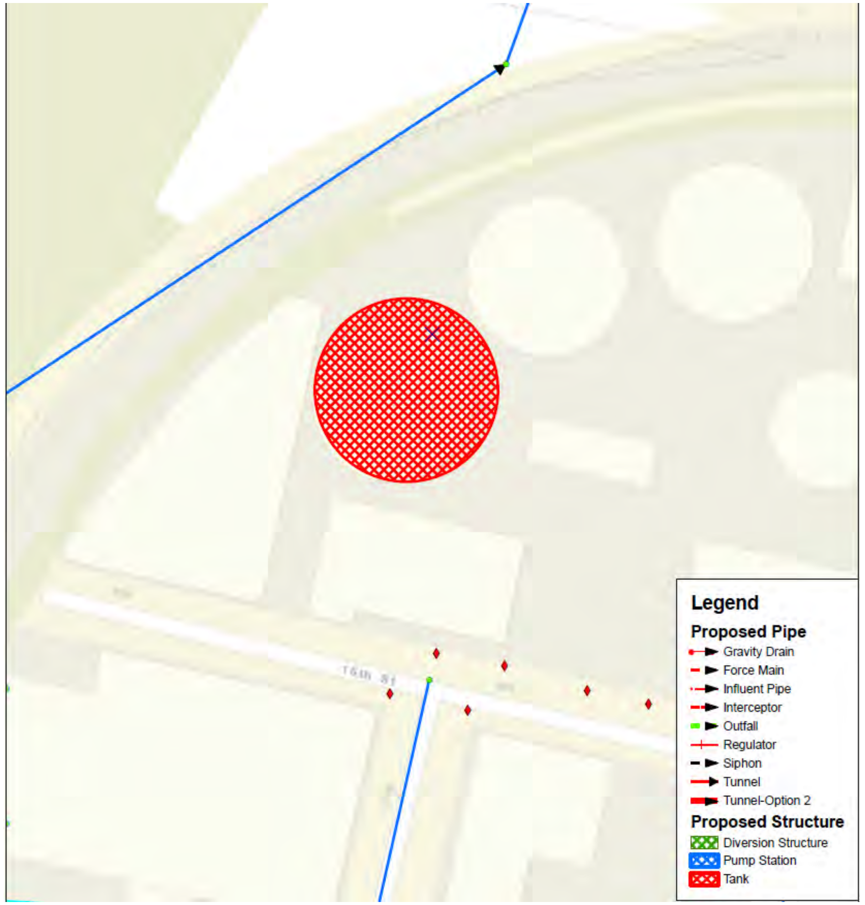
- To achieve no more than 4 overflows in the system annually, in addition to the proposed upgrades in Hoboken, Weehawken and Union City, the following upgrades at the WWTP may be required
- Yellow piping is the existing outfall pipe and outfall structure



Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: Replace Existing Trickling Filter with a 20 MG CSO Storage Tank

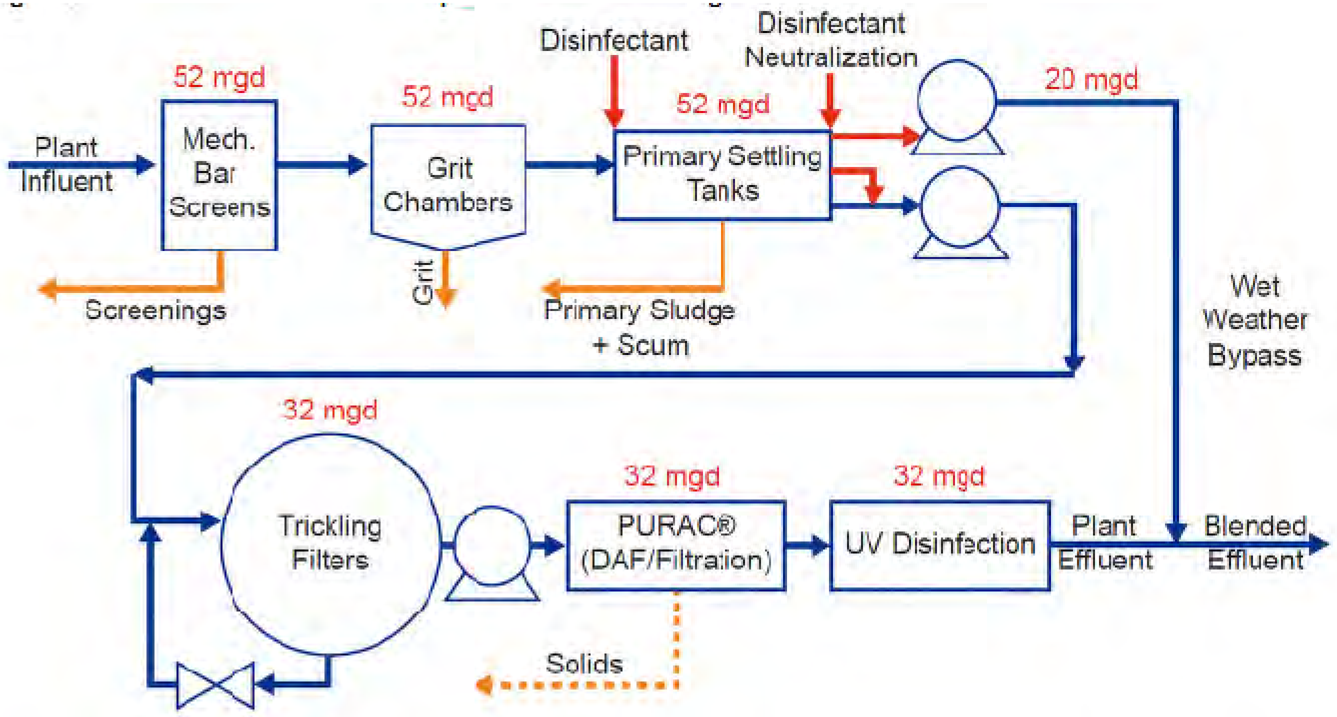


- 118’ Diameter
- Based on preliminary geotechnical analysis, the maximum available depth below ground surface is approximately 92 ft to avoid rock excavation
- Based on the available dimensions, the volume below ground is approximately 7 MG
- This would require approximately 160 ft above ground for 13 MG of storage at 20 MG total

Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: Increase Capacity of WWTP Through Side Stream Treatment



- Recent regulations have approved side stream treatment as a form of treatment during wet weather to meet effluent standards.
- This diagram represents treatment during wet weather, where the maximum capacity would be 52 mgd

Analysis

4 Overflows Per Year Systemwide-Adams Street

Example: Construct New Plant Outfall

- To handle upgrade capacity of WWTP, a new WWTP outfall must be installed.
- This would run along 17th street at an estimated diameter of 66". This diameter is dependent on the slope of the pipe and would be finalized in design.

Analysis

4 Overflows Per Year Systemwide-Adams Street

- In summary, to achieve no more than 4 overflows in the system annually, the following projects may be required in tandem:

Drainage Basin	Outfall	Requirements for 4 overflows/year
H1	002A	3.65 MG Underground Storage Tank at Observer Highway and Hudson Street
H3/H4/HSI	005A	4.67 MG In-Water Storage Tank
H5	006A	2.35 MG In-Water Storage Tank at Maxwell Place
18PS	012A	Increase Capacity of Pump Station at 18th Street
W1234	013A	• 2 MG In-Water Storage Tank at W1234 Outfall • Construct 72” Parallel Siphon Along Park Avenue back to Adams Street WWTP
W5	015A	Construct High Level Storm Sewer along Boulevard East
Adams Street WWTP	001A	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 20 MG storage tank

Analysis in River Road WWTP Service Area
4 Overflows Per Year Systemwide

Analysis

4 Overflows Per Year Systemwide-River Road WWTP Service Area

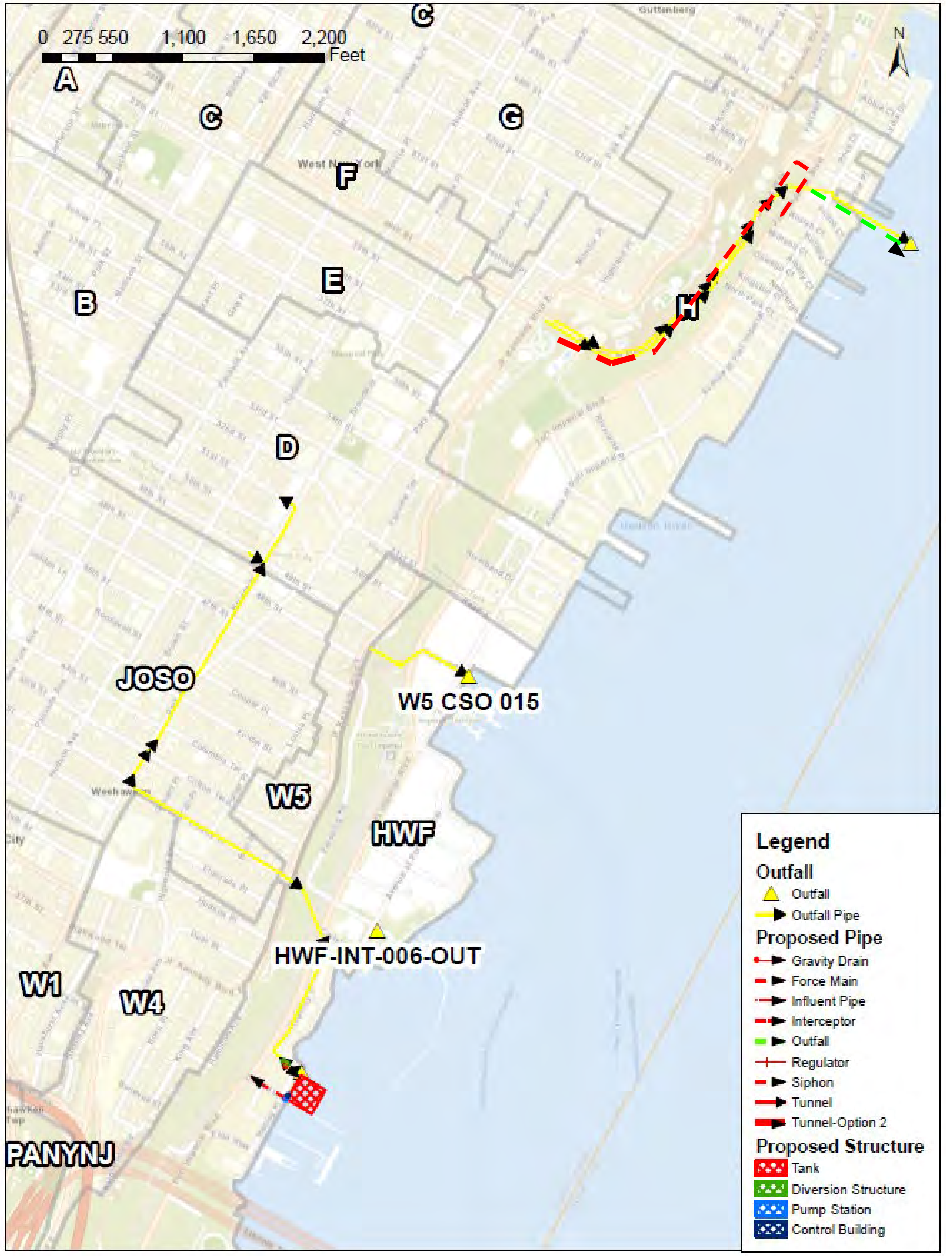
- Each outfall currently has a range of 48 to 53 overflows per year, ranging in volume.
- To achieve permit compliance through this plan, there is a maximum of 4 overflows allotted at all outfalls per year.
- This would require an increase in capacity in all drainage basins whether through storage tanks, pump stations to convey flow back to the plant, or additional piping.

Drainage Basin	Outfall	Current Estimated Number of Overflows Per Year
JOSO	002A	48
WNY1	005A	53

Analysis

4 Overflows Per Year Systemwide-River Road

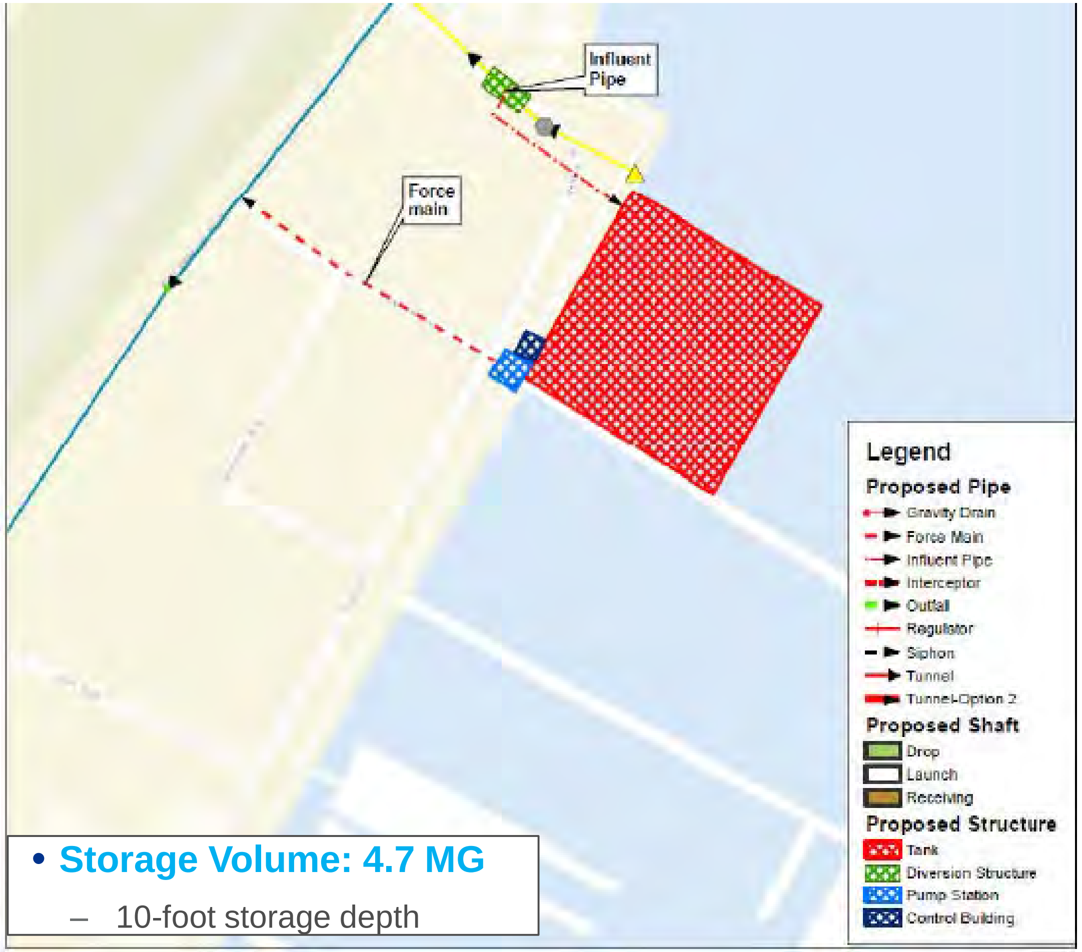
- To achieve no more than 4 overflows in the system annually, the storage tanks shown in the service area may be required
- These storage tanks would capture volume during a rainstorm. After the storm, the volume would be pumped to the treatment plant



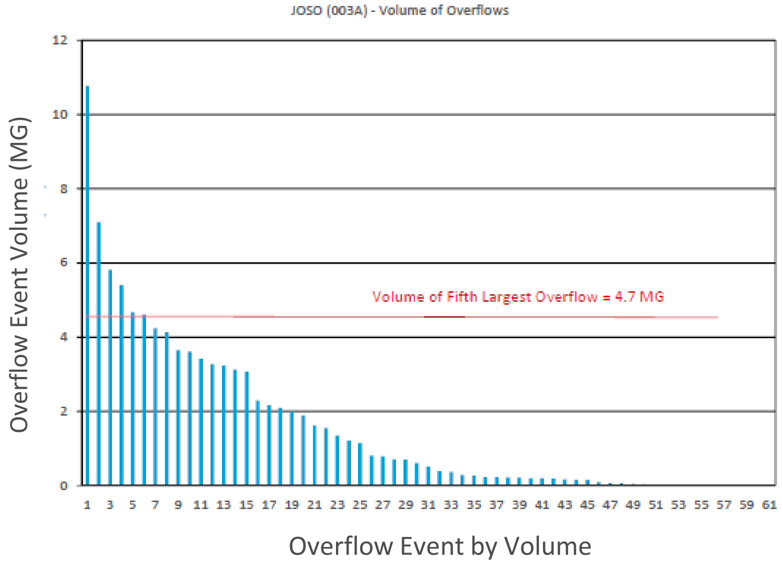
Analysis

4 Overflows Per Year Systemwide-River Road

Example: In-Water CSO Storage Structure in Hudson River



- **Storage Volume: 4.7 MG**
  – 10-foot storage depth

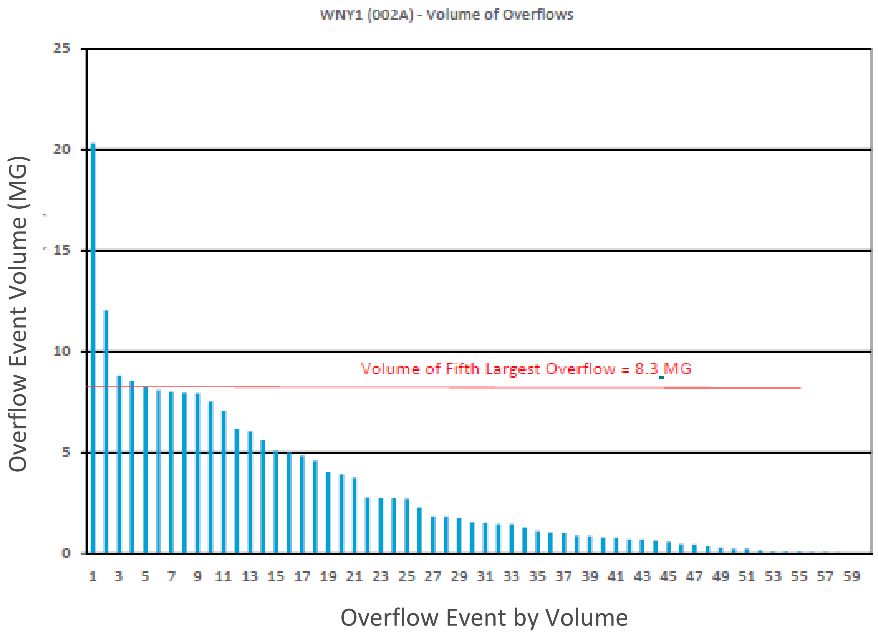


Analysis

4 Overflows Per Year Systemwide-River Road

Example: Linear Storage Tunnel at Anthony M. Defino Way, Treatment and Parallel Outfall

- **Storage Volume: 8.3 MG**
  - 26-foot diameter
  - 2,200 feet in length



(Reduces overflows to 0)

Analysis

4 Overflows Per Year Systemwide-River Road

- In summary, to achieve no more than 4 overflows in the system annually, the following projects may be required in tandem:

Drainage Basin	Outfall	Requirements for 4 overflows/year
JOSO	002A	4.7 MG In-Water Storage Tank
WNY1	001A	-Construct 8.3 MG Tunnel and Treatment on Anthony M. Defino Way -Construct Parallel Outfall

Analysis in Adams Street WWTP Service Area

Percent Capture

Analysis

Percent Capture – Adams Street WWTP

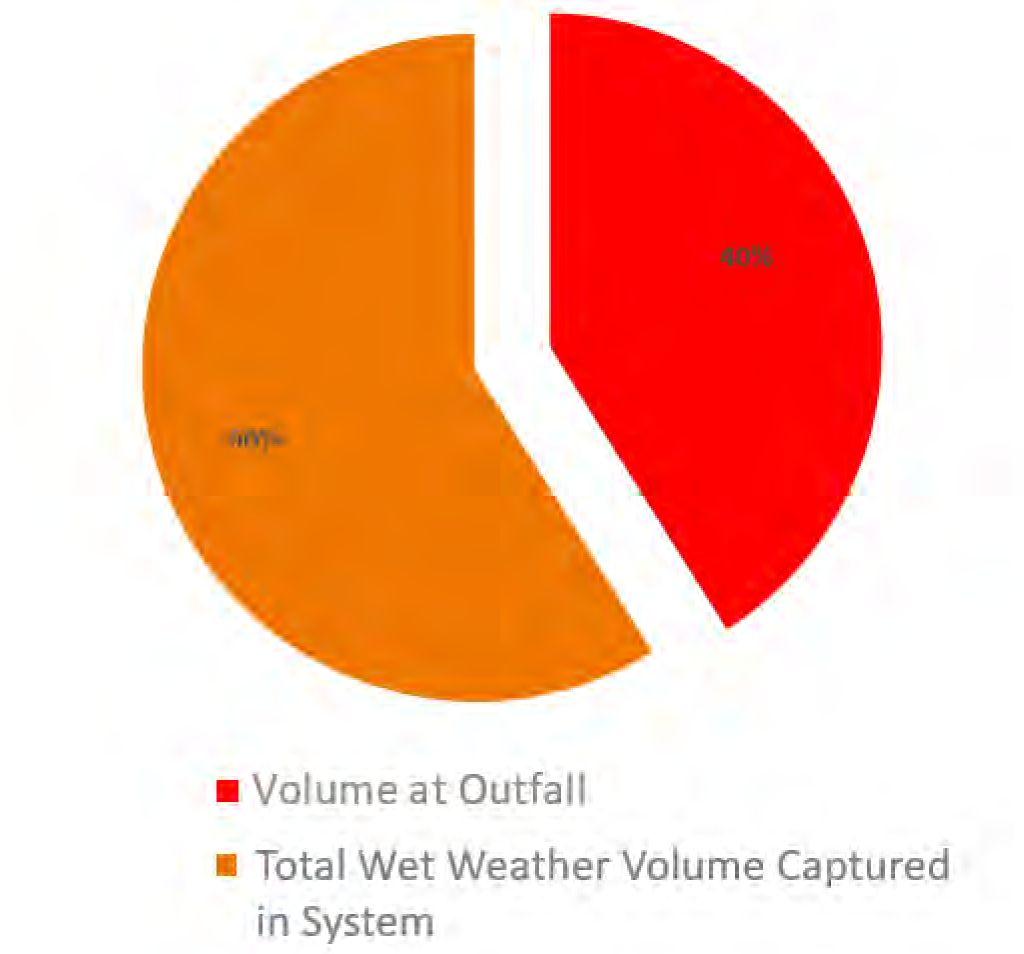
- Two main elements to maximizing the percent capture of the Adams Street service area:
  - Maximize the capacity of the Adams Street WWTP either through treatment processes or storage
  - Minimize the amount of volume at the outfalls by diverting to the WWTP

Analysis

Percent Capture – Adams Street

Including the control methods within H6/H7 and high level storm sewer in W5, current Percent Capture is **60%**

	Existing Overflow Volume in Typical Year, MG
H1 Outfall	45
H3/H4 Outfall	78
H5 Outfall	24
18PS Outfall	5
W1234 Outfall	243



Analysis

Percent Capture – Adams Street

Scenario 1:

Existing Percent Capture **60%**

\+

Collection System Controls

Blvd East High Level Storm Sewer
0.5% Capture

Divert partial volume from H1 and all volume from H3/H4/HSI with Siphon and Increase Capacity of 5th Street Pump Station from 15 mgd to 47 mgd
10% Capture

Increase Capacity 11th Street Pump Station from 11.6 mgd to 20 mgd
3% Capture

Parallel 48" Park Ave Siphon
11.5% Capture

\+

WWTP Controls*

Increase Capacity of WWTP by 20 MGD through Side Stream Treatment

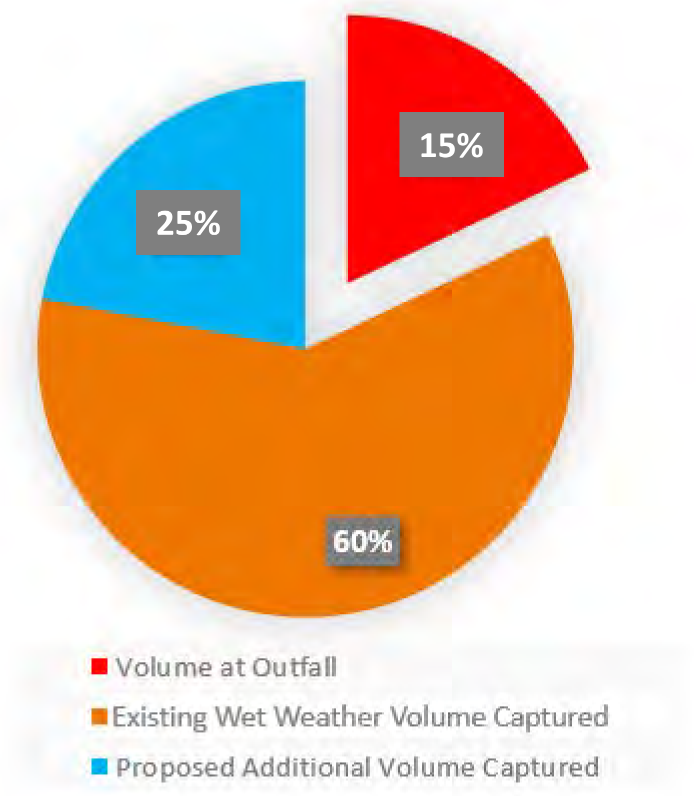
8 MG Storage Tank+
2 MG Storage Tank

Larger Diameter WWTP Outfall

=

TOTAL

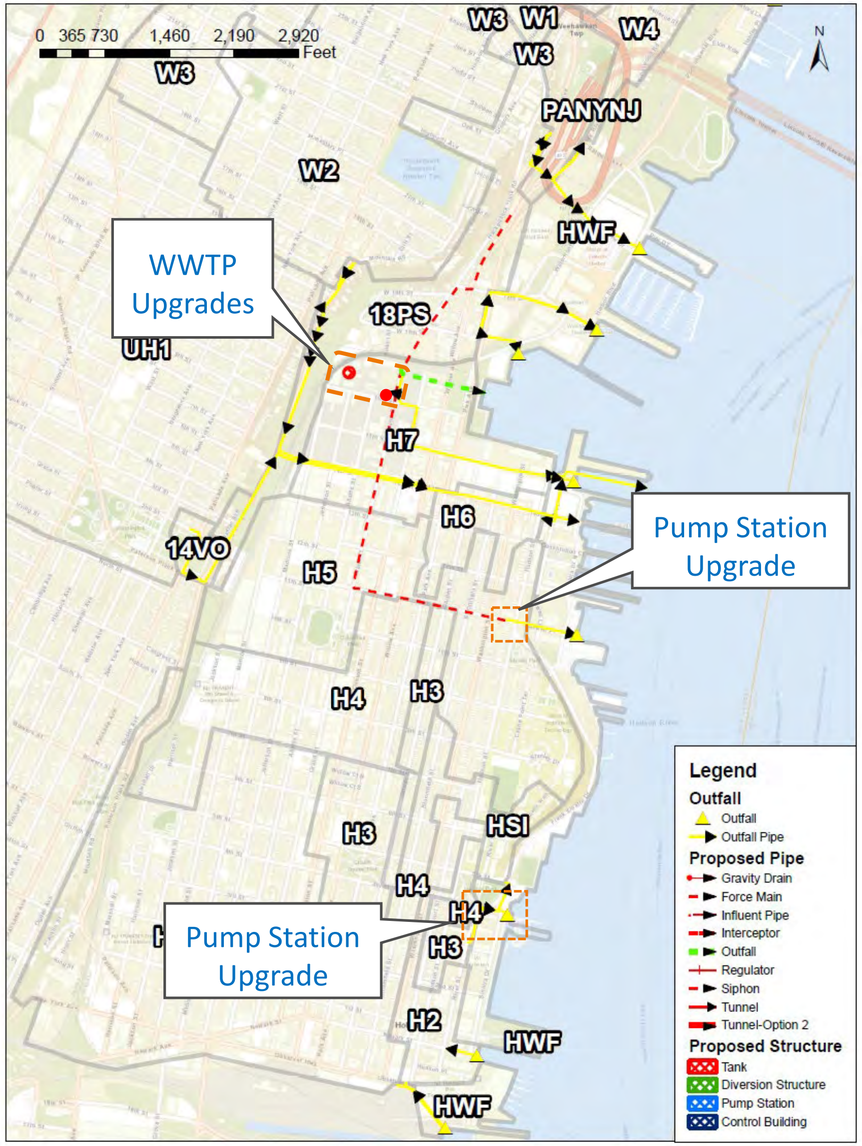
85% Capture



*Pending updates to infrastructure in headworks at plant

Analysis

Percent Capture – Adams Street



Analysis

Percent Capture – Adams Street

Scenario 2:

Existing Percent Capture
60%

+

Collection System Controls

Divert partial volume from H1 and all volume from H3/H4/HSI with Siphon and Increase Capacity of 5th Street Pump Station from 15 mgd to 47 mgd
10% Capture

1.5 MG Underground Storage at H1
2% Capture

Parallel 42” Park Ave Siphon
8.5% Capture

1.3 MG In-Water CSO Storage Tank at W1234
4% Capture

Blvd East High Level Storm Sewer
0.5% Capture

+

WWTP Controls*

Increase Capacity of WWTP by 20 MGD through Side Stream Treatment

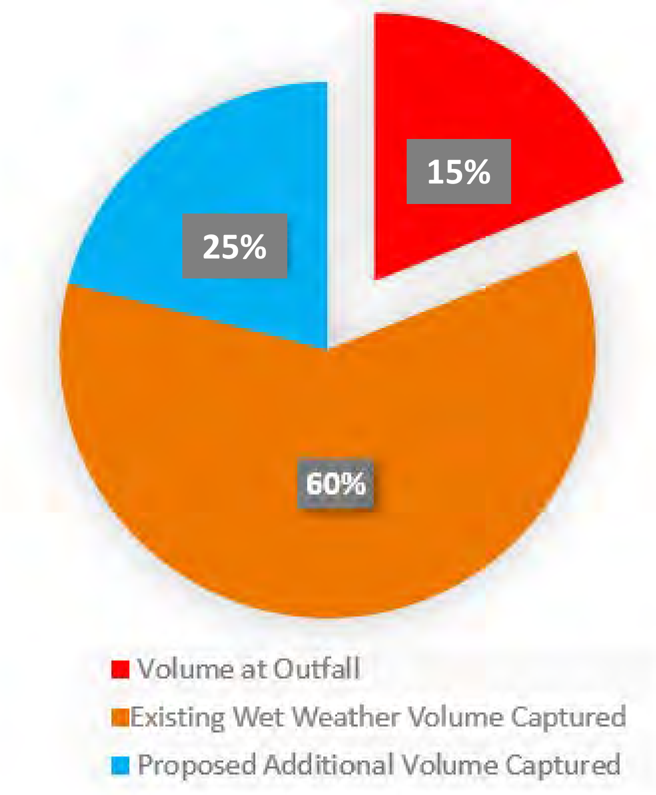
8 MG Storage Tank

Larger Diameter WWTP Outfall

=

TOTAL

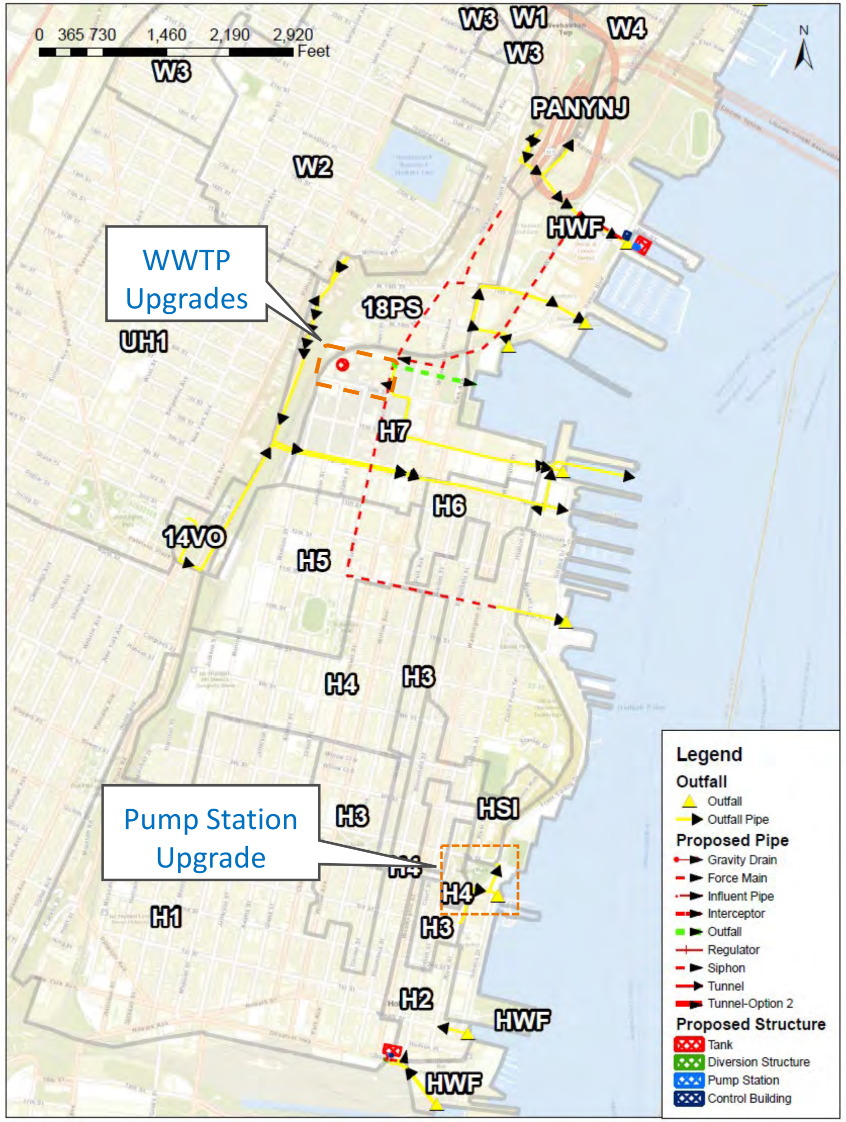
85% Capture



*Pending updates to infrastructure in headworks at plant

Analysis

Percent Capture – Adams Street



Analysis

Percent Capture – Adams Street

Scenario 3:

Existing Percent Capture **60%**

+

Collection System Controls

Blvd East High Level Storm Sewer **0.5% Capture**

H1 Storage-7 MG **4% Capture**

H5 Storage-4 MG **2% Capture**

72" Park Ave Siphon **19.5% Capture**

+

WWTP Controls*

Increase Capacity of WWTP by 20 MGD through Side Stream Treatment

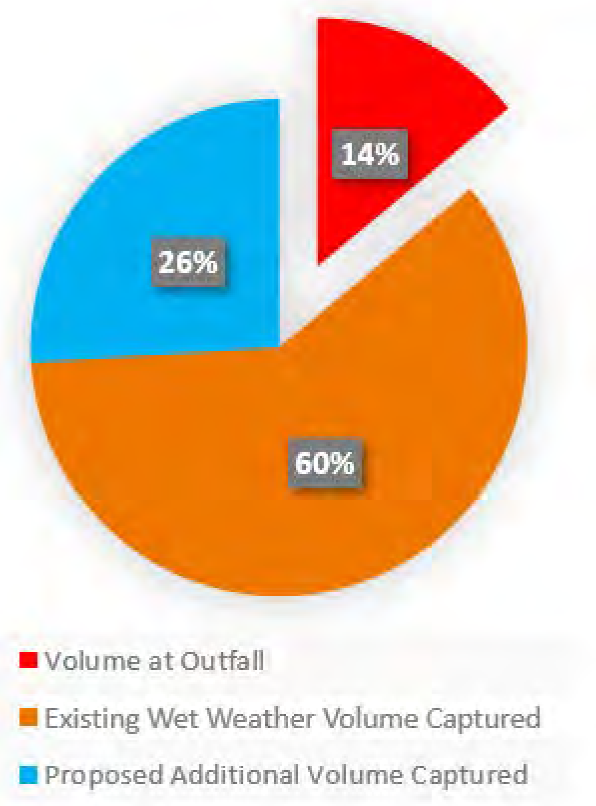
10 MG Storage Tank

Larger Diameter WWTP Outfall

=

TOTAL

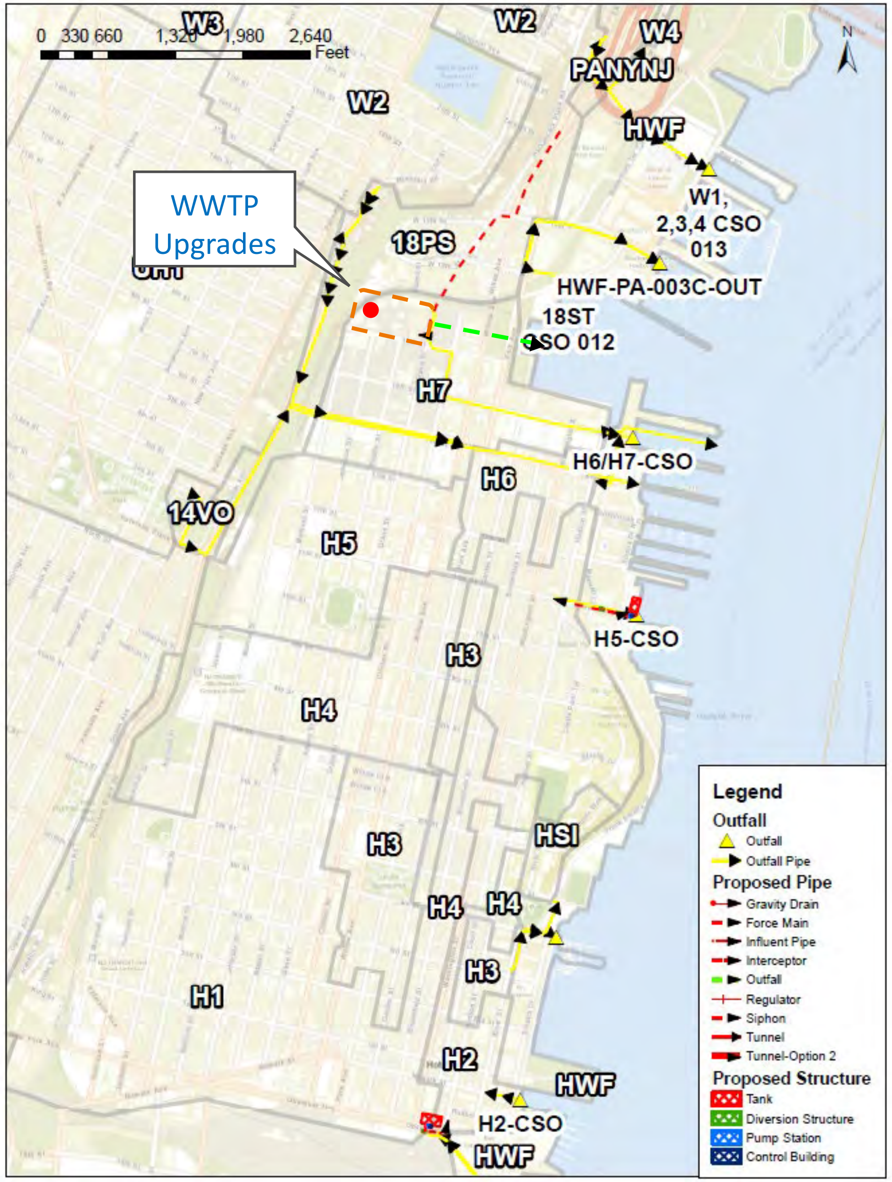
86% Capture



*Pending updates to infrastructure in headworks at plant

Methodology

Percent Capture Analysis – Adams Street



Summary

Drainage Basin	Outfall	Scenario 1	Scenario 2	Scenario 3
H1	002A	Divert partial volume from H1	Divert partial volume from H1 and 1.5 MG Underground Storage Tank	7 MG Underground Storage Tank
H3/H4/HSI	005A	Divert all volume from H3/H4/HSI with additional Siphon after 11th Street Pump Station and upgrade 5th Street Pump Station to 47 mgd	Divert all volume from H3/H4/HSI with Additional Siphon after 11th Street Pump Stastiona nd upgrade 5th Street Pump Station to 47 mgd	
H5	006A	Increase Capacity of 11th Street Pump Station to 20 mgd	Increase Capacity of 11th Street Pump Station to 20 mgd	4 MG Underground Storage Tank
18PS	012A	-	-	-
W1234	013A	Construct Parallel 48" Park Ave Siphon back to Adams Street WWTP	Construct Parallel 42" Park Ave Siphon back to Adams Street WWTP and 1.3 MG In Water Storage Tank	Construct Parallel 72" Park Ave Siphon back to Adams Street WWTP
W5	015A	Construct High Level Storm Sewer along Boulevard East	Construct High Level Storm Sewer along Boulevard East	Construct High Level Storm Sewer along Boulevard East
Adams Street WWTP	001A	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 8 MG storage tank and 2 MG storage tank	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 8 MG storage tank	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 10 MG storage tank

Analysis in River Road WWTP Service Area

Percent Capture

Analysis

Percent Capture – River Road WWTP

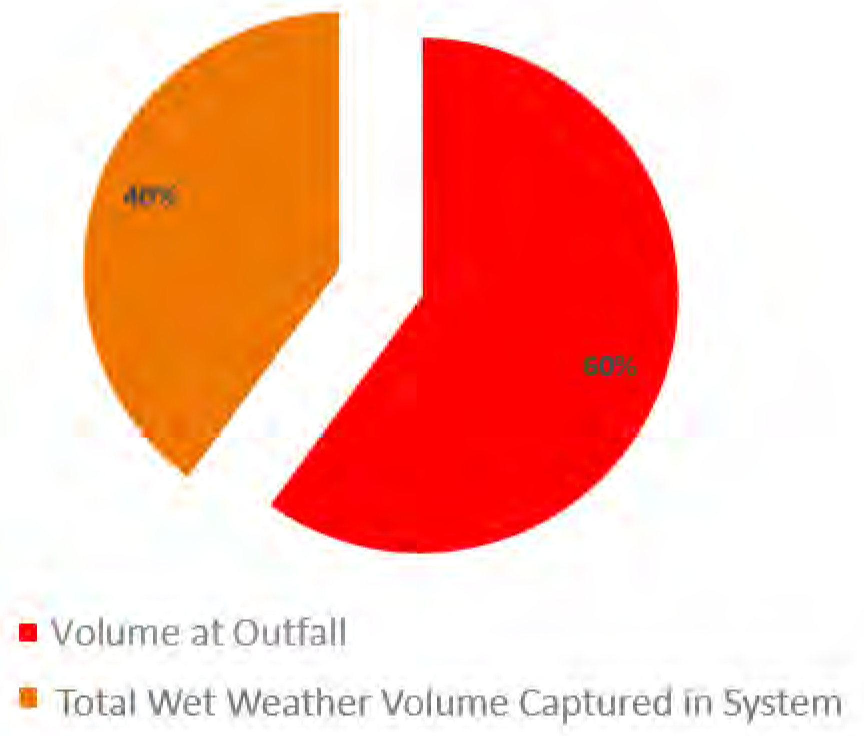
- Two main elements to maximizing the percent capture of the River Road service area:
  - Maximize the capacity of the River Road WWTP either through treatment processes or storage
  - Maximize the amount of conveying volume away from outfalls and to the WWTP to the extent feasible

Analysis

Percent Capture – River Road

Existing Percent Capture is **40%**

	Existing Overflow Volume in Typical Year, MG
WNY1 Outfall	192
JOSO Outfall	94



Analysis

Percent Capture – River Road

Scenario 1:

Controls

Existing Percent Capture
40%

\+

8 MG Storage at lot north of WWTP
33% Capture

Raise JOSO Weirs by 1 foot
13% Capture

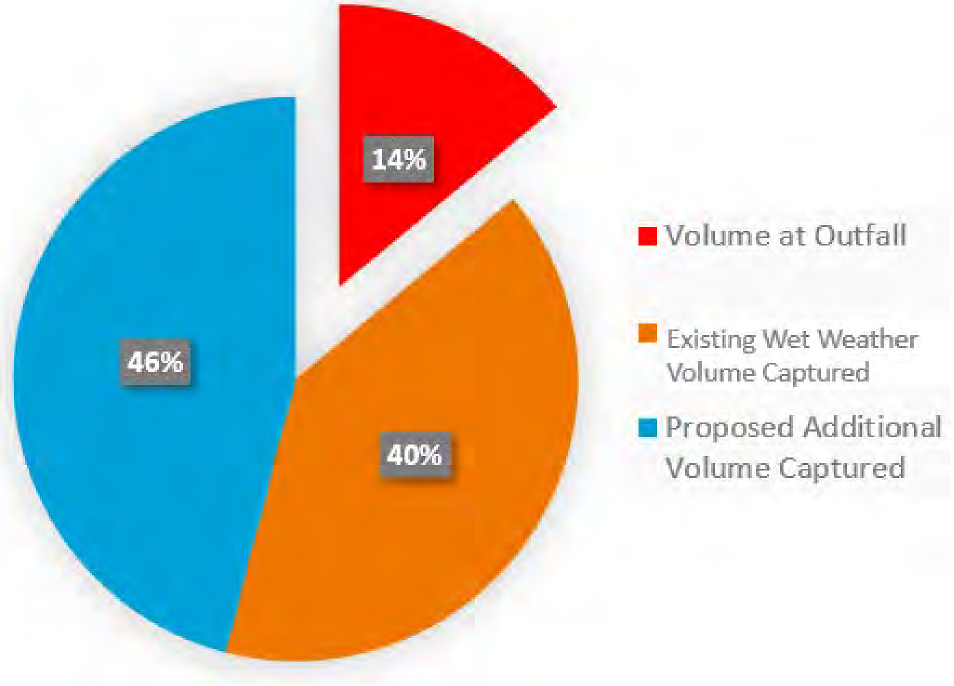
\+

Increase capacity at River Road to 35 MGD with High Level Treatment

=

TOTAL

86% Capture

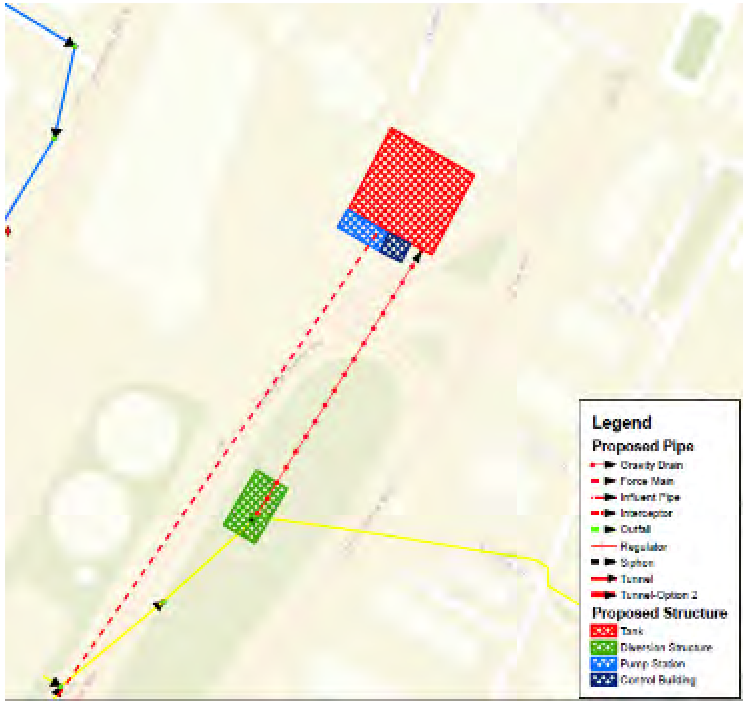


Analysis

Percent Capture – River Road

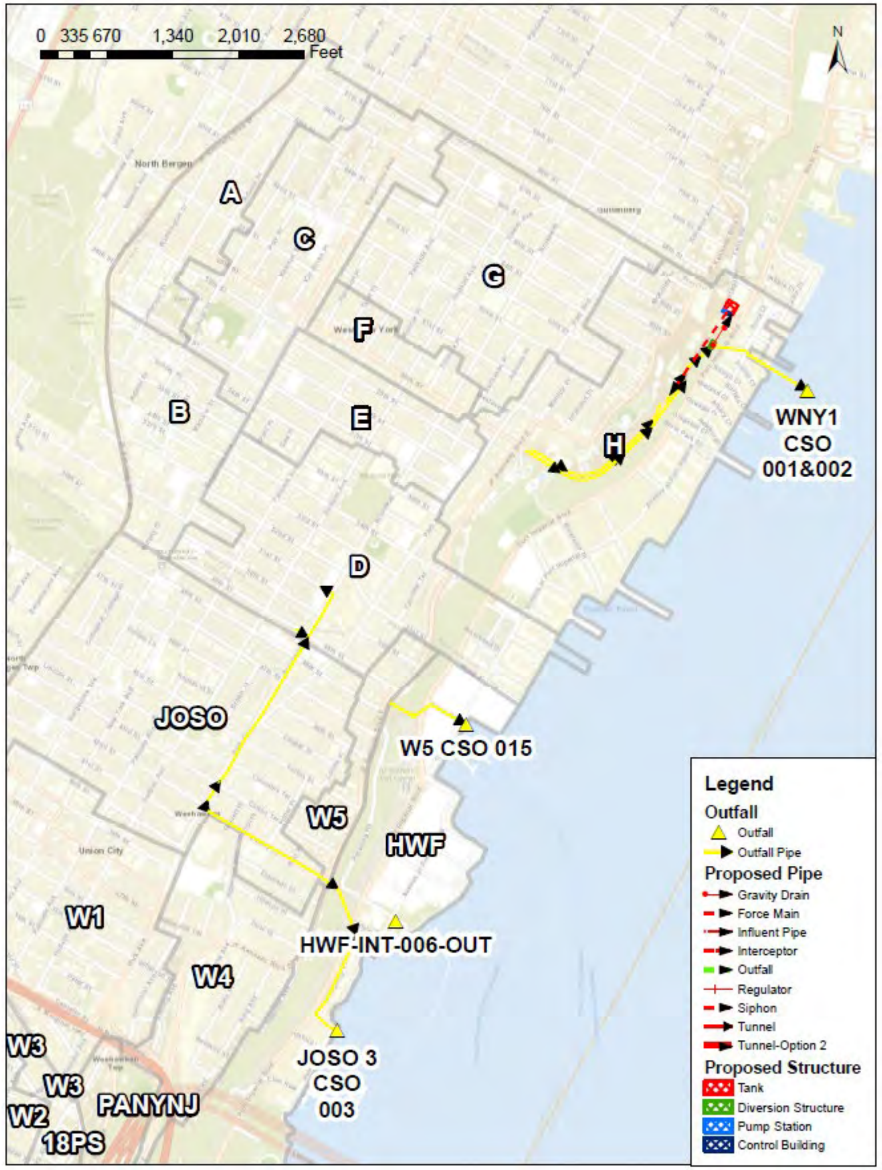
CSO Storage Tank North of River Road Treatment Plant

- The existing footprint of the River Road WWTP is extremely constrained and identifying any storage nearby is imperative
- Feasibility of a CSO Storage Tank at vacant lot north of plant is currently being analyzed
- Similar area to Adams Street, tank would be 50% above and 50% below ground dependent on volume



Analysis

Percent Capture – River Road



Analysis

Percent Capture – River Road

Scenario 2: Controls

Existing Percent Capture **40%**

\+

8 MG Storage at lot north of WWTP **33% Capture**

1.5 MG In-Water Storage at JOSO **12% Capture**

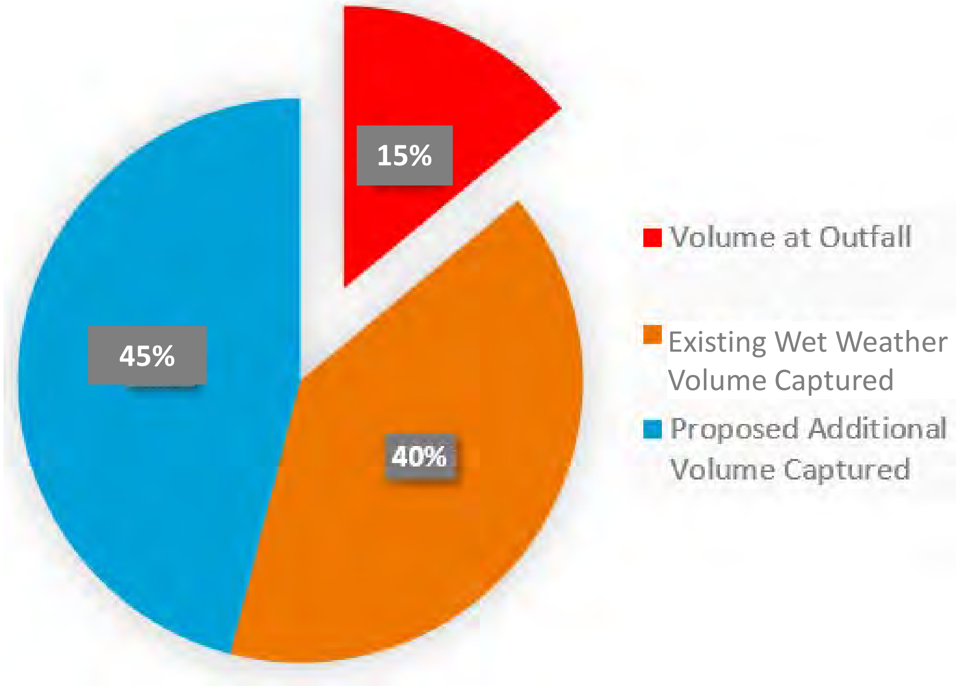
\+

Increase capacity at River Road to 35 MGD with High Level Treatment

=

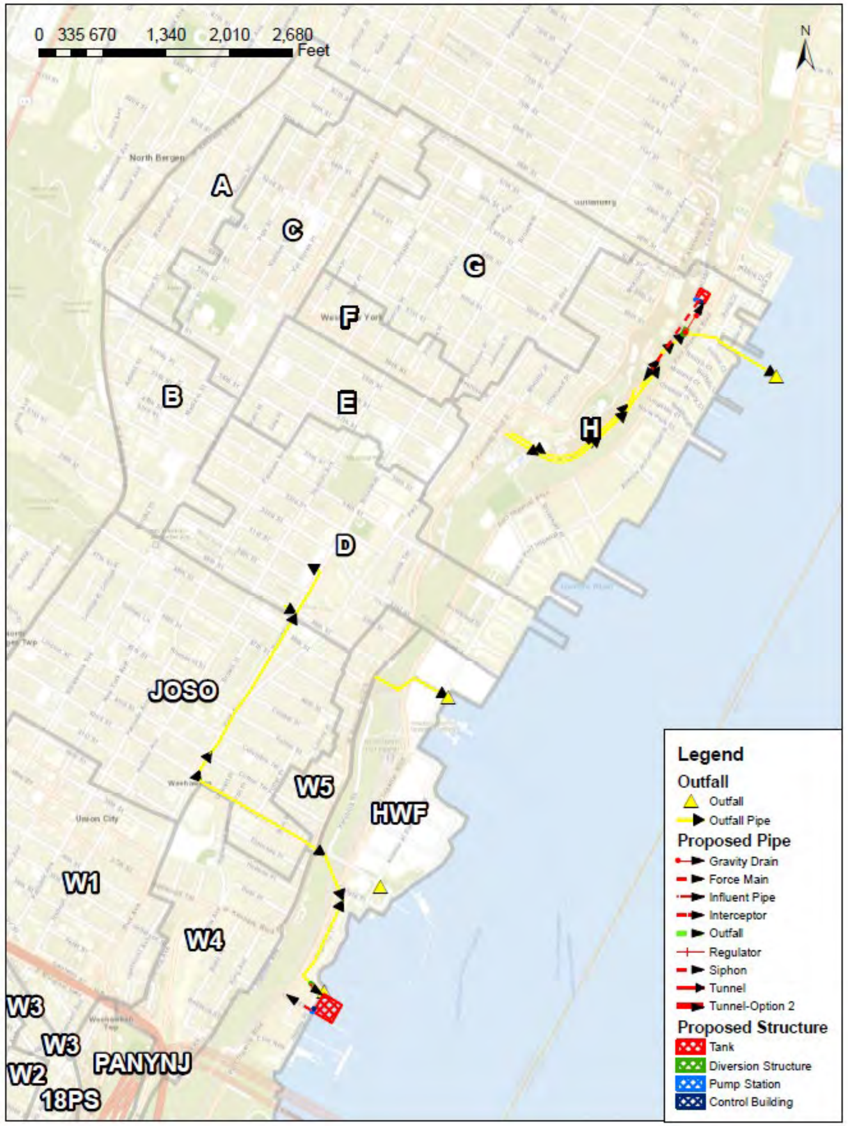
TOTAL

85% Capture



Analysis

Percent Capture – River Road



Analysis

Percent Capture – River Road

Scenario 3:

Controls

Existing Percent Capture **40%**

\+

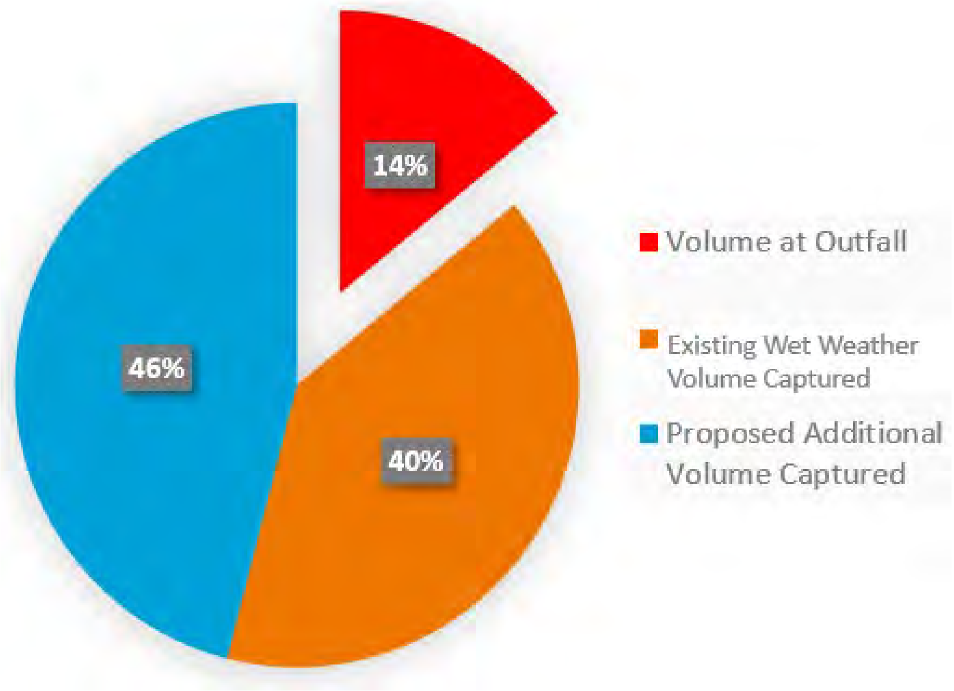
Linear Storage on Anthony M. Defino Way
40% Capture

0.8 MG In-Water Storage at JOSO
6% Capture

=

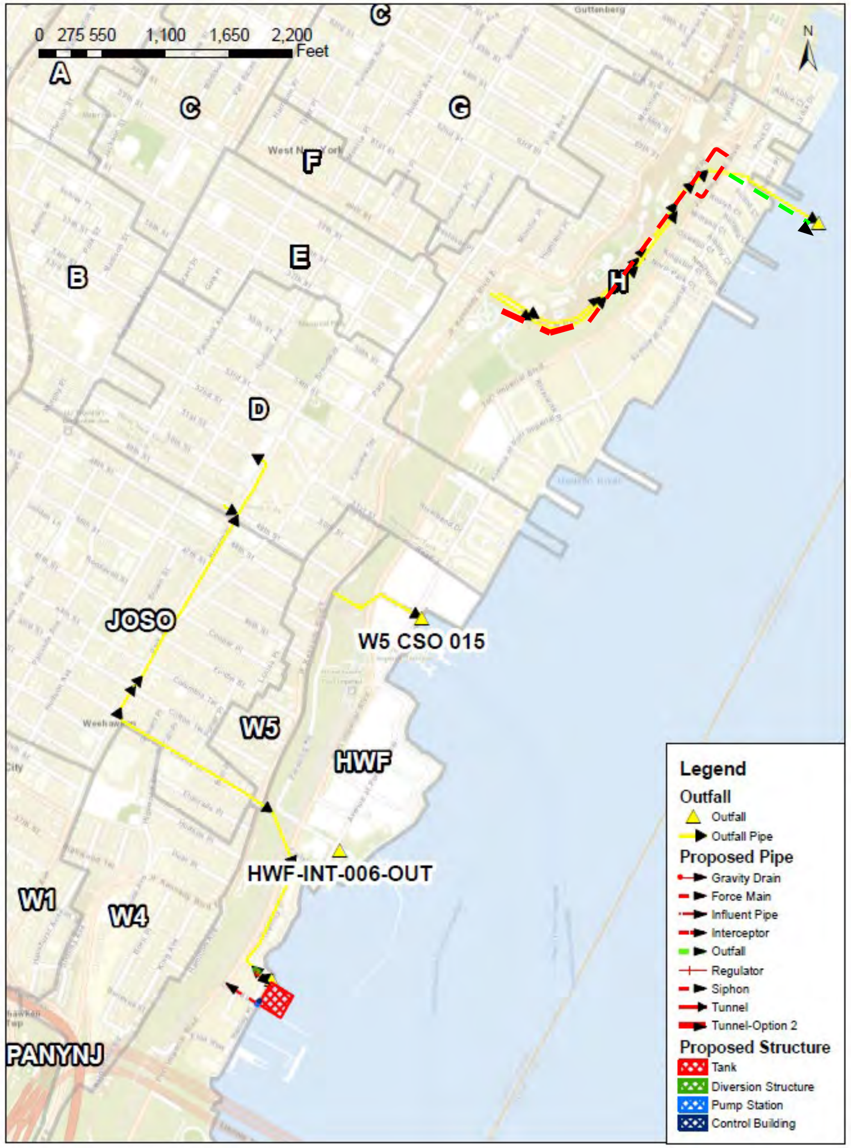
TOTAL

86% Capture



Analysis

Percent Capture – River Road



Comparison

- To achieve no more than 4 overflows in the system annually or reach 85% Total Wet Weather flow capture, the following may be required:

Drainage Basin	Outfall	Scenario 1	Scenario 2	Scenario 3
JOSO	001A	Raise weirs on JOSO interceptor	1.5 MG In Water Storage Tank	0.8 MG In Water Storage Tank
WNY1	002A	Construct 8 MG storage tank north of treatment plant	Construct 8 MG storage tank north of treatment plant	-Construct 8.3 MG Tunnel and Treatment on Anthony M. Defino Way -Construct Parallel Outfall
River Road WWTP	001A	Increase treatment capacity from 8 MGD to 35 MGD with new high level treatment processes	Increase treatment capacity from 8 MGD to 35 MGD with new high level treatment processes	

Summary

Comparison

➢ To achieve no more than 4 overflows in the system annually or reach 85% Total Wet Weather flow capture, the following may be required:

Drainage Basin	Outfall	Requirements for 4 overflows/year	Requirements for 85% Capture Systemwide
H1	002A	3.65 MG Underground Storage Tank at Observer Highway and Hudson Street	Divert partial volume from H1
H3/H4/HSI	005A	4.67 MG In-Water Tank either in water at 5th Street	Divert all volume from H3/H4/HSI with Additional Siphon after 11th Street Pump Station and upgrade 5th Street Pump Station to 47 mgd
H5	006A	2.35 MG In-Water Tank at Maxwell Place	Increase Capacity of 11th Street Pump Station to 20 mgd
18PS	012A	Increase Capacity of Pump Station at 18th Street	-
W1234	013A	• 2 MG In-Water Storage Tank at W1234 Outfall • Construct 72” Parallel Siphon Along Park Avenue back to Adams Street WWTP	Construct Parallel 48” Park Ave Siphon back to Adams Street WWTP
W5	015A	Construct High Level Storm Sewer along Boulevard East	Construct High Level Storm Sewer along Boulevard East
Adams Street WWTP	001A	Construct Larger Outfall Increase capacity by 20 MGD with blending Replace trickling filter with 20 MG storage tank	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 8 MG storage tank and 2 MG storage tank

Comparison

- To achieve no more than 4 overflows in the system annually or reach 85% Total Wet Weather flow capture, the following may be required:

Drainage Basin	Outfall	Requirements for 4 overflows/year	Requirements for 85% Capture Systemwide
JOSO	001A	Construct 4.57 MG In-Water CSO Storage Tank at outfall	Raise weirs on JOSO interceptor
WNY1	002A	-Construct 8.3 MG Tunnel and Treatment on Anthony M. Defino Way -Construct Parallel Outfall	Construct 8 MG storage tank north of treatment plant
River Road WWTP	001A	-	Increase treatment capacity from 8 MGD to 35 MGD with new treatment processes

North Hudson Sewerage Authority CSO Long Term Control Plan - Public Meeting Minutes

PROJECT: North Hudson Sewerage Authority Alternatives Analysis

MEETING DATE: November 18, 2019

MEETING TIME: 7:00 PM – 8:45 PM

LOCATION: 1600 Adams Street, Hoboken, NJ

The fourth public meeting regarding the Alternatives Analysis for development of the Long Term Control Plan (LTCP) for the North Hudson Sewerage Authority service areas was held on November 18th, 2019. Previously the meetings discussed the beginning stages of the Alternatives Analysis. The purpose of this meeting is to discuss the next steps after the alternatives analysis at each drainage basin and to discuss the feasibility of the alternatives and analyzed performance of each scenarios. The previous newsletters were distributed and described at the start of the meeting. The meeting began with a presentation on the alternatives selection process to date and potential alternatives. These slides can be seen on the Authority's website. A sign-in sheet for attendance was at the front desk. The following summarizes the questions and comments following the presentation.

Q: What causes the overflow?

A: The NHSA Service area is a combined sewer system which coveys both sewer water and stormwater. Rainfall events will increase the flow to the plant and when the flow exceeds the plant capacity, excess flow will be directly discharged to the receiving water body and overflow occurs. The bulk of flow would be stormwater which dilutes the amount of discharged sewage. The big discharge pipe with light in Weehawken indicated CSO's been discharged in last 24hrs.

Q: There was a question about visible structures, sizes etc.

A: For storage tanks, most parts will be underground with exception of the control facility. Using the H1 Pump Station as an example, the pump station is underground adjacent to NJ rail yard and the 2-story control room is on Washington Observer Highway near the structure. Proposed structures will have similar size but ideally double the footprint if available.

Q: Are these each an option or all would have to happen together?

A: All options will work together and contribute to the improvements.

Q: For the proposed tank at the parking lot onObserver Hwy. and Washington Street , would this require a new control building or use the existing?

A: This would require a new structure and has been considered in the concept.

Q: For the first 85 percent capture scenario at Adams Street, will there be any tanks or structures on the waterfront?

A: No, Scenario 1 will only have construction within the Authorities' facility with the exception of the proposed siphons.

Q: For the second scenario proposed for 85 percent capture in the Adams Street service area, For the in-water Structure at the W1234 outfall, are there any existing structures?

A: Yes, this alternative would be an extension of the footprint for the W1234 S/F facility that has a park on top.

Q: Which is the most expensive alternative?

A: This hasn't been decided yet, but we will have numbers and put them in the context of the 2% cap. GI was not included in the capture because due to its small impact, but Hoboken already started 3 projects that are being funded by the State. We are aiming on large millions of gallons captures but this otherwise is not.

Q: The 11th street pump station located in Hoboken with the siphon after it, does that flow go back to the WWTP?

A: Yes, there is a generator on Hudson Street. The pump station size may need to be increased.

Q: Water can be stored in the system by raising weirs, are there any other places to store water in Hoboken?

A: No, Hoboken has a flat system and storing in the system is not as feasible.

Q: Does this consider redevelopment in Northwest Hoboken?

A: Yes, it does.

Q: The 85% capture method seems to be favorable, but besides 85% capture would we consider some other options for future treatment or these options covers what is needed to cover based upon all the analysis efforts?

A: The Authority is comfortable with the present analysis for the foreseeable future. In the future there may be new technologies, but the present analysis certainly considers any future development.

Q: With four overflows, is there a factor of safety considered?

A: Yes, there is, but how much we can't say. For the last 20 years we've required detention for new development. Right now, we're detaining approximately 1 MG in the system on those instances. Currently the downtown tank is filling pretty quickly.

Q: Next year at the next meeting, will selections be decided?

A: No, at the next public meeting we will be focusing on financial and sequencing. But will narrow down the options.

Q: Would it be possible to have more than one meeting and more involvement?

A: Yes, we are considering going out and scheduling meetings in other condo associations and businesses .

Q: If you were to think of storm and number of overflows, how many are there in situation like Sandy?

A: Sandy was not typical as there wasn't a lot of rain, Irene is more what you would be worried about. The Cinco De Mayo storm (2019) was about 4 inches. It came down so quickly about 3 inches an hour. Our analysis is presented for a Typical Year which includes some of these larger storms but may not account for very extreme cases such as these.

NHSA CSO LTCP Public Meeting #5

March 9, 2020

Public Meeting #5 Sign In Sheet

DATE: 3/9/2020

PREPARED BY: CH2M HILL

Name	Affiliation	Email
Philip Reeve	Jacobs	philip.reeve@jacobs.com
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Steve Hudock	Jacobs	steve.hudock@jacobs.com
Don Conger	NHSA - Ops	don.conger@jacobs.com
CARTER CRAFT	CITIZEN, RATEPAYER	CARTER.CRAFT@MINBUZA.NL
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North Hudson Sewerage Authority
Long Term Control Plan

03.2020

Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP)

Mandated by NJDEP and USEPA

- Submission of preliminary planning to NJDEP by June 1, 2020

Goal

- To dramatically reduce the discharges of combined sewer overflows into the nation's waterbodies

Long-term

- Implementation over a 35 to 40 year time frame

Cost

- NHSA sees a 35 year path to completion without raising the rate beyond annual 2% cap
- Estimates over a 35 to 40 year time frame are preliminary in nature

LTCP GOAL IS TO REDUCE CSO DISCHARGES. IT IS NOT A FLOOD MITIGATION PROGRAM.

NJDEP CSO Control Mandate

Long Term Control Plan (LTCP) Requires NHSA:

1. TO UNDERTAKE A MAJOR STUDY OF THE COLLECTION SYSTEM, TREATMENT WORKS AND DISCHARGES INTO WATER BODIES (“SYSTEM CHARACTERIZATION”)
    - This includes hydraulic analysis and condition assessment of wastewater collection systems, pumping stations, regulators and sewage treatment facilities
    - The purpose is to provide the basis for the development of a long-term plan to regulate CSO discharges
    - **THIS STUDY HAS BEEN SUCCESSFULLY COMPLETED BY NHSA**
2. TO UNDERTAKE A MAJOR STUDY OF THE POSSIBLE ALTERNATIVES TO REDUCE CSOs (“ALTERNATIVES EVALUATION”)
    - Identify and evaluate possible opportunities to reduce CSOs
    - Estimate costs for possible opportunities
    - **THIS STUDY HAS BEEN SUCCESSFULLY COMPLETED BY NHSA**
3. TO DEVELOP A LTCP TO BE SUBMITTED TO THE NJDEP BY JUNE 1, 2020
    - Determine what system improvement projects will be needed over the next 30 to 40 years to reduce the frequency, volume and impacts of CSOs.
    - **THIS INITIAL PLAN IS DISCUSSED IN THIS PRESENTATION. THE FINAL DRAFT WILL BE SUBMITTED TO NJDEP ON TIME**

NJDEP CSO Control Mandate

Permit Compliance can be achieved in 1 of 2 ways:

1. CAPTURE A MINIMUM OF 85% OF WET WEATHER VOLUME ANNUALLY
   - Based on the comprehensive study of its system, NHSA will opt for this method of meeting NJDEP requirements

or

2. REDUCE ANNUAL OVERFLOWS TO 4 PER YEAR SYSTEM-WIDE
   - Given the size of the NHSA system, number of outfalls in three cities, and technical requirements, this option is not feasible

NHSA IS REQUIRED BY THE NJDEP TO REVIEW EACH OPTION

Analysis: 4 Overflows Per Year Option

FOUR (4) OVERFLOWS PER YEAR SYSTEM-WIDE

CURRENT VS MANDATED OVERFLOWS SYSTEM-WIDE

- **Currently**, Adams Street WWTP System: 12 to 60 overflows/year; River Road WWTP System: 48-53
- **Mandated,** 4 overflows/year for entire system

Adams Street WWTP System

Drainage Basin	Outfall	Current Estimated Number of Overflows Per Year
H1	002A	33
H3/H4/HSI	005A	45
H5	006A	16
H6/H7	008A	15
18St. Pump Station	012A	12
W1234	013A	60
W5	015A	24

River Road WWTP System

Drainage Basin	Outfall	Current Estimated Number of Overflows Per Year
JOSO	002A	48
WNY1	005A	53

Technically Viable Solutions and Estimated Costs

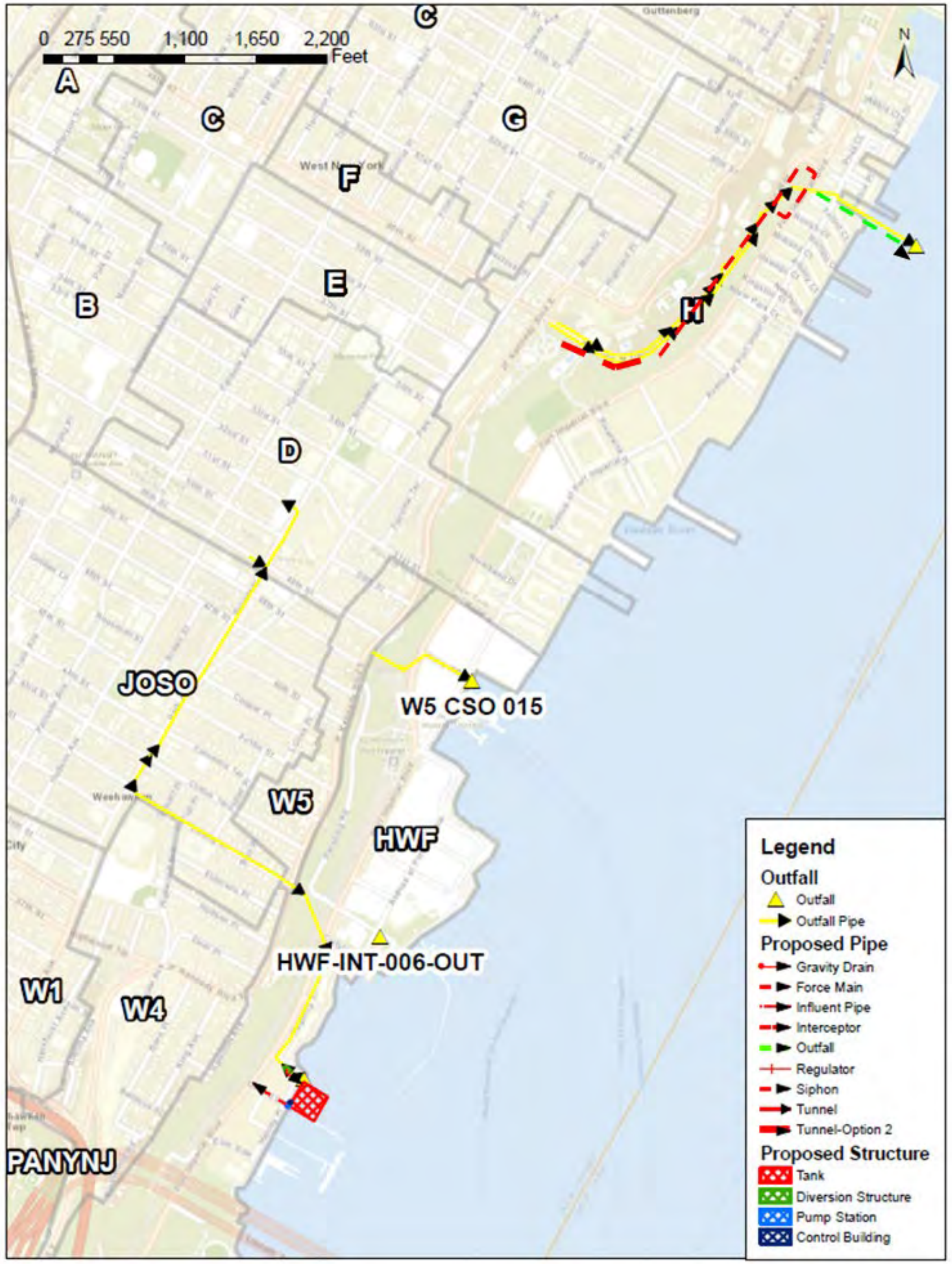
Adams Street WWTP: 4 Overflows Per Year

Drainage Basin	Outfall	Controls for 4 overflows/year	Construction Cost
H1	002A	3.65 MG Underground Storage Tank at Observer Highway and Hudson Street	$58,000,000
H3/H4/HSI	005A	4.67 MG In-Water Storage Tank	$49,000,000
H5	006A	2.35 MG In-Water Storage Tank at Maxwell Place	$47,000,000
H6/H7	008A	1 MG Storage Tank at Northwest Resiliency Park	$30,000,000
18PS	012A	Increase Capacity of Pump Station at 18th Street	$6,000,000
W1234	013A	• 2 MG In-Water Storage Tank at W1234 Outfall • Construct 72” Parallel Siphon Along Park Avenue back to Adams Street WWTP	$25,000,000 $32,000,000
W5	015A	Construct High Level Storm Sewer along Boulevard East	$5,000,000
Adams Street WWTP	001A	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 20 MG storage tank	$5,000,000 $13,000,000 $169,000,000
		TOTAL	$439,000,000

Technically Viable Solutions and Estimated Costs

River Road WWTP: 4 Overflows Per Year

Drainage Basin	Outfall	Controls for 4 overflows/year	Construction Cost
JOSO	002A	4.7 MG In-Water Storage Tank	$82,000,000
WNY1	001A	-Construct 8.3 MG Tunnel and Treatment on Anthony M. Defino Way -Construct Parallel Outfall	$171,000,000
		TOTAL	$253,000,000



4 Overflows Option: Pros and Cons

The 4 Overflows Option has only one technically viable approach

- The total estimated cost for that approach is $692 million ($439 million for Adam Street WWTP service area and $253 million for the River Road WWTP service area)
- This approach is also heavily reliant upon the construction of large storage tanks, 4 of which would be underwater just off the waterfront
- It is also highly disruptive to the waterfront communities and their residents

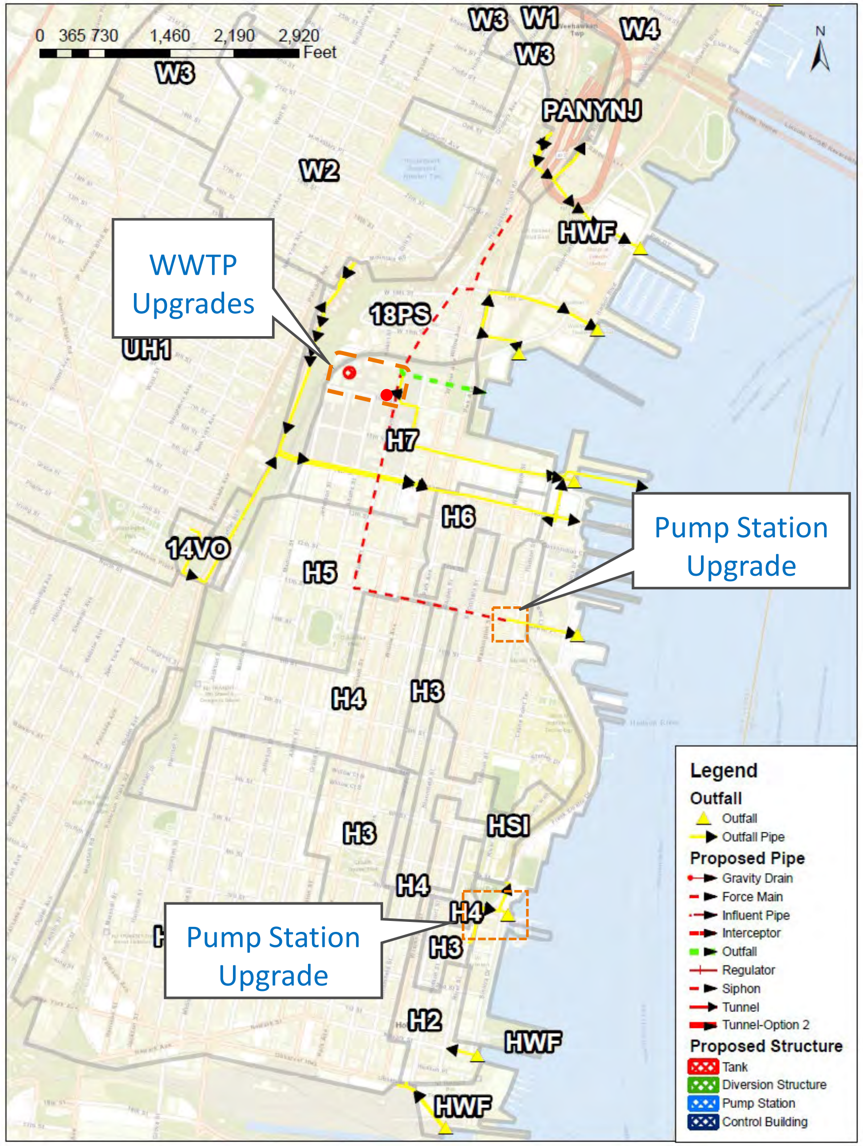
Analysis: 85% Capture Option

85% Capture Options

- Unlike the single approach for the 4 Overflows Option, the 85% Capture Option has several (3) viable technical approaches (scenarios)
- Each scenario or approach includes two elements:
    - A plan for the area serviced by the Adams Street WWTP
    - A plan for the area serviced by the River Road WWTP
- This section shows the three technically viable approaches for each WWTP service area

Technically Viable Solutions and Estimated Costs

Adams Street WWTP: 85% Capture

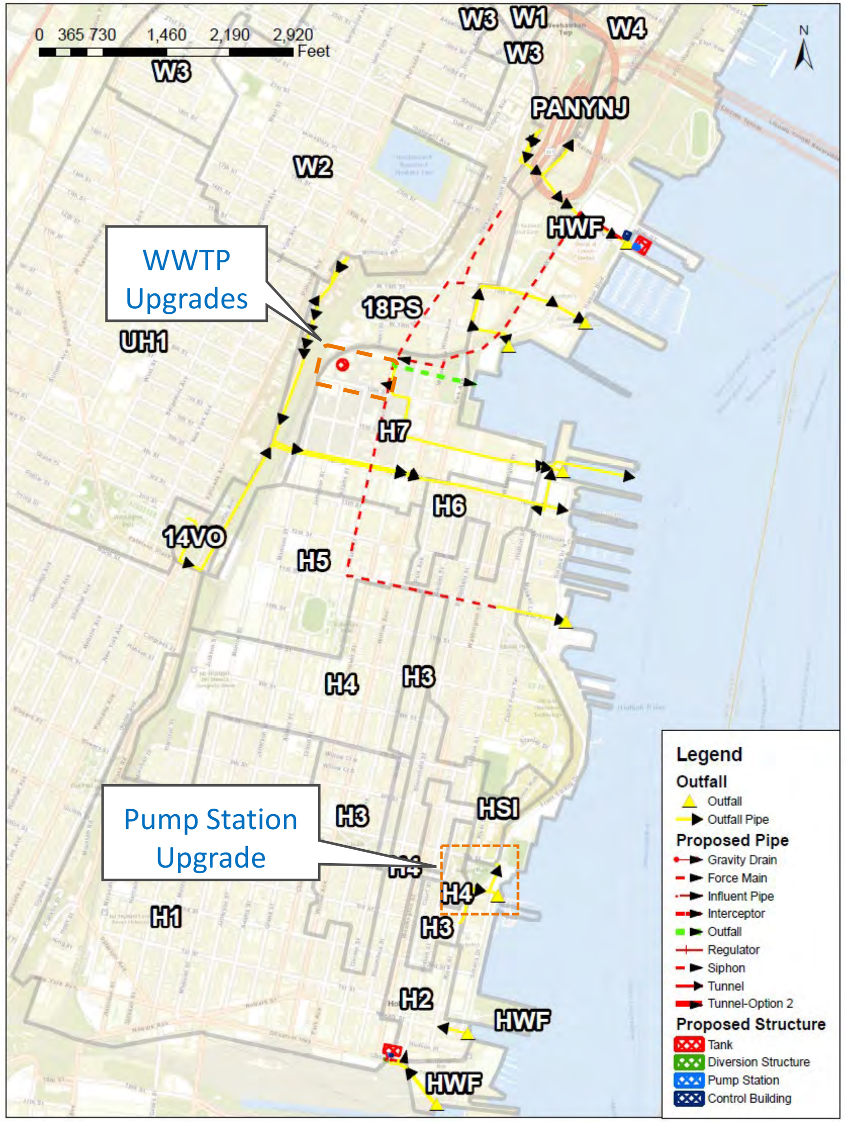


Scenario 1

Collection System and WWTP Controls	Construction Cost
Integration of 1 MG, $12 million Resiliency Park storage tank into NHSA conveyance system	$30,000,000
Increase Capacity of 5th Street Pump Station from 15 mgd to 47 mgd AND Construct Parallel 11th Street Siphon to divert partial volume from H1 and all volume from H3/H4/HSI	$35,000,000
Increase Capacity 11th Street Pump Station from 11.6 mgd to 20 mgd	$24,000,000
Parallel 48" Park Ave Siphon	$28,000,000
Increase Capacity of WWTP by 20 MGD through Side Stream Treatment	$13,000,000
8 MG Storage Tank at Adams Street WWTP 2 MG Storage Tank at Adams Street WWTP	$68,000,000 $17,000,000
Construct New WWTP Outfall	$5,000,000
TOTAL	**$220,000,000**

Technically Viable Solutions and Estimated Costs

Adams Street WWTP: 85% Capture

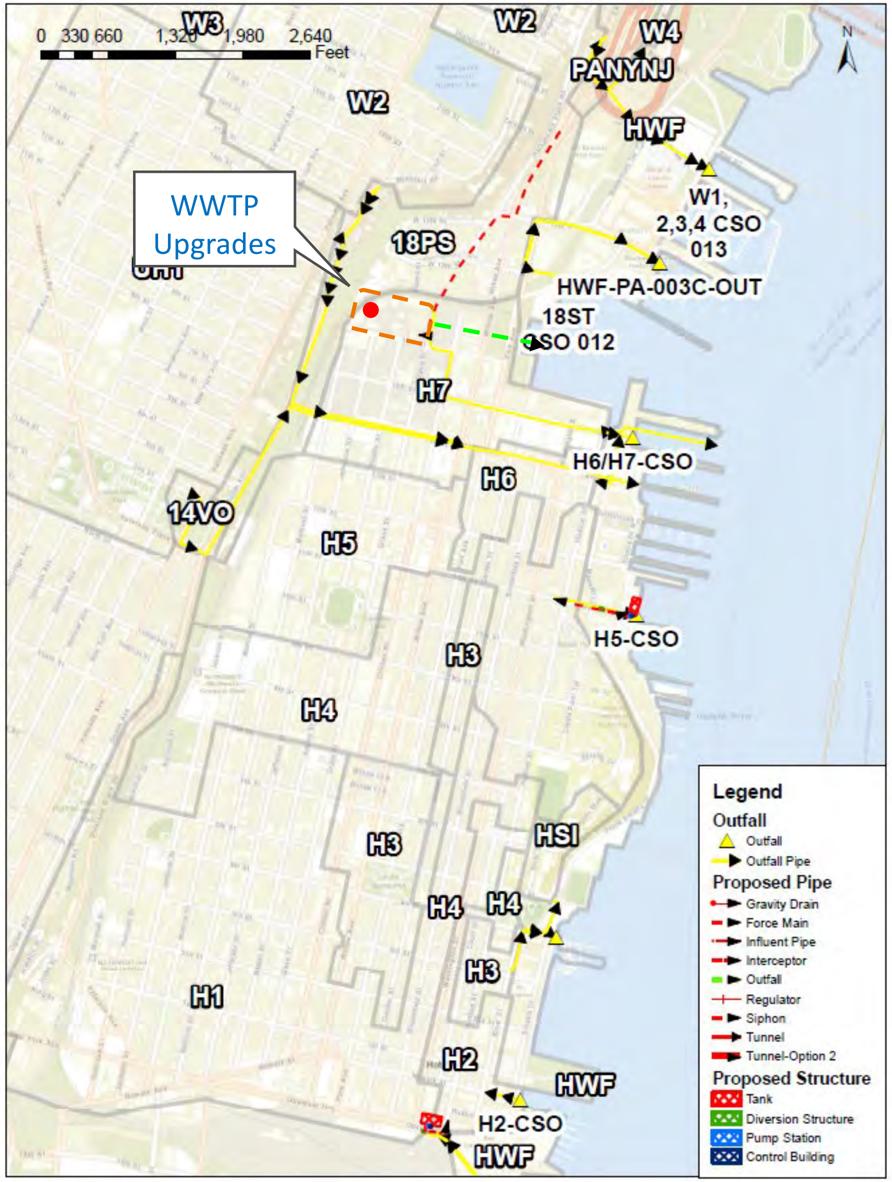


Scenario 2

Collection System and WWTP Controls	Construction Cost
Integration of 1 MG, $12 million Resiliency Park storage tank into NHSA conveyance system	$30,000,000
Construct High Level Storm Sewer on Blvd East	$5,000,000
Divert partial volume from H1 and all volume from H3/H4/HSI with Siphon and Increase Capacity of 5th Street Pump Station from 15 mgd to 47 mgd	$35,000,000
1.5 MG Underground Storage at H1 near PATH	$35,000,000
Parallel 42" Park Ave Siphon	$28,000,000
Increase Capacity of WWTP by 20 MGD through Side Stream Treatment	$13,000,000
8 MG Storage Tank at Adams Street WWTP	$77,000,000
Construct New WWTP Outfall	$5,000,000
1.3 MG In-Water Storage at W1234	$26,000,000
TOTAL	**$254,000,000**

Technically Viable Solutions and Estimated Costs

Adams Street WWTP: 85% Capture

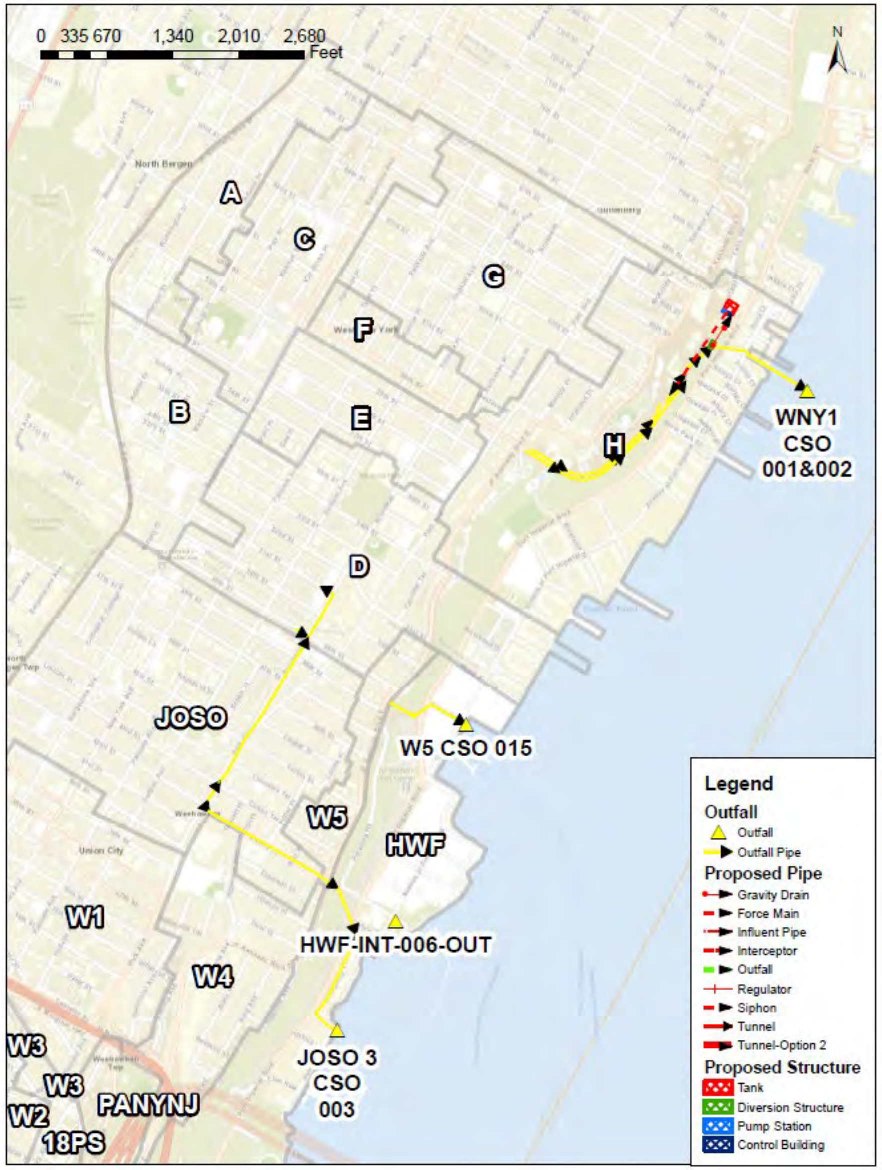


Scenario 3

Collection System and WWTP Controls	Construction Cost
Integration of 1 MG, $12 million Resiliency Park storage tank into NHSA conveyance system	$30,000,000
Construct High Level Storm Sewer on Blvd East	$5,000,000
Construct 7 MG Storage at lot on Observer Highway and Washington Street	$70,000,000
Construct 4 MG storage tank at Maxwell Place	$56,000,000
72” Park Ave Siphon	$32,000,000
Increase Capacity of WWTP by 20 MGD through Side Stream Treatment	$13,000,000
10 MG Storage Tank at Adams Street WWTP	$84,000,000
Construct New WWTP Outfall	$5,000,000
TOTAL	**$295,000,000**

Technically Viable Solutions and Cost Estimates

River Road WWTP: 85% Capture

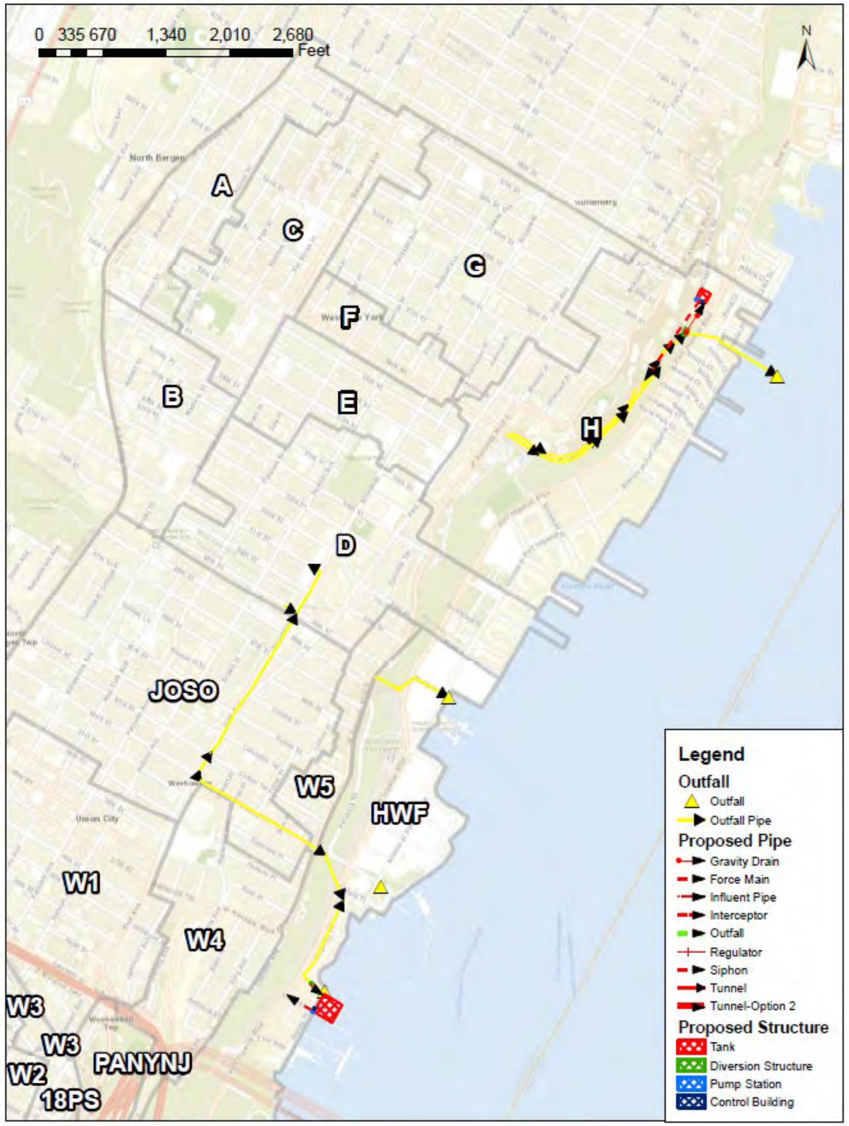


Scenario 1

Collection System and WWTP Controls	Construction Cost
8 MG Storage at lot north of WWTP	$77,000,000
Raise JOSO Weirs by 1 foot	$2,000,000
Increase capacity at River Road WWTP to 35 MGD with High Level Treatment	$13,000,000
TOTAL	**$91,000,000**

Technically Viable Solutions and Estimated Costs

River Road WWTP: 85% Capture

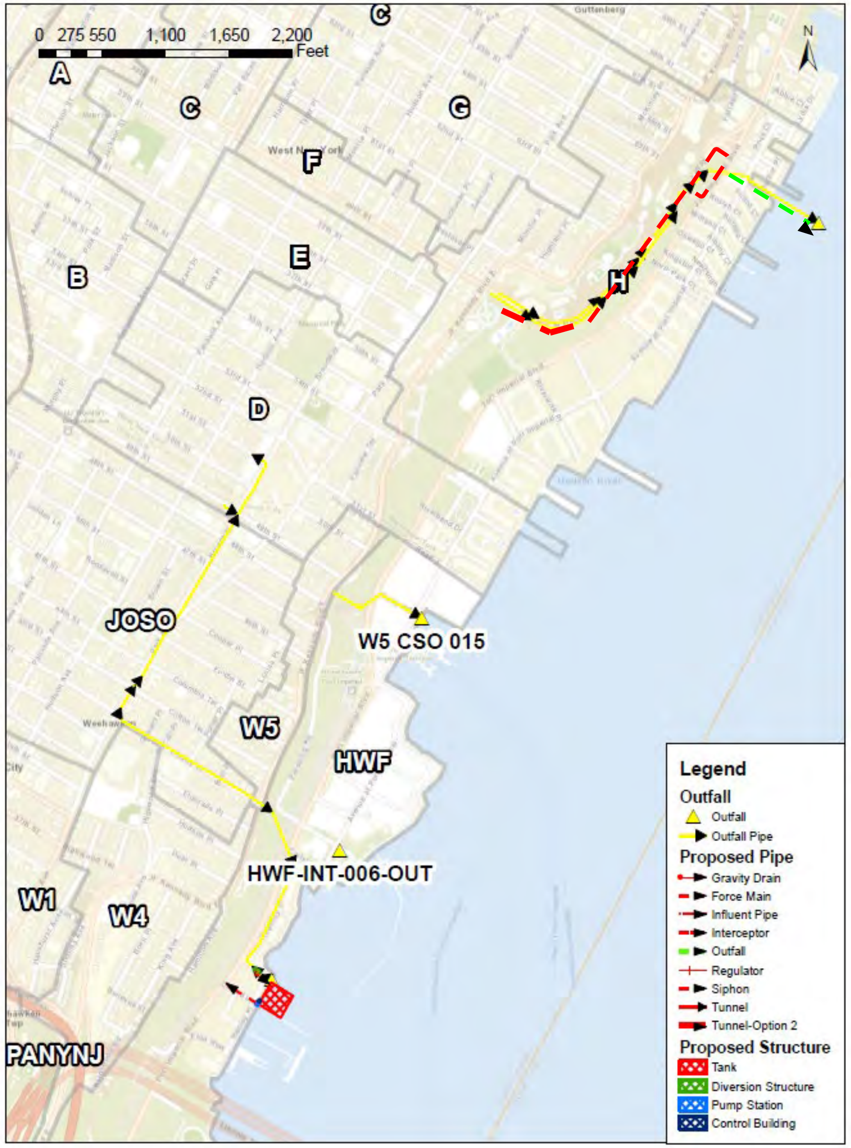


Scenario 2

Collection System and WWTP Controls	Construction Cost
8 MG Storage at lot north of WWTP	$77,000,000
1.5 MG In-Water Storage at JOSO	$27,000,000
Increase capacity at River Road WWTP to 35 MGD with High Level Treatment	$13,000,000
TOTAL	**$117,000,000**

Technically Viable Solutions and Estimated Costs

River Road WWTP: 85% Capture



Scenario 3

Collection System Controls	Construction Cost
Linear Storage/Treatment on Anthony M. Defino Way	$171,450,000
0.8 MG In-Water Storage at JOSO	$13,500,000
TOTAL	**$184,950,000**

NHSA: 4 Overflows/Year OR 85% Capture

Criteria:

- Least disruption to the service area communities
- Comparative technical feasibility
- Relative cost effectiveness

Recommendation:

- 85% Capture: less disruption, technically preferable, and more cost effective
- Scenario 1 for Adams Street WWTP service area
- Scenario 1 for River Road WWTP service area

NHSA LTCP Preliminary Projects, Construction Cost & Construction Time

Collection System and WWTP Controls	Construction Cost	Year
Integration of 1 MG, $12 million Resiliency Park storage tank into NHSA conveyance system	$30,000,000	2024-6
Land Purchase for WNY1 Storage Tank		2028
Construct New Adams Street WWTP Outfall	$5,000,000	2031
Increase Capacity at River Road WWTP to 35 MGD with High Level Treatment	$13,000,000	2042
Increase Capacity at Adams Street WWTP by 20 MGD through Side Stream Treatment	$13,000,000	2043
Raise JOSO Weirs by 1 foot	$2,000,000	2044
Parallel 48" Park Ave Siphon	$28,000,000	2044
Increase Capacity of 5th Street Pump Station from 15 mgd to 47 mgd AND Construct Parallel 11th Street Siphon to divert partial volume from H1 and all volume from H3/H4/HSI	$35,000,000	2046
Increase Capacity 11th Street Pump Station from 11.6 mgd to 20 mgd	$24,000,000	2048
Adams Street WWTP 2 MG Storage Tank	$17,000,000	2050
River Road WWTP 8 MG Storage Tank	$77,000,000	2054
Adams Street WWTP 8 MG Storage Tank	$68,000,000	2058
TOTAL	**$311,000,000**	

Financing the CSO LTCP

Key Assumptions

- Operating expenses increase at the rate of 2% per year in conformity with the required 2% annual cap
- Connection fees will remain steady at $3.1 million per year (less than recent receipts)
- Facilities charges increase at 2% per year
- Water consumption declines at 1% per year for the next 5 years, then declines at 0.5% per year thereafter
- A 2% per year increase in revenue from sewer usage based consumption charge

Financing the CSO LTCP

Financing Strategy

- Excluding NJ Infrastructure Bank loans, current NHSA debt is paid in full in 2044
- Between now and 2044, NHSA would use some NJIB loans plus some capital cash to fund a limited number of LTCP projects
- Implementing a limited number of LTCP projects over that period can enable the Authority to live within the 2% per year net increase in revenue
- After 2044 and through 2060, NHSA would borrow additional funds and use capital cash to complete the LTCP, while still maintaining the focus on 2% per year net increase in revenue
- Between now and 2060, NHSA will continue to replace/reline sewers and make other improvements as needed, at a modest pace

North Hudson Sewerage Authority CSO Long Term Control Plan - Public Meeting Minutes

PROJECT: North Hudson Sewerage Authority Alternatives Analysis

MEETING DATE: March 9, 2020

MEETING TIME: 7:00 PM – 7:45 PM

LOCATION: 1600 Adams Street, Hoboken, NJ

The fifth public meeting regarding the Alternatives Analysis for development of the Long Term Control Plan (LTCP) for the North Hudson Sewerage Authority service areas was held on March 9th, 2020. Previously the meetings discussed the beginning steps of the Long Term Control Plan. The purpose of this meeting is to discuss the next steps for the Long Term Control Plan and the various alternatives scenarios tested for both service areas. The previous newsletters were distributed and described at the start of the meeting. The meeting began with a presentation on the alternatives selection process to date and potential scenarios for each service area. These slides can be seen on the Authority's website. A sign-in sheet for attendance was at the front desk. The following summarizes the questions and comments following the presentation.

Q: Does the Park Avenue siphon provide in-line storage?

> A: The pipe is at a very steep slope and the additional siphon will help convey more flow and lower the velocities in the existing siphons. With the steeper slope, in-line storage is not expected.

Q: Is the same true for the 11th Street siphon?

> A: The 11th Street siphon is slightly different than the Park Avenue Siphon as this siphon is inaccessible. The Authority has analyzed ways to bypass and inspect this line but it is not possible. The 2nd line would be a force main over a siphon that can give the redundancy needed to inspect and repair the existing siphon.

Q: Is the 11th Street Siphon alignment as shown on the slides?

> A: It's currently a schematic but we would look for a route that would cross the least amount of existing utilities, it does not need to run parallel to the existing line.

Q: Will all flow from the H4 and H5 drainage basins come back to the Adams Street WWTP?

> A: This capture is for about 95%.

Q: As a homeowner, it is desirable to do more at the community and property level. There is public space available: the city has dug up asphalt across from a church and are replacing natural landscape with hardscape and AstroTurf as opposed to green spaces.

> A: The Authority is making efforts to make a statement in that area. There are currently 2 grants for green infrastructure. West New York is taking a project and installing permeable pavement at

the parking authority. This is being attempted with the state's money, we've also partnered with the city and have agreed to maintain bioswales. There is more that can be done on a local green basis and the Authority hope to be more helpful in that.

Q: Some community surface structure edits are easy to do. I was working as a construction representative and they are extending tree pits to 10 feet and creates a lot of green space. Why aren't we doing that?

A: The Authority does not own the sidewalks and is unable to work in these areas.

Q: The community has spoken with Dawn Zimmer regarding the green space near the light rail and there seems to be a disconnect with Rebuild by Design but the public hopes you'll consider the RBD project and housing area.

A: This is not off of the table but the Authority can only do so much at one time. The construction of storm sewers at housing authorities is viable down the road. It's not off the table and is on the original RBD layout and it could eventually happen.

Q: It would be nice if the green space could build that into what we're doing now. The green infrastructure on Washington Street was planned 6 years ago and is now finally constructed. There is a lot of sidewalk with the Housing program and Board of Education.

A: The Authority will discuss with the city the possibility to do green infrastructure in these areas. The current budget allows 3 green infrastructure projects a year.

Q: On 6th Street, the public has a PhD student measuring biochar to see what contaminants are in the bioswales. The space is available for a potential teaming.

A: A few years ago the Authority was working with the university in this same manner.

Q: When is the expanding of the 5th Street Pump Station scheduled to be done and how large will that be? I am on the Board of Waterfront. One plan is extending the little league field. How would this impact the potential little league expansion?

A: The 5th Street Pump station would be 2 stories the way it is now and is within the Authority's property limits but the idea is to expand much larger than it is currently. A new façade would be put in place.

Q: On the housing authority, there's some plans to reconfigure the housing authority in the next few years. It is recommended to check in with Mark Grecko on these plans.

A: That will be pursued at that time.

Q: After everything is built on site at the plant, is there room for anything else to revolutionize the WWTP process?

A: There are no plans to increase footprint.

Q: Where does the light rail play into this?

A: The new housing is behind the Adams Street WWTP trickling filters.

The meeting ended at about 7:45 pm.

NHSA CSO LTCP Public Meeting #6

May, 2020

Public Participation Meeting #6 Sign In Sheet

DATE 5/11/2020

PREPARED BY: JACOBS

Name	Affiliation	Email
Richard Wolff	North Hudson Sewerage Authority	rwolff@nhudsonsa.com
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Joe Mannick	NJDEP	Joe.mannick@dep.nj.gov
Susan Rosenwinkel	NJDEP	Susan.rosenwinkel@dep.nj.gov
Siying Wang	Jacobs	Siying.wang@jacobs.com
Jason Capizzi	Port Imperials Homeowners Association	N/A
Carter Craft	Hoboken Cove Community Boathouse	N/A
Mo Kinberg	N/A	N/A
Stephen Seeberger	N/A	N/A
Ed Markus	Amawalk Consulting	N/A

North Hudson Sewerage Authority
Long Term Control Plan

05.2020

Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP)

Mandated by NJDEP and USEPA

- Submission of preliminary planning to NJDEP by June 1, 2020

Goal

- To dramatically reduce the discharges of combined sewer overflows into the nation's waterbodies

Long-term

- Implementation over a 25 to 30 year time frame

Cost

- NHSA sees a 25 -30 year path to completion without raising the rate beyond annual 2% cap for the first 10 years, then up to 3.5% throughout the remainder of the plan

LTCP GOAL IS TO REDUCE CSO DISCHARGES. IT IS NOT A FLOOD MITIGATION PROGRAM.

NJDEP CSO Control Mandate

Long Term Control Plan (LTCP) Requires NHSA:

1. TO UNDERTAKE A MAJOR STUDY OF THE COLLECTION SYSTEM, TREATMENT WORKS AND DISCHARGES INTO WATER BODIES (“SYSTEM CHARACTERIZATION”)
   - This includes hydraulic analysis and condition assessment of wastewater collection systems, pumping stations, regulators and sewage treatment facilities
   - The purpose is to provide the basis for the development of a long-term plan to regulate CSO discharges
   - **THIS STUDY HAS BEEN SUCCESSFULLY COMPLETED BY NHSA**
2. TO UNDERTAKE A MAJOR STUDY OF THE POSSIBLE ALTERNATIVES TO REDUCE CSOs (“ALTERNATIVES EVALUATION”)
   - Identify and evaluate possible opportunities to reduce CSOs
   - Estimate costs for possible opportunities
   - **THIS STUDY HAS BEEN SUCCESSFULLY COMPLETED BY NHSA**
3. TO DEVELOP A LTCP TO BE SUBMITTED TO THE NJDEP BY JUNE 1, 2020
   - Determine what system improvement projects will be needed over the next 25 to 30 years to reduce the frequency, volume and impacts of CSOs.
   - **THIS INITIAL PLAN IS DISCUSSED IN THIS PRESENTATION. THE FINAL DRAFT WILL BE SUBMITTED TO NJDEP ON TIME**

NJDEP CSO Control Mandate

Permit Compliance can be achieved in 1 of 2 ways:

1. CAPTURE A MINIMUM OF 85% OF WET WEATHER VOLUME ANNUALLY ⇐ **Selected Method**
   - Based on the comprehensive study of its system, NHSA will opt for this method of meeting NJDEP requirements

or

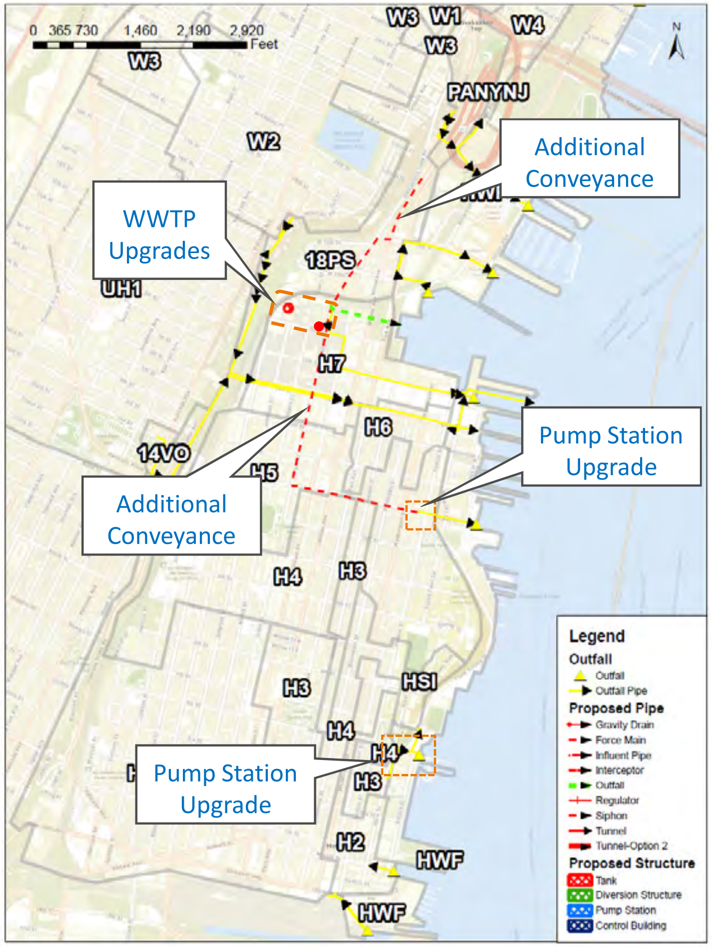
2. REDUCE ANNUAL OVERFLOWS TO 4 PER YEAR SYSTEM-WIDE
   - Given the size of the NHSA system, number of outfalls in three cities, and technical requirements, this option is not feasible

NHSA IS REQUIRED BY THE NJDEP TO REVIEW EACH OPTION

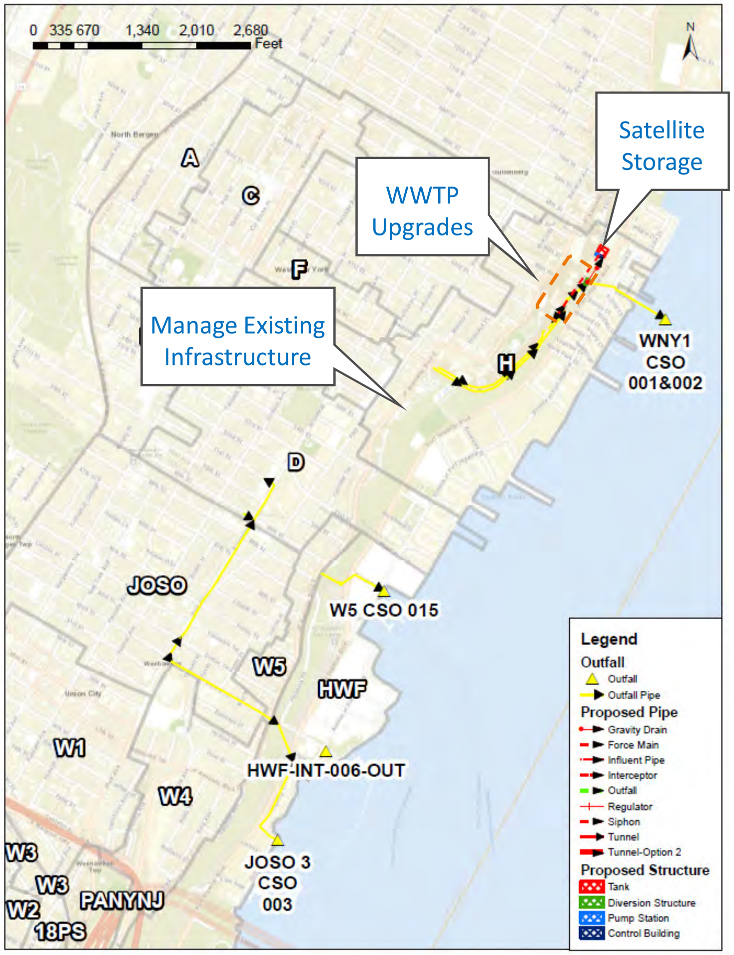
Selected 85% Capture Option

LTCP Selected Solutions

Adams Street WWTP: 87% Capture



River Road WWTP: 92% Capture



NHSA LTCP Projects, Construction Cost & Construction Timeline

Collection System and WWTP Controls	Capital Cost	Year
Integration of 1 MG, Resiliency Park storage tank into NHSA conveyance system-Phase 1, Pump Station Construction	$17,300,000	2020
Land Purchase for WNY1 Storage Tank	$4,000,000	2021
Integration of 1 MG Resiliency Park storage tank into NHSA conveyance system-Phase 2, Electrical and Mechanical Work on Pump Station	$4,000,000	2024
Increase Capacity at River Road WWTP to 35 MGD with High Level Treatment	$13,000,000	2025
Integration of 1 MG Resiliency Park storage tank into NHSA conveyance system -Phase 3, Installation of High Level Storm Sewer System	$16,000,000	2026
Construct New Adams Street WWTP Outfall	$5,000,000	2027
Raise JOSO Weirs by 1 foot	$2,000,000	2029
Increase Capacity at Adams Street WWTP by 20 MGD through Side Stream Treatment	$13,000,000	2030
Parallel 48" Park Ave Siphon	$28,000,000	2033
Increase Capacity of 5th Street Pump Station from 15 mgd to 47 mgd AND Construct Parallel 11th Street Siphon to divert partial volume from H1 and all volume from H3/H4/HSI	$30,000,000	2036
Increase Capacity 11th Street Pump Station from 11.6 mgd to 25 mgd	$13,000,000	2039
Adams Street WWTP 2 MG Storage Tank	$17,000,000	2042
River Road WWTP 8 MG Storage Tank	$77,000,000	2045
Adams Street WWTP 8 MG Storage Tank	$68,000,000	2048
TOTAL	$307,300,000	

Financing the CSO LTCP

To Finance the LTCP, the Authority Will:

- Utilize low-interest loans from the New Jersey Infrastructure Bank (NJ I-Bank)
- Pay for certain improvements with cash on hand

Financing Assumptions

Operating expenses will increase at an average rate of 2% per year and the general rate of inflation in consumer prices will be 2% per year

- Capital cost will increase at an average rate of 3% per year
- The NJ I-Bank will have sufficient loan funds available in each year to finance routine capital improvements for the Authority's system plus up to $25 million in each year to finance the proposed LTCP projects
- The capital markets are readily accessible in each year to borrow funds at reasonable terms and interest rates
- No other capital investments and O&M expenses will be mandated by the federal or state governments, unless such mandates are fully funded by the applicable agency(ies)
- Based on these and other assumptions presented in the report, there would be a 2.0% per year increase in revenue from all customer charges for the next 10 years (2031); after which revenues from customer charges will increase between 3.0-3.5% per year

Financing the CSO LTCP

Financing Approach

- After paying down $68 million of its debt in the last eight years, the Authority's senior debt will be paid in full by 2044.
- Between now and 2048, if the NJ I-Bank does not have sufficient funding the Authority may issue bonds to pay for certain LTCP projects.
- Between now and 2048, funds will continue to be available to reline/replace sewers and make other improvements as needed.
- The financial impacts on the Authority of the COVID-19 shelter-in-place requirements are yet to be determined at the time of this presentation. Depending upon the severity and duration of such impacts, the schedule for the LTCP could be affected.

Financing the CSO LTCP

Financial Capability Assessment

- The Financial Capability Assessment, as required by the EPA/NJDEP, evaluates the effect of the proposed cost of the LTCP on NHSA customers.
- This assessment includes defining a Residential Indicator and analyzing Financial Capability Indicators to ultimately define the Financial Capability of the service area.

Financial Capability Indicators

Indicators include:
- Authority’s Bond Rating
- Net Debt as a Percentage of Full Market Property Value
- Unemployment Rate in Service Area
- Property Tax Revenue and Property Tax Collection Rate

Residential Indicator

Defined as the approximate cost per household for the capital improvements as a percentage of the median household income for the service area

Financial Capability

Financing the CSO LTCP

Financial Capability Assessment

- Based on the range of values for the financial capability indicators, a score of 1-3 is assigned for each and an average score is assigned for the service area. The residential indicator is an estimated percentage of the cost per household based on the median household income for the service area
- These values are compared with the Financial Capability Matrix to determine the overall burden for the service area.

Financial Capability Indicator Score	Residential Indicator (Cost per Household as % of Median Household Income)		
	Low (Below 1.0%)	Mid-Range (1.0%-2.0%)	High (Above 2.0%)
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (1.5-2.5)	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

Financing the CSO LTCP

Financial Capability Assessment

- Our preliminary analysis indicates that the impact on the customer should be between a low burden and a medium burden.

- Depending on the final evaluation, low burden would be costs below 1% of Median Household Income. Medium burden would be costs between 1% and 2% of Median Household Income.

- These figures are applied to our service area as a whole, encompassing four municipalities.

Financing the CSO LTCP

Potential COVID-19 Impact on the Authority

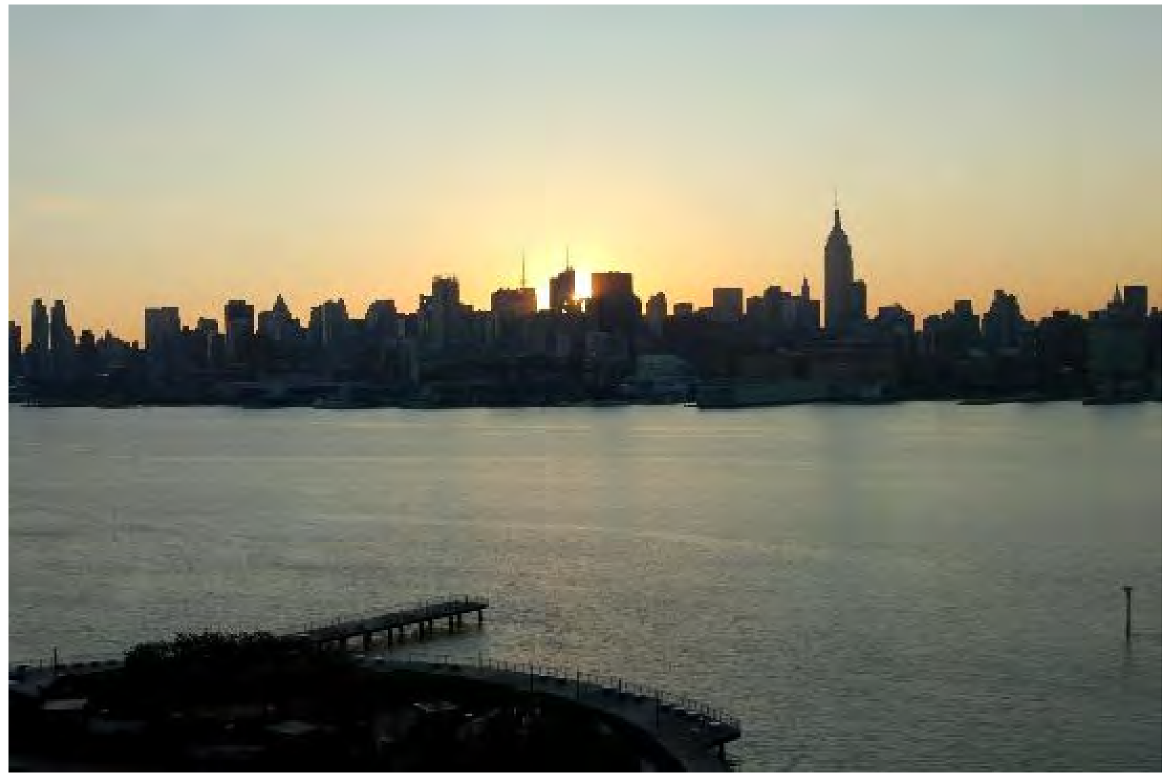
- The estimated effect of the COVID-19 restrictions on FY 2020 revenues is a reduction in the range of $5.6 million to $9.8 million.
- For the current fiscal year, NHSA does not foresee any difficulties in absorbing this potential revenue shortfall.
- Since the duration and severity of the COVID-19 impact is yet to be determined, there may be some effect on the Authority's LTCP implementation schedule.

Summary

- Over the next 25-30 years, the Authority will implement a long-term plan with the goal of reducing combined sewer overflows by collecting and treating at least 85% of combined sewage that is produced in the system annually for a construction cost of approximately $307 million.
- The program will be funded through a combination of loans from the NJ I-Bank, cash on hand, and after 2044 potential new bond offerings.
- If our projections hold steady, we anticipate rate increases of 2% per year for the next 10 years, followed by increases of up to 3.5% per year through the completion of the program.

Summary

- The Authority's commitment to environmental stewardship and addressing the needs of the community will remain top priorities through the implementation of this program.
- It is our goal to continue this dialogue throughout the program so that together we may achieve the goal of a cleaner, more sustainable future.



Questions?

North Hudson Sewerage Authority CSO Long Term Control Plan - Public Meeting Minutes

PROJECT: North Hudson Sewerage Authority Alternatives Analysis

MEETING DATE: May 11, 2020

MEETING TIME: 7:00 PM – 7:45 PM

LOCATION: GoTo Meeting

The sixth public meeting regarding the Alternatives Selection for development of the Long Term Control Plan (LTCP) for the North Hudson Sewerage Authority service areas was held on May 11th, 2020. Due to effects of the COVID-19 situation, the meeting was held virtually using the GoTo Meet platform. Previously the meetings discussed the beginning steps of the Long Term Control Plan. The purpose of this meeting is to discuss the proposed selected alternatives for the Long Term Control Plan and the anticipated financials for both service areas. The previous newsletters were distributed and described at the start of the meeting. The meeting began with a presentation on the alternatives selection process to date and potential cost estimates for each service area. These slides can be seen on the Authority's website. Meeting attendees were recorded from the platform. The following summarizes the questions and comments following the presentation.

Q: The public would really like the LTCP to be the best plan possible and would like some green infrastructure incorporated into the plan. Environmental health is public health and the public is hoping that the next generation is also invested in environmental health. Hoboken is doing different strategies to update the city but with the exception of Northwest Resiliency Park, it seems Hoboken has become stagnant on green infrastructure.

> A: The Authority shares the commitment to the environment with turning the Authority around 180 degrees to a functioning authority. We also have the desire to maintain environmental and public health. At this time inserting a full green infrastructure program into our plan may not be the most effective route but this does not mean we cannot start another program as a separate initiative. The Authority has a GI program that is funded every year and will fund three more projects next year in January. Please continue the conversation, sending emails and meet with Fred and/or Richard and the Authority is very open to this.

Q: Recently conversations were had with Dawn Zimmer and she questioned if the Authority could fund the Jackson Street concept around Hoboken Housing. Realizing what a great physical resource they have, the Authority can do a lot more than some of these other agencies. Examples are Newman Yard, three corners of Willow Avenue, City Garage, maybe those three things make sense to make improvements there. The conversation became a lot smaller when the Authority was removed and all these other groups cannot work together.

> A: What the Authority can and cannot do is in the Sewer Act and our actions must somehow impact the sewer system. However in the course of repairing a sewer line, we can make improvements such as replacing the sidewalk.

Q: Is any land acquisition either around the plant or elsewhere that the Authority will cover?

A: Yes purchasing land is already in the process for the proposed storage tank in the River Road plan near the West New York plant.

Q: With the planned expansion for Adams Street, does that build out 80, 90% of the industrial use of the space?

A: At Adams Street we will be within the footprint we have now. The current outfall will be replaced by 2 million gallon storage tank.

Q: Is the Authority involved in the city's involvement in the SmartGRID and municipal fleet vehicle? Is anything on the Authority's property part of that?

A: Yes the Authority is involved in the SmartGRID. It is not far enough along to answer any questions but Hoboken has told us when planning to build a plant outfall, the Authority will be including some empty conduit for some microgrid to be wired.

Q: Is the Authority planning on submitting the LTCP on June 1st?

A: The Authority will be submitting on June 1st, the original date.

Q:.Will there be additional public outreach before June 1st?

A: Not before June 1st but once comments are received the Authority will follow up

Q: Will the presentation be available online?

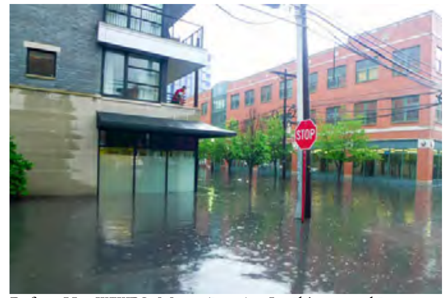
A: Yes

The meeting ended at about 7:45 pm.

NHSA CSO LTCP Advertorial Volume 1

February 2019

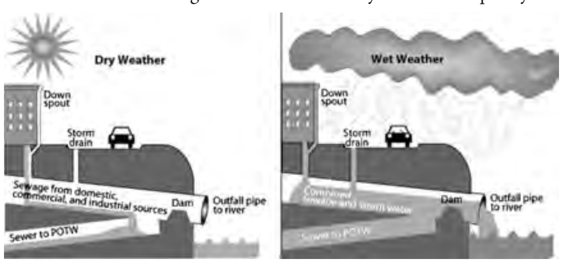
THE FACTS ABOUT HOBOKEN AND WET WEATHER


Before H-5 WWPS, May 31, 2015: Looking northwest at Madison and 9th Streets. (Credit: Hoboken411)


After H-5 WWPS, October 27, 2018: Looking southwest at Madison and 9th Streets. (Credit: NHSA)

It wasn't that long ago that a heavy rainfall with a high tide in the Hudson River combined to severely flood the low-lying southwestern and northwestern areas of Hoboken. Rainwater mixed with sewage would rise as high as three feet and remain on the streets for up to 48 hours. Longtime residents of these neighborhoods know what it used to be like. Yet, many new residents don't realize the vast improvements made in the last seven years.

Hoboken is a Combined Sewer Overflow (CSO) system. There are essentially no separate pipes to convey rainwater collected on roofs, on properties and on the streets, so rainwater and sewage mix in a single piping system – a combined sewer. In heavy rainstorms, excess flow is diverted into the Hudson River, where it undergoes primary treatment before discharging. Flooding occurs during severe storms when flows cannot be discharged to the river because of high tide or when the system is at capacity.

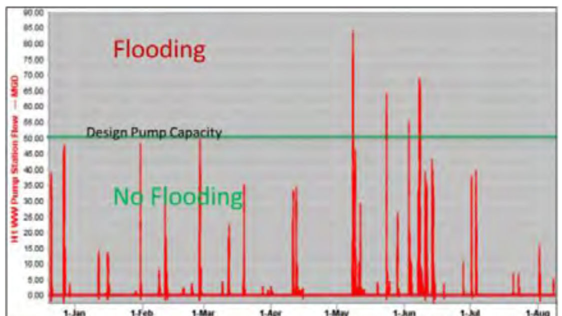


Credit: U.S. Environmental Protection Agency

In 2011, at the cost of $18 million, the North Hudson Sewerage Authority built its first Wet Weather Pump Station (H-1) on Observer Highway at Washington Street to address the flooding in the southwest neighborhoods. Its two massive 50 million gallons per day (mgd) pumps can pump flow out of the City and into the river against high tide. The pump station has had an immediate beneficial impact.


H-1 Wet Weather Pump Station

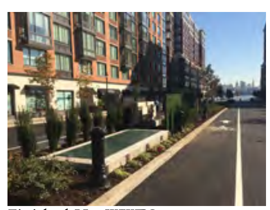
An independent review by EmNet, a firm specializing in combined sewer system monitoring, examined rainfall data from December 2012 to August 2013. During this period, there were 36 rain events that triggered the pumps. Previously, these events would have caused significant street flooding. With the pumps operating, only four events saw street water pooling which was rapidly drained off by the pump station.



H-1 WWPS flow rates from December 20, 2012 through August 10, 2013

North Hudson and the City of Hoboken entered into a partnership in 2014 to address chronic flooding in the neighborhoods around ShopRite. The City paid for the construction of the H-5 Wet Weather Pump Station on 11th Street at Hudson Street. North Hudson assumed responsibility for the design, easements, and operations and maintenance. The H-5 Pump Station has two 40 mgd pumps which, along with the control system, are entirely underground in a landscaped island on 11th Street.


H-5 WWPS pumps during construction.


Finished H-5 WWPS

Between November 2016 and April 2017, the new pump station handled four storms large enough to previously cause flooding along 9th and Madison. In each case, the pump prevented flooding. It was not until the extreme storm of May 5, 2017 that street water was seen in this area, and the pump station rapidly drained the water from the roadways.

Even with the pumps operational, extremely intense storms may cause some flooding. When residents see water ponding in the streets, some wonder if the pumps are working properly. They are. During intense storms, the rain falls so quickly that the catch basins and combined sewer lines fill up within minutes. The pumps kick in and begin pumping water out of the lines even against the tide, but some pooling of water on low-lying streets will occur. The pumps handle the rainwater as fast as it can be conveyed, the limitations being low street grades, water infiltration, and sewer capacity.

If capacity is an issue, why don't we just tear up the streets, rip out the old sewers and install larger ones with more capacity? Even if this were financially and operationally feasible – which it is not – this would not solve the problem. "Capacity" is not just about the size of the sewer. Capacity is determined by the slope, size and condition of the pipes.

To address the problem of slope, street grades must be raised in low lying areas, probably by an average of four feet. Water infiltration also reduces capacity. Since 2008, North Hudson has spent $45 million to reline and replace scores of sewers, which partially addresses the capacity issue. But alone this will not eliminate road flooding – unless street grades are raised.

The key to mitigating the climate-induced wet weather effect is to address the problem of street elevations and continue with green and gray infrastructure initiatives (such as bioswales, green and blue roofs, and storm water detention systems). Fortunately, in cases of extreme wet weather, we have the pumping capacity to rapidly clear street ponding. The wet weather pump stations are also an essential component of the Rebuild-by-Design project and our State-mandated CSO Long Term Control Plan.

Although we have made a great deal of progress in the last 20 years, we remain committed to further improve wet weather flood control in our service area.

The North Hudson Sewerage Authority

1600 Adams Street, Hoboken

www.nhudsonsa.com

NHSA CSO LTCP Advertorial Volume 2

May 2019

THRIVE, HUDSON RIVER

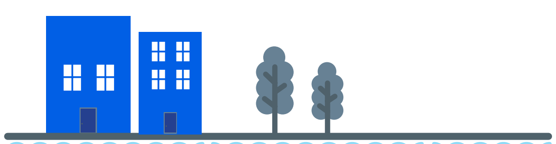
VOL 2

STEWARDS OF THE HUDSON RIVER

One of the most important roles of the North Hudson Sewerage Authority (North Hudson) is contributing to the ongoing water quality improvement of the Hudson River. This almost 50-year effort, which was mandated by the 1972 Clean Water Act, has made great progress. Today, fish have returned to the river waters and kayaks are a common sight.

Getting to this point has not been easy, especially because North Hudson has a combined sewer system. Most of our system is a single pipe system, combining, when it rains, stormwater with wastewater.

In dry weather, the wastewater passes easily through the treatment plants, and the cleaned flow is discharged harmlessly into the Hudson River. But when it rains, the combined flows can become too much for the wastewater plants to handle. The plants are by-passed, and some of the combined wastewater and stormwater (CSO) is discharged into the Hudson River.



A LONG-TERM PLAN TO REDUCE CSOs

These partially treated overflows do not help to make the River cleaner. That's why in 2015 the Federal and State governments required all NJ water body dischargers with CSOs to develop plans to reduce the number of combined overflows. Since then, North Hudson has been working on a Long-Term CSO Control Plan (LTCP) which is due in June 2020.

The LCTP has several stages: system characterization, development of alternatives, selection of approach, and implementation – all spread over the next 20 to 30 years.

STEP 1: SYSTEM CHARACTERIZATION

System characterization is just a fancy phrase for knowing the ins-and-outs of our operations and assets. What do we have? How is it working? What kind of shape is it in?

The primary objective is to develop a detailed understanding of our combined sewer system and its impact on the Hudson River. This assessment establishes the existing baseline conditions. From there, we can figure out what we need to do to improve Hudson River water quality. In short, the characterization work helps to identify and prioritize specific CSO controls that will be in our LTCP.

PROGRESS TO DATE

We started our system characterization program in 2015. Here's what we've done so far.

- We compiled the latest information on land uses and planned developments that will affect sanitary and drainage flows.
- Street by street, we deployed crews with GPS systems to confirm the locations of all our catch basins, pipes, manholes and other assets to update our GIS databases.
- We used cameras to get a better handle on the condition of our pipes and to quantify the amount of water that is infiltrating our sewers from groundwater and drinking water pipe leaks.
- We collected water samples from our sewers when it was raining to test for bacteria concentrations.

- We deployed sensors in our sewers to measure flows during dry and wet weather for six months.
- Using the sensor data, we compiled computer models of our sewers.
- We used our models to calculate the dry and wet weather flows to monitor performance.
- We participated in a new, year-long monitoring program of the Hudson River to test for bacteria and identify sensitive areas for recreation uses and fish and wildlife habitat.

HOW ARE WE USING THIS INFORMATION?

Our engineers have been using the data collected from all these programs to draw a picture of the condition and performance of our systems. In the next edition of this newsletter, we will share our findings.

Join North Hudson to discuss the development of the LTCP and its progress at upcoming public meetings this year on August 19th and November 18th. The meetings are held at North Hudson's office at 1600 Adams Street, Hoboken.

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NHSA CSO LTCP Advertorial Volume 3

November 2019

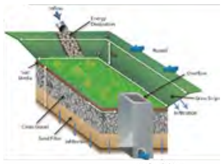
VOL 3

THRIVE, HUDSON RIVER

HOW WOULD IT WORK?

The goal of the LTCP is to reduce and treat the combined overflow. Here are some examples of how that might work:

- **Collecting Excess Flow Using Storage Tanks and Green Infrastructure.**



Both storage tanks and green infrastructure prevent excess flows from entering the sewer system during rainstorms, combining with regular sewer flow, by-passing (because of the high volume) the treatment plants and discharging into the river.

- **End-Of-Pipe and Contact Basin Treatment**

Before the CSO enters a water body, the flow would be chemically treated to effectively reduce bacteria and any harmful contaminants. This would involve the construction of treatment facilities at the outfall along the Hudson River shoreline or in the water itself.

- **Wastewater Treatment Plant Upgrade**

This category includes several different ways to reduce CSOs. One of the system upgrades is to increase the capacity of the wastewater treatment plants by adding storage tanks that will effectively decrease the stress of overflow during wet weather events. This solution requires space on our plant sites in Hoboken and West New York which needs to further examination.

- **Building Storm Sewers**

This option is limited to the few remaining undeveloped sections of our service area, particularly northwest Hoboken. With the inclusion of a 1 million gallon storage tank under the new City-owned Northwest Resiliency Park, there is an opportunity to build a storm sewer system which will separate rain water from normal sewage flow and provide more capacity, thus reducing CSO events.

CSO LONG-TERM CONTROL PLAN (LTCP)

The NHSA continues to advance the development of its LTCP, and we continue to share our progress with the public. We are now at the stage of identifying specific options to reduce the number of CSO discharges into the Hudson.

We encourage you to get involved in our environmental mission. Understanding how the combined sewer system works and why it is important to reduce CSO discharges is important for anyone who cares about our environment.

WHAT ARE THE POTENTIAL OPTIONS?

We started by analyzing more than 50 engineering alternatives that might reduce CSOs. As a first step, we identified various options that would work. Subsequently, we will select from this list of options to create combinations that can effectively reduce our CSO discharges.

Here are the types of approaches that, in different combinations, would work:

1. Install Underground Storage Tanks - Detain combined flow and slowly release for treatment

2. Perform End-Of-Pipe/ Contact Basin treatment - Treat combined flow right before it has been discharged into the water way

3. Wastewater Treatment System Upgrade - Increase system capacity and optimize treatment process

4. Pump Stations - Convey flow to the optimal location to treat

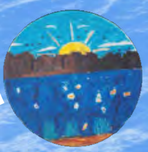
5. Separate the combined sewer system -Separate storm water from the combined sewer system to increase out sewer system capacity during wet weather events

6. Green Infrastructure - Reduce storm water for decompressing sewer system

NEXT STEP: SELECTION OF ALTERNATIVES

In order to achieve our goals NHSA will have to choose among these groups of alternatives. That's the next step, and our next newsletter will outline the preferred approach. The selection will be informed by public feedback, engineering issues, and cost.

Join North Hudson to discuss the LTCP at our next public meeting on November 18th. The meetings are at North Hudson's office at 1600 Adams Street, Hoboken.



Twitter @northhudsonsaLTCP

www.nhudsonsa.com/thrive/cso.html

NHSA CSO LTCP Advertorial Volume 4

March 2020

North Hudson Sewerage Authority

THRIVE, HUDSON RIVER

Progress to Date

We continue to move forward with our NJDEP-mandated long-term plan to reduce CSO discharges into the Hudson River. While no decisions have yet been made concerning the go-forward blue print for CSO reduction, we have made significant progress in our planning over the last two years.

Following the directives of the NJDEP, we first "characterized" our collection system in our service area. This gave us the research and data about the combined sewers necessary to consider viable engineering approaches. Then, in accordance with the NJDEP schedule, we developed general approaches that are workable from an engineering point of view.

Now, we are at the stage of combining these alternative approaches to determine how they might work within the system to reach permit compliance.

Working with Customers, Residents and Government Officials

In order to achieve the goals of the CSO LTCP and satisfy the NJDEP permit, we must demonstrate that our proposed approach satisfies one of the following criteria:

- The sewer system cannot have more than a total of 4 overflows per year at all outfalls;

OR

- The sewer system must capture and treat 85% of the combined sewer volume per year.

So far, we have been looking at how to meet either the 4 overflows goal or the 85% capture goal. At this stage, we have looked at solutions that are technically feasible. This means solutions that would, strictly from an engineering point of view, meet one or the other criteria.

Some technical alternatives are more practical and feasible than others -- when accounting for available land, future development, impact on quality of life, and cost. We are striving to select a program that will not only meet the requirements of our NJDEP permit, but also causes the least disruption possible to our communities. That's why we will start the new year of 2020 by sharing our latest thinking with our elected officials and our service area residents.

Possible Approaches

The following tables show the structures/improvements that, when certain ones are implemented together in a comprehensive program, could achieve each of the two goals presented. But keep in mind this chart does not answer the question: "At what price?" We are compelled by the NJDEP to review thoroughly and share with the public ALL technically feasible approaches. However, this does not mean that these approaches will, in the end, be selected. We must factor in the input of the government officials and the community, as well as consider cost and disruptions, before submitting our plan to NJDEP.

Here are technically valid approaches. Again, these are not chosen or preferred approaches. In fact, some of them would be quite disruptive and, on that basis alone, would be disqualified.

Adams Street Service Area

Drainage Basin/ Outfall	Structures/Improvements for 4 Overflows per year at all Outfalls	Structures/Improvements for Capture and Treatment of 85% of the Combined Sewer Volume Per Year
H1/002A	3.65 MG Underground Storage Tank at Observer Highway and Hudson Street*	Divert partial volume from H1 with construction at 5th Street Pump Station
H3/H4/HSI/005A	4.67 MG In-Water Tank either in water at 5th Street*	Divert all volume from H3/H4/HSI with Additional Siphon after 11th Street Pump Station and upgrade 5th Street Pump Station to 47 mgd*
H5/006A	2.35 MG In-Water Tank at Maxwell Place*	Increase Capacity of 11th Street Pump Station to 20 mgd
18PS/012A	Increase Capacity of Pump Station at 18th Street*	-
W1234/013A	2 MG In-Water Storage Tank at W1234 Outfall* Construct 72" Parallel Siphon Along Park Avenue back to Adams Street WWTP	Construct Parallel 48" Park Ave Siphon back to Adams Street WWTP
W5/015A	Construct High Level Storm Sewer along Boulevard East	Construct High Level Storm Sewer along Boulevard East
Adams Street WWTP/001A	Construct Larger Outfall Increase capacity by 20 MGD with blending Replace trickling filter with 20 MG storage tank	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 8 MG storage tank and construct 2 MG storage tank near front of WWTP
* Alternative would require construction on public property not within the roadway		

River Road Service Area

Drainage Basin/Outfall	Structures/Improvements for 4 Overflows per year at all Outfalls	Structures/Improvements for Capture and Treatment of 85% of the Combined Sewer Volume Per Year
JOSO/001A	Construct 4.57 MG In-Water CSO Storage Tank at outfall*	Raise weirs on JOSO interceptor
WNY1/002A	Construct 8.3 MG Tunnel and Treatment on Anthony M. Defino Way* Construct Parallel Outfall*	Construct 8 MG storage tank north of treatment plant*
River Road WWTP/001A	-	Increase treatment capacity from 8 MGD to 35 MGD with new treatment processes
* Alternative would require construction on public property not within the roadway		

NEXT STEPS

- Undertake a cost analysis of various technical alternatives
- Meet with government officials to solicit input
- Solicit input from the public in our fifth community meeting
- Refine the alternatives based on the above
- Prepare submission to the NJDEP, due June 2020

Join North Hudson to discuss the development of the LTCP and its progress at upcoming public meeting March 9, 2020. The meetings are held at North Hudson's office at 1600 Adams Street, Hoboken.

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NHSA CSO LTCP Advertorial Volume 5

May 2020

NHSA CSO LTCP Newsletter Volume 1

May 2019

Many communities in NJ operate Combined Sewer Overflow systems (CSOs) which annually discharge 23 billion gallons of minimally treated sewage and stormwater into our waterways. The North Hudson Sewerage Authority (North Hudson) is working closely with the NJ Department of Environmental Protection (NJDEP) to address this issue in North Hudson's service area.

Reducing CSO flows into the Hudson River presents enormous operational and financial challenges. In the past, the State has been a good partner in this effort. The NJDEP assures North Hudson that the State will continue to support wastewater infrastructure projects designed to reduce CSO discharges.

This newsletter is designed to familiarize customers and residents with NHSA's long-term plans to reduce CSOs. We urge you to learn more about our efforts to continue to improve the quality of the Hudson River. We look forward to your input and encourage you to visit NHSA's website at www.nhudsonsa.com for ongoing information and updates.

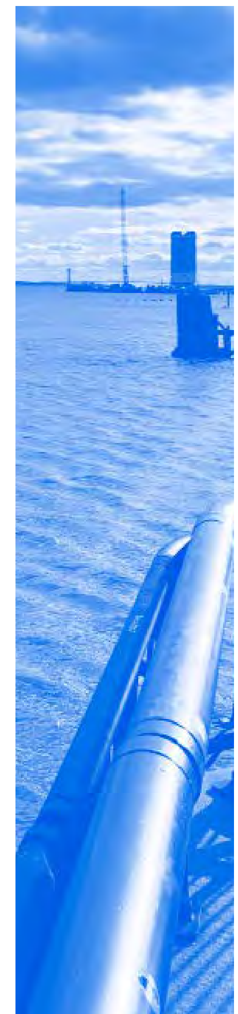
Let's make this a three-way effort: North Hudson, NJDEP and you!

Dr. Richard J. Wolff
Executive Director, NHSA

Joe Mannick
CSO Program Coordinator, NJDEP

A Newsletter of the North Hudson Sewerage Authority

THRIVE, HUDSON RIVER

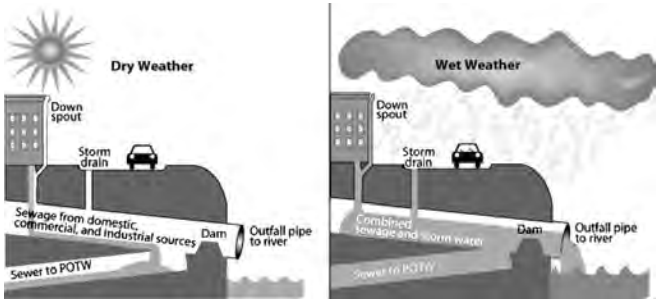


WHAT ARE CSOs?

"CSO" stands for Combined Sewer Overflow. But what does that mean? Let's take the first two words: Combined Sewer. In a CSO system, sanitary sewers, which convey household and commercial wastewater to treatment plants to be sanitized, and storm sewers, which transport rainwater and melted snow to a waterway, are combined into one, single sewer. That's where the "C" and the "S" come in.

Not all systems combine sanitary flow and stormwater in the same sewer pipe. A CSO system is normal in older urban areas, like Hudson County, where sewer infrastructure can date from the Civil War. In newer communities, there are separate sewer pipes for sanitary and storm flow.

During dry weather, CSO systems work just fine. The problem is when it rains. In wet weather, with the rain water and sanitary flow forced into a single sewer line, the combined flow can become too much to transport and treat at the wastewater plants. Consequently, the combined wastewater and stormwater is diverted from the plants into the Hudson River, a sort of "overflow" of the system. That's where the "O" in CSO comes from. So, now you have it: CSO = Combined Sewer Overflow.



WHY REDUCE CSOs?

Do you care enough about the environment to want a cleaner and safer Hudson River? If so, then we have to reduce significantly the number of CSO discharges to the river.

In rain events, a combined system diverts flow from the treatment plants to the river. The flow is not treated at the plant. Although there is some basic treatment at the end of the overflow pipes, this just removes solid waste, like bottles and garbage. The minimally treated effluent that goes into the Hudson often has high levels of pollutants, like fecal matter and bacteria.

The Federal goal, embodied in the 1972 Clean Water Act, to make US rivers and waterbodies swimmable and fishable, depends on reducing CSO discharges. CSO communities, like Hoboken, Union City, Weehawken and West New York, are expected to reduce minimally treated CSO flows into waterways. In 2015, the NJDEP issued requirements that all CSO dischargers in New Jersey develop Long-Term CSO Control Plans (LTCP) by June 2020. For North Hudson, these plans will be the blueprint for what needs to be done in subsequent years to reduce dramatically CSO discharges into the Hudson River.

So, why reduce CSO discharges? To continue the rehabilitation of the Hudson River until it is virtually swimmable again!

WHAT'S IT GOING TO TAKE?

That's the question that North Hudson is looking at right now. Engineering studies are underway to determine by 2020 what strategies and initiatives North Hudson will implement, with NJDEP approval, to reach its stated goal.

Controlling CSOs requires significant investment in infrastructure, some of which is over 100 years old. North Hudson has stayed ahead of the curve by making substantial capital investments in infrastructure and maintenance for the last 25 years. Thus, relative to other sewer systems around the State, North Hudson is in a strong position to successfully develop and implement its LTCP. To do so takes not only engineering expertise, but also considerable capital.

So far, the State provides low interest loans to support sewer infrastructure, but no outright grants. North Hudson has taken advantage of the low interest loans and has prudently managed its finances so that it is in the best possible position to implement its mandated LTCP after 2020. The infrastructure costs will be spread over decades which will minimize the impact on current customers. Meeting these environmental goals will be made even more difficult if the pending 2% cap on annual rate increases is ultimately found to be constitutional by the New Jersey courts.

WHAT HAVE WE DONE SO FAR?

- The work to reduce CSOs goes back many years, before the current 2015 Federal and State mandate.
- Over the last 20 years, North Hudson has eliminated three CSOs that discharge into the Hudson River. Today, it has nine.
- Over 5.5 miles of sewers have been relined, replaced and rehabilitated to increase capacity and flow to the treatment plants during rain events.
- Treatment systems have been upgraded.
- End-of-pipe controls have been put into place to provide basic treatment at the outfalls.
- Green infrastructure projects have been undertaken throughout the entire service area.
- Detention tanks have been built under public parks.
- Wet weather pump stations have been constructed.

All these initiatives – a $65 million investment – have already made a difference in reducing the volume of CSO discharges during rain events.

WHAT CAN WE EXPECT?

In the next edition of this newsletter, we will focus on explaining in detail some of the LTCSO projects that are both underway and envisioned going forward. We are anxious that the public understand the goals, strategies and expected outcomes of North Hudson's LTCP. Please check our website, www.nhudsonsa.com and the schedule of public meetings.

Join NHSA to discuss the LTCP and its progress on the following dates in 2019: February 25th, May 20th, August 19th and November 18th. The February meeting is at NHSA offices, 1600 Adams Street, Hoboken. Other locations, TBD.

NHSA CSO LTCP Newsletter Volume 2

August 2019

This series of newsletters is designed to familiarize customers and residents with North Hudson's long-term plans to reduce CSOs. Our first newsletter, available upon request, gave a general explanation of the North Hudson system and the challenges involved in reducing CSOs. This second volume explains "system characterization."

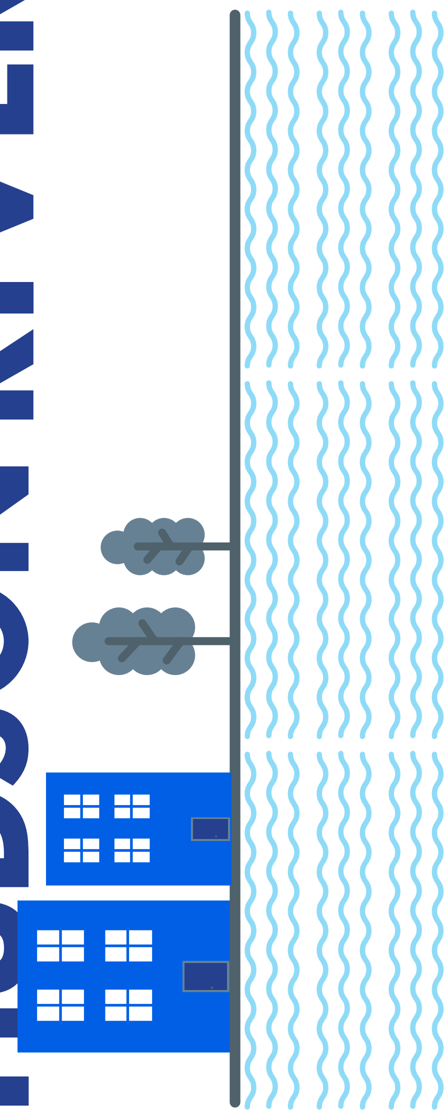
Visit us at www.nhudsonsa.com and follow us on Twitter at @northhudsonsaLTCP for ongoing information and updates.

Join North Hudson to discuss the development of the LTCP and its progress at upcoming public meetings this year on August 19th and November 18th. The meetings are held at North Hudson's office at 1600 Adams Street, Hoboken.

Dr. Richard J. Wolff
Executive Director, NHSA

A Newsletter of the North Hudson Sewerage Authority

THRIVE, HUDSON RIVER



VOL 2

STEWARDS OF THE HUDSON RIVER

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Getting to this point has not be easy, especially because North Hudson has a combined sewer system. Most of our system is a single pipe system, combining, when it rains, stormwater with wastewater.

In dry weather, the wastewater passes easily through the treatment plants, and the cleaned flow is discharged harmlessly into the Hudson River. But when it rains, the combined flows can become too much for the wastewater plants to handle. The plants are by-passed, and some of the combined wastewater and stormwater (CSO) is discharged into the Hudson River.

A LONG-TERM PLAN TO REDUCE CSOs

These partially treated overflows do not help to make the River cleaner. That's why in 2015 the Federal and State governments required all NJ water body dischargers with CSOs to develop plans to reduce the number of combined overflows. Since then, North Hudson has been working on a Long-Term CSO Control Plan (LTCP) which is due in June 2020.

The LCTP has several stages: system characterization, development of alternatives, selection of approach, and implementation – all spread over the next 20 to 30 years.

WHAT DO WE KNOW ABOUT OUR CSOs?

For years, North Hudson has been regularly updating its information database. So, we already know a lot about our CSOs. This gives us a head-start in our long-term planning.

Our Geographic Information Systems (GIS) have the locations, age, materials, and other data on our assets. Our maintenance programs keep track of our sewer cleanings, inspections and repairs. We have state-of-the-art monitoring systems to operate our facilities and collect data that we use to improve our operations.

We participate in a Hudson River water quality monitoring program with other wastewater authorities. We also provide the public with a real-time alert system of when CSOs occur, which can be viewed online at www.nhudsonsa.com. This is particularly helpful to those recreational users of the Hudson.

But to develop our LTCPs, we needed more detailed investigations to understand our systems. That's where "system characterization" comes in.

STEP 1: SYSTEM CHARACTERIZATION

System characterization is just a fancy phrase for knowing the ins-and-outs of our operations and assets. What do we have? How is it working? What kind of shape is it in?

The primary objective is to develop a detailed understanding of our combined sewer system and its impact on the Hudson River. This assessment establishes the existing baseline conditions. From there, we can figure out what we need to do to improve Hudson River water quality. In short, the characterization work helps to identify and prioritize specific CSO controls that will be in our LTCP.

PROGRESS TO DATE

We started our system characterization program in 2015. Here's what we've done so far.

- We compiled the latest information on land uses and planned developments that will affect sanitary and drainage flows.
- Street by street, we deployed crews with GPS systems to confirm the locations of all our catch basins, pipes, manholes and other assets to update our GIS databases.
- We used cameras to get a better handle on the condition of our pipes and to quantify the amount of water that is infiltrating our sewers from groundwater and drinking water pipe leaks.
- We collected water samples from our sewers when it was raining to test for bacteria concentrations.

- We deployed sensors in our sewers to measure flows during dry and wet weather for six months.
- Using the sensor data, we compiled computer models of our sewers.
- We used our models to calculate the dry and wet weather flows to monitor performance.
- We participated in a new, year-long monitoring program of the Hudson River to test for bacteria and identify sensitive areas for recreation uses and fish and wildlife habitat.

HOW ARE WE USING THIS INFORMATION?

Our engineers have been using the data collected from all these programs to draw a picture of the condition and performance of our systems. In the next edition of this newsletter, we will share our findings.

NHSA CSO LTCP Newsletter Volume 3

November 2019

CSO LONG-TERM CONTROL PLAN (LTCP)

This is the 3rd volume of North Hudson Sewerage Authority (NHSA)'s newsletter series explaining our NJDEP-mandated CSO LTCP.

Volume 1 discussed CSOs and why limiting the number of over flows means a cleaner Hudson River.

Volume 2 reviewed the first step in the Plan: system characterization or, put simply, the development of a detailed understanding of our combined sewer system and its environmental impact on the Hudson River.

In this Volume, we discuss the second step: the development of several general, workable options to reduce the CSO overflows into the Hudson River.

It is our intention that this series of newsletters, along with other public outreach efforts, will encourage you to get involved in our environmental mission. Understanding how the combined sewer system works and why it is important to reduce CSO discharges into our waterways is important for anyone who cares about our environment.

We hope our efforts at public education will result in greater public participation in our long-term CSO planning.

A Newsletter of the North Hudson Sewerage Authority

THRIVE, HUDSON RIVER

VOL 3

WHAT ARE THE POTENTIAL OPTIONS?

We started by analyzing more than 50 engineering alternatives that might reduce CSOs. As a first step, we wanted to identify various options that would work in our system. Subsequently, we will select from this list of options to create combinations that can effectively reduce our CSO discharges.

Here are the types of approaches that, in different combinations, would work:

1. Install Underground Storage Tanks - Detain combined flow and slowly release for treatment

2. Perform End-Of-Pipe/ Contact Basin treatment - Treat combined flow right before it has been discharged into the water way

3. Wastewater Treatment System Upgrade - Increase system capacity and optimize treatment process

4. Pump Stations - Convey flow to the optimal location to treat

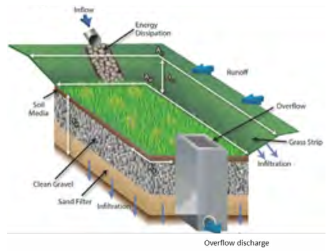
5. Separate the combined sewer system -Separate storm water from the combined sewer system to increase out sewer system capacity during wet weather events

6. Green Infrastructure - Reduce storm water infiltration into the sewer system

HOW WOULD IT WORK?

The goal of the LTCP is to reduce and treat the combined overflow. Here are some examples of how it might work to achieve that objective:

● Collecting Excess Flow Using Storage Tanks and Green Infrastructure.



Both storage tanks and green infrastructure prevent excess flows from entering the sewer system during rainstorms, combining with regular sewer flow, by-passing (because of the high volume) the treatment plants and discharging into the river. Underground storage tanks have already been installed under parks in Hoboken, and others are in the works. The tanks store the rainwater and then later release it for treatment. Also, a variety of green infrastructure projects have been completed throughout our service area: rain gardens, detention basins, permeable pavement, and green roofs -- all of which effectively absorb rainwater.

● End-Of-Pipe and Contact Basin Treatment

Before the CSO enters a water body, the flow would be chemically treated to effectively reduce bacteria and any harmful contaminants. This would involve the construction of treatment facilities at the outfall along the Hudson River shoreline or in the water itself. Some of these treatment facilities might be large and considered undesirable along the Hoboken, Weehawken and West New York riverfronts. However, end-of-pipe treatment is an effective approach from the point of view of doing the job of cleaning the CSOs before discharging into the River.

● Wastewater Treatment Plant Upgrade

This category includes several different ways to reduce CSOs. One of the system upgrades is to increase the capacity of the wastewater treatment plants by adding storage tanks at the treatment plants that will effectively decrease the stress of overflow during wet weather events. This solution requires space on our plant sites in Hoboken and West New York which needs further examination.

● Building Storm Sewers

This option is limited to the few remaining undeveloped sections of our service area, particularly northwest Hoboken. With the inclusion of a 1 million gallon storage tank under the new City-owned Northwest Resiliency Park, there is an opportunity to build a storm sewer system which will separate rain water from normal sewage flow and provide more capacity, thus reducing CSO events.

NEXT STEP: SELECTION OF ALTERNATIVES

In order to achieve the goal of CSO capture, NHSA will have to choose among these multiple groups of alternatives to form a program. That's the next step, and our next newsletter will outline the preferred approach. The selection will be informed by public feedback, engineering issues, and cost.

Join North Hudson to discuss the development of the LTCP and its progress at our next public meeting on November 18th. The meetings are held at North Hudson's office at 1600 Adams Street, Hoboken.

Twitter @northhudsonsaLTCP

www.nhudsonsa.com/thrive/cso.html

NHSA CSO LTCP Newsletter Volume 4

March 2020

Progress to Date

This is the 4th Volume of the North Hudson Sewerage Authority (NHSA) newsletter series explaining our NJDEP-mandated CSO Long Term Control Plan planning process to reduce CSO discharges into the Hudson River.

While no decisions have yet been made concerning the go-forward blue print for CSO reduction, we have made significant progress in our planning over the last two years. Following the directives of the NJDEP, we first "characterized" our collection system in our service area. This gave us the research and data about the combined sewers necessary to consider viable engineering approaches. Then, in accordance with the NJDEP schedule, we developed general approaches that are workable from an engineering point of view.

Now, we are at the stage of combining these alternative approaches to determine how they might work within the system to reach permit compliance. **Before any final conclusions are drawn, we will discuss our findings with government officials in our service area, as well as with our customers in several future public meetings.**

Over the next few months, NHSA will work closely with elected representatives and the community to ensure that the recommendations to the NJDEP not only meet our permit requirements, but also satisfy the concerns of the residents of our service area.

A Newsletter of the North Hudson Sewerage Authority

THRIVE, HUDSON RIVER

VOL 4

Working with Customers, Residents and Government Officials

In order to achieve the goals of the CSO LTCP and satisfy the NJDEP permit, we must demonstrate that our proposed approach satisfies one of the following criteria:

- The sewer system cannot have more than a total of 4 overflows per year at all outfalls;

OR

- The sewer system must capture and treat 85% of the combined sewer volume per year.

So far, we have been looking at how to meet either the 4 overflows goal or the 85% capture goal. At this stage, we have looked at solutions that are technically feasible. This means solutions that would, strictly from an engineering point of view, meet one or the other criteria.

Some technical alternatives are more practical and feasible than others -- when accounting for available land, future development, impact on quality of life, and cost. We are striving to select a program that will not only meet the requirements of our NJDEP permit, but also causes the least disruption possible to our communities. That's why we will start the new year of 2020 by sharing our latest thinking with our elected officials and our service area residents.

Possible Approaches

The following tables show the structures/improvements that, when certain ones are implemented together in a comprehensive program, could achieve each of the two goals presented. But keep in mind this chart does not answer the question: "At what price?" We are compelled by the NJDEP to review thoroughly and share with the public ALL technically feasible approaches. However, this does not mean that these approaches will, in the end, be selected. We must factor in the input of the government officials and the community, as well as consider cost and disruptions, before submitting our plan to NJDEP.

Here are technically valid approaches. Again, these are not chosen or preferred approaches. In fact, some of them would be quite disruptive and, on that basis alone, would be disqualified. But on the direction of the NJDEP and to further transparency, we are obligated to show all technically feasible preliminary approaches before selecting the final elements of the CSO Long-Term Control Plan.

Adams Street Wastewater Treatment Plant Service Area

Drainage Basin/Outfall	Structures/Improvements for 4 Overflows per year at all Outfalls	Structures/Improvements for Capture and Treatment of 85% of the Combined Sewer Volume Per Year
H1/002A	3.65 MG Underground Storage Tank at Observer Highway and Hudson Street*	Divert partial volume from H1 with construction at 5th Street Pump Station
H3/H4/HSI/005A	4.67 MG In-Water Tank either in water at 5th Street*	Divert all volume from H3/H4/HSI with Additional Siphon after 11th Street Pump Station and upgrade 5th Street Pump Station to 47 mgd*
H5/006A	2.35 MG In-Water Tank at Maxwell Place*	Increase Capacity of 11th Street Pump Station to 20 mgd
18PS/012A	Increase Capacity of Pump Station at 18th Street*	-
W1234/013A	2 MG In-Water Storage Tank at W1234 Outfall* Construct 72" Parallel Siphon Along Park Avenue back to Adams Street WWTP	Construct Parallel 48" Park Ave Siphon back to Adams Street WWTP
W5/015A	Construct High Level Storm Sewer along Boulevard East	Construct High Level Storm Sewer along Boulevard East
Adams Street WWTP/001A	Construct Larger Outfall Increase capacity by 20 MGD with blending Replace trickling filter with 20 MG storage tank	Construct Larger Outfall Increase capacity by 20 MGD with side stream treatment Replace trickling filter with 8 MG storage tank and construct 2 MG storage tank near front of WWTP

* Alternative would require construction on public property not within the roadway

River Road Wastewater Treatmement Plant Service Area

Drainage Basin/Outfall	Structures/Improvements for 4 Overflows per year at all Outfalls	Structures/Improvements for Capture and Treatment of 85% of the Combined Sewer Volume Per Year
JOSO/001A	Construct 4.57 MG In-Water CSO Storage Tank at outfall*	Raise weirs on JOSO interceptor
WNY1/002A	Construct 8.3 MG Tunnel and Treatment on Anthony M. Defino Way* Construct Parallel Outfall*	Construct 8 MG storage tank north of treatment plant*
River Road WWTP/001A	-	Increase treatment capacity from 8 MGD to 35 MGD with new treatment processes

* Alternative would require construction on public property not within the roadway

NEXT STEPS

- Undertake a cost analysis of various technical alternatives
- Meet with government officials to solicit input as we move to refine the plan
- Solicit input from the public in our fifth community meeting
- Refine the alternatives based on the above
- Prepare submission to the NJDEP, due June 2020

Finally, don't forget that this program is likely to be implemented over a 35 to 40 year timeframe.

Join North Hudson to discuss the development of the LTCP and its progress at upcoming public meetings in 2020. The meetings are held at North Hudson's office at 1600 Adams Street, Hoboken.

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NHSA CSO LTCP Newsletter Volume 5

May 2020

This is the 5th volume of the North Hudson Sewerage Authority (NHSA) newsletter series explaining our NJDEP-mandated CSO LTCP.

PREVIOUSLY IN VOL.4

NHSA has been developing a Long Term Control Plan (LTCP) strategy for reducing Combined Sewer Overflow (CSO) for a cleaner Hudson River. The LTCP is a state and federal requirement for the protection of public health and the environment outlined in the Clean Water Act (CWA) for communities impacted by CSOs. NHSA has made significant progress in our planning over the last two and a half years. Following the directives of the NJDEP, we first did a thorough review of the combined sewer systems in the NHSA service area. After this, the team developed several general, workable alternatives within the sewer system to reduce CSOs. NHSA could meet the state requirements through one of two approaches: 1) Either capturing 85% of wet weather flows annually, or 2) Reducing annual overflows (CSOs in the system) from an approximate high of 113 to 4 per year systemwide. Now, after a cost evaluation for the alternatives presented in Volume 4, we are at the stage of selecting one of these two approaches.

A Newsletter of the North Hudson Sewerage Authority

THRIVE' HUDSON RIVER

VOL 5

CSO Reduction Strategy:

Based on the cost evaluation of all the CSO reduction alternatives, NHSA has selected the following strategy for CSO reduction under the CWA:

- 85% capture of wet weather flows annually
- Scenario 1: Adams Street WWTP
- Scenario 1: River Road WWTP

This strategy for CSO reduction was selected based on the following criteria: least disruptive to the service area communities, comparative technical feasibility, and relative cost effectiveness. A summary of the strategy is outlined below in Table 1

85% capture makes the most sense for NHSA.

Table 1: Selected Alternatives for CSO Reduction

Collection System and WWTP Controls	Construction Cost	Year
Integration of 1 MG, Resiliency Park storage tank into NHSA conveyance system-Phase 1, Pump Station Construction-	$17,300,000	2020
Land Purchase for WNY1	$4,000,000 (Estimated)	2021
Integration of 1 MG Resiliency Park storage tank into NHSA conveyance system-Phase 2, Electrical and Mechanical Work on Pump Station	$4,000,000 (Grant)	2024
Increase Capacity at River Road WWTP to 35 MGD with High Level Treatment	$13,000,000	2025
Integration of 1 MG Resiliency Park storage tank into NHSA conveyance system -Phase 3, Installation of High Level Storm Sewer System	$16,000,000	2026
Construct New Adams Street WWTP Outfall	$5,000,000	2027
Raise JOSO Weirs by 1 foot	$2,000,000	2029
Increase Capacity at Adams Street WWTP by 20 MGD through Side Stream Treatment	$13,000,000	2030
Parallel 48" Park Ave Siphon	$28,000,000	2033
Increase Capacity of 5th Street Pump Station from 15 mgd to 47 mgd AND Construct Parallel 11th Street Siphon to divert partial volume from H1 and all volume from H3/H4/HSI	$30,000,000	2036
Increase Capacity 11th Street Pump Station from 11.6 mgd to 25 mgd	$13,000,000	2039
Adams Street WWTP 2 MG Storage Tank	$17,000,000	2042
River Road WWTP 8 MG Storage Tank	$77,000,000	2045
Adams Street WWTP 8 MG Storage Tank	$68,000,000	2048
TOTAL	$307,300,000	

Financing

The cost of all the selected CSO reduction alternatives is approximately $307,300,000. However, it is important to keep in mind that the entire program to construct these alternatives and bring NHSA in compliance with its permit will be implemented over a 25 to 30 year timeframe.

It is the goal of NHSA to work together with NJDEP over this timeframe to implement a limited number of LTCP projects at any one time such that the Authority can maintain a cap at 2% per year net increase in revenue from sewer usage based consumption charge.

NEXT STEPS: Cost Analysis and Refining Alternatives

- Develop a LTCP Report that outlines the methodology, selected alternatives, and overall strategy adopted by NHSA to reduce CSOs and comply with federal and state regulations under the CWA.
- Solicit input from the public in our sixth community meeting.
- Prepare for submission of the finalized LTCP to the NJDEP in June 2020.

Join North Hudson to discuss the development of the LTCP and its progress at the last public meeting to be held virtually at 7pm on Monday, May 11, 2020. To join the meeting please look for the link to the meeting at

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Twitter @northhudsonsaLTCP

THRIVE, HUDSON RIVER

For several years, NHSA has been developing a Long Term Control Plan (LTCP) strategy for reducing Combined Sewer Overflow (CSO) for a cleaner Hudson River. The LTCP is a state and federal requirement for the protection of public health and the environment outlined in the Clean Water Act (CWA) for communities impacted by CSOs.

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TOTAL	$307,300,000	

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Appendix D
Financial Capability Assessment Details

Table D-1. Cost per Household

Line #	Cost Item	
	Current Water and Wastewater Costs	
100	**Annual O&M Expenses (Excluding Depreciation)**	
	Administration	$3,323,000
	Cost of Providing Services	$19,237,000
	Subtotal Annual O&M (Line 100)	**$22,560,000**
101	**Annual Debt Service (Principal and Interest)**	
	Principal	$12,187,000
	Interest	$15,951,000
	Rate Stabilization/Defeasance Program	$2,457,000
	Surplus to Fund Capital Projects	$4,000,000
	Subtotal Annual Debt Service (Line 100)	**$34,595,000**
	Renewal & Replacement Reserve	
	Current	
	Future to maintain Reserve per Bond Covenants	
	Subtotal R&R Reserve	**$0**
102	**Subtotal Current Water and Wastewater Costs**	**$57,155,000**
	Projected Wastewater, CSO, and LTCP Capital Costs	
	NHSA CIP:	
	Adams St. PURAC	$8,733,500
	WWTP Improvements	$17,250,000
	CSO LTCP Design	$3,000,000
	Sewer cleaning, lining & rehab.	$12,800,000
	Long Term State of Good Repair	$156,000,000
	Estimated Cost of LTCP Program	$307,300,000
	Subtotal NHSA CIP	**$505,083,500**
103	Additional Annual O&M Expenses due to CIP	$5,051,000
104	Annual Debt Service (Principal and Interest)	$40,530,000
105	**Subtotal Projected Wastewater**	**$45,581,000**
106	**Total Current and Projected WWT and CSO Costs**	**$102,736,000**
	Revenues (FY 2020 (ending January 31) Budget	
	Residential	$43,372,980
	Non-Residential	$6,481,020
	Total Units	**$49,854,000**
	Residential Percentage	87.00%
107	**Residential Share Total WWT and CSO Costs**	**$89,381,000**
108	**Total Number of Households in Service Area**	**75,386**
109	**Cost Per Household (annual)**	**$1,200**

CSO = combined sewer overflow
LTCP = Long Term Control Plan
O&M = operations and maintenance
NHSA = North Hudson Sewerage Authority
WWT = wastewater treatment
WWTP = wastewater treatment plant

Table D-2. Residential Indicator

Line Number	Item	Result	Comment
	Median Household Income (MHI)		
201	MHI for NHSA Service Area (2018)	$82,400	US Census. American Community Survey. S1903-Median Income In The Past 12 Months.
202	MHI Adjustment Factor	1.016	(1 + CAGR for CPI 2018 to 2019)
203	Adjusted MHI (2019 Dollars)	$83,758	Line 201 x Line 202
		$1,200	
204	Annual Sewer CPH		
	20-year planning period	**1.43**	from Table D-1 -- CPH
		$755	
205	**Residential Indicator (Percent of MHI)**	0.90	
	Annual Typical Residential Bill	$82,400	
	Typical Residential Bill as % MHI	1.016	

CPH = cost per household

Table D-3. Bond Rating

Line Number	Item	2020 Permit Report	Note:
	Most recent General obligation		
	Date		
	Rating agency (Moody's or S&P)		
301	Rating		n/a
	Most recent Revenue (water/sewer) bond		
	Date:	11/19/2019	
	Rating agency:	Fitch, S&P	
	Bond insurance:	Unenhanced	
302	Rating:	A, A+	NHSA
303	Summary bond rating	A, A+	NHSA
EPA Score/Rating		**3**	

U.S. Environmental Protection Agency (EPA) Scoring Criteria

EPA Rating (Score)	Bond ratings (S&P)	Bond ratings (Moody's)
Weak (1)	BB–D	Ba–C
Mid-range (2)	BBB	Baa
Strong (3)	AAA–A	Aaa–A

Table D-4. Overall Net Debt as a Percentage of Fair Market Property Value

Line Number	Item	Amount	Notes
401	Direct Net Debt	$78,499,576	Weighted Average based on Households
402	Debt of Overlapping Entities (Proportionate Share of Multijurisdictional Debt)	$53,098,869	Weighted Average Based on Households.
403	Overall Net Debt	**$131,598,444**	Lines 401 + 402
404	Market Value of Property	$4,979,254,380	Weighted Average based on Households
405	**Overall Net Debt as a Percentage of Full Market Property Value**	**2.64**	**(Line 403/Line 404*100)**

A. Overlapping entities	B. Outstanding debt (less sinking fund)	C. Percent chargeable to your service area	D. Outstanding debt attributable to permitee's service area
County	$162,035,446[1]	100%	$162,035,446
School District	$36,127,514	100%	$36,127,514
Total overlapping debt			$198,162,960

[1]This is the amount allocated to all four cities

EPA Scoring Criteria

EPA Rating (Score)	Net debt as a % of FMPV
Weak (1)	Above 5%
Mid-range (2)	2–5%
Strong (3)	Below 2%

Table D-5. Unemployment

Line Number	Item	Value
501	Annual average unemployment rate (service area/community)	4.9%
502	Unemployment Rate - County	
503	Annual average national unemployment rate	5.9%
	Difference (Line 501 - Line 503)	**-1.0%**

EPA Rating (Score)	Unemployment
Weak (1)	More than 1% above the national average
Mid-range (2)	+/- 1% of the national average
Strong (3)	More than 1% below the national average

Table D-6. Median Household Income

Line Number	Item	Value
601	MEDIAN HOUSEHOLD INCOME IN THE PAST 12 MONTHS (IN 2018 INFLATION-ADJUSTED DOLLARS)	$82,400
	National MHI	
602	MEDIAN HOUSEHOLD INCOME IN THE PAST 12 MONTHS (IN 2018 INFLATION-ADJUSTED DOLLARS)	$60,293
603	MHI Adjustment Factor	1.000
604	Adjusted MHI	$60,293
	Percent difference in MHI for U.S. and your community	**36.67%**

Source: data.census.gov/cedsci. Survey/Program=American Community Survey. Table ID = B19013. Product: 2018: ACS 5-year Estimates Detailed Tables.

EPA Rating (Score)	MHI
Weak (1)	More than 25% below national MHI
Mid-range (2)	+/- 25% of national MHI
Strong (3)	More than 25% above national MHI

Table D-7. Property Tax Revenues as a Percentage of Fair Market Property Value

Line Number	Item	Value	Notes:
701	Full Market Property Value (FMPV)	$4,979,254,380	**from Table D-4 Line 404**
702	Property tax revenue	$118,977,807	**from Table D-8 Line 801**
703	**Property tax revenue as a percent of FMPV**	**2.4**	**Line 702 / Line 701 * 100**

EPA Scoring Criteria

EPA Rating (Score)	Property tax revenue as a % of FMPV
Weak (1)	Above 4%
Mid-range (2)	2–4%
Strong (3)	Below 2%

Table D-8. Property Tax Revenue Collection Rate

Line Number	Item	Value	Notes:
801	Property tax revenue collected	$118,977,807	for localities within NHSA service area.
802	Property taxes levied	$120,091,134	for localities within NHSA service area.
803	Property tax revenue collection rate	**99.07**	Line 801 / Line 802 * 100

EPA Scoring Criteria

EPA Rating (Score)	Property tax revenue collection rate
Weak (1)	Below 94%
Mid-range (2)	94–98%
Strong (3)	Above 98%