CITY OF BATH, MAINE

JULY 2022

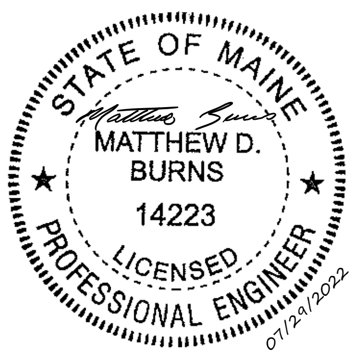
CSO Master Plan Update

WRIGHT-PIERCE
Engineering a Better Environment

CSO Master Plan Update

City of Bath, Maine

July 2022



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Section 1 Summary, Conclusions and Recommendations

1.1 Summary

The City of Bath, Maine is located along the Kennebec River in Sagadahoc County and has a year-round population of approximately 8,338 according to 2019 census data. The City of Bath (City) has provided wastewater collection services to its residents and businesses for over 50 years; the sewer collection system currently serves approximately 2,900 residences, 240 commercial properties, and 50 governmental properties in the City, as well as Bath Iron Works, a major industrial user. The City owns and operates the wastewater collection and treatment system with approximately 39 miles of collection sewers and interceptors, 5 miles of sewer force main, and 13 pump stations. The City's 13 pump stations, which vary in size and capacity, serve to pump raw wastewater from the City's collection system to the WPCF for treatment. The WPCF was originally constructed in 1971 and updated and expanded in 1993, 1996 and 2016. The WPCF was designed to provide secondary treatment for average daily flows of 3.5 MGD and maximum day flow of 7.0 MGD. Flows in excess of 7.0 MGD receive primary treatment and disinfection and are discharged through the CSO Disinfection tank.

Like many communities throughout Maine and the nation prior to the Clean Water Act, sanitary wastewater and stormwater were conveyed within the same collection system and discharged untreated into the nearest water body. In the early 1970s, the City constructed a number of pump stations throughout the City and a central water pollution control facility (WPCF). However, due to the nature of the original collection system, many Combined Sewer Overflow (CSO) discharge points remained in place to allow relief points within the system when flows in excess of system capacity occurred.

Beginning in the 1970s, the City began to separate portions of the collection system into separate sanitary and stormwater systems in order to improve water quality and minimize human health issues through the reduction in the number of CSO locations and events. In the early 1990s, the City initiated planning for major upgrades to its sanitary sewer system and WPCF. This planning covered an upgrade and expansion of the WPCF to meet enhanced water quality standards and flows, and the evaluation of the sanitary sewer system especially directed at mitigation of direct discharges of combined sanitary and storm water flow through CSOs. Recommendations included a major upgrade and expansion of the WPCF, in addition to sewer system improvements and separations to provide substantial reductions in the frequency and volume of CSOs. The City has made significant strides in reducing the overall pollution load discharged to the Kennebec River as a result of CSO reduction. The City has reduced the number of active CSOs from seven in 1971 to four in 2020. The four active CSOs in the sanitary sewer system are:

- CSO #003 – Rose Street Pump Station
- CSO #004 – Pleasant Street Pump Station
- CSO #005 – Commercial Street Pump Station
- CSO #008 – Harward Street Pump Station

Both prior to and since the last major CSO Master Plan Update in July 2007, the City has implemented numerous projects and procedures designed to reduce the number, frequency, and duration of CSOs from licensed discharge points. The City's Public Works Department has been proactive in its efforts to protect the State of Maine's natural resources and has worked extensively with state and federal agencies, as well as the public, toward that mutual goal. The City has reduced its annual volume of CSOs from greater than 36 million gallons in 2006 to approximately

12 million gallons in 2012 to approximately 2.9 million gallons in 2020. This tremendous achievement speaks highly of the City of Bath's dedicated staff and elected officials and their commitment to protecting the environment. It should also encourage those responsible to continue those efforts amongst the challenges of aging infrastructure and stricter regulations.

This Combined Sewer Overflow Facilities Plan Update (Plan) was prepared to meet the conditions set forth in Special Condition K (4) of the City of Bath's December 10, 2020 Maine Pollutant Discharge Elimination System (MEPDES) permit and Waste Discharge License. By December 31, 2021, the City is required to submit a draft update of their *City of Bath – 2006 Combined Sewer Overflow Master Plan Update*, dated July 2007. In addition, there have been three revision letters (2008, 2011, and 2015) submitted to DEP updating the scope of work and schedule for selected projects.

A map of the current collection system and location of each CSO has been included in Section 2.2.3 of this CSO Master Plan. City staff have been monitoring activity at each CSO location since 1992. This Plan focuses on data collection between 2014 (date of last Plan update) and 2020 to identify current conditions.

1.2 Conclusions

The following is a summary of the key conclusions made as a result of this Plan.

1.2.1 Bath Water Pollution Control Facility

The WPCF was originally constructed in 1971 and was upgraded and expanded over the course of two upgrades in 1993 and 1997. The WPCF is an activated sludge plant with mechanical screening, vortex grit removal, primary clarification, activated sludge treatment, secondary clarification, and effluent disinfection and dechlorination. Secondary solids are settled in primary and secondary sludge tanks and dewatered using rotary screw presses. Dewatered sludge is trucked to the City's landfill on Detritus Drive for disposal. The WPCF was designed to provide secondary treatment for an average daily flow of 3.5 MGD and a maximum daily flow of 7.0 MGD. The current average daily flow is approximately 1.90 MGD, and the facility receives peak hour flows of 18.85 MGD.

A CSO related bypass of secondary treatment exists at the WPCF (Outfall #002A). To minimize the volume and frequency of CSO related bypass of secondary treatment occurrences at the WPCF, existing excess tankage at the WPCF is used for wet weather storage. During 8-9 of the warmer months, the WPCF operates with one of the two primary clarifiers offline and one side of the aeration basin offline. These tanks provide a combined total of approximately 600,000 gallons of stormwater storage. During the 3-4 colder months when both primary clarifiers are online, one aeration basin remains offline and is available for storage of approximately 400,000 gallons. When flows entering the WPCF exceed 7.0 MGD and the offline tanks have reached capacity, a motorized gate in Flow Distribution Structure No. 2 (downstream of the primary clarifiers) is raised, allowing wastewater to bypass the aeration basins and flow to the CSO Disinfection and Dechlorination Tank. Therefore, flows exceeding 7.0 MGD receive primary treatment, disinfection, and dechlorination, after which they are discharged to the Kennebec River through the outfall pipe. After the storm event has stopped, the wastewater is pumped from the offline aeration tanks back to the head of the WPCF for treatment.

Analysis of historical CSO events in the collection system and at the WPCF indicates that the collection system CSOs only happen after a CSO related bypass of secondary treatment has begun at the WPCF. This shows that the pump stations are maximizing the capacity of the WPCF before CSOs in the collection system occur.

1.2.2 Sewer System Flow Monitoring

Pump station data was used to determine which drainage areas may have I/I that could be contributing to CSOs in the collection system. For those drainage areas showing potential I/I, field investigations were conducted in the City's wastewater collection system to better determine the magnitude and source(s) of I/I using flow metering and smoke testing. The results of the field investigations indicated that the following drainage areas show signs of I/I:

- Pleasant Street
- Commercial street
- Farrin Place
- Harward Street

Select projects to reduce I/I are discussed in Section 8 of the report. It may be more cost-effective to remove high impact I/I sources within the collection system than to initiate a high capital cost CSO capture/abatement project within one or more CSO drainage areas. I/I removal costs may range from $3.00 per gallon removed to as high as $20.00 per gallon removed, depending on the complexity of the work involved in its removal. Additional flow monitoring should be conducted in targeted areas in order to identify sources of I/I that are cost-effective to remove.

Given the high capital cost of CSO capture/abatement alternatives, the City may wish to consider greater enforcement of private I/I removal requirements in order to reduce the scope/magnitude of the future CSO capital improvement projects. Private I/I removal projects are a very effective CSO reduction tool, however they can be quite expensive, time consuming and intrusive to private homes and businesses, so selection of projects for the greatest success is critical.

1.2.3 Design Storm

It is important to identify the design storm event that will be utilized as the basis of evaluation of any CSO elimination of abatement alternatives. The CSO volumes and storm durations were analyzed for each storm event that resulted in a CSO at any of the four licensed CSOs between 2014 to 2020. The goal was to determine the recurrence interval storm event that causes a CSO. Establishing this baseline helps to set the design storm. The data showed that 68% of total CSO flows between 2014 and 2020 occur during storms with a less than 1-year recurrence interval for varying durations.

Reduction in CSO flows by 68% to abate the 1-year storm event is not a feasible goal over the next 5-year permit window. One main focus of the recommended work over the next 5-years is sanitary sewer overflow (SSO) abatement, which is viewed as higher priority than CSO abatement at this time. The projects focusing on solving SSO issues will increase flow within the collection system in some areas and likely result in more CSO volume for large storm events. Thus, for the purposes of this plan, a performance-based CSO abatement strategy is recommended for this 5-year permit window. Targeted performance goals for each CSO are recommended below.

- Rose Street CSO #003 - Target CSO abatement goal of 100% elimination of CSO flows at this location for the 5-year planning window.
- Pleasant Street CSO #004 - No CSO abatement goal is recommended for this CSO for the 5-year planning window since this is the lowest priority CSO, although some work is planned in this drainage area.

- Commercial Street CSO #005 - Reevaluate the CSO abatement goal for this drainage area in a future CSO Master Plan revision. Complete projects in the 5-year window aimed at SSO abatement and determine the impacts on CSO volumes to set the abatement goal.
- Harward Street CSO #008 - Reevaluate the CSO abatement goal for this drainage area in a future CSO Master Plan revision. Complete InfoSWMM modeling and construction projects in the 5-year window aimed at SSO abatement and determine the impacts on CSO volumes to set the abatement goal.

1.2.4 CSO Abatement Prioritization

Based upon the CSO prioritization described in Section 7, the following would be the recommended priority list for elimination or abatement of the four CSOs in the City of Bath.

1. Harward Street CSO #008
2. Rose Street CSO #003
3. Commercial Street CSO #005
4. Pleasant Street CSO #004

The CSOs above have been listed in order of priority (highest at the top), based upon a matrix assessment summarized in Section 7 of this Plan. However, it is important to note that elimination of Rose Street CSO #003 may be more attainable in the short term than the remaining CSOs due to the smaller volumes it discharges. Therefore, the recommended plan summarized in Section 9 focuses efforts in the Rose Street area early in the implementation schedule to potentially eliminate this CSO within the next 5 to 10 years.

1.2.5 CSO Long-Term Control Alternatives

Section 8 outlines the potential long-term CSO abatement alternatives that were evaluated for each licensed CSO. In general, they include the following:

- Inflow/Infiltration Removal
- Collection, Pumping, and Treatment System Capacity Increase
- Reroute Pump Station Force Mains
- In-Line Storage
- Off-Line Storage

The following is a summary of each CSO, and the alternatives evaluated at each location. Refer to Section 8 for detailed descriptions of each alternative.

1.2.5.1 Rose Street CSO #003

The Rose Street CSO #003 serves as a relief point for upstream drainage areas including Bridge, Riverview, and Hunt Street, and for gravity flows from the Rose Street sewer drainage area. As shown in Figure 4-6 in Section 4.2, the annual number of CSO events at Rose Street CSO has ranged from 2 to 9 between 2014 and 2020 with a total of 31 events and a total volume of approximately 3.94 million gallons. The following list is a summary of the alternatives targeted for further evaluation to address CSO events at the Rose Street CSO.

- Alternative 2 - Pump Station Capacity Modifications

- Alternative 3 - Reroute Pump Station Force Main
- Combination Alternative 6 – Hunt Street Pump Station Capacity Modifications and Reroute Hunt Street Pump Station Force Main

1.2.5.2 Pleasant Street CSO #004

The Pleasant Street CSO #004 serves as a relief point for upstream drainage areas including pumped flows from Rose Street Pump Station, and for gravity flows from the Pleasant Street sewer drainage area. As shown in Figure 4-10 in Section 4.3, the annual number of CSO events at the Pleasant Street CSO has ranged from 1 to 5 between 2014 and 2020 with a total of 21 events and a total volume of approximately 3.47 million gallons. The following list is a summary of the alternatives targeted for further evaluation to address CSO events at the Pleasant Street CSO.

- Alternative 1 – I/I Removal
- Alternative 2 – Collection system capacity increases
- Alternative 5 – Off-line storage of CSO Flow

1.2.5.3 Commercial Street CSO #005

The Commercial Street CSO #005 serves as a relief point for upstream drainage areas including pumped flows from Pleasant Street, and for gravity flows from the Commercial Street sewer drainage area. As shown in Figure 4-14 in Section 4.4, the annual number of CSO events at the Commercial Street CSO has ranged from 3 to 11 between 2014 and 2020 with a total of 45 events and a total volume of approximately 4.0 million gallons. The following list is a summary of the alternatives targeted for further evaluation to address CSO events at the Commercial Street CSO.

- Alternative 1 – I/I Removal
- Alternative 2 – Collection System Capacity Increase
- Alternative 3 – Pump Station Capacity Increase
- Alternative 4 – Stormwater Pump Station
- Alternative 5 – In-Line Storage of CSO Flow
- Alternative 7 – Reroute Pump Station Force Main

1.2.5.4 Harward Street CSO #008

The Harward Street CSO #008 serves as a relief point for upstream drainage areas including the Landfill and Aegis Pump Stations, and for gravity flows from the Harward Street sewer drainage area. As shown in Figure 4-18 in Section 4.5, the annual number of CSO events at the Harward Street CSO has ranged from 8 to 18 between 2014 and 2020 with a total of 96 events and a total volume of approximately 8.97 million gallons. The following list is a summary of the alternatives targeted for further evaluation to address CSO events at the Harward Street CSO.

- Alternative 1 – I/I Removal
- Alternative 2 – Collection System Capacity Increase
- Alternative 3 – New Sewer Pump Station
- Alternative 4 – Relocate CSO #008
- Alternative 5 – In-Line Storage of CSO Flow
- Alternative 6 – Off-Line Storage of CSO Flow
- Combination Alternative 7:
    - Alternative 2 – Collection System Capacity Increases – Phase 1 and Phase 2 only

- Combination Alternative 8:
  - Alternative 2 – Collection System Capacity Increases – Phase 1 and 3 only
  - Alternative 3 – New Sewer Pump Station
  - Alternative 4 – Relocate CSO #008

1.2.5.5 Collection System Alternatives Not Associated with Licensed CSOs

There are a number of alternatives that would result in abatement of SSOs and/or CSO volumes throughout the overall collection system but are not directly associated with a licensed CSO. The following alternatives are targeted for further evaluation to address SSO and CSO volumes:

- Alternative 1 – Farrin Place I/I Removal
- Alternative 2 – Farrin Place Pump Station Capacity Increase
- Alternative 6 – Off-Line Storage of CSO Flow
- Alternative 7 – Telemetry Upgrades

1.3 Recommendations

1.3.1 Summary of Recommended CSO Abatement Plan

Table 1-1 below summarizes the recommended, preliminary 5-year CSO abatement plan of the remaining four CSOs in the City of Bath. Implementation of the projects in Table 1-1 target the following goals:

- Elimination of the Rose Street CSO #003
- Abatement of known SSOs in the Rose Street, Commercial Street, Harward Street, and Farrin Place drainage areas
- Pursues the strategy of forcing more SSO flows to licensed CSOs in the Commercial Street and Harward Street drainage areas.

The costs presented in Table 1-1 are estimated capital costs to implement each of the Phases as outlined above. These costs are planning level estimates (suitable for comparison of alternatives only). The costs include a 15% contingency and 20% design and construction phase engineering costs. For planning purposes, the future costs have been estimated depending upon the year at which the project would commence and assuming a 3% annual rate of inflation.

The Target Completion Date is the proposed schedule for implementation of the next 5-year CSO abatement period. The start of the 5-year period would coincide with final approval of the CSO Master Plan from Maine DEP. For planning purposes, we have assumed January 2022 as the start of the 5-year period. Target completion dates will be adjusted if necessary pending Maine DEP's review comments and subsequent time to revise the CSO Master Plan.

The recommended plan in Table 9-1 seeks to balance SSO and CSO abatement with capital costs, and to phase the projects such that the City is spending money in the most cost-effective manner to achieve SSO and CSO abatement. It is important to note that initial phases may reduce or eliminate the need to pursue subsequent phases, and this document should be continuously revisited after completion of each project to determine the ultimate result of projects completed.

Table 1-1 Preliminary 5-Year CSO Abatement Plan

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
Rose Street CSO #003			
CSO Abatement Phase 1 • *Pump Station Capacity Upgrade and Force Main Bypass:* Upgrade Hunt Street Pump Station to 3.5 MGD capacity and install new force main from Hunt Street Pump Station to Corliss Street to bypass Rose Street Pump Station.	$4,100,000	2025	$4,615,000
CSO Abatement Phase 2 • It is expected that Phase 1 will eliminate CSOs at Rose. Monitor CSO flows at Rose Street after completion of Phase 1 for remainder of 5-year CSO Master Plan period.	$0	5 years from completion of Phase 1	$0
Pleasant Street CSO #004			
CSO Abatement Phase 1 • *Investigation of influences on CSO Flows:* Field investigations to determine whether recorded CSO flows at CSO #004 are artificially high due to surcharging of the system.	$25,000	2022	$26,000

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
CSO Abatement Phase 2 • *I/I Removal:* Separation of two catch basins north of the intersection of High Street and South Street, separation of two catch basins on West Street, and separation of five catch basins on Richardson Street.	$900,000	2026* Timing of this project depends on the City's CIP paving schedule	$1,043,000
Commercial Street CSO #005			
CSO Abatement Phase 1 • *I/ Removal:* SSES Investigations between York Street and School Street to identify sources of I/I contributing to SSOs along the railroad tracks	$200,000	2023	$212,000
• *I/I Removal:* Separation of one catch basin on King Street and separation of two catch basins on South Street	$350,000	2022	$361,000
CSO Abatement Phase 2 • *I/I Removal:* Construction project(s) based on findings of SSES investigations. Update InfoSWMM model after completion of separation project	$1,500,000	2026	$1,739,000

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
Harward Street CSO #008			
CSO Abatement Phase 1 • *Collection System Capacity Increase Phase 1:* Develop InfoSWMM model of sewer interceptor from CSO #008 to Harward Street Pump Station	$100,000	2022	$103,000
• *I/I Removal:* Separation of combined catch basins on Green Street (4), Oak Street (2), High Street (4), and Meadow Way (2)	$1,320,000	2022	$1,360,000
CSO Abatement Phase 2 • *Collection System Capacity Increase Phase 2:* Increase sewer interceptor from Denny Road to Washington Street to abate SSOs. Size and extents of upgrade to be confirmed by InfoSWMM model	$2,500,000	1 Year from completion of InfoSWMM model	$2,652,000 (Assume 2023)
• *Collection System Capacity Increase Phase 2:* Replace existing pumps at Harward Street Pump Station with new solids handling pumps, generator, and ancillary equipment	$1,750,000	2023 Concurrent with sewer interceptor increase	$1,857,000 Assume (2023)
CSO Abatement Phase 4 • *Collection System Capacity Increase Phase 4:* Future construction project to further abate CSOs. Type and extents of construction project to be determined after InfoSWMM model and CSO Abatement Phase 2 results	$2,000,000	2025	$2,251,000

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
Collection System Alternatives Not Associated with Licensed CSOs			
CSO Abatement Phase 1 • *Farrin Place Pump Station Capacity Increase*: Install pig launch and clean force main; rebuild existing pumps to increase capacity and abate SSOs upstream of pump station	$195,000	2023	$207,000
• *Collection System Communications Telemetry Upgrade:* Install new telemetry equipment at remote pump stations and flow meters at select stations to digitally record flow data in SCADA	$200,000	2023	$212,000
CSO Abatement Phase 2 • *Farrin Place Pump Station I/I Removal:* Separate up to eight combined catch basins on East Milan Street, Washington Street, and Mechanic Street	$1,000,000	2025	$1,126,000
• *WPCF Bypass Increasing Hydraulic Capacity Analysis:* Engineering analysis to determine what modifications are needed to increase the hydraulic throughput of the WPCF CSO related bypass of secondary treatment	$20,000	2025	$23,000
Total Project Cost for Recommended Projects	**$16,160,000**	-	**$17,787,000**

1.4 Long Term CSO Abatement Strategy

The control alternatives presented above should be implemented in the five year planning window to mitigate SSO and CSO flows. This CSO Master Plan identifies a number of CSO abatement strategies that ultimately are not recommended for implementation now but may be suitable in the future as part of a long term strategy. In general, long term goals that the City should continue to evaluate include transporting and treating flows, offline storage, and continued sewer separation and I/I removal. Each long term strategy has advantages and disadvantages. The City should continue to monitor the success of the recommended projects over the next 5 years and then evaluate and refine its long-term strategies to ultimately eliminate SSOs and CSO discharges.

Section 2 Introduction, Background and Purpose of CSO Master Plan Update

2.1 Introduction

This Combined Sewer Overflow (CSO) Facilities Plan Update (Plan) was prepared to meet the conditions set forth in Special Condition K (4) of the City of Bath's December 10, 2020 Maine Pollutant Discharge Elimination System (MEPDES) permit and Waste Discharge License. By December 31, 2021, the City is required to submit an update of their *City of Bath – 2006 Combined Sewer Overflow Master Plan Update*, dated July 2007. In addition, there have been three revision letters (2008, 2011, and 2015) submitted to DEP updating the scope of work and schedule for selected projects.

Both prior to and since the last major CSO Master Plan Update in July 2007, the City of Bath (City) has implemented numerous projects and procedures designed to reduce the number, frequency, and duration of combined sewer overflows from the City. The City's Public Works Department has been proactive in its efforts to protect the State of Maine's natural resources and has worked extensively with state and federal agencies, as well as the public, toward that mutual goal. According to records collected by the City, the City has reduced its annual volume of CSOs from greater than 36 million gallons per year in 2006 to approximately 12 million gallons in 2012 to approximately 2.9 million gallons in 2020. This tremendous achievement speaks highly of the City of Bath's dedicated staff and elected officials and their commitment to protecting the environment. It should also encourage those responsible to continue those efforts amongst the challenges of an aging infrastructure.

2.2 Background

The City has provided wastewater collection services to its residents and businesses for over 50 years. Like many communities throughout Maine and the nation prior to the Clean Water Act, sanitary wastewater and stormwater were conveyed within the same collection system and discharged untreated into the nearest water body. In the early 1970s, the City constructed a number of pump stations throughout the City and a central water pollution control facility (WPCF). However, due to the nature of the original collection system, many CSO discharge points remained in place to allow relief points within the system when flows in excess of system capacity occurred. The seven original CSOs in the Bath collection system are identified as follows:

- CSO 002 – Hunt Street Pump Station
- CSO 003 – Rose Street Pump Station
- CSO 004 – Pleasant Avenue Pump Station
- CSO 005 – Commercial Street Pump Station
- CSO 006 – Farrin Place Pump Station
- CSO 007 – Hyde Park Pump Station
- CSO 008 – Harward Street Pump Station

Beginning in the 1980s, the City began to separate portions of the collection system into separate sanitary and stormwater systems in order to improve water quality and minimize human health issues through the reduction in the number of CSO locations and events. These separation projects included Valley Road, the western portion of Oliver Street, Middle Street from Center Street to North Street, Marshall Street, Washington Street from the Hunt Street Pump Station to Marshall Street, Getchell Street, and a section of Middle Street near Getchell Street, which resulted in the elimination of the Hunt Street CSO (CSO 002).

In the early 1990’s, the City initiated planning for major upgrades to its sanitary sewer system and WPCF. This planning covered an upgrade and expansion of the WPCF to meet enhanced water quality standards and flows, and the evaluation of the sanitary sewer system especially directed at mitigation of direct discharges of combined sanitary and storm water flow through CSOs. Recommendations included a major upgrade and expansion of the WPCF, in addition to sewer system improvements and separations to provide substantial reductions in the frequency and volume of CSOs. The City has made significant strides in reducing the overall pollution load discharged to the Kennebec River as a result of CSO reduction. Currently, there are only four active CSOs in the sanitary sewer system:

- CSO 003 – Rose Street Pump Station
- CSO 004 – Pleasant Avenue Pump Station
- CSO 005 – Commercial Street Pump Station
- CSO 008 – Harward Street Pump Station

A CSO related bypass of secondary treatment also exists at the WPCF (Outfall #002A). To minimize the volume and frequency of CSO occurrences at the WPCF, existing excess tankage at the WPCF is used for wet weather storage. During 8-9 of the warmer months, the WPCF operates with one of the two primary clarifiers offline and one side of the aeration basin offline. These tanks provide a combined total of approximately 600,000 gallons of stormwater storage. During the 3-4 colder months when both primary clarifiers are online, one aeration basin remains offline and is available for storage of approximately 400,000 gallons. When flows entering the WPCF exceed 7.0 MGD and the offline tanks have reached capacity, a motorized gate in Flow Distribution Structure No. 2 (downstream of the primary clarifiers) is raised, allowing wastewater to bypass the aeration basins and flow to the CSO Disinfection and Dechlorination Tank. Therefore, flows exceeding 7.0 MGD receive primary treatment, disinfection, and dechlorination, after which they are discharged to the Kennebec River through the outfall pipe. After the storm event has stopped, the wastewater is pumped from the offline aeration tanks back to the head of the WPCF for treatment.

Since the 2006 CSO Master Plan, the City has completed numerous collection system CSO abatement projects that have included a range of measures, such as sewer separation, manhole sealing, pipe repair, pipe replacement, and capacity upgrades. These efforts, coupled with numerous pump station and treatment facility capacity upgrades, have allowed the City to reduce the number of active CSOs from 7 to 4 between 1971 and 2020. During this time, the total annual CSO volume has been reduced from 36.1 million gallons in 2006 to 2.87 million gallons in 2020, a 92% reduction.

2.2.1 Summary of Historical I/I Studies and Sewer System Evaluation Surveys

The City has historically undertaken a number of studies that have generated numerous reports, master plans, master plan updates, and collection system-related projects associated with the CSO system. The description of several reports conducted between 1991 and 2020 are included in Appendix A. Table 2-1 summarizes the historic reports and studies related to the CSO system.

Table 2-1 Summary of Historic I/I Studies and Evaluation Surveys

Report Title	Author	Date
Report: Preliminary Planning of Sewage Works Improvements	Fay, Spofford & Thorndike	Jun. 1964
Report: Preliminary Planning of Storm Drain Improvements	Fay, Spofford & Thorndike	Mar. 1965
Preliminary Sewer Study, Hyde Park, Congress Avenue	Edward C. Jordan, Co	Jul. 1974
Infiltration/Inflow Analysis of Existing Sewerage System	Coffin & Richardson	Jan. 1976
Supplement to Infiltration/Inflow Analysis of Existing Sewerage System	Coffin & Richardson	Mar. 1976
Infiltration/Inflow Analysis	Wright-Pierce	Oct. 1979
Storm Drainage Master Plan	Wright-Pierce	Jan. 1980
Contract and Specifications: Sewer System Rehabilitation (Hyde Park)	Wright-Pierce	Sep. 1980
Smoke Testing Report	New England Pipe Cleaning Co.	Oct. 1980
Contract and Specifications for Sewer Separation Projects	Wright-Pierce	Jul. 1982
Sewer System Evaluation Survey	Wright-Pierce	Dec. 1983
Phase II Sewer Separation Project	Kimball Chase Company, Inc.	Sep. 1988
Continuous Flow Monitoring	Utility Pipeline Services, Inc.	Oct. 1992
1994 Sewer System Evaluation	Vermont Pipeline Services, Co.	1994
Revised Facilities Planning Report: Combined Sewer Overflows and Pump Stations	Whitman & Howard, Inc	Mar. 1994
Wastewater Treatment Facility Upgrade and Expansion	Lewis & Zimmerman Assoc. Inc.	Jun. 1994
Sanitary Sewer Maintenance Log and Cleaning Program	City of Bath	1988-1995

Sewer System Video Inspection Reports	All Clean Environmental Services	Jul. 1995
Nine Minimum Controls for Combined Sewer Overflows	Environmental Engineering and Remediation, Inc. (1)	May 1996
Project Manual: Washington Street Sewer Separation Project	Environmental Engineering and Remediation, Inc. (1)	Jun. 1996
Sewer Separation Project Washington Street/Summer Street	Environmental Engineering and Remediation, Inc. (1)	Nov. 1997
Combined Sewer Overflow Focused Feasibility Study Commercial Street/Pleasant Avenue Drainage Area	Environmental Engineering and Remediation, Inc. (1)	Jan. 1998
Project Manual: Hyde Park Improvements	Environmental Engineering and Remediation, Inc. (1)	Mar. 1999
Project Manual: Infrastructure Improvements Project	Environmental Engineering and Remediation, Inc. (1)	Mar. 1999
Facility Planning Report for the Wastewater Treatment Facility Upgrade and Expansion	Whitman & Howard, Inc.	1992
Facilities Planning Report, Combined Sewer Overflows, and Pumping Stations	Whitman & Howard, Inc.	1993
Basis of Design Report, Wastewater Treatment Facility Phase II Improvements	Whitman & Howard, Inc.	1994
Supplemental Combined Sewer Overflow Facilities Plan Study	Environmental Engineering & Remediation, Inc. (1)	1995
Preliminary Design Report, Harward Street Pump Station	Environmental Engineering & Remediation, Inc. (1)	1996
Basis of Design Report for Commercial Street and Front Street Pump Station Upgrades and Force Main Extension	Environmental Engineering & Remediation, Inc. (1)	2001
Pleasant Avenue Pump Station Upgrade, Basis of Design Report	Jacobs Edwards & Kelcey	2006
Revised 2006 Combined Sewer Overflow Master Plan Update	Jacobs Edwards & Kelcey	2006
December 2010 Revision to the CSO Master Plan and Associated CSO Project Tracking Tables	Ransom Environmental Consultants, Inc.	2011
Wastewater System Evaluation and Strategic Plan	Wright-Pierce	2013
2014 Revision Letter to the CSO Master Plan	Wright-Pierce	2014
Wastewater Transport System Evaluation – Hunt St. and Rose St. Pump Station Service Areas	Wright-Pierce	2015

2017 Revision Letter to the CSO Master Plan	Wright-Pierce	2017
Wastewater Transport System Evaluation – Hunt St. and Rose St. Pump Station Service Areas – Study 3	Wright-Pierce	2017
Willow and Middle Street Combined Sewer Modeling – Model Results, Alternatives Analysis, Costs and Recommendations Memorandum	Wright-Pierce	2017
Water Pollution Control Facility Phase 1 Upgrade and Collection System Capital Improvements	Wright-Pierce	2017
Harward Street Pump Station Drainage Area Infiltration and Inflow Study Phase 1	Wright-Pierce	2018
Harward Street Pump Station Drainage Area Infiltration and Inflow Study Phase 2 Field Investigations	Wright-Pierce	2018
Harward Street Pump Station Drainage Area I/I Study – Phase 2 Interceptor Capacity Analysis	Wright-Pierce	2018
Denny Road Overflow Capacity Requirements Memorandum	Wright-Pierce	2021

Notes:

1. Formerly Environmental Engineering and Remediation, Inc., Now Jacobs Edwards and Kelcey

2.2.2 Summary of Historical I/I Reduction Projects or System Improvements

The City has been working to complete I/I reduction projects since the 1980s. A description of completed construction projects is included in Appendix A. Table 2-2 also summarizes the construction projects completed since the 1990s and CSO abatement projects that are still to be completed.

Table 2-2 Summary of Historic I/I Studies and Evaluation Surveys

Project	Drainage Area	Year
Completed Projects		
WPCF Upgrade	N/A	1997
Lambert Park Area Separation	Harward	1997
Harward Street Pump Station Upgrade	Harward	1997
Commercial Street Area	Commercial	1999

Commercial Street Pump Station Upgrade	Commercial	2002
Centre Street Area Separation	Commercial	2003
Separation of Evergreen Street (CSO Abatement Project #9)	Pleasant	2008
Pleasant Avenue Pump Station Upgrade (CSO Abatement Project #4)	Pleasant	2009
Bowery Street Hydraulic Restrictions (CSO Abatement Project #7)	WPCF	2009
Juniper Street/Park Street Hydraulic Restrictions (CSO Abatement Project #12)	Harward	2009
Separation of Aspen Lane (CSO Abatement Project #19)	Harward	2009
Oak Street Separation	Commercial	2009-2010
Oak, Front, and Commercial Street Separations	Commercial	2010
Centre Street Separation Project	Commercial	2010
Harward Street Pump Station Force Main Replacement (CSO Abatement Project #30)	Harward	2012
Sanitary Sewer Modifications and Separation of Green and High Streets (CSO Abatement Project #31)	Commercial	2014
Disconnect Hyde School Pond Overflow from Sanitary Sewer (CSO Abatement Project #10)	Pleasant	2013
Eliminate Cross Connection, High Street near Nichols Street (CSO Abatement Project #6)	Pleasant	2016
Separation of Roof and Basement Drains from Sanitary Sewer, Phase 1 (CSO Abatement Project #11)	Harward	2012
Lambert Park Hydrobrake Modifications (CSO Abatement Project #13)	Harward	2012
Storm Sewer Modifications (Park/Winship Streets) (CSO Abatement Project #24)	Harward	2014
BIW Parking Lot Separation (CSO Abatement Project #8)	Pleasant	2012
Leeman Highway Separation (CSO Abatement Project #29)	Commercial	2016

Separation of High Street, South Street, and Middle Street (CSO Abatement Project #23)	Commercial	2016
CSO Abatement Project #42 – Separation of Roof Drains and Sump Pump at Former Re-Store Property	Commercial	2014
CSO Abatement Project #43 – Sewer Repairs on High Street	Pleasant	2014
CSO Abatement Project #44 – Separation of Catch Basins on Pearl Street	Commercial	2014
CSO Abatement Project #32 – Evaluation of South End Sewer System	Hunt and Rose	2014
CSO Abatement Project #46 – Infiltration & Inflow Study – Harward Street Pump Station Drainage Area	Harward	2017
CSO Abatement Project #34 – Evaluation of Rose Street Pump Station Service Area for Phase 2 South End Projects	Rose	2017
CSO Abatement Project #36 – Evaluation of Hunt Street Pump Station Service Area for Phase 2 South End Projects	Hunt	2017
CSO Abatement Project #41 – Separation of Catch Basins at School Street near Train Tracks	Commercial	2017
CSO Abatement Project #35 - South End – Phase 1 Sewer Relining and Manhole Repair Project	Hunt and Rose	2018
CSO Abatement Project #40 – Separation of Catch Basins at Fisher Mitchell School	Pleasant	2019
Water Pollution Control Facility – Phase 1 Upgrade	N/A	2019
CSO Abatement Project #45 – Separation of Catch Basins at Washington Street and North Street	Commercial	2019
Potential Infiltration Leading to Harward Street Pump Station (CSO Abatement Project #16)	Harward	2020
CSO Abatement Project #35, #37, #38 - South End – Phase 2 Sewer and Storm Drain Replacement	Hunt and Rose	2020
Projects to be Completed		
Pipe Damage near Upper Leeman Highway (CSO Abatement Project #18)	Commercial	2022
Separation of Farrin Place Pump Station Drainage Area (Oliver, Mechanic, and Milan Streets) (CSO Abatement Projects #20 and #22)	Farrin	2021 or later
Separation of Roof and Basement Drains from the Sanitary Sewer, Phase II (CSO Abatement Project #21)	Harward	2021-2025

Willow Street/Railroad Track Sanitary Sewer Modifications (CSO Abatement Project #15)	Commercial	Partially Completed – 2013
Separation of Western Avenue and Cottage Street (CSO Abatement Project #25)	Commercial and Pleasant	2022
Separation of Crescent, Middle, and York Streets (CSO Abatement Project #26)	Commercial	Target 2016 – Date TBD
Bedford Road Separation (CSO Abatement Project #27)	Commercial	Partially Completed – 2018
North and Grove Street Separation (CSO Abatement Project #28)	Commercial	2023
CSO Abatement Project #33 – Reinstate Hunt Street CSO	Hunt	TBD
CSO Abatement Project #39 – Design/Construction of Phase 3 South End Projects	Hunt	2021-2022
CSO Abatement Project #14 and #17 – Cross Country Interceptor near Dike Newell School/Leading to Harward Street Pump Station	Harward	2021-2022

2.2.3 Description of Existing Collection System and Treatment Facilities

The following is a general discussion of the existing Bath collection system and treatment facility. Detailed discussions of the existing collection system and treatment facility can be found in Section 5 and Section 6, respectively.

2.2.3.1 Collection System

The City of Bath owns and operates a wastewater collection and treatment system with approximately 39 miles of collection sewers and interceptors, 5 miles of sewer force main, and 13 pump stations. The City's 13 pump stations, which vary in size and capacity, serve to pump raw wastewater from the City's collection system to the WPCF for treatment. Many of the City's pump stations were constructed around the same time as the original WPCF in 1971. The City is comprised of 14 sewer drainage areas. Each drainage area is generally referred to by the name of the pump station in that particular drainage area. Figure 2-1 shows each drainage area within the City.

Excess combined sanitary and storm water that enters the collection system during wet weather events is discharged from four combined sewer overflows within the collection system that receive no treatment. These CSO discharges are authorized by the City's Maine Pollutant Discharge Elimination System (MEPDES) permit. The City maintains licensed CSO discharges at four locations in the collection system.

- Rose Street (CSO #003)
- Pleasant Street (CSO #004)
- Commercial Street (CSO #005)
- Harward Street (CSO #008)

ISCO 2150 area-velocity flow meters are installed in the CSO discharge pipe at each CSO location to monitor and measure flow during CSO events.

Figure 2-2 is a schematic showing the 14 drainage areas and pump stations, along with the four licensed CSOs in the collection system and the CSO at the WPCF. As discussed in further detail in this CSO Master Plan, many of the pump stations are interconnected; the flow from one station gets pumped to the gravity collection system of a downstream station, and then further pumped to the next drainage area, until eventually reaching the WPCF.

Figure 2-1 Collection System Sewer Drainage Areas Map

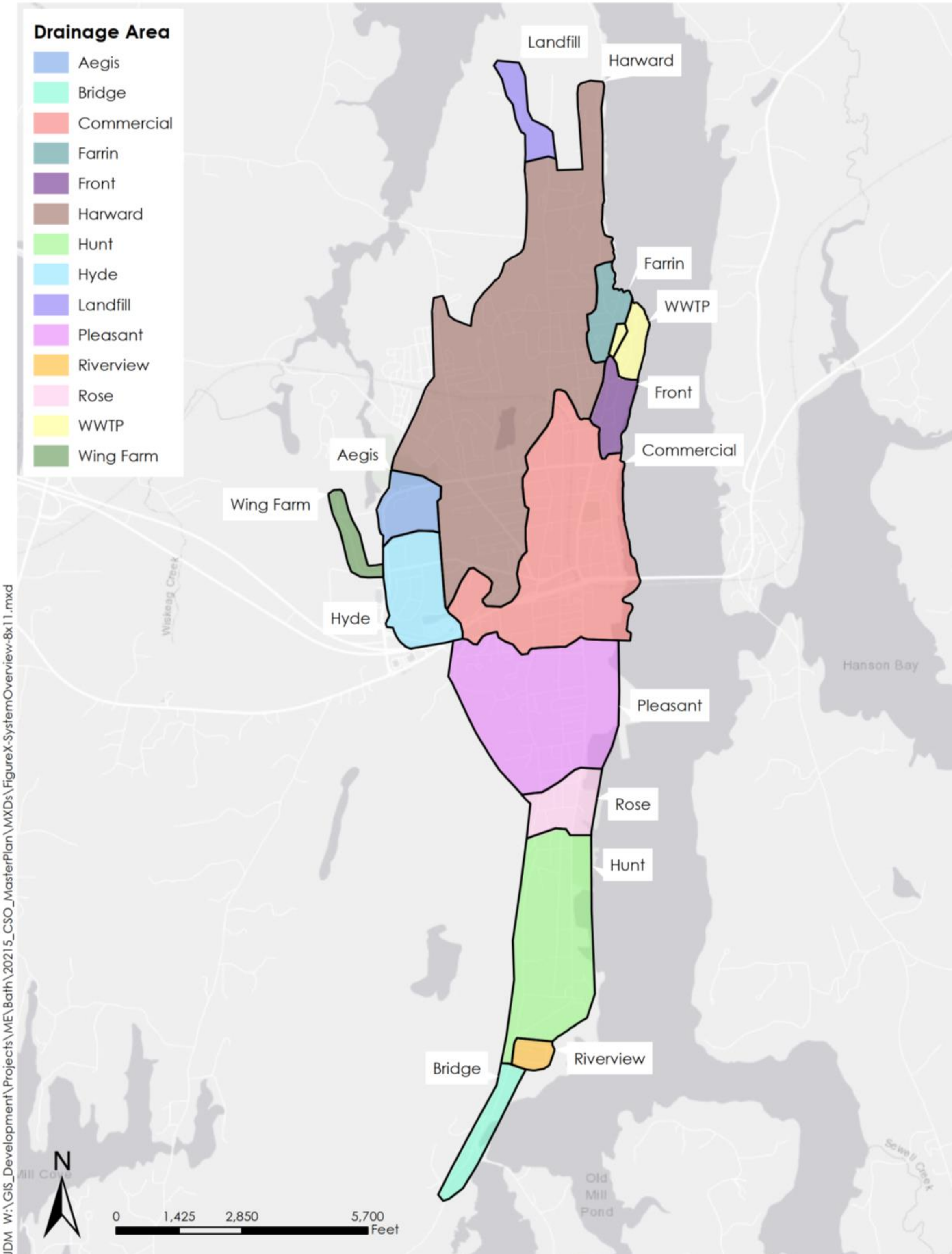
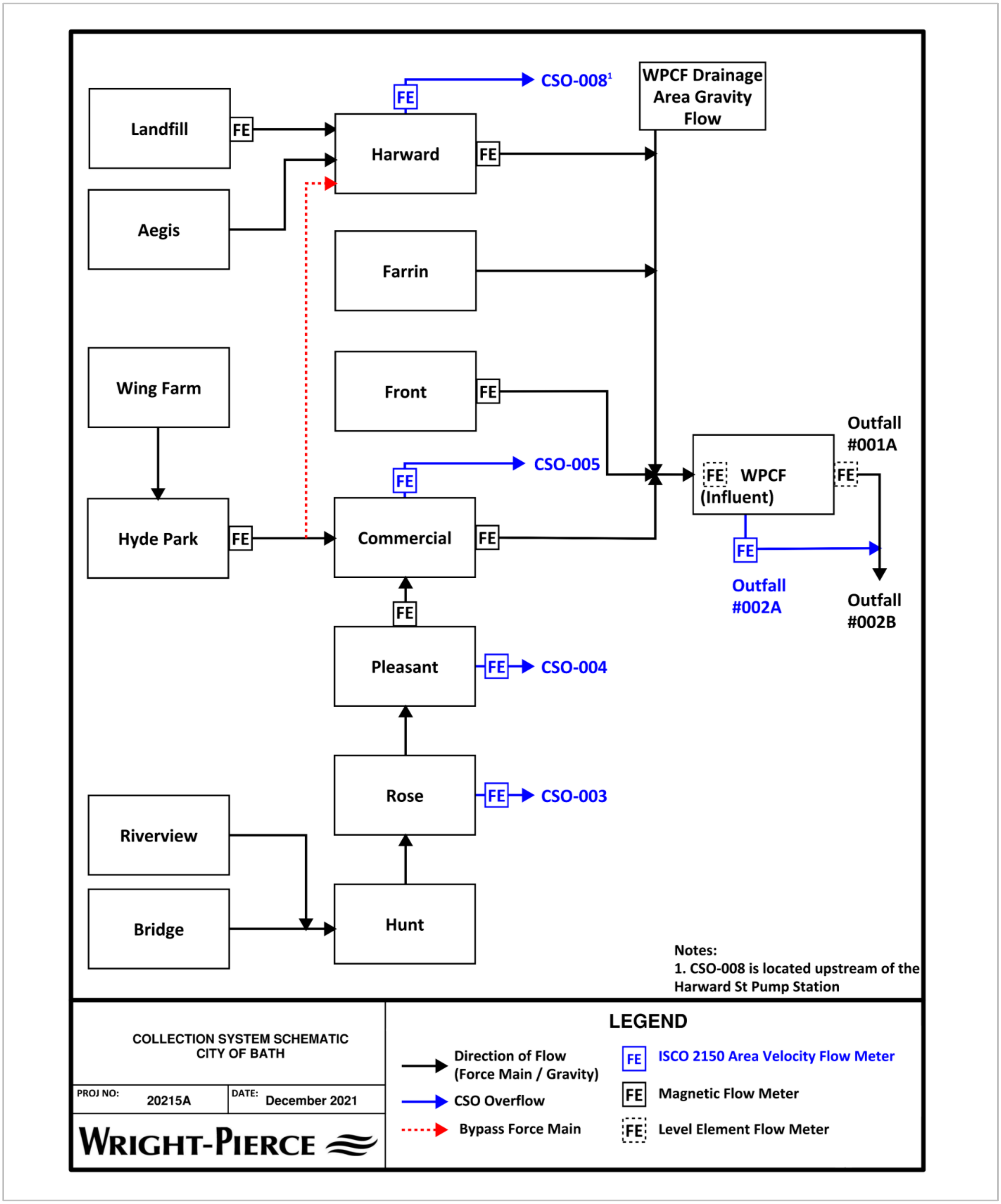


Figure 2-2 Collection System Schematic



2.2.3.2 Treatment System

The City of Bath owns and operates a water pollution control facility located at 1 Town Landing Road. The WPCF was originally constructed in 1971 and was updated and expanded over the course of three upgrades in 1993, 1997, and 2016. The WPCF was designed to provide secondary treatment for an average daily flow of 3.5 MGD and a maximum daily flow of 7.0 MGD. While the current average flow is only 1.90 MGD, the facility receives peak hour flows up to 18.85 MGD. Secondary treated flows are discharged through Outfall #001A located at the Chlorine Contact Tank. Flows in excess of 7.0 MGD receive primary treatment and disinfection and are discharged through Outfall #002A at the CSO Disinfection Tank. Both flows are then blended in a manhole downstream of both tanks and discharged through a 36-inch pipe (Outfall #002B) into the Kennebec River, a Class SB waterway in Bath. The effluent discharge must meet minimum effluent discharge requirements set forth in state and federal water quality legislation. The plant's effluent quality requirements are contained in the City's MEPDES permit.

2.3 Summary of EPA/DEP CSO Regulations/Guidelines

Chapter 570 of the Maine DEP Combined Sewer Overflow Abatement guidelines outlines the basis by which a discharge from a combined overflow point within a sewerage system can be permitted. In order for a CSO to be allowable by the Maine DEP Chapter 570 guidelines, the discharge must meet the following conditions:

1. Discharge in excess of design capacity: The discharge consists of wastewater in excess of design capacity of the sewerage system or treatment facilities;
2. Discharge not due to mechanical failure: The discharge is not the result of mechanical failure, improper design or inadequate operation or maintenance, and;
3. CSO Master Plan: The licensee is actively developing or implementing a CSO Master Plan in accordance with Chapter 570 guidelines, and as approved by the Department; or the licensee has implemented the CSO Master Plan, and a discharge occurs that is caused by conditions exceeding those upon which the Plan is based.

The City of Bath meets all the above criteria for allowable CSOs at its licensed overflows.

The MEPDES discharge license for the City of Bath WPCF (WDL #W002678-6D-O-R/MEPDES Permit #ME0100021) was renewed on December 10, 2020 for a five-year period. The highlights of this permit, as pertaining to this CSO Master Plan, are summarized below:

- Licensed for an unspecified quantity of secondary treated sanitary wastewater and an unspecified quantity of excess combined sanitary and storm water receiving primary treatment, disinfection and dechlorination.
- An unspecified quantity of excess combined sanitary and storm water during wet weather events from four combined sewer overflow outfalls into the Kennebec River.
- Report Flow, BOD, TSS, Fecal Coliform Bacteria, and Total Residual Chlorine at Outfall #002A year-round during reportable overflow occurrences.
- Daily Maximum Discharge Limitations at Blended Outfall #002B include: BOD = 8,206 lbs/day, TSS = 18,423 lbs/day, Fecal Coliform Bacteria = 200 col/100 ml, Total Residual Chlorine = 1.0 mg/L.
- Requirement to submit a CSO Master Plan Update and abatement schedule on or before December 31, 2021.
- CSO Compliance Monitoring must be conducted, including block testing or flow monitoring at all CSO locations and annual CSO flow volumes reported.

- Requirement to implement and follow the Nine Minimum Controls (NMC) These minimum controls are set forth to reduce CSO activity and pollutant discharges while long-range plans are being completed. The NMC will be discussed further in Section 8 of this plan.
- Annual CSO Progress Reports must be submitted each year summarizing CSO flow activity and volumes and CSO Abatement project status updates.

2.4 Purpose of CSO Master Plan

The purpose of this CSO Facilities Plan Update is to set forth a recommended approach, budgetary costs and schedule for abating or eliminating the impacts of CSO discharges in the City of Bath, Maine. The elements of this CSO Facilities Plan Update, and their respective Sections within this Plan, are as follows:

1. CSO Assessment and Monitoring
    a. *Section 3*, Receiving Waters of CSO Overflows
    b. *Section 4*, CSO Flow Monitoring
    c. *Section 5*, Sewer System Flow Monitoring
    d. *Section 6*, Treatment Facility Evaluation
2. Prioritization and Alternative Analysis
    a. *Section 7*, Prioritization of CSO Discharge Abatement
    b. *Section 8*, Screening and Evaluation of Control Alternatives
    c. *Section 9*, Recommended CSO Abatement Plan
3. Implementation Schedule
    a. *Section 9*, Recommended CSO Abatement Plan
4. Proposed Budget
    a. *Section 9*, Recommended CSO Abatement Plan

Section 1 - Summary, Conclusions and Recommendations acts as a succinct summary of Sections 2 through 9.

Section 3 Receiving Waters of CSO Overflows

3.1 Receiving Water Quality Standards

Table 3-1 below summarizes the four permitted CSOs within Bath, as well as their respective receiving waters and water body classification. Figures showing the locations of the CSO locations are included in Section 4. The City also has a permitted wet weather bypass at the Water Pollution Control Facility (WPCF). This outfall is utilized during wet weather events when the influent flow exceeds the capacity of the WPCF. Flow receives primary treatment and disinfection before being discharged through this outfall.

Table 3-1 Maine DEP Permitted CSOs and Receiving Waters Classifications

CSO Outfall #	Location	Receiving Water & Class
003	Rose Street Pump Station	Kennebec River, Class SB
004	Pleasant Street Pump Station	Kennebec River, Class SB
005	Commercial Street Pump Station	Kennebec River, Class SB
008	Harward Street Pump Station	Kennebec River, Class SB

A summary of the waterbody classification requirements for Class SB are included below.

3.1.1 Class SB Waters

Maine law, 38 M.S.R.A §469 classifies all estuarine and marine waters lying within the boundaries of the State and which are not otherwise classified (which includes the Kennebec River), as Class SB waters. Of the three standards for classification of estuarine and marine waters, Class SB is the second highest classification (between Class SA and Class SC). Class SB waters must meet the following criteria[1] :

- Class SB waters must be of such quality that they are suitable for the designated uses of recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, navigation and as habitat for fish and other estuarine and marine life. The habitat must be characterized as unimpaired.
- The dissolved oxygen content of Class SB waters must not be less than 85% of saturation. Between May 15th and September 30th, the numbers of enterococcus bacteria of human and domestic animal origin in these waters may not exceed a geometric mean of 8 per 100 mL or an instantaneous level of 54 per 100 mL. The numbers of total coliform bacteria or other specified indicator organisms in samples representative of the waters in shellfish harvesting areas may not exceed the criteria recommended under the National Shellfish Sanitation Program, United States Food and Drug Administration (FDA).

[1] Title 38 §469: Waters and Navigation, Chapter 3: Protection and Improvement of Waters, Subchapter 1: Environmental Protection Board, Article 4-A: Water Classification Program, Section 469.

- Discharges to Class SB waters shall not cause adverse impact to estuarine and marine life in that the receiving waters shall be of sufficient quality to support all estuarine and marine species indigenous to the receiving water without detrimental changes in the resident biological community. There shall be no new discharge to Class SB waters which would cause closure of open shellfish areas by the Department of Marine Resources.

3.2 Impairments To Use Due To CSO Overflows

3.2.1 State Water Quality Assessment

The State of Maine 2016 Integrated Water Quality Monitoring and Assessment Report lists the Kennebec River at Bath (Waterbody #710-03) as, "Category 4-A(b): Estuarine and Marine Waters with Impaired Use – TMDL Completed (Bacteria from Combined Sewer Overflows). The City's discharge license requires the City to implement CSO control projects in accordance with the most current approved CSO Master Plan and abatement schedule. As the treatment facilities and collection systems are upgraded and maintained in accordance with the CSO Master Plan, there should be reductions in the frequency and volume of CSO activities and, over time, improvement in the quality of the receiving waters.

3.2.2 Shellfish Harvesting

The Maine Department of Marine Resources (DMR) is responsible for assessing information on shellfish growing areas to ensure that shellfish harvested are safe for consumption. In general, DMR regulates the opening and closure of clam flats due to pollution or potential pollution threat or poor water quality. Biologists from the DMR office in Boothbay Harbor, Maine are responsible for testing and opening or closing the shellfish harvesting areas in close proximity to Bath. There are no known shellfish harvesting locations in close proximity to Bath. See Appendix B for a status map of the shellfish harvesting areas (current as of December 2021).

The DMR traditionally closes shellfish harvesting areas if these are known sources of discharges with unacceptable bacteria levels (in-stream thresholds established in the National Shellfish Sanitation Program) or maintains shellfish harvesting closure areas due to lack of updated information regarding ambient water quality condition. The standard for clam flat opening is that the clams must be consumable in raw form as mandated by the FDA. Currently, the criteria for opening shellfish harvesting areas are water sampling test results that are less than a geometric mean of 14 fecal coliform colonies per 100 mL (14 FC/100 mL) and a peak of less than 49 FC/100 mL based on the most recent 30 samples taken. There also must be no point source discharges (CSOs, outfalls, marinas, etc.) impacting the area or non-point source discharges (ditches, wildlife, agriculture, etc.) for un-restricted harvesting.

To adequately protect the public health, there are certain situations that "trigger" an automatic closure of the shellfish harvesting areas. Usually, a greater than 2" rainstorm over 24 hours would start a process of reviewing the overall rainfall in the state. There are several computer websites and reporting stations that DMR staff utilize to determine rainfall amounts per region. DMR also has a pollution reporting hotline and automated website that rain gauge monitoring volunteers can use to report rainfall totals. Recent amounts of rain, frozen ground, groundwater table, etc. all go into a decision to close an area to harvesting. Some weather systems impact regions of the state more than others, i.e., specific regions of the coast may close while others remain open. Predicted heavy storms (tropical storms) may require a preemptive closure to forewarn harvesters because of early day tides and boats working leased sites. Recalling harvested shellfish due to potential bacterial contamination is never desirable.

3.2.3 Additional Potential Impairments

In addition to restricted shellfish harvesting, there are a number of additional potentially restricted uses due to CSO events, including:

- DMR prohibits the use of water from a CSO-impacted area to be used for shellfish processing plants, flow-through or raft holding tanks ("wet storage") containing shellfish (pounds, eating establishments, etc.). Considering the water in the Kennebec River in Bath is brackish, this is not a potential use in Bath.
- Swimming is prohibited near the CSOs during and immediately after a CSO event

3.3 Potential Uses Realized with CSO Abatement

The elimination or abatement of CSO events could improve water quality within the Kennebec River. Without further study, it is difficult to state with certainly what impact the abatement or elimination of the Bath CSOs would have with respect to downriver shellfish harvesting or other potential uses. The area of the Kennebec River where the Bath CSOs discharge is classified as prohibited; however, Merrymeeting Bay and the upstream portion of the Kennebec, as far north as Augusta, are also classified as prohibited. Other sources of bacterial contamination can be attributed to:

- *Overboard Discharges (OBDs):* DEP maintains a GIS database of all active, removed, and inactive OBDs in the state. OBDs are licensed discharges from sources such as small commercial and residential overboard dischargers. As of September 2021, there were 11 OBDs in Bath and neighboring Woolwich discharging to the Kennebec River. See Table 3-2 below for locations and permitted flow rates.
- Of the 10 discharges, nine are located near the WPCF CSO related bypass of secondary treatment and Harward Street CSO, and two are located near Pleasant Street CSO and Commercial Street CSO. Assuming full use of the capacity of the active OBDs (for lack of actual flow information), up to 16.6 million gallons of wastewater may have been discharged to the receiving waters from January 2014 through June 2020. This represents 6.9% of the volume discharged through the CSOs during the same period.
- *Stormwater Discharges:* The collection and conveyance of untreated stormwater to the Kennebec River can convey bacterial and other pollutant loads that may trigger closure of shellfish harvesting areas.
- *Upstream WPCFs and CSOs:* Numerous other wastewater treatment facilities discharge to the Kennebec River upstream of Bath, or which a number are CSO communities.

In short, the CSOs within Bath are not the sole contributors to water quality impairment due to bacterial contamination. However, the City is committed to the protection of the environment and improving water quality. This CSO Master Plan outlines the recommended approach to eliminating or abating the CSOs within Bath which, will in turn, increase the potential uses realized.

Table 3-2 Current List of Overboard Discharges (As of September 2021)

DEP ID	Name	Location	Flow (gpd)	Licensed Duration	Expiration	Waterbody
001851	Corey & Jenee Westerfeld	1600 Washington Street	600	Year-Round	11/6/2024	Kennebec River
001850	Jeffrey I. Bunker Living Trust	1571 Washington Street	600	Year-Round	3/20/2025	Kennebec River
002095	Christopher Mann	1569 Washington Street	600	Year-Round	11/28/2023	Kennebec River
009182	Mary Lou Ciolfi & Stephan Schuchert	1569 Washington Street	600	Year-Round	12/7/2022	Kennebec River
001846	Jay M. Trudeau	1570 Washington Street	600	Year-Round	8/12/2025	Kennebec River
001987	William & Cheryl Black	1557 Washington Street	600	Year-Round	6/2/2026	Kennebec River
002464	Steele Young Family Trust	1543 Washington Street	600	Year-Round	7/13/2025	Kennebec River
006033	Robert & Nancy Montgomery	6 Old Stage Road	600	Year-Round	11/12/2023	Kennebec River
004689	Richard & Betsy Bisson	127 River Road	600	Year-Round	8/12/2025	Kennebec River
002184	Edward Hill	36 Carlton Point Road	600	Year-Round	9/14/2025	Kennebec River

Section 4 CSO Flow Monitoring

4.1 Introduction

The City of Bath has been monitoring flow at its CSO discharge points since 1992. Table 4-1 and Figure 4-1 present overflow volumes and rainfall from 2006 (date of CSO Master Plan update by Jacobs, Edwards & Kelcey) through December 31, 2020. As various collection system improvements and treatment plant and pump station upgrades have been completed, the volume of CSO events has been reduced considerably. From 2006 to 2012, overflows averaged approximately 18 million gallons per year. Since 2013, overflows have averaged approximately 2.9 million gallons per year. This reduction is a commendation to the City's diligence in undertaking CSO master plan projects to reduce I/I into the collection system.

Figure 4-2 shows the annual precipitation compared to the total gallons of CSO overflow for each year from 2006 through 2020. Figure 4-3 summarizes the downward trend of CSO gallons compared to the normalized precipitation data by dividing the annual CSO volume by the annual rainfall. By normalizing the precipitation compared to CSO volume, the chart shows trends in CSO volume independent from yearly precipitation and allows for comparison of CSO volumes year to year without the impact of total precipitation. Figure 4-4 shows the flow from each CSO location for the years from 2014 through 2020. Note that the data in the table is for the four licensed CSOs and does not include secondary bypass flows at the WPCF.

Table 4-1 Summary of Annual CSO Volumes and Rainfall

Year	No. of CSO Events	Annual CSO Volume (Gallons)	Annual Rainfall (inches)[1]
2006	71	36,105,693	60.93
2007	39	20,783,335	48.27
2008	59	24,383,592	57.11
2009	44	11,323,061	54.65
2010	54	12,930,203	54.62
2011	24	10,067,181	45.52
2012	42	12,199,904	43.61
2013	38	2,768,794	39.18
2014	44	4,990,910	47.37
2015	21	2,727,901	34.53
2016	24	1,616,038	36.17
2017	16	1,697,080	31.92
2018	31	3,753,898	41.45
2019	27	2,800,232	44.47
2020	31	2,874,579	39.49

Notes:

1. Source – Notice of Combined Sewer Overflow Activity (NCSO) forms sent by the City to DEP

The graphs below show the progress that the City of Bath has made since 2006 to reduce the number of events and total CSO volume in the collection system. It is apparent that significant improvements were made from 2006 to 2013. When focusing specifically on 2014 (latest date range of last CSO Master Plan Update) through 2020, continued reductions in CSO volume and events are present, albeit at a more modest rate than in previous years.

It is interesting to observe the increase in CSO flows in 2018 relative to the other years in the data set. When analyzing the CSO flows normalized by precipitation, an increase in CSO flows in 2018 is present even though one would expect the normalized flow to remain constant or decrease once precipitation totals are accounted for. One likely explanation for this increase in 2018 may be the seasonal timing of precipitation events in 2018. More precipitation events occurred during the winter months (November to March) in 2018 than any other year in the data set. Total winter precipitation was 13.2”, or 49% more than all other years during the winter months. During colder months, the frozen ground cannot absorb precipitation, resulting in higher surface runoff volumes that may enter the collection system via combined catch basins. Additionally, the normalized CSO flows do not account for increased groundwater via snowmelt. For example, a 2-inch rain event in January produces significantly more runoff than the 2 inches of precipitation alone, as snowmelt is exacerbated by the precipitation event.

Figure 4-1 Annual CSO Volume and Occurrences 2006-2020

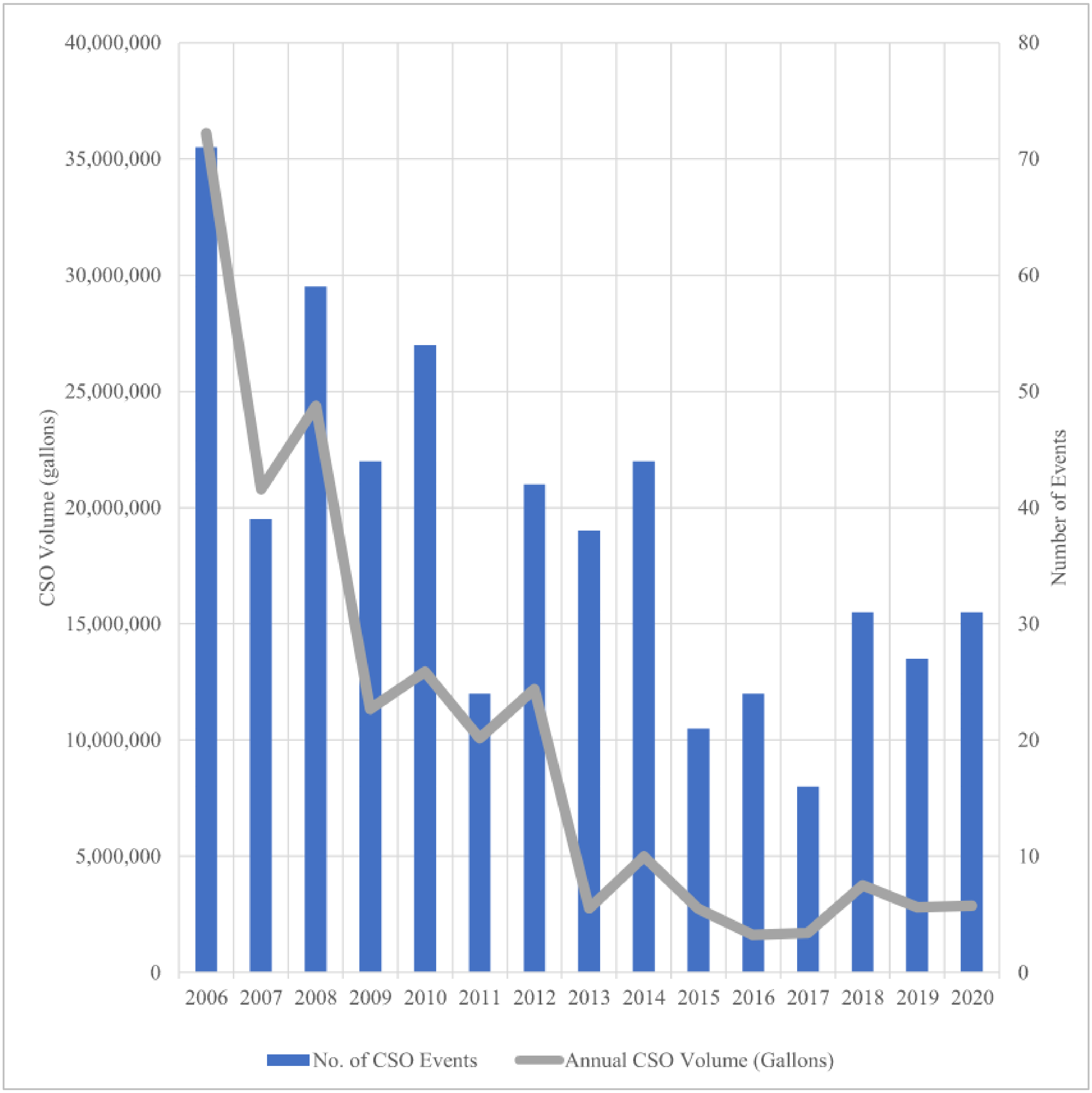


Figure 4-2 Annual CSO Volume and Precipitation 2006-2020

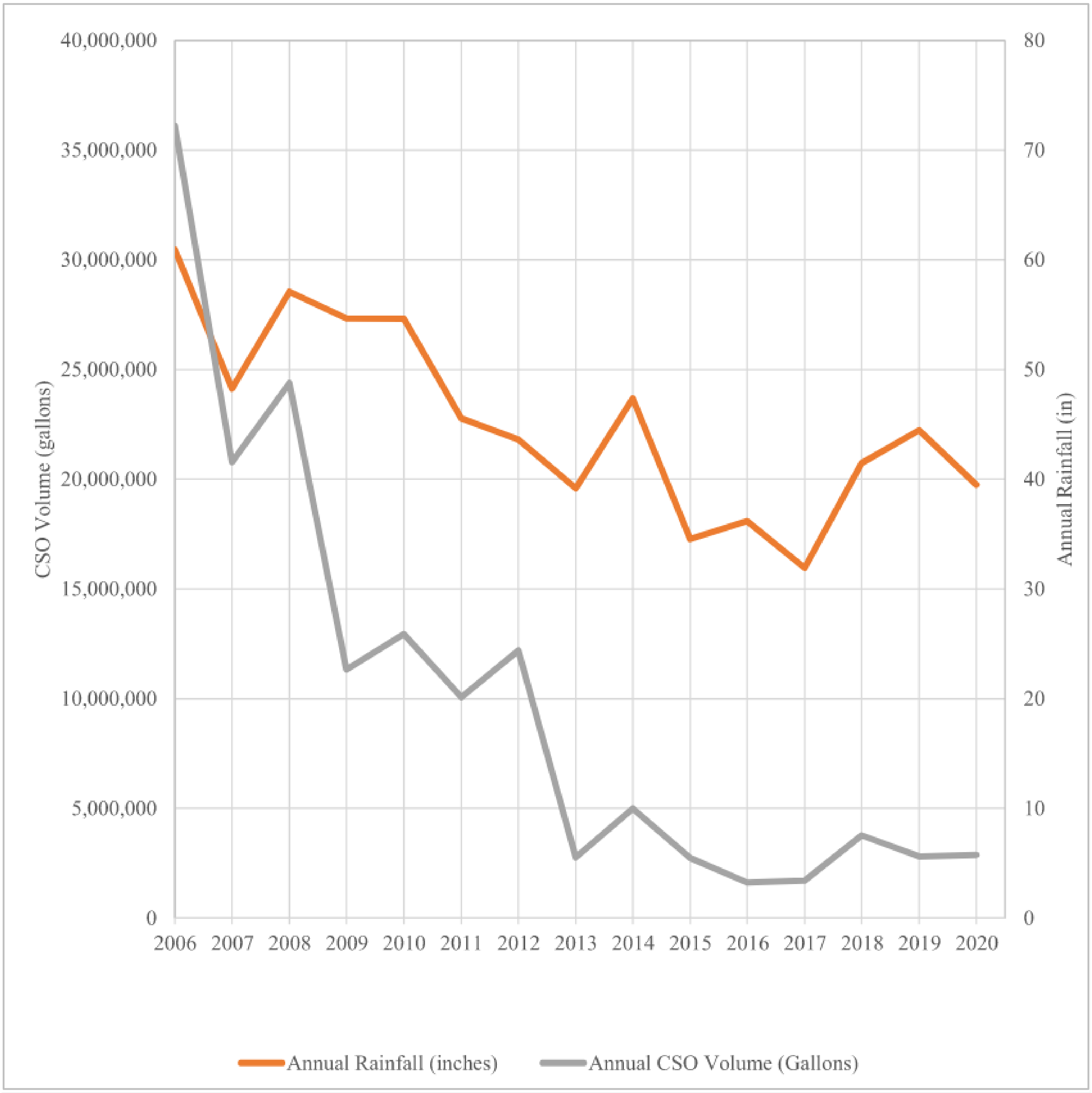


Figure 4-3 Annual CSO Volume Normalized by Precipitation 2006-2020

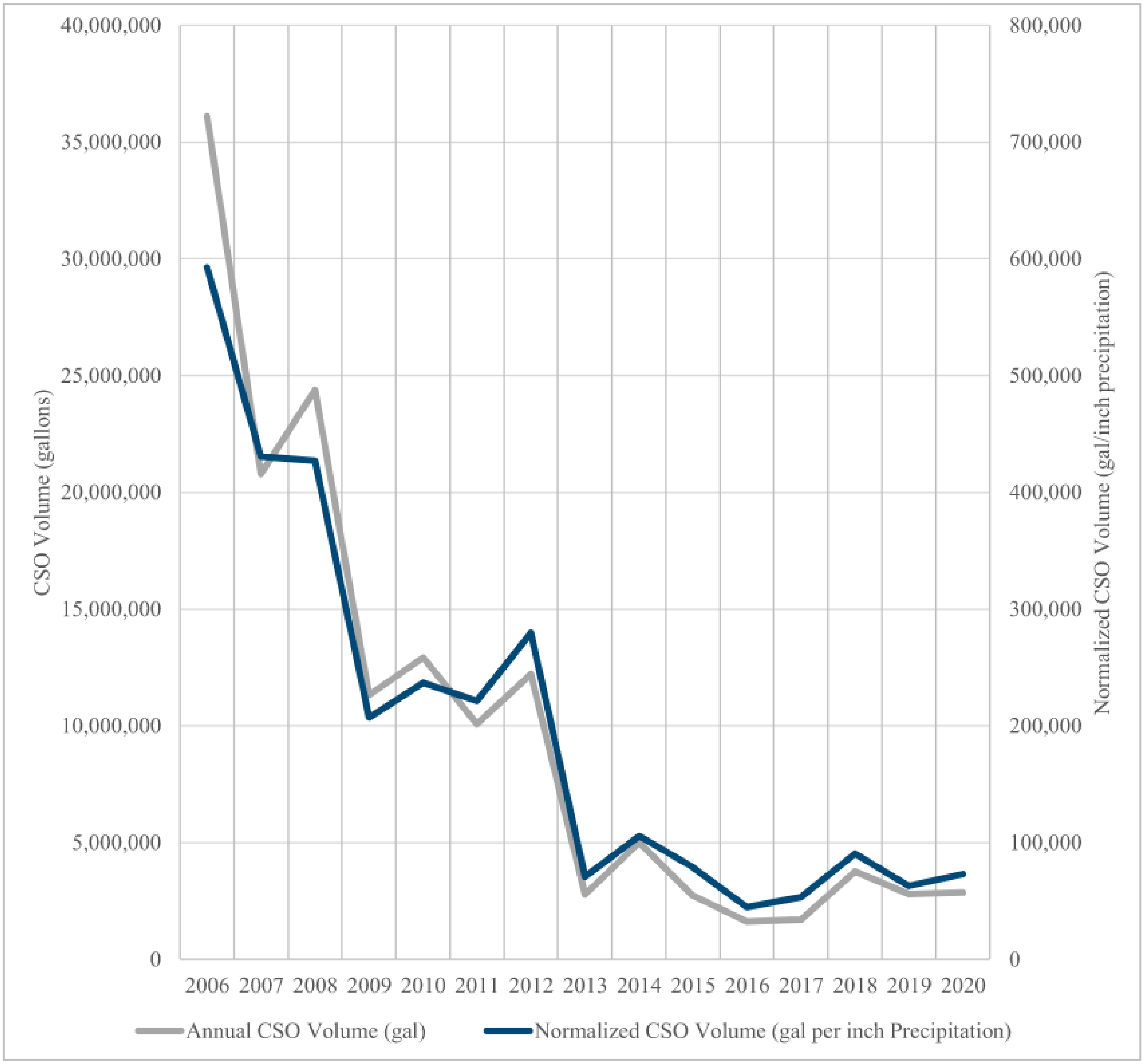
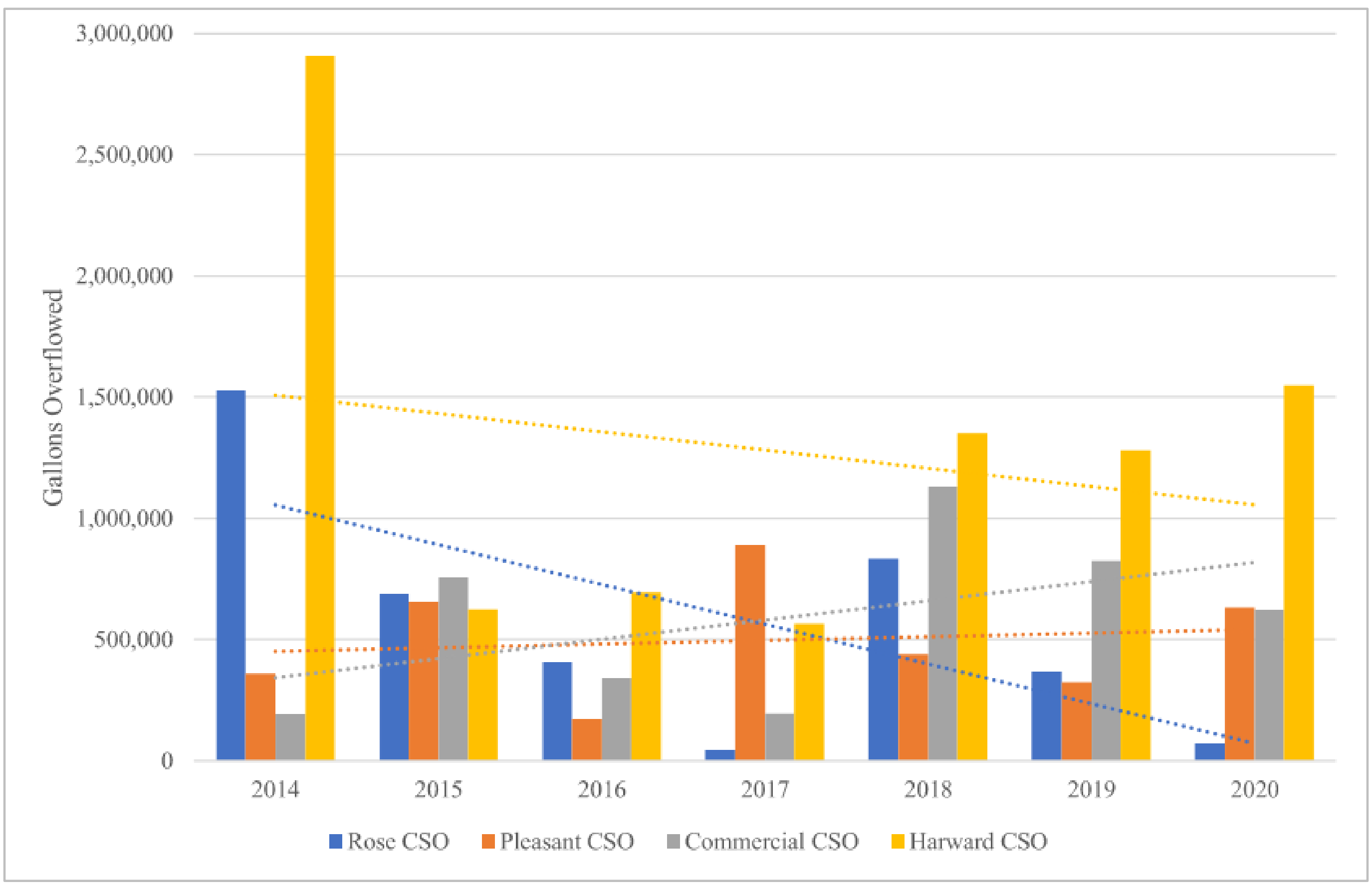


Figure 4-4 shows CSO volumes at each licensed CSO in the collection system from 2014 through 2020 along with trend lines for total CSO volume at each station. The Harward Street CSO historically has the highest CSO volume, followed by Commercial Street. Pleasant Street and Rose Street have alternated in terms of total CSO flow since 2018. This variation can be attributed in part to the sewer separation work that has occurred in both of these drainage areas over the past 3 years. Specifically, separation of combined catch basins at Fisher Mitchell School in 2018 in the Pleasant Street drainage area, and the South End Phase 1 and Phase 2 separation projects in the Rose Street area in 2018 and 2020, respectively.

One important item to note is the CSO volume recorded at Pleasant Street in 2017. There was a single CSO event recorded that year that resulted in 890,000 gallons of CSO flow. The pump station lost power during this one rain event and the backup generator failed to start. Fallen trees prevented the City from accessing the pump station to turn on the generator so no flow was pumped from the station for the duration of the storm. This data point is viewed as an outlier; had the generator started and powered the pumps, the CSO volume would have been significantly less. However, it has been included in the data set for completeness.

When reviewing the general trends of CSO volumes at each location for the date range of 2014 through 2020, the following is observed: Rose and Harward have shown a decreasing trend in CSO volumes, Pleasant has not shown a change in trend, and Commercial has shown an increasing trend in CSO volumes as more flow from upstream drainage areas and CSO #003 and CSO #004 reaches Commercial Street.

Figure 4-4 CSO Volume (Gallons) by Location 2014-2020



Prior to expected CSO events based on forecasted weather, City staff check the pump station equipment to make sure that it is functioning properly, and in the event of a power outage, that the emergency generator is in operation (applicable at 9 stations including Bridge, Commercial, Farrin, Front, Harward, Hyde, Pleasant, Rose and Wing). CSO events due to mechanical failure are not permitted. They do occur occasionally, and the City notifies Maine DEP of a non-rainfall related CSO within 24 hours. The City also reports CSO events due to mechanical failure on their monthly and annual reports. However, the City takes a proactive approach to equipment maintenance to minimize these occurrences as much as possible.

City staff checks each CSO location after a rain event to see if a CSO has occurred. This is done by checking if a wooden block placed on top of the CSO baffle wall has been tipped off the wall and over, indicating flow out the CSO pipe. Data from the CSO flow meters are downloaded after each CSO event. The City submits an annual CSO report which describes activity for all four permitted CSOs.

The following sections describe the location of the various CSOs and an analysis of CSO activity from the previous 2014 CSO Master Plan Update through December 2020.

4.2 Rose Street CSO #003

The Rose Street CSO is located at the Rose Street Pump Station just south of the intersection of Rose Street and Washington Street. Refer to Figure 5-9 in Section 5.9 for an overview of the drainage area. The structure has an 18-inch CSO overflow pipe that discharges into a marsh connected to the Kennebec River. Figure 4-5 shows the CSO structure, which is denoted as SMH-959 in the City's GIS database.

Figure 4-5 Rose Street CSO Structure

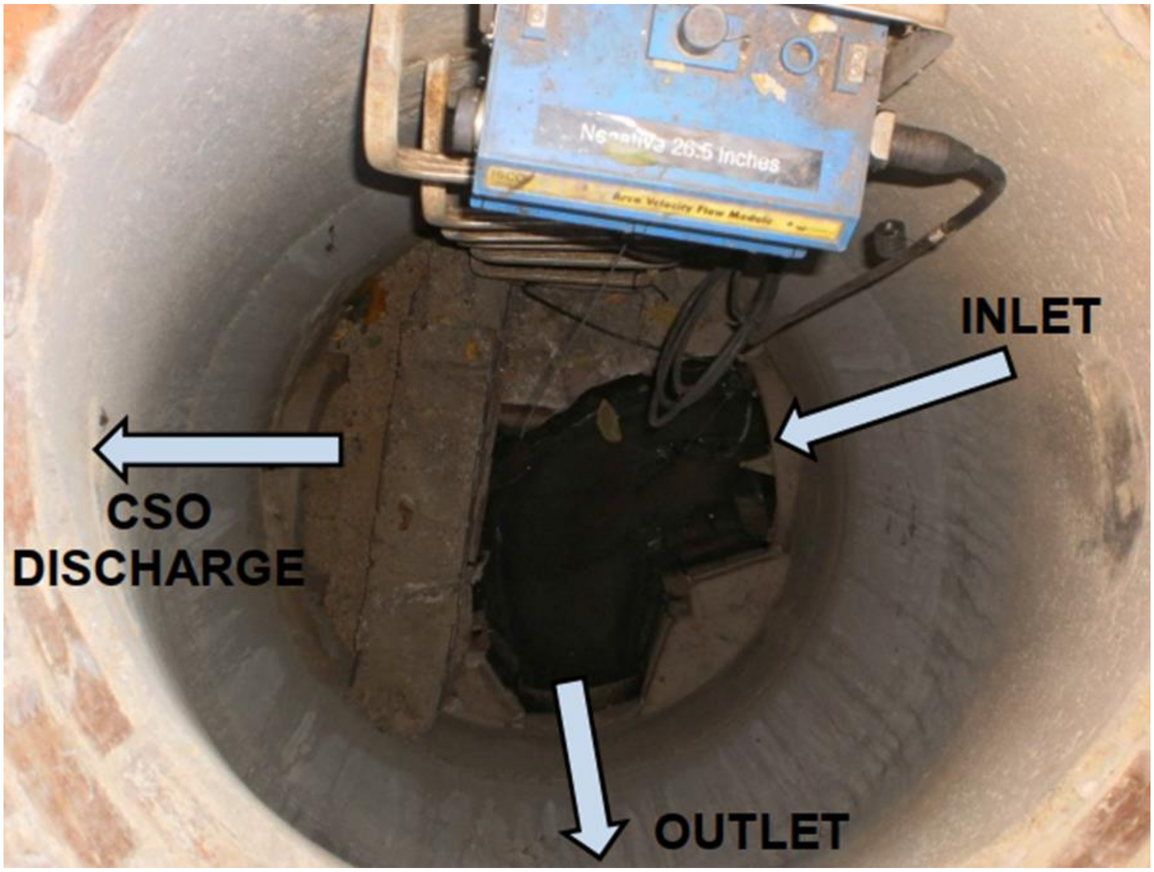


Figure 4-6 shows the number of annual CSO events from the Rose Street CSO from January 2014 through December 2020 as well as the maximum, median and average events for each year on a volumetric basis. As shown in the graph, the number of yearly CSOs decreased from 2014 to 2017, then spiked in 2018 and have decreased over the past two years. Figure 4-7 shows the annual precipitation from January 2014 through December 2020 as well as the maximum, median and average CSO events on a volumetric basis. In 2018 through 2020, there were more rainfall events and significantly more rainfall volume compared to 2015 through 2017, which could explain why the annual CSO events were greater in 2018 and 2019.

Figure 4-8 normalizes CSO volume for precipitation. Interestingly, 2018 still shows increased normalized CSO volume compared with other years. Section 4.1 discusses the impact of storms during the winter and the impact they have on groundwater table and runoff, which may explain the increase in normalized CSO flows.

Since 2014, I/I projects that were completed include the Phase 1 and Phase 2 South End Improvements. Phase 1 consisted of relining of various sewer pipes in the Hunt and Rose drainage areas, which was completed in summer of 2018. Phase 2 work included separation of catch basins and replacement of various sewer pipes in Hunt and Rose drainage areas and was completed in November of 2020. The success of the Phase 1 project is apparent; CSO volumes decrease from 2018 to 2020, and so does normalized CSO volume. It is too early to see the effects of the Phase 2 project in this dataset; however, preliminary flow metering results in the Hunt and Rose drainage areas show a decrease in flow, ultimately resulting in a reduction of CSO volume in 2020. Refer to Sections 5.8 and 5.9 for more details on the flow metering results before and after the Phase 1 and Phase 2 projects were completed.

Figure 4-6 Rose Street Annual CSO Summary

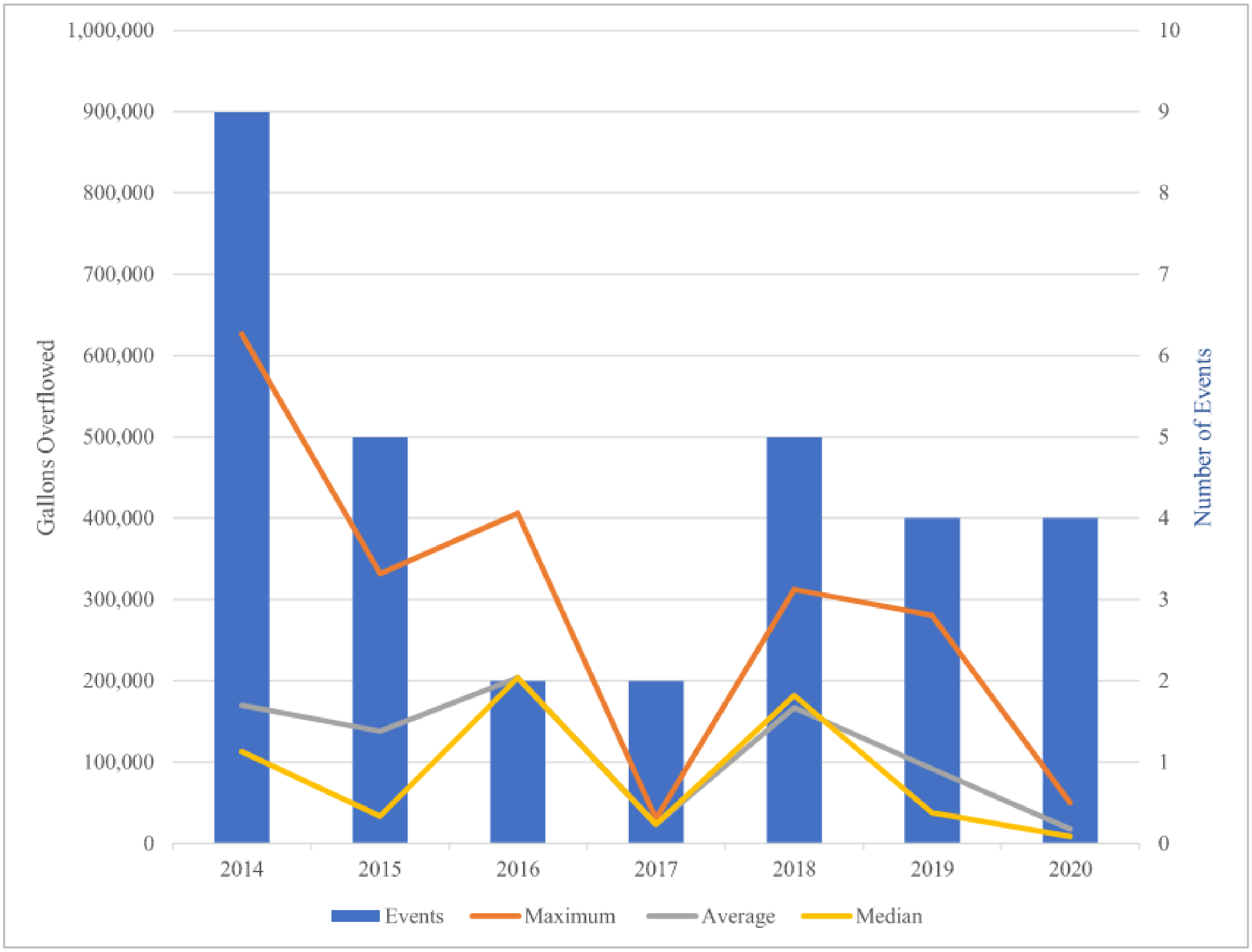


Figure 4-7 Annual Precipitation and Rose Street CSO Summary

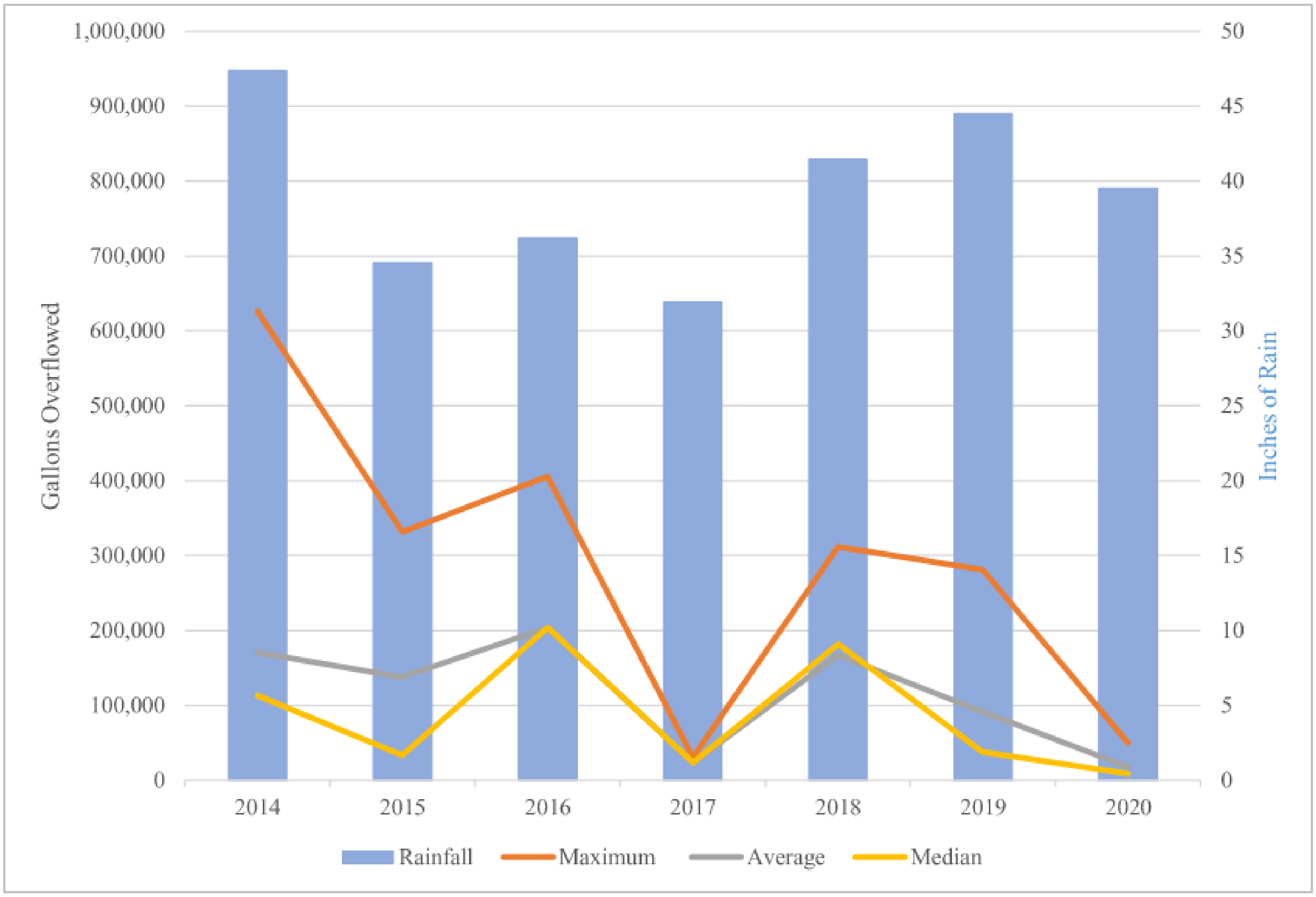
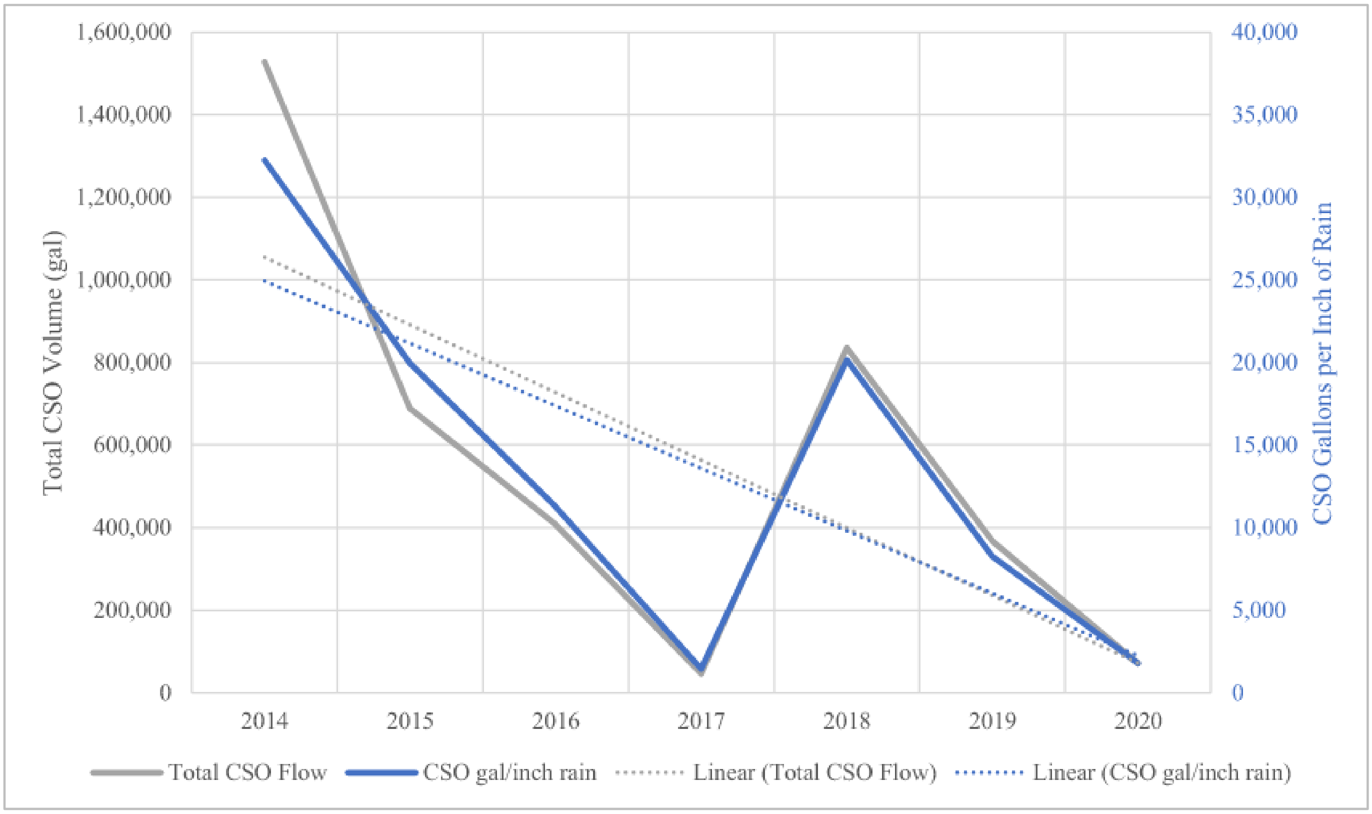


Figure 4-8 Rose Street CSO Gallons Normalized by Precipitation



4.3 Pleasant Street CSO #004

The Pleasant Street CSO is located on Washington Street, east of the Pleasant Street Pump Station. The Pleasant Street Pump Station/CSO has historically also been referred to as the Castine Avenue Pump Station/CSO. This report will refer to this Pump Station/CSO as the Pleasant Street Pump Station/CSO. Refer to Figure 5-11 in Section 5.10 for an overview of the drainage area. The structure has a 12-inch incoming line from the north, a 30-inch incoming line from the west, and one 18-inch outgoing line to the pump station. CSO flows over a weir wall to a 30-inch pipe which runs on Bath Iron Works property before discharging to the Kennebec River. A Tideflex valve is installed on the CSO discharge pipe downstream of the CSO weir to prevent tidal water from surcharging the weir. The City inspects the Tideflex valve annually and have not observed any issues with the valve. However, a block set on top of the CSO weir wall has been observed on both sides of the weir wall after storm events, indicating that flow is surcharging from the CSO pipe back over the weir wall. Figure 4-9 shows the CSO structure, which is denoted as SMH-846 in the City's GIS database. The Tideflex valve is installed in SMH-856.

Figure 4-9 Pleasant Street CSO Structure

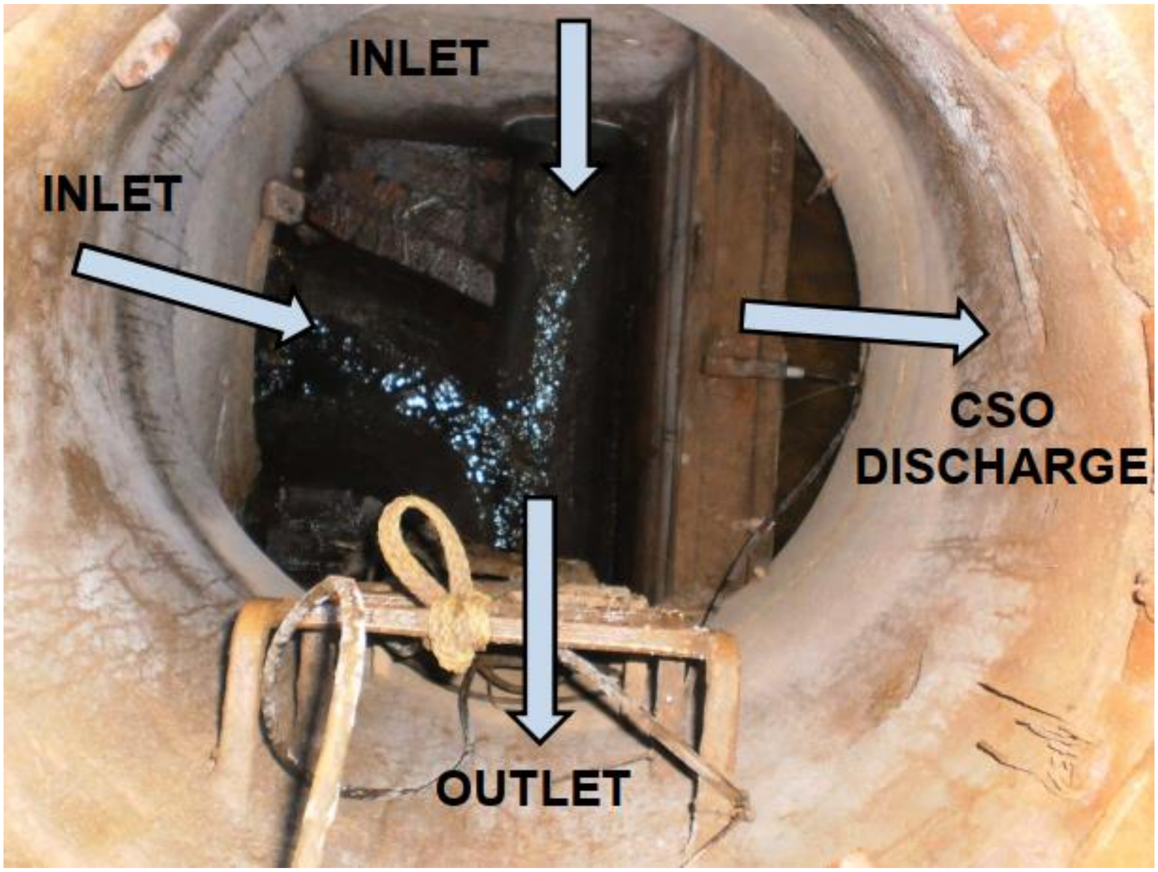


Figure 4-10 shows the number of annual CSO events from the Pleasant Street CSO from January 2014 through December 2020 as well as the maximum, median and average events for each year on a volumetric basis. CSO events decreased from 2014 to 2017, with one large event (approximately 890,000 gallons) occurring in 2017. This one large storm event in 2019 is an anomaly. The Pleasant Street Pump Station lost power during this storm event and the backup generator failed to start, meaning that the pumps were not operational. The City could not get to the pump station to troubleshoot the generator and pumps because the roads were blocked due to fallen trees. Essentially all flow to the pump station during this event ended up bypassing the station as a CSO since the wetwell was full and the pumps were not conveying any wastewater. While this data was recorded as a CSO, it should be noted that this particular event was a significant outlier due to a multitude of factors occurring simultaneously that exacerbated the problem.

Figure 4-11 shows the annual precipitation from January 2014 through December 2020 as well as the maximum, median and average CSO events on a volumetric basis.

In 2014, sewer repairs and catch basin separations were conducted on High Street north of Russell Street. In 2016, a sewer and storm drain cross-connection at High Street near Nichols Street was eliminated. In 2019, the City separated 12 catch basins from the sewer system at the Fisher-Mitchell School. While not immediately apparent when reviewing the data, the impact of these projects has been a success anecdotally. A flow meter installed in the separated catch basins at Fisher-Mitchell school recorded 145,000 gallons of flow during the storm event on

6/30/2020, an event which did not result in a CSO at Pleasant Street. In summary, fewer annual CSO events occur at the CSO, and CSOs occur less frequently during large rain events than was happening prior to the separation projects.

What's less clear is the yearly fluctuation in CSO volume normalized for precipitation. When the 2017 outlier data point is eliminated, the normalized CSO volume has shown a slight increase since 2014. Potential reasons for this fluctuation include:

- Winter Storms - Refer to Section 4.1 for discussion of suspected increased CSO flows due to winter storms in 2018.
- CSO Flow Meter Data Inconsistencies - The City has experienced issues with the ISCO 2150 flow meter measuring CSO flows. Neither recalibrating the meter each week nor replacement of the meter has resolved the issue. Occasionally, CSO data does not record properly, and the City must estimate CSO volumes that are discharged despite the City's best efforts.
- Tidal influences - The City has indicated inconsistent CSO flow meter data when the weir wall has been surcharged (as evidenced by the CSO block being upstream of the weir wall). Wright-Pierce analyzed the timing of CSO events relative to tidal data. Average tidal ranges vary depending on astronomical conditions. During each lunar cycle (a period of 29.5 days), there are two periods where the gravitational pull of the moon and the sun are nearly aligned, which creates larger tidal ranges that produce higher elevations than normal high tide events. These are called "spring tides" and are predictable using NOAA tidal datums for a given location. The Earth and Moon's position within their orbits also have an effect on tides. When the moon circles closest to the earth, it is in a position called perigee. When the earth circles closest to the sun, it is in a position called perihelion. King tides are a special type of spring tide that occur when the Earth is in perihelion and the moon is in perigee. The gravitational pull from both the moon and sun are even greater at these close distances, making king tides even more pronounced than regular spring tides. Historical tidal data from NOAA is available in Bath for 2019 and 2020. Looking at the historical tides relative to CSO events at Pleasant Street, three of the four recorded CSO events occurred during a spring tide, and two of the four events occurred during a king tide. It appears that tidal elevations are influencing the accuracy of the CSO meter for reported events, which makes drawing additional conclusions from the CSO volume data presented challenging. Additional investigations are needed to determine whether the Tideflex valve is not operating as intended and allowing tidal water into the sewer system, or if the downstream CSO pipe is at capacity and not allowing CSO flows to drain to the river.

Figure 4-10 Pleasant Street Annual CSO Summary

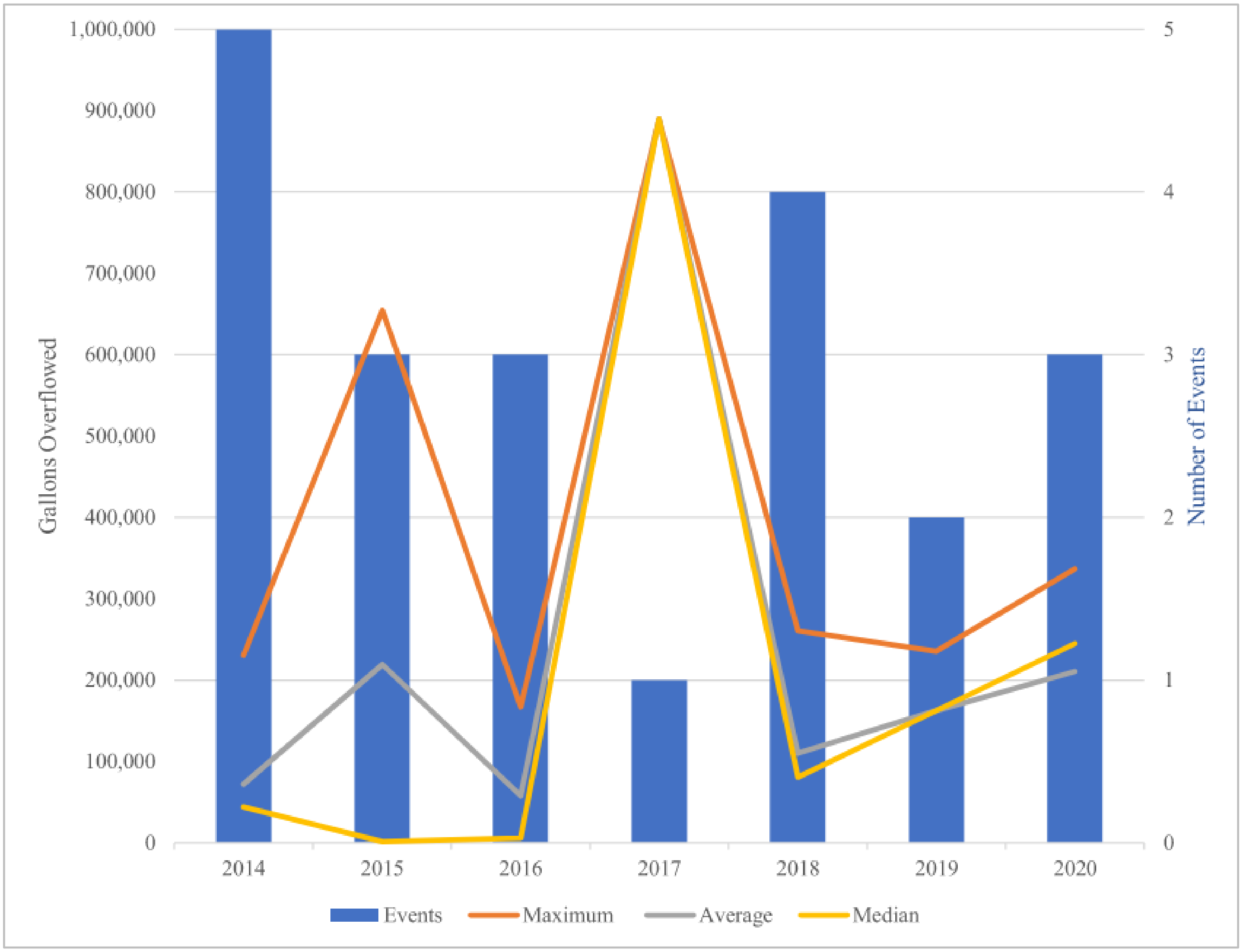


Figure 4-11 Annual Precipitation and Pleasant Street CSO Summary

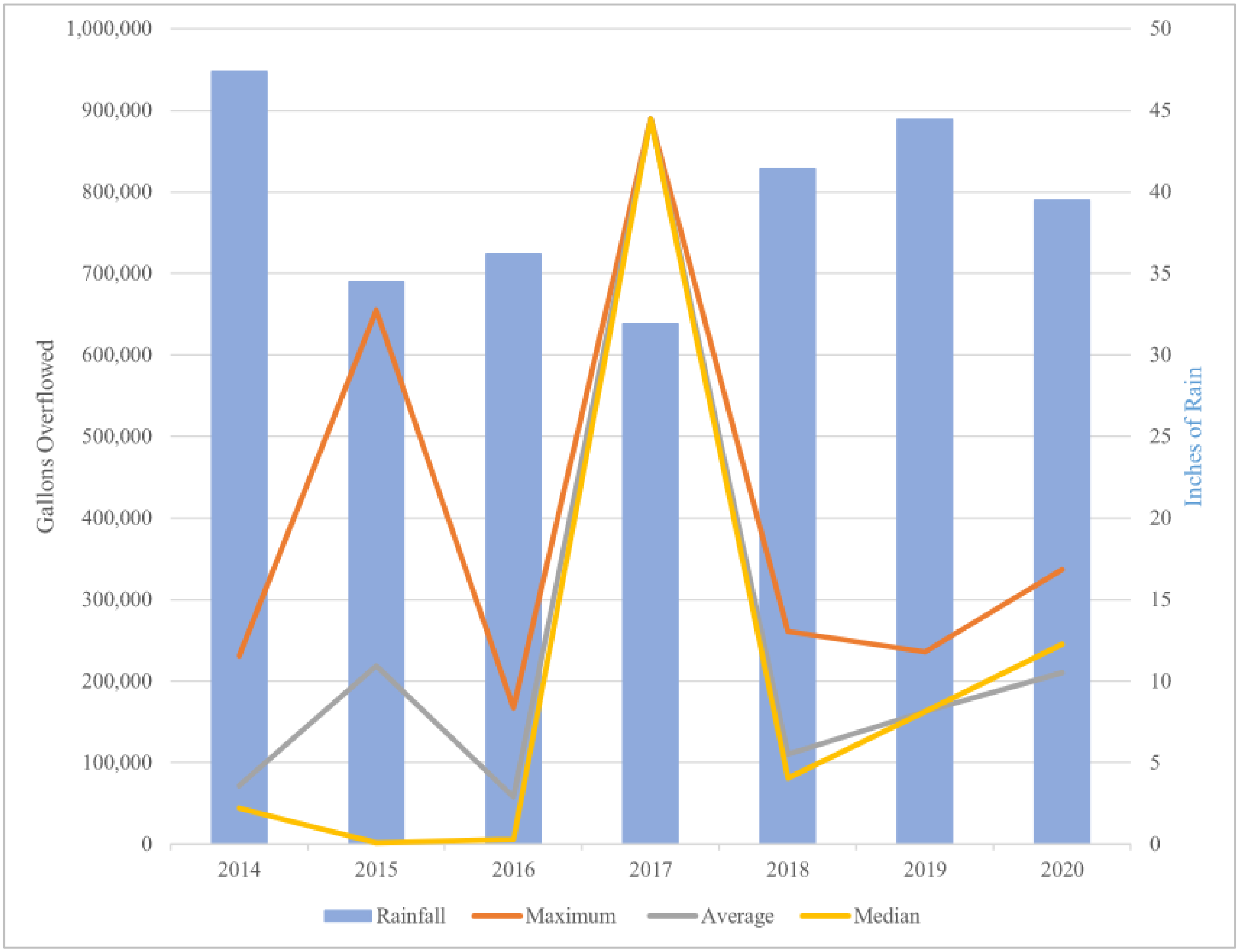
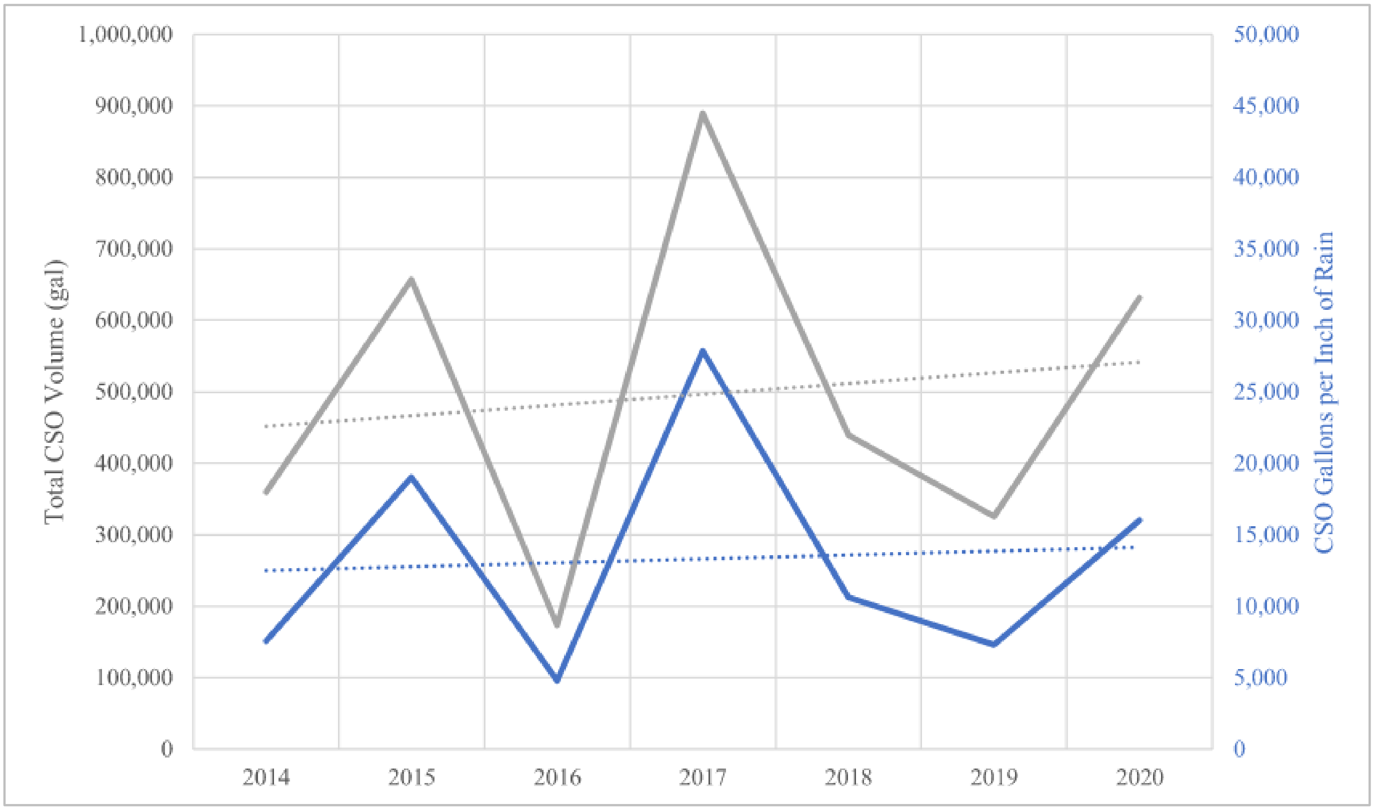


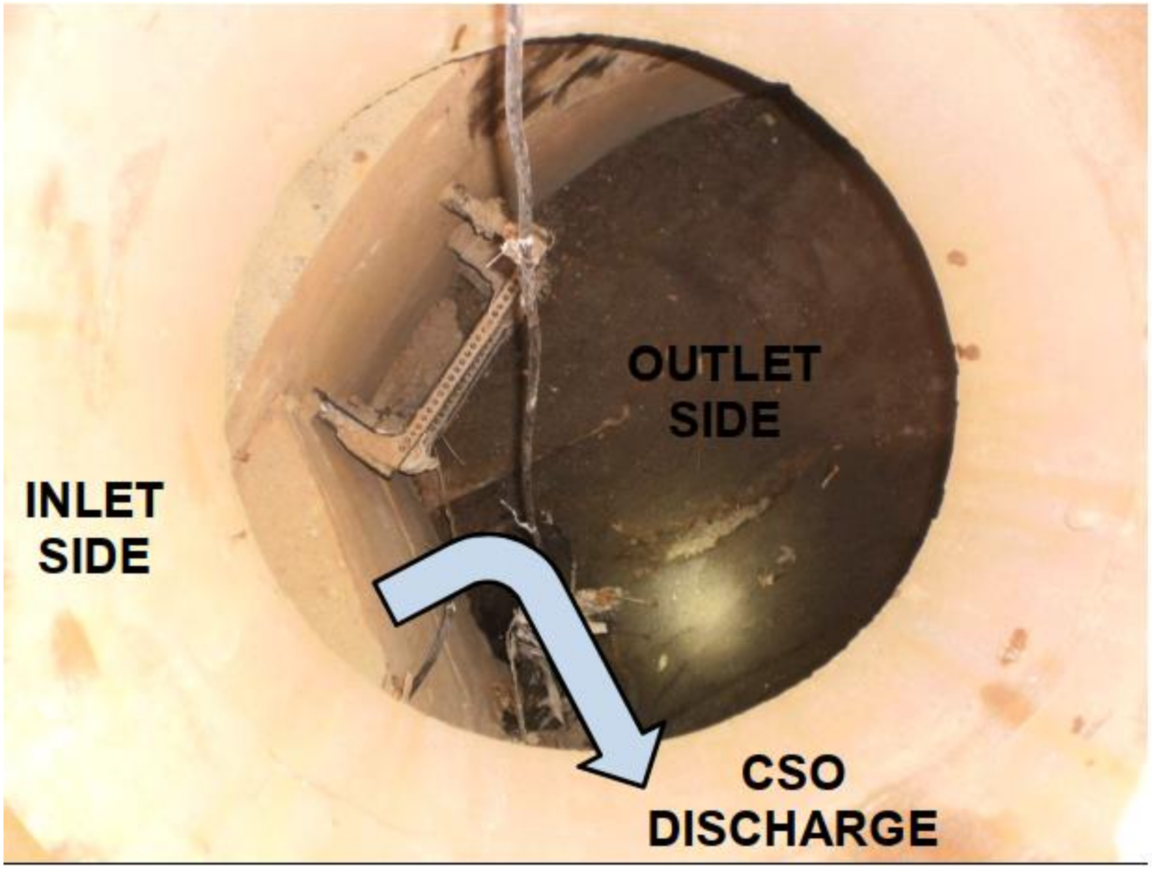
Figure 4-12 Pleasant Street CSO Gallons Normalized by Precipitation



4.4 Commercial Street CSO #005

The Commercial Street CSO structure is located in the intersection of Washington Street and School Street, and the Commercial Street Pump Station is located approximately 1,000 feet away, under the Sagadahoc Bridge. Refer to Figure 5-12 in Section 5.11 for an overview of the drainage area. Wright-Pierce engineers inspected this CSO structure using a pole camera and did not observe any dry-weather flow in the storm drain line that receives the CSO flow. The structure has a 42-inch outgoing line to the pump station. The CSO discharge line flows to DMH-1348 which has a 54-inch size outlet pipe. Figure 4-13 shows the CSO structure, which is denoted as SMH-1376 in the City's GIS database. A hinged gate is installed in a separate manhole downstream of the CSO structure to prevent tidal flow into the CSO manhole. The City last inspected the gate in October 2020, and it appeared to be in good condition.

Figure 4-13 Commercial Street CSO Structure



Modeling studies for the Commercial Street CSO have been completed to determine different options to reduce known SSOs from the interceptor along the railroad tracks upstream of the CSO structure. The modeling efforts have included the Commercial Street Pump Station and main interceptor lines, which has shown that the pump station becomes overwhelmed during wet weather events. The elevation in the wet well increases and flow surcharges the two upstream interceptor pipes, including the pipe that leads back to the CSO structure. As the pipes between the CSO structure and the pump station surcharge, the CSO structure also surcharges and results in a CSO.

Catch basin separations were completed between Green Street and High Street, as well as on the fire station property in 2014. Roof drain and sump pump connections were terminated from the former Re-Store property in 2014. Maine DOT began a road reconstruction project of Leeman Highway in 2016 which separated 25 catch basins from the sewer system. The project was completed in 2018. In 2017 and 2019, the City separated catch basins at School Street near the railroad tracks and catch basins at the intersection of North Street and Washington Street, respectively. Additional field investigations including flow metering and smoke testing have been completed to help confirm sources of I/I. Refer to Section 5.11 for a summary of field investigation findings.

Figure 4-14 shows the number of annual CSO events from the Commercial Street CSO from January 2014 to June 2020 as well as the maximum, median and average events for each year on a volumetric basis. As shown in the graph, CSO events trended down from 2014 to 2017, then increased in 2018 and have been gradually decreasing over the past two years. Figure 4-15 shows the annual precipitation from January 2014 to June 2020 as well as the maximum, median and average CSO events on a volumetric basis. Figure 4-16 shows the CSO volume normalized by annual precipitation.

Average CSO volume has held fairly constant since 2014, with a downward trend since 2018 evident. The maximum CSO flow peaked in 2018 (refer to discussion about storm event conditions in Section 4.1) and has decreased in 2019 and 2020. These factors point towards I/I projects that have reduced the impact of wet weather events on CSOs. However, more work is needed in this drainage area including work to mitigate upstream SSOs which could result in a temporary increase in CSOs.

Figure 4-14 Commercial Street Annual CSO Summary

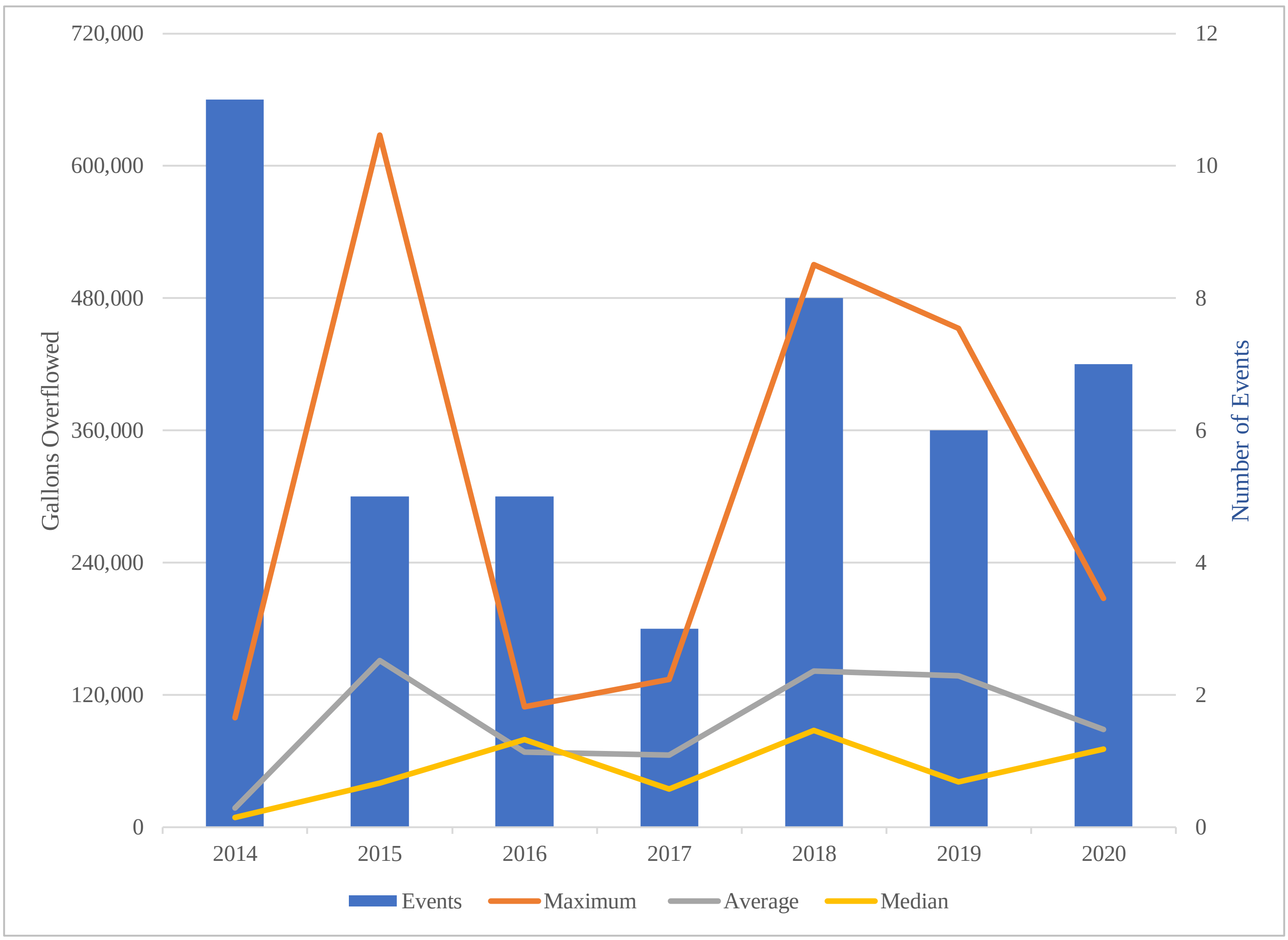


Figure 4-15 Annual Precipitation and Commercial Street CSO Summary

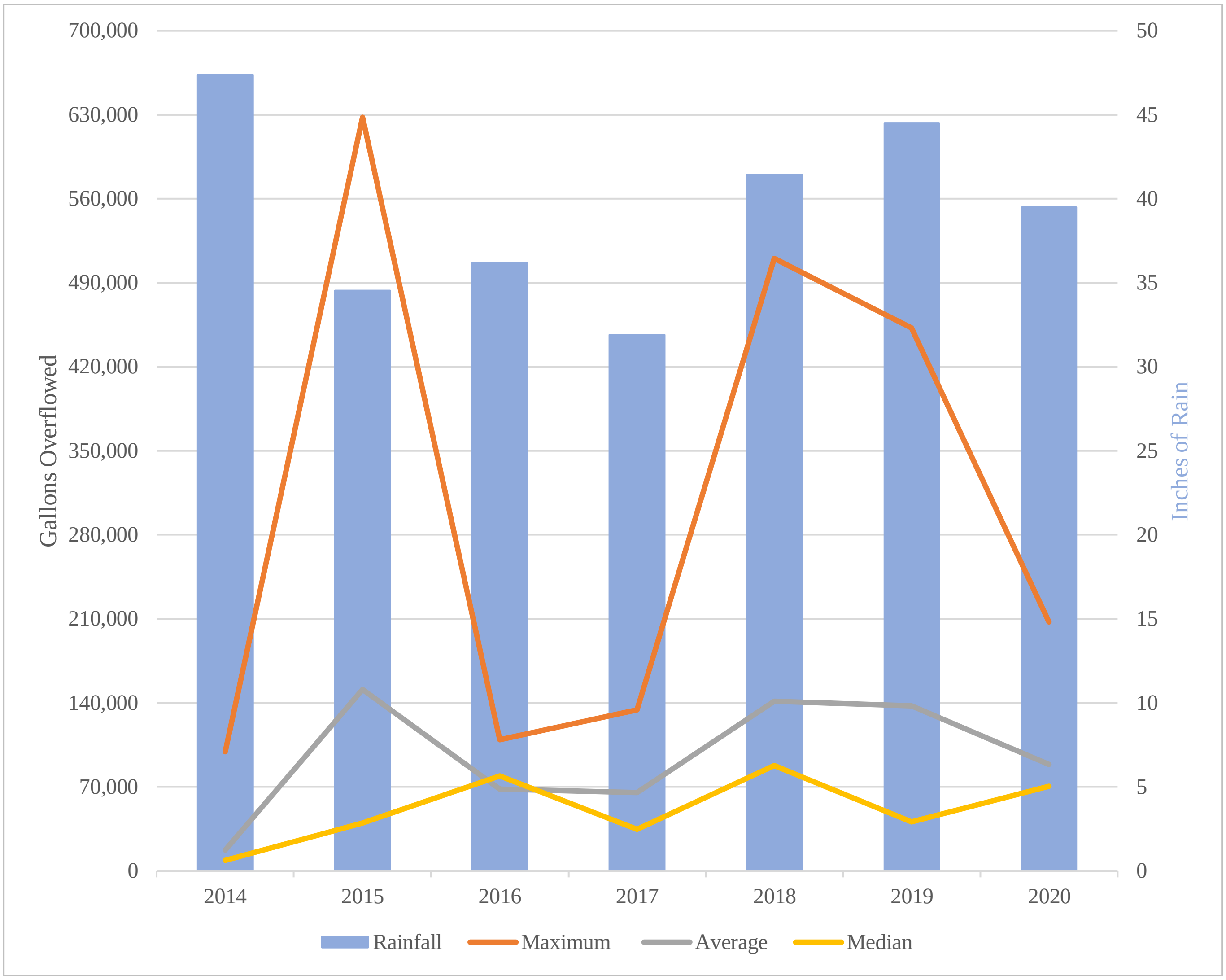
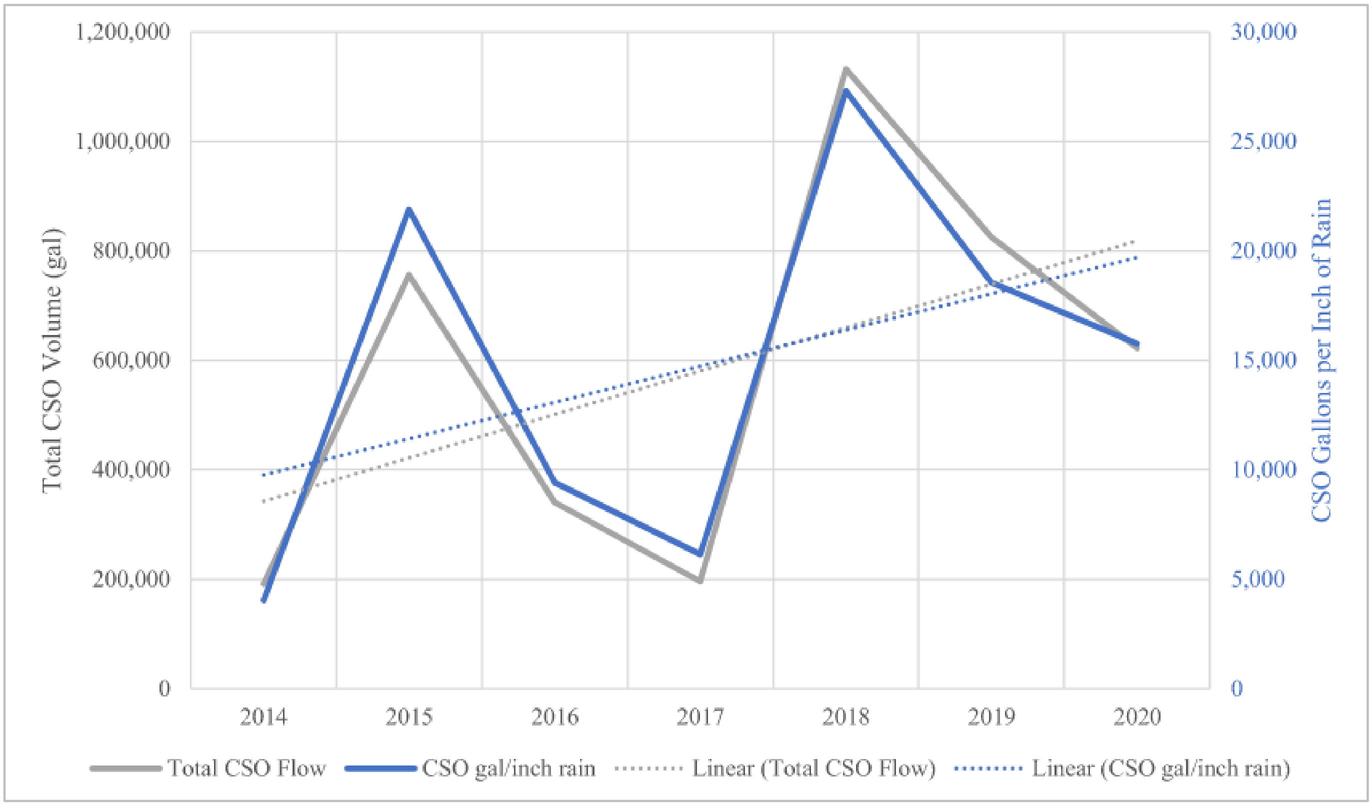


Figure 4-16 Commercial Street CSO Gallons Normalized by Precipitation



4.5 Harward Street CSO #008

The Harward Street CSO, which is in the Harward Street Pump Station catchment area, is located approximately one mile upstream of the pump station. Refer to Figure 5-16 in Section 5.13 for an overview of the drainage area. The CSO structure contains a main sanitary line and a 2-foot-high weir. Sanitary flows that crest this weir discharge to a combined sewer pipe that runs approximately 1 mile to an outfall south of the Harward Street Pump Station. The CSO structure itself is in relatively poor condition, and it is evident that the structure and upstream/ downstream sewer pipes run through low-lying, wet areas. Figure 4-17 shows the CSO structure, which is denoted as SMH-1142 in the City's GIS database.

Figure 4-17 Harward Street CSO Structure

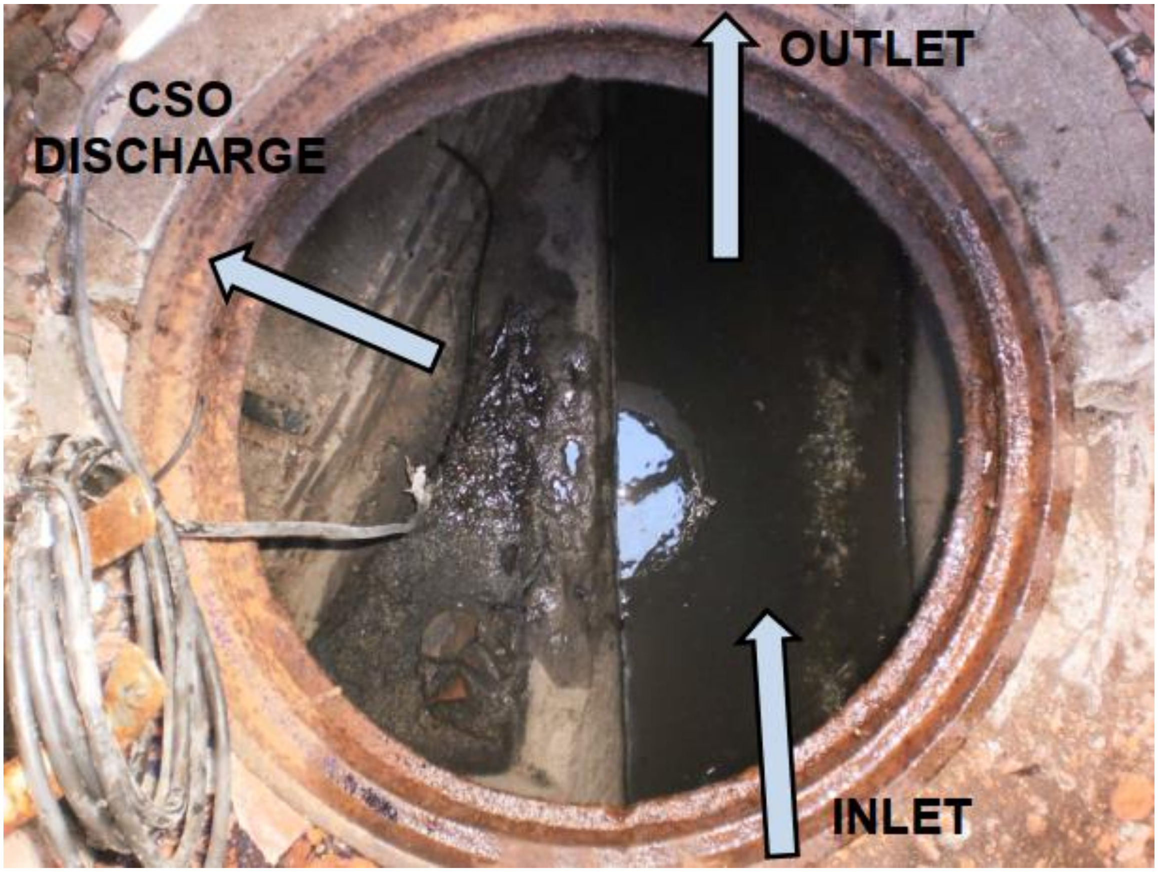


Figure 4-18 shows the number of annual CSO events from the Harward Street CSO from January 2014 to June 2020 as well as the maximum, median and average events for each year on a volumetric basis. As evident from the graph, CSO events decreased in general between 2014 and 2017. Figure 4-19 shows the annual precipitation from January 2014 to June 2020 as well as the maximum, median and average CSO events on a volumetric basis. Figure 4-20 shows the CSO volume normalized by annual precipitation.

The data shows the annual average CSO volume has remained consistent since 2015, while the maximum CSO volume has increased since 2017. The number of CSO events has generally continued to increase since 2015, while the normalized CSO volumes have trended downward since 2014. As with other CSO locations, 2018 CSO volumes increased compared with previous years, likely due to the storm conditions described in Section 4.1.

This is a complex drainage area with known CSO and SSO issues. The City has spent time, effort, and financial resources in this drainage area to reduce CSO flows and mitigate known SSO locations. Catch basins were separated by the City on High Street adjacent to Dike Newell School and at the intersection of Keel and Bedford Street in 2018. In 2020, two low-lying sewer lines were relined to reduce infiltration within this drainage area. Additionally, a number of studies and field investigations have occurred in this drainage area to better understand the collection system and hydraulic issues present.

The impact of these separation projects is promising, as average CSO volumes have remained steady and normalized CSO flows are trending downward. While it is too early to see the effects of the 2020 relining project in this data, preliminary flow metering results show a decrease in I/I in the project area. Refer to Section 5.13 for more details on the flow metering results before and after the relining project.

One complicating factor in measuring the effect of these separation projects is the impact of SSOs in this drainage area. Any discussion about CSO flows at Harward Street CSO #008 must also include discussions about SSOs in this drainage area. Downstream of the Harward Street CSO #008, the interceptor that delivers wastewater to the Harward Street Pump Station has two manhole structures where SSOs occur from time to time during wet weather events, which are reported to Maine DEP. Those manholes are located off Denny Road (SMH-1114) and off Juniper Street (SMH-157). The manholes are monitored by City staff during and after wet weather events. If SSOs are observed, or appear to have occurred (debris around manhole after rain event), the City reports SSOs to Maine DEP. Both SMH-1114 and SMH-157 are located in low-lying areas and the depth from manhole rim to invert is shallow. During wet weather events, the capacity of the sewer collection system is overwhelmed, and the hydraulic grade line exceeds the height of the manhole, resulting in SSOs. Refer to Section 5 for discussions regarding flow metering conducted in this drainage area and known capacity restrictions along the sewer interceptor line that are contributing to SSOs.

While it may seem counter intuitive to say that average CSO volumes remaining steady is promising, one must consider the interrelationship between SSOs and CSOs in this drainage area. The I/I projects undertaken by the City are located upstream of the CSO structure (which is located about halfway between the upper reaches of the drainage area and the Harward Street Pump Station). These projects have reduced I/I in the collection system *upstream* of the CSO. Unfortunately, known capacity issues *downstream* of the CSO limit the amount of flow that can get to the pump station. These capacity issues result in SSOs that are reported to Maine DEP. Without making significant changes to the collection system downstream of the CSO structure, or eliminating enough flow to mitigate capacity issues, one would not expect any real change in CSO volumes upstream of the CSO structure. The wastewater has nowhere to go in the collection system and eventually surcharges the system until exiting the system as either a CSO or SSO.

The City is committed to eliminating SSOs in this drainage area and has undertaken a number of steps towards this goal. In Spring 2021, after consultation with the Maine DEP, the CSO weir wall was lowered by one course of bricks to reduce the hydraulic grade line. By the end of 2021, the City is planning to install a regulator structure on the sanitary sewer line just downstream of CSO #008. The regulator structure includes a slide gate that can throttle the amount of flow in the sewer system, thereby shunting more flow to the CSO. The intent is that the City can adjust the position of the gate valve to restrict flow to a point that SSOs no longer occur. Obviously, any flow restriction to eliminate SSOs comes at the expense of increased CSO flows, which are not included in the CSO flows reported in Figure 4-18. Lowering the weir wall and installation of a regulator structure are meant to be short-term, temporary solutions while the City further analyzes and develops long-term solutions to eliminate SSOs and reduce CSO flows in this drainage area.

Figure 4-18 Harward Street Annual CSO Summary

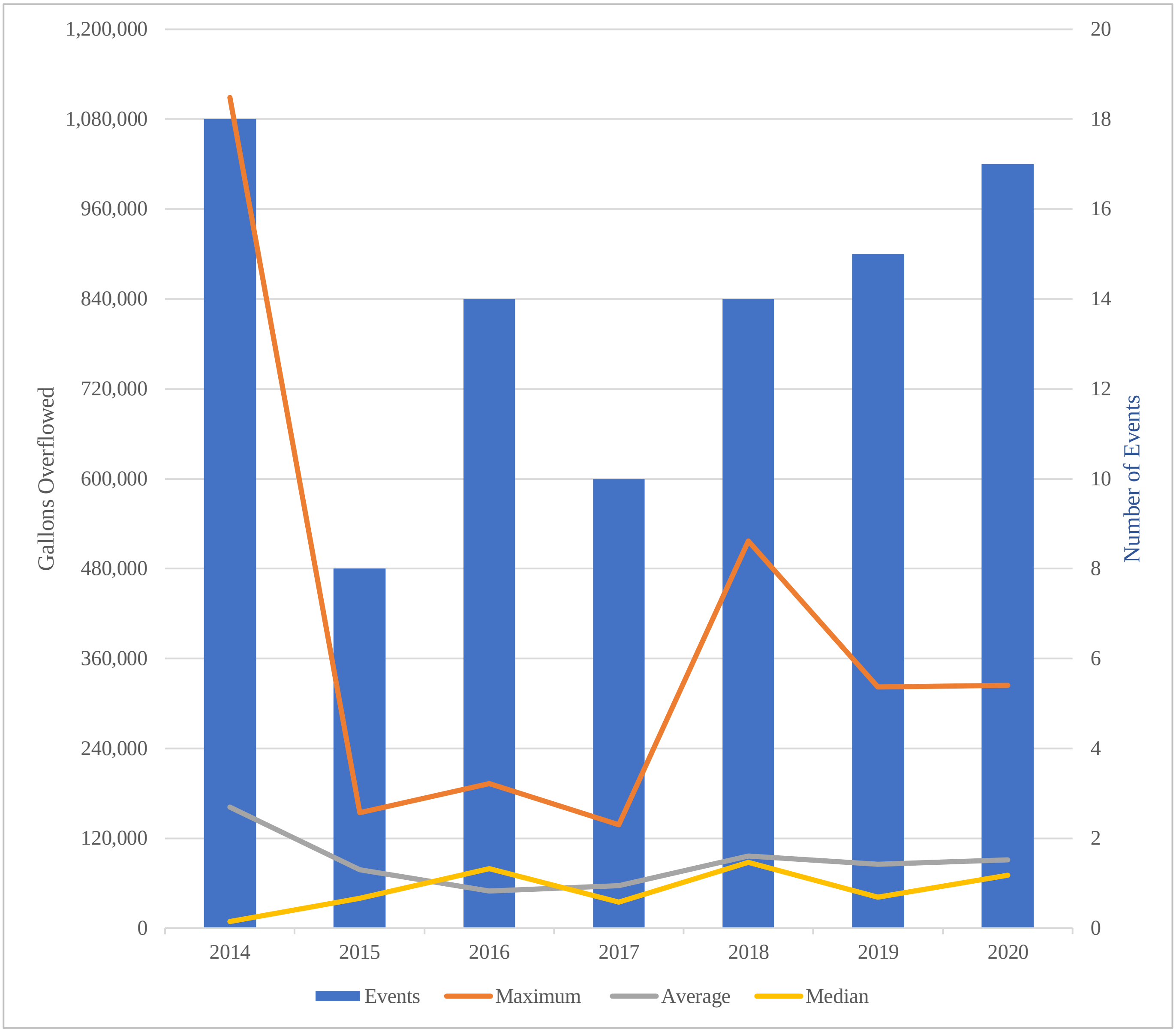


Figure 4-19 Annual Precipitation and Harward Street CSO Summary

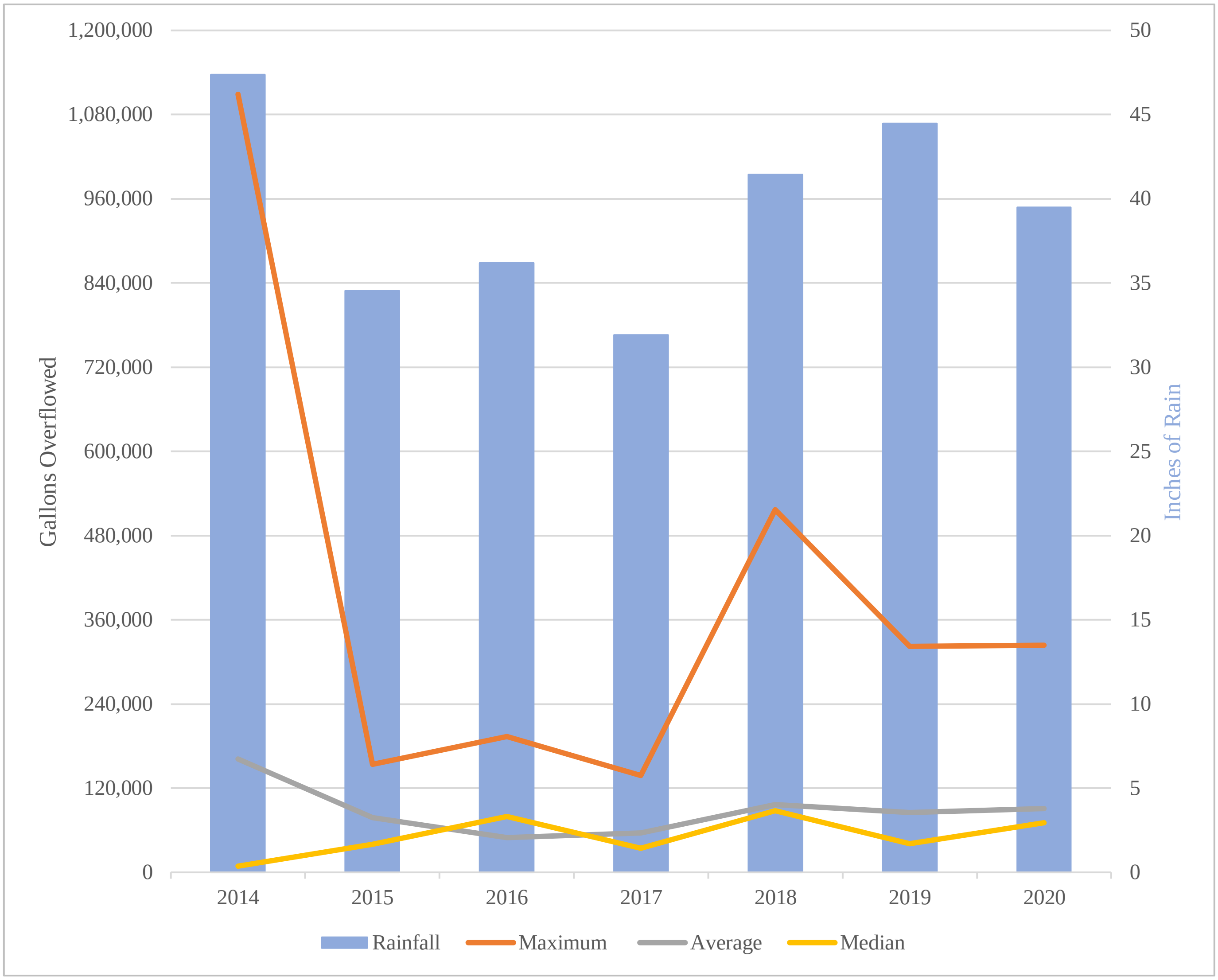
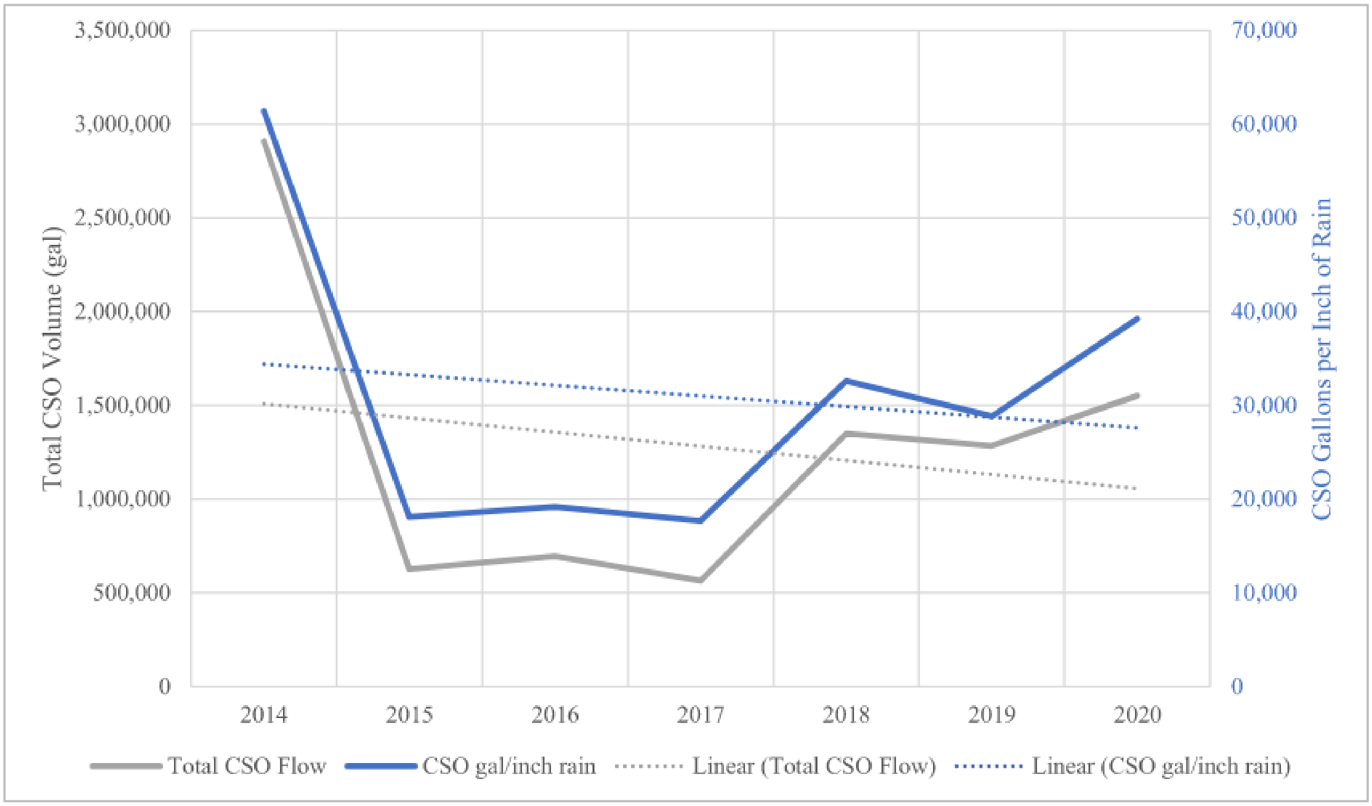


Figure 4-20 Harward Street CSO Gallons Normalized by Precipitation



4.6 Pump Station Flow Analysis

Wright-Pierce reviewed flow and pump run time data for the four pump stations with licensed CSOs. Pump station flow and run time data were compared to the recorded CSO flows at each pump station to determine if the pump stations are operating at maximum capacity when CSO events occur. The discussion below presents analysis and findings at each location.

At Harward Street, Commercial Street, and Pleasant Street Pump Stations, flows are measured using a flow meter that stores and totalizes flow locally at the station. Neither the daily nor instantaneous flow is reported back to SCADA, so City staff visit each pump station every 2 to 3 days and record the totalized flow. City staff then calculate how much flow has been pumped since the last reading. Average flow rates (in MGD) are calculated by dividing the recorded flow volume by the time period between readings. Since there is no flow meter at Rose Street Pump Station, total pumped volume is estimated by multiplying pump run time (in hours, recorded by City staff) by average pump capacity. City staff periodically conduct drawdown tests at these stations to determine average flow rates. Upgrades to record remote pump station flows to SCADA are recommended and summarized in 8.5.5.

When CSOs occur, daily discharge volumes at all four CSOs are recorded by the City using ISCO area velocity flow meters. Graphs of CSO discharge volumes at all four locations from 2014 to 2020 are presented in Sections 4.2 through 4.5. CSO volume is totalized from the ISCO flow meters for each storm event at each CSO location.

In order to determine if each pump station with a licensed CSO is at maximum capacity during wet weather events, flows were analyzed during two wet weather events. The baseline criteria to select these wet weather events were: 1) events with precipitation greater than 2-inches, 2) events that resulted in CSOs at each licensed outfall location, and 3) events that happened in different years to potentially capture effects of recent separation work that the City has completed. Time, duration, and total precipitation of the wet weather events selected and analyzed are as follows:

Table 4-2 Pump Station Flow Analysis - Summary of Selected Precipitation Events

Start Date	Storm Duration (hours)	Total Precipitation (inches)
January 12, 2018	8	2.14
July 12, 2019	6	2.22
June 29, 2020	16	4.32
July 9, 2021	5	3.02

During a CSO event, the pump stations should ideally operate at maximum capacity to minimize CSO flows. The theoretical maximum capacities of each pump station are listed in Table 4-3 and are based on pump station basis of designs and recent drawdown tests performed by the City.

Table 4-3 CSO Pump Stations - Pumping Capacities

Pump Station	Theoretical Design Capacity (gpm)	Measured Drawdown Capacity (gpm)	Date of Drawdown Test
Pleasant Ave	3,800	4,530	3/5/21
Commercial Street	8,100	N/A	N/A
Harward Street	4,200	4,320	11/30/20
Rose Street	1,075	1,213	2/1/21

The theoretical capacity (volume, in million gallons) that each pump station *could* pump if operating at maximum capacity during the CSO events was compared to the actual flow pumped as recorded by City staff. Because pump station flow readings are not taken at the start and end of the CSO events and are averaged over multiple days, this approach is not as accurate for short CSO events and leads to artificially high theoretical pumped volumes. For longer CSO events, such as the events at all four pump stations during the Jan 12-13, 2018 storm, the calculated flow pumped values are likely more representative of actual flows pumped because the CSO duration is similar to the 24-hour averaged flow pumping rates.

To overcome this limitation, City staff recorded flows at each station for the July 9, 2021 storm event. City staff recorded the totalized flow at the start of the day and 12 hours later at the end of the day. By averaging flows over a 12-hour period, more accurate flow rates during the CSO event can be obtained instead of averaging flows over 2-3 days. Instantaneous pump flow data would allow for the flow to be analyzed just during the CSO event and compared to the CSO flow data for the same time period. However, since that data does not exist at this point, an estimation of pump flow over a 12-hour period is as close an estimate that can be obtained.

Table 4-4 presents the results of the pump station flow analyses for each CSO location and various storm events. The table presents the theoretical capacity each pump station was expected to pump (assuming design pumps running at maximum capacity for the duration of the CSO event), and the calculated pumped flow during the CSO event. When the calculated pumped flow during the CSO event is less than the theoretical flow, the pump station is not operating at maximum capacity during CSO events.

Lastly, Table 4-4 compares the total CSO volume to the capacity of the station and determines if the pump station *had* been operating at maximum capacity, could the recorded CSO event been avoided. It should be noted that this simple analysis does not take into consideration a number of more complicating factors, such as variations in flow rates (both pump station and CSO), upstream hydraulic limitations, downstream pipe capacities, and ability of the treatment plant to adequately handle increased flows. Further discussions about these more complicating factors are presented in Section 5, Section 8, and Section 9.

Table 4-4 Results of CSO Pump Station Capacity Analysis

CSO Location	Parameter	Wet Weather Events	
		Jan 12, 2018	July 9, 2021
Pleasant Street PS	Theoretical Capacity During CSO Event (MG)[1]	2.80	0.63
	Actual Flow Pumped During CSO Event (MG)	1.37	0.29
	PS at max capacity?	Yes[2]	Yes[2]
	CSO Duration (hours)	10.3	2.3
	CSO Volume (MG)	0.26	0.08

CSO Location	Parameter	Wet Weather Events	
	Theoretical Capacity ≥ Flow Pumped + CSO Volume? (i.e., could CSO have been eliminated?)	No	No
Harward Street PS	Theoretical Capacity During CSO Event (MG)[1]	6.13	1.93
	Actual Flow Pumped During CSO Event (MG)	2.52	0.81
	PS at max capacity?	No	No
	CSO Duration (hours)	20	6.3
	CSO Volume (MG)	0.52	0.03
	Theoretical Capacity ≥ Flow Pumped + CSO Volume? (i.e., could CSO have been eliminated?)	Yes	Yes
Commercial Street PS	Theoretical Capacity During CSO Event (MG)[1]	7.82	1.19
	Actual Flow Pumped During CSO Event (MG)	4.27	0.76
	PS at max capacity?	No	No
	CSO Duration (hours)	16.1	2.5
	CSO Volume (MG)	0.51	0.03
	Theoretical Capacity ≥ Flow Pumped + CSO Volume? (i.e., could CSO have been eliminated?)	Yes	Yes
Rose Street PS	Theoretical Capacity During CSO Event (MG)[1]	0.55	0.16
	Actual Flow Pumped During CSO Event (MG)	0.38	0.06

CSO Location	Parameter	Wet Weather Events	
	PS at max capacity?	Yes[3]	No
	CSO Duration (hours)	10.5	3.0
	CSO Volume (MG)	0.31[4]	0.03
	Theoretical Capacity ≥ Flow Pumped + CSO Volume? (i.e., could CSO have been eliminated?)	No	Yes

Notes

1. Theoretical Capacity During CSO Event represents the pump flow rate (assuming pumps are operating at maximum capacity) multiplied by the hours of CSO discharge.
2. Although Flow Pumped is less than the Theoretical Capacity, the City typically observes all three pumps operating near 100% speed at the Pleasant Street Pump Station during CSO events.
3. Although Flow Pumped is less than the Theoretical Capacity, the difference is within the margin of error given the limited granularity of pump station flows. Furthermore, the City has not observed capacity issues at this station during CSO events.
4. Flow meter was out of service during this wet weather event. Discharge estimated by City staff.

A summary of Table 4-4 and which pump stations appear to have a CSO event without the pump station operating at full capacity is below:

- The Pleasant Street Pump Station does not appear to have operated at maximum pumping capacity during the January 2018 and July 2021 wet weather events. However, anecdotal evidence from the City indicates that the pump station typically operates at maximum capacity during storm events.
- The Harward Street Pump Station does not appear to operate at maximum pumping capacity during any of the selected wet weather events. This analysis matches anecdotal evidence from the City that the pump station does not operate at maximum capacity during storm events. Known bottlenecks in the collection system and main interceptor leading to the pump station limit flow to the station during wet weather events.
- The Commercial Street Pump Station does not appear to operate at maximum pumping capacity during the selected wet weather events. This analysis matches anecdotal evidence from the City that the pump station is not set to operate at maximum capacity. When all four pumps were operating at full speed, SSOs were occurring at the influent manhole to the WPCF. The City has since reduced the speed of the last pump that operates during wet weather events to limit pumped flows and prevent SSOs downstream of the pump station.
- The Rose Street Pump Station appears to be operating close to maximum pumping capacity during the January 2018 storm event, but not during the July 2021 storm event. With the short duration of CSO events during the July 2021 storm, the averaged pump station flow is likely not representative of the flow that

occurred during the CSO event only (refer to discussion above). This analysis matches anecdotal evidence from the City that the pump station typically operates at maximum capacity during storm events.

The four pump stations with CSOs should be operating at maximum capacity before a CSO event occurs. Section 8 presents screenings and evaluation of various alternatives to increase the capacity of the CSO pump stations and discusses the impacts on the collection system and treatment plant if each station were to operate at maximum capacity.

Section 5 Sewer System Flow Monitoring

5.1 Introduction

A series of field investigations were performed in the City's wastewater collection system between April 2020 and October 2021. The goals of the field investigations were three-fold:

1. To determine which drainage areas may have high inflow/infiltration (I/I)
2. For those drainage areas showing high I/I, to ascertain whether the source of I/I is primarily infiltration (leaking manholes, pipe joints, pipe defects and connections); inflow (roof drains, catch basins, foundation drains, sump pumps, etc. connected to the sewer system); or both; and
3. To determine wastewater flows during dry and wet weather.

The City of Bath has 14 sewer drainage areas which are denoted in Figure 2-1. Figures showing the extents and sewer infrastructure in each drainage area are included in Sections 5.2 through 5.15 below for reference.

An I/I analysis was not completed for the Landfill Pump Station because there is only a small amount of gravity sewer contributing to the pump station. With the future planned closure/capping of the landfill, any I/I that may be present will only decrease as the landfill continues to close cells.

To determine which drainage areas may have high I/I, pump station run time data and pump station flow meter data (for pump stations with flow meters) were reviewed. Pump stations that show increases in pumped flow (as indicated by a peak in pump run times or a peak in measured flow) during storm events suggest I/I may be present within the drainage area. The data reviewed was used as a first pass to determine which drainage areas require more focus and additional field investigations.

Four rain events were used for the pump station analysis and peaking factors calculated. The period from October 8, 2020 through October 12, 2020 was selected as the dry weather baseline time period. The City of Bath installed a new rain gage in November 2020, so the storms analyzed were selected so that localized precipitation data from the new rain gage could be used in the analysis. These storms were selected to represent various precipitation totals, intensities, and durations to provide a representative cross-section for analysis. Peaking factors for each event are presented in Table 5-1. Pump stations with a calculated peaking factor greater than 10 (typically indicative of high I/I) are highlighted. Characteristics of each rain event are summarized below:

- November 23, 2020 – 2.33” of rain with a storm duration of 10 hours
- November 30, 2020 – 1.76” of rain with a storm duration of 9.5 hours
- January 16, 2021 – 1.74” of rain with a storm duration of 9 hours
- July 9, 2021 – 3.02” of rain with a storm duration of 8.5 hours

Table 5-1 Pump Station Peaking Factors – Various Storms

Pump Station	Calculated Peaking Factors			
	11/23/2020	11/30/2020	01/16/2021	07/09/2021
Riverview[3]	5	8	5	5
Bridge[3]	3	5	3	1
Rose[3]	8	**14**	9[1]	8[1]
Farrin[3]	**22**[2]	**37**	**16**[2]	**21**[2]
Wing[3]	**11**	**10**	6	3
Aegis[3]	1	1	1	1
Hunt[3]	8	**10**	7	6[2]
Front[4]	**11**	**17**	8	7
Commercial[4]	9[1]	**15**	8[1]	9[1]
Hyde[4]	6	7	5[2]	7
Harward[4]	**12**[1,2]	**17**[2]	9[1, 2]	8[1, 2]
Pleasant[4]	7	**11**	7	7[1]

Notes:

1. CSO event took place in this drainage area during this storm event
2. SSO event(s) took place in this drainage area during this storm event
3. Pump station does not have a flow meter. Pump run times during storm was compared to baseline dry weather pump run times to calculate peaking factor
4. Pump station has a flow meter. Flow meter data during storm was compared to baseline dry weather flow meter data to calculate peaking factor

Table 5-1 indicates some general trends at each pump station. It should be noted that while there is a direct correlation between total precipitation and peaking factor, there are a number of other factors that need to be considered. Storm duration, intensity, ground saturation, and preceding weather all play a roll. For example, the 11/23 storm likely saturated the ground so that the 11/30 storm event likely had less saturation and quicker inflow/infiltration into the sewer system. This could explain why the peaking factors for the 11/30 storm are higher than the 11/23 storm, even though both storms had similar precipitation and duration totals.

One additional item that must be considered in this analysis is that some pump stations are tributary to other pump stations. Figure 2-2 shows a schematic diagram of the pump stations within the City of Bath and how each pump station connects with other pump stations. For example, the Pleasant Street Pump Station force main discharges within the Commercial Street Pump Station drainage area. I/I that is entering the Pleasant Street Pump Station drainage area is pumped to the Commercial Street Pump Station drainage area and then subsequently pumped by the Commercial Street Pump Station. The data analyzed does not subtract out tributary flows, so peaking factors calculated at an upstream station are included in the downstream pump station. Thus, the results in Table 5-1 need to be taken within context of other upstream conditions, observed wet weather conditions, and anecdotal evidence from the City.

As discussed in Section 4.6, the pump station flow meter and run time data are collected every 2-3 days. The data used to calculate the peaking factors in Table 5-1 are an average of the flows and run times recorded over the 2 or 3 days surrounding the storm event. This is true for the storms in Table 5-1 except for the July 9, 2021 storm event. In an attempt to obtain more granular data around the July 9, 2021 storm, City staff collected pump station flows and run times just before the storm began and immediately after the storm ended for all the pump stations included as part of the analysis. Therefore, the peaking factors for the July 9, 2021 storm are for the duration of the storm only. It is expected that the peaking factors calculated using this method would be more accurate because the flows and run times are not averaged and diluted over 2-3 days. The data does not show a significant variation in peaking factors calculated for each pump station using this more granular method. This indicates that the peaking factors calculated for other storm events are generally representative of what is occurring in the collection system. During the July 9, 2021 storm, CSOs at all five licensed locations, including the WPCF occurred. SSOs also occurred at various locations, validating the significance of this storm.

The results of Table 5-1 were discussed with City staff. Each drainage area showing potential I/I issues (highlighted in blue) was reviewed and the City provided additional insight into whether there are known or suspected sources of I/I in each drainage area.

With the City's insight and WP's previous knowledge of suspected I/I in particular drainage areas, combined with the peaking factor results presented in this section, the drainage areas with suspected I/I were narrowed down to the following locations for further investigation and flow metering:

- Hunt Street Pump Station Drainage Area
- Rose Street Pump Station Drainage Area
- Pleasant Street Pump Station Drainage Area
- Commercial Street Pump Station Drainage Area
- Farrin Place Pump Station Drainage Area
- Harward Street Pump Station Drainage Area

5.1.1 Flow Metering Methodology

The City of Bath owns and maintains 11 area/velocity flow meters, four of which are dedicated to CSO locations and seven that are portable and have been used extensively throughout the sewer drainage areas to help measure I/I flows. The data collected over the years has helped identify areas of high I/I flows and has led to several I/I reduction projects including sewer relining and sewer and manhole replacement. This data has also been useful in determining the flow capacities for the various CSO abatement alternatives discussed in Section 9 of this report.

Though Section 9 describes CSO abatement alternatives and costs, it is important to continue flow monitoring throughout the City to identify areas in the sewer system that could benefit from future I/I reduction projects, and private I/I sources that can be removed without major construction costs to the City or property owners. Future flow monitoring efforts should include metering in high priority areas, CCTV inspection of pipes, and dye testing of suspect roof leaders, floor drains, and storm drains in high priority areas.

Using collected flow meter data, two methods to identify areas of high I/I were used. The first method calculates the peaking factor for each sub-area by relating the peak storm flow to the baseline flow. As previously mentioned, peaking factors above 10 are indicative of probable I/I into the collection system. The second method calculates the baseline infiltration rate in gallons per day per inch of diameter per mile of pipe (gpd/idm) to determine if excessive infiltration is present. The baseline infiltration rate is calculated as described below:

- Dry-weather flow is defined as wastewater flow exclusive of peak infiltration and wet-weather flow (inflow). It consists of base sanitary flow (BSF) and base infiltration (BI). Base (or permanent) infiltration occurs in the system even under relatively low groundwater conditions. Dry-weather flow occurs during periods of low groundwater, which tends to be seasonal.
- Infiltration enters the sewer collection system through pipe joints, pipe defects (including main sewer lines and service laterals), and defective manhole walls, benches, and pipe seals. Infiltration for the project area was calculated based on analysis of flow meter data using methodology that incorporates average dry daily flows and minimum night flows to estimate infiltration.
- The approach used an empirical method employing the "Stevens-Schutzbach" equation (Paul S. Mitchell, Patrick L. Stevens, and Adam Nazaroff, "A comparison of methods and a simple empirical solution to quantifying base infiltration in sewers." Water Practice, 2007).

Infiltration rates have been normalized based on collection system "size" (sewer pipe length and diameter) for comparison across the entire sewer shed. The pipe lengths were derived from the City's sewer GIS data. Some pipe diameter information was missing for certain sewer lines in each sub-area. Where available, infiltration rates were calculated using known pipe diameters. When unavailable, Wright-Pierce calculated the average pipe diameter for each subarea. For example, if four pipes exist in a drainage area, and two pipe diameters are known (8-inch and 16 inch), the remaining two unknown pipe diameters were assumed to be the average of the known pipe diameters, or 12-inch diameter each in this example.

To determine flow meter sub-area size relative to others, each pipe length was converted to units of inch-diameter-miles (idm). A unit base infiltration rate, expressed in gallons per day per inch diameter-mile (gpd/idm), was then calculated by dividing the peak base infiltration for each subarea by the computed "idm".

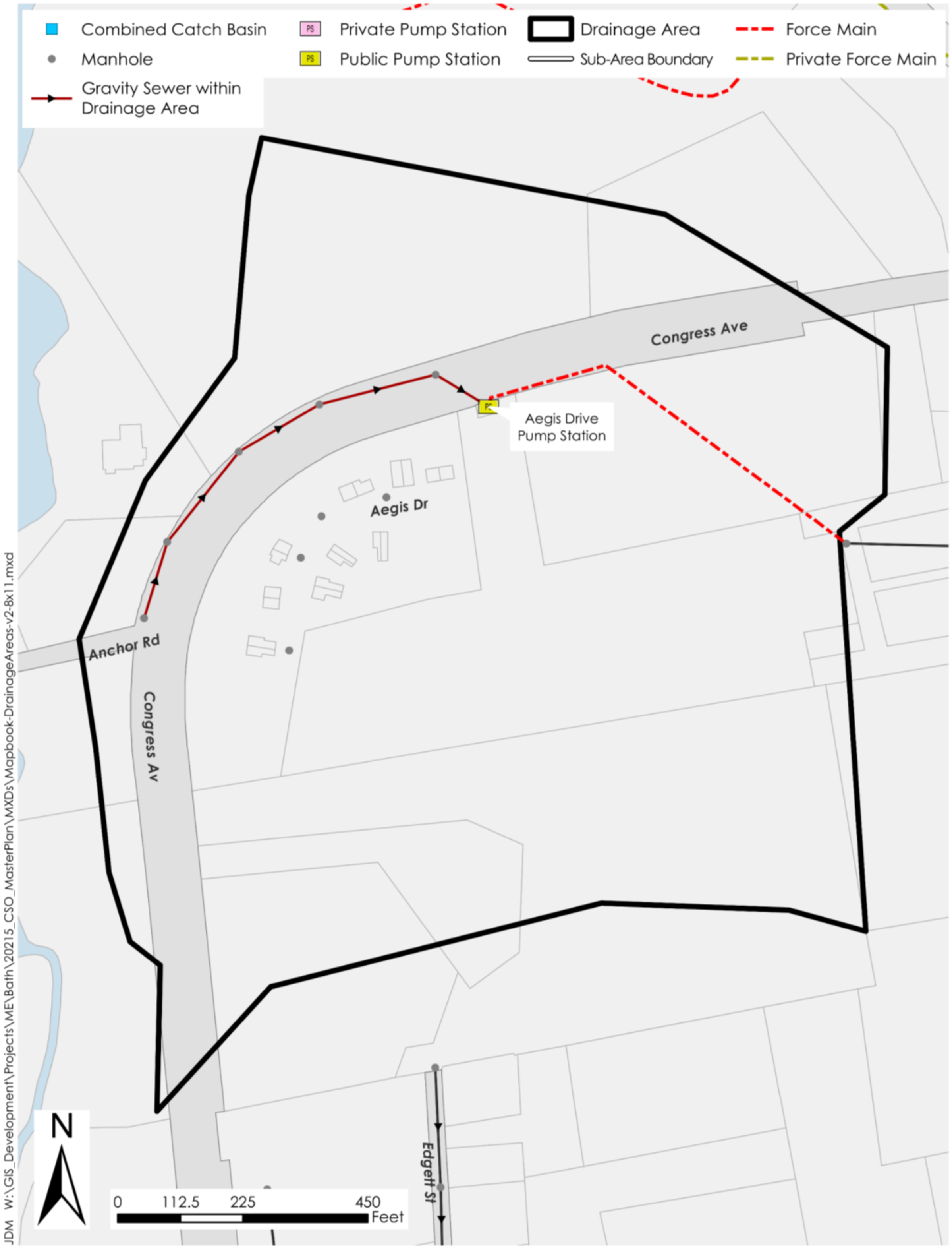
The "industry standard" indicator that further investigation and/or rehabilitation may be cost effective are flows exceeding 4,000 gpd/idm. This "industry standard" indicator is defined by the Massachusetts Department of Environmental Protection in the *Guidelines for Performing Infiltration/Inflow Analysis and Sewer System Evaluation Survey*. Results of both approaches (peaking factor and baseline infiltration rate) are discussed in each drainage area section where flow metering was completed.

These two methods of analysis were used to help infer if I/I is present in each drainage area or sub-area. It should be noted that some drainage areas and sub-areas are so small that a high peaking factor (greater than 10) or high infiltration rate (greater than 4,000 gpd/idm) means that although there appears to be excess flow in the system, it is a small amount of excess flow that it is inconsequential when comparing it to excess flows found in other larger drainage areas. Creating projects to address small amount of flow that will minimally decrease CSO or SSO flows is not cost effective, making these small areas a lower priority. Refer to each drainage area writeup below for peaking factor and baseline infiltration findings for drainage areas that were flow metered.

5.2 Aegis Drive Drainage Area

The Aegis Drive drainage area serves a very small area in the west side of the City south of the Bath Middle School. The drainage area includes 5 manholes connected by gravity sewer pipe which flows to the Aegis Drive Pump Station. Figure 5-1 shows the extents of the drainage area. Table 5-1 indicated a low peaking factor for this drainage area, so no additional sewer system flow monitoring was conducted.

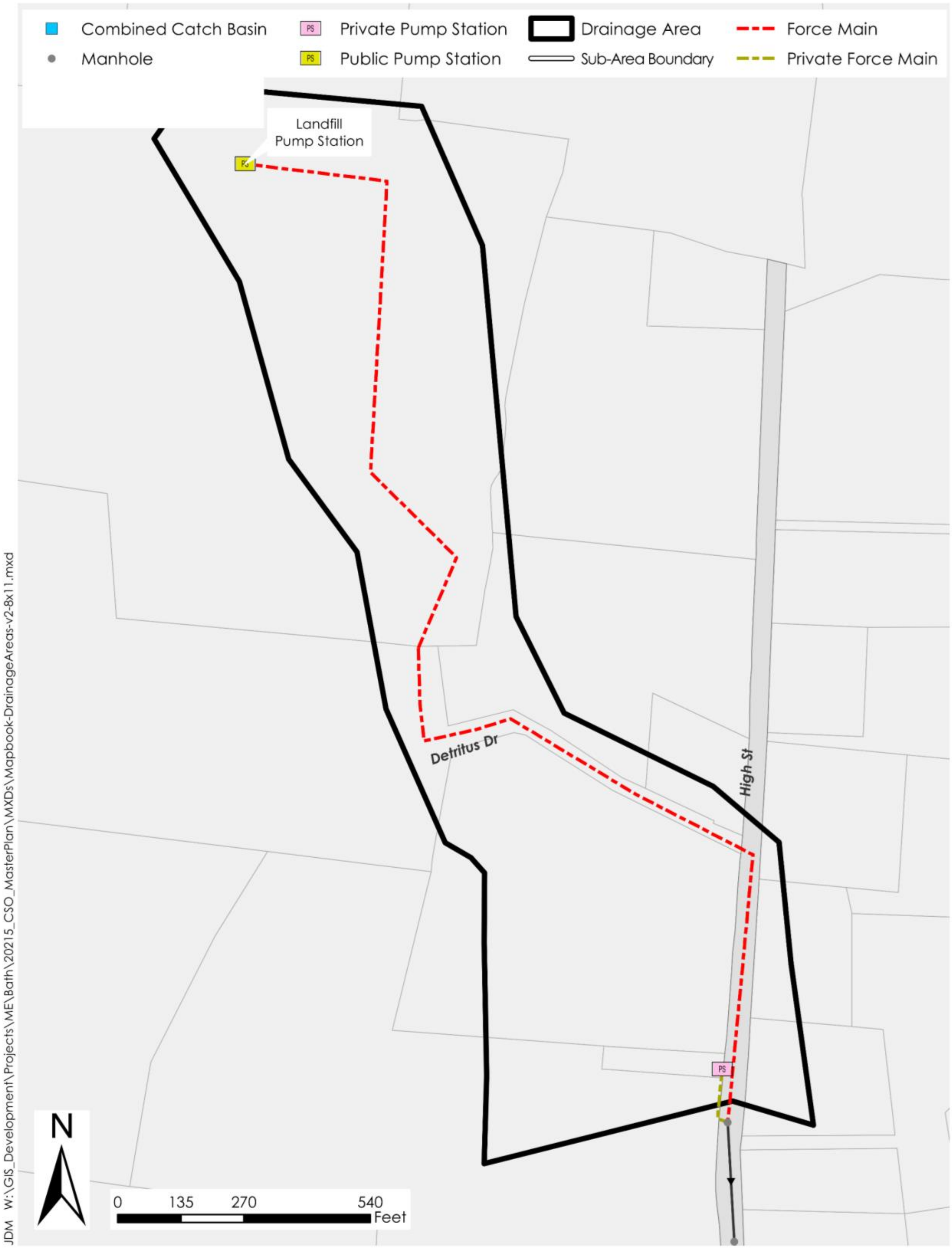
Figure 5-1 Aegis Drive Pump Station Drainage Area



5.3 Landfill Drainage Area

The Landfill drainage area contains minimal system sewer pipe or manholes; therefore, there are little to no sources of I/I aside from rainfall on the open face of the landfill which should be reduced over time as the landfill is capped. The Landfill Pump Station has a 6-inch force main that ties into the Harward Street drainage area. Figure 5-2 shows the extents of the drainage area. Pump station flow data was not reviewed for this pump station. No additional sewer system flow monitoring is planned for this area.

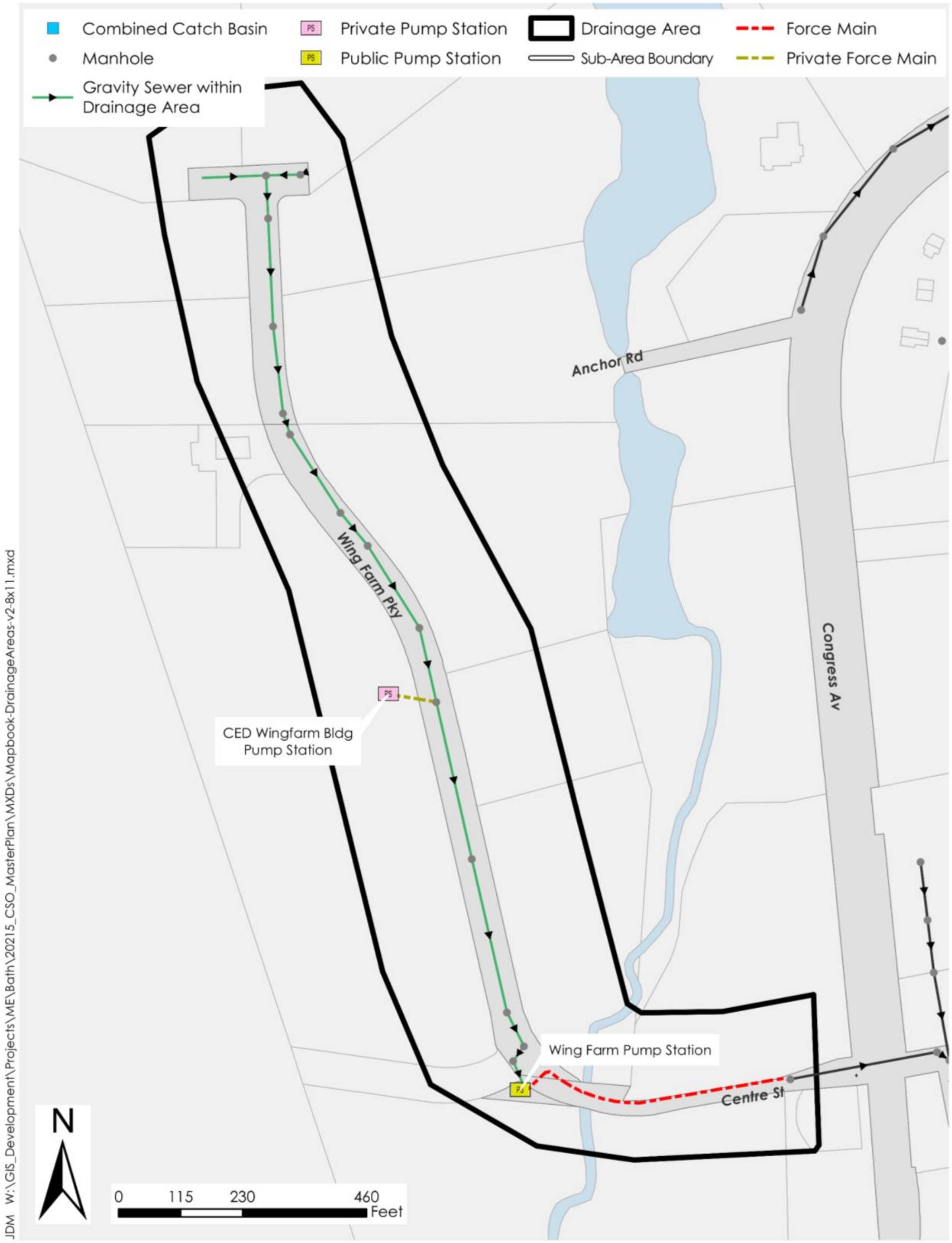
Figure 5-2 Landfill Pump Station Drainage Area



5.4 Wing Farm Drainage Area

The Wing Farm drainage area serves the Wing Farm Parkway in the westernmost area of Bath. The drainage area includes 15 manholes connected by gravity sewer pipe which flows to the Wing Farm Pump Station. The sewer in this area is relatively new compared to the rest of the City's collection system. Figure 5-3 shows the extents of the drainage area. Table 5-1 indicated a low peaking factor for this drainage area, so no additional sewer system flow monitoring was conducted.

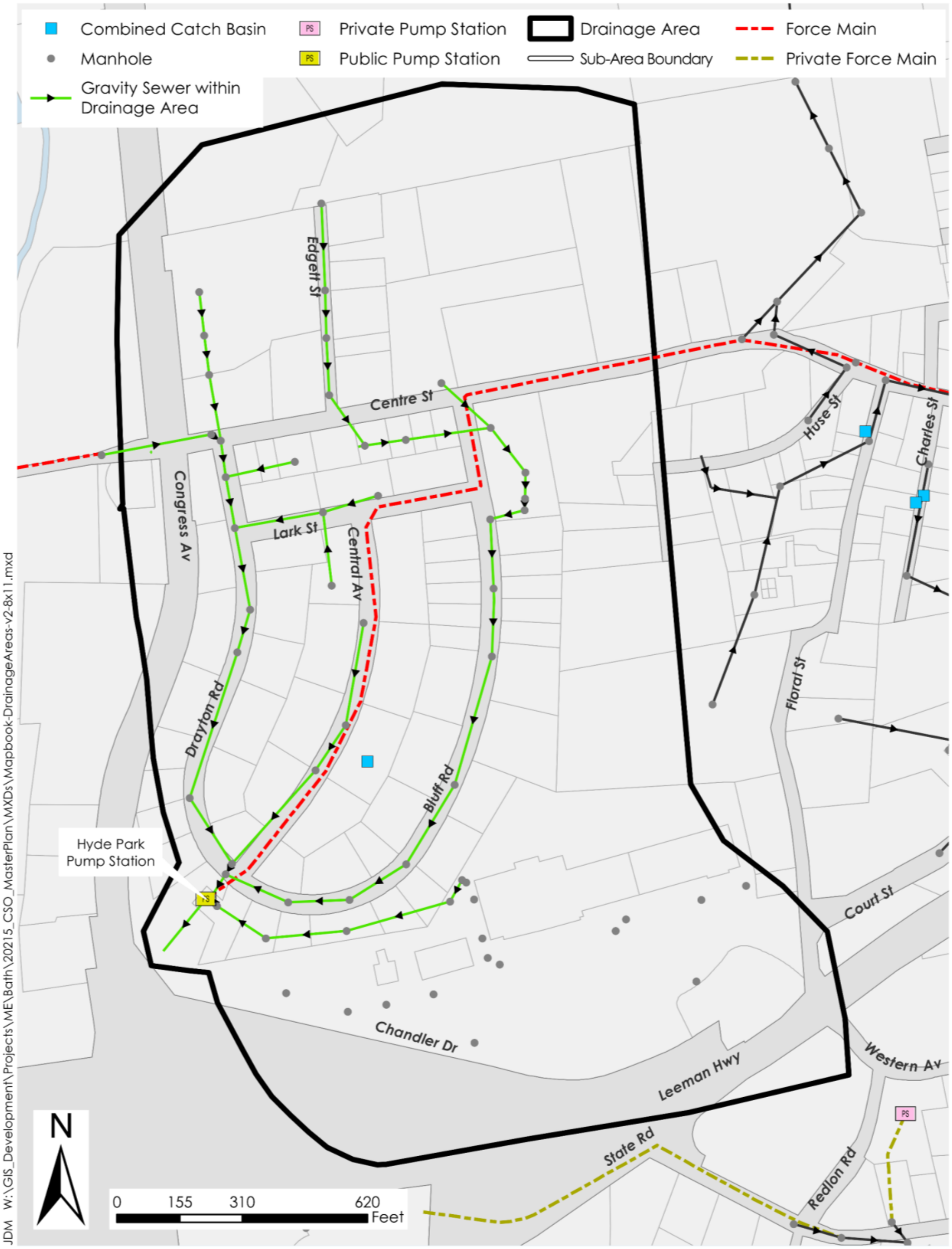
Figure 5-3 Wing Farm Pump Station Drainage Area



5.5 Hyde Park Drainage Area

The Hyde Park drainage area serves a small area in western Bath north of Route 1. The Hyde Park Pump Station receives flow from the Wing Farm Pump Station force main. The ongoing Western Avenue, Academy Street, and Cobb Road Storm Drain and Sewer Improvements construction project includes relining of a section of sewer pipe in Central Avenue to reduce infiltration. Figure 5-4 shows the extents of the drainage area. Table 5-1 indicated a low peaking factor for this drainage area, so no additional sewer system flow monitoring was conducted.

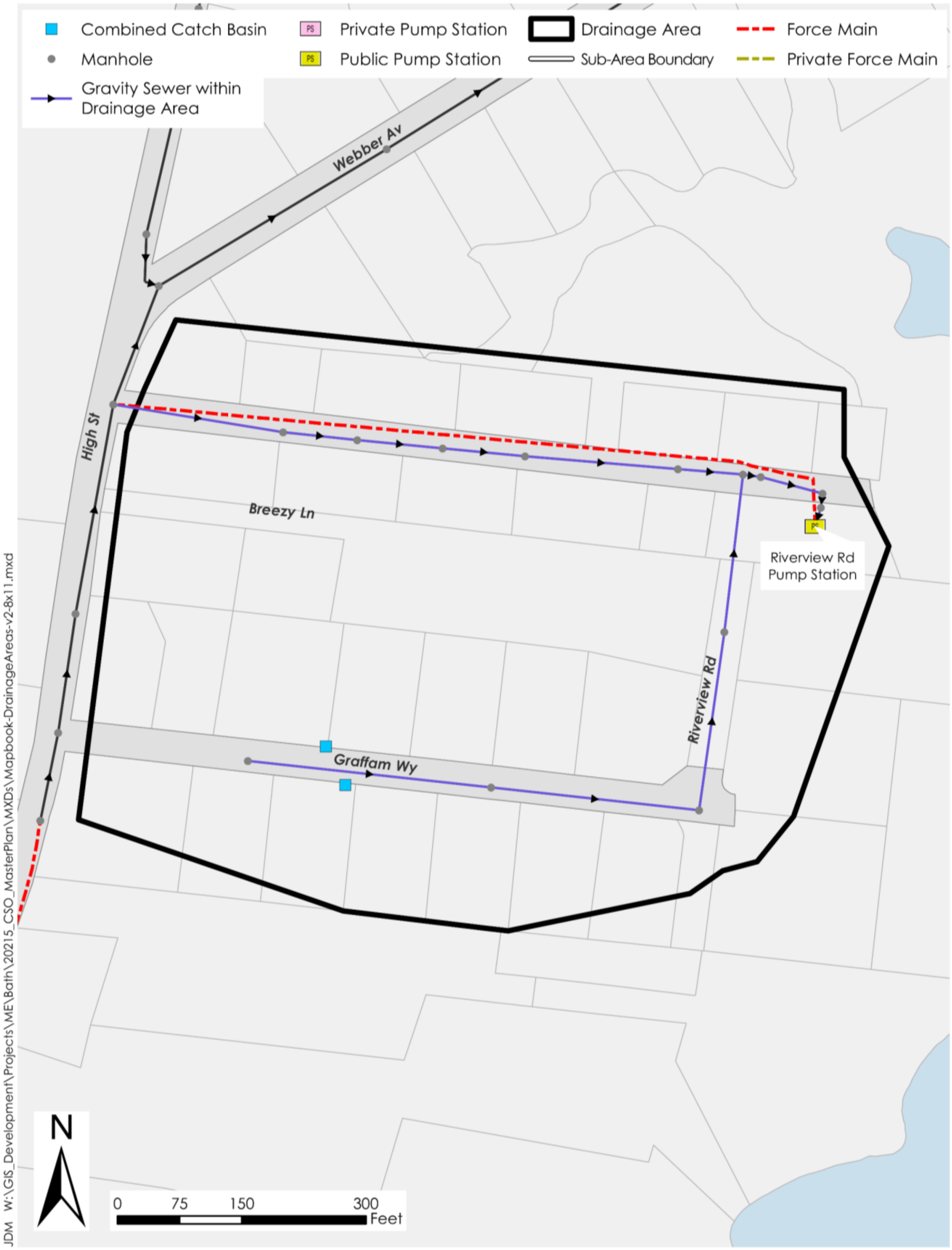
Figure 5-4 Hyde Park Pump Station Drainage Area



5.6 Riverview Road Drainage Area

The Riverview Road drainage area serves a small area in southern Bath which includes Riverview Road and Graffam Way. The drainage area includes 13 manholes connected by gravity sewer pipe which flows to the Riverview Road Pump Station. Figure 5-5 shows the extents of the drainage area. Table 5-1 indicated a low peaking factor for this drainage area, so no additional sewer system flow monitoring was conducted.

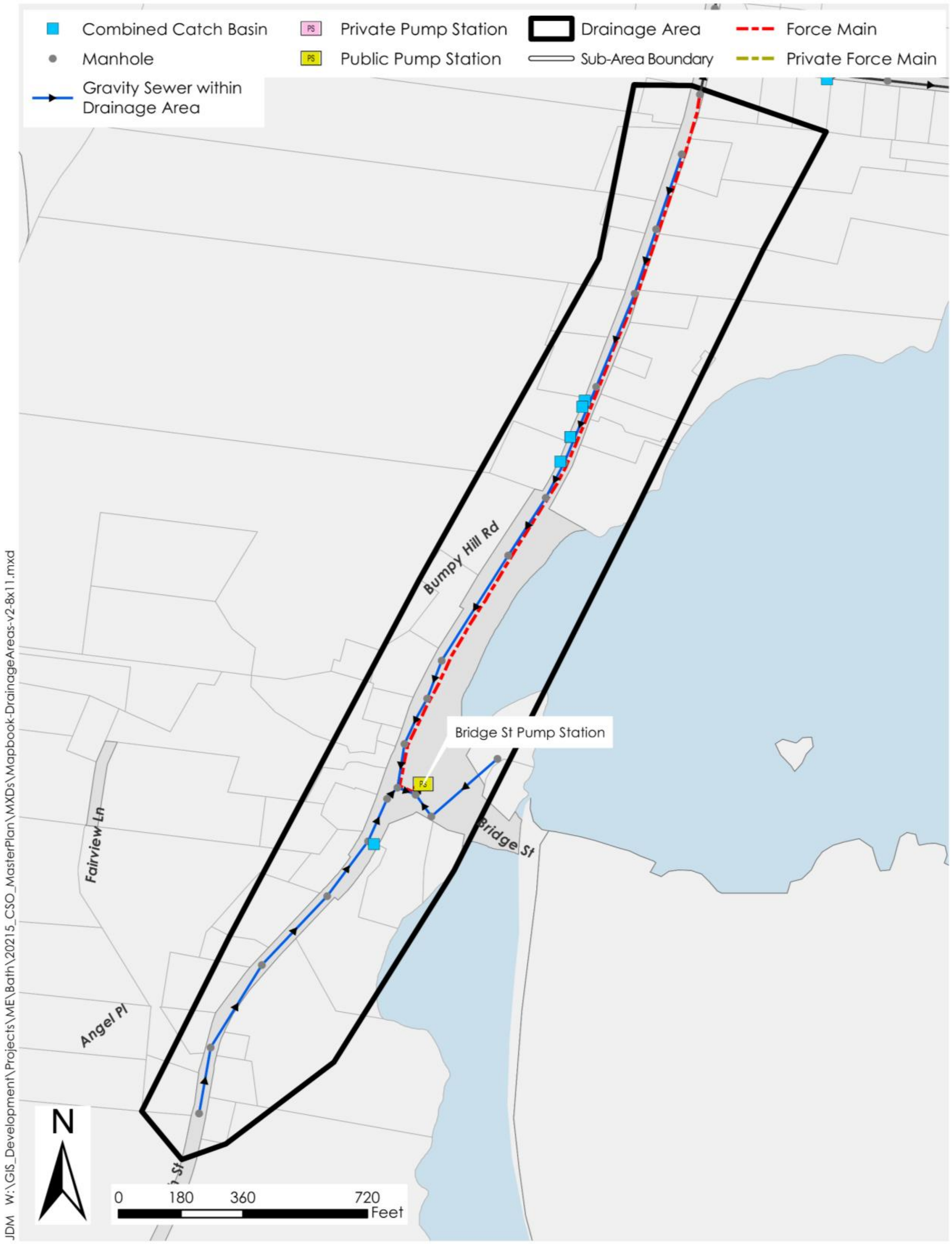
Figure 5-5 Riverview Road Pump Station Drainage Area



5.7 Bridge Street Drainage Area

The Bridge Street drainage area serves the southernmost area in Bath which mainly consists of High Street. The Bridge Street Pump Station force main runs north and ties into the Hunt Street drainage area. Figure 5-6 shows the extents of the drainage area. Table 5-1 indicated a low peaking factor for this drainage area, so no additional sewer system flow monitoring was conducted.

Figure 5-6 Bridge Street Pump Station Drainage Area



5.8 Hunt Street Drainage Area

The Hunt Street drainage area serves a large portion of the south end of Bath. The Riverview Road and Bridge Street Pump Station force mains tie into the Hunt Street drainage area. Figure 5-7 shows the extents of the drainage area. Sources of I/I were found while flow metering in the Hunt Street Drainage Area in 2014. Analysis of the flow meter data and field investigation findings were provided to the City in the 2015 'Wastewater Transport System Evaluation' report. Recommended actions to reduce infiltration in the drainage area were also included in this report and resulted in the City completing two projects in 2018 and 2021, which included relining and replacement of select sewer pipes and manholes in this drainage area. The areas where work was completed are shown in Figure 5-8. Work completed in the SMH-XC and SMH-992 sub-areas consisted of sewer relining and sewer pipe replacement as shown in Figure 5-8 with the goal to reduce infiltration.

Post-project flow metering was conducted in 2021 and compared to the 2014 flow meter data to determine how effective the projects were at reducing infiltration in the collection system. Flow meters were installed in 2021 in the same manholes (SMH-XC and SMH-992) as the 2014 metering effort to allow for direct comparison (meter locations shown in Figure 5-8). Refer to Appendix C for graphs of flow meter data during select storm events for each sub-area before and after the two sewer projects were completed.

Table 5-2 summarizes the measured baseline flows and calculated baseline infiltration rates for the sub-areas before and after the two sewer projects were completed. Flow meter data in Appendix C shows that it takes several days for the flow to return to baseline in both sub-areas before the two sewer projects. After the projects, the flow returns to the baseline in a number of hours. This trend suggests a reduction in infiltration in both sub-areas. The results in Table 5-2 show the baseline flow and baseline infiltration rate decreased after the projects were completed in both sub-areas, showing the success of infiltration removal.

Table 5-2 Summary of I/I Analysis – Hunt Street Drainage Area

SMH No.	Measured Baseline Flow (MGD)	Baseline Infiltration Rate (gpd/idm)
SMH-XC		
Before Sewer Projects (Dry Weather: 5/28/14 – 6/3/14)	0.014	3,657
After Sewer Projects (Dry Weather: 8/7/21 – 8/12/21)	0.011	2,813
SMH-992		
Before Sewer Projects (Dry Weather: 5/28/14 – 6/3/14)	0.010	1,977
After Sewer Projects (Dry Weather: 9/12/21 – 9/16/21)	0.006	1,267

The peak flow charts for SMH-XC in Appendix C show consistent increases in the flow data that are more pronounced after storm events. These peaks are from the private Schooner Ridge Pump Station which ties into this sub-area. The frequency of these peaks increases during wet weather events, indicating inflow may be entering the Schooner Ridge pump station. However, field investigation of the Schooner Ridge property confirmed roof leaders, sump pumps, and catch basins do not tie into the sewer system. Average excess flow from Schooner Ridge for the storms analyzed is approximately 15 gpm, which inconsequential considering the total flow in this drainage area. Therefore, no additional I/I investigations or sewer separation work in this sub-area is recommended.

The City has observed SSOs in the manholes just upstream of the pump station. It was determined in the 2015 Wastewater Transport System Evaluation that peak metered flows to Hunt Street Pump Station exceeded the station's capacity during select storm events, suggesting that station is undersized to handle wet weather events. This is discussed in more detail in Section 8.5.

Figure 5-7 Hunt Street Pump Station Drainage Area

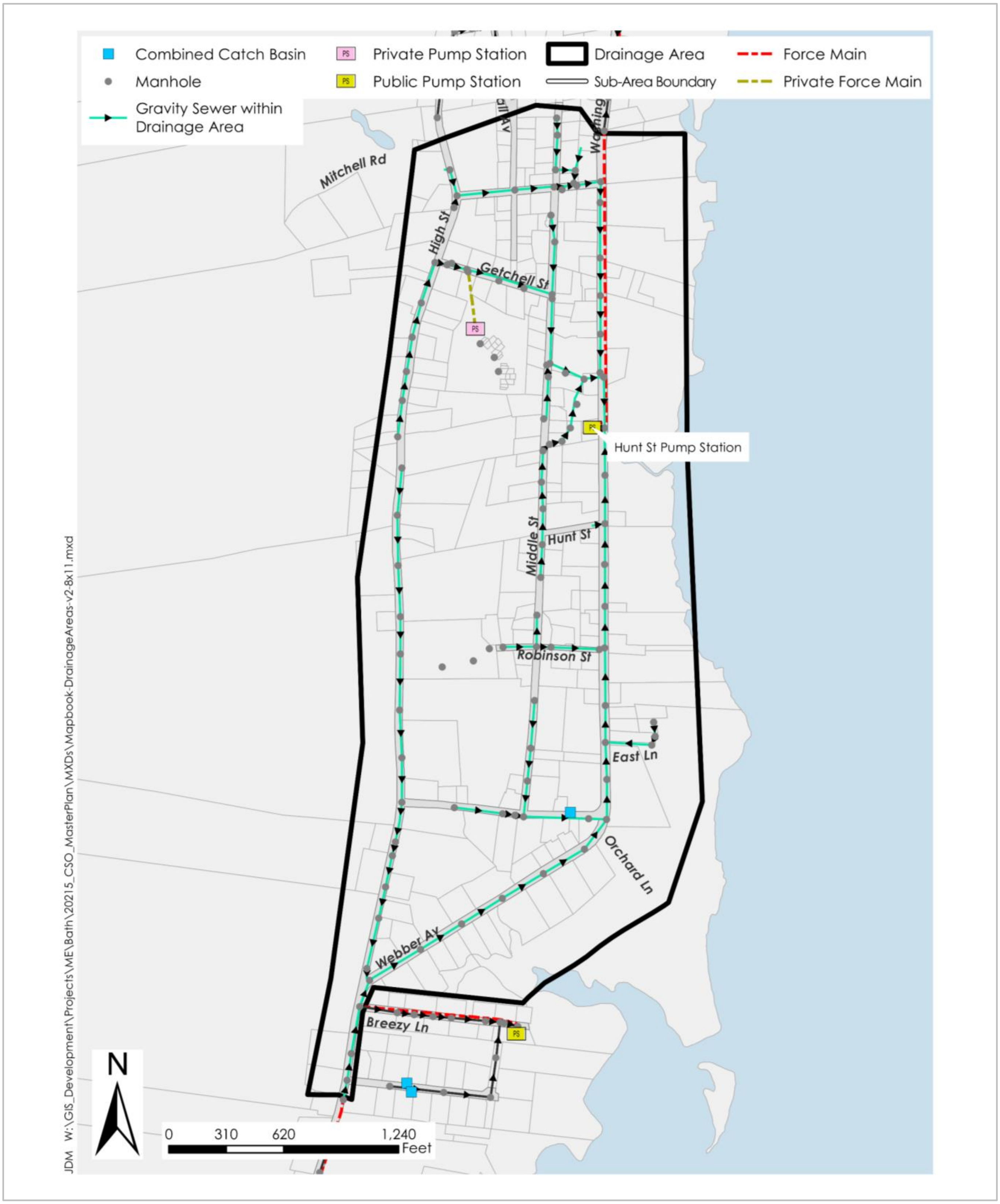


Figure 5-8 Hunt Street – Historical Sewer Rehabilitation Projects

5.9 Rose Street Drainage Area

The Rose Street drainage area serves a small portion of the south end of Bath. Flows from the Riverview Road, Bridge Street, and Hunt Street drainage areas drain into the Rose Street drainage area. Figure 5-9 shows the extents of the drainage area. Sources of I/I were found while flow metering in the Rose Street Drainage Area in 2014. Analysis of the flow meter data and field investigation findings were provided to the City in the 2015 'Wastewater Transport System Evaluation' report. Recommended actions to reduce inflow and infiltration in the drainage area were also included in this report and resulted in the City completing two projects in 2018 and 2021, which included relining of select sewer pipes and manholes, replacement of select sewer pipes and manholes, and separation of catch basins via installation of new storm drain systems in this drainage area. The areas where work was completed are shown in Figure 5-10.

Post-project flow metering was conducted in 2021 and compared to the 2014 flow data to determine how effective the projects were at reducing I/I in the collection system. A flow meter was installed in 2021 in the same manhole (SMH-919) as the 2014 metering effort to allow for direct comparison (meter location shown in Figure 5-10). Refer to Appendix C for graphs of flow meter data during select storm events for the sub-area before and after the two sewer projects were completed.

Table 5-3 summarizes the measured baseline flows, peak flows, baseline infiltration rates, and peaking factors for the sub-area before the two projects were completed and after the projects for three selected storm events. Flow meter data in Appendix C shows that it takes several days for the flow to return to baseline in both sub-areas before the two sewer projects. After the projects, the flow returns to the baseline in a number of hours. This trend suggests a reduction in infiltration in both sub-areas and agrees with the reduction in baseline infiltration rate. Additionally, the peak flows shown in the charts in Appendix C are significantly less after the two sewer projects than the peak flow recorded before the two projects. The results in Table 5-3 show the baseline infiltration rate and the peaking factor decreased after the projects were completed, showing the success of I/I removal.

Table 5-3 Summary of I/I Analysis – Rose Street Drainage Area

Sub-Area	Measured Baseline Flow (MGD)	Measured Peak Flow (MGD)	Baseline Infiltration Rate (gpd/idm)	Peaking Factor During Storm (MGD/MGD)
SMH-919				
Before Sewer Projects (Wet Weather: 6/13/14 Precip.: 3.00” Duration: 10 hrs)	0.0067[1]	1.670	1,756	242
After Sewer Projects (Wet Weather: 7/4/21 Precip.: 0.85” Duration: 8 hrs)	0.0060[2]	0.065	1,508	11
After Sewer Projects (Wet Weather: 7/9/21 Precip.: 3.02” Duration: 5 hrs)	0.0060[2]	0.523	1,508	87
After Sewer Projects (Wet Weather: 7/18/21 Precip.: 0.80” Duration: 5 hrs)	0.0060[2]	0.204	1,508	34

Notes:

1. Baseline flows were measured from 5/28/14 – 6/3/14.
2. Baseline flows were measured from 8/1/21 – 8/5/21.

Although the peaking factor significantly decreased after the two sewer projects were completed, they still indicate sources of inflow. Field investigations from 2014 confirmed eight illicit connections from properties located within this sub-area. The removal of private I/I sources can be costly in some cases and has potential for public resistance. If the removal of roof drains, foundation drains, sump pumps, etc. is cost-effective and feasible, the City will consider their removal. However, each connection has to be investigated to determine if it is a cost-effective, feasible option for the City.

Figure 5-9 Rose Street Pump Station Drainage Area

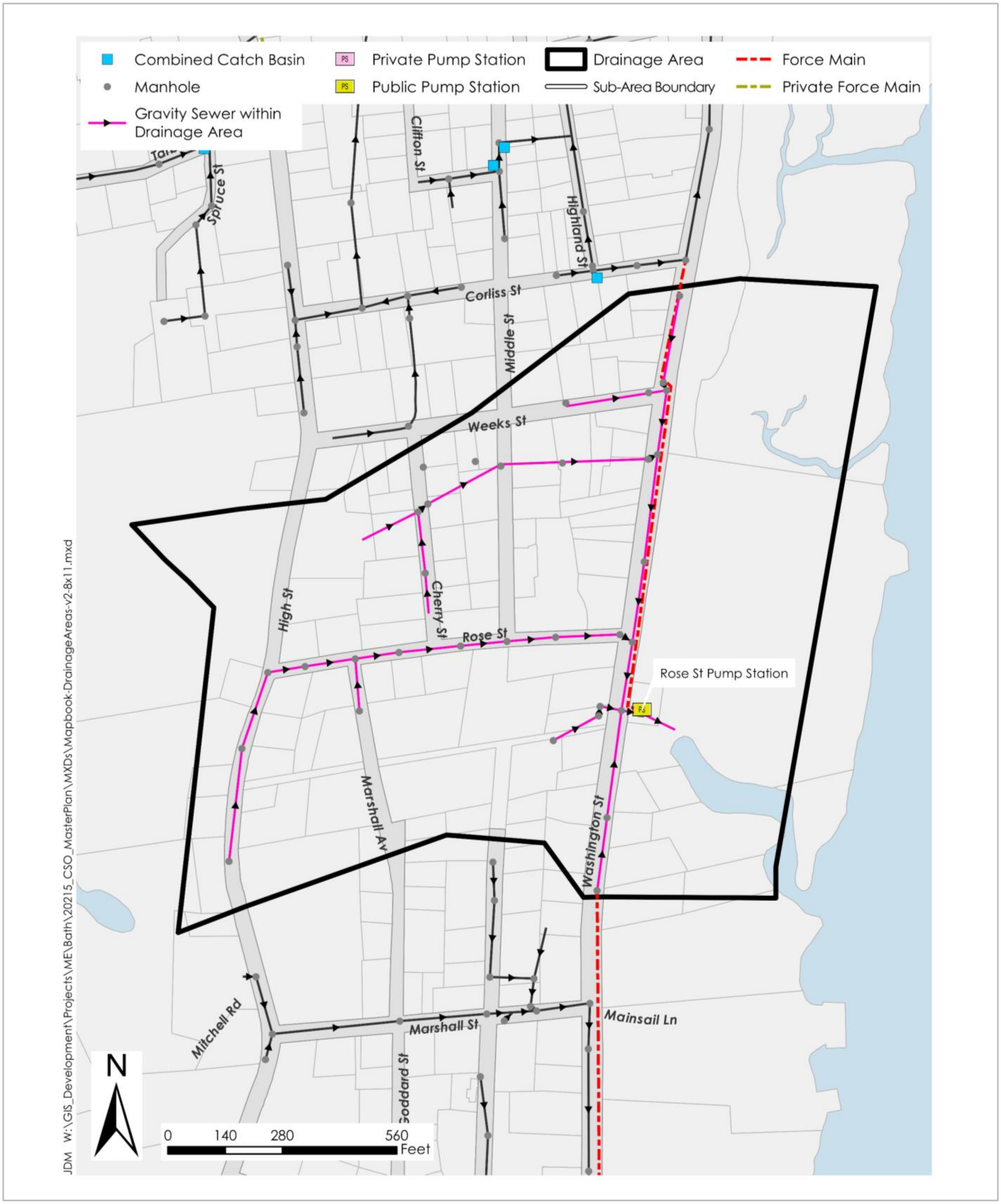


Figure 5-10 Rose Street – Historical Sewer Rehabilitation Projects

5.10 Pleasant Street Drainage Area

The Pleasant Street drainage area serves a large portion of the central area of Bath. The Riverview Road, Bridge Street, Hunt Street, and Rose Street Pump Station force mains tie into the Pleasant Street drainage area. Figure 5-11 shows the extents of the drainage area. Table 5-1 indicated a low peaking factor for this drainage area; however, sources of I/I are suspected in this drainage area, so flow meters were installed to further break up the drainage area and to help identify where sources of I/I may be present.

Three flow meters were installed in the summer of 2020 in SMH-433 and SMH-849. Two meters were installed in SMH-849, with one meter one measuring flows entering the manhole from the east and the other measuring flows entering the manhole from the west. Refer to Figure 5-11 for the flow meter locations installed in this drainage area.

Initial flow metering in SMH-849 West indicated I/I was present, so the drainage area was divided into two smaller sub-areas and flow metered in fall 2021 to further pinpoint sources of I/I. Two flow meters were installed in SMH-871, one to measure flows from the northwest and the other to measure flows from the southwest. Refer to Figure 5-11 for flow meter locations and sub-areas draining to each flow meter. Table 5-4 summarizes the baseline flows, peak flows, baseline infiltration rates, and peaking factors recorded for the flow metering analysis.

Table 5-4 Summary of I/I Analysis – Pleasant Street Drainage Area

Sub-Area	Measured Baseline Flow (MGD)	Measured Peak Flow (MGD)	Baseline Infiltration Rate (gpd/idm)	Peaking Factor During Storm (MGD/MGD)
SMH-433 (Wet Weather: 6/6/20 Precip.: 0.65” Duration: 9 hrs)	0.002[4]	0.152	275	88
SMH-849 East (Wet Weather: 6/29/20 Precip.: 4.32” Duration: 16 hrs)	0.089[1, 5]	0.748	3,980	8[2]
SMH-849 West (Wet Weather: 6/29/20 Precip.: 4.32” Duration: 16 hrs)	0.004[5]	3.150	146	705

Sub-Area	Measured Baseline Flow (MGD)	Measured Peak Flow (MGD)	Baseline Infiltration Rate (gpd/idm)	Peaking Factor During Storm (MGD/MGD)
SMH-871 Northwest[3] (Wet Weather: 9/29/21 Precip.: 3.88" Duration: 13 hrs)	0.026[6]	4.787	1,605	182
SMH-871 Southwest[3] (Wet Weather: 10/31/21 Precip.: 3.38" Duration: 11 hrs)	0.027[6]	1.982	3,392	73

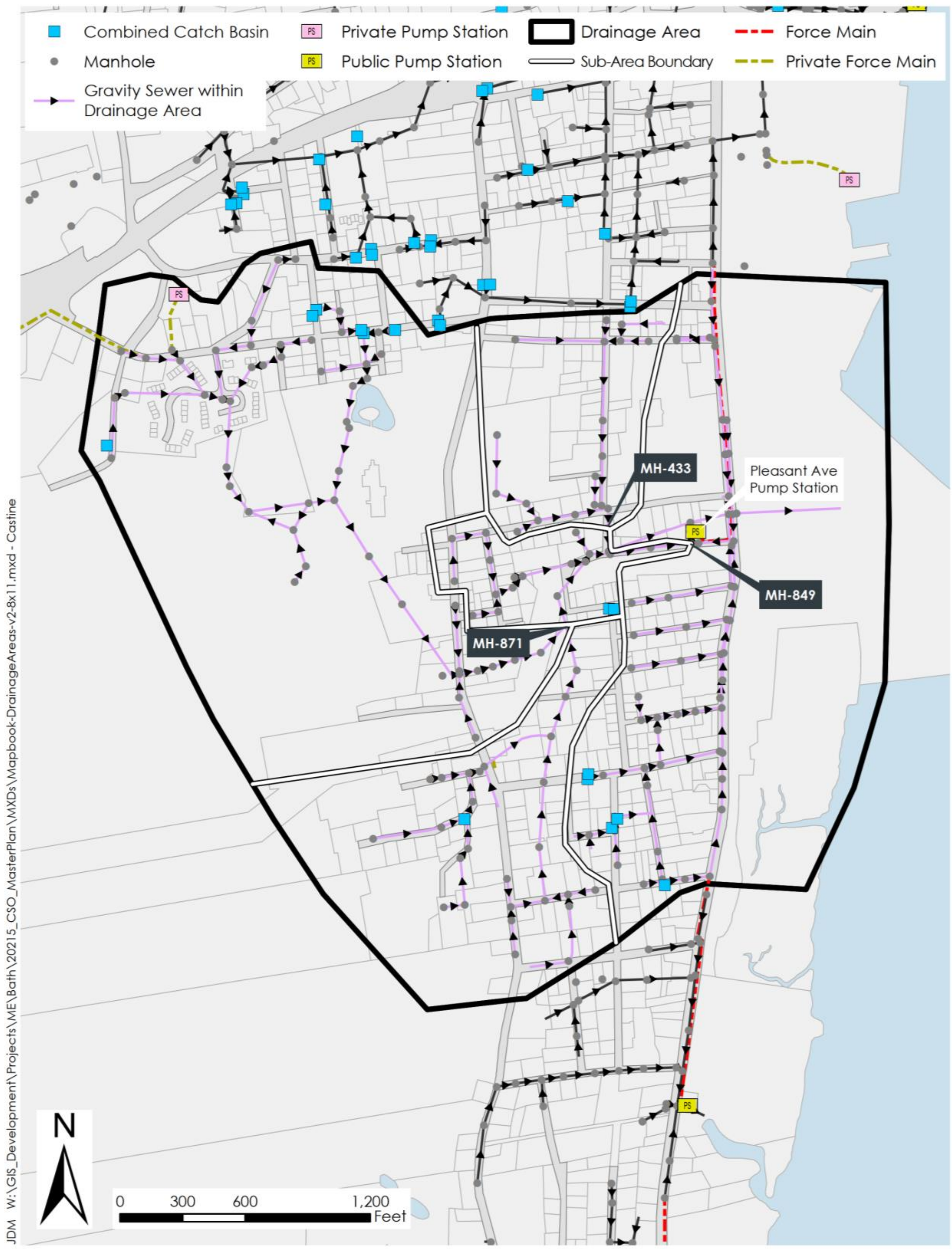
Notes:

1. Baseline flow for sub-area SMH-849 East only. Rose Street Pump Station flows were subtracted from the metered flows.
2. Peaking factor calculated after subtracting Rose Street Pump Station flows from metered flows.
3. Sub-area contained in SMH-849 West sub-area.
4. Baseline flows were measured from 6/7/20 – 6/12/20
5. Baseline flows were measured from 6/15/20 – 6/19/20
6. Baseline flows were measured from 9/3/21 – 9/6/21

As shown in Table 5-4, all three sub-areas (SMH-433, SMH-849 East, SMH-849 West) resulted in a baseline infiltration rate less than the industry standard of 4,000 gpd/idm, indicating infiltration is not a concern in the Pleasant Street drainage area. Two of the three sub-areas (SMH-433 and SMH-849 West) resulted in peaking factors greater than 10. There are no known combined catch basins in the SMH-433 sub-area and private inflow is suspected based on the high peaking factor. Smoke testing confirmed seven combined catch basins in the SMH-849 West sub-area, confirming the source of high peaking factor calculated. Smoke testing also confirmed seven combined catch basins in the SMH-849 East sub-area. Refer to Appendix C for charts showing the flow meter data for the three sub-areas.

A tidal influence in the SMH-849 East sub-area was also present in the flow meter data. Refer to Appendix C showing the depth measured by the flow meter over three days, which shows a peak every six hours that corresponds with daily tide changes. The peak flows from the Rose Street Pump Station can also be observed in the chart included in Appendix C. Omitting Rose Street Pump Station flows, approximately 0.1 to 0.5 MGD of tidal flow enters the SMH-849 East sub-area depending on the level of the tide. Based on field investigations and observations from the City, tidal water does not appear to be backflowing from the river over the Pleasant CSO weir wall. It appears that tidal flows are inflowing to the sewer system upstream of the CSO during dry weather. Further field investigations are necessary to pinpoint the location of tidal influence.

Figure 5-11 Pleasant Street Drainage Area and Flow Meter Locations



5.11 Commercial Street Drainage Area

The Commercial Street drainage area serves a large portion of the eastern side of Bath. The Riverview Road, Bridge Street, Hunt Street, Rose Street, Pleasant Street, Hyde Park and Wing Farm Pump Station force mains tie into the Commercial Street drainage area. Figure 5-12 shows the extents of the drainage area broken into four sub-areas. Table 5-1 indicated a low peaking factor for this drainage area; however, known sources of I/I are present in this drainage area.

Previous studies within this drainage area consist of flow metering and InfoSWMM modeling. The City completed separation of 25 catch basins along Route 1 in 2018. Flow meters were installed in 2020 in SMH-690, SMH-729 from the south, and SMH-729 from the west to determine if I/I is present. Refer to Figure 5-12 for sub-area boundaries and meter locations. Table 5-5 summarizes the baseline flows, peak flows, baseline infiltration rates, and peaking factors for each flow meter sub-area.

Table 5-5 Summary of I/I Analysis – Commercial Street Drainage Area

Sub-Area	Measured Baseline Flow (MGD)[2]	Measured Peak Flow (MGD)	Baseline Infiltration Rate (gpd/idm)	Peaking Factor During Storm (MGD/MGD)
SMH-690 (Wet Weather: 10/13/20 Precip.: 2.44" Duration: 13 hrs)	0.155	1.135	6,362	7[1]
SMH-729 South (Wet Weather: 10/13/20 Precip.: 2.44" Duration: 13 hrs)	0.062	2.532	3,486	41
SMH-729 West (Wet Weather: 11/30/20 Precip.: 1.73" Duration: 10 hrs)	0.023	6.070	1,089	264

Notes:

1. The July 2021 Commercial Street CSO Extension Memorandum concluded that flow backs up from the Commercial Street Pump Station wet well and surcharges the three influent lines, (one of which is the line from SMH-690). The surcharged flow is evident in the flow meter data for SMH-690 in the form of peak flows; resulting in unrealistic peaking factors for four storms. Therefore, the peaking factor for this sub-area was calculated for a smaller storm where the system was not in a surcharged state.
2. Baseline flows were measured from 10/8/20 – 10/12/20.

Refer to Appendix C for charts showing the flow meter data for the three sub-areas. The flow metering results show a low infiltration rate, less than the industry standard of 4,000 gpd/idm, in two of the three sub-areas that were flow metered (SMH-729 South and SMH-729 West). Sub-area SMH-690 resulted in a baseline infiltration rate greater than 4,000 gpd/idm. The City is aware of cracked pipes in this sub-area and has included relining of nearly 1,500 feet of sewer on Commercial Street as part of the upcoming 'Western Ave, Academy Street and Cobb Road Storm Drain and Sewer Improvements' construction project. The construction scope of work is shown in Figure 5-13.

The flow meter data for sub-area SMH-690 also shows a tidal influence from the Kennebec River getting into the sewer system during dry and wet periods. Refer to Appendix C showing flow meter data over eight days, which shows a peak every six hours that corresponds with daily tide changes. There is approximately 0.2-0.8 MGD of additional flow entering the sewer system during high tide, dry weather conditions. Field investigations including dye and smoke testing were conducted in this sub-area but no cross-connections to the storm drain that outlets into the river were identified. After completion of the sewer relining as part of the Western Ave, Academy Street and Cobb Road Storm Drain and Sewer Improvements project, flow metering should be conducted to determine if a cross-connection was eliminated via relining. If tidal influences are still observed, CCTV is recommended to determine if there is a direct connection in this sub-area.

The peaking factor for the SMH-690 sub-area is low and the peaking factor for the other two sub-areas (SMH-729 South and SMH-729 West) are high. Field investigations confirmed 12 combined catch basins in the SMH-729 South sub-area. The City's GIS database shows 19 combined catch basins are present in the SMH-729 West sub-area. The upcoming construction project Western Ave, Academy Street and Cobb Road Storm Drain and Sewer Improvements includes separation of nine of the 19 combined catch basins and is scheduled to be completed in June 2022.

Smoke testing in 2021 confirmed 26 combined catch basins in the Willow, Middle, York, Crescent Street area, upstream of known SSOs. Smoke testing also identified two locations of cracked pipe on the cross-country sewer line between SMH-273 and SMH-275, and SMH-280 and SMH-1297.

Figure 5-12 Commercial Street Drainage Area

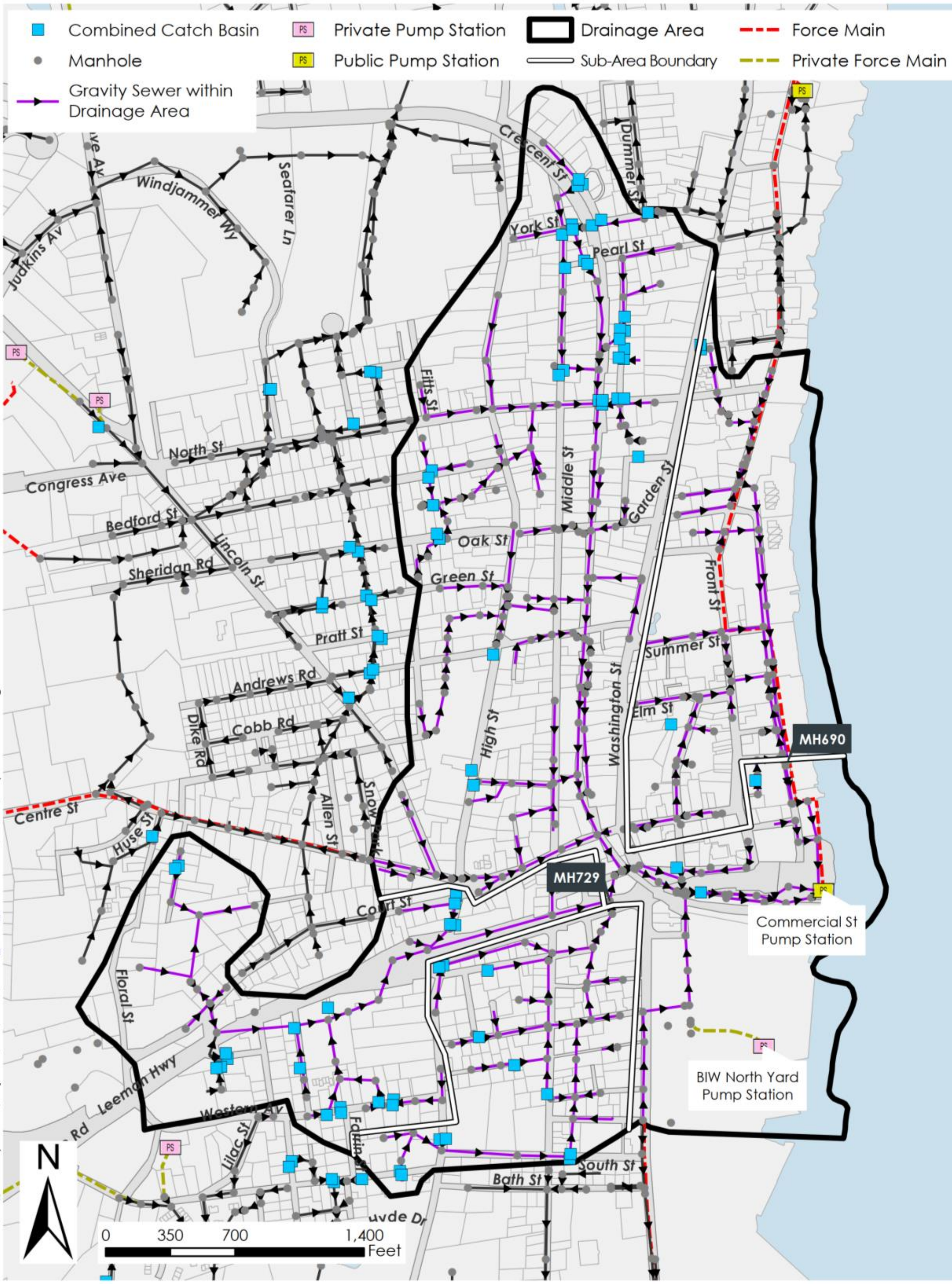
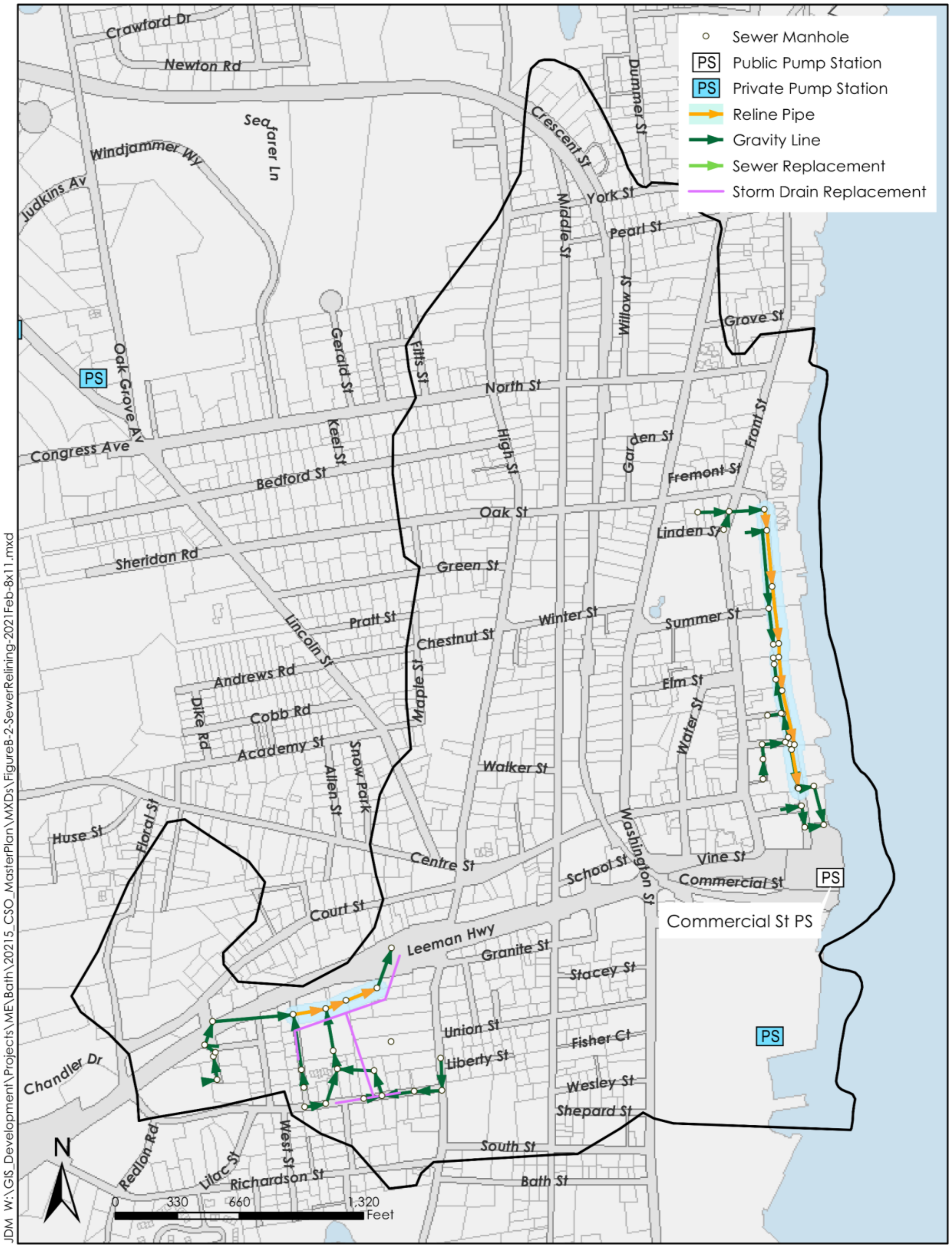


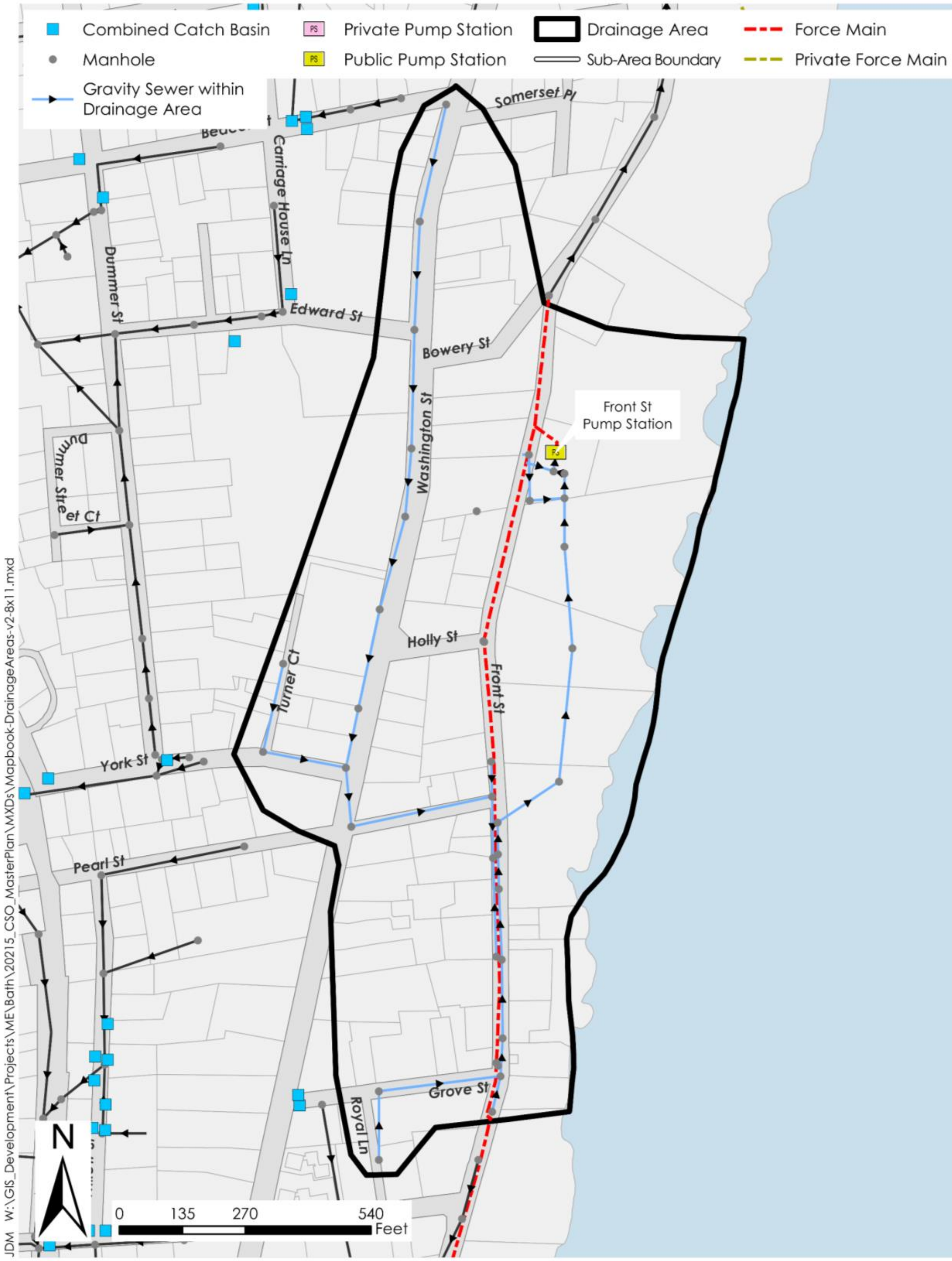
Figure 5-13 Western Ave, Academy Street and Cobb Road Storm Drain and Sewer Improvements Project



5.12 Front Street Drainage Area

The Front Street drainage area serves a small portion of the eastern area of Bath. The Front Street Pump Station force main combines with the Commercial Street Pump Station force main and continue north toward the WPCF. Figure 5-14 shows the extents of the drainage area. Table 5-1 indicated a low peaking factor for this drainage area, so no additional sewer system flow monitoring was conducted.

Figure 5-14 Front Street Pump Station Drainage Area



5.13 Farrin Place Drainage Area

The Farrin Place drainage area serves a small-medium portion of the north-eastern area of Bath. Figure 5-15 shows the extents of the drainage area. Table 5-1 indicated a moderate peaking factor for this drainage area, indicating I/I is likely present. SSES field investigations were completed including smoke testing to confirm combined catch basins and flow metering to isolate sources of I/I.

A flow meter was installed in the fall of 2021 in SMH-202 to determine if I/I is present in the portion of cross-country sewer north of the pump station parallel to the Kennebec River. Refer to Figure 5-15 for the flow meter location and the sub-area draining to the flow meter location. Table 5-6 summarizes the baseline flows, peak flows, baseline infiltration rates, and peaking factors recorded for the flow metering analysis.

Table 5-6 Summary of I/I Analysis – Farrin Place Drainage Area

Sub-Area	Measured Baseline Flow (MGD)[1]	Measured Peak Flow (MGD)	Baseline Infiltration Rate (gpd/idm)	Peaking Factor During Storm (MGD/MGD)
SMH-202 (Wet Weather: 9/26/21 Precip.: 3.88" Duration: 13 hrs)	0.009	0.026	7,688	3
SMH-202 (Wet Weather: 10/31/21 Precip.: 3.38" Duration: 11 hrs)	0.009	0.197	7,688	22

Notes:

1. Baseline flows were measured from 10/5/21 – 10/9/21.

As shown in Table 5-6, the sub-area associated with SMH-202 resulted in a relatively high baseline infiltration rate of 7,688 gpd/idm, suggesting infiltration of groundwater is an issue in this sub-area.

A tidal influence in this sub-area was also present in the flow meter data. Refer to Appendix C showing the depth measured by the flow meter over four days, which shows a peak every six hours that corresponds with daily tide changes. This results in an additional 5 gpm of tidal flow getting into the sewer system during high tide dry weather conditions and is considered an insignificant amount of infiltration.

This sub-area has low-lying sewer pipe adjacent to the Kennebec River with infiltration. Cleaning and CCTV of this pipe section should be conducted to confirm the condition of the sewer pipe and identify sources of infiltration. The peaking factor indicates sources of inflow, which may be from private sources connected to the sewer, but no investigations have been completed to date. Smoke testing confirmed 17 combined catch basins in this drainage area that were not flow metered. Separation of these catch basins should be considered.

Figure 5-15 Farrin Place Pump Station Drainage Area

5.14 Harward Street Drainage Area

The Harward Street drainage area is the largest geographical wastewater drainage area in Bath and serves a large portion of the central-northern area of Bath. The Landfill and Aegis Drive Pump Station force mains tie into the Harward Street drainage area. Figure 5-16 shows the extents of the drainage area. While Table 5-1 indicated a low peaking factor for this drainage area, there are known sources of I/I are present. There are both CSOs and SSOs upstream of the pump station, and the pump station is not at maximum capacity when CSOs and SSOs occur.

As part of a 2017 flow metering effort, a report titled 'Harward Street Pump Station Drainage Area Infiltration and Inflow Study – Phase 1' was developed which divided the Harward Street Drainage Area into multiple sub-areas and analyzed each sub-area for I/I. Flow data was collected from May 2017 through June 2017. Figure 5-17 shows the sub-areas and flow meter locations. Note that multiple flow meter setups were analyzed. Figure 5-17 shows Setup 2, which focused on sub-areas that showed I/I from Setup 1. Refer to the 2017 report for more information.

Based on flow meter results, the 2017 report made recommendations for each sub-area and grouped them by high, medium, and low priority as summarized in Table 5-7. The rankings attempt to reflect the impact that removing I/I from a particular sub-area will have on the collection system in terms of CSO and SSO flows; removing I/I from high priority sub-areas should have a larger impact than removing I/I from low priority areas. The recommended actions that are struck through have been completed by the City since 2017. As can be seen, the City has made significant progress in the High Priority areas and continue to focus efforts in these areas to eliminate SSOs and reduce CSO flows. Some of the recommended actions that were completed between 2017 and 2021 resulted in the recommendation of additional actions or projects. A number of these projects are included in Section 8.5.4.

Figure 5-16 Harward Street Pump Station Drainage Area

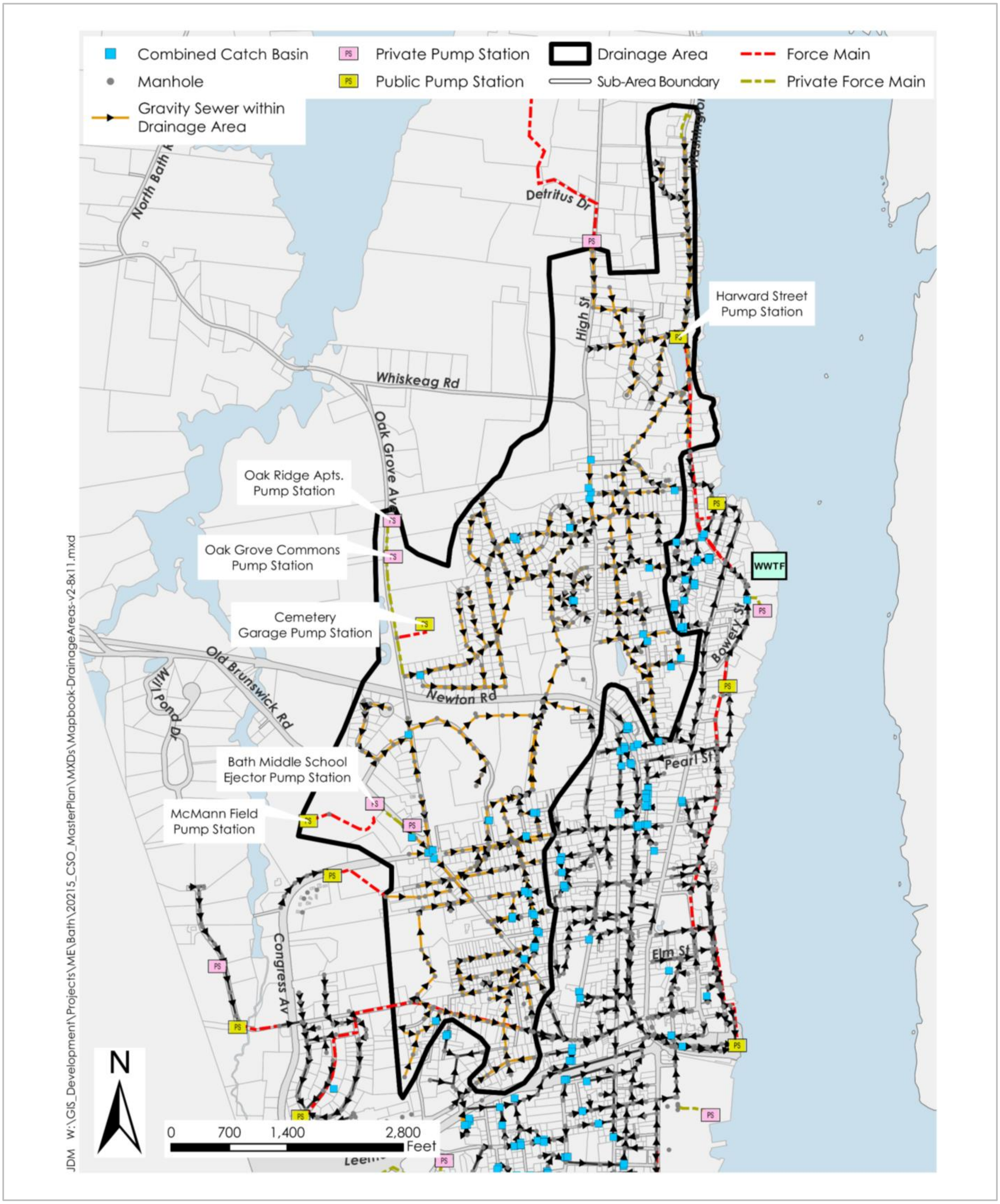


Figure 5-17 Harward Street Drainage Area Flow Metering

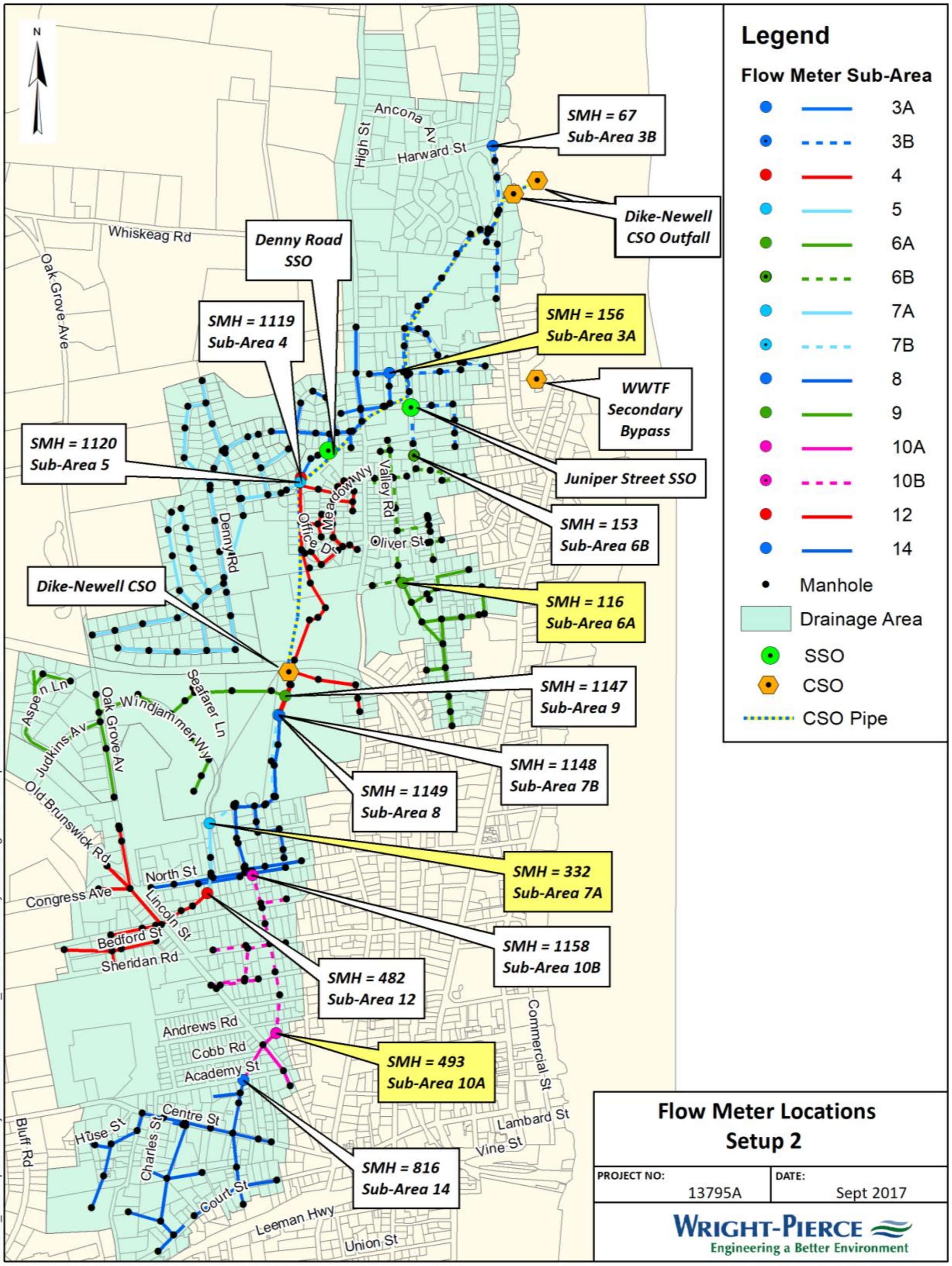


Table 5-7 Harward Street – Summary of Sub-Drainage Area Historical Recommendations

Sub-Drainage Area	I/I Issues Identified	Recommended Action
High Priority		
4	• High inflow • Infiltration observed in CCTV inspections • Low infiltration rate	• City to perform CCTV work on Meadow Way • ~~CCTV remaining cross-country lines~~ • ~~Smoke testing to confirm connection of six combined catch basins~~ • ~~Survey of combined catch basins (no existing nearby stormwater system)~~ • ~~Manhole inspections of cross-country lines~~ • Repair defective sewer lines identified from CCTV inspections
6	• High inflow • Moderate infiltration rate	• ~~Smoke testing to confirm connection of six catch basins~~ • ~~Survey of combined catch basins and existing nearby stormwater system~~ • Home inspections if time/budget allow
7	• Anecdotal inflow • Infiltration observed in CCTV inspections • High infiltration rate	• ~~Smoke testing of cross-country lines~~ • ~~Smoke testing to confirm connection of one combined catch basin~~ • ~~Manhole inspections of cross-country lines~~ • ~~Repair defective sewer lines identified from CCTV inspections~~
10	• High inflow • High infiltration rate	• ~~Smoke testing to confirm connection of 14 combined catch basins~~ • ~~Survey of combined catch basins and existing nearby stormwater system~~ • Home inspections if time/budget allow
Medium Priority		
3	• High infiltration rate • Low inflow	• Smoke testing to confirm connection of ten catch basins • Survey of combined catch basins and existing nearby stormwater system • ~~Manhole inspections of cross-country lines~~
5	• Moderate inflow (low volume)	• Dye testing to confirm connection of one combined catch basin • Survey of combined catch basin and existing nearby stormwater system • Home inspections if time/budget allow
8	• Unknown inflow and infiltration rates	• ~~CCTV remaining cross country lines~~

Sub-Drainage Area	I/I Issues Identified	Recommended Action
	• Infiltration observed in CCTV inspections	• ~~Dye testing to confirm three separated catch basins~~ • ~~Smoke testing to confirm connection of three combined catch basins~~ • ~~Survey of combined catch basins and existing nearby stormwater system~~ • ~~Repair defective sewer lines identified from CCTV inspections~~
12	• High inflow • Moderate infiltration	• Smoke testing to confirm connection of four catch basins • Survey of combined catch basins and existing nearby stormwater system
14	• Unknown inflow and infiltration rate • Infiltration observed in CCTV inspections	• CCTV remaining cross country lines • Smoke testing to confirm connection of five combined catch basins • Survey of combined catch basins and existing nearby stormwater system • Manhole inspections of cross-country lines • Repair defective sewer lines identified from CCTV inspections
Low Priority		
9	• Low inflow • Low infiltration rate	• No action is recommended at this time

In 2018, the City completed separation of three combined catch basins at the intersection of Keel and Bedford Streets (sub-area 10) and separation of two combined catch basins on High Street near Dike Newell school (sub-area 4). Post-metering after separation of these catch basins was not completed as part of this CSO Master Plan.

Relining of the two cross-country interceptors upstream of CSO #008 was completed in the spring of 2020 to reduce infiltration. The sections of sewer pipe relined are shown in Figure 5-18. Post-project flow metering was conducted in the fall of 2020 and compared with the 2017 flow data to determine how effective the project was at reducing infiltration in the collection system. Flow meters were installed in 2020 in the same manholes (SMH-1148, sub-area 7, and SMH-1149, sub-area 8) as the 2017 metering effort to allow for direct comparison. Refer to Appendix C for graphs of flow meter data during select storm events for each sub-area before and after the sewer relining project was completed.

Figure 5-18 Harward Street Drainage Area – Historical Sewer Rehabilitation Projects

Table 5-8 below summarizes the baseline flows and baseline infiltration rates for the sub-areas before and after the sewer relining project. Flow meter data in Appendix C shows that it takes several days for the flow to return to baseline in both sub-areas before the two sewer projects. After the projects, the flow returns to the baseline in a number of hours. This trend suggests a reduction in infiltration in both sub-areas. The results in Table 5-8 show the baseline flow and baseline infiltration rate decreased after the projects were completed in both sub-areas, showing the success of infiltration removal.

Table 5-8 Summary of I/I Analysis – Harward Street Drainage Area

SMH No.	Measured Baseline Flow (MGD)	Baseline Infiltration Rate (gpd/idm)
SMH-1148 (Sub-area 7)		
Before Relining (Dry Weather: 4/17/17-4/20/17)	0.193	27,650
After Relining (Dry Weather: 10/8/20-10/12/20)	0.019	2,700
SMH-1149 (Sub-area 8)		
Before Relining (Dry Weather: 5/18/17-5/22/17)	0.060	4,539
After Relining (Dry Weather: 10/8/20-10/12/20)	0.014	1,049

As discussed in Section 4.6, the City is implementing various measures to eliminate and reduce SSO and CSO discharges in the Harward drainage area. After completion of these projects, the City should conduct additional analysis to determine the impact on the collection system. Various projects recently undertaken by the City include the following:

- The CSO weir wall was first lowered in order to create capacity downstream of the CSO to reduce SSO volume and frequency.
- A CSO regulator structure is also being installed downstream of the CSO structure to regulate flow with a slide gate. The gate will be able to be raised or lowered based on the amount of flow the downstream system can handle in an effort to reduce SSO discharges.
- Separation of six catch basins on Oak Street and Green Street is in design and will result in a construction project in the near future.

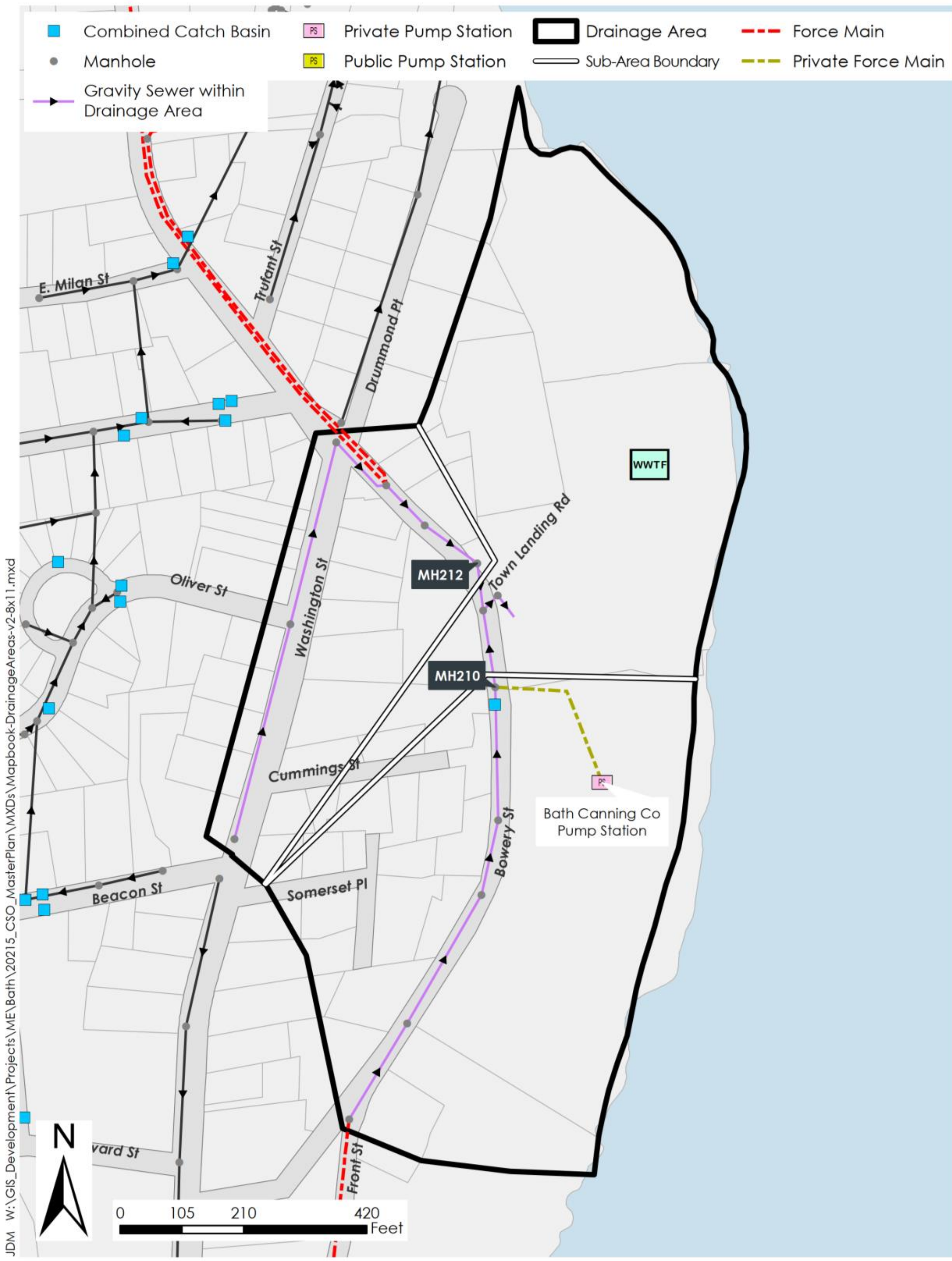
5.15 WPCF Drainage Area

The WPCF drainage area is a very small area that flows by gravity directly to the WPCF. Figure 5-19 shows the extents of the drainage area. Flow metering was conducted in the WPCF Drainage Area on Bowery Street just before the influent manhole into the WPCF to help quantify I/I in the WPCF drainage area. The drainage area was split into two sub-areas to meter flows in the northern portion and flows in the southern portion of the drainage area. Flow meters were installed in SMH-212 and SMH-210 as shown in Figure 5-19.

In addition to the gravity flow at SMH-212 and SMH-210 from the drainage area, the Farrin Place and Harward Street Pump Stations discharge to a terminus manhole upstream of SMH-212. The Front Street and Commercial Street Pump Stations discharge to a terminus manhole upstream of SMH-210. Pump station flows were subtracted from the flow meter measured flows to determine if I/I is present in the WPCF drainage area.

Pump station flow data is collected every 2-3 days as previously mentioned. Pump station flows were totaled during a storm event on October 13, 2020 and compared with the totalized flow at SMH-212 and SMH-210. At SMH-212, the total measured flow was less than the sum of flows from Farrin Place and Harward Street pump station over the same time period. At SMH-210 the total measured flow was less than the sum of flows from the Front Street and Commercial Street pump stations. While this is not possible and the flow data readings were sporadic, the fact that the flow meters read less flow than the sum of the upstream tributary pump stations suggests there is little I/I in the drainage sub-areas.

Figure 5-19 WPCF Drainage Area



5.16 Summary

Table 5-9 summarizes whether inflow and/or infiltration issues have been identified in each drainage area and sub-drainage area(s).

Table 5-9 Summary of I/I Findings per Drainage Area

Drainage Area	Inflow Identified?	Infiltration Identified?
Aegis	No	No
Landfill	No	No
Wing	No	No
Hyde	No	No
Riverview	No	No
Bridge	No	No
Hunt		
SMH-XC sub-area	No	No
SMH-992 sub-area	No	No
Rose		
SMH-919 sub-area	No	No
Pleasant		
SMH-433 sub-area	No	No
SMH-849E sub-area	Yes	No
SMH-849W sub-area	Yes	No

Drainage Area	Inflow Identified?	Infiltration Identified?
Commercial		
SMH-690 sub-area	Yes	Yes
SMH-729S sub-area	Yes	No
SMH-729W sub-area	Yes	No
Front	No	No
Farrin		
SMH-202 sub-area	Yes	Yes
Harward		
Sub-Area 3	No	Yes
Sub-Area 4	Yes	No
Sub-Area 5	Yes	No
Sub-Area 6	Yes	No
Sub-Area 7 (SMH-1148)	Yes	No
Sub-Area 8 (SMH-1149)	Yes	No
Sub-Area 9	No	No
Sub-Area 10	Yes	Yes
Sub-Area 12	Yes	Yes
Sub-Area 14	Yes	Yes

Drainage Area	Inflow Identified?	Infiltration Identified?
WPCF		
SMH-212 sub-area	No	No
SMH-210 sub-area	No	No

Section 6 Treatment Facility Evaluation

The Bath Water Pollution Control Facility (WPCF) has undergone two major upgrades, one in 1997 and the most recent one in 2019. This section evaluates the current conditions at the WPCF with respect to both secondary treatment capacity and CSO related bypass flows.

The 1997 upgrade consisted of a new Headworks Building with a lower-level pump room, vortex grit removal system, and mechanical bar screen in the influent channel with manual bar rack in the bypass channel. Additionally, the final clarifiers were transitioned into the primary clarifiers, and new secondary clarifiers were installed. Two new flow distribution structures were installed upstream and downstream of the primary clarifiers and one new structure was installed just upstream of the secondary clarifiers. A CSO bypass system was also installed which consisted of a CSO Disinfection and Dechlorination tank and the existing Chlorine Contact Tank is used for flows that receive primary and secondary treatment (i.e., not CSO bypass flows). A new Pump and Blower Building was constructed to house the aeration blowers on the first level and the chemical storage and feed system, as well as sludge and scum pumps in the lower level. Two new sludge storage tanks were installed.

The 2019 upgrade consisted of upgrades to the aeration system with the installation of new fine bubble diffusers. New chemical storage tanks and a new chemical feed system was installed to replace the existing system in the lower level of the Pump and Blower Building. A third sludge storage tank was installed along with coarse bubble diffusers and a new blower housed in the Pump and Blower Building. The WPCF also underwent a large dewatering upgrade that replaced the two belt filter presses with sludge thickening and dewatering equipment, new blended sludge pumps, new polymer system, and new sludge conveyance system to carry dewatered sludge to the sludge loading area. Refer to the following sections for a discussion of each unit process in more detail.

6.1 General

The City's WPCF is a conventional activated sludge plant which consists of influent flow metering and screening, two primary clarifiers, two aeration trains (six tanks), three secondary clarifiers, sludge dewatering, sodium hypochlorite disinfection, dechlorination, and ultimate discharge into the Kennebec River. The facility includes a secondary bypass system that bypasses flows more than 7 MGD to a disinfection contact chamber with dechlorination after primary treatment. Primary and secondary sludge is blended, thickened, and dewatered using two rotary screw thickeners and screw presses and trucked less than 1.5 miles to the City's landfill on Detritus Drive using a roll-off truck and dumpster.

6.2 Headworks

Raw wastewater is pumped to the WPCF via Commercial Street, Harward Street, Farrin Place, and Front Street Pump Stations, as well as gravity sewer. The influent sewer pipe discharges flow into an influent channel equipped with a manual bar rack. If the mechanical screen fails to operate, wastewater will overtop a gate and flow through the manual bar rack. Screenings collected by the mechanical bar screen are discharged directly into a roll off container for disposal at the City's landfill.

After screening, flow converges back into one channel before entering the vortex grit chamber for grit removal. Separated grit is drawn from the grit chamber by a single recessed impeller grit pump located in the Lower Pump Room. While the pump is original to the 1997 upgrade, the pump impeller was replaced in 2018. The pump is typically operated in continuous mode. Grit is pumped to a new cyclone and classifier for dewatering installed as part of the 2019 upgrade. Dewatered grit is discharged into the same roll off container as the screenings for landfill disposal.

A new influent flow meter was installed on the influent pipe between the Headworks Building and the Primary Clarifier Flow Splitter No. 1 as part of the Phase 1 upgrade. Influent flow ranges from a minimum hour flow of 0.7 MGD to a peak hour flow of 29.5 MGD.

6.3 Primary Clarifiers

Wastewater flows by gravity from the Headworks to Flow Distribution Structure No. 1, a two-way splitting structure that directs flow to Primary Clarifiers No. 1 and No. 2. The circular primary clarifiers were originally final clarifiers installed in 1971. The sidewalls were raised, and the tanks were converted to primary clarifiers as part of the 1997 upgrade with new plow-and-rake style sludge and scum collection mechanisms.

6.4 Aeration Tanks

After primary treatment, wastewater flows converge in Flow Distribution Structure No. 2, a two-way splitting structure that directs flows to Aeration Tanks No. 1 and No. 2. Each tank, which consists of two zones, facilitates suspended growth of activated sludge. Each zone has the capability to receive both primary effluent and return activated sludge (RAS) that is collected and pumped from the secondary clarifiers. Each tank is 125 ft by 42 ft by approximately 15 ft deep.

Both tanks are equipped with fine bubble diffusers, which were replaced during the Phase 1 Upgrade. Three positive displacement dual-lobe blowers that were installed as part of the 1997 upgrade provide air to the fine bubble diffusers. The blowers are manually activated, typically run one at a time at minimum speed, and are rotated seasonally for even wear. Two dissolved oxygen (DO) probes were also installed as part of the upgrade to provide monitoring capabilities through SCADA to allow operators to optimize the process based on real-time measurements.

The City typically only has one train online at any given time and the offline tank is utilized as a peak flow storage tank. Plant staff have fabricated weirs to allow overflow into the offline tank during flows greater than 5.0 MGD. Any primary effluent that spills over to the offline tank during a storm event is pumped back to the headworks after the storm event.

6.5 Secondary Clarifiers

Following aeration, wastewater flows to Flow Distribution Structure No. 3, a three-way splitting structure that directs flows to Secondary Clarifiers No. 1, 2, and 3 for settling and removal of activated sludge. The rectangular secondary clarifiers were constructed as part of the 1997 upgrade and are equipped with chain and flight sludge and scum removal mechanisms. Scum collected in the clarifiers is directed into a manhole and then flows by gravity into the Secondary Scum Well. The clarifier mechanisms were replaced in 2011. Rectangular secondary clarifiers were selected for the Bath WPCF as they allow for more clarifier area on a tight site than circular clarifiers. The clarifier drives were replaced as part of the Phase 1 Upgrade, as they had reached the end of their useful lives.

6.6 Disinfection and Dechlorination

As part of the Phase 1 Upgrade, two new 5,000-gallon bulk storage tanks were installed, one for sodium hypochlorite and one for sodium bisulfite. Additionally, four new chemical feed peristaltic pumps were provided for disinfection and dechlorination of the plant effluent, as well as four new chemical feed peristaltic pumps for the

CSO Bypass disinfection system. The new equipment and instruments were integrated into the Chemical Control Panel and SCADA.

Secondary clarifier effluent flows through a chlorine contact tank where it gets disinfected with sodium hypochlorite. Flow then enters a dechlorination structure where it is dechlorinated with sodium bisulfite. Effluent wastewater flows over a fixed weir into an effluent metering structure where the flow rate is recorded. Similarly, when high flows into the WPCF trigger the CSO bypass system, CSO bypass flow travels through a CSO disinfection and dechlorination tank where sodium hypochlorite is injected at the front end of the tank and sodium bisulfite is injected at the back end of the tank.

6.7 Sludge Handling

Primary sludge and primary scum are pumped from the primary clarifiers directly to Sludge Holding Tanks No. 1 and 2 to store primary sludge separate from waste activated sludge (WAS). Activated sludge collected in the secondary clarifiers is either recycled back to the aeration tanks as RAS or wasted for disposal (WAS) into Sludge Holding Tank No. 3, a new aerated sludge storage tank constructed as part of the Phase 1 Upgrade. Four new Penn Valley pumps were installed as part of the Phase 1 Upgrade to blend primary sludge and WAS in the pipeline prior to entrance into the new sludge thickening and dewatering technology. The sludge aeration system consists of three positive displacement blowers (one new as of Phase 1 Upgrade) and fine bubble diffuser systems in each tank.

As part of the Phase 1 Upgrade, the existing belt filter presses were demolished and two new flocculation tanks, rotary screw thickeners, and screw presses were installed for sludge thickening and dewatering. Two new polymer make-down systems were provided to condition the sludge prior to dewatering. Shaftless screw conveyors were also provided to convey sludge from the screw presses to the Sludge Loading Area where dewatered sludge fills a dedicated sludge roll-off truck and dumpster.

6.8 WPCF Outfall

Disinfected effluent wastewater flows over a fixed weir into an effluent metering structure where the flow rate is recorded. From the effluent metering structure, effluent wastewater flows via a 36” discharge pipe through a manhole and then discharges into the Kennebec River.

6.9 CSO-Related Bypass System

The secondary treatment system is designed to treat peak hour flows up to 7 MGD. However, during wet weather events, the WPCF receives peak hour flows up to 18 MGD. Therefore, to avoid overwhelming the secondary process during high flow events, infrastructure at the facility has been designed to bypass flows in excess of 7 MGD around the secondary treatment process to a CSO Disinfection and Dechlorination Tank. This system, which was constructed during the 1997 upgrade, is authorized by permit to provide primary treatment and disinfection of flows in excess of 7 MGD.

The offline aeration tank is used as storage when the plant receives as overwhelming amount of flow. Plant staff have fabricated weirs in the aeration tanks to allow wastewater to spill into the offline tank during flows greater than 5 MGD. When storage in the offline aeration tank has reached capacity, and flows entering the plant are still in excess of 7 MGD, a motorized gate in Flow Distribution Structure No. 2 (downstream of the primary clarifiers) is raised, allowing wastewater to bypass the aeration basins and flow to the CSO disinfection and dechlorination tank. Sodium hypochlorite is introduced to the wastewater stream at the head of the tank. The tank has baffle walls and mechanical mixers to promote thorough chemical mixing. Just prior to the tank discharge, dechlorination of the wastewater is achieved by adding sodium bisulfite via diffuser.

A secondary bypass composite sampler is located in a small exterior doghouse and collects samples just prior to the tank discharge. The effluent flow rate and CSO flow rate is measured by a Miltronics OCM III located just inside the door of the Blower Building. After passing through the CSO effluent flow meter, CSO bypass flow combines with the WPCF effluent downstream of the effluent metering structure.

6.10 WPCF Capacity Versus CSO Flows

The WPCF was designed to treat a peak instantaneous flow of 17 MGD: 7 MGD through the secondary treatment process and 10 MGD through the secondary bypass (primary treatment followed by disinfection). The 1997 upgrade contemplated the need for a 2016 future peak capacity of 24 MGD, with the additional 7 MGD over and above 17 MGD to be treated in a separate CSO abatement system located at the WPCF but was ultimately not included in the design at the time, for reasons unknown. Refer to Section 8.5.5.5 for a discussion about a future study to analyze the need for a hydraulic capacity increase at the WPCF.

The Commercial Street and Harward Street Pump Stations deliver the majority of the flow to the WPCF. The upsizing of the Harward Street Pump Station force main is 2012 resulted in peak instantaneous flows to the WPCF of 18 MGD and above, which exceeds the 1997 peak design capacity of 17 MGD. The plant has been able to treat these flows and still meet its discharge permit, although the City has noted that this flow approaches the hydraulic capacity limit of some structures. The Harward Street Pump Station could be upgraded with new pumps to maximize the capacity of the 16-inch force main that was installed in 2012. However, a pump upgrade at this station would likely result in an additional 3 MGD to the WPCF during peak flow events. Prior to increasing the capacity of the Harward Street Pump Station, modifications would be required at the WPCF to accept and treat flows in excess of 17-18 MGD.

Analysis of CSO events in the collection system and at the WPCF indicates that the collection system CSOs only happen after a CSO related bypass of secondary treatment has begun at the WPCF. This shows that the pump stations are maximizing the capacity of the WPCF before CSOs in the collection system occur.

To eliminate CSO flows from the collection system, the pump stations would need to be upgraded with larger pumps to handle the additional flow. However, as CSOs are occurring in Harward and Commercial drainage areas when the pumps are not operating a maximum capacity, hydraulic limitations are clearly present upstream of the pump stations and upsizing the pumps would not solve the problem. Even if upsizing the pumps could eliminate CSO flows in Harward and Commercial drainage areas, the additional flow to the WPCF would exceed 18 MGD (not including flows from Front, Farrin, and gravity flow). The WPCF is already experiencing capacity limitations when seeing 18 MGD, and any additional flow to the WPCF could cause SSOs at the influent of the treatment facility (SSOs at the influent manhole to the WPCF were seen when all four pumps at Commercial Street Pump Station were running at maximum capacity. Thus, the City operates one of the four pumps at a lower speed to avoid SSO events at the influent manhole). The WPCF would have to undergo a substantial bypass flow upgrade to handle the additional flows from the collection system if CSO flows in the collection system were eliminated.

The City has observed that the pumps at Harward Street Pump Station do not reach maximum capacity during wet weather conditions. The priority is to get all the flow in the Harward drainage area to the pump station by completing projects outlined in Section 9, such as upsizing the interceptor. Projects in this drainage area will help reduce and eliminate SSOs and convey additional flow to the pump station so that the pumps operate at maximum capacity. Once the pumps at Harward Street Pump Station are operating at maximum capacity, controls can be integrated between the pump station and the WPCF such that when the WPCF is at capacity, a signal is sent to Harward that either ramps down or turns off the pumps. Alternatively, when flows at the WPCF are low, a signal can be sent to indicate the pumps can ramp up/turn on and send flow to the WPCF. A similar arrangement could be integrated at Commercial Street Pump Station to help regulate the flow being sent from the pump station to the WPCF when the WPCF is overwhelmed.

The City has observed that the Harward Street pumps clog during wet weather events. The City has been able to mitigate the impacts of pumps clogging by sequencing the pumps to run in a Lead/Lag/Standby mode, allowing an offline pump to come on should one of the Lead or Lag pumps clog. Increasing flow to the Harward Street Pump Station may necessitate the need for screenings, maceration, or more robust solids handling pumps in the future and should continue to be evaluated as projects in this drainage area are completed.

Section 7 Prioritization of CSO Discharge Abatement

7.1 Chapter 570 CSO Discharge Prioritization List

Section 3 identifies the existing and potential uses of areas impacted by the four Bath CSOs. Chapter 570 of the Maine DEP Combined Sewer Overflow Abatement guidelines requires that a CSO Facilities Plan place high priority on abatement of CSOs that affect waters having the greatest potential for public use or benefit and attempt to relocate any remaining discharges to areas where minimal impacts or losses of uses would occur.[1] The list of priorities for abatement includes, but is not limited to the following (shown in order of importance):

1. Discharges that occur during dry weather periods
2. Discharges that may impact public drinking water intakes
3. Discharges that may impair water contact recreational uses or create public health concerns in the receiving waters
4. Discharges into areas determined to have redeemable shellfish resources or important fish or wildlife habitat
5. Discharges that contain industrial or medical wastes
6. Discharges that function during the months of June through September
7. Discharges that cause localized nuisance conditions
8. All other CSO discharges

Three additional categories have been included as part of this Plan, including the number of CSO events, volume of CSO events, and number of SSO events.

7.2 Evaluation of CSO Prioritization

Based upon the list of priorities for abatement included in Section 7.1, Table 7-1 assigns a ranking from not applicable (score of 0) to highly important/highly likely (score of 5). The CSOs with the highest score rank as the highest priority CSOs for elimination or abatement. It is important to note that input from the City of Bath and Maine DEP is essential to complete the final prioritization ranking process.

Based upon the CSO prioritization list shown in Table 7-1, the following would be the recommended priority list for elimination or abatement of the four CSOs in the City of Bath.

1. Harward Street CSO #008
2. Rose Street CSO #003
3. Commercial Street CSO #005
4. Pleasant Street CSO #004

CSOs #003 and #005 were determined to be very similar in priority. Both CSO points can discharge between June and September and the number of CSO and SSO events are similar. CSO #003 has a higher priority than CSO #005 because it discharges into a marsh instead of directly to the Kennebec River like CSO #005. Additionally, CSO #003

[1] Chapter 570 Combined Sewer Overflow Abatement, Maine DEP Paragraph 3.B.

was given higher priority due to the fact that it may be feasible to eliminate CSO #003 during the next 5 years as discussed in Section 8 and Section 9.

Table 7-1 CSO Prioritization

Priority	CSO Location				Comments
	Rose Street (CSO #003)	Pleasant Street (CSO #004)	Commercial Street (CSO #005)	Harward Street (CSO #008)	
1. Discharges that occur during dry weather periods	0	0	0	0	
2. Discharges that may impact public drinking water intakes	0	0	0	0	
3. Discharges that may impair water contact recreational uses or create public health concerns in the receiving waters	3	3	3	3	
4. Discharges into areas determined to have redeemable shellfish resources or important fish or wildlife habitat	2	2	2	2	It is unlikely that shellfish harvesting could occur even if CSOs were inactive due to upstream pollution concerns
5. Discharges that contain industrial or medical wastes	1	1	1	1	

Priority	CSO Location				Comments
	Rose Street (CSO #003)	Pleasant Street (CSO #004)	Commercial Street (CSO #005)	Harward Street (CSO #008)	
6. Discharges that function during the months of June through September	4	1	3	4	
7. Discharges that cause localized nuisance conditions	0	0	0	0	
8. All other CSO discharges	-	-	-	-	
9. Number of CSO Events	2	1	3	5	
10. Volume of CSO Events	3	1	3	5	
11. Number of SSO Events	3	0	3	5	
Total Score	**19**	**9**	**18**	**25**	

Notes for Prioritization Scoring:

0 = Not Applicable, 1 = Not very important/likely, 2 = Somewhat important/likely, 3 = Important/likely, 4 = Very important/likely, 5 = Highest importance/highly likely

Section 8 Screening and Evaluation of Control Alternatives

8.1 Introduction

The City of Bath is committed to the effective operation and maintenance of its existing facilities and infrastructure and implement high value capital improvements to minimize the frequency and duration of CSO events from its licensed discharge points. In past and current NPDES permits, the City has been required to implement, where applicable, the Nine Minimum Controls as put forth by the US EPA in its CSO Control Policy.[1] The Nine Minimum Controls (NMCs) are minimum technology-based controls that can be used to address CSO issues without extensive engineering studies or significant construction costs, prior to implementation of long-term control measures. The City's current NPDES permit requires the development of this CSO Master Plan, including screenings and evaluation of control alternatives to reduce or eliminate the impacts of CSO overflows on receiving waters. This section outlines the NMCs, the City's efforts to meet those controls, and the screening and evaluation of long-term control alternatives for mitigation of CSOs.

8.2 Summary of Nine Minimum Controls

8.2.1 Proper Operation and Regular Maintenance

The Wastewater Treatment Facility has an Operations and Maintenance (O&M) Manual in place to ensure that the collection system, pump stations and treatment facility function in a way to maximize treatment of wastewater and comply with MEPDES permit requirements. A simple way to evaluate whether or not the existing O&M program is being implemented is to assess the frequency of CSO events related to mechanical failure or improper operations. Certainly, equipment failures do occur. However, rapid notification and response by maintenance crews is critical to minimizing the impact of such events. From January 2006 to present, there has only been two non-wet weather-related overflow events at CSO locations which were reported by the City as sanitary sewer overflows (SSOs).

The City inspects the CSO structures on a weekly basis and each pump station is inspected 3 times per week to ensure proper operation. The City has also implemented a Maintenance Plan through which sewer piping is cleaned and TV-inspected, and catch basins are cleaned on a regular basis. The purpose of this program is to maximize the capacity of the sanitary and storm systems, to confirm the condition of the pipes, to locate service connections and to establish pipe relining or replacement priorities.

The O&M Manuals contain the pertinent information regarding organizational structure, procedures for routine maintenance, non-routine maintenance and emergency situations, inspections, training, and periodic review of O&M plans. The City of Bath maintains an adequate budget to implement the O&M program.

A High Flow Operating Plan is also in place to serve as a guide to operating the WWTF during wet weather flows. Refer to Appendix D for a copy of the current plan.

[1] Guidance for Nine Minimum Controls, Combined Sewer Overflows, USEPA 8320B-95-003, May 1995

8.2.2 Maximum Use of the Collection System for Storage

The City's Maintenance Plan requires that all sewer piping be cleaned and inspected at 5-year intervals. This allows the City to identify pipe segments in need of relining or replacement. All catch basins are to be cleaned every year. This maximizes the use of both the sanitary and storm sewer systems and minimizes grit that enters the sewer system from catch basins that are connected to the sewer.

8.2.3 Review and Modification of Pretreatment Requirements

The City does not have a pretreatment program, as there are no significant industrial users in Bath's Collection system that do not have on-site pre-treatment.

8.2.4 Maximization of Flow to the Treatment Facility

The capacity of the Water Pollution Control Facility and several major pump stations (Commercial, Harward, Pleasant, Riverview, and Bridge) have been increased through various projects implemented since 1997. Dedicated generators are installed at nine of the 13 pump stations, and generator hook-ups exist at 3 pump stations (Riverview, Hunt, Landfill) to allow operation of the pumps during power outages from large storms.

8.2.5 Elimination of CSOs During Dry Weather

As a result of the City's collection system improvements, pump station and treatment system upgrades and operation and maintenance activities, CSO events during dry weather (not related to mechanical failures) have been eliminated.

8.2.6 Control of Solid and Floatable Material in CSOs

There are currently no systems in place to remove or capture solids or floatable materials in CSOs.

8.2.7 Pollution Prevention Program

The City has actively initiated catch basin identification and removal projects to separate these sources of high inflow from the sanitary sewer system. When street reconstruction projects have been conducted, catch basins have been separated from the sewer system and tied into existing or new storm drain infrastructure. The City has an annual household waste day to mitigate household waste from entering the storm system. Additionally, the City has a weekly curbside collection program of municipal solid waste and recycling, and a drop off program for organic (food) waste material.

The City has implemented an Asset Management System for their collection system components and a Work Order System for fixing issues within the collection system as they come up. Additional pollution prevention measures taken by the City include inspection of manholes for SSO activity during rain events, keeping records of sewer pipe CCTV videos, regularly updating GIS records, and installation of four local weather stations to aid in data analysis.

8.2.8 Public Notification

All four CSOs are currently posted with the following signage for public notification:

CITY OF BATH
WET WEATHER
SEWAGE DISCHARGE
CSO# AND NAME

As previously mentioned, all shellfish areas downriver of the four CSOs have been closed for a number of years. There have been some initial discussions on transmitting high level alarms from Rose Street, Pleasant Street, and Commercial Street Pump Stations directly to the Department of Marine Resources/WPCF to provide rapid notification of the potential for CSO activity. However, this has not been implemented.

8.2.9 Monitoring to Effectively Characterize CSO Impacts and Effectiveness of CSO Controls

Bath has been monitoring activity at each of its CSO discharge locations since 1992. The City will continue to monitor the date, time, flow rate, and total volume of each CSO through the use of its flow measurement devices.

8.3 Description of Generic Control Alternatives

Long-term CSO abatement alternatives were developed for the City to cover a wide range of options that vary both in cost and degree of predictable benefits. The long-term CSO abatement alternatives evaluated as part of this plan are listed below:

- Continue program of cost-effective, high benefit inflow/infiltration removal;
- Collection system, pumping, and/or treatment system capacity increase;
- Reroute pump station force mains around surcharged interceptors;
- In-line storage; and/or
- Off-line storage;

The control alternatives identified above aim to find a cost-effective balance between I/I removal, capacity upgrades, treatment, and storage alternatives. Each of these control alternatives is described briefly in Sections 8.3.1 through 8.3.5 below, followed by an evaluation of their applicability to each of the City's CSOs in Section 8.5.1 through 8.5.5.

8.3.1 Inflow/Infiltration Removal

As of December 2020, there were 155 known catch basins connected to the City's sanitary sewer system, of which eight are privately owned. Concentrated areas that are still combined may or may not be cost-effective or feasible to separate, depending upon the topography, geology and water quality of the stormwater receiving streams. Section 9 of this plan summarizes the recommended separation projects which would contribute to abating or eliminating SSOs and overflows from the remaining permitted CSOs.

The City should continue to build upon its current knowledge base of flow monitoring data and manhole and sewer inspection efforts to determine those I/I removal projects that are cost-effective for removal. As street reconstruction projects occur, the City should continue to place a high priority on reviewing all historically documented I/I sources and confirm their previous removal or continued existence. A single catch basin or broken pipe/abandoned service in a low-lying area could have a major impact on the amount of extraneous flow being conveyed to an interceptor or pump station with potential CSO consequences. In an ideal world, complete elimination of CSOs could be realized cost-effectively by implementing this alternative alone. However, identification and removal of I/I can range in cost from approximately $3.00 per gallon to more than $20.00 per gallon of I/I removed. For example, if a mile of 8-inch pipe exhibited an infiltration rate of 80,000 gpd, and it cost $100 per linear foot to replace the mile of pipe ($528,000), the cost per gallon of I/I removed would be $6.60 per gallon. This assumes that complete replacement of a pipe completely eliminates I/I, which is not usually the case. Therefore, the City should target I/I removal projects on the low end of this cost range.

Moving forward, the City may want to consider focusing upon removal of private inflow sources such as roof drains, foundation drains, and basement sump pumps. This approach has a high potential to be met with public resistance, although in some cases, it may be more cost-effective to remove these sources rather than continue to upgrade the capacity of public sewers, pump stations or treatment systems. Each private source would have to be reviewed individually to determine the cost-effectiveness and technical feasibility of rerouting private I/I from the sanitary collection system to the storm drain system. Historically, the cost of maintaining or modifying the service connection from the property line to the house has been borne by the homeowner. The Maine Clean Water SRF program will provide funding to replace services up to the outside wall of the foundation. However, any work inside the home is not eligible for federal or state funding. The cost of removal of the roof drains, foundation drains, sump pumps, etc. can range from a few hundred dollars to thousands of dollars depending upon site-specific conditions. Once removed, continued confirmation inspections are important to ensure their continued removal.

In reality, even after sources of inflow are removed and deteriorated piping is relined or replaced, high volumes of infiltration could still occur through broken or leaky service connections. Sewer piping and service connections installed in trenches over ledge are susceptible to rapid, storm-induced infiltration. When the trenches fill with groundwater (storm-induced or seasonally), infiltration takes the path of least resistance. Even when main sewer lines are relined, the groundwater may rise to the elevation where infiltration into service connection lines is a major problem. The City should work with residents to address the services as much as practicable during street reconstruction projects when it is the most cost-effective. During replacement of services, it is often found that house roof drains, foundation perimeter drains, or sump pumps are connected to the sewer services. These sources of inflow can then be tied into the storm drain system or daylighted to natural drainage areas.

One drawback of redirecting inflow into stormwater collection systems or to daylight is the pollutant load this water can also carry to waterways. While not a regulated MS4 community under the stormwater Phase II regulations, the City should continue to weigh the benefits of inflow removal from the sewer system against the potential drawbacks of introducing the same flow to the stormwater system.

8.3.2 Collection, Pumping, and Treatment System Capacity Increase

The City has conducted numerous pump station capacity upgrades between 1997 and 2009 to enable conveyance of greater peak flows to the treatment facility and reduce the frequency and duration of CSO events. These include upgrades to the following:

- 1997 - WPCF Secondary Bypass Facility
- 1997 - Harward Street Pump Station
- 2002 - Commercial Street Pump Station
- 2002 - Force Main Replacement to bypass Front Street Pump Station
- 2009 - Pleasant Avenue Pump Station
- 2009 - Pleasant Avenue Force Main partial replacement to remove hydraulic restriction
- 2012 – Harward Street Force Main replaced and upsized

The WPCF was upgraded in 1997 to treat 7.0 MGD through the secondary treatment system while treating up to an additional 11.0 MGD through a CSO-related bypass system (primary treatment and disinfection). City staff have reported that up to 18.85 MGD can be treated through the CSO bypass system at times. This system is discussed in detail in Section 6.

8.3.3 Reroute Pump Station Force Mains Around Surcharged Interceptors

This alternative was primarily introduced to examine the impact of the Hunt Street Pump Station at the downstream Rose Street PS CSO (CSO #003). The alternatives analysis includes examining the impact of rerouting this force main around the Rose Street PS to decouple the Rose Street CSO from flows in the Hunt Street drainage area in an effort to reduce or eliminate the Rose Street CSO and decrease the size of the Rose Street Pump Station. The alternative is also considered for the Pleasant Street force main to bypass the Commercial Street CSO #005.

8.3.4 In-Line Storage

In-line storage refers to the temporary containment of combined sewage flows within the conveyance conduit (i.e., the sewer). In-line storage can consist of existing sewer piping, if existing piping is of suitable design, or of new below-grade concrete conduits (e.g., concrete box culverts). In either case, the conduit is designed to contain the design peak flows by employing a flow restriction device to surcharge the conduit. In addition, instrumentation and control systems are provided to allow for automation of activities and remote annunciation of alarm conditions at the WPCF (e.g., flow measurement, volume/level measurement, flow restriction device control, etc.) to the extent desired. The primary advantages of in-line storage are captured flows receive secondary treatment at the WPCF; captured flows do not need to be pumped back into the system; post-storm maintenance is minimal; and existing facilities can be utilized at relatively low cost, if available. The primary disadvantages are limited capacity available for storage and high capital cost if existing facilities are not available. Typically, this abatement alternative is applicable with deep, long, and relatively flat interceptor piping with large easements or adjacent land available to install below-grade concrete conduits.

8.3.5 Off-Line Storage

Off-line storage refers to the temporary containment of diverted combined sewage in storage facilities. Storage facilities considered would consist of partially below-grade or below-grade concrete tanks with CSO discharges flowing by gravity to the new tank. The contents of the tank would be returned to the sewer system via new pumping facilities following the storm event and after peak sewer flows have subsided. Tipping gates and/or tank washdown facilities would be provided to allow for automation of activities and remote annunciation of alarm conditions at the WPCF (e.g., flow measurement, volume/level measurement, pump controls, etc.) to the extent desired. The primary advantage of off-line storage is that captured flows receive secondary treatment at the WPCF. The primary disadvantages of off-line storage are high capital cost, real estate needs, the potential for odors if the combined wastewater needs to be stored for long periods of time, and labor-intensive operation and maintenance requirements.

8.4 Design Storm

It is important to identify the design storm event that will be utilized as the basis of evaluation of any CSO elimination of abatement alternatives. The US EPA CSO guidance document regularly refers to storm events with 1-year, 24-hour recurrence intervals (RI) or less[2]. It is obvious that storm duration is critical to properly classify an actual storm event recurrence interval (frequency). Short duration events with smaller rainfall amounts than much longer events can be as damaging as longer duration storms with large rainfall amounts[3].

[2] Combined Sewer Overflows: Guidance for Long-Term Control Plan, U.S. EPA Office of Water. EPA 932-B-05-002. September 1995.

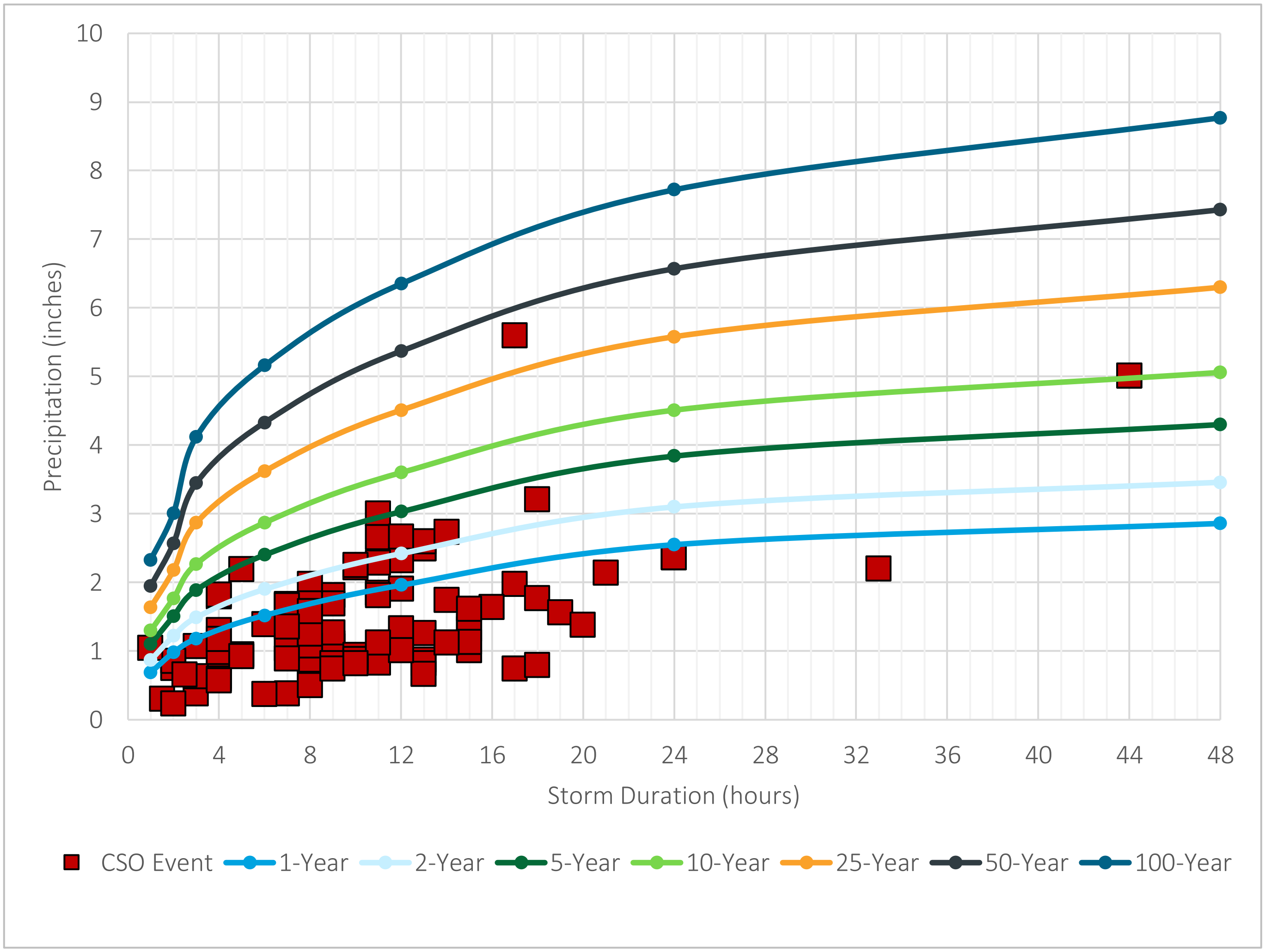
[3] Classifying the Recurrence Interval (Frequency) of Actual Storm Events using the National Weather Service Precipitation-Frequency Data Server. (2021). Retrieved 24 November 2021, from https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=43446.wba

CSO volumes and storm durations were analyzed for each storm event that resulted in a CSO at any of the four licensed CSOs between 2014 to 2020. The goal was to determine the recurrence interval storm event that causes a CSO. Establishing this baseline helps to set the design storm. Precipitation totals and storm durations for each storm event were obtained from the City of Bath and compared with total precipitation volumes from the National Oceanic and Atmospheric Administration (NOAA) weather station located in Wiscasset, Maine (Station Name: WISCASSET AIRPORT, ME US). In cases where there were discrepancies in recorded precipitation amounts, NOAA precipitation totals were used.

Figure 8-1 shows the RI curves[4] for 1-year through 100-year storm events of varying duration and precipitation. Also shown are the precipitation and storm duration data points for each CSO event recorded at the four licensed CSOs between 2014 and 2020. The data in Figure 8-1 shows that CSOs are occurring for storms with a less than 1-year recurrence interval for varying durations.

[4] Extreme Precipitation in New York & New England. (2021). Retrieved 13 September 2021, from http://precip.eas.cornell.edu/

Figure 8-1 Recurrence Intervals for Recorded CSO Events, 2014-2020



CSO volumes were summed for storms with a less than 1-year RI for all durations and compared with total CSO volumes at each location. Findings are presented in Table 8-1. The data indicates that more than half of CSO flows at each licensed CSO occur during storms with a less than 1-year RI.

Table 8-1 CSO Flows for Storms with ≤ 1-Year Recurrence Interval 2014 - 2020

Location	CSO Flow (gallons), ≤ 1-year RI	% of Total CSO Flow
Rose Street CSO #003	2,738,933	69%
Pleasant Street CSO #004	2,280,840	66%
Commercial Street CSO #005	2,215,991	55%

Location	CSO Flow (gallons), ≤ 1-year RI	% of Total CSO Flow
Harward Street CSO #008	6,626,701	74%
Sum of CSO Flows	**13,862,465**	**68%**

Reduction in CSO flows by 68% to abate the 1-year storm event is not a feasible goal over the next 5 years and will be cost prohibitive. Some of the work over the next 5 years will be focused on SSO mitigation which is higher priority than CSO mitigation. The projects focusing on solving SSO issues will increase flow within the collection system in some areas and likely result in more CSO volume for large storm events. Thus, for the purposes of this plan, a performance-based CSO abatement strategy is recommended for this 5-year permit window. Targeted performance goals for high priority areas are recommended below.

8.4.1 Rose Street CSO #003

CSO volumes at Rose Street have been trending down since 2018 due to the I/I separation projects the City has undertaken in the South End. Given the average and maximum CSO volumes recorded since 2018, the recommended target CSO abatement goal is 100% elimination of SSOs at the Hunt Street Pump Station and CSO flows at CSO #003 for the 5-year planning window.

8.4.2 Pleasant Street CSO #004

As stated in Section 4.3, there are inconsistencies with the flow meter recording CSO flows at this station. Given these inconsistencies and the Pleasant Street CSO being the lowest-priority CSO, no CSO abatement goal is recommended for this CSO for the 5-year planning window, although some work is planned in this drainage area to better understand the actual magnitude and frequency of CSOs.

8.4.3 Commercial Street CSO #005

SSO abatement is the primary goal in this drainage area. Recommended projects to separate I/I and improve capacity of the sewer system to eliminate SSOs will also reduce CSO volumes during small storm events. However, these same projects during large storm events will result in SSO flows becoming CSO flows. Given the complexity in estimating SSO volumes and the impacts on CSO volumes, no CSO abatement goal is recommended for this CSO for the 5-year planning window. It would be prudent to reevaluate the CSO abatement goal for this drainage area in a future CSO Master Plan revision after completion of projects in the 5-year planning window aimed at SSO abatement to determine the impacts on CSO volumes.

8.4.4 Harward Street CSO #008

SSO abatement is the primary goal in this drainage area. Recommended projects to separate I/I and improve capacity of the sewer system to eliminate SSOs will also reduce CSO volumes during small storm events. However, these same projects during large storm events will result in SSO flows becoming CSO flows. Given the complexity in estimating SSO volumes and the impacts CSO volumes, no CSO abatement goal is recommended for this CSO for the 5-year planning window. Section 9 recommends InfoSWMM modeling to better understand the hydraulic relationships in this drainage area. It would be more prudent to complete InfoSWMM modeling and construction projects in the 5-year window aimed at SSO abatement and determine the impacts on CSO volumes then reevaluate the CSO abatement goal for this drainage area in a future CSO Master Plan revision.

8.5 Screening and Evaluation of Long-Term Control Alternatives

The following sections summarize the potential long-term control alternatives available for each of the four remaining collection system CSOs in Bath along with an evaluation of their effectiveness and relative cost. The same general outline is followed for the discussion of each CSO:

- Introduction
- Screening level evaluation of alternatives (summary table)
- Summary and description of feasible alternatives
- Alternative effectiveness evaluation and relative costs (summary table)

Each of the alternatives is evaluated qualitatively and quantitatively where possible to determine the impact of its implementation at each CSO. For complex alternatives and alternatives that are recommended to be implemented, figures showing an overview of the alternative have been developed and are included in Appendix E. Section 9 of this plan summarizes the recommended long-term control plan along with the preliminary cost estimates.

The costs presented in Section 1, Section 8, and Section 9 are planning level estimates only, which are based upon an ENR Index of 12465 (October 2021). The ENR index measures the "inflation rate" of construction cost by how much it costs to purchase a hypothetical package of goods compared to what it was in the base month and year. By fixing the ENR index of the alternative cost estimates, it is possible to estimate the costs at some date in the future by inflating the costs by the factor of future ENR index divided by the factor of past ENR index. An example of this would be if the ENR index in December 2021 were 12800, the cost increase factor would be 12800/12465. or 1.027 This would make an estimated $5 million project in August 2021 an estimated $5.14 million project in December 2021. Conversely, inflating a current cost estimate to some future time period can be done by assuming an annual inflation rate (i.e., 3%) on the current cost of a project. Section 9 presents the cost of abatement alternatives in 2021 dollars as well as the potential future cost across the future implementation plan. It is important to note that the alternative costs presented herein include 20% design and construction phase engineering costs to provide a total project cost.

8.5.1 Rose Street CSO #003

The Rose Street CSO #003 serves as a relief point for upstream drainage areas including Bridge, Riverview, and Hunt Street, and for gravity flows from the Rose Street sewer drainage area. As shown in Figure 4-6 in Section 4.2, the annual number of CSO events at Rose Street CSO has ranged from 2 to 9 between 2014 and 2020 with a total of 31 events and a total volume of approximately 3.94 million gallons. The following table is a screening level evaluation of alternatives for the Rose Street CSO.

Table 8-2 Screenings Level Evaluation of Alternatives – Rose Street CSO #003

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
1. *I/I Removal:* Continue program of flow monitoring to document significant sources of I/I within collection system. Continue to include high value I/I removal projects in Capital Improvements Plan		✓		The City has already conducted approximately $1.5 million in separation projects within the Rose Street drainage area. The remaining documented I/I sources are likely private sources. Removal of private I/I sources may be difficult to enforce/confirm
2. *Pump Station Capacity Modifications* Upgrade Hunt Street and Rose Street Pump Stations from existing design capacity of 1.45 MGD to design flow of 3.5 MGD to eliminate SSOs and reduce CSOs.	✓		1. Pump stations would be appropriately sized for the design flows and to eliminate occasional SSOs in the Hunt Street drainage area. 2. Pump stations would be appropriately sized for the design flows and eliminate CSOs at Rose Street CSO #003	1. Depending upon the magnitude of the capacity change, the City may need to change the Hunt Street and Rose Street force main sizes to accommodate larger design flows. 2. This alternative would continue the need to pump all flows from the South End twice to get to the Pleasant Street Pump Station and require major upgrades to both Hunt Street and Rose Street Pump Stations 3. Highest Capital Cost 4. Increase CSOs at Pleasant Street
3. *Reroute Pump Station Force Main:* Reroute the Hunt Street Pump Station force main past the Rose Street Pump Station.	✓		1. Reduce peak flows at Rose Street Pump Station by an amount equal to peak flow from Hunt Street Pump Station 2. Eliminate CSO #003	1. High capital cost 2. Force main extension would increase friction loss and require higher horsepower pumps at Hunt Street PS.

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
			3. Eliminate need to upgrade Rose Street Pump Station	3. Increase CSOs at Pleasant Street
4. *In-Line Storage of CSO Flow:* Utilize existing collection system piping or install new in-line storage conduit within drainage area		✓		Insufficient storage capacity within existing sewers and no feasible location for new in-line conduits. This option has been eliminated from further consideration
5. *Off-Line Storage of CSO Flow:* Off-line storage and CSO pump station facility located at Rose Street Pump Station		✓		Insufficient storage capacity within existing sewers and no feasible location for new off-line conduits. This option has been eliminated from further consideration

Each of the alternatives listed above could be considered on a stand-alone basis or in combination with more than one feasible alternative, depending on its cost-effectiveness, design sizing considerations and effect on downstream interceptors/pump stations.

Based upon the table above, the following alternatives are targeted for further evaluation to address CSO events:

- Alternative 2 – Pump Station Capacity Modifications
- Alternative 3 – Reroute Pump Station Force Main
- Combination Alternatives:
    - Alternative 6 – Combination of the following alternatives:
        - Alternative 2 – Pump Station Capacity Modifications
        - Alternative 3 – Reroute Pump Station Force Main

The following sections outline the design considerations and cost impacts of each of the alternatives listed above.

8.5.1.1 Rose Street CSO: Alternative 2 – Pump Station Capacity Modifications

This alternative includes upsizing the Hunt Street Pump Station to handle up to 3.5 MGD peak flows, thereby abating SSO flows at the sewer manholes in front of the station (note that final design capacity will need to be verified via extended flow metering at the pump station). Any capacity increase to the Hunt Street Pump Station directly impacts the downstream Rose Street Pump Station and CSO #003. The Rose Street Pump Station capacity would also need to be increased to match the flow output from Hunt Street Pump Station.

Both the Hunt Street and Rose Street Pump Stations would be upgraded in-place with new wet weather pumps sized to handle wet weather flows and a new dry weather pump to achieve pumping turndown. Various upgrades to the building and ancillary systems required for the new pumps (instrumentation, electrical, controls) would be provided.

This alternative also includes replacing approximately 1,650 feet of the existing Hunt Street 8-inch diameter force main with a new 12-inch diameter force main from Hunt Street Pump Station to the existing terminus manhole to handle increased flows. This alternative also includes replacing 1,150 feet of the existing Rose Street 8-inch diameter force main with a new 12-inch diameter force main from the Rose Street Pump Station to the existing terminus manhole in Washington Street to handle increased flows. Since sections of the gravity interceptor from Corliss Street to the Pleasant Street Pump Station are currently at or above capacity, the gravity sewer should be replaced with larger pipe (24-inch diameter gravity sewer pipe assumed for cost estimating).

This alternative would eliminate SSOs at the Hunt Street Pump Station and reduce CSOs at the Rose Street Pump Station.

The capital cost to implement Alternative 2 - Pump Station Capacity Modifications is shown in Table 8-3 at the end of this section.

8.5.1.2 Rose Street CSO: Alternative 3 – Reroute Hunt Street Pump Station Force Main

All flows from the Hunt Street Pump Station service area are pumped directly to the Rose Street Pump Station, which has its own service area with a combined gravity sewer system.

This alternative would extend the Hunt Street force main to bypass Rose Street Pump Station and send flows to the Pleasant Avenue drainage area. A new 14-inch force main would be installed from the Hunt Street Pump Station to a terminus manhole on Corliss Street (approximately 3,200 feet). Since sections of the gravity interceptor from Corliss Street to the Pleasant Street Pump Station are currently at or above capacity, the gravity sewer should be replaced with larger pipe (24-inch diameter gravity sewer pipe assumed for cost estimating).

Extending the force main will require upgrades to the Hunt Street Pump Station pumps to overcome the increased head condition, so the existing pumps will need to be replaced with new pumps. Rather than replacing the pump solely for the new head condition, the pumps should be sized to account for current peak flows to eliminate SSOs as discussed in Alternative 2. Upsizing the force main is not possible without significant capital improvements to the pump station. Therefore, this alternative was eliminated from consideration as a *standalone* option.

8.5.1.3 Rose Street CSO: Combination Alternative 6 – Pump Station Capacity Modifications (Alt 2) and Reroute Hunt Street Pump Station Force Main (Alt 3)

This combined alternative includes the following:

- Increase capacity of Hunt Street Pump Station to eliminate SSOs.
- Increase Hunt Street force main diameter from 8-inch to 14-inch, and extend force main beyond the Rose Street Pump Station to ‘decouple’ the two pump stations (approximately 3,200 feet of force main total)
- Replace 1,900 feet of existing gravity sewer from new Hunt Street Pump Station terminus manhole (approximately at the intersection of Washington Street and Corliss Street) with new 24-inch diameter sewer to alleviate known capacity issues.

Refer to Figure E-1 in Appendix E for an overview of this alternative.

This alternative eliminates the need to complete any pump upgrades at the Rose Street Pump Station in the near-term. An evaluation of pump motor runtimes at both stations showed that the majority of flow to the Rose Street Pump Station comes from the Hunt Street Pump Station. Eliminating the Hunt Street Pump Station input to the Rose Street Pump Station would reduce station capacity concerns and likely allow operation of a future smaller duty pump to handle normal flows, and larger wet weather pump(s) to handle wet weather flows as needed. For cost estimating purposes, no modifications to the Rose Street Pump Station have been assumed since the station could operate with its existing pumps if the Hunt Street force main bypassed Rose Street.

This alternative would eliminate SSOs at the Hunt Street Pump Station and eliminate overflows at CSO #003. Monitoring of the Rose Street CSO #003 is recommended after completion of this project to ensure that the CSO outlet is no longer required. Overflows at Pleasant Street CSO #004 may increase as a result of more flow being pushed downstream from Hunt Street and Rose Street Pump Stations. The capacity of the CSO discharge pipe leaving the CSO structure is approximately 20 MGD which is sufficient to handle the estimated increased flows.

The capital cost to implement Combination Alternative 6 – Pump Station Capacity Modifications and Reroute Hunt Street Pump Station Force Main is shown in Table 8-3 at the end of this section.

Table 8-3 Planning Level Capital Upgrade Costs – Rose Street CSO

Alternative	Estimated Cost
Alternative 2 - Pump Station Capacity Modifications (Hunt Street and Rose Street)	$4,700,000
Alternative 6 - Pump Station Capacity Modifications and Reroute Hunt Street Pump Station Force Main	$4,100,000[1]

Notes:

1. Cost does not include climate adaptation measure costs.

Based on the advantages/disadvantages and discussions listed above, along with the planning level costs presented, the recommended approach is to move forward with Alternative 6 at this time. Other alternatives may be considered in the future.

8.5.2 Pleasant Street CSO #004

The Pleasant Street CSO #004 serves as a relief point for upstream drainage areas including pumped flows from Rose Street Pump Station, and for gravity flows from the Pleasant Street sewer drainage area. As shown in Figure 4-10 in Section 4.3, the annual number of CSO events at the Pleasant Street CSO has ranged from 1 to 5 between 2014 and 2020 with a total of 21 events and a total volume of approximately 3.47 million gallons. The following table is a screening level evaluation of alternatives for the Pleasant Street CSO.

Table 8-4 Screenings Level Evaluation of Alternatives – Pleasant Street CSO #004

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
1. *I/I Removal:* Continue program of flow monitoring to document significant sources of I/I within collection system. Continue to include high-value I/I removal projects in Capital Improvement Plan	✓		1. Reduction of I/I in the collection system has the combined benefit of: • reducing CSO events/volume/duration; • Reducing operating costs to pump and treat extraneous flows; • Reducing need for capital upgrades to increase pumping/treatment capacity. 2. Continued efforts may lead to reduced capital expenditures or equipment sizing during implementation of long-term control plans 3. There are areas of concentrated catch basins tied to the sanitary collection system that can be separated as part of larger projects 4. Provide capacity to accept increased flow from Hunt Street Pump Station when upgraded	1. Removal of private I/I sources may be difficult to enforce/confirm 2. Potentially high cost to eliminate/reduce CSOs with I/I projects alone 3. I/I reduction is a timely endeavor whose outcomes are difficult to predict
2. *Collection System Capacity Increases:* Increase the capacity of the pump station to enable conveyance of peak flow rates	✓		1. CSOs can be contained within the collection system for gravity conveyance to a treatment system 2. Pump station is at maximum capacity during CSO events. Upsizing the pump station to handle more flows would reduce CSO volume	1. Depending on the magnitude of the capacity increase, the City may need to upsize the force main or install a parallel force main 2. By itself, this option exacerbates downstream capacity issues and would likely increase CSO frequency and volumes at CSO #005 3. High capital cost 4. This force main and interceptor runs along an important transportation artery. Heavy traffic

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
				and numerous utilities make this project difficult and expensive to construct
3. *In-Line Storage of CSO Flow:*		✓		Insufficient storage capacity within existing sewers and no feasible location for new in-line conduits. This option has been eliminated from further consideration
4. *Off-Line Storage of CSO Flow:* Off-line below-grade CSO storage facility located at Pleasant Street Pump Station beneath parking lot on City-owned property	✓		1. Captured flows receive secondary treatment after the peak flows subside within the collection system 2. Potential land available beneath parking lot on City-owned property next to Pleasant Street Pump Station	1. Attention required at remote facility 2. Storage tanks would require occasional confined space entries, may generate odors, and would necessitate the installation of cleaning apparatus and/or odor control equipment 3. Temporary loss of parking for BIW staff during construction of tank

Each of the alternatives listed above could be considered on a stand-alone basis or in combination with more than one feasible alternative, depending on its cost-effectiveness, design sizing considerations and effect on downstream interceptors/pump stations.

Based upon the table above, the following alternatives are targeted for further evaluation to address CSO events:

- Alternative 1 – I/I Removal
- Alternative 2 – Collection system capacity increases
- Alternative 5 – Off-line storage of CSO Flow

The following sections outline the design considerations and cost impacts of each of the alternatives listed above.

8.5.2.1 Pleasant Street CSO: Alternative 1 – I/I Removal

Section 5 of this report summarizes the historical I/I investigations conducted to date, projects completed as a result of those investigations and areas recommended for further evaluation. However, as a long-term CSO control strategy, it is difficult to predict whether I/I reduction efforts alone would eliminate CSO events during the design storm at the Pleasant Street CSO. The City should continue its cost-effective, high impact I/I removal projects to reduce the magnitude and frequency of CSO events, reduce pumping costs and reduce the magnitude of future capital improvement projects required to increase pumping and treatment capacity while it focuses on alternate long-term CSO control strategies.

Three I/I separation projects that should be considered as high impact projects include:

- Separation of two combined catch basins on West Street
- Separation of five combined catch basins on Richardson Street
- Separation of two combined catch basins north of the intersection of High Street and South Street

It should be noted that five of the nine catch basins to be separated tie into the Pleasant Street drainage area (CB-972, -968, -969, -971, -970) and four tie into the Commercial Street drainage area (CB-973, -974, -998, -999). Although the catch basins span across two drainage areas, the nine catch basins are all within close proximity of each other and will be designed and bid as part of the same project. This report envisions separation of all nine catch basins as one project and is presented as such in subsequent sections. Since the majority of the storm flow would be removed from the Pleasant Street drainage area, the project has been designated as a Pleasant Street drainage area project.

This alternative is contingent on the City's paving schedule for High Street, West Street, and Richardson Street. Refer to Figure E-2 in Appendix E for an overview of this alternative.

Section 5.10 summarizes the flow meter findings related to tidal influence in the Pleasant Street drainage area. As part of this alternative, further investigation to determine the source(s) of tidal influence will be required. Investigations include inspection of the Bath Iron Works (BIW) stormwater system downstream of the CSO structure to determine if the pipes are surcharging during wet weather/high tide and inhibiting CSO flows from discharging the system or providing false readings of CSOs.

The capital cost to implement Alternative 1 – I/I Removal is shown in Table 8-5 at the end of this section.

8.5.2.2 Pleasant Street CSO: Alternative 2 – Collection System Capacity Increases

This option includes increasing the capacity of the pump station and potentially the force main as a result. The alternative results in more flow to the Commercial Street Pump Station. As discussed in this report, the Commercial Street Pump Station is already limited by the amount of flow that can be pumped because of SSOs that occur outside the WPCF. The Commercial Street Pump Station wet well also backs up and surcharges the influent pipes during storm events, contributing to CSOs and SSOs within the collection system. By increasing the flow from Pleasant Street Pump Station, the Commercial Street Pump Station will experience even larger backups resulting in larger CSO and SSO volumes in the Commercial drainage area. Because the issues in Commercial Street are so extensive, the benefits of reducing or eliminating the Pleasant Street CSO by increasing the size of the pump station do not outweigh the drawbacks of increasing the amount of flow to the Commercial Street Pump Station. Therefore, this alternative was eliminated from consideration.

8.5.2.3 Pleasant Street CSO: Alternative 5 – Off-line Storage of CSO Flow

While there may be sufficient space available adjacent to the Pleasant Street Pump Station site to construct a CSO storage tank of the size necessary to contain the largest CSO event recorded between 2018 and 2020 of 336,000 gallons, a larger tank would be needed to abate larger volumes resulting from larger storm events. Potentially hazardous materials may exist under this lot that used to be owned by BIW, which may cause issues with the feasibility of the project. Additionally, the Pleasant Street CSO is the lowest priority out of the CSO locations. Therefore, this alternative was eliminated from consideration at this time.

Table 8-5 Planning Level Capital Upgrade Costs – Pleasant Street CSO

Alternative	Estimated Cost
Alternative 1 – I/I Removal	I/I Separation Projects: $900,000 Investigation of Influences on CSO Flows: $25,000

Based on the advantages/disadvantages and discussions listed above, along with the planning level costs presented, the recommended approach is to move forward with Alternative 1 at this time. Other alternatives may be considered in the future.

8.5.3 Commercial Street CSO #005

The Commercial Street CSO #005 serves as a relief point for upstream drainage areas including pumped flows from Pleasant Street, and for gravity flows from the Commercial Street sewer drainage area. As shown in Figure 4-14 in Section 4.4, the annual number of CSO events at the Commercial Street CSO has ranged from 3 to 11 between 2014 and 2020 with a total of 45 events and a total volume of approximately 4.0 million gallons. The following table is a screening level evaluation of alternatives for the Commercial Street CSO.

Table 8-6 Screenings Level Evaluation of Alternatives – Commercial Street CSO #005

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
1. *I/I Removal:* Continue program of flow monitoring to document significant sources of I/I within collection system. Continue to include high value I/I removal projects in Capital Improvements Plan	✓		1. Reduction of I/I in the collection system has the combined benefit of: • reducing CSO events/volume/duration; • Reducing operating costs to pump and treat extraneous flows; • Reducing need for capital upgrades to increase pumping/treatment capacity 2. There are areas of concentrated catch basins tied to the sanitary collection system that can be separated as part of larger projects 3. Continued efforts may lead to reduced capital expenditures or equipment sizing during implementation of long-term control plans 4. Reduction in CSO volumes will lead to reductions in SSO occurrences and volumes in this drainage area	1. Removal of private I/I sources may be difficult to enforce/confirm 2. Potentially high cost to eliminate/reduce CSOs with I/I projects alone 3. I/I reduction is a timely endeavor whose outcomes are difficult to predict 4. Reductions in SSO volumes may result in increased CSO volumes
2a. *Collection System Capacity Increase:* Upsize interceptor lines leading to the Commercial Street Pump Station to prevent SSOs	✓		1. Increased interceptor will reduce SSO occurrences and volumes 2. CSOs can be contained within the collection system for gravity conveyance to a treatment or storage system 3. Upsizing interceptor lines will alleviate known bottlenecks in the collection system	1. Commercial Street Pump Station operates near capacity during peak storm flows. Increasing the interceptor line to promote more flow to the station will require an upgrade to the pump station itself to increase capacity 2. WPCF is near capacity during peak storm flows. Increased flows from the Commercial Street Pump Station will result in an SSO at the force main terminus manhole without modifications to that structure

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
				3. Even if modifications are made to the terminus manhole to prevent SSOs, increased flow from Commercial Street may overwhelm the WPCF 4. Known bottlenecks are in highly trafficked areas, making construction challenging and expensive 5. Does not reduce CSO volumes and does not reduce the impact of CSO events when they do occur 6. Capacity limitations existing in sewers in the downtown area, and upsizing upstream sewers could result in downstream SSOs
2b. *Collection System Capacity Increase:* Upsize interceptor lines at FM terminus manhole to prevent SSOs	✓		1. Commercial Street pumps are currently flow limited to prevent SSOs. Increase interceptor line would allow pumps to run at full capacity and reduce CSOs	2. The interceptor line to be upsized is the main influent line to the WPCF. Construction to upsize this line would require temporary pumps to bypass all influent flows to the WPCF.
3. *Pump Station Capacity Increase:* Increase the capacity of the pump station to enable conveyance of peak flow rates	✓		1. CSOs can be contained within the collection system for gravity conveyance to a treatment system 2. Pump station is at maximum capacity during CSO events. Upsizing the pump station to handle more flows would reduce CSO volumes	1. Depending on the magnitude of the capacity increase, the City may need to upsize the force main or install a parallel force main 2. By itself, this option exacerbates downstream capacity issues and would result in capacity and treatment issues at the WPCF 3. High capital cost
4. *Reroute Collection System Drainage Areas:* Install new stormwater pump station to separate combined sewer flows	ü		1. Reducing flows in the Commercial Street drainage area will alleviate known SSOs in the sewer interceptor along the railroad tracks, and alleviate known bottlenecks downstream	1. New pump station would be required, higher operations and maintenance costs and additional maintenance for City staff 2. High capital cost

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
from York/Willow/Crescent Streets to stormwater system on Washington Street			of the SSOs closer to Commercial Street Pump Station 2. Potential in-line storage volumes in the Commercial Street drainage area would be reduced	3. Higher degree of complexity compared with other alternatives 4. While SSOs would be eliminated, it does not guarantee that CSOs volumes would be reduced. Additional modeling needed to determine impacts on CSO volumes.
5. *In-Line Storage of Flows:* Install new in-line storage conduit along railroad tracks and/or micro-storage tanks	✓		1. Reduce volume and occurrence of known SSO events 2. Captured flows receive secondary treatment after the peak flows subside within the collection system	1. Few feasible locations within drainage area for new in-line conduits. 2. High capital cost 3. Main goal is to address SSO events; only marginally addresses impact of CSO events when they do occur
6. *Off-Line Storage of CSO Flow:* Off-line storage and CSO pump station facility located at Commercial Street Pump Station		✓		Limited available space to site new off-line storage tank and CSO pump station adjacent to existing Commercial Street Pump Station. This option has been eliminated from further consideration
7. *Reroute Pump Station Force Main:* Extend Pleasant Street Pump Station force main past CSO #005	✓		1. Reduce peak flows at Commercial Street Pump Station by an amount equal to the Pleasant Street Pump Station	1. High capital cost 2. Force main extension would be required in highly trafficked areas of the City, making construction very difficult and costly 3. Force main extension would increase friction loss and require higher horsepower pumps 4. No other benefit derived from extending force main beyond conveying flows past CSO #005

Each of the alternatives listed above could be considered on a stand-alone basis or in combination with more than one feasible alternative, depending on its cost-effectiveness, design sizing considerations and effect on downstream interceptors/pump stations.

Based upon the table above, the following alternatives are targeted for further evaluation to address CSO events:

- Alternative 1 – I/I Removal
- Alternative 2 – Collection System Capacity Increase
- Alternative 3 – Pump Station Capacity Increase
- Alternative 4 – Stormwater Pump Station
- Alternative 5 – In-Line Storage of CSO Flow
- Alternative 7 – Reroute Pump Station Force Main

The following sections outline the design considerations and cost impacts of each of the alternatives listed above.

8.5.3.1 Commercial Street CSO: Alternative 1 – I/I Removal

Section 5 of this report summarizes the historical I/I investigations conducted to date, projects completed as a result of those investigations and areas recommended for further evaluation. However, as a long-term CSO control strategy, it is difficult to predict whether I/I reduction efforts alone would eliminate CSO events during the design storm at the Commercial Street CSO. The City should continue its cost-effective, high impact I/I removal projects to reduce the magnitude and frequency of CSO events, reduce pumping costs and reduce the magnitude of future capital improvement projects required to increase pumping and treatment capacity while it focuses on alternate long-term CSO control strategies.

Two I/I separation projects that should be considered as high impact projects include:

- Separation of one combined catch basin on King Street

- Separation of two combined catch basins on South Street

Refer to Figure E-3 in Appendix E for an overview of this alternative.

The Commercial Street drainage area is a candidate for more intensive sewer system evaluation survey (SSES) work to determine the I/I contribution from public sources (cracked sewer interceptors, combined catch basins, etc.) and private sources (deteriorated service connections, sump pumps, foundation drains, flat roof buildings with illicit connections to sewer system, etc.). Additional SSES investigations are recommended between York Street and School Street within the Commercial Street drainage area as outlined in the 2021 Willow and Middle Street Combined Sewer Modeling Memo. Continuing to pursue separation projects downstream of the Willow/Middle Street area will create additional capacity in the downstream sewer system and abate SSOs. For planning purposes, a budgetary cost of $1,500,000 to implement project(s) in the public right-of-way resulting from SSES investigations has been included in the cost estimate.

The capital cost to implement Alternative 1 – I/I Removal (two separation projects and additional SSES investigations) is shown in Table 8-7 at the end of this section.

Ongoing I/I removal projects in the Commercial Street drainage area are outlined below. Both projects are currently in construction and scheduled to be completed by June 2022.

- Previous CSO Abatement project #25 – Separation of Western Ave and Cottage Street
- Relining of Commercial Street interceptor

Section 5.11 summarizes the flow meter findings related to tidal influence in the Commercial Street drainage area. Relining the Commercial Street interceptor will potentially eliminate the sources of tidal influence but if not, further investigation will be required. If the source of tidal influence is found to be a cross-connection to the storm drain which surcharges during high tide, separation of the cross-connection should be completed.

8.5.3.2 Commercial Street CSO: Alternative 2A – Collection System Capacity Increase

This alternative includes upsizing the interceptor line along railroad tracks from approximately York Street to School Street to increase capacity and reduce SSO volumes and occurrences. Previous InfoSWMM modeling efforts have shown that increasing the size of this interceptor pipe, while able to reduce SSO occurrences along the railroad tracks, increases the likelihood of flooding to grade further downstream in the collection system near the downtown area during large storm events. Prior to proceeding with this alternative, separation, I/I removal, and possible micro-storage projects are recommended to reduce peak flows. Once these projects are completed, the InfoSWMM model should be recalibrated with updated flows, and then used to size the interceptor. This alternative was eliminated from consideration as part of this CSO Master Plan. This alternative may be reviewed in the future, after completion of I/I removal and potential micro-storage projects.

8.5.3.3 Commercial Street CSO: Alternative 2B – Collection System Capacity Increase

This alternative includes upsizing the interceptor line at the Commercial Street force main terminus manhole to the WPCF. Occasional SSOs were observed at the terminus manhole when Commercial Street was pumping at full capacity. To eliminate SSOs, the City throttles the Commercial Street pumps so that they do not pump at full capacity. Increasing the interceptor line would increase the capacity of the collection system, thereby allowing Commercial Street to operate at full capacity and reduce CSO flows.

The section of interceptor pipe to be upgraded is the main influent line to the WPCF. All flows to the WPCF would need to be bypassed to allow for this line to be replaced. Given the very wide range of flows that the WPCF sees and difficulties in bypassing this line, this alternative was eliminated from consideration as part of this CSO Master Plan.

8.5.3.4 Commercial Street CSO: Alternative 3 – Pump Station Capacity Increase

This option includes increasing the capacity of the Commercial Street Pump Station such that the station is sized to eliminate CSOs during the design storm. While this option would reduce CSO flows at Commercial Street Pump Station, it would result in significant additional flow to the treatment plant, which is near maximum capacity during peak flow conditions.

Currently, the capacity of the existing pump station is intentionally limited to prevent SSOs at the force main terminus manhole. Two small jockey pumps normally operate, followed by a third, duty pump during wet weather. A fourth duty pump turns on if needed, but the speed of the last duty pump is limited to ~54 Hz to prevent an SSO from occurring downstream of the terminus manhole in Bowery Street.

Upsizing this pump station to reduce CSO flows cannot be accomplished without significant capital investment in the Commercial Street Pump Station, force main, and treatment facility. Therefore, this alternative was eliminated from consideration at this time.

8.5.3.5 Commercial Street CSO: Alternative 4 – Stormwater Pump Station

A stormwater pump station could be installed between the railroad tracks and Willow Street to separate 26 combined catch basins. The proposed pump station property is owned by the City (Maplot 21-042-000) and is directly adjacent to seven combined catch basins on Willow Street. The parcel is also in a relatively low-lying area, making it an ideal location for a new pump station. The following is a summary of the expected infrastructure necessary to implement this alternative:

- Construction of a dry pit/wet well pump station sized to eliminate SSOs along the railroad tracks in the York Street / Willow Street area for a 10-year 24-hour storm event.
- New CMU building containing stormwater pumps, piping, electrical equipment, instrumentation equipment, and emergency standby generator.
- Construction of new gravity storm drain piping from the combined catch basins to the pump station wet well.
- Overflow pipe from drain manhole outside of pump station back to sewer system to act as a relief valve.
- Construction of a new force main to pump flow from the pump station to an existing, separated storm drain manhole at the intersection of North Street and Washington Street. For cost estimating purposes, a 12-inch diameter force main has been assumed.
- Replacement of the gravity storm drain from the terminus drain manhole at the intersection of North Street and Washington Street to the existing outfall, east of the intersection of Front and North Street, adequately sized to handle the increased flow from the pump station. For cost estimating purposes, a 36-inch diameter storm drain has been assumed.

Construction of a stormwater pump station will reduce the volume of stormwater contributing to the sewer interceptor along the railroad tracks, ultimately reducing SSO volume along Middle Street, Willow Street, and the railroad tracks. Refer to Figure E-4 in Appendix E for an overview of this alternative.

The capital cost to implement Alternative 4 – New Stormwater Pump Station is shown in Table 8-7 at the end of this section.

8.5.3.6 Commercial Street CSO: Alternative 5 – In-Line Storage of CSO Flow

This alternative includes micro-storage tanks along the railroad tracks interceptor to reduce SSO occurrences and volume. This alternative was conceptualized in the 2017 Willow and Middle Street Combined Sewer Modeling Memo. There are limited feasible locations to install storage tanks between Middle and Willow Street, and the locations that are feasible are relatively small in size. Larger tanks would be needed to abate larger volumes of stormwater resulting from larger storm events, reducing the feasibility of this option. The main goal of this alternative is to reduce SSO occurrences and volume, and only marginally reduces CSO volume. Therefore, this alternative was eliminated from consideration at this time, but may be reconsidered after further SSES work.

8.5.3.7 Commercial Street CSO: Alternative 7 – Reroute Pump Station Force Main

This option includes extending the force main from the Pleasant Street Pump Station past CSO #005 in order to reduce the peak flows at CSO #005. While this option would reduce peak flows at Commercial Street Pump Station, the existing force main is 0.3 miles, and would need to be extended another 1.3 miles. The existing pumps would need to be replaced with significantly larger pumps to overcome the headloss, and construction along Washington Street and crossing Commercial Street/Route 1 would be challenging. Therefore, this alternative was eliminated from consideration.

Table 8-7 Planning Level Capital Upgrade Costs – Commercial Street CSO

Alternative	Estimated Cost
Alternative 1 – I/I Removal	I/I Separation Projects: $350,000 SSES Investigations: $200,000 Future Construction Projects: $1,500,000
Alternative 4 – Stormwater Pump Station	$7,100,000

Based on the advantages/disadvantages and discussions listed above, along with the planning level costs presented, the recommended approach is to move forward with Alternative 1 as a phased approach at this time. Other alternatives may be considered in the future.

8.5.4 Harward Street CSO #008

The Harward Street CSO #008 serves as a relief point for upstream drainage areas including the Landfill and Aegis Pump Stations, and for gravity flows from the Harward Street sewer drainage area. As shown in Figure 4-18 in Section 4.5, the annual number of CSO events at the Harward Street CSO has ranged from 8 to 18 between 2014 and 2020 with a total of 96 events and a total volume of approximately 8.97 million gallons. The following table is a screening level evaluation of alternatives for the Harward Street CSO.

Table 8-8 Screenings Level Evaluation of Alternatives – Harward Street CSO #008

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
1. *I/I Removal:* Continue program of flow monitoring to document significant sources of I/I within collection system. Continue to include high value I/I removal projects in Capital Improvements Plan	✓		1. Reduction of I/I in the collection system has the combined benefit of: • reducing CSO events/volume/duration; • Reducing operating costs to pump and treat extraneous flows; • Reducing need for capital upgrades to increase pumping/treatment capacity 2. There are areas of concentrated catch basins tied to the sanitary collection system that can be separated as part of larger projects 3. Continued efforts may lead to reduced capital expenditures or equipment sizing during implementation of long-term control plans 4. Reduction in CSO volumes will lead to reductions in SSO occurrences and volumes in this drainage area	1. Removal of private I/I sources may be difficult to enforce/confirm 2. Potential high cost to eliminate/reduce CSOs with I/I projects alone 3. I/I reduction is a timely endeavor whose outcomes are difficult to predict 4. Reductions in SSO volumes may result in increased CSO volumes
2. *Collection System Capacity Increase:* Upsize the main sewer interceptor in the drainage area downstream of the CSO to the pump station	✓		1. Increased interceptor will reduce SSO and CSO occurrences and volumes 2. CSOs can be contained within the collection system for gravity conveyance to a treatment or storage system 3. More flow will reach the Harward Street Pump Station, allowing station to operate closer to maximum capacity during storm events	1. WPCF is near capacity during peak storm flows. Increased flows from the Harward Street Pump Station may overwhelm the WPCF 2. High capital cost 3. Requires upgrades to Harward Street Pump Station to handle increased flow

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
3. *Reroute Collection System Drainage Areas – New Sewer Pump Station:* Divide drainage area into two smaller drainage areas and install a new pump station near Office Drive	✓		1. Reducing the size of drainage area will allow more flow in collection system to reach Harward Street Pump Station and maximize capacity of station 2. Reduces known capacity issues in the collection system by removing a portion of the flow from the interceptor 3. Main interceptor from Park Street to Harward Street Pump Station may not need to be increased to handle peak flows since peak flow rates would be split between two drainage areas	1. New pump station would be required, higher operations and maintenance costs and additional maintenance for City staff 2. High capital cost 3. Higher degree of complexity compared with other alternatives 4. Harward Street Pump Station pumps may be oversized for the reduced flows and potentially need to be replaced 5. Additional modeling needed to determine optimal location for new pump station 6. Land may not be available for a new pump station in the best location from a technical standpoint.
4. *Relocate CSO #008*	✓		1. Reduce and potentially eliminate known SSOs	1. By itself, this option exacerbates capacity issues and would likely increase CSO frequency and volumes at CSO #008 2. Requires upgrading the interceptor upstream of the new CSO location to alleviate known bottlenecks and get all flow to the new CSO location
5. *In-Line Storage of CSO Flow:*	ü		1. Reduce volume and occurrence of known SSO events	1. Additional maintenance for City staff periodically cleaning out storage conduits 2. High capital cost

Alternative	Feasible	Not-Feasible	Advantages	Disadvantages
Utilize existing collection system piping or install new in-line storage conduit within drainage area			2. Captured flows receive secondary treatment after the peak flows subside within the collection system 3. Potential to reuse existing sewer piping if new, upsized sewer pipe is to be installed parallel to existing	3. Insufficient storage capacity within existing sewers to store all CSO flows.
6. *Off-Line Storage of CSO Flow:* Off-line storage and CSO pump station facility located near Office Drive	✓		1. Reduce volume and occurrence of known SSO events 2. Captured flows receive secondary treatment after the peak flows subside within the collection system 3. Potential land available beneath existing community gardens; located adjacent to existing Denny Road SSO	1. New pump station required, additional maintenance for City staff 2. Attention required at remote facility 3. Storage tanks would require occasional confined space entries, may generate odors, and would necessitate the installation of cleaning apparatus and/or odor control equipment

Each of the alternatives listed above could be considered on a stand-alone basis or in combination with more than one feasible alternative, depending on its cost-effectiveness, design sizing considerations and effect on downstream interceptors/pump stations.

Based upon the table above, the following alternatives are targeted for further evaluation to address CSO events:

- Alternative 1 – I/I Removal
- Alternative 2 – Collection System Capacity Increase
- Alternative 3 – New Sewer Pump Station
- Alternative 4 – Relocate CSO #008
- Alternative 5 – In-Line Storage of CSO Flow
- Alternative 6 – Off-Line Storage of CSO Flow
- Combination Alternatives:
  - Alternative 7 – Combination of the following alternatives:
    - Alternative 2 – Collection System Capacity Increases – Phase 1 and Phase 2 only
  - Alternative 8 – Combination of the following alternatives:
    - Alternative 2 – Collection System Capacity Increases – Phase 1 and Phase 3 only
    - Alternative 3 – New Sewer Pump Station
    - Alternative 4 – Relocate CSO #008

The following sections outline the design considerations and cost impacts of each of the alternatives listed above.

8.5.4.1 Harward Street CSO: Alternative 1 – I/I Removal

Section 5 of this report summarizes the historical I/I investigations conducted to date, projects completed as a result of those investigations and areas recommended for further evaluation. However, as a long-term CSO control strategy, it is difficult to predict whether I/I reduction efforts alone would eliminate CSO events during the design storm at the Harward Street CSO. The City should continue its cost-effective, high impact I/I removal projects to reduce the magnitude and frequency of CSO events, reduce pumping costs and reduce the magnitude of future capital improvement projects required to increase pumping and treatment capacity while it focuses on alternate long-term CSO control strategies.

Three I/I separation projects that should be considered as high impact projects include:

- Separation of four combined catch basins on Green Street and two combined catch basins on Oak Street. These catch basins are located upstream of CSO #008 and separation will reduce CSO flow.
- Separation of four combined catch basins at the intersection of Park Street and High Street. These catch basins are located directly upstream of the Denny Road SSO and separation will reduce flow in the sewer interceptor.
- Separation of two combined catch basins on Meadow Way. These catch basins are located directly upstream of the Denny Road SSO and separation will reduce flow in the sewer interceptor.

Refer to Figures E-5, E-6, and E-7 in Appendix E for an overview of this alternative.

The capital cost to implement Alternative 1 – I/I Removal is shown in Table 8-9 at the end of this section.

8.5.4.2 Harward Street CSO: Alternative 2 – Collection System Capacity Increase

This is a very complex drainage area with challenging hydraulics. Section 4.5 summarizes known capacity limitations in this drainage area that lead to SSOs and CSOs. A phased approach is recommended to mitigate SSOs and CSOs in this drainage area as outlined below.

Phase 1 - Development of a calibrated InfoSWMM model of the main interceptor from CSO #008 to the Harward Street Pump Station. The InfoSWMM model will allow for an effective means to understand the hydraulics of this drainage area. Once calibrated, the model can be used to as a tool to analyze potential projects to increase the capacity of the interceptor to mitigate SSOs and CSOs.

Phase 2 - Construction project to upsize the interceptor from SMH-97 at Denny Road to SMH-56 at Washington Street to address known bottlenecks in the interceptor and eliminate SSOs. The InfoSWMM model in Phase 1 should be used to verify the diameters and extents of interceptor replacement necessary to eliminate SSOs. For the purposes of estimating cost for this Phase 2 project, a conservative estimate of 36-inch diameter pipe has been assumed to replace the existing interceptor, which varies in size from 24-inch to 27-inch. Refer to Figure E-8 in Appendix E for an overview of this alternative. Utility easements will be needed between Park Street and Winship Street. Utility easements are in place from Winship Street to Washington Street.

The Harward Street Pump Stations were installed in 1997 and are reaching the end of their useful lives. It should be noted that the City sees frequent rags in this drainage area that clog the pumps. Given the size and criticality of this pump station and frequent clogging that takes one pump out of service, an upgrade to the pump station should be completed if more flow will be sent to the station. Upgrades should include replacing the existing pumps with more robust solids handling pumps sized to handle the design flow with one pump offline. The extent of this upgrade can vary depending on how much ancillary equipment must be replaced. For planning purposes, a budgetary cost range to upgrade the pumps and ancillary equipment (including new generator) has been included in the cost estimate.

Phase 3 – Future potential construction project to upsize the interceptor from CSO #008 to SMH-97 at Denny Road to mitigate CSO flows for the design storm. The InfoSWMM model in Phase 1 should be recalibrated to account for impacts from Phase 2, and then used to verify the diameters and extents of interceptor replacement necessary from CSO #008 to Denny Road to mitigate CSOs. For the purposes of estimating cost for this Phase 3 project, a conservative estimate of 36-inch diameter pipe has been assumed to replace the existing interceptor, which varies in size from 15-inch to 18-inch. Refer to Figure E-9 in Appendix E for an overview of this alternative. Utility easements will be needed between Office Drive and CSO #008. Implementation of Alternative 2 Phase 3 as a standalone option is not recommended as it will exacerbate SSO flows; this project should be combined with other alternatives as outlined below.

Phase 4 – Future potential collection system construction project based on findings from the InfoSWMM model in Phase 1 to reduce CSO flows. Without results from the InfoSWMM model, it is difficult to determine what locations will benefit most from construction projects. This project could consist of upsizing the interceptor from CSO #008 to Denny Road to eliminate known bottlenecks, or the InfoSWMM model may help identify a more beneficial project to reduce CSO flows at Harward and abate SSOs. The results of the updated InfoSWMM model after completion of the Phase 2 construction project will help determine if any of the previous alternatives or combination of alternatives could be selected to eliminate SSO flows and further reduce CSO flows in the Harward Street drainage area. For cost estimating purposes, a budgetary cost of $2,000,000 has been included for a future Phase 4 construction project.

The 2018 capacity analysis indicated that *if* all flow could be sent to the Harward Street Pump Station, the pump station would be undersized to handle peak flows. Completion of Phase 2 and Phase 3 as a standalone project will necessitate capacity upgrades to the Harward Street Pump Station. Upgrading the Harward Street Pump Station to handle these increased flows will subsequently result in more flow being pumped to the WPCF, and additional upgrades will be needed there. These additional upgrades at the WPCF are not envisioned as being part of this CSO Master Plan Update and not planned to occur within the next 5-years. In the meantime, as an alternative to upgrades at the WPCF, the Harward Street Pump Station capacity may need to be flow limited (i.e., max output of the pumps limited to a certain flow rate so as not to overwhelm the WPCF) until capacity at the WPCF can be increased.

The capital cost to implement Alternative 2 – Collection System Capacity Increases is shown in Table 8-9 at the end of this section.

8.5.4.3 Harward Street CSO: Alternative 3 – New Sewer Pump Station

A new pump station will divide the existing Harward Street drainage area into two smaller sub-areas. A new pump station could be located adjacent to Office Drive upstream of the two known SSO locations at Denny Road and Juniper Street. The proposed pump station property is owned by the City (Maplot 19-136-000) and is directly adjacent to the main sewer interceptor, making it an ideal location for a new pump station. The following is a summary of the expected infrastructure necessary to implement this alternative:

- Construction of a dry pit/wetwell pump station sized to mitigate CSO volume for the design storm. Additional long-term flow metering is necessary to understand design flow rates for a new pump station.
- New CMU building containing pumps, piping, electrical equipment, instrumentation equipment, and emergency standby generator.
- Construction of a new gravity sewer main to divert flow from the interceptor to the pump station
- Construction of a new force main to pump flow from the pump station to the WPCF via Office Drive and Oliver Street to a terminus manhole on Washington Street. For cost estimating purposes, a 16-inch diameter force main has been assumed.
- Construction of new gravity sewer from the terminus manhole on Washington Street to SMH-198 in front of the WPCF, adequately sized to handle the increased flow from the pump station. For cost estimating purposes, a 15-inch diameter gravity sewer pipe has been assumed.

Refer to Figure E-10 in Appendix E for an overview of this alternative.

Construction of a new pump station will reduce the peak flows to the Harward Street Pump Station and may allow the Harward Street Pump Station to operate without a capacity increase. InfoSWMM modeling should be conducted to model the impacts of a new pump station on peak flows at the Harward Street Pump Station to determine whether pump capacity upgrades are warranted. Hydraulic modeling should also be conducted at the WPCF to determine the impacts of a new pump station on peak flows at the WPCF to determine whether capacity upgrades are needed. As stated above, capacity upgrades at the WPCF are not envisioned as part of this CSO Master Plan update 5-year cycle.

The capital cost to implement Alternative 3 – New Sewer Pump Station is shown in Table 8-9 at the end of this section.

8.5.4.4 Harward Street CSO: Alternative 4 – Relocate CSO #008

Given the low grade around the Harward Street Pump Station and elevation of the Kennebec River during high tides and storm events, it would not be possible to have the CSO structure at the pump station itself without having an SSO at the pump station.

The existing CSO outfall pipe runs parallel to the main sewer interceptor from CSO #008 to Washington Street just upstream of the Harward Street Pump Station. The relocated CSO could be located anywhere along the existing outfall pipe, and a cross connection to the parallel sewer line established. Possible locations for the new CSO overflow structure include in the vicinity of Park Street, or further downstream near Barque Road. Key considerations for relocating the CSO structure include:

- The location must be high enough such that that the Kennebec River water level will not surcharge back over the weir
- The location can't be relocated so far downstream that capacity issues *upstream* of the CSO are exacerbated, causing new SSOs.
- The elevation of the weir must be set at an appropriate level such that sewer flow to the Harward Street Pump Station (and subsequently the WPCF) does not overwhelm the pump station. The weir should be adjustable so that the elevation can be adjusted as various CSO mitigation strategies are implemented and flows to the CSO structure are reduced with time.
- The location should be accessible by vehicle so that City staff can periodically inspect the CSO structure and download CSO flow data from the meter.

Another alternative approach to mitigate SSO flows is to install a temporary cross connection between the Denny Road manhole SMH-1113 and the adjacent CSO discharge line. This would require approximately 20-feet of pipe and would eliminate SSOs at this location. This cross-connection would likely be considered a new CSO discharge location. Once other projects in this drainage area are completed and SSOs are no longer likely, the temporary cross connection could be abandoned and the CSO discharge eliminated.

With most alternatives in play at the Harward Street CSO, relocation of CSO #008 must be considered to protect the Harward Street Pump Station from becoming overwhelmed and minimize the chance of SSOs at the pump station itself.

The capital cost to implement Alternative 4 –Relocate CSO #008 is shown in Table 8-9 at the end of this section.

8.5.4.5 Harward Street CSO: Alternative 5 – In-Line Storage of CSO Flow

Under the existing CSO conditions, box culverts could be installed along the sewer main interceptor from Park Street to Washington Street in the utility right-of-way to attenuate peak flows during storm events.

The capital cost to implement Alternative 5 –In-Line Storage of CSO Flow is shown in Table 8-9 at the end of this section.

If Alternative 2 – Collection System Capacity Increases is implemented and new sewer pipe is installed, there is the potential to keep the existing sewer main interceptor line in place and use it as in-line storage. A weir and overflow pipe would be installed on the new interceptor at the upstream end of the storage line. An automatic gate and return overflow pipe would be installed on the old interceptor at the downstream end of the storage line. The automatic gate would close during storm events to hold flows in the old interceptor line. After the storm event passed and flows subsided, the gate would be opened, and flows returned to the new interceptor line where they would flow to the Harward Street Pump Station for pumping to the WPCF. Depending on the extent of pipe replaced, the storage capacity will vary. Regardless of the extent replaced, there is not enough storage capacity to eliminate CSO flows based on current average CSO volumes.

8.5.4.6 Harward Street CSO: Alternative 6 – Off-Line Storage of CSO Flow

There is not sufficient space available at CSO #008 for the installation of offline storage tanks necessary to abate current CSO flows. There is space available at the City-owned lot adjacent to Office Drive (Maplot 19-136-000) and the sewer main interceptor.

The following is a summary of the expected infrastructure necessary to implement this alternative.

- Construction of a new underground storage tank sized to attenuate CSO flows for the design storm. Size to be confirmed by additional flow metering and InfoSWMM modeling. For the purposes of estimating cost for this alternative, a 1-million-gallon tank has been assumed to attenuate flows from the largest CSO event observed between 2018 and 2020. A 1-million-gallon tank would be approximately 130 feet long by 130 feet wide by 8 feet deep.
- For the purposes of estimating cost for this alternative, a typical range of cost of $5 to $12 per gallon of storage volume was used. Based on site specific considerations that included potential for ledge, this estimate was refined to be between $6 to $9 per gallon of storage.
- The tank would be equipped with level controls and alarms, tipping buckets, or storm water flushing gates to clean the tanks after an event passed and a chlorination/mixing system for odor control.
- Installation of a new manhole with overflow weir and new gravity sewer from the main interceptor to the storage tank.
- Construction of a new force main from the storage tank to the main interceptor to pump stored flows back to the collection system.
- Construction of an access road from Office Drive to the CSO Storage Tank.

The capital cost to implement Alternative 6 – Off-Line Storage of CSO Flow is shown in Table 8-9 at the end of this section.

8.5.4.7 Harward Street CSO: Combination Alternative 7 – Collection System Capacity Increases (Alt 2, Phase 1, and Phase 2)

This combined alternative includes collection system capacity increases of the sewer main interceptor, specifically Phase 1 – Development of a calibrated InfoSWMM model of the interceptor, and Phase 2 - Construction project to upsize the interceptor from Denny Road to Washington Street. This combination alternative serves one main purpose, namely to reduce SSOs due to capacity limitations of the main sewer interceptor.

The capital cost to implement Combination Alternative 7 – Collection System Capacity Increases is shown in Table 8-9 at the end of this section.

8.5.4.8 Harward Street CSO: Combination Alternative 8 – Collection System Capacity Increases (Alt 2, Phase 1, and Phase 3), New Sewer Pump Station (Alt 3), and Relocate CSO #008 (Alt 4)

This combined alternative includes collection system capacity increases of the sewer main interceptor, specifically Phase 1 – Development of a calibrated InfoSWMM model of the interceptor and Phase 3 – Construction project to upsize the interceptor from CSO #008 to a new sewer pump station located at Varnum Field. It also includes construction of a new sewer pump station and relocating CSO #008.

This combination alternative serves three purposes:

1. Reduce SSOs due to capacity limitations of the main sewer interceptor
2. Reduce CSO volume by dividing the drainage area and removing extraneous CSO flow from the drainage area and diverting it to a new pump station
3. Relocate CSO #008 to ensure that additional flows to the Harward Street Pump Station do not overwhelm the station and result in new SSOs.

Refer to Figure E-11 in Appendix E for an overview of this alternative. The proposed site for the new sewer pump station is downstream of CSO #008 and downstream of known capacity issues on the main interceptor. In order to get all sewer flows to the new pump station without having an SSO, the interceptor must be upsized from the existing CSO #008 to the new pump station (Alternative 1 Phase 3). Instead of the 36-inch interceptor envisioned in Alternative 1 Phase 3, a smaller 24-inch interceptor has been assumed for cost estimating purposes. The new pump station will be sized to handle peak flows so CSO #008 in its current location is no longer needed. InfoSWMM modeling will be needed to verify that the interceptor downstream of the new sewer pump station to Washington Street is adequately sized to convey peak flows, which will be reduced due to the new sewer pump station. For cost estimating purposes, it is assumed that the existing pipe can convey peak flows and no cost has been carried to upsize the interceptor. This will need to be verified by the InfoSWMM model. CSO #008 should be relocated downstream of the new sewer pump station to act as a relief valve to prevent Harward Street Pump Station from becoming overwhelmed and new SSOs occurring. The long-term goal is to eliminate CSO #008 after a sufficient period of time to monitor the system and ensure that elimination of CSO #008 in its new location will not result in SSOs. Some means of limiting peak flows from the Harward Street Pump Station may be necessary to ensure the WPCF does not become overwhelmed during peak flow events. Additional InfoSWMM modeling will verify the expected output of the Harward Street Pump Station after the drainage area is divided and should be compared with the peak hydraulic throughput of the WPCF.

The capital cost to implement Combination Alternative 8 – Collection System Capacity Increases, New Sewer Pump Station, and Relocate CSO #008 is shown in Table 8-9 at the end of this section.

Table 8-9 Planning Level Capital Upgrade Costs – Harward Street CSO

Alternative	Estimated Cost
Alternative 1 – I/I Removal	$1,320,000
Alternative 2 – Collection System Capacity Increase	Phase 1: $100,000 Phase 2 (Increase Interceptor): $2,500,000 Phase 2 (Upgrade Pump Station): $1,250,000 to $1,750,000 Phase 3: $1,400,000 Phase 4: $2,000,000
Alternative 3 – New Sewer Pump Station	$8,100,000
Alternative 4 – Relocate CSO #008	$60,000
Alternative 5 – In-Line Storage of CSO Flow	$9,500,000
Alternative 6 – Off-Line Storage of CSO Flow	$8,900,000 to $11,700,000
Alternative 7 – Collection System Capacity Increase (Alt 2 Phase 1 + 2)	$2,600,000
Alternative 8 – Collection System Capacity Increase (Alt 2 Phase 1 + 3), New Sewer Pump Station (Alt 3), and Relocate CSO #008 (Alt 4)	$9,100,000

Based on the advantages/disadvantages and discussions listed above, along with the planning level costs presented, the recommended approach is to move forward with Alternative 1, and Alternative 2 (Phases 1, 2 and 4) at this time. Other alternatives may be considered in the future.

The City should not move forward with any recommended projects other than Alternative 1 until InfoSWMM modeling has been completed. Once the model has been developed and calibrated, the City will be able to make informed decisions on which alternatives should be selected.

8.5.5 Collection System Alternatives Not Associated with Licensed CSOs

There are a number of alternatives that would result in abatement of SSOs and/or CSO volumes throughout the overall collection system but are not directly associated with a licensed CSO.

Each of the alternatives listed below could be considered on a stand-alone basis or in combination with more than one feasible alternative, depending on its cost-effectiveness, design sizing considerations and effect on downstream interceptors/pump stations.

The following alternatives are targeted for further evaluation to address SSO and CSO volumes:

- Alternative 1 – Farrin Place I/I Removal
- Alternative 2 – Farrin Place Pump Station Capacity Increase
- Alternative 6 – Off-Line Storage of CSO Flow
- Alternative 7 – Telemetry Upgrades

8.5.5.1 Farrin Place: Alternative 1 – I/I Removal

Since the Farrin Place Pump Station and drainage area does not have a licensed CSO, recommendations for potential projects to reduce I/I within this drainage area are presented in this section. Section 5 of this report summarizes I/I investigations conducted to date and areas recommended for further evaluation. SSOs have been observed in the drainage area. The City should continue its cost-effective, high impact I/I removal projects to reduce the magnitude and frequency of SSO events, reduce pumping costs and reduce the magnitude of future capital improvement projects required to increase pumping and treatment capacity.

One I/I separation projects that should be considered as high impact projects include:

- Separation of one combined catch basin on East Milan Street, two combined catch basins at the intersection of East Milan and Washington Street, and five combined catch basins on Mechanic Street.

Refer to Figure E-12 in Appendix E for an overview of this alternative.

In addition to the I/I separation project, this alternative includes cleaning and CCTV of the low-lying sewer lines adjacent to the Kennebec River. The City indicated roots are present in these sewer lines, and SSOs have been observed at the manholes in this area. Cleaning and CCTV of the lines will help determine the condition of the sewer pipe. Additionally, during smoke testing investigation, smoke was observed from the ground at the cross-country line east of the pump station between SMH-207 and SMH-208. If pipe relining or replacement are concluded based on the CCTV results of the sewer adjacent to the river, this section of sewer should be considered, as well.

The capital cost to implement Alternative 1 – I/I Removal is shown in Table 8-10 at the end of this section.

8.5.5.2 Farrin Place: Alternative 2 – Pump Station Capacity Increase

This alternative includes increasing the capacity of the pump station. The Farrin Place Pump Station design capacity is approximately 700 gpm. Drawdown tests show the pump station only pumps approximately 230 gpm. A pig launcher should be installed at the Farrin Place Pump Station so that the force main can be cleaned and inspected and then drawdown tests conducted again to determine updated pump station capacity. Based on the results of the force main inspection, a new or partially new force main may be required.

Operating data shows that the existing pumps do not operate on the pump curve, indicating additional problems beyond reduced capacity due to a clogged force main. The City recently rebuilt both pumps at the station to see if that resolves the capacity issues. After rebuilding the pumps, drawdown tests indicated a flow rate of 567 gpm, which is closer to the design point but still not at full capacity. For cost estimating purposes, this alternative includes the cost of the pig launcher and replacement of both pumps at the Farrin Place Pump Station. For cost estimating purposes, no new force main costs have been included.

The capital cost to implement Alternative 2 – Pump Station Capacity Increase is shown in Table 8-10 at the end of this section.

8.5.5.3 WPCF CSO Bypass: Alternative 6 – Off-Line Storage of CSO Flow

The CSO related bypass system at the WPCF provides primary treatment and disinfection of CSO flows, which is described in detail in Section 6.9 and 6.10 of the report. As CSO Master Plan projects are completed in the coming years, more flow will be pushed to the WPCF which is already at maximum capacity during wet weather events. Construction of an off-line storage tank upstream of the WPCF could be considered to allow for more flows to the WPCF in the future from Commercial Street, Farrin Place, and Harward Street Pump Stations during wet weather events.

The storage tank would allow flow to be stored in the tank until peak flows subside, and then flows from the storage tank pumped to the head end of the WPCF for treatment when the WPCF is no longer in bypass operation. There is not sufficient space available at the WPCF for the installation of tanks necessary to abate current CSO flows from the collection system. There is space for a tank available at the City-owned lots at either 2 Town Landing Road or the boat launch on Town Landing Road, both adjacent to the WPCF. For cost estimating purposes, the boat launch on Town Landing Road has been assumed because it is further from the WPCF resulting in a more conservative cost estimate.

The following is a summary of the expected infrastructure necessary to implement this alternative for either location.

- Construction of a new underground storage tank sized to attenuate CSO flows for the design storm. Size to be confirmed by additional flow metering and InfoSWMM modeling. For cost estimating purposes, site specific considerations that included potential for ledge, sheeting, and site sizing constraints were considered to develop cost estimates ranging from $6 to $9 per gallon of storage. The design volume would be determined after modeling, but a tank assumed to be around 1 million gallons was used for the cost estimate.
- The tank would be equipped with pumps, level controls and alarms, tipping buckets, or storm water flushing gates to clean the tanks after an event passed.
- Construction of a new 36-inch gravity sewer pipe from influent manhole SMH-213 to the proposed tank site.
- Construction of a new 8-inch force main from the proposed storage tank to the influent manhole SMH-213

The capital cost to implement Alternative 6 - Off-Line Storage of CSO Flow is shown in Table 8-10 at the end of this section.

8.5.5.4 Collection System Communications: Alternative 7- Telemetry Upgrades

The current radio telemetry equipment at the pump stations do not reliably communicate to the WPCF. A telemetry upgrade to provide new radios and ancillary systems would improve the reliability of the communications system and allow City staff to monitor alarms and controls remotely.

Additionally, there is no means to communicate flow from the remote pump stations to SCADA even though a number of remote pump stations have flow meters. City staff must manually record flows at each station every 2 to 3 days. Telemetry upgrades would allow the flow meters to transmit instantaneous and historical flow data to a centralized WPCF SCADA system which will be very beneficial when it comes to making decisions about pump capacity modifications.

The following is a summary of the expected infrastructure necessary to implement this alternative.

- Installation of new radio telemetry equipment at the following pump stations:
  - Commercial Street
  - Farrin Place
  - Front Street
  - Harward Street
  - Hunt Street
  - Hyde Park
  - Landfill
  - Pleasant Avenue
  - Rose Street
- Installation of flow meter at Rose Street and Hunt Street Pump Stations.

The capital cost to implement Alternative 7 –Telemetry Upgrades is shown in Table 8-10 at the end of this section.

8.5.5.5 WPCF CSO Bypass: Alternative 8 – Increasing WPCF Hydraulic Capacity Analysis

The CSO related bypass system at the WPCF offers primary treatment of CSO flows which is described in detail in Section 6.9. As the City of Bath completes additional CSO abatement projects and alternatives, a larger percentage of the total flows collected within the system will be transported to the WPCF. To prepare the WPCF for these potential increased flows, a hydraulic analysis should be performed at the facility. This analysis would result in a determination of the current hydraulic capacity and identify opportunities for future upgrades or changes to daily operations that could result in increased capacity at the WPCF.

The capital cost to implement Alternative 8 - Increasing WPCF Hydraulic Capacity Analysis is shown in Table 8-10 at the end of this section.

Table 8-10 Planning Level Capital Upgrade Costs – Miscellaneous Collection System Areas

Alternative	Estimated Cost
Farrin Place:	$1,000,000

Alternative	Estimated Cost
Alternative 1 – I/I Removal	
Farrin Place: Alternative 2 – Pump Station Capacity Increase	$195,000
WPCF: Alternative 6: Off-Line Storage of CSO Flows	$9,600,000
Collection System Communications: Alternative 7: Telemetry Upgrade	$200,000
WPCF Bypass: Alternative 8: Increasing WPCF Hydraulic Capacity Analysis	$20,000

Based on the advantages/disadvantages and discussions listed above, along with the planning level costs presented, the recommended approach is to move forward with Alternative 1, Alternative 2, Alternative 7, and Alternative 8 at this time. Other alternatives may be considered in the future.

Section 9 Recommended CSO Abatement Plan

9.1 Introduction

Section 8 of this CSO Master Plan outlines the feasible long-term control alternatives for each of the remaining active CSOs in Bath as well as the relative cost of each alternative to abate SSOs and reduce CSO volumes. It is important to emphasize that the City should actively pursue a phased approach to SSO and CSO abatement. Implementation of any project should be followed by flow monitoring and additional investigation to determine the ultimate result of the project. Implementation of initial phase may reduce or eliminate the need to pursue subsequent phases. However, it is also important to note that the remaining four CSOs will be the most challenging to abate or eliminate due to their location and the magnitude of the recorded CSO volumes and peak flow rates.

This Section also provides planning level cost estimates for the recommended alternatives, a recommended implementation schedule, and project financing options.

9.2 Summary of Recommended CSO Abatement Plan and Implementation Schedule

Table 9-1 below summarizes the recommended, preliminary 5-year CSO abatement plan of the remaining four CSOs in the City of Bath. Implementation of the projects in Table 9-1 target the following goals:

- Elimination of the Rose Street CSO #003
- Abatement of known SSOS in the Rose Street, Commercial Street, and Harward Street drainage areas
- Pursues the strategy of forcing more SSO flows to licensed CSOs in the Commercial Street and Harward Street drainage areas.

The costs presented in Table 9-1 are estimated capital costs to implement each of the Phases as outlined above. These costs are planning level estimates (suitable for comparison of alternatives only). The costs include a 15% contingency and 20% design and construction phase engineering costs. For planning purposes, the future costs have been estimated depending upon the year at which the project would commence and assuming a 3% annual rate of inflation.

The Target Completion Date is the proposed schedule for implementation of each project during the next 5-year CSO abatement period. The start of the 5-year period would coincide with final approval of the CSO Master Plan from Maine DEP. For planning purposes, we have assumed January 2022 as the start of the 5-year period. Target completion dates will be adjusted if necessary pending Maine DEP's review comments and subsequent time to revise the CSO Master Plan.

The recommended plan in Table 9-1 seeks to balance SSO and CSO abatement with capital costs, and to phase the projects such that the City is spending money in the most cost-effective manner to achieve SSO and CSO abatement. It is important to note that initial phases may reduce or eliminate the need to pursue subsequent phases, and this document should be continuously revisited after completion of each project to determine the ultimate result of projects completed.

Table 9-1 Preliminary 5-Year CSO Abatement Plan

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
Rose Street CSO #003			
CSO Abatement Phase 1 • *Pump Station Capacity Upgrade and Force Main Bypass:* Upgrade Hunt Street Pump Station to 3.5 MGD capacity and install new force main from Hunt Street Pump Station to Corliss Street to bypass Rose Street Pump Station.	$4,100,000	2025	$4,615,000
CSO Abatement Phase 2 • It is expected that Phase 1 will eliminate CSOs at Rose. Monitor CSO flows at Rose Street after completion of Phase 1 for remainder of 5-year CSO Master Plan period.	$0	5 years from completion of Phase 1	$0
Pleasant Street CSO #004			
CSO Abatement Phase 1 • *Investigation of influences on CSO Flows:* Field investigations to determine whether recorded CSO flows at CSO #004 are artificially high due to surcharging of the system.	$25,000	2022	$26,000

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
CSO Abatement Phase 2 • *I/I Removal:* Separation of two catch basins north of the intersection of High Street and South Street, separation of two catch basins on West Street, and separation of five catch basins on Richardson Street.	$900,000	2026* Timing of this project depends on the City's CIP paving schedule	$1,043,000
Commercial Street CSO #005			
CSO Abatement Phase 1 • *I/ Removal:* SSES Investigations between York Street and School Street to identify sources of I/I contributing to SSOs along the railroad tracks	$200,000	2023	$212,000
• *I/I Removal:* Separation of one catch basin on King Street and separation of two catch basins on South Street	$350,000	2022	$361,000
CSO Abatement Phase 2 • *I/I Removal:* Construction project(s) based on findings of SSES investigations. Update InfoSWMM model after completion of separation project	$1,500,000	2026	$1,739,000

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
Harward Street CSO #008			
CSO Abatement Phase 1 • *Collection System Capacity Increase Phase 1:* Develop InfoSWMM model of sewer interceptor from CSO #008 to Harward Street Pump Station	$100,000	2022	$103,000
• *I/I Removal:* Separation of combined catch basins on Green Street (4), Oak Street (2), High Street (4), and Meadow Way (2)	$1,320,000	2022	$1,360,000
CSO Abatement Phase 2 • *Collection System Capacity Increase Phase 2:* Increase sewer interceptor from Denny Road to Washington Street to abate SSOs. Size and extents of upgrade to be confirmed by InfoSWMM model	$2,500,000	1 Year from completion of InfoSWMM model	$2,652,000 (Assume 2023)
• *Collection System Capacity Increase Phase 2:* Replace existing pumps at Harward Street Pump Station with new solids handling pumps, generator, and ancillary equipment	$1,750,000	2023 Concurrent with sewer interceptor increase	$1,857,000 Assume (2023)
CSO Abatement Phase 4 • *Collection System Capacity Increase Phase 4:* Future construction project to further abate CSOs. Type and extents of construction project to be determined after InfoSWMM model and CSO Abatement Phase 2 results	$2,000,000	2025	$2,251,000

CSO Location / Recommendation	Preliminary Project Cost Estimate (ENR 12465)	Target Completion Date	Preliminary Project Cost Estimate (Future Dollars)
Collection System Alternatives Not Associated with Licensed CSOs			
CSO Abatement Phase 1 • *Farrin Place Pump Station Capacity Increase*: Install pig launch and clean force main; rebuild existing pumps to increase capacity and abate SSOs upstream of pump station	$195,000	2023	$207,000
• *Collection System Communications Telemetry Upgrade:* Install new telemetry equipment at remote pump stations and flow meters at select stations to digitally record flow data in SCADA	$200,000	2023	$212,000
CSO Abatement Phase 2 • *Farrin Place Pump Station I/I Removal:* Separate up to eight combined catch basins on East Milan Street, Washington Street, and Mechanic Street	$1,000,000	2025	$1,126,000
• *WPCF Bypass Increasing Hydraulic Capacity Analysis:* Engineering analysis to determine what modifications are needed to increase the hydraulic throughput of the WPCF CSO related bypass of secondary treatment	$20,000	2025	$23,000
Total Project Cost for Recommended Projects	$16,160,000	-	$17,787,000

9.3 Long Term CSO Abatement Strategy

The control alternatives presented in Section 8 include alternatives to be considered for implementation within the next five year planning window. There are a number of alternatives that are discussed but not recommended for implementation over the next 5 years; however these alternatives may be suitable in the future beyond the 5-year planning window as part of a longer-term CSO abatement strategy. While this report only focuses on the next 5-years, the City should continue to evaluate and refine its long-term strategies to ultimately eliminate SSOs and CSO discharges. A brief summary of long-term strategies to be considered are discussed below.

9.3.1 Transport and Treat

One long term strategy to mitigate SSOs and CSOs in the collection system is to transport all flow to the WPCF for treatment. This strategy would involve removing conveyance limitations to ensure all flow can reach the pump stations, and ensuring that the pump stations operate at full capacity during wet weather events. Specifically, conveyance limitations have been observed at Harward Street and Commercial Street Pump Stations. Upsizing the interceptor between the Harward CSO #008 and the pump station will mitigate SSOs and CSOs and force more flow to the WPCF. Similarly, operating the Commercial Street pump station pumps at full speed would push more flow to the WPCF, but would result in SSOs at the WPCF influent manhole, requiring the influent pipe to be upsized.

At the WPCF, the CSO related bypass of secondary treatment is near maximum capacity. As projects are completed over the next 5 years and more flow is pushed to the WPCF, upgrades to the CSO related bypass system may be needed (and will be identified in Hydraulic Capacity Analysis to be completed in 2025). Additionally, all influent flow goes through the Headworks prior to reaching the CSO related bypass system. The Headworks is operating near maximum hydraulic capacity and upgrades may be needed there as well. This transport and treat strategy is expected to require costly upgrades. The extent of the upgrades needed won't be known until a clearer picture of total flow being pumped to the WPCF after upgrades listed in Table 9-1 are completed.

9.3.2 Offline Storage

An alternative strategy to the transport and treat is to add offline storage locations throughout the collection system and/or at the WPCF to store wet weather flows until capacity at the pump stations/WPCF is restored and flow can be conveyed through the collection system and treated at the WPCF. Offline storage in the collection system would ideally be located adjacent to bottlenecks causing SSOs or CSOs, which would allow flow to be directed to a storage tank instead of surcharging the collection system pipes and causing CSOs or SSOs. Offline storage locations in the collection system were considered based on City-owned property in proximity to bottleneck locations but ultimately not recommended as part of the 5-year planning window. Completion of projects recommended in the 5-year planning window will change pumped flows, CSO flows, and SSO flows, so updated flow data would be needed to properly size a future storage tank to mitigate SSOs and CSOs.

Additionally, offline storage may be added at the WPCF. Offline storage at the WPCF would be installed in lieu of upgrading the WPCF headworks and CSO related bypass system to handle more capacity as outlined in Section 9.3.1. The alternative of adding offline storage at the WPCF is outlined in Section 8.5.5.3. While not recommended within the next five years, it may be a cost effective option for the City to implement in the future depending on the success of the recommended projects and how they impact collection system flows.

9.3.3 Continued Sewer Separation and I/I Removal

The City has seen historical success removing public I/I from the collection system and is reaching the point where the areas left to separate are more difficult and costly. To help identify I/I sources and determine which sources have the biggest impact, hydraulic models are beneficial. The high priority drainage areas such as Harward and Commercial are also the more complex drainage areas where a hydraulic model would be beneficial. A hydraulic model in these drainage areas will help prioritize which I/I sources (public or private) upstream of CSOs and SSOs would have the biggest impact if separated. For lower priority drainage areas where I/I has already been successfully reduced such as Hunt, Rose, and Farrin, I/I can be further identified with a simple capacity analysis and/or flow metering, if necessary.

9.3.4 Summary

A combination of the long-term strategies identified above may be selected by the City as part of a longer-term CSO abatement strategy. Progress made over the next five years will dictate the direction the City goes in the subsequent years and be used as the basis for designing a WPCF upgrade, sizing storage tanks or identifying and removing I/I. The long-term strategies presented should be continuously revisited as the City progresses through the next 5-year planning window. Each recommended project should contemplate how it will impact the City short-term, and how it will fit into the City's long-term abatement strategy.

9.4 Financing Options and Recommendations

9.4.1 DEP Clean Water State Revolving Fund

The Maine DEP Clean Water State Revolving Fund (CWSRF) program provides grants and low-interest loans to local communities and quasi-municipal entities for wastewater infrastructure improvement projects. Asset-specific adaptation measures with a significant capital cost are likely be eligible for CWSRF grant or loan funding. CWSRF loan principal and interest would need to be fully repaid over the term of the loan (typically 20 years or the expected life of the asset) unless the City qualified for a grant or principal forgiveness. To be eligible for a CWSRF loan, the City would need to complete a CWSRF loan application with the Maine Municipal Bond Bank and other CWSRF program requirements including an environmental impact review report and preliminary design report.

As a result of the COVID-19 pandemic, the federal government released funds as part of the American Rescue Plan Act (ARPA) which were partially distributed through state programs, including the CWSRF program. Maine received the first of two allocations from ARPA in 2021. It is expected that the remainder of these funds will be released in 2022, with a portion included as part of the 2022 CWSRF program.

In the coming years, a significant increase in available CWSRF funding will be seen as a result of the 2021 Bipartisan Infrastructure Deal, which will allow for the EPA to distribute funding to States to be administered through the existing CWSRF programs. This portion of CWSRF funding will be administered as 49% grant and principal forgiveness loans, with the remaining 51% as low-interest loans.

9.4.2 Maine Community Development Block Grant (CDBG) Program

The Maine Department of Economic and Community Development (DECD) administers the CDBG program for the State of Maine. Grants are provided to municipalities and quasi-municipal entities for eligible capital improvement projects. The City could apply for CDBG funds to implement recommended CSO Master Plan projects with a significant capital cost. CDBG funding would be preferable to CWSRF loan funding because grant funds would not need to be repaid. To be eligible for CDBG funds, the City would need to complete a grant application and other CDBG program requirements including an income survey, environmental review report and a preliminary engineering report. The City would be competing in a state-wide pool of applicants for limited grant funds.

9.4.3 U.S. Department of Commerce's Economic Development Administration (EDA) Grant Program

The U.S. Economic Development Administration (EDA) also has a grant program for municipal infrastructure construction necessary to attract or increase commercial and/or industrial development. Grants of 50% of project cost, typically up to a maximum of $1,000,000, are available. One of the primary eligibility criteria is that the project must create or maintain employment opportunities in an economically disadvantaged area. Since it is unlikely that the recommended projects can be shown to create or maintain employment, securing EDA funds is unlikely.

9.4.4 State and Tribal Assistance Grant (STAG)

The State and Tribal Assistance Grant (STAG) funding is an appropriations-based grant for states, tribal and local governments for a variety of water and wastewater infrastructure projects. This grant is administered by the Environmental Protection Agency. This grant requires strong support by City management, Maine DEP, and the congressional delegation. Grants up to $2,000,000 have previously been awarded, although the typical grant award is $300,000 to $500,000. The City should consider submitting an application and follow up with its congressional delegation on the possibility of funding.

9.4.5 USDA Grant/Loan Program

The U.S. Department of Agriculture (USDA) Rural Development (RD) offers Water & Waste Disposal Predevelopment Grants to eligible communities to assist with the initial planning and development of RD Water & Waste Disposal direct loans/grants. RD also offers Water & Waste Disposal direct loans/grants for sanitary sewage disposal, solid waste disposal and stormwater drainage projects. The City would likely qualify again for RD water & waste disposal loan and grant funding.

For CDBG, CWSRF and RD funding, applicants are required to prepare an environmental review report and preliminary engineering report. The State of Maine's CDBG and CWSRF programs are willing to accept an environmental impact review report and preliminary engineering report prepared for RD funding to satisfy their requirements. Therefore, if the City intends to seek outside funding for the recommended asset-specific adaptation measures, it is recommended that an environmental impact review report and preliminary engineering report be prepared to RD standards to satisfy the preliminary requirements of all three funding programs.

9.4.6 Federal Emergency Management Agency (FEMA)

There are a number of grants through FEMA that are available for planning and construction projects to assist communities in implementation of hazard mitigation measures. FEMA Flood Mitigation Assistance (FMA) grants are available for planning and construction projects that reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program (NFIP). FEMA Building Resilient Infrastructure and Communities (BRIC) grants are available to support communities as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. FEMA Hazard Mitigation Grant Program (HMGP) assists in implementing long-term hazard mitigation planning and projects following a presidential disaster declaration. The ongoing COVID-19 Pandemic has triggered this presidential declaration, allowing for funds to be released for this grant program. Both BRIC grants and HMGP can fund up to 75% of the project cost, requiring the City of Bath to provide 25% of the cost in non-federal funding. The non-federal funding can come from state or local government, an individual, construction labor, and in-kind services.

To apply for the above FEMA grants, the City would be required to submit a project application to the State Hazard Mitigation Officer to then be forwarded on to the Regional FEMA office for review and approval. The hazard mitigation project would also be required to conform with the State and local Hazard Mitigation Plans to be eligible for FMA grants. Depending on the grant and available funds each year, the City could be competing for FMA grant funds within a national pool of applicants. FEMA funding would be preferable to CWSRF loan funding because grant funds would not need to be repaid.

9.4.7 Water Infrastructure Finance and Innovation Act (WIFIA) Program

The Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) established the WIFIA program, a federal credit program administered by EPA for eligible water and wastewater infrastructure projects. Eligible borrowers include local, state, tribal, and federal government entities, partnerships and joint ventures, corporations and trusts and Clean Water and Drinking Water State Revolving Fund (SRF) programs. The WIFIA program can fund projects that are eligible for the Clean Water SRF including development phase activities such as planning, preliminary engineering, design, environmental review, revenue forecasting, and other pre-construction activities, construction, reconstruction, rehabilitation, and replacement work, acquisition of real property or an interest in real property, environmental mitigation, construction contingencies, and acquisition of equipment.

Although the design and construction costs of the recommended projects would be categorically eligible for federal WIFIA program funds, the WIFIA program can only fund up to 49% of project costs and requires a minimum project size of $5 million. In addition, typical SRF program requirements including an Environmental Review, Davis-Bacon wage rates and American Iron and Steel requirements would apply to WIFIA funding. Given these eligibility criteria and funding limitations, WIFIA program financing would not be a preferred funding source when compared to USDA Rural Development, CDBG and the Maine DEP CWSRF funding programs.

Appendix A
Summary of Collection System I/I Studies and Improvements

Summary of Historical I/I Studies and Sewer System Evaluation Surveys

Full copies of a number of reports written between 1964 and 1999 were not available for review but are noted below.

Table A-1 Previous Studies

Report Title	Author	Date
Report: Preliminary Planning of Sewage Works Improvements	Fay, Spofford & Thorndike	Jun. 1964
Report: Preliminary Planning of Storm Drain Improvements	Fay, Spofford & Thorndike	Mar. 1965
Preliminary Sewer Study, Hyde Park, Congress Avenue	Edward C. Jordan, Co	Jul. 1974
Infiltration/Inflow Analysis of Existing Sewerage System	Coffin & Richardson	Jan. 1976
Supplement to Infiltration/Inflow Analysis of Existing Sewerage System	Coffin & Richardson	Mar. 1976
Infiltration/Inflow Analysis	Wright-Pierce	Oct. 1979
Storm Drainage Master Plan	Wright-Pierce	Jan. 1980
Contract and Specifications: Sewer System Rehabilitation (Hyde Park)	Wright-Pierce	Sep. 1980
Smoke Testing Report	New England Pipe Cleaning Co.	Oct. 1980
Contract and Specifications for Sewer Separation Projects	Wright-Pierce	Jul. 1982
Sewer System Evaluation Survey	Wright-Pierce	Dec. 1983
Phase II Sewer Separation Project	Kimball Chase Company, Inc.	Sep. 1988
Continuous Flow Monitoring	Utility Pipeline Services, Inc.	Oct. 1992
1994 Sewer System Evaluation	Vermont Pipeline Services, Co.	1994
Revised Facilities Planning Report: Combined Sewer Overflows and Pump Stations	Whitman & Howard, Inc	Mar. 1994
Wastewater Treatment Facility Upgrade and Expansion	Lewis & Zimmerman Assoc. Inc.	Jun. 1994
Sanitary Sewer Maintenance Log and Cleaning Program	City of Bath	1988-1995
Sewer System Video Inspection Reports	All Clean Environmental Services	Jul. 1995
Nine Minimum Controls for Combined Sewer Overflows	Environmental Engineering and Remediation, Inc. (1)	May 1996

Project Manual: Washington Street Sewer Separation Project	Environmental Engineering and Remediation, Inc. (1)	Jun. 1996
Sewer Separation Project Washington Street/Summer Street	Environmental Engineering and Remediation, Inc. (1)	Nov. 1997
Combined Sewer Overflow Focused Feasibility Study Commercial Street/Pleasant Avenue Drainage Area	Environmental Engineering and Remediation, Inc. (1)	Jan. 1998
Project Manual: Hyde Park Improvements	Environmental Engineering and Remediation, Inc. (1)	Mar. 1999
Project Manual: Infrastructure Improvements Project	Environmental Engineering and Remediation, Inc. (1)	Mar. 1999

Notes:

1. Formerly Environmental Engineering and Remediation, Inc., Now Jacobs Edwards and Kelcey

Summary of Reports, Studies, and Master Plans for which summaries are available

Project: Facility Planning Report for the Wastewater Treatment Facility Upgrade and Expansion
Year: 1992
Engineer: Whitman & Howard, Inc.
Summary: Whitman & Howard conducted a comprehensive evaluation of the WPCF, including analysis of current and projected flows and loads, permit requirements, unit processes, and building systems. A project implementation schedule was also proposed. The report did not address the collection system. However, it was noted that flows in excess of 7 mgd (peak design flow) were considered to be surface inflow and should be treated via CSO facilities. It was also noted in the report that previous separation projects did not reduce flows to the facility.

Project: Facilities Planning Report, Combined Sewer Overflows, and Pumping Stations
Year: 1993
Engineer: Whitman & Howard, Inc.
Summary: Whitman & Howard prepared a facilities planning report on the City's CSOs and pump stations. The report proposed a long-term CSO abatement program, including CSO monitoring at all locations. Notable recommendations include elimination of the Rose Street, Pleasant Street, and Farrin Place CSOs via separation projects and implementation of BMPs, as well as construction of wet-weather bypass facilities at the WPCF (note that the Farrin Place CSO has since been eliminated and the bypass facilities have been constructed). Sewer separation in the Commercial Street and Harward Street pump station drainage areas was recommended, in addition to increasing the size of those stations to mitigate CSO flows. Whitman & Howard also recommended various improvements to eight of the City's pump stations and presented best management practices for the City to follow.

Project: Basis of Design Report, Wastewater Treatment Facility Phase II Improvements
Year: 1994
Engineer: Whitman & Howard
Summary: Whitman & Howard summarized their basis of design for a comprehensive upgrade of the WPCF. Their recommendations included construction of a secondary bypass facility at the WPCF so that flows in excess of 7 mgd and up to 17 mgd could receive primary treatment, disinfection, and dechlorination. This facility was constructed as part of the 1997 upgrade.

Project: Supplemental Combined Sewer Overflow Facilities Plan Study
Year: 1995
Engineer: Environmental Engineering & Remediation, Inc.
Summary: EER's study focused on implementation of CSO abatement in the Harward Street and Farrin Place drainage areas. Several specific projects were recommended, many of which were indicated as having already been completed or soon to be constructed. A number of major projects in the Harward Street drainage area were slated for 10+ years out from the date of the study.

Project: Preliminary Design Report, Harward Street Pump Station
Year: 1996
Engineer: Environmental Engineering & Remediation, Inc.
Summary: This report summarized existing conditions, presented upgrade alternatives, and made recommendations for an upgrade of the Harward Street Pump Station. The report proposed a 33% increase in pumping capacity at the station, as well as various electrical and instrumentation upgrades. The pump station has since been upgraded.

Project: Basis of Design Report for Commercial Street and Front Street Pump Station Upgrades and Force Main Extension
Year: 2001
Engineer: Environmental Engineering & Remediation, Inc.
Summary: EER's report summarized proposed upgrades to the Commercial Street and Front Street pump stations. (This report was preceded by a CSO Focused Feasibility Study conducted by EER in 1998.) At Commercial Street, the proposed new pumps were designed to more than double the station's capacity. An emergency standby generator was also recommended for the station. The Commercial Street Pump Station has since been upgraded. Proposed upgrades at Front Street included new pumps and force main modifications.

Project: Pleasant Avenue Pump Station Upgrade, Basis of Design Report
Year: 2006

Engineer: Edwards & Kelcey

Summary: This report summarized a proposed Pleasant Avenue Pump Station upgrade, including replacement of pumps, piping, and valves, installation of a flow meter, and upgrades to controls and HVAC systems. The report recommended replacement of the CSO tide gate to prevent backflow into the pump station, as well as replacement of 600 feet of the 15-inch pump station discharge line with 18-inch pipe to improve hydraulic conditions. The report also recommended installation of a permanent generator at Pleasant Avenue Pump Station and installation of portable generator receptacles at Hunt Street and Rose Street Pump Stations (note that Pleasant Avenue Pump Station upgrades were completed in 2009).

Project: Revised 2006 Combined Sewer Overflow Master Plan Update

Year: 2006

Engineer: Jacobs Edwards & Kelcey

Summary: As part of the CSO Master Plan Update, JEK conducted field inspections and flow analyses of the City's four CSOs. JEK recommended that the City implement BMPs and maximize flow to the WPCF to minimize CSO discharges. It was also recommended that the City do field confirmation of the sanitary sewer and stormwater drainage systems to update GIS maps. JEK also recommended several short-term and long-term CSO mitigation projects, including upgrade of Pleasant Avenue Pump Station, TV inspection and repair of several sections of sewer, and multiple separation projects, a number of which have been completed and are listed below.

Project: December 2010 Revision to the CSO Master Plan and Associated CSO Project Tracking Tables

Year: 2011

Engineer: Ransom Environmental Consultants, Inc.

Summary: Ransom provided a letter to DEP summarizing completed and ongoing CSO abatement projects. Several GIS figures were included. The letter noted that the CSO master plan would be updated in 2012; however this update was completed in 2015 by Wright-Pierce.

Project: Wastewater System Evaluation and Strategic Plan

Year: 2013

Engineer: Wright-Pierce

Summary: W-P conducted a comprehensive evaluation of the WPCF and five pump stations. Additional study of the collection system, included flow metering, was recommended in advance of upgrades at Hunt Street and Rose Street Pump Stations. The potential for bypassing flows from Hunt Street around Rose Street Pump Station was presented.

Project: 2014 Revision Letter to the CSO Master Plan

Year: 2014

Engineer: Wright-Pierce
Summary: W-P provided a letter to DEP summarizing completed and ongoing CSO abatement projects, and presented new projects identified since 2011.

Project: Wastewater Transport System Evaluation – Hunt St. and Rose St. Pump Station Service Areas
Year: 2015
Engineer: Wright-Pierce
Summary: W-P conducted collection system field investigations in the Hunt Street and Rose Street Pump Station service areas, including long-term in situ flow metering, instantaneous flow metering and smoke testing. The report quantified dry weather and wet weather flows, identified probable sources of I/I, evaluated pump station capacities and each station's ability to handle current and potential future flows, and identified CSO abatement projects and anticipated costs for inclusion in the City's 2016 CSO Master Plan Update.

Project: 2017 Revision Letter to the CSO Master Plan
Year: 2017
Engineer: Wright-Pierce
Summary: W-P provided a letter to DEP summarizing completed and ongoing CSO abatement projects. The letter is the culmination of numerous meetings and correspondence between the City, W-P, and Maine DEP regarding the previous 2014 Letter Update. The letter identified updated CSO Abatement Projects scheduled for 2016-2020, and projects scheduled for 2021 and beyond. Lastly, the letter requested removal of some projects from the CSO Master Plan Update.

Project: Wastewater Transport System Evaluation – Hunt St. and Rose St. Pump Station Service Areas – Study 3
Year: 2017
Engineer: Wright-Pierce
Summary: W-P conducted additional collection system field investigations in the Hunt Street and Rose Street Pump Station service areas with the goal of identifying point sources of I/I for sub-areas shown to have high I/I in the 2015 Evaluation. Additional field investigations included home inspections, manhole inspections, and CCTV of sewer and stormwater mains. The report identified houses with illicit connections to the sewer system, aging sewer infrastructure contributing I/I, and combined catch basins discharging stormwater to the sewer system. The report recommended specific CSO abatement projects in the Hunt St. and Rose St. drainage areas to be implemented to reduce I/I. A number of these projects were completed in 2018 and 2020.

Project: Willow and Middle Street Combined Sewer Modeling – Model Results, Alternatives Analysis, Costs and Recommendations Memorandum
Year: 2017
Engineer: Wright-Pierce
Summary: The memo summarizes the results of flow metering and InfoSWMM modeling performed for the Willow Street and Middle Street areas. Flow metering and subsequent modeling was conducted and analyzed to identify project alternatives that have the potential to minimize or eliminate surcharging and flooding of the combined sewer in the project area and is identified in the 2006 CSO Master Plan as Project #15. Wright-Pierce completed two subsequent rounds of metering and modeling between 2019 and 2021 with the recommendation to look into I/I removal and possible small-scale storage in this drainage area prior to upsizing the interceptor along the railroad tracks.

Project: Water Pollution Control Facility Phase 1 Upgrade and Collection System Capital Improvements
Year: 2017
Engineer: Wright-Pierce
Summary: The report identified upgrades to the Water Pollution Control Facility (WPCF), which included a number of treatment upgrades. Specific to CSOs, the report identified upgrades needed to the chemical feed system associated with the CSO bypass at the WPCF to adequately treat the range of flows seen during wet weather events. These upgrades were subsequently completed during the 2019 WPCF Phase 1 Upgrade. The report also developed preliminary designs for a number of collection system projects identified in either the 2006 CSO Master Plan or subsequent Letter Updates. A number of these projects have since been completed.

Project: Harward Street Pump Station Drainage Area Infiltration and Inflow Study Phase 1
Year: 2018
Engineer: Wright-Pierce
Summary: The report summarized findings of field investigations to identify sources of I/I in the Harward Street Pump Station Drainage Area. In-situ flow monitoring was conducted in 14 sub-areas to quantify dry weather and wet weather flows to identify potential sources of I/I. Additional targeted investigative work was recommended within the drainage area to isolate sources of I/I to the collection system.

Project: Harward Street Pump Station Drainage Area Infiltration and Inflow Study Phase 2 Field Investigations
Year: 2018
Engineer: Wright-Pierce
Summary: Additional field investigations that were recommended in the Phase 1 study were completed and the findings summarized in the report. Manhole inspections, smoke testing, and additional flow metering were conducted to further identify potential

sources of I/I. Project recommendations were made for a number of the 14 sub-areas, including separation of combined catch basins and relining of aging sewer mains that showed defects. Relining in sub-areas 4, 7, and 8 behind Dike Newell school was subsequently completed in 2020.

Project: Harward Street Pump Station Drainage Area I/I Study – Phase 2 Interceptor Capacity Analysis
Year: 2018
Engineer: Wright-Pierce
Summary: The report summarizes a preliminary spreadsheet capacity model developed to identify bottlenecks in the Harward Street Drainage Area interceptor during wet weather events. A subsequent InfoSWMM model was developed to characterize hydraulics during wet weather events and to determine if upsizing of the interceptor would alleviate SSO and CSO issues during various design storm events.

Project: Denny Road Overflow Capacity Requirements Memorandum
Year: 2021
Engineer: Wright-Pierce
Summary: Wright-Pierce evaluated short-term options to minimize and/or eliminate discharges from the Denny Road SSO in response to concerns from a resident. The memo recommended installing an overflow pipe from the sewer main to the nearby CSO overflow pipe associated with the Harward St. CSO #008. Additional flow metering was recommended to confirm that the CSO pipe can handle the flow. This work has not been completed to date.

Summary of Historical I/I Reduction Projects or System Improvements

A number of past separation and upgrade projects were noted in the City's 2006 CSO Master Plan Update. Several separation projects were conducted in the 1980s. Affected streets are noted below:

- Valley Road (from Oliver Street to Park Street)
- Oliver Street (western portion)
- Middle Street (from Center Street to North Street)
- Marshall Street
- Washington Street (from Hunt Street Pump Station to Marshall Street)
- Getchell Street
- Middle Street (near Getchell Street)

A number of larger upgrades and separation projects were conducted in the 1990s, as summarized below:

Project: WPCF Upgrade
Drainage Area: N/A
Year: 1997
Summary: Construction of secondary bypass facilities

Project: Lambert Park Area Separation
Drainage Area: Harward
Year: 1997
Summary: 85 catch basins were removed from the sanitary system, and a combined sewer was converted to stormwater only

Project: Harward Street Pump Station Upgrade
Drainage Area: Harward
Year: 1997
Summary: Capacity upgrade and addition of an emergency standby generator

Project: Commercial Street Area
Drainage Area: Commercial
Year: 1999
Summary: New stormwater trunk drain outfall was constructed

Project: Commercial Street Pump Station Upgrade
Drainage Area: Commercial
Year: 2002

Summary: Capacity upgrade, force main replacement to bypass Front Street Pump Station, and addition of emergency standby generator

Project: Centre Street Area Separation
Drainage Area: Commercial
Year: 2003
Summary: New storm drain installed between Washington Street and High Street

Several separation projects were conducted in the late 1990s and early 2000s in conjunction with the City's Streets Improvements Program. Affected streets are noted below:

- Office Drive
- Lambert Park
- Bedford Street/High Street
- Tarbox Hill
- Washington Street (Leaping Weir)
- Pine Street
- Pleasant Avenue
- Middle Street (from Rose Street to Spring Street)
- Hyde Park
- High Street
- Trufant Street
- Bedford Road
- Sheridan Street
- Shepard Street
- Academy Street (from Page Street to Snow Park)
- Andrews Road
- Highland Street
- Wesley Street
- Union Street
- Snow Park

Details of recently-completed, current, and future projects were provided in Ransom's 2011 CSO Master Plan Revision letter and subsequently updated in Wright-Pierce's 2016 CSO Master Plan Revision letter, and are summarized below:

Project: Separation of Evergreen Street (CSO Abatement Project #9)
Drainage Area: Pleasant
Status: Completed
Year: June 2008
Summary: Removed two combined catch basins from sanitary sewer system

Project: Pleasant Avenue Pump Station Upgrade (CSO Abatement Project #4)
Drainage Area: Pleasant
Status: Completed
Year: February 2009
Summary: Increased pumping capacity to 3,400 gpm; added emergency standby generator; replaced CSO tide valve; increased discharge pipe size to reduce hydraulic restriction

Project: Bowery Street Hydraulic Restrictions (CSO Abatement Project #7)
Drainage Area: WPCF
Status: Completed
Year: February 2009
Summary: Replaced three sections of gravity sewer on Bowery Street with larger pipe to increase capacity to WPCF and reduce CSOs at Commercial Street

Project: Juniper Street/Park Street Hydraulic Restrictions (CSO Abatement Project #12)
Drainage Area: Harward
Status: Completed
Year: February 2009
Summary: Constructed a gravity sewer line to bypass flows around hydraulic restrictions in Park Street area directly to Harward Street Pump Station in order to reduce SSOs and overflows to stormwater system

Project: Separation of Aspen Lane (CSO Abatement Project #19)
Drainage Area: Harward
Status: Completed
Year: June 2009
Summary: Separated stormwater collection system discharge from sanitary system, removing six catch basins from the system; completion of this CSO Abatement Project by June 30, 2011 was a permit requirement noted in the City's WDL.

Project: Oak Street Separation
Drainage Area: Commercial
Status: Completed
Year: 2009-2010
Summary: Five catch basins separated from sanitary system to reduce volume of combined sewer flowing into undersized sewer along Willow Street

Project: Oak, Front, and Commercial Street Separations
Drainage Area: Commercial
Status: Completed
Year: Spring 2010
Summary: Four catch basins separated from sanitary system by developer

Project: Centre Street Separation Project
Drainage Area: Commercial
Status: Completed
Year: November 2010
Summary: Hyde Park Pump Station force main extended to Commercial Street Pump Station drainage area to reduce Harward Street CSO discharges; installed stormwater and underdrain collection systems; removed 12 catch basins from sanitary system

Project: Harward Street Pump Station Force Main Replacement (CSO Abatement Project #30)
Drainage Area: Harward
Status: Completed
Year: 2012
Summary: Discharge force main identified as undersized, leading to upstream SSOs and CSOs; replacement/upsizing of force main completed.

Project: Sanitary Sewer Modifications and Separation of Green and High Streets (CSO Abatement Project #31)
Drainage Area: Commercial
Status: Completed
Year: 2014
Summary: Sewer main discovered to be constructed out of granite blocks required replacement; five municipal catch basins at Green and High Street and four catch basins on the fire station property were identified as combined; separation of nine catch basins and installation of stormwater line was completed.

Project: Disconnect Hyde School Pond Overflow from Sanitary Sewer (CSO Abatement Project #10)
Drainage Area: Pleasant
Status: Completed
Year: 2013
Summary: Overflow line from a pond located at the Hyde School was believed to cause an unknown volume of inflow into the sanitary system through the overflow line during wet weather events when the pond level rises. City investigations concluded that the pond does not overflow into the sanitary sewer system. Therefore, this project was recognized as being complete.

Project: Eliminate Cross Connection, High Street near Nichols Street (CSO Abatement Project #6)
Drainage Area: Pleasant
Status: Completed
Year: 2016
Summary: Identified cross-connection between a sanitary manhole and stormwater drain manhole; cross-connection blocked off by the City.

Project: Separation of Roof and Basement Drains from Sanitary Sewer, Phase 1 (CSO Abatement Project #11)
Drainage Area: Harward
Status: Completed
Year: 2012
Summary: Study completed to identify private sources of inflow in a catchment area upstream of Park Street, including approximately 120 houses. The City does not plan to conduct any engineering or construction following completion of the evaluation. Therefore, this project is complete and has been removed from the CSO master plan.

Project: Lambert Park Hydrobrake Modifications (CSO Abatement Project #13)
Drainage Area: Harward
Status: Completed
Year: 2012
Summary: City identified possible blockage in Hydrobrake (vortex flow control) structure, which is also the location of an existing cross-connection between the sewer system and storm drain system which allowed sanitary flows to enter the collection system during wet weather events. The blockage was cleared and the 18-inch cross-connection was sealed off by the City in 2012.

Project: Storm Sewer Modifications (Park/Winship Streets) (CSO Abatement Project #24)
Drainage Area: Harward
Status: Completed
Year: 2014
Summary: Identified stream and other stormwater runoff that runs directly to a catch basin which acts as a hydraulic restriction on the upstream stormwater system near Park Street. Modifications were made to redirect flow from the large impervious area to a different discharge location and alleviate the hydraulic restriction.

Project: BIW Parking Lot Separation (CSO Abatement Project #8)
Drainage Area: Pleasant
Status: Completed
Year: 2012
Summary: As many as six catch basins in the BIW parking lot had been identified as connected to the sanitary sewer system. Subsequent investigation showed that the catch basins are

not in fact combined. Therefore, this project was recognized as being complete and eliminated from the City's MEPDES Final Permit.

Project: Pipe Damage near Upper Leeman Highway (CSO Abatement Project #18)
Drainage Area: Commercial
Status: Ongoing
Year: Construction starting October 2021. Target completion of Spring 2022
Summary: Identified potential pipe damage based on wet weather flow monitoring results and field observations. Line was CCTV'ed and issues identified. Sewer line to be repaired to reduce I/I flows.

Project: Separation of Farrin Place Pump Station Drainage Area (Oliver, Mechanic, and Milan Streets) (CSO Abatement Projects #20 and #22)
Drainage Area: Farrin
Status: Not Started
Year: 2021 or later
Summary: Identified entire area as combined sanitary and storm sewer, including as many as 14 catch basins; recommended evaluation of separation potential. CSO Abatement Projects #20 and #22 were eliminated from the City's 2009 MEPDES Final Permit via the 2012 Final Permit Modification; however, it remains in the CSO Master Plan.

Project: Separation of Roof and Basement Drains from the Sanitary Sewer, Phase II (CSO Abatement Project #21)
Drainage Area: Harward
Status: Ongoing
Year: Target 2021-2025 per 2017 Wright-Pierce letter
Summary: Project 21 includes separation of homes identified with illicit connections as part of CSO Abatement Project #11. Given the challenges both financially and politically with removing I/I on private property, the City is evaluating impacts of public separation projects before beginning large-scale private I/I removal.

Project: Willow Street/Railroad Track Sanitary Sewer Modifications (CSO Abatement Project #15)
Drainage Area: Commercial
Status: Partially Completed/Ongoing
Year: 2013
Summary: Preliminary investigations, including TV inspection, identified deteriorated sanitary lines and as many as 19 catch basins tied into the sanitary system; recommended reevaluating in conjunction with other upstream sewer separations due to complexity and potential costs to fix problems in this area; First phase included replacement of deteriorated sewer pipe leading to infiltration between York and North Street. In addition, the City connected catch basins on Willow and North Street into one network and connected the network to the new sewer pipeline at one connection point. A one-

way valve was installed to prevent sewage from backing up into the catch basins and out of the sanitary sewer system. The remaining study consists of review of the SWMM model prepared by TetraTech, as well as expansion and calibration of the model based on collected flow data. Three rounds of flow metering and modeling were completed. I/I removal and possible small scale storage tanks in this area have been discussed to reduce peak flows within the sewer line prior to possible replacement of the interceptor in the railroad tracks.

Project: Separation of Western Avenue and Cottage Street (CSO Abatement Project #25)
Drainage Area: Commercial and Pleasant
Status: Ongoing
Year: Construction starting October 2021. Target completion of Spring 2022
Summary: Identified as many as 18 catch basins tied into sanitary system; recommended evaluation of separation potential and additional stormwater abatement techniques. Evaluation completed and separation of 9 catch basins in the Commercial Street drainage area is under construction; targeted for completion in Spring 2022.

Project: Leeman Highway Separation (CSO Abatement Project #29)
Drainage Area: Commercial
Status: Completed
Year: 2016
Summary: Identified dozens of catch basins on Route 1 that are tied into the sanitary system, which contribute to CSOs at Commercial Street; catch basins were separated from the sanitary sewer system and connected to a new stormwater main as part of Maine DOT's Route 1 viaduct replacement. The City coordinated closely with Maine DOT to separate additional catch basins in and around the on and off ramps from Route 1 to High Street.

Project: Separation of High Street, South Street, and Middle Street (CSO Abatement Project #23)
Drainage Area: Commercial
Status: Completed
Year: 2016 (Removed from CSO Master Plan in 2016 Letter Revision)
Summary: Identified nine catch basins potentially tied into sanitary system, based on wet-weather flow monitoring, field observations, and GIS maps; recommended evaluation of separation potential. Separation potential was too costly; DEP agreed to remove from CSO Master Plan and focus efforts and resources in other areas with higher CSO flows.

Project: Separation of Crescent, Middle, and York Streets (CSO Abatement Project #26)
Drainage Area: Commercial
Status: Ongoing
Year: Target 2016, per 2011 Ransom letter
Summary: Identified as many as 14 catch basins tied into the sanitary system; recommended evaluation of separation potential based on recommendations from CSO Abatement Project #15.

Project: Bedford Road Separation (CSO Abatement Project #27)
Drainage Area: Commercial
Status: Partially completed; ongoing
Year: Target 2017, per 2011 Ransom letter
Summary: Three catch basins at the intersection of Keel Street and Bedford Street were separated by the City. Wright-Pierce is currently designing the separation of six more catch basins (two on Oak Street and four on Green Street) to be separated and tied into the system already separated by the City at the intersection of Keel and Bedford Street.

Project: North and Grove Street Separation (CSO Abatement Project #28)
Drainage Area: Commercial
Status: Ongoing
Year: 2023
Summary: Identified four catch basins, two on North Street and two on Grove Street, tied into the sanitary system. Two basins on North Street were separated in 2019. The two basins on Grove Street have not yet been separated.

The following completed projects were not part of the 2006 CSO Master Plan or 2011 CSO Master Plan Update, but the City recognized the value in investing in these projects as part of the overall goal of understanding and eliminating CSO discharges:

Project: CSO Abatement Project #42 – Separation of Roof Drains and Sump Pump at Former Re-Store Property
Drainage Area: Commercial
Status: Completed
Year: 2014
Summary: I/I entering the sanitary sewer via roof drains and a sump pump were eliminated as part of a redevelopment by a private investor.

Project: CSO Abatement Project #43 – Sewer Repairs on High Street
Drainage Area: Pleasant
Status: Completed
Year: 2014
Summary: A number of sections of sewer were found to be in poor condition and contributing to I/I. In addition, three catch basins on High Street just north of Russell Street were identified as connected to the sanitary sewer system. The sewer lines were replaced and the catch basins separated as part of the High Street road reconstruction project that was completed in November 2014.

Project: CSO Abatement Project #44 – Separation of Catch Basins on Pearl Street
Drainage Area: Commercial
Status: Completed
Year: 2014
Summary: The City separated two catch basins that were draining into the sanitary sewer line between Willow and Middle Street

Additional recently completed and current projects from 2017 to 2020 are summarized below:

Project: CSO Abatement Project #35 - South End – Phase 1 Sewer Relining and Manhole Repair Project
Drainage Area: Hunt, Rose
Status: Completed
Year: 2018
Summary: Phase 1 completed, which included relining of various aging sewer mains in the South End of the City that were contributing I/I to the sewer system as identified in the 2017 Wastewater Transport System Evaluation – Hunt St. and Rose St. Pump Station Service Areas – Study 3. Work included relining of existing sewer mains and rehabilitation of defective manholes.

Project: CSO Abatement Project #40 – Separation of Catch Basins at Fisher Mitchell School
Drainage Area: Pleasant
Status: Completed
Year: 2019
Summary: Separation of 12 combined catch basins via installation of new storm drain pipe.

Project: Water Pollution Control Facility – Phase 1 Upgrade
Drainage Area: N/A
Status: Completed
Year: 2019
Summary: Project included extensive upgrades to various systems including dewatering, sludge handling, and aeration. Work related to CSOs included upgrades to the chemical feed

system associated with the CSO bypass at the WPCF to adequately treat the range of flows seen during wet weather events.

Project: Potential Infiltration Leading to Harward Street Pump Station (CSO Abatement Project #16)
Drainage Area: Harward
Status: Completed
Year: 2020
Summary: Sanitary sewer lines in low-lying wetland areas identified as contributing I/I relined.

Project: CSO Abatement Project #46 – Infiltration & Inflow Study – Harward Street Pump Station Drainage Area
Drainage Area: Harward
Status: Completed
Year: 2017
Summary: Study consisting of flow metering analysis to isolate areas with a high incidence of I/I. Upon completion of the flow metering, smoke testing, CCTV inspection, manhole inspections, and dye testing were conducted to further define I/I sources. Based on these findings, project recommendations were made.

Project: CSO Abatement Project #34 – Evaluation of Rose Street Pump Station Service Area for Phase 2 South End Projects
Drainage Area: Rose
Status: Completed
Year: 2017
Summary: Cleaning, CCTV, manhole inspection and house-to-house inspections to identify possible illicit connections to the sanitary sewer system.

Project: CSO Abatement Project #36 – Evaluation of Hunt Street Pump Station Service Area for Phase 2 South End Projects
Drainage Area: Hunt
Status: Completed
Year: 2017
Summary: Cleaning, CCTV, manhole inspection and house-to-house inspections to identify possible illicit connections to the sanitary sewer system.

Project: CSO Abatement Project #32 – Evaluation of South End Sewer System
Drainage Area: Hunt, Rose
Status: Completed
Year: 2014
Summary: Wright-Pierce conducted an evaluation of the collection system associated with the Hunt Street and Rose Street Pump Station service areas to quantify dry weather and wet weather flows, identify probably I/I sources, and evaluate pump station capacities and each station's ability to handle current and potential future flows. The findings of Project #32 resulted in identification of several new CSO abatement projects. These projects are presented as CSO Abatement Project #33 - #39.

Project: CSO Abatement Project #35, #37, #38 - South End – Phase 2 Sewer and Storm Drain Replacement
Drainage Area: Hunt, Rose
Status: Completed
Year: 2020
Summary: Phase 2 completed, which included replacement of various aging sewer mains in the South End of the City that were contributing I/I to the sewer system as identified in the 2017 Wastewater Transport System Evaluation – Hunt St. and Rose St. Pump Station Service Areas – Study 3. Additionally, new stormwater infrastructure was installed to separate existing combined catch basins.

Project: CSO Abatement Project #33 – Reinstate Hunt Street CSO
Drainage Area: Hunt
Status: Not Started
Year: TBD
Summary: The City completed Projects #35, #36, #37, and #38 and is evaluating the impacts of these projects on SSOs before considering whether to reinstate the Hunt Street CSO. However, at this time reinstatement of the Hunt Street CSO is not planned.

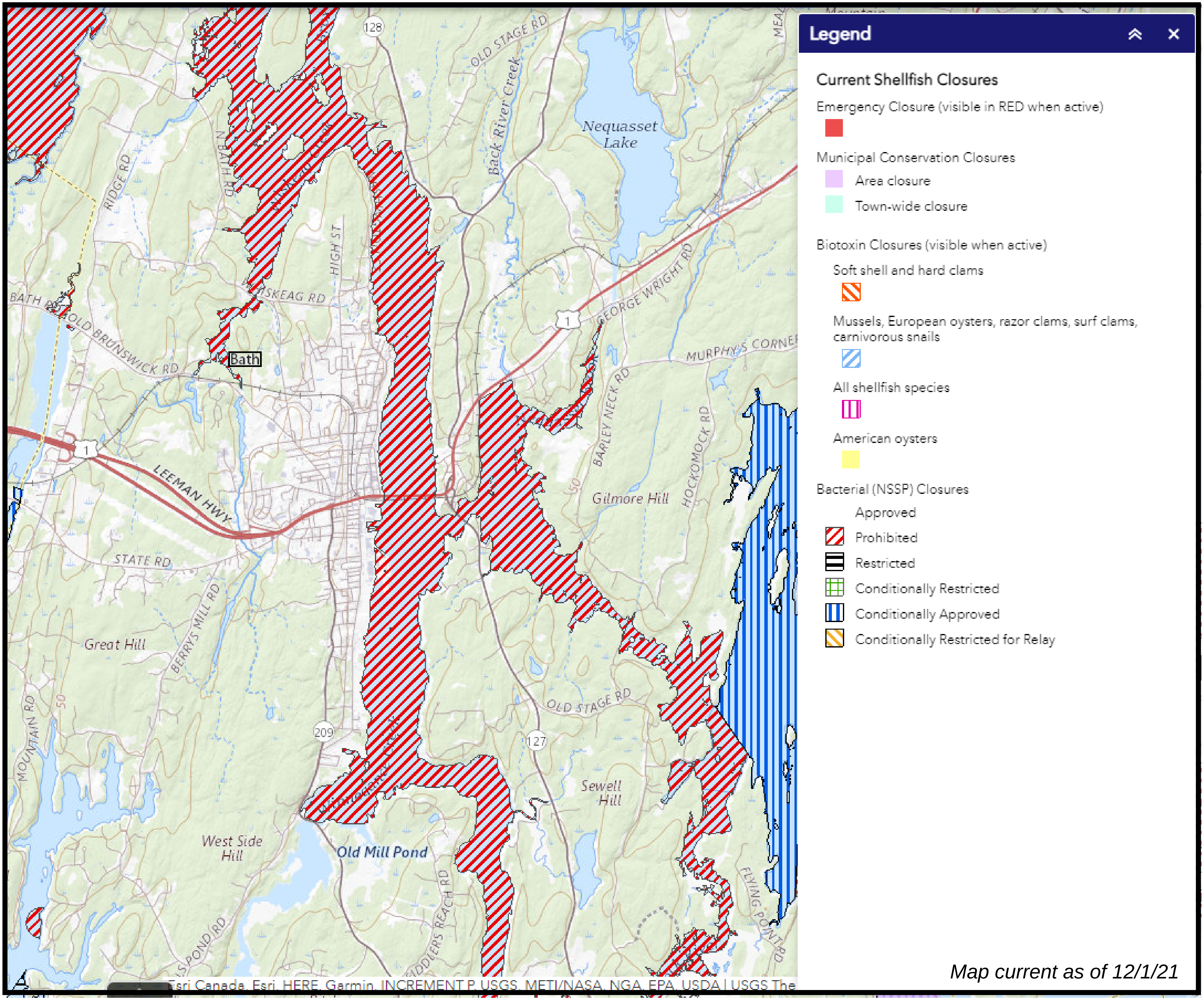
Project: CSO Abatement Project #39 – Design/Construction of Phase 3 South End Projects
Drainage Area: Hunt
Status: Not Started
Year: 2021-2022
Summary: The Hunt Street force main will be upsized and extended to bypass the Rose Street Pump Station (instead of pumping directly to the Rose Street Pump Station), and both pump stations will be either upgraded or replaced. Projects #35, #37, #38, and #40 have all been completed to reduce I/I in the collection system, which will allow for the force main to be appropriately sized.

Project: CSO Abatement Project #41 – Separation of Catch Basins at School Street near Train Tracks
Drainage Area: Commercial
Status: Completed
Year: 2017
Summary: Several catch basins in the School Street area were identified as combined or potentially combined. The projects consisted of design and construction to separate the combined catch basins from the sewer system and connection to the storm water system.

Project: CSO Abatement Project #45 – Separation of Catch Basins at Washington Street and North Street
Drainage Area: Commercial
Status: Completed
Year: 2019
Summary: As part of the reconstruction of North Street from Washington Street west to High Street, two catch basins were separated at the corner of Washington Street and North Street and redirected to the existing storm drain on the east end of North Street.

Project: CSO Abatement Project #14 and #17 – Cross Country Interceptor near Dike Newell School/Leading to Harward Street Pump Station
Drainage Area: Harward
Status: Not started
Year: 2021-2022
Summary: The City has identified a hydraulic restriction in this interceptor. Upsizing this segment of the interceptor would result in more flow near Juniper Street and Park Street where there is already sewer overflow flooding during wet weather events, as well as more flow out CSO #008. The City plans to conduct hydraulic modeling of the interceptor from the Harward Street Pump Station to CSO #008 to identify options to eliminate SSOs prior to resolving the hydraulic restriction downstream of CSO #008.

Appendix B
Shellfish Harvesting Map



Map current as of 12/1/21

Appendix C
Flow Metering Charts

C-1: Hunt Street Flow Meter Data

Figure C-1 Hunt Street Flow Meter Data – SMH-XC

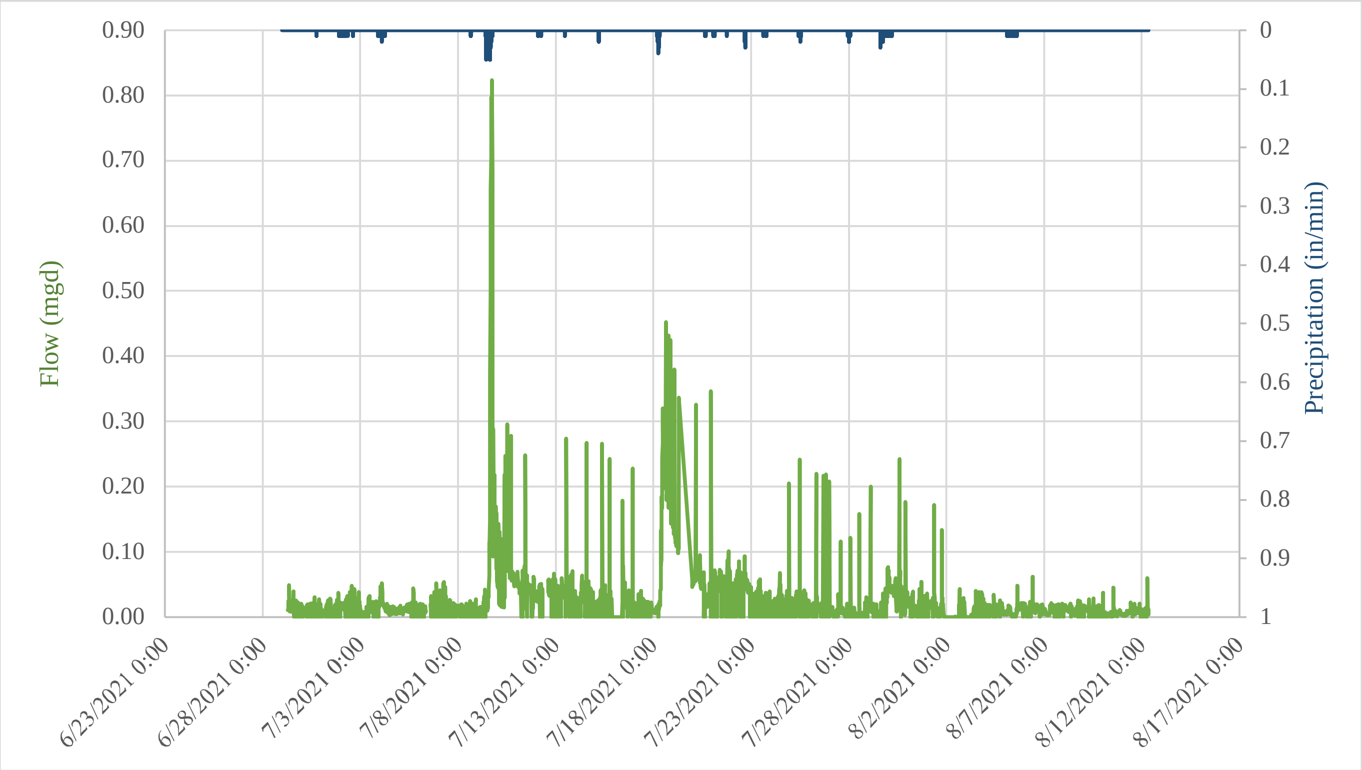


Figure C-2 Hunt Street Flow Meter Data – SMH-XC Peak Flow – 6/13/14 Storm Event

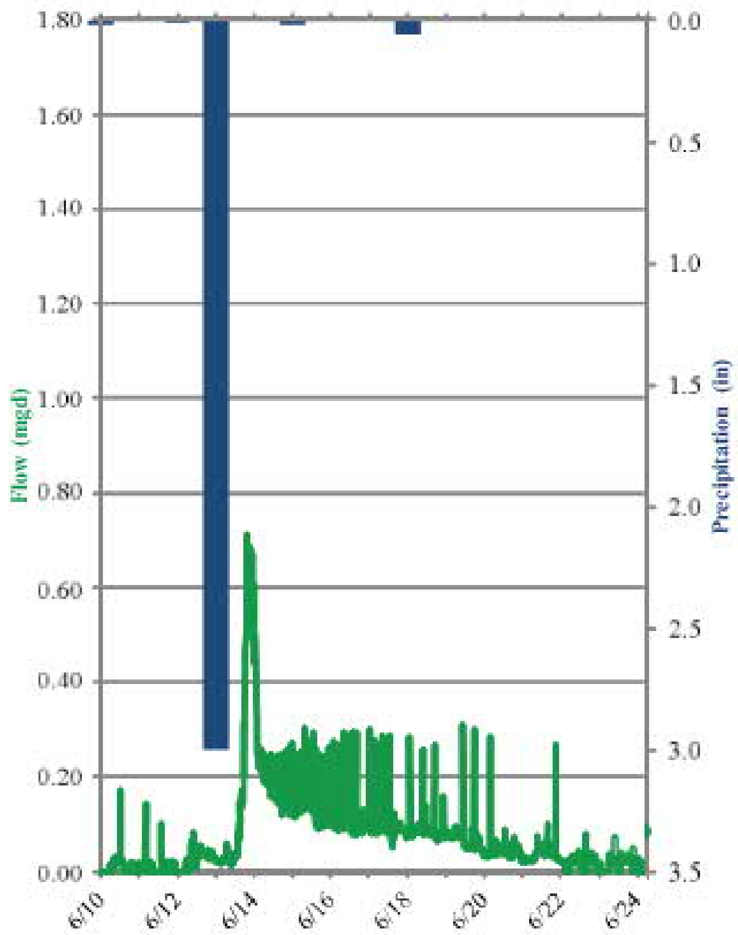


Figure C-3 Hunt Street Flow Meter Data – SMH-XC Peak Flow – 7/4/21 Storm Event

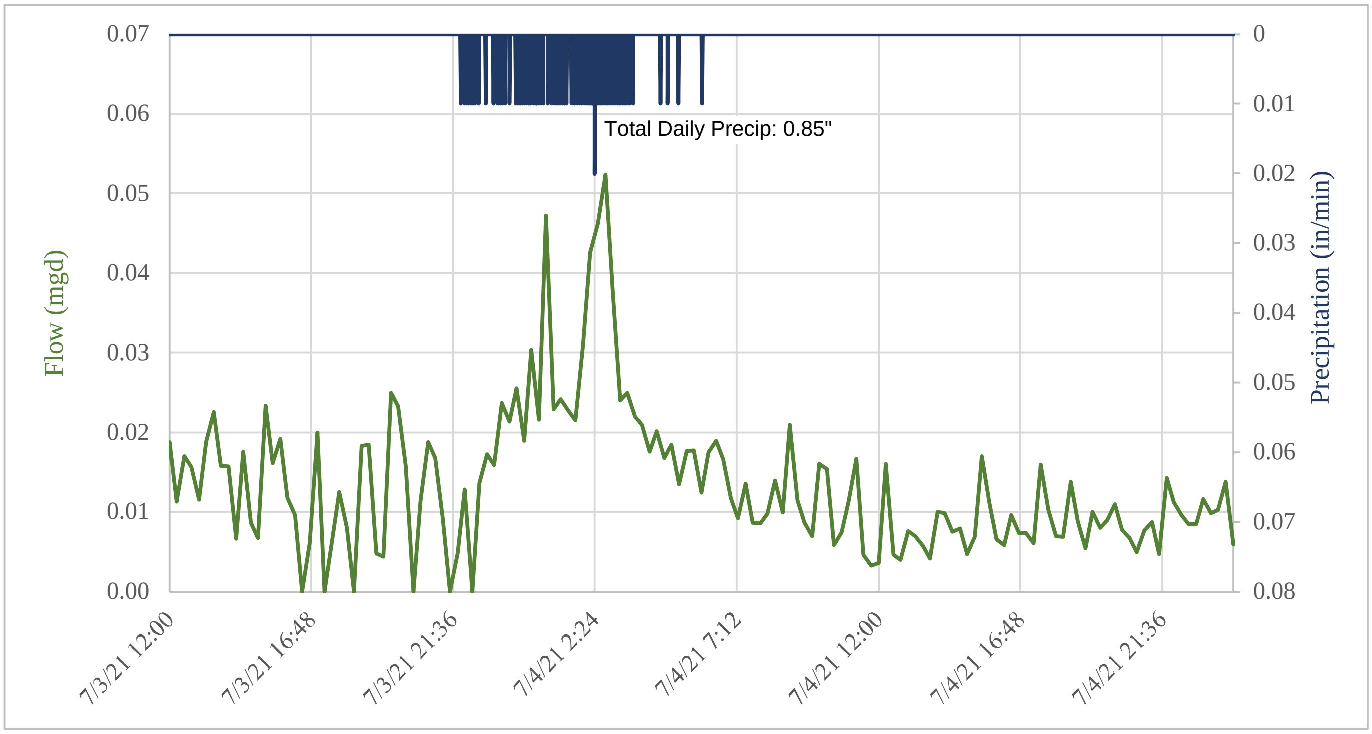


Figure C-4 Hunt Street Flow Meter Data – SMH-XC Peak Flow – 7/9/21 Storm Event

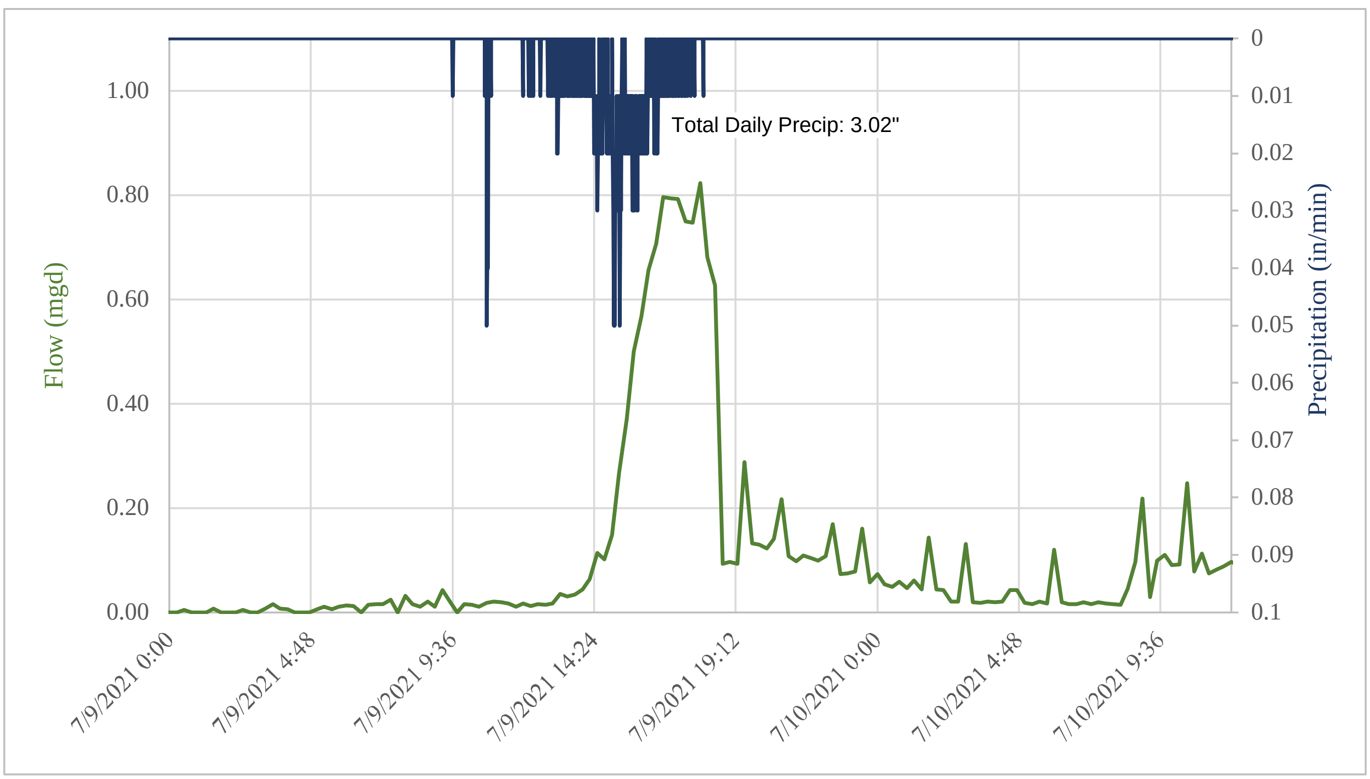


Figure C-5 Hunt Street Flow Meter Data – SMH-XC Peak Flow – 7/18/21 Storm Event

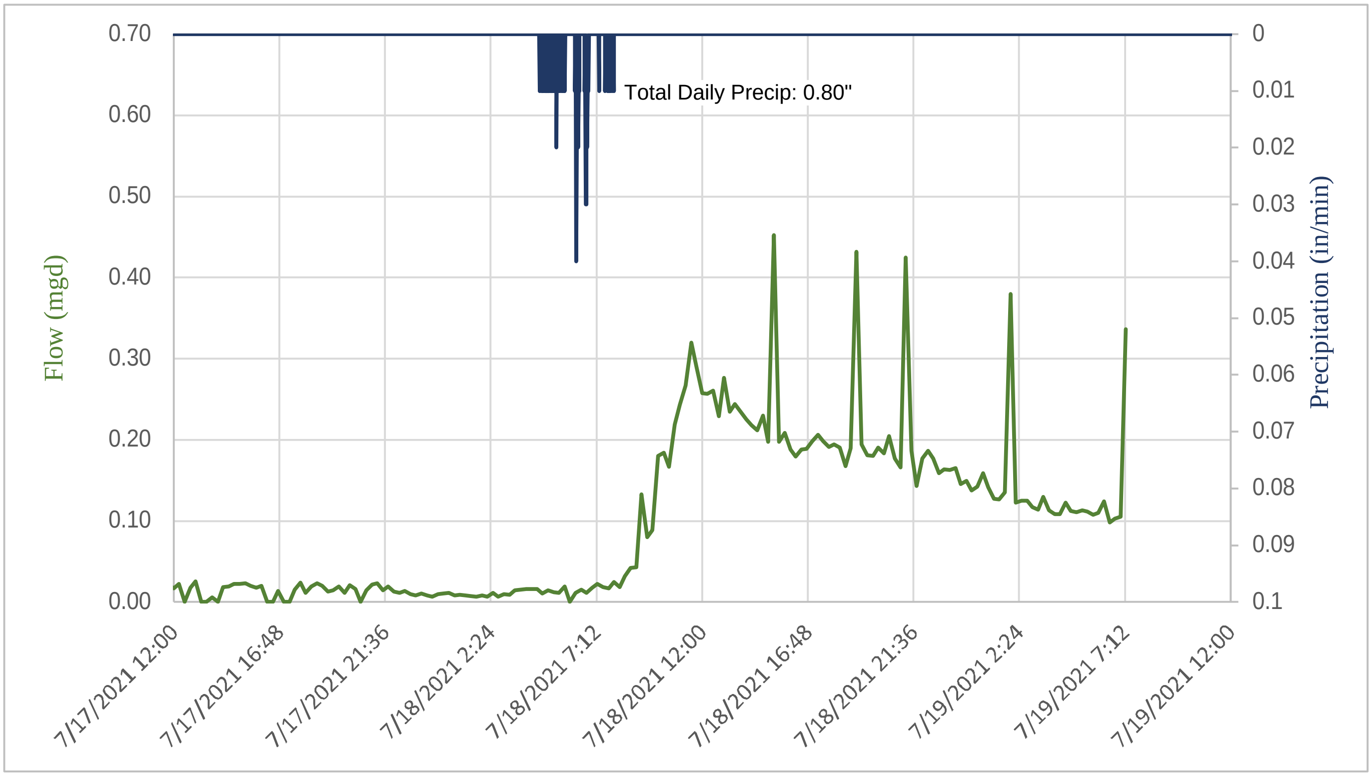


Figure C-6 Hunt Street Flow Meter Data – SMH-992

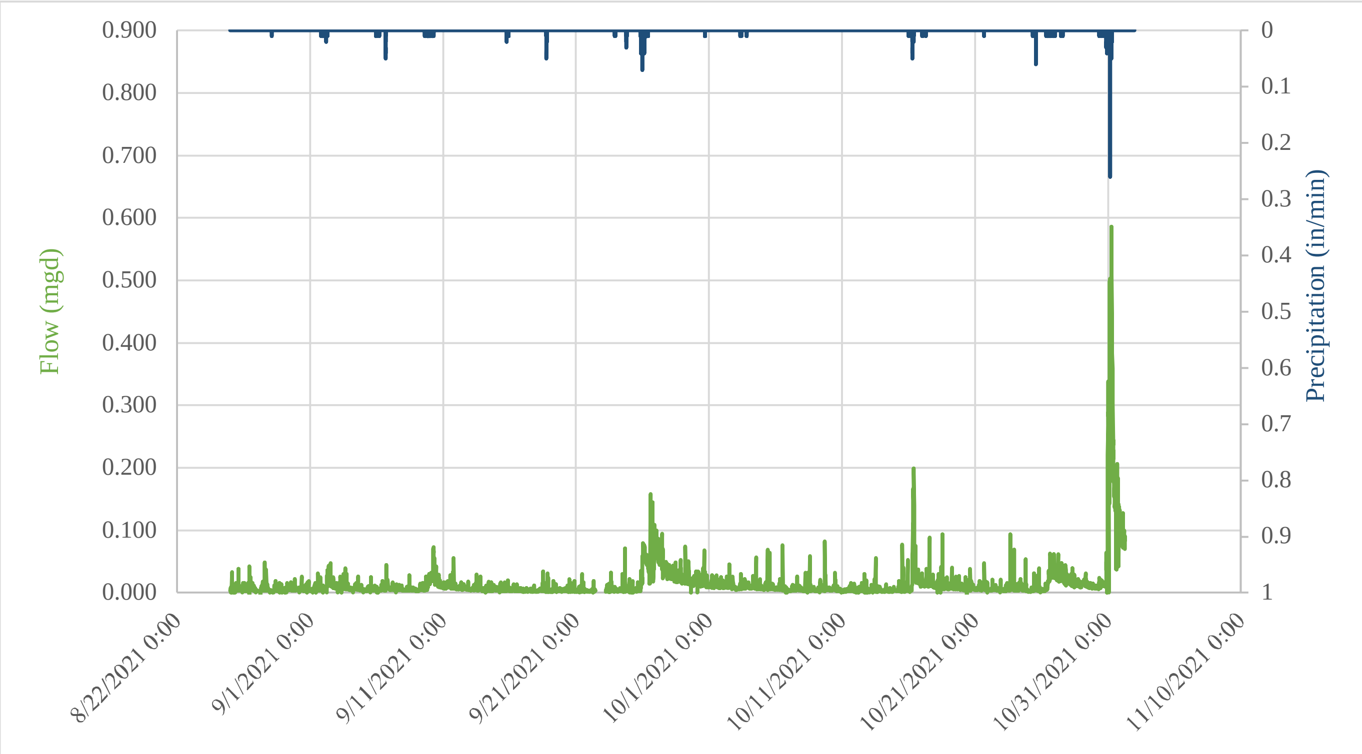


Figure C-7 Hunt Street Flow Meter Data – SMH-992 Peak Flow – 6/13/14 Storm Event

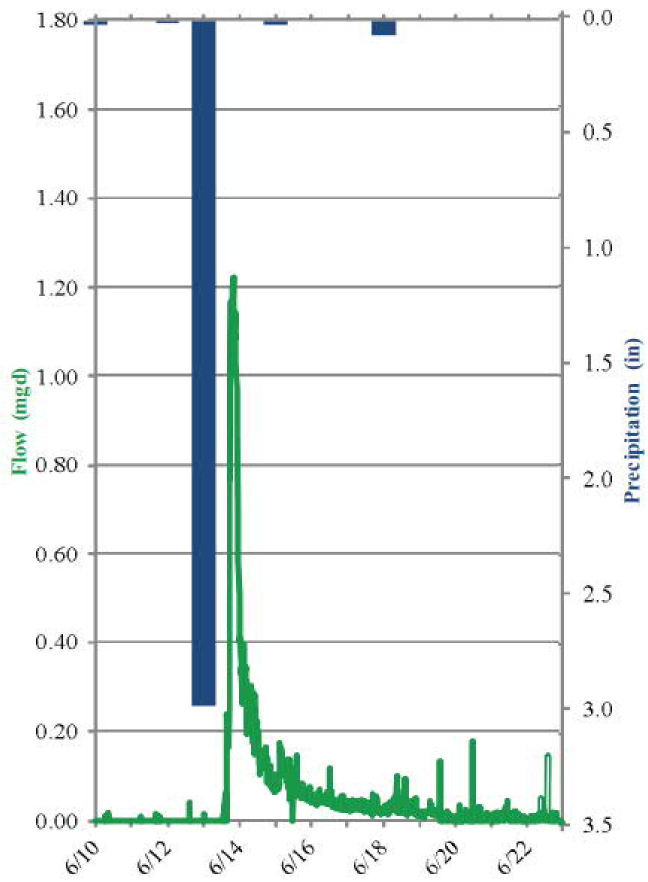


Figure C-8 Hunt Street Flow Meter Data - SMH-992 Peak Flow – 9/9/21 Storm Event

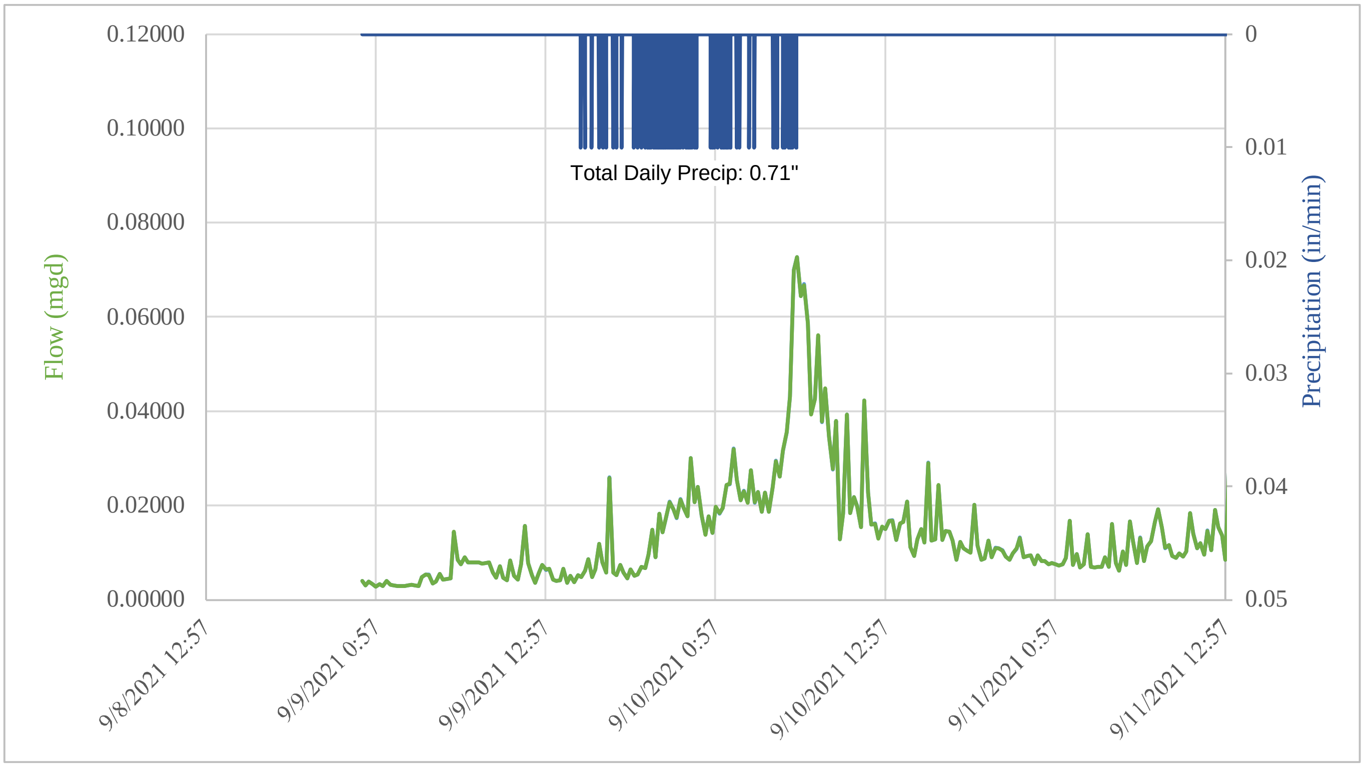
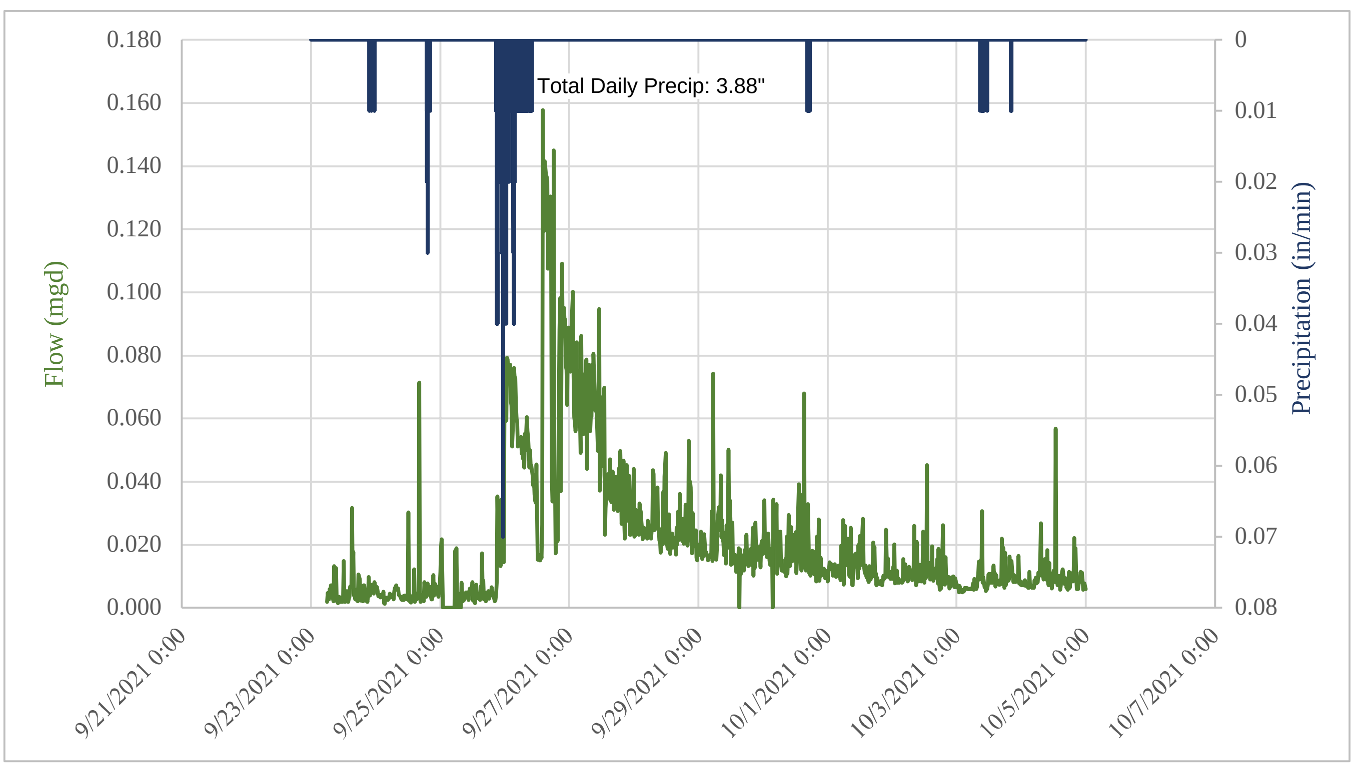


Figure C-9 Hunt Street Flow Meter Data – SMH-992 Peak Flow – 9/26/21 Storm Even



C-2: Rose Street Flow Meter Data

Figure C-10 Rose Street Flow Meter Data – SMH-919

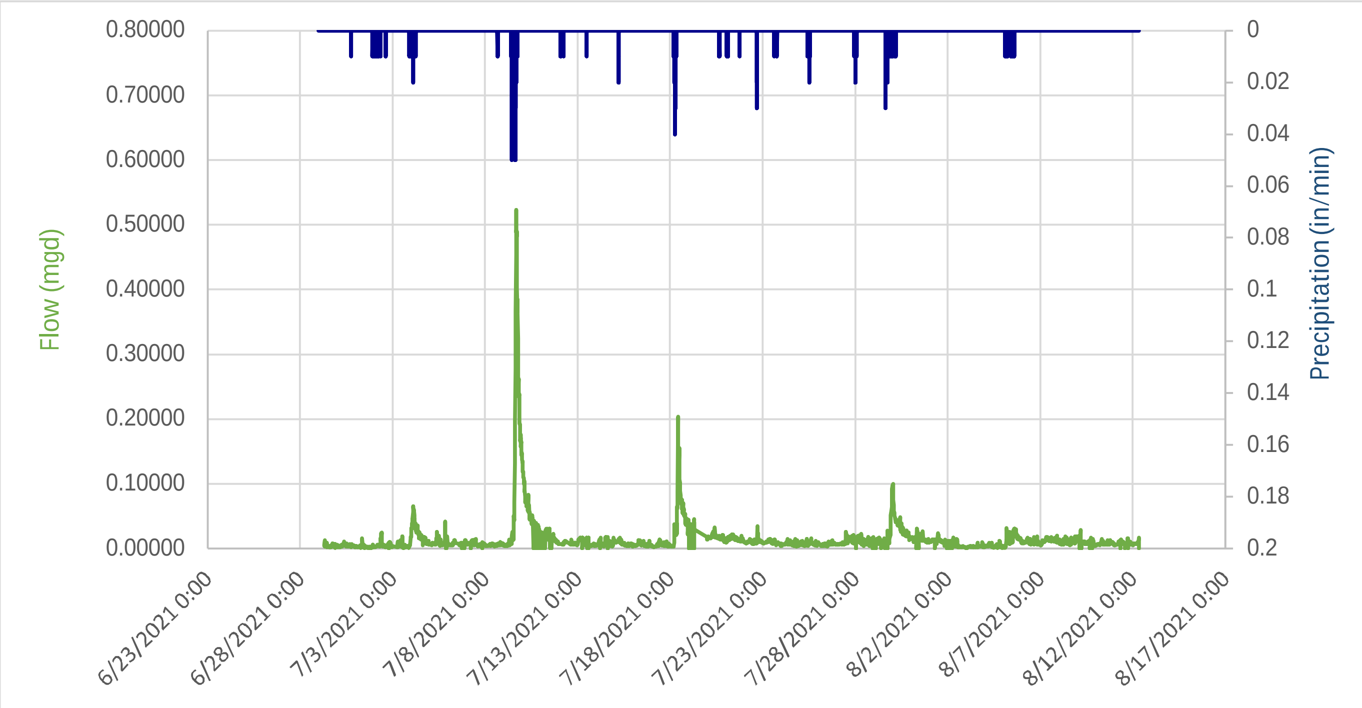


Figure C-11 Rose Street Flow Meter Data – SMH-919 Peak Flow – 6/13/14 Storm Event

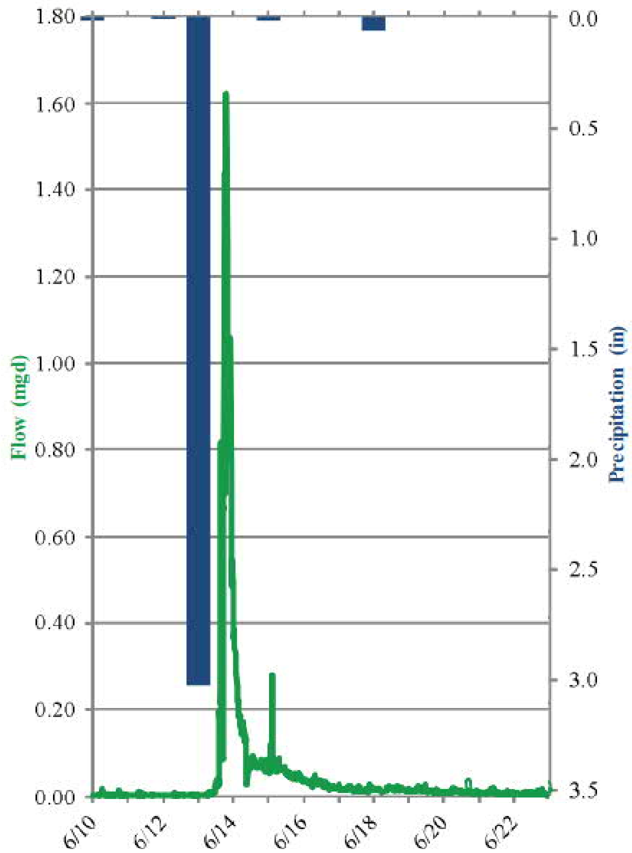


Figure C-12 Rose Street Flow Meter Data – SMH-919 Peak Flow – 7/4/21 Storm Event

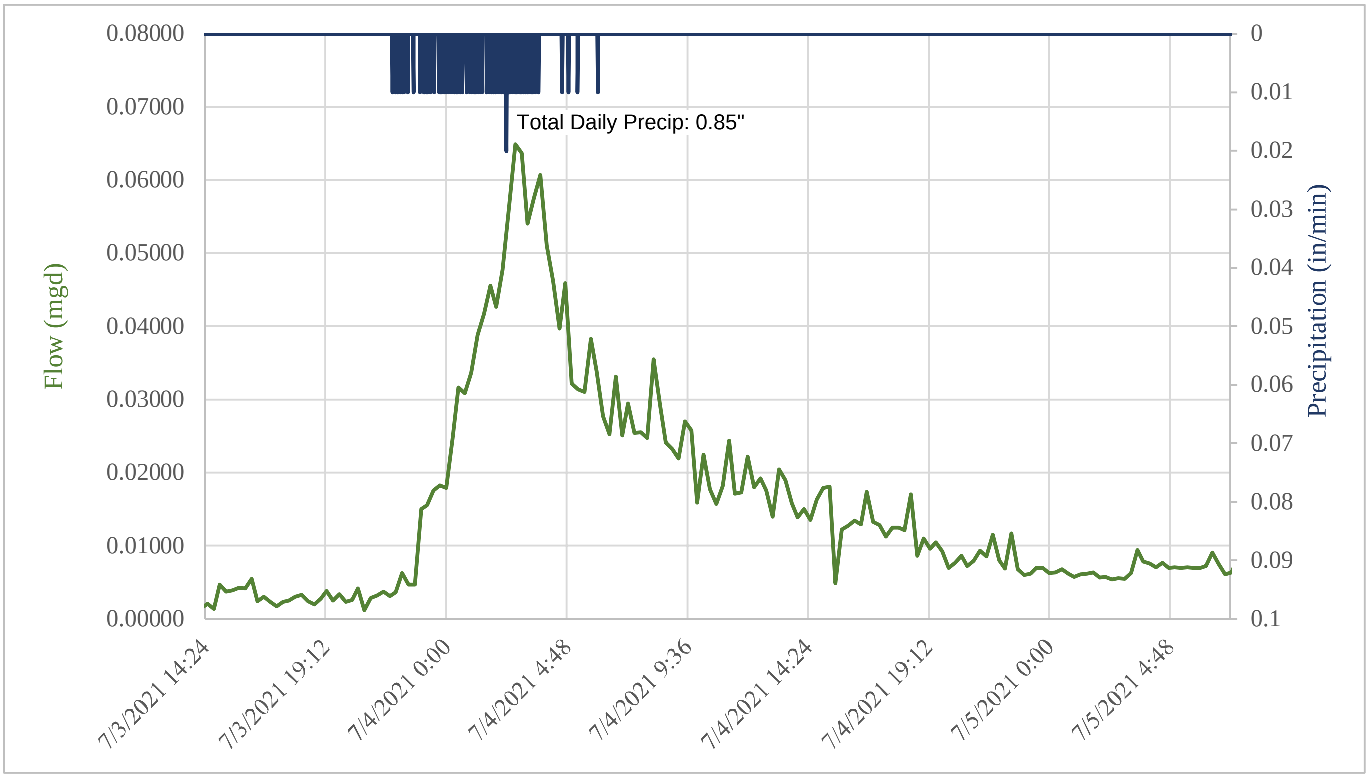


Figure C-13 Rose Street Flow Meter Data – SMH-919 Peak Flow Peak Flow – 7/9/21 Storm Event

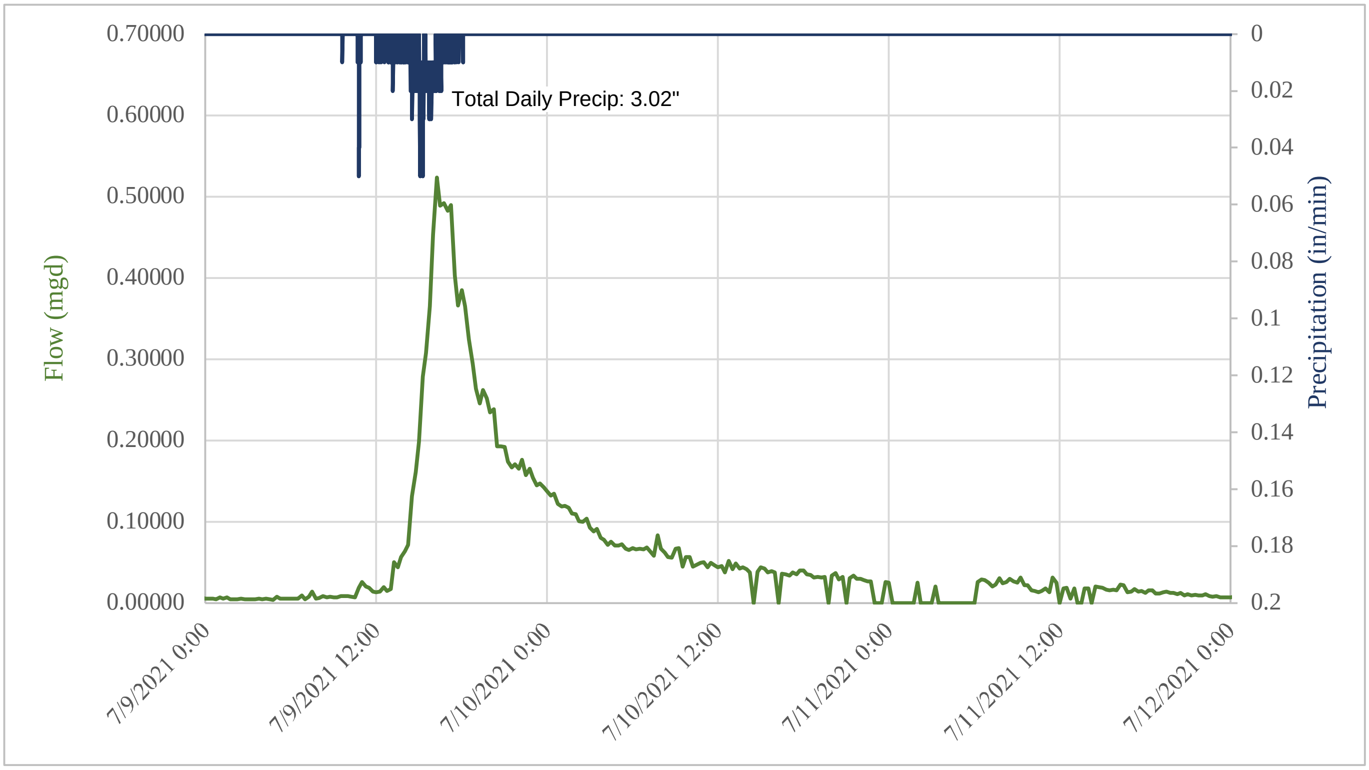
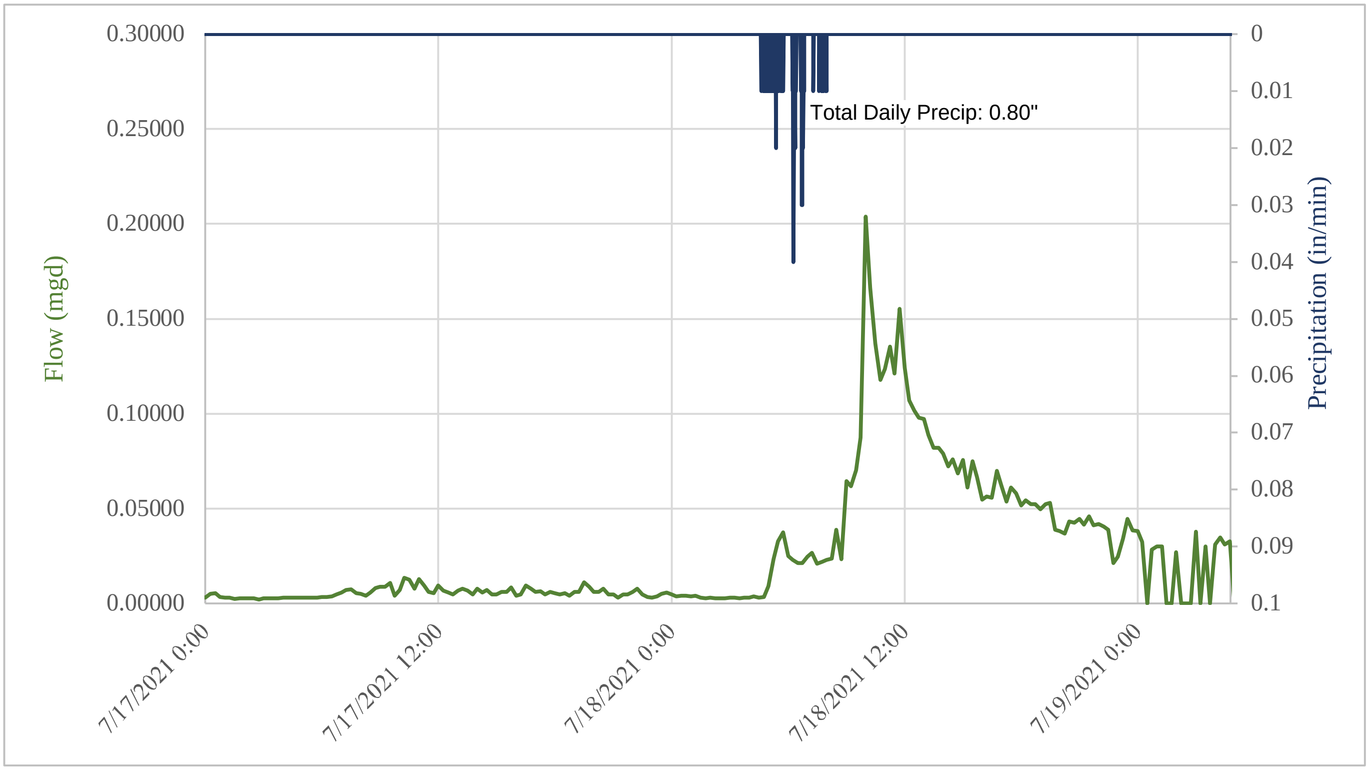


Figure C-14 Rose Street Flow Meter Data – SMH-919 Peak Flow – 7/18/21 Storm Event



C-3: Pleasant Street Flow Meter Data

Figure C-15 Pleasant Street Flow Meter Data – SMH-433

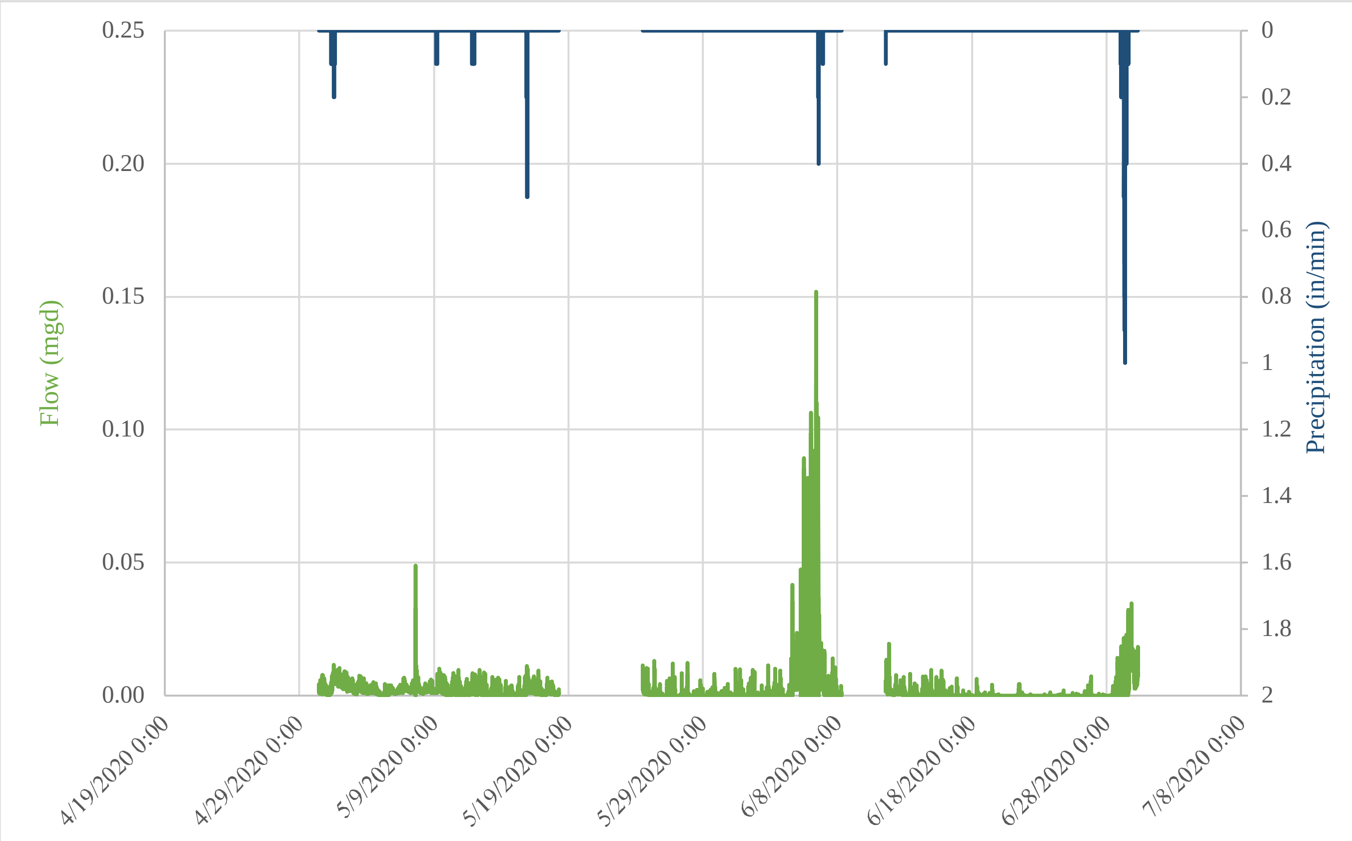
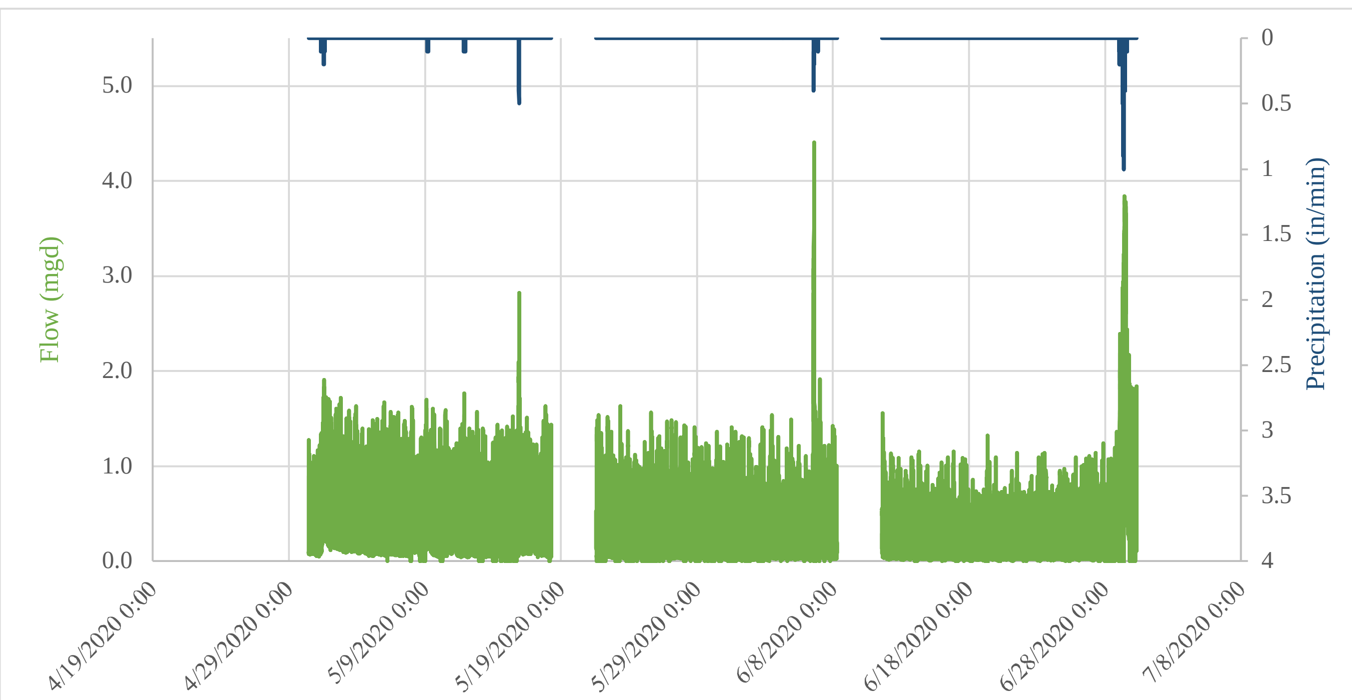


Figure C-16 Pleasant Street Flow Meter Data – SMH-849 East



Notes: 1. Rose Street Pump Station flows are included in flow data.

Figure C-17 Pleasant Street Flow Meter Data – SMH-849 East – Tidal Influence

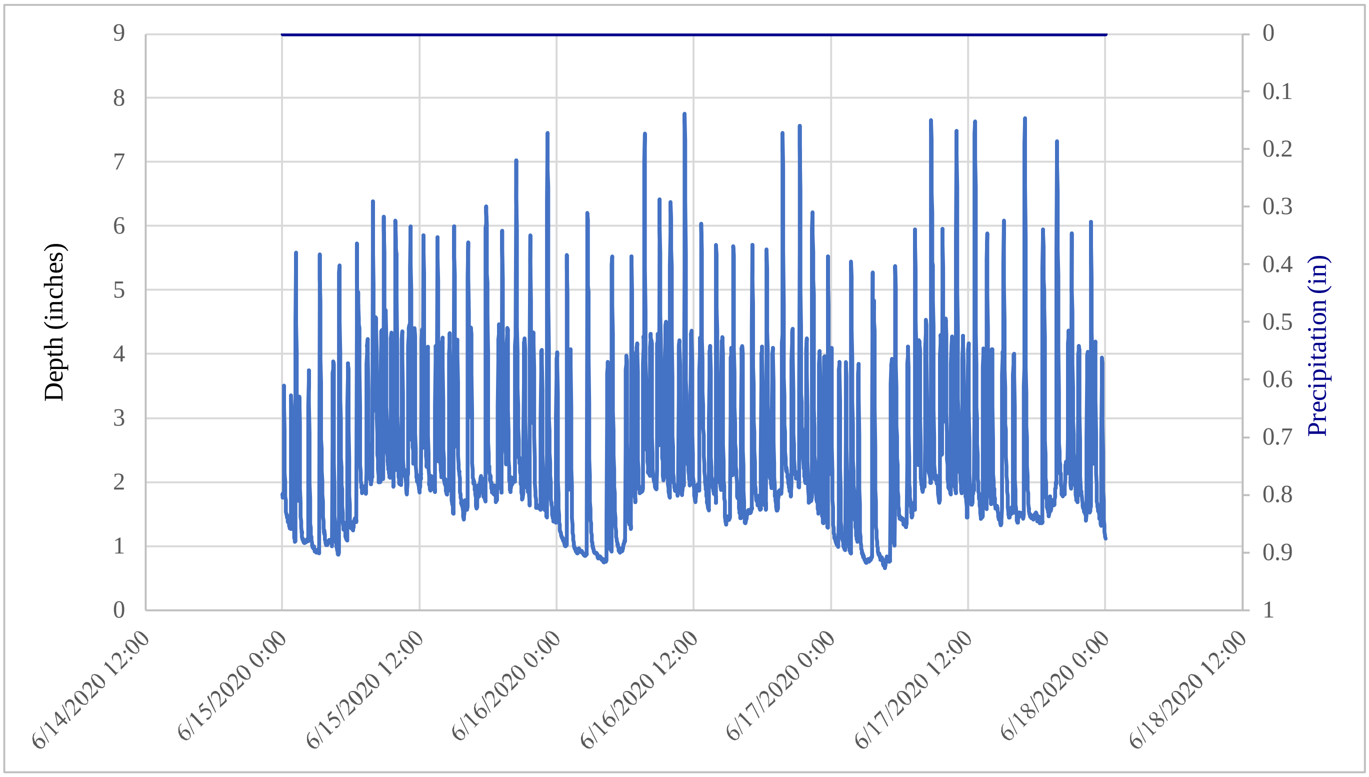


Figure C-18 Pleasant Street Flow Meter Data – SMH-849 West

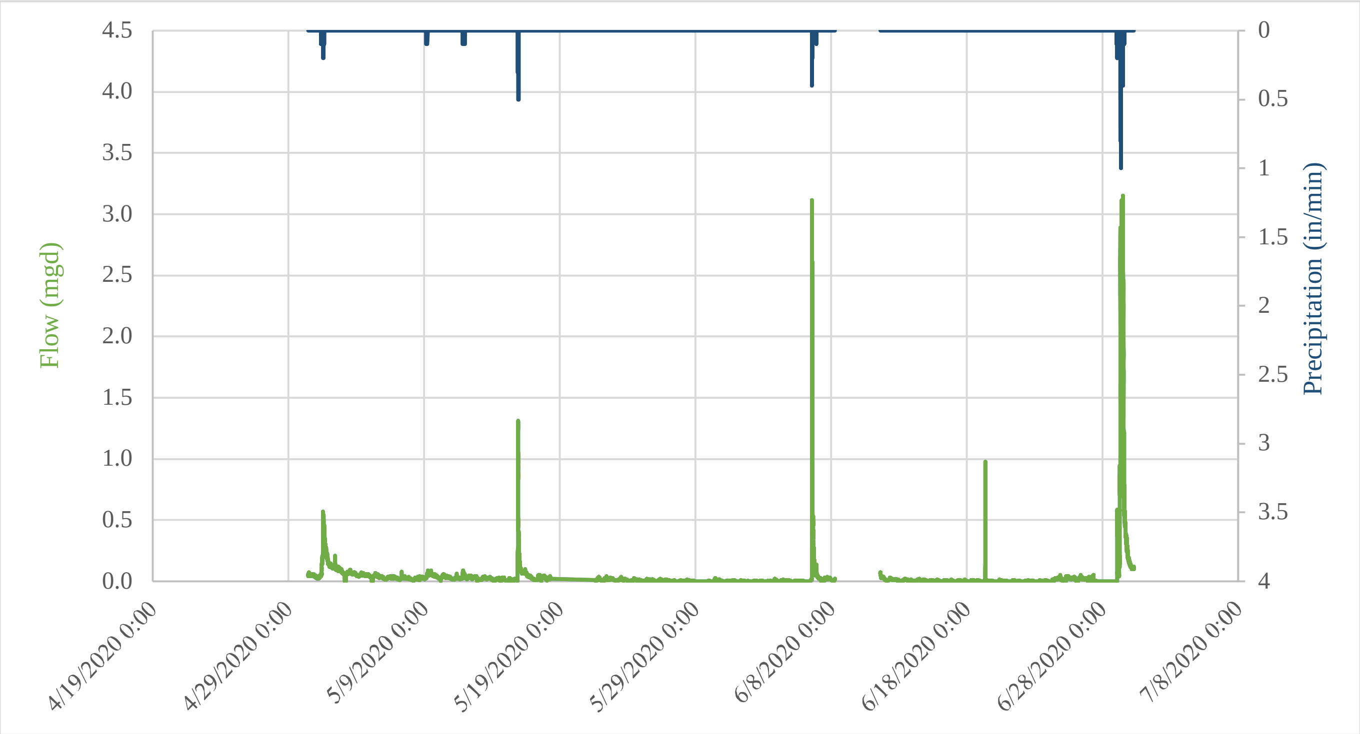


Figure C-19 Pleasant Street Flow Meter Data – SMH-871 Northwest

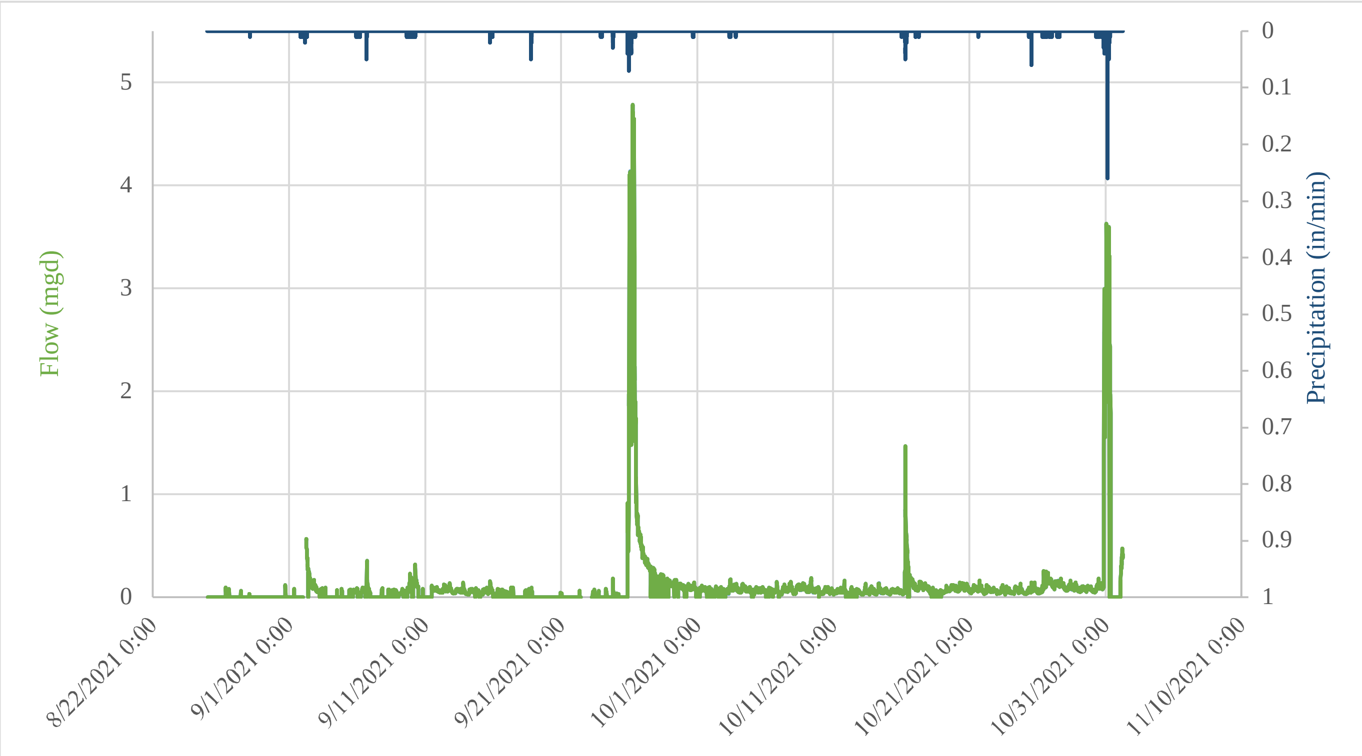
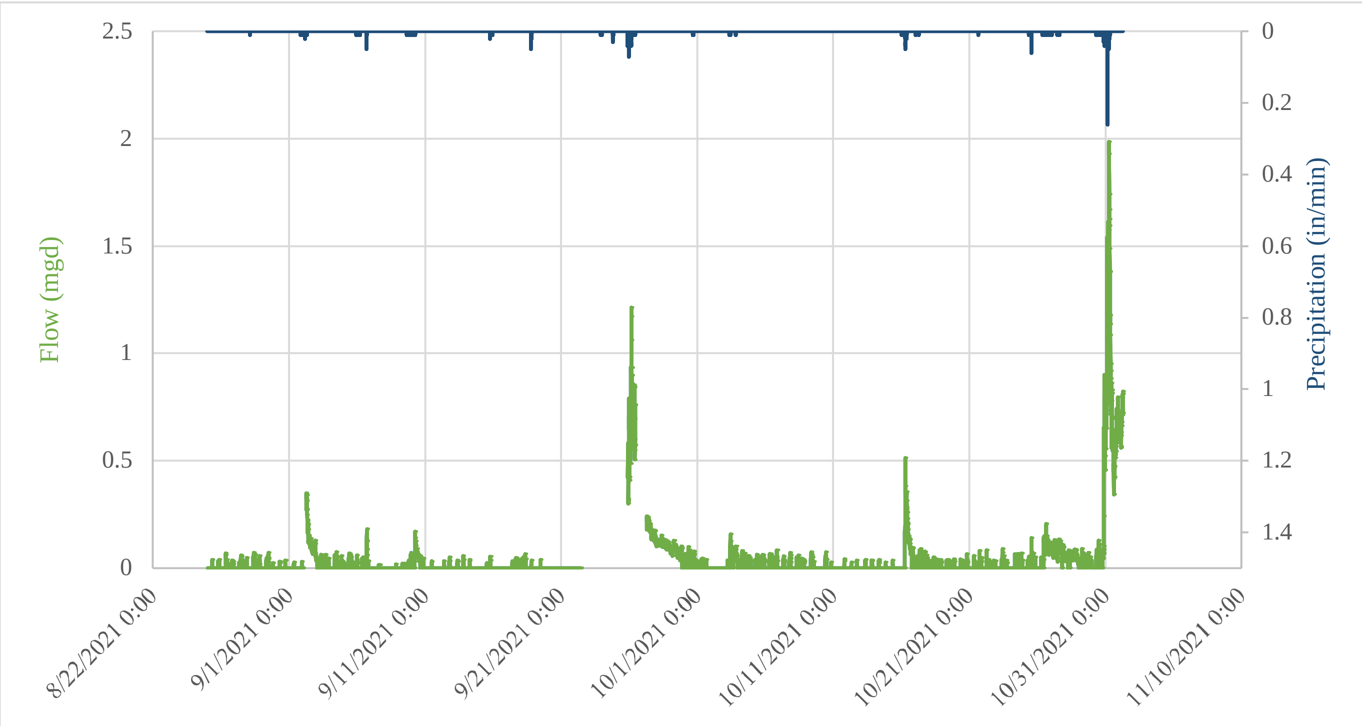


Figure C-20 Pleasant Street Flow Meter Data – SMH-871 Southwest



C-4: Commercial Street Flow Meter Data

Figure C-22 Commercial Street Flow Meter Data – SMH-690

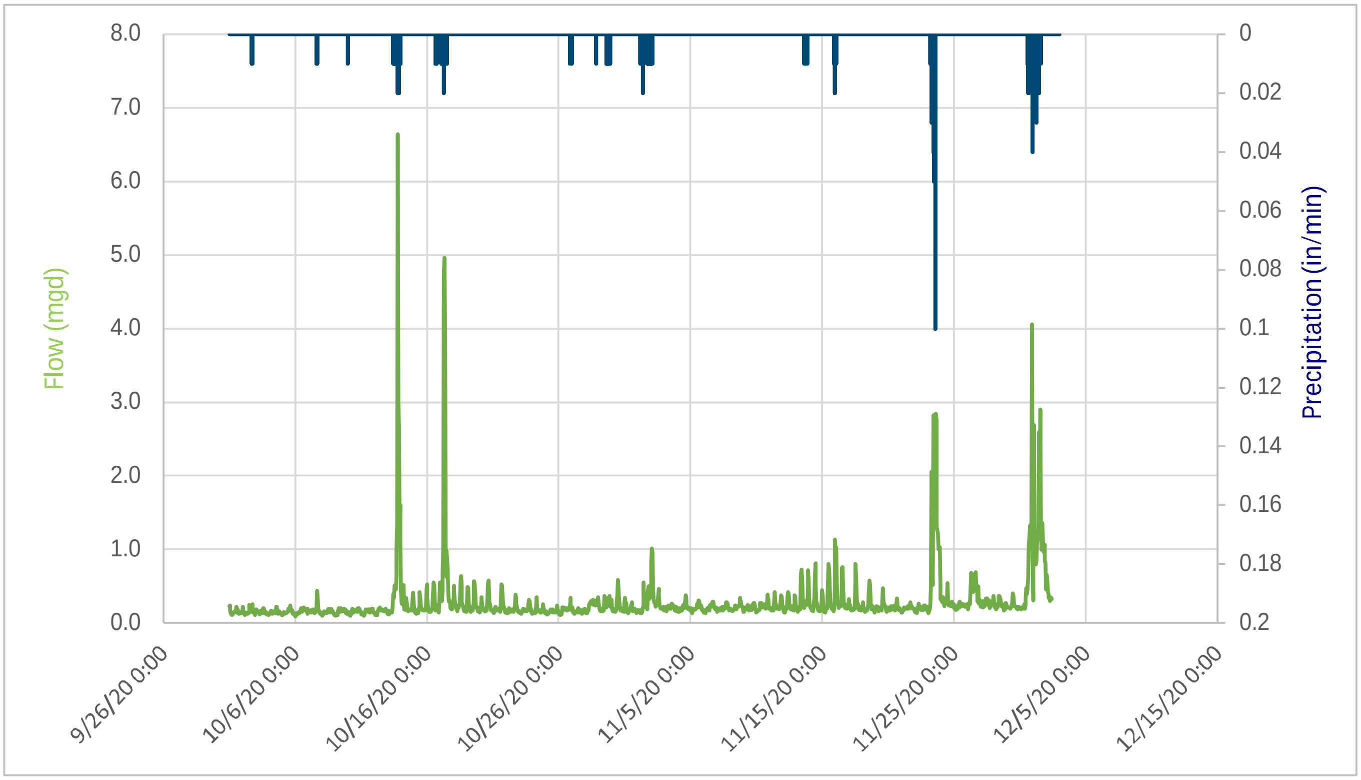


Figure C-23 Commercial Street Flow Meter Data – SMH-690 – Tidal Influence

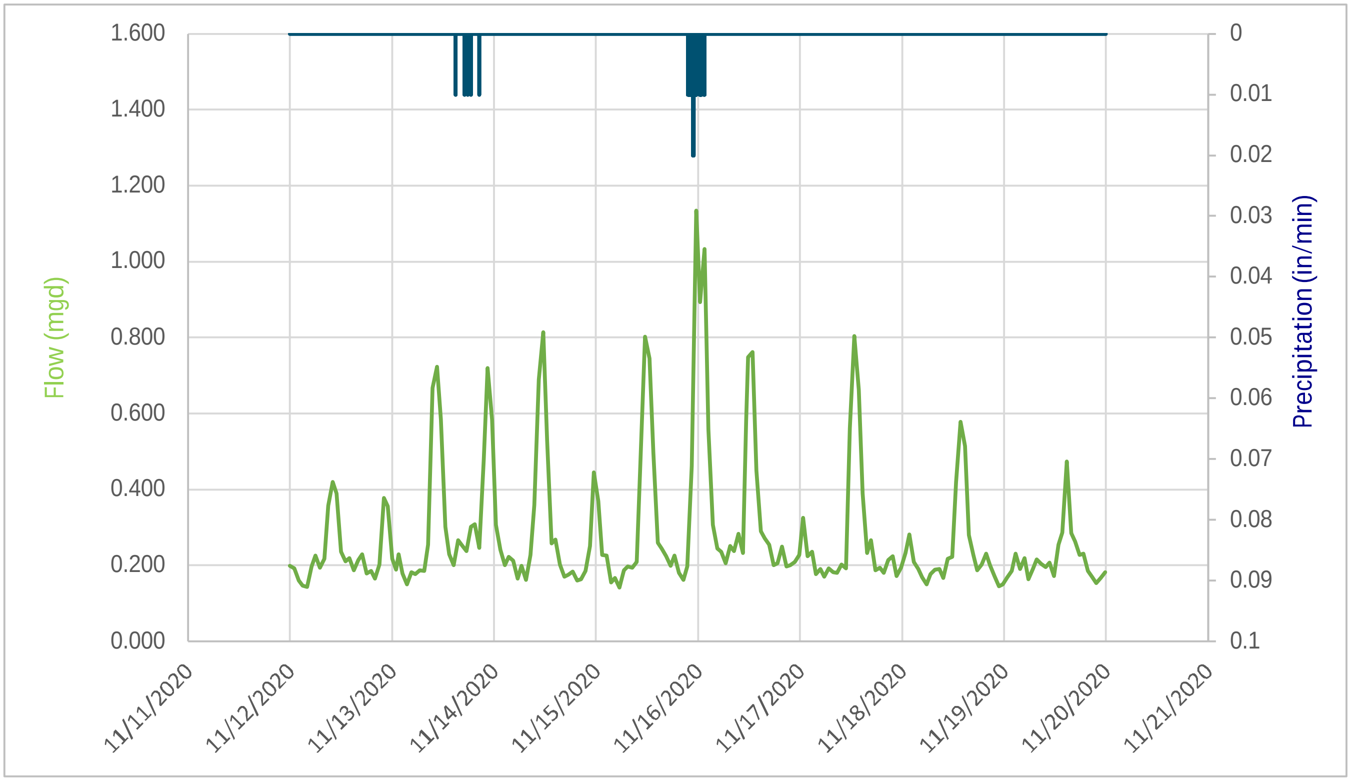


Figure C-24 Commercial Street Flow Meter Data – SMH-729 South

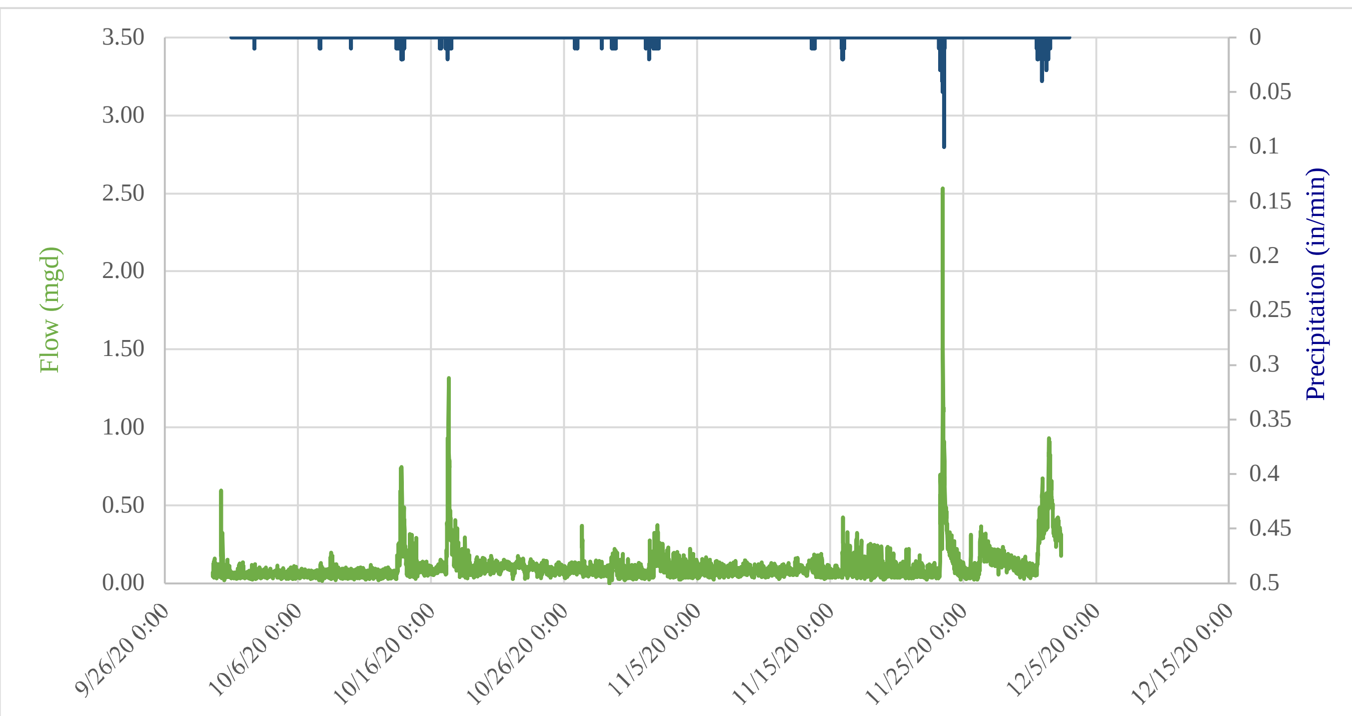
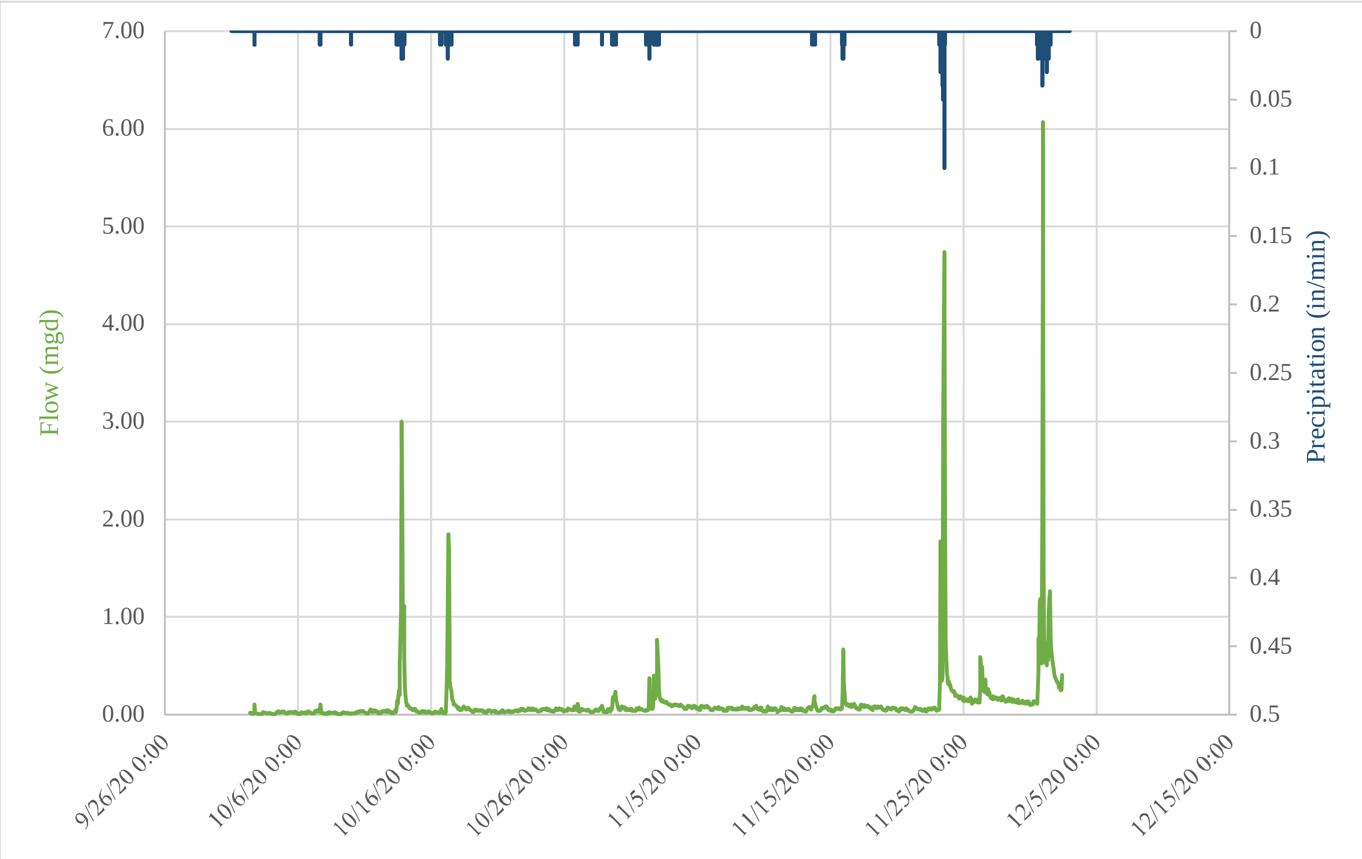


Figure C-25 Commercial Street Flow Meter Data – SMH-729 West



C-5: Farrin Place Flow Meter Data

Figure C-26 Farrin Place Flow Meter – SMH-202

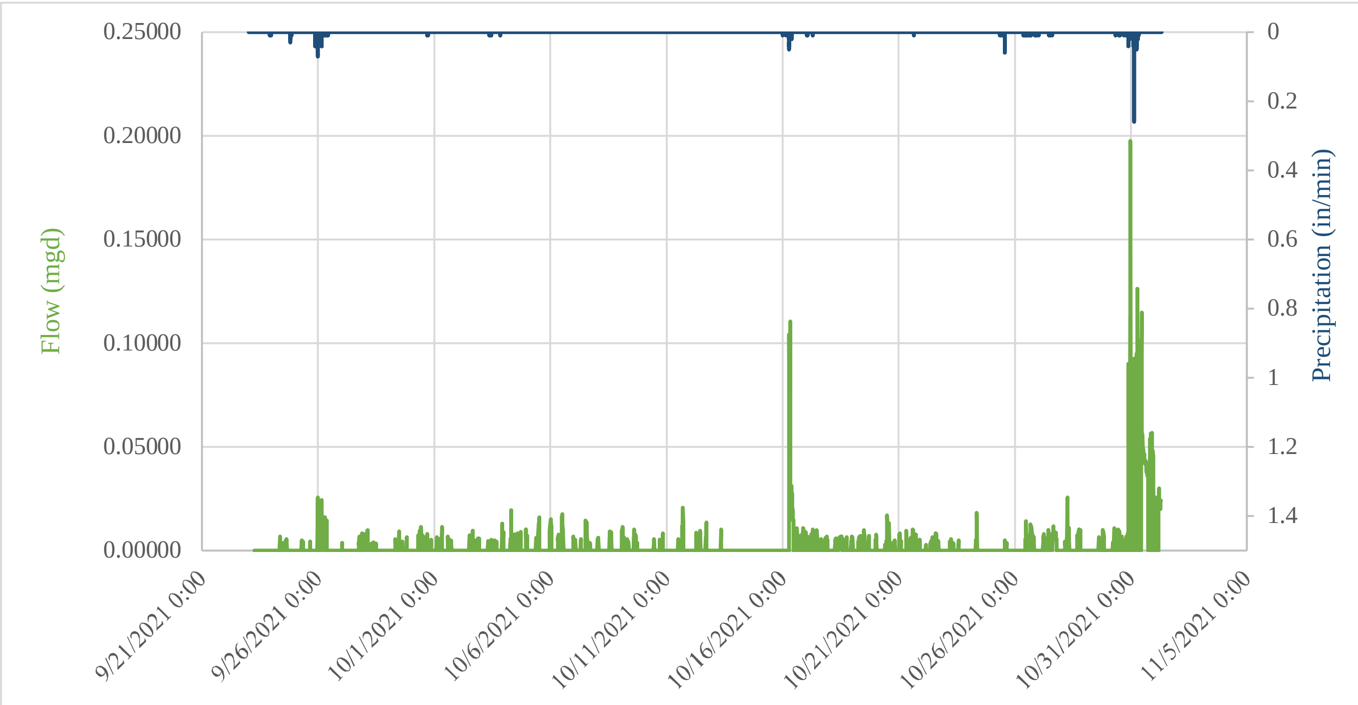
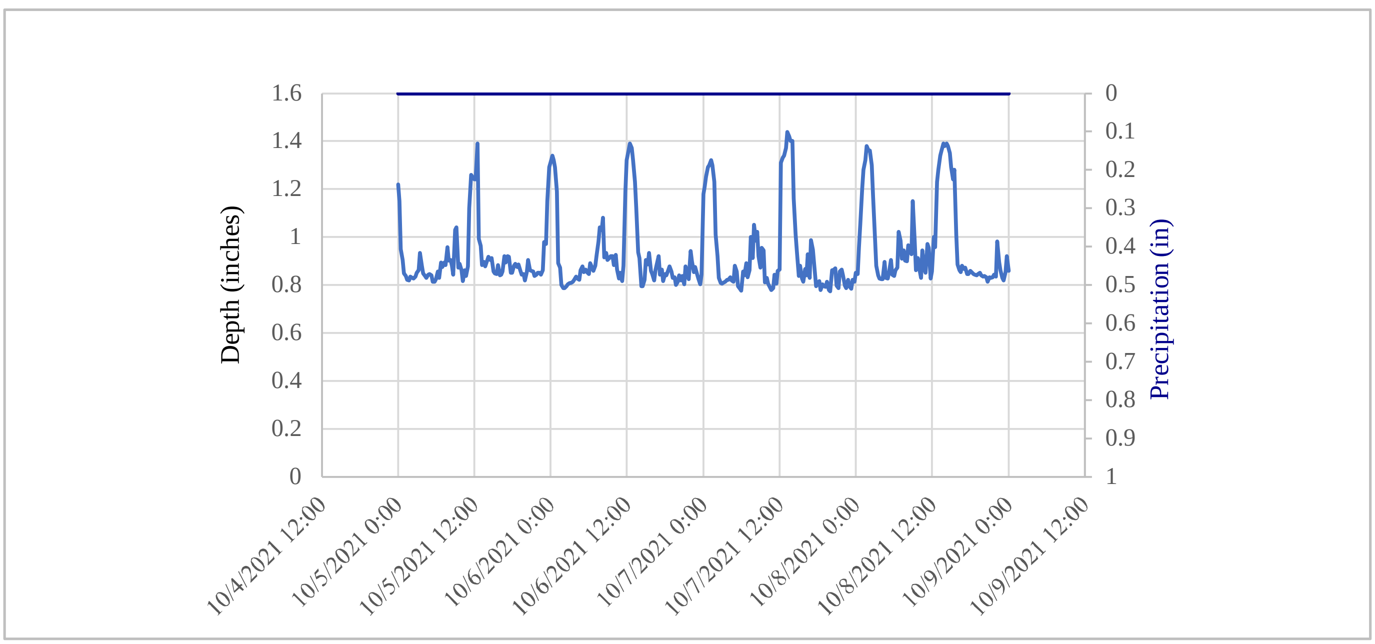


Figure C-27 Farrin Place Flow Meter – SMH-202 – Tidal Influence



C-6: Harward Street Flow Meter Data

Figure C-28 Harward Street Flow Meter – SMH-1148

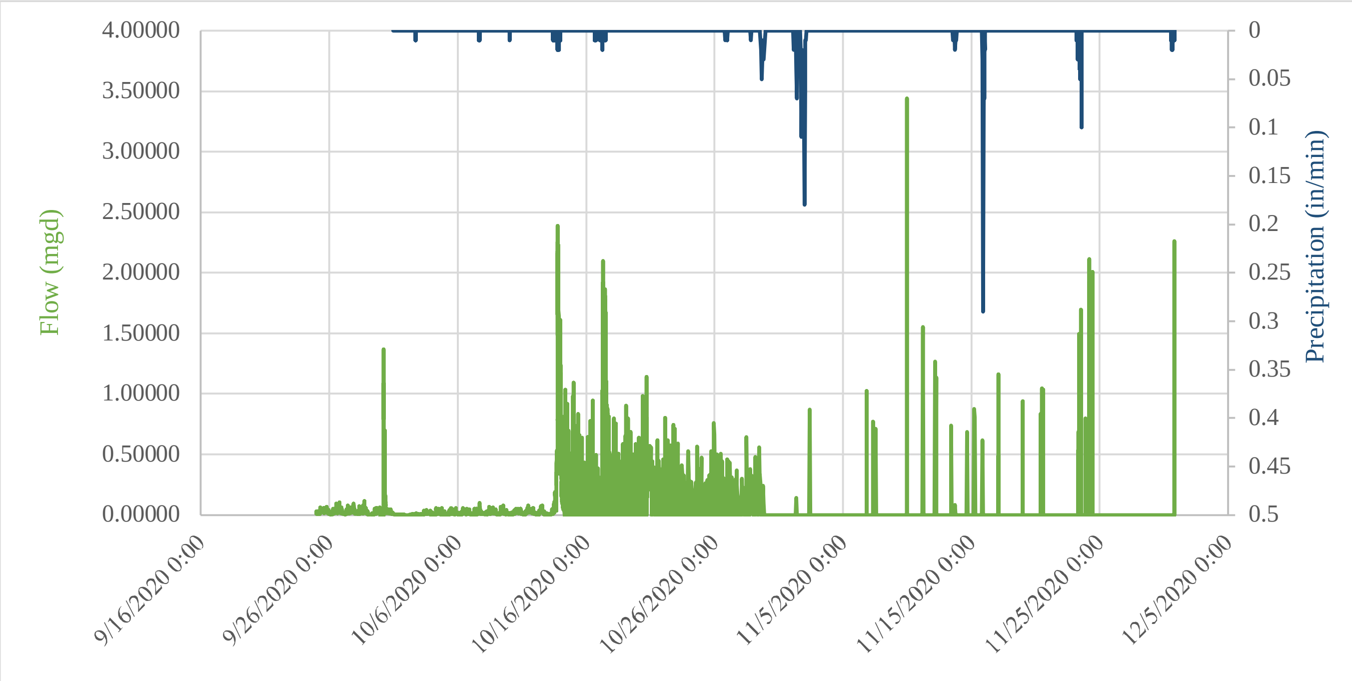


Figure C-29 Harward Street Flow Meter – SMH-1148 Peak Flow – 5/26/17 Storm Event (Before Projects)

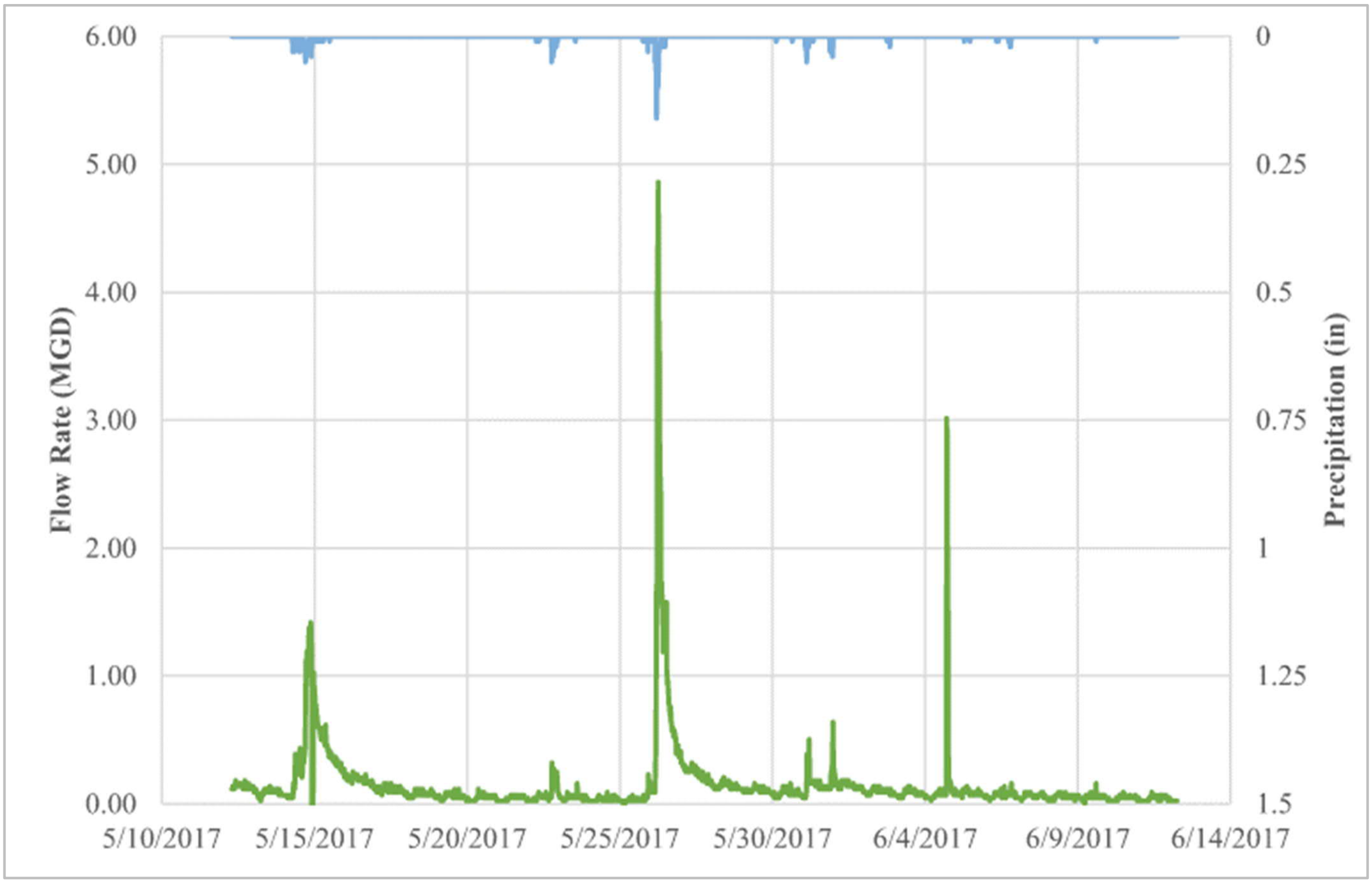


Figure C-30 Harward Street Flow Meter – SMH-1148 Peak Flow – 10/13/20 Storm Event (After Projects)

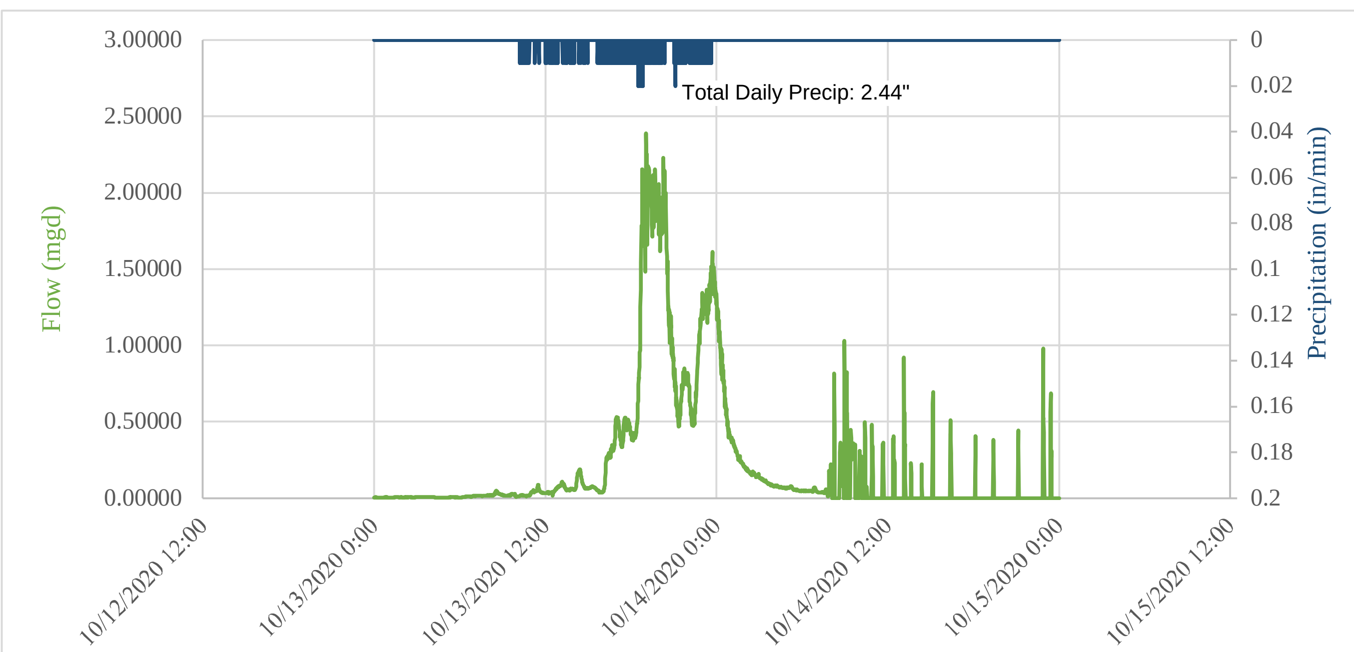


Figure C-31 Harward Street Flow Meter – SMH-1149

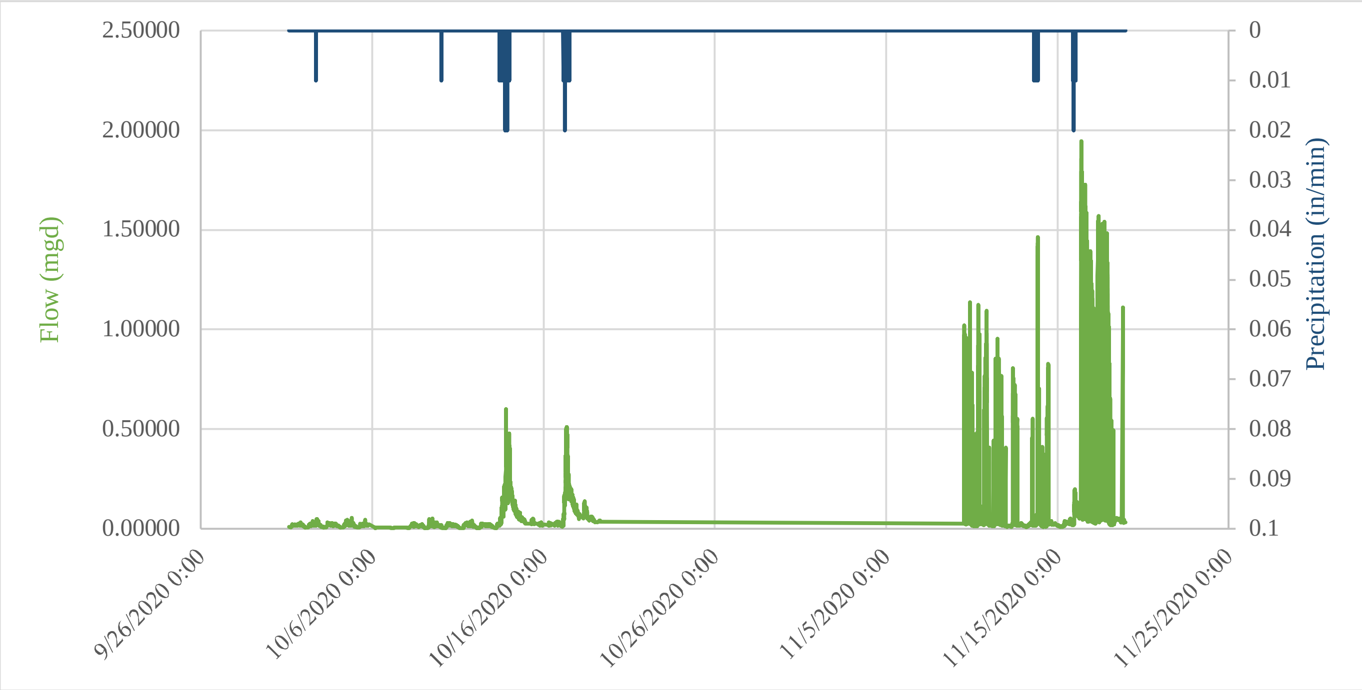


Figure C-32 Harward Street Flow Meter – SMH-1149 Peak Flow – 4/26/17 Storm Event (Before Projects)

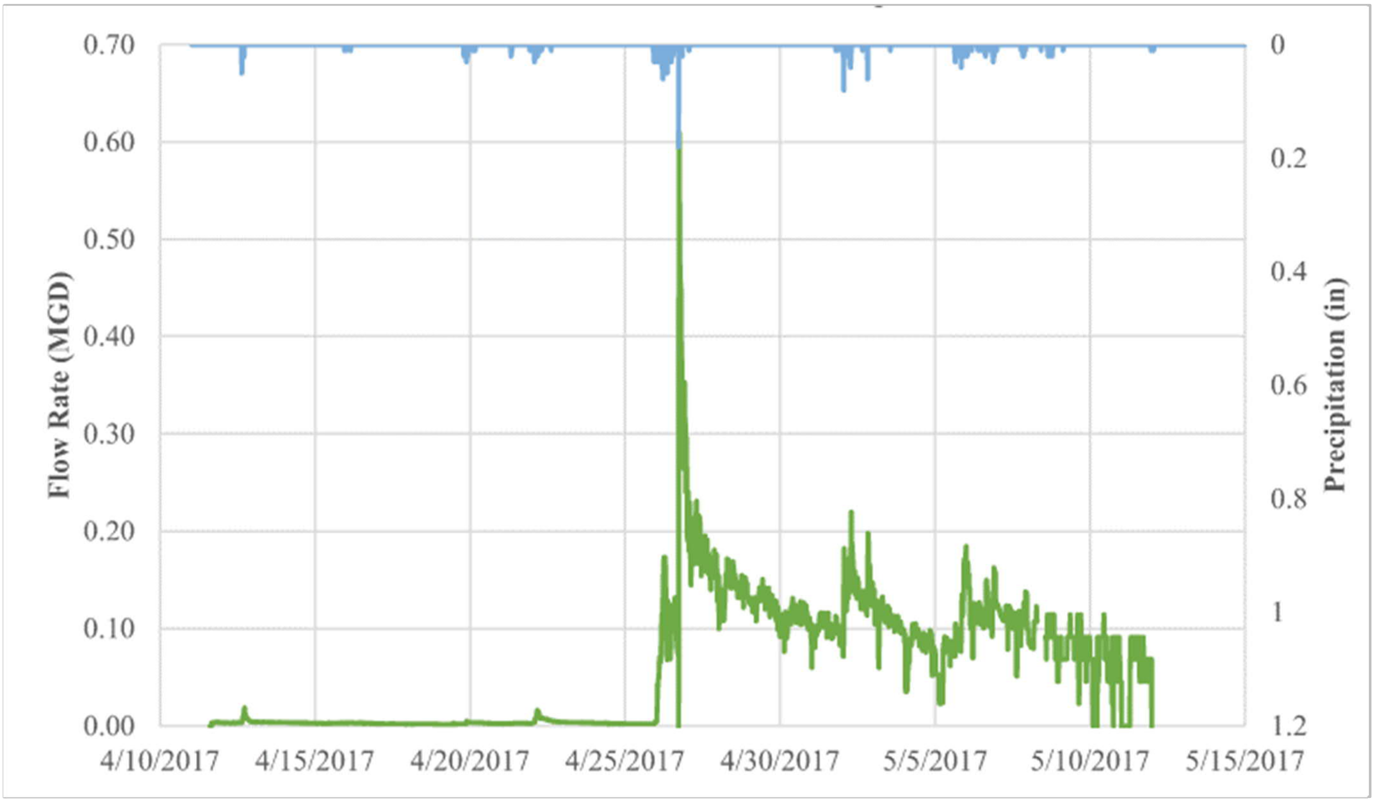


Figure C-33 Harward Street Flow Meter – SMH-1149 Peak Flow – 10/13/20 Storm Event (After Projects)

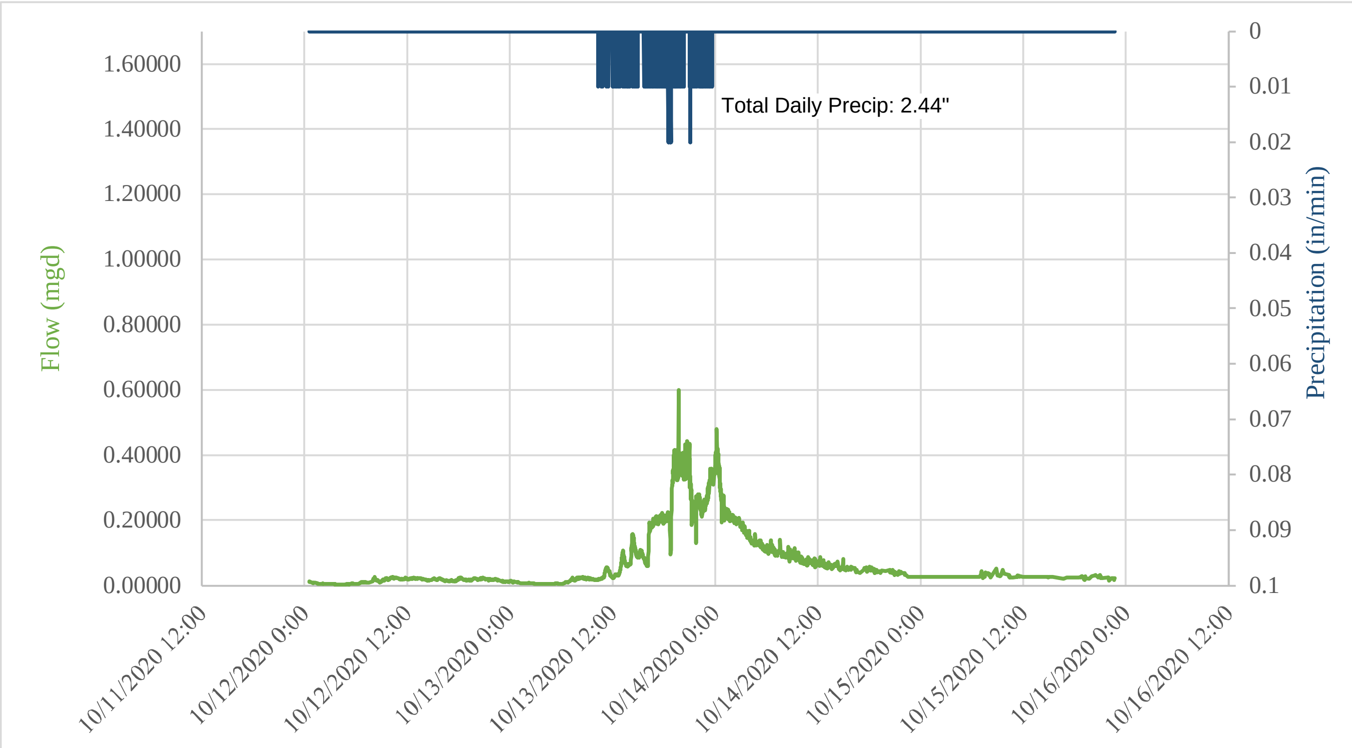
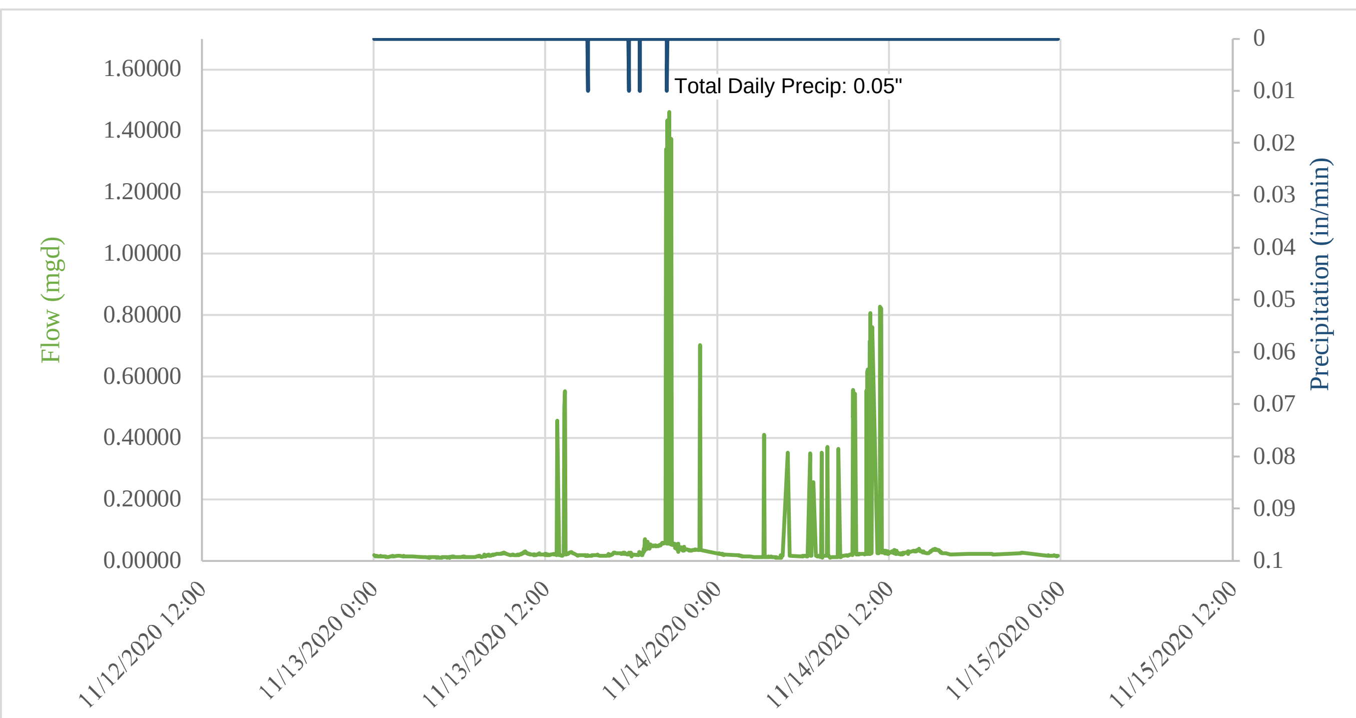


Figure C-34 Harward Street Flow Meter – SMH-1149 Peak Flow – 11/13/20 Storm Event (After Projects)



Appendix D
Wet Weather Operating Plan

Bath, Maine

Wastewater Treatment Facility

WET WEATHER PLAN

(HIGH FLOW MANAGEMENT)
(Rev. July 2020)

Operational Overview (Wet Weather)

1. **Mechanical Bar Screen:** During wet weather no adjustment is needed as the screen operates in the differential mode at all times, maintaining maximum captures.

2. **Vortex Grit Chamber:** Chamber is a fixed design, designed for maximum grit collection during wet weather flows.

3. **Primary Clarifiers:** Solids inventory is kept low overall to prevent degradation of the primary effluent during bypass activity. If a high flow event can be anticipated, automatic primary sludge pumps will be run on hand to remove the entirety of the primary blanket. Scum collection is fixed and cannot be adjusted.

4. **Wet Weather Storage (Seasonal):** A single primary, a single secondary tank and half of the aeration basin are kept empty to provide storage for wet weather flows. During high flow a fixed weir allows a portion of plant flows > 6MGD to fall into the empty primary clarifier. If plant flow increases beyond the fixed weir's ability to control flow or the primary tank becomes full, fixed weirs and an automatic aeration influent gate opens and diverts approximately 1MGD of the plant flow to the empty half of the aeration basin and the bypass structure and gate are activated to control flow to the secondary aeration basin. A fixed weir for an empty secondary will allow another 0.2MGD of the plant flow. This helps collect a good portion of the "First Flush "and prevents bypass activity during the smaller events. Stored volumes are pumped back for secondary treatment after plant flows return to normal.

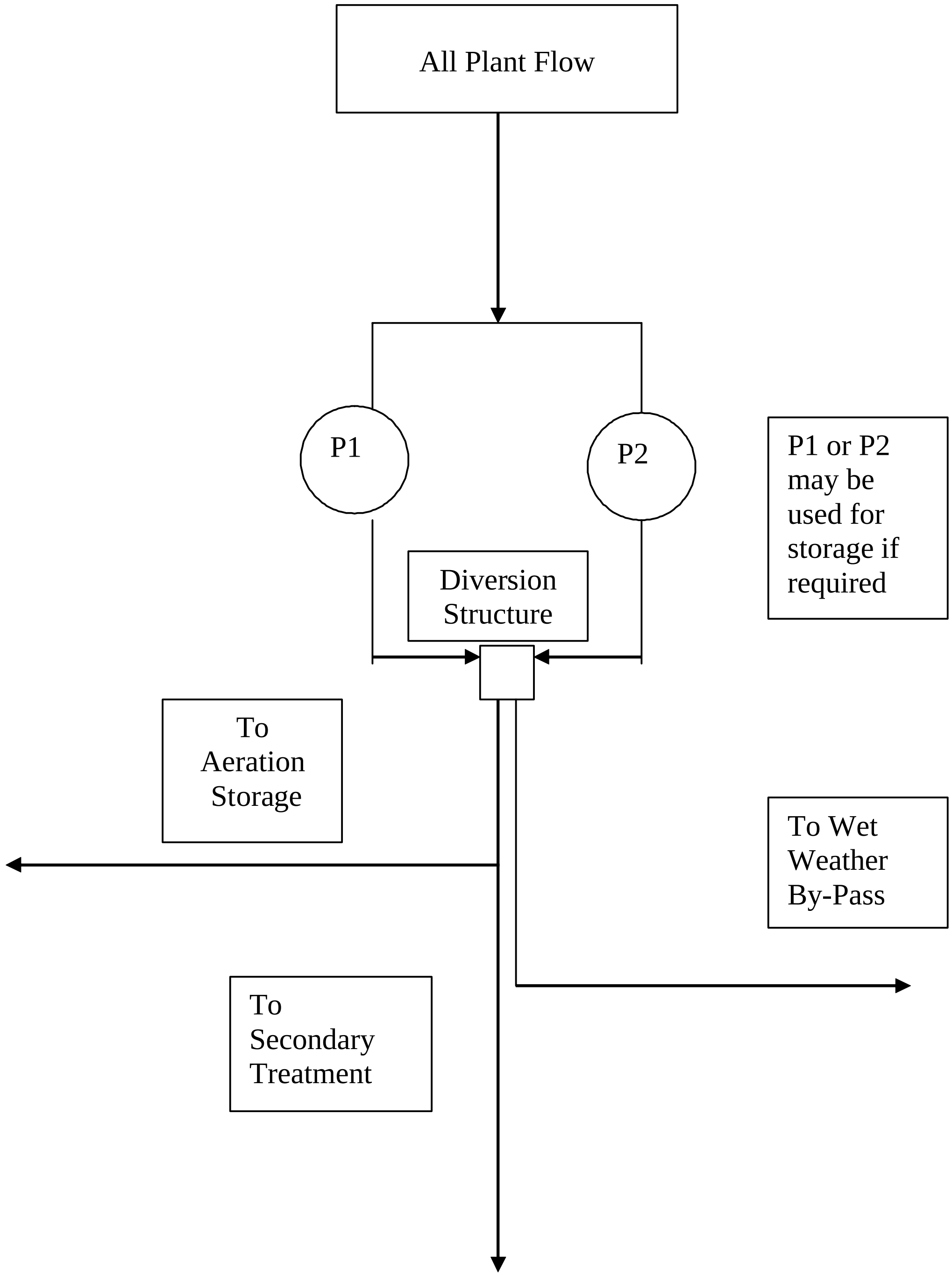
5. **Bypass Structure and Gate:** If the plant flow rate exceeds the design parameters of our secondary treatment process (7MGD) or, if high plant flows leads to severe degradation of the secondary effluent, an automatic bypass gate will divert a portion of the primary effluent to the high rate disinfection structure for treatment. Careful observations of past events have enabled us to determine the best target flow for this diversion.

6. **Aeration Basin:** Solid's inventory, distribution, and dissolved oxygen are maintained throughout the year to provide best treatment for average daily flows. We experimented with various modes and determined that the contact stabilization mode gives us the best overall performance particularly during high flow if return rates are not increased. Future events will determine if adjustments need to be made to the basin feed points or if solids need to be distributed differently to maximize performance during a high flow event.

7. **Secondary Clarifiers:** Solids inventory in the clarifiers are maintained at the lowest possible levels without affecting efficient return and waste feed concentrations to prevent solids carry over during high flow.

8. **Process: S**etpoints in SCADA allows the aeration blowers to turn off when the flow reaches that setpoint for a designated amount of time. The aeration blowers will turn back on after the flow reaches another changeable setpoint for a designated amount of time. Once the CSO tank reaches a level high enough to run the mixers, the CSO alarm rings out and the WAS pump is disabled. For imminent wet weather events, the air can be manually turned off ahead of time to protect the solids in the aeration basin. When this method is used, chlorination and dechlorination should be increased. Ahead of imminent wet weather events or during periods of dry flow, the Commercial pump station should be set up for a flushing event utilizing the wet weather pump to "scour" the lines.

9. **After the Event:** When flows return to a normal level, all storage tanks should be pumped back through the process and then cleaned. A grit chamber flush should be done as well and all alarms that were bypassed should be returned to normal. If the event happened over a weekend and the CSO tank remains full but is no longer active, the CSO mixer #3 should be turned off so the WAS pump can run automatically.



BATH WATER POLLUTION CONTROL FACILITY

The City of Bath Water Pollution Control Facility has adopted a wet weather plan for plant bypass operations in excess of seven million gallons a day thru the secondary clarifiers. The City conducts the same testing on the CSO flows as what is required for testing on the secondary flows for that day. A sampling/reporting day is 7 am to 7 am. The following standard operating procedure is mandatory and will be used in every event. In the anticipation of wet weather, the laboratory operator will set up our plant to the best of our ability to hold all solids thru high flow.

The actual event will be set off by plant influent reaching a 7.0 mgd flow. At 5.0 mgd (operator changeable), the automated slide gate on the empty aeration side, located at the head end of the aeration basin will begin to open to allow flow to fill the empty tanks. These tanks are pumped back thru the process as high flows decrease. When plant effluent flow reaches 7.0 mgd the automated CSO gate begins to close maintaining only 7.0 mgd to secondary treatment. All remaining flow is directed to the CSO bypass tank. As flow is detected at the CSO tank all the chemical mixers are started automatically. As chemical mixer number 2 starts, it sends an alarm thru the SCADA system, which sets off an auto dialer to begin the call-in process. Once the operator is contacted, they will respond to the plant.

Upon arrival the operator will complete all required tests, and record data on the Plant Bypass Worksheet. The tests required in this plan are subject to change following the State and Federal mandates.

The operator will be required to perform the following tasks:

- Duplicate all the testing that was done on the secondary treated effluent for that reporting day.
- When required, ice packs are used to preserve the BOD samples; packs are placed in the center of the sampler.
- Two samples will be drawn for the chlorine residual test of the bypass 1 prior to the sodium bisulfite and 1 after sodium bisulfite. A total chlorine residual test will be done on both samples and recorded. A pH sample should be done on the CSO effluent for in-house tracking.
- When required, a sample will be drawn at the final CSO outfall effluent and a Fecal Coliform test will be done.

After all testing is completed the operator will record all data including air temperature, weather conditions, precipitation (the next day), on the Plant bypass worksheet. A total plant walk around will be done to note any problems we may have during the event. A check of the secondary clarifiers will be done to check the performance.

The following day after the event all composite samples taken will be tested (when applicable). We will perform all necessary testing which may include a Biochemical Oxygen Demand, Total Suspended Solids, pH, Chlorine Residual, and a Fecal Coliform on both the influent and effluent sample. All data will be recorded on the Maine State Report 49 form.

Also, at the Bath Water Pollution Control Facility, our collection system (Pump Station High Water alarms) may ring in prior to the CSO being activated. Occasionally the alarms will come in at the same time. At that time, the SCADA alerts the supervisor, who contacts the pump station operator. The operator will respond to all 13-pump stations to assure proper operation. Wet weather spot checks are also mandatory and a checklist of these locations will be available.

During events that staff responds to after regular work hours the following is standard procedure.

- Start the effluent sampler if necessary, run a manual sample for the first bottle. The effluent sampler is located next to the blower building in the sampling hut.
- Ice packs are used to preserve the collected samples; packs are placed in the center of the sampler.
- Samples will be drawn from the CSO tank, front and rear to assure chlorine presence in the head end, and less than 1 mg/l at the final outfall. A pH check will also be done on the CSO effluent.
- Fecal coliform testing on the CSO effluent will also be done, when necessary. A minimum of 2 should be conducted at least 30 minutes apart. Chlorine residuals will be tested alongside each fecal coliform test.
- The on-duty operator completes a complete plant walk around and evaluation.

After all required testing is complete the operator will record all data collected on the plant bypass worksheet. The following day after the high flow event all composite samples collected will be analyzed.

PLANT BYPASS WORKSHEET

Operator ________ Day ________ Date ________

Weather Conditions ________ Precip. ________ Air Temp. ________

Flow

Total Gallons Bypassed ________ Treated Secondary ________

Ph

Final CSO Outfall ________ Max. Flow ________ complete checklist on back

Chlorine Residual

CSO Before Bisulfite ________ Final CSO Outfall ________ CL2 Tank ________

Secondary CL2 Setpoint ________ Sec. Bisulfite Setpoint ________

CSO CL2 Setpoint ________ CSO Bisulfite Setpoint ________ Final Effluent ________

PREPARED BY: ________ TIME: ________ DATE: ________

ANALYSIS BY: ________ TIME: ________ DATE: ________

RE-CHECK ________ CL2 Residual Eff. ________ (before) ________ (after)

5 -DAY B.O.D.	SEED		ML	SEED FACTOR			MG/L	
FLOW	EFFL	EFFL	EFFL.	EFFL.	EFFL.	DILUTION	SEED	SEED
BOTTLE #								
% DILUTION								
INT. D. O.								
5 DAY D.O.								
MG/L								
Average Effluent mg/l						PH		

TEMPERATURE: ________ TEMPERATURE ________ pH ________

BAR. PRESS. ________ BAR. PRESS. ________

CALIBRATION: ________ CALIBRATION ________ EFFLUENT TEMP. ________

Standard Methods 5210 - B

SUSPENDED SOLIDS Effluent ________ ml

Drying Time In ________

W-2 ________

W-1 ________ Drying Time Out ________

mg/l ________

Standard Methods 2540-D

FECAL COLIFORM

Sample By: ________

Analysis By: ________

Date ________ Time #1 ________ Time #2 ________ Time #3 ________

CL2 Residual #1 ________ #2 ________ #3 ________

Final Effluent #1 ________ #2 ________ #3 ________

INCUBATED TIME #1 ________ 100 mL ________

INCUBATED TIME #2 ________ 100 mL ________

INCUBATED TIME #3 ________ 100 mL ________

READ DATE/ TIME ________

Large Wells ________ Small Wells ________

Geometric Mean ________ ________ ________

________ ________

PLANT BYPASS CHECKLIST

Initial Call In Procedures	Turn Off Air	
	Bypass Mixer Alarms on SCADA	
	Set up effluent CSO sampler for BOD when the secondary BOD sampler is in use	
	Record chlorine residuals from chlorine detention tank and final effuent tank	
	Record chlorine residuals from CSO tank influent and effluent (CSO Tank Influent to be >6.0)	
	Record PH of CSO effluent	
	If fecal incubator has trays in it, take 2 fecal samples, 30 min. apart with the 97 well tray	
	Record air temp., date and time, weather conditions and name	
	List final setpoints for both chemical pumps for the CSO. Record any adjustments you made.	
	Check the headworks for grit and bar screen problems. Rake cans	
	Check the blower building for any issues	
	Do a walkaround outside and note any issues	
	Check SCADA	
	Record CSO effluent residual on 49 form.	
Next Day Procedures	If CSO tank is flowing, check inf. and eff. chlorine residuals on new bypass sheet	
	If CSO tank is flowing, check CSO effluent PH on the new bypass sheet	
	If CSO BOD sampler was used:	
	1) Fill out flow proportion chart	
	2) Gather BOD effluent sample from bottles using flow proportioning	
	3) Run TSS + BOD tests and paperwork using CSO eff. proportioned sample	
	4) Reset CSO BOD sampler and clean bottles	
	5) Start CSO sampler again if running secondary BOD sampler	
	6) Record TSS data and CSO effluent residual on 49 form	
	If CSO fecal coliform test was taken from the initial call-in:	
	1) Record readings 18-22 hours after incubation time	
	2) Calculate geomeans and enter on 49 form and previous days paperwork	
	3) If testing secondary for fecal coliform, do 2 tests on CSO if still active	
	Record CSO flow, treated secondary and max flow on previous days sheet	
	Fill out CSO cut sheet	
	Do a complete walkaround	

SSO Checkpoints

Date	Time	Active	Plant Flow	Comments	Operator
Denny Road		*Y / N*	MGD		

Date	Time	Active	Plant Flow	Comments	Operator
Juniper Street		*Y / N*	MGD		

Date	Time	Active	Plant Flow	Comments	Operator
Washington		*Y / N*	MGD		
Harward					

Date	Time	Active	Plant Flow	Comments	Operator
Washington		*Y / N*	MGD		
Hunt					

Date	Time	Active	Plant Flow	Comments	Operator
Willow Street		*Y / N*	MGD		

Date	Time	Active	Plant Flow	Comments	Operator
Middle Street		*Y / N*	MGD		

Date	Time	Active	Plant Flow	Comments	Operator
		Y / N	MGD		

Date	Time	Active	Plant Flow	Comments	Operator
		Y / N	MGD		

Upon receiving high water alarms, operator being dispatched will fill out above form to report any SSOs

Bath Water Pollution Control Facility

Collection System Combined Sewer Overflow Checklist

DATE: ____________________ Wet Weather Event ______

TIME: ____________________ Weekly Maintenance Check ______

SITE	Commercial (005)		Pleasant Ave (004)		Rose (003)		Harward / Dike (008)	
Battery Voltage								
Is the Woodblock Present?	Yes	No	Yes	No	Yes	No	Yes	No
Battery Changed?	Yes	No	Yes	No	Yes	No	Yes	No

COMMENTS: ____________________

Tide Condition: ____________ Weather Condition: ____________

Willow Street Active		Washington St. Active		Juniper Active	
Denny Road					

OPERATOR: ____________________

FACILITY DATA:	
Influent Flow	
Effluent Flow	
CSO Flow	

After a rain event, operators will upload the isco information in the CSO outfalls around the City to report any flows to the DEP and/or the DMR

Appendix E
Figures for Project Alternatives

Figure E-1 Rose Street CSO: Alternative 6 – Pump Station Capacity Modifications (Alt 2) and Reroute Hunt Street Pump Station Force Main (Alt 3)

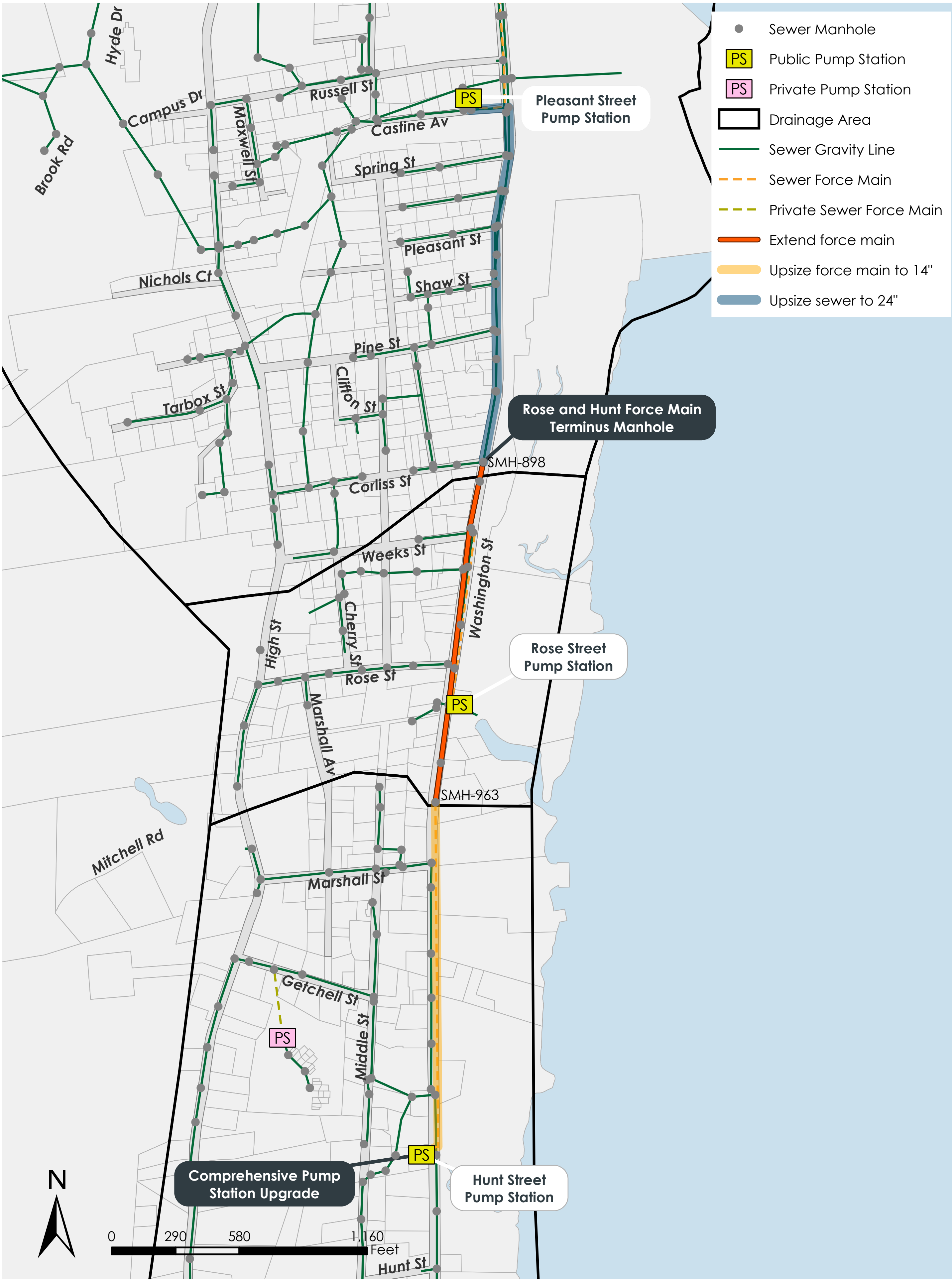


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Figure E-2 Pleasant Street CSO: Alternative 1 – I/I Removal

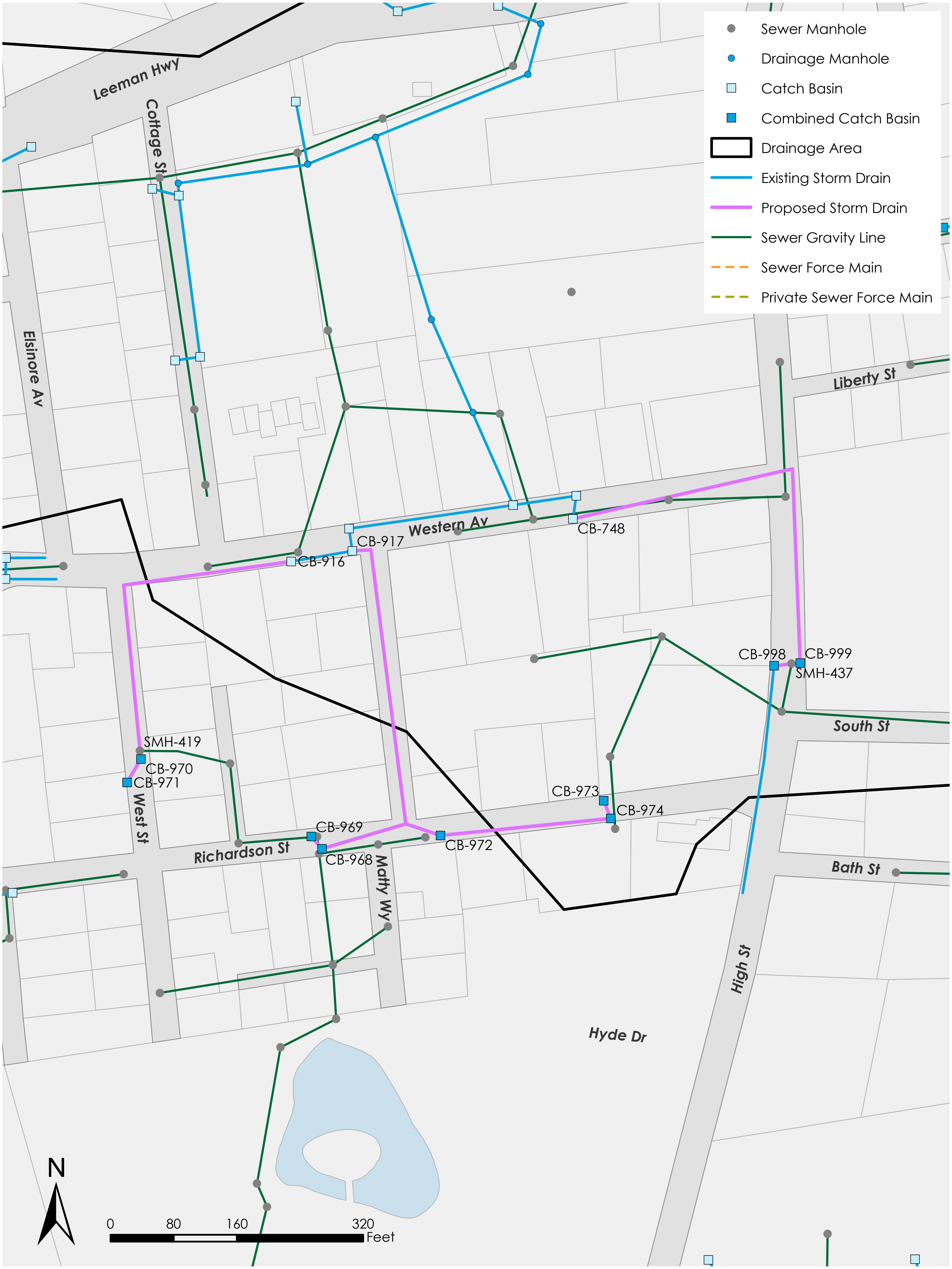

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Figure E-3 Commercial Street CSO: Alternative 1 – I/I Removal

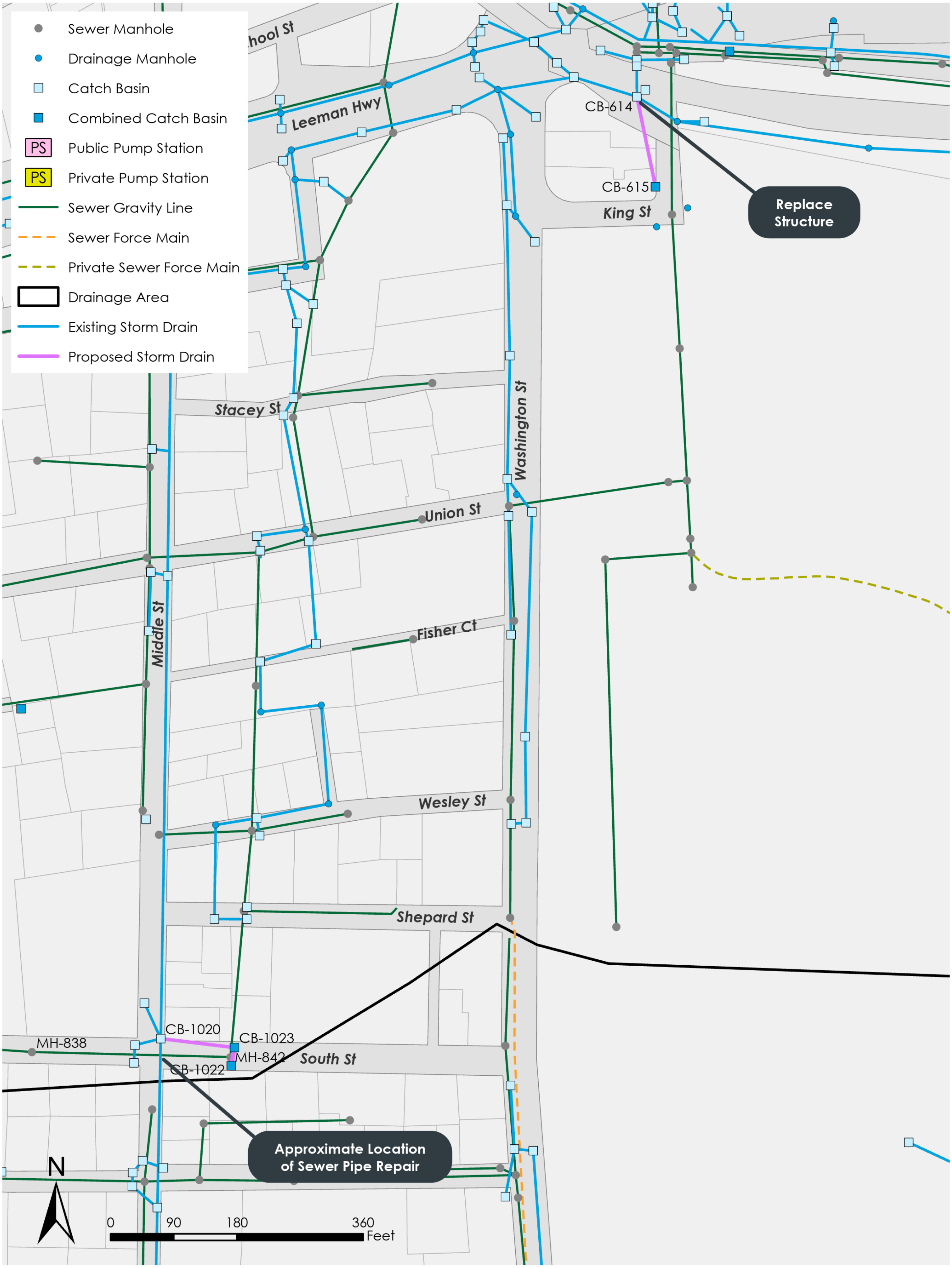

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Figure E-4 Commercial Street CSO: Alternative 4 – Stormwater Pump Station

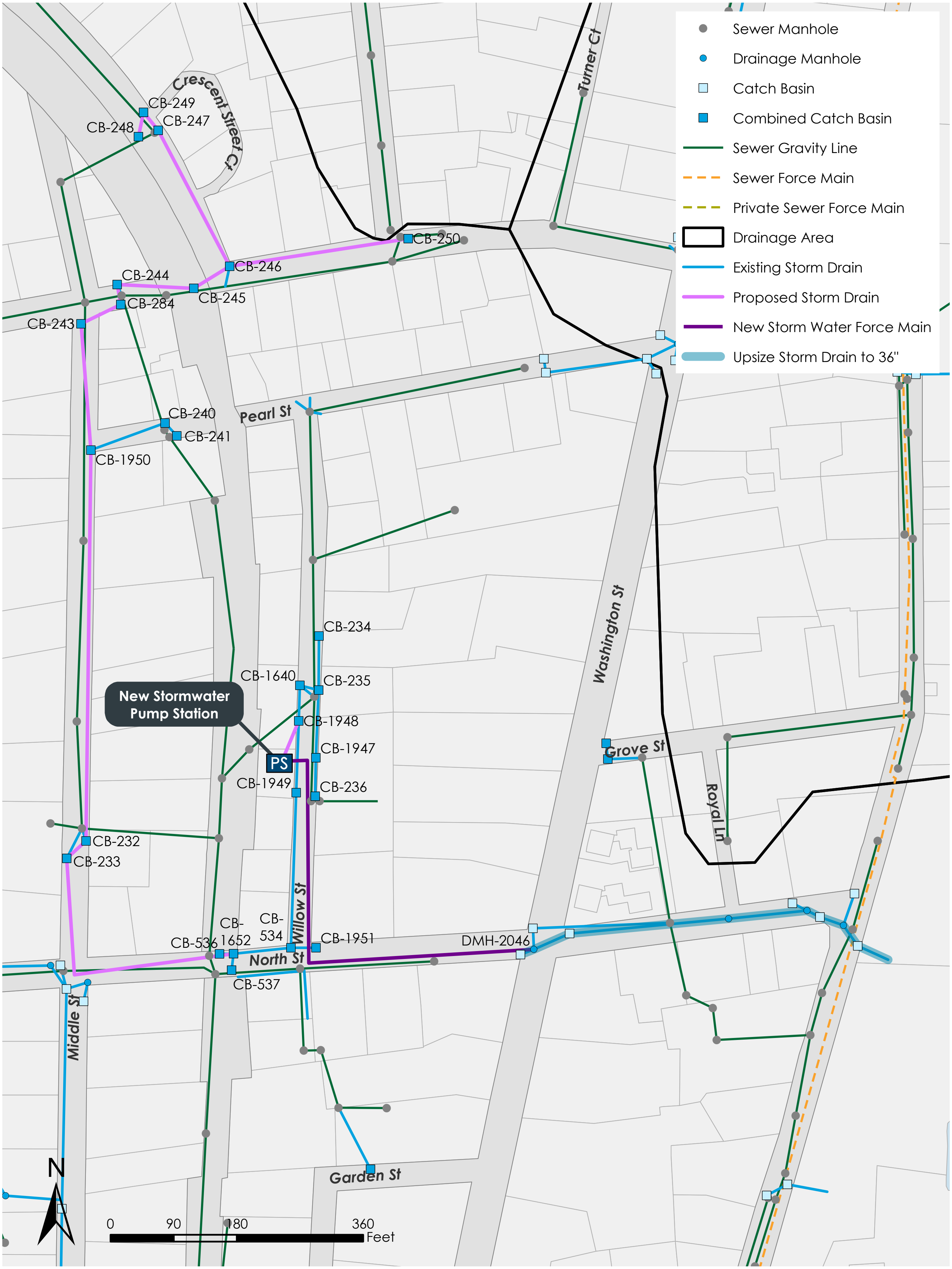

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Figure E-5 Harward Street CSO: Alternative 1 – I/I Removal – Green Street

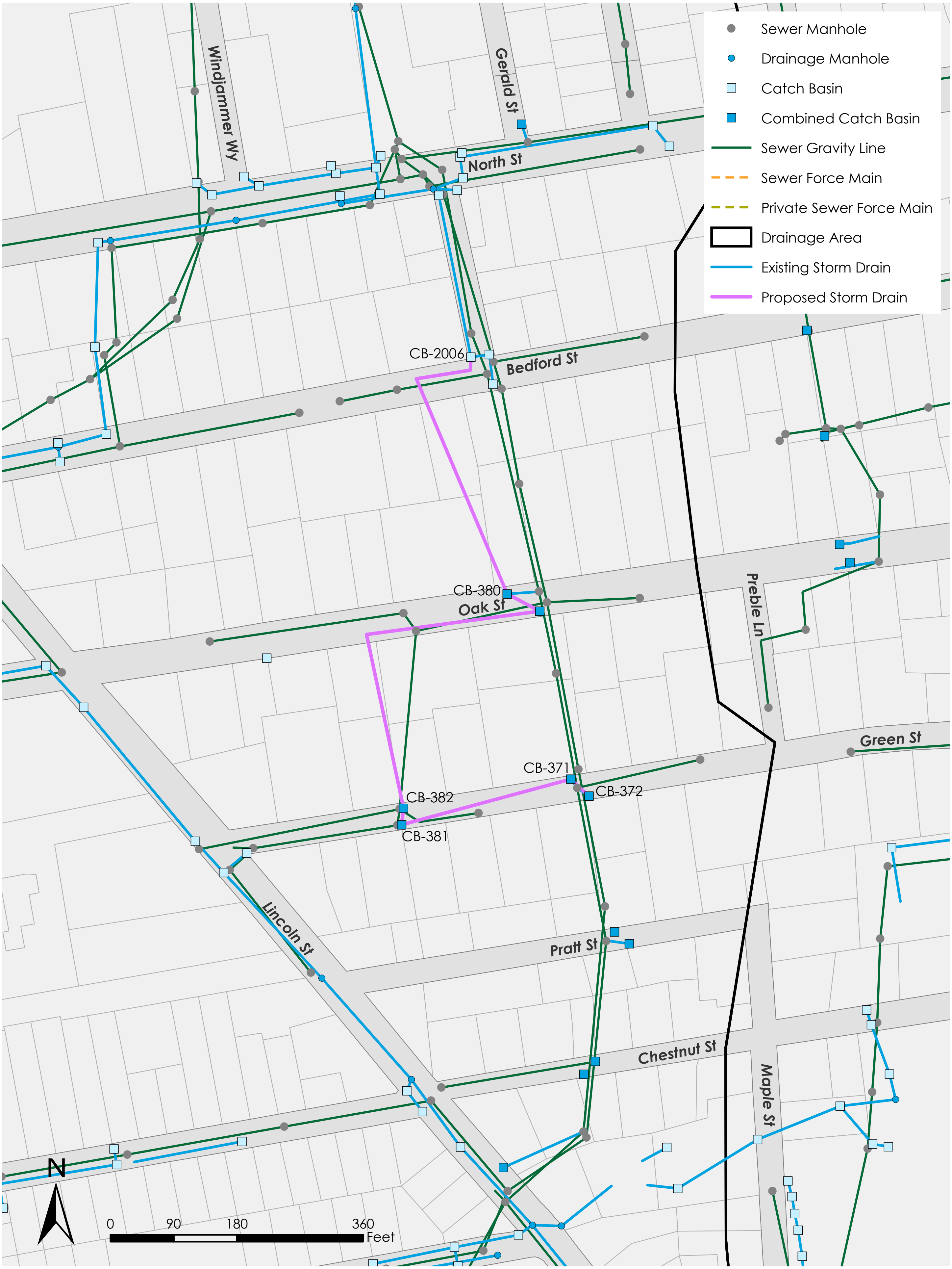

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Figure E-6 Harward Street CSO: Alternative 1 – I/I Removal – High Street

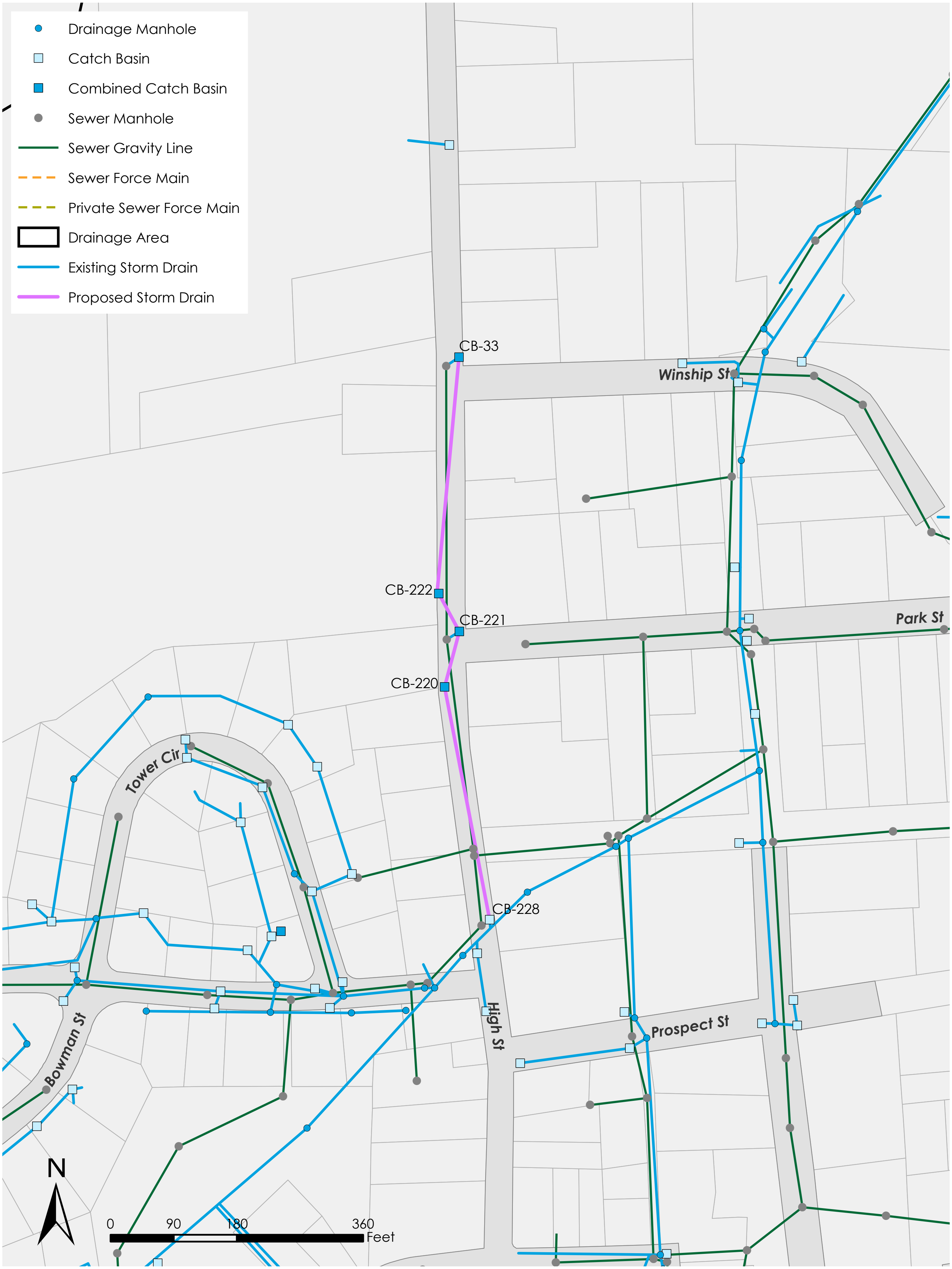

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Figure E-7 Harward Street CSO: Alternative 1 – I/I Removal – Meadow Way

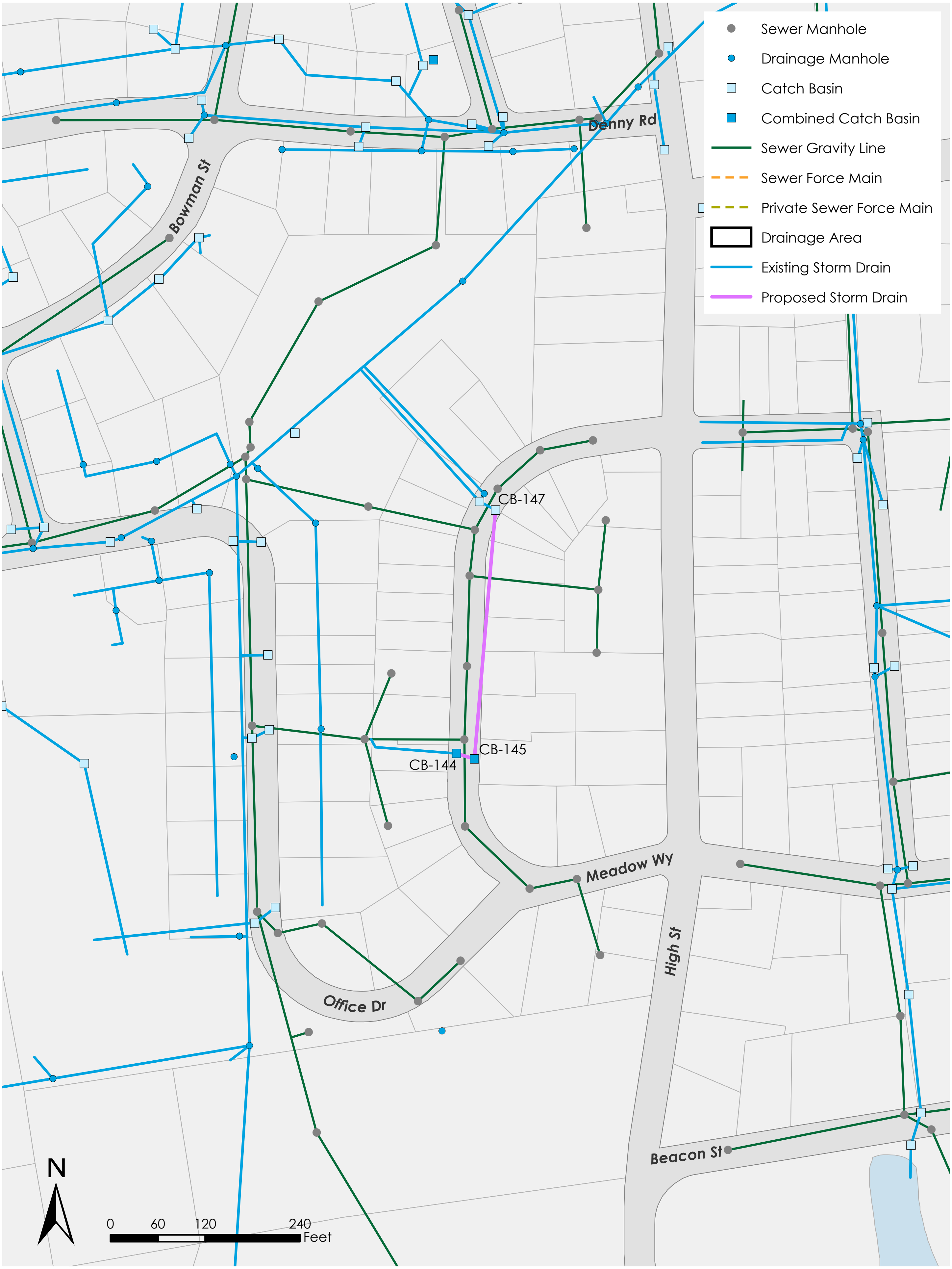

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Figure E-8 Harward Street CSO: Alternative 2 – Collection System Capacity Increase – Phase 2

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Figure E-9 Harward Street CSO: Alternative 2 – Collection System Capacity Increase – Phase 3

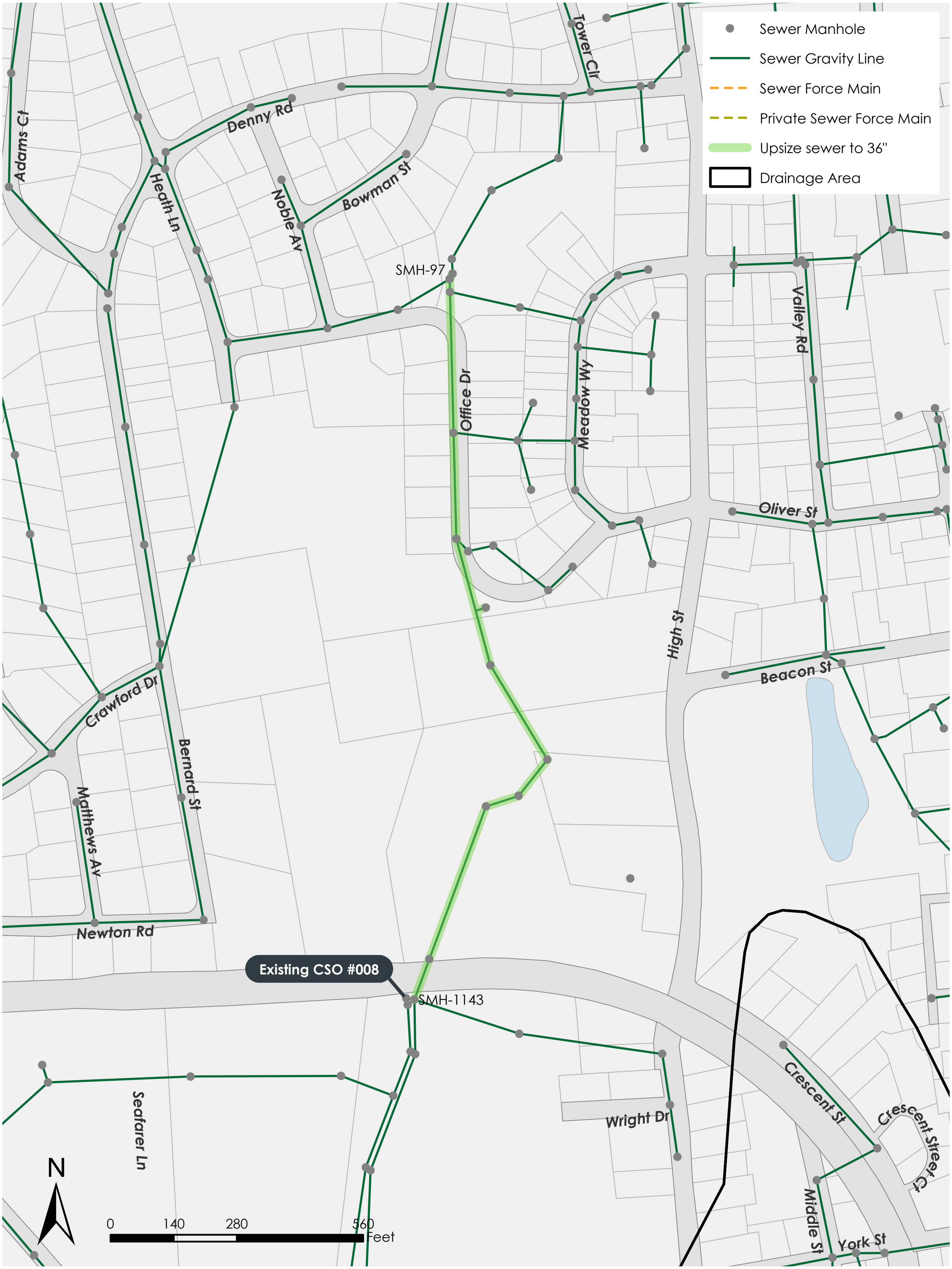

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Figure E-10 Harward Street CSO: Alternative 3 – New Sewer Pump Station

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Figure E-11 Harward Street CSO: Alternative 8 – Collection System Capacity Increases (Alt 2, Phase 1, and Phase 3), New Sewer Pump Station (Alt 3), and Relocate CSO #008 (Alt 4)

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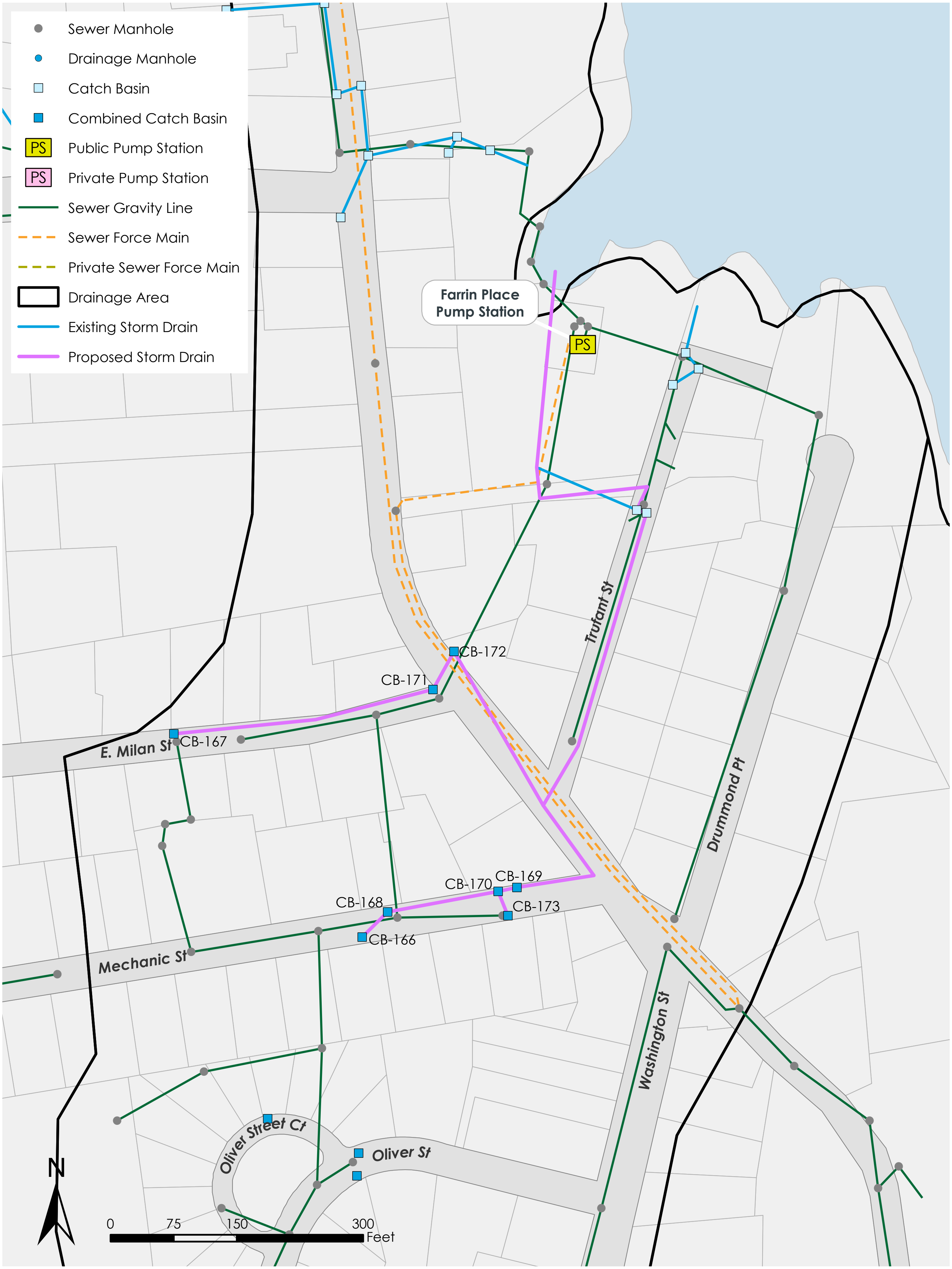
Figure E-12 Farrin Place: Alternative 1 – I/I Removal



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