Haverhill

Robert E. Ward, Deputy DPW Director
Water/Wastewater Division
Phone: 978-374-2382 Fax: 978-521-4083
rward@haverhillwater.com

February 22, 2017

Ms. Joy Hilton
U.S. EPA Water Technical Unit (OES04-3)
U.S. EPA - New England, Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

Subject: City of Haverhill, MA NPDES Permit # MA 0101621
Consent Decree Submittal (Civil Action No. 16-11698-IT)
Integrated Final Combined Sewer Overflow Long Term Control Plan

Dear Ms. Hilton:

Enclosed is a copy of the Integrated Final Combined Sewer Overflow Long Term Control Plan (FLTCP) required by Item VII N.55 of the above-referenced Consent Decree (CD).

Please note the FLTCP provides a cohesive plan which includes the system improvements recommended in the CMOM Assessment and Corrective Action Plan, and the Comprehensive Plant Evaluation which were submitted separately.

As discussed, the City's request (letter dated January 27, 2017) for an extension of time for these submittals to February 28, 2017 was approved. I want to thank you for the extension as it greatly improved the quality of the reports.

Enclosed is the certification statement required by paragraph 99 of the Consent Decree.

If you require additional information, please call me at (978) 374-2382.

Sincerely,

Robert E. Ward
Deputy DPW Director

Enclosure

cc: Chief, Environmental Enforcement Section, U.S. DOJ
Susan Poswistilo, U.S. Attorney, MA District
Michael Wagner, USEPA, wagner.michael@epa.gov
Kevin Brander, DEP, kevin.brander@state.ma.us
I. Andrew Goldberg, MA Assistant Attorney General, andy.goldberg@state.ma.us
Mayor James J. Fiorentini, City of Haverhill, mayor@cityofhaverhill.com
William Cox, City Solicitor, billcoxlaw@aol.com
Michael Leon, Nutter, McClennen & Fish LLP, MLeon@nutter.com
Mike Stankovich, DPW Director, mstankovich@cityofhaverhill.com
Paul Jessel, Wastewater, pjessel@haverhillwater.com
Fred Haffty, WWTP Facility Manager, fhaffty@haverhillwater.com

Certification Statement

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Robert E. Ward
Deputy DPW Director
City of Haverhill

2/22/17
(date)

City of Haverhill,
Massachusetts

Integrated Final Combined Sewer Overflow (CSO) Long-Term Control Plan and Supplemental Environmental Impact Report (EOEA #12088)

February 2017

CDM Smith

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List of Acronyms and Abbreviations

7Q10	Low-flow (7Q10) is the 7-day average low flow occurring once in 10 years
BOD	Biochemical Oxygen Demand
CCTV	Closed-circuit Television
CD	Consent Decree
CMMS	Computerized Maintenance Management System
CMOM	Capacity, Management, Operation and Maintenance
CPE	Comprehensive Plant Evaluation
CSO	Combined Sewer Overflows
CSS	Combined Sewer System
CWA	Clean Water Act
EIR	Environmental Impact Report
ENR	Engineering News Record
EPA	Environmental Protection Agency
FLTCP	Final Phase I CSO Long Term Control Plan
GIS	Geographical Information System
GLSD	Greater Lawrence Sanitary District
gpm	Gallons Per Minute
HFMP	Haverhill High (River) Flow Management Plan
HSPF	Hydrological Simulation Program—Fortran
I/I	Infiltration/Inflow
IDDE	Illicit, Discharge, Detection and Elimination
LRC	Little River Conduit
LTCP	Long-Term Control Plan
MA	Massachusetts
MADEP	Massachusetts Department of Environmental Protection
mg/l	Milligrams Per Liter
mgd	Million Gallons Per Day
MOUSE	Modeling of Urban Sewers
MPS	Marginal Pump Station
MRBC	Merrimack River Basin CSO Coalition
MS4	Municipal Separate Storm Sewer System
MS4s	Municipal Separate Storm Sewer System
NH	New Hampshire
NMC	Nine Minimum Control Measures
NPDES	National Pollution Discharge Elimination
NPS	Nonpoint Source
Org	Organisms Per Milliliter
O&M	Operations and Maintenance
PCC	Pre-stressed Concrete Cylinder
PCCP	Pre-Stressed Concrete Cylinder Pipe
PLC	Programmable Logic Controller
POTW	Publicly Owned Treatment Work
PS	Pump Station

SCADA	Supervisory Control and Data Acquisition
SSO	Sanitary Sewer Overflows
SWMM	Stormwater Management Model
TSS	Total Suspended Solids
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analyses
USACE	United States Army Corp. of Engineers
WASP	Water Quality Simulation Program
WQS	Massachusetts State Water Quality Standards
WWTP	Wastewater Treatment Plant
µg/L	Micrograms Per Liter
BMP	Best Management Practices
FOG	Fats, oil, and grease
DAF	Dissolved air floatation
UV	Ultra-violet
SMH	Sewer Manhole
MG	Million Gallons

Executive Summary

Haverhill, MA Integrated Final CSO LTCP

ES.1 Background

The city of Haverhill owns and operates a combined sewer system (CSS) that discharges untreated combined sewer overflows (CSOs) into the Little River and the Merrimack River periodically during rain events. Haverhill has completed a significant number of system improvements over the last 20 years to systematically reduce CSOs to address these regulations. However, the city is still obligated under state and federal regulations to develop a final plan to reduce untreated CSO discharges to a reasonable level.

On November 10, 2016, the U.S. District Court for the District of Massachusetts approved a final Consent Decree, filed by the U.S. Department of Justice (DOJ), against the city of Haverhill. The CD was negotiated by the DOJ, Massachusetts Office of the Attorney General, U.S. Environmental Protection Agency (USEPA), Massachusetts Department of Environmental Protection (MADEP) and the city. The CD required that the city complete additional assessment of the wastewater and stormwater collection system and wastewater treatment plant (WWTP) to meet other requirements of the federal Clean Water Act (CWA) and the Massachusetts Clean Waters Act, and to achieve and maintain compliance with the city's WWTP National Pollution Discharge Elimination System (NPDES) permit and its Small Municipal Separated Sanitary Stormwater System (MS4) General Permit under the federal Phase II Stormwater NPDES permit program. One of the remedial measures is the completion and submittal of this FLTCP.

The city engaged a team of consulting engineers to complete a set of detailed facility assessments to address these regulatory requirements and to identify necessary system improvements. Based on these recommendations, Haverhill developed an integrated implementation plan to complete the system improvements required to address the city's wastewater and stormwater discharges to the nearby receiving waters.

ES.2 Existing Wastewater System

Haverhill, through its Wastewater Division, owns and operates a wastewater treatment plant (WWTP) and sewer and storm collection systems. Wastewater collected throughout the city is conveyed to the WWTP by its interceptor piping network.

The sewer collection system is comprised of separated and combined sewersheds. Separated sewersheds, primarily located outside of the densely populated downtown areas, only convey sanitary flow. Stormwater is conveyed through a separate pipe network that discharges directly into a receiving water body. Combined sewersheds convey both stormwater and sanitary flow through the same pipe network. Dry weather flow and a portion of the wet weather flow are conveyed to the WWTP and excess wet weather flow is discharged out of the CSO outfalls.

Haverhill's combined sewer system currently has 15 CSO regulators/structures that are connected to 13 outfalls. Of the 13 outfalls, five discharge to the Little River, and eight discharge to the Merrimack River.

The WWTP is located off of South Porter Street. It provides primary treatment, secondary treatment and disinfection of wastewater prior discharging it through an outfall to the Merrimack River. The WWTP has an average day design capacity of 18 million gallons per day (mgd) and a peak wet weather flow capacity of 65 mgd. During wet weather event, as much flow as possible is passed through secondary treatment and the remaining wet weather flow is bypassed to protect the secondary process/system.

ES.3 City's CSO Abatement Progress

As noted above, the city has been making progress on abatement of its CSO discharges for more than 20 years.

Phase I CSO Abatement Program

In August 2002, a Final Phase I CSO Long Term Control Plan (FLTCP) was submitted to the EPA and the Massachusetts Department of Environmental Protection (MADEP). The work to prepare this plan began several years earlier. The recommended CSO control plan included improvements to increase treatment capacity at the WWTP, influent pump station upgrades to handle additional wet weather flow and regulator modifications to the five Bradford-side CSOs on the south bank of the Merrimack River.

The improvements were implemented by 2006. The Phase I CSO Abatement Program improvements reduced the annual CSO volume discharged to 30 million gallons and increased wet weather flow capture to 97 percent.

Phase II CSO Abatement Program

In June 2013, the city submitted its Revised Phase II CSO Long Term Control Plan (LTCP) for CSO abatement to the EPA and MADEP. The plan documented the effectiveness of Phase I CSO controls and improvements and recommended a plan to continue to address the remaining CSOs. The Revised Phase II Plan included the permanent closure of 13 CSOs, raising of weirs at three CSO regulators, and implementation of the Wet Weather System Maximization/CSO Structure Modifications project (CSO regulator modifications, a new diversion sewer, and installation of a real-time automated flow control system) to further increase CSO discharge control.

These system improvements will be completed by March 2017 as required by the November 2016 CD and will reduce the annual CSO volume discharged to approximately 20 million gallons and increase wet weather flow capture to about 98 percent.

ES.4 CSO Regulatory Compliance

ES.4.1 Regulations

CSO discharges to the waters within the Commonwealth of Massachusetts have to meet the requirements of the federal Clean Water Act (CWA) and the state's Surface Water Quality Standards (WQS). Both the federal and state governments have developed separate, but similar, CSO control policies to guide the abatement of CSO discharges given the technical, social, and economic challenges for each community. Under the federal CSO policy, CSO discharges must ultimately meet state water quality standards.

In Massachusetts, under the NPDES permit, CSO discharges must comply with the Surface Water Quality Standards (314 CMR 4.00). The Little River is designated a Class B river and the Merrimack River is designated as both a Class B (upstream of the Little River) and Class SB river (downstream of the Little River). Under these classifications, CSOs must either be eliminated or the rivers need to be reclassified, or a variance or partial use designation must be granted, to allow for continued excursions of water quality standards resulting from CSO discharges. If the classification of these rivers is revised to include the CSO designation (i.e., Class B_{CSO} or SB_{CSO}) under the State's CSO Policy, the CSOs may remain but must be compatible with the water quality goals (i.e., overflows must not occur more than 4 times per year or a 3-month design storm control level).

ES.4.2 Compliance

Haverhill's FLTCP controls CSO discharges to the 3-Month design storm. The FLTCP results in a CSO discharge frequency of four times per year on average, which meets the B_{CSO} water quality classification and MADEP CSO Control policies for the river (downstream of Haverhill based on Haverhill CSO impacts).

There are other sources of pollution along the river from other community CSOs, stormwater, and other non-point sources that impact the river water quality. USEPA CSO policy and program manuals state that a review of receiving water quality standards and use objectives by state agencies, involving all stakeholders along the rivers, is the necessary step in the setting of appropriate, reasonable, and attainable river goals that will help guide the development and implementation of CSO LTCPs and watershed initiatives.

Any further implementation of CSO abatement controls, beyond this FLTCP, by the city of Haverhill should be subject to a comprehensive watershed assessment to ensure that the city's further investment will be realized in further use attainment consistent with the objectives of the river stakeholders. Because the City's FLTCP will achieve such substantial reductions in its remaining CSO amounts, it is expected that further improvements in the water quality of the Merrimack can be achieved by upstream reductions in wet weather flows, as well as reductions in non-point pollutant loading.

ES.5 CSO Abatement Improvements Alternative Analysis

A full range of potential CSO technologies and abatement strategies were examined based on current CSO control approaches used in other communities and based on the approach recommended in the USEPA guidance manual for the development of an LTCP. Each technology/strategy was examined as to its ability to control the quantity or quality of the CSO discharges to meet water quality standards. The report summarizes each of these candidate technologies and strategies and identifies the most feasible ones that could be implemented for CSO control in the city.

The range of alternatives included No Action, Complete elimination of CSOs and Intermediate Design Control. Intermediate control levels are based on the design control levels recommended in the USEPA guidance manual for developing LTCPs. Comprehensive system investigations and flow metering at the CSO outfalls were used to calibrated the Stormwater Management Model (SWMM) of the interceptor pipe network and CSO regulators. The calibrated SWMM model was used to develop and assess each of these alternatives.

No Action

The No-Action alternative is to continue with the present system without structural modifications for CSO control. The city could continue with its current level of spending on Best Management Practices, such as for street sweeping and catch basin cleaning, public education, and system maintenance activities. I/I reduction programs would also continue.

Haverhill would continue to capture and treat approximately 98 percent of wet weather flow annually and annual CSO volume would remain at about 20 MG per year. With this plan, the city would not incur any additional costs.

Complete Elimination of CSOs

Complete elimination of CSO discharges is the only permanent solution to CSO control that does not involve changing the water quality classification of receiving water bodies. The USEPA typically considers complete separation of the combined sewer system to be equivalent to complete elimination. Sewer separation involves constructing a new collection system so that the wastewater and stormwater will be two separate piping systems.

In Haverhill, SWMM modeling showed that traditional sewer separation may not completely eliminate all CSO discharges. A typical sewer separation project is only 80 percent effective at removing wet weather flow; 20 percent of the wet weather flow (mostly from private inflow) would continue to enter the sewer system. To completely eliminate CSO discharges in Haverhill, the city would have to identify and remove sources of private inflow or construct CSO storage facilities. Further, it has been recognized that even well-controlled wet weather discharges from separated systems continue to introduce bacterial and nutrient loads in the receiving waters, making sewer separation less than completely effective.

Intermediate Design Control

Complete elimination of CSOs represents a financial burden for any community. Intermediate control alternatives are based on the six design control levels (i.e., 1-Month, 3-Month, 6 Month, 1-year, 2-year, and 5-year) recommended in the USEPA guidance manual for developing LTCPs.

For each intermediate design storm control level, a set of alternatives - using storage facilities, CSO regulator modifications, and sewer separation - were evaluated. System-wide improvement programs were also considered to either achieve individual CSO control for each of the control levels or to supplement the control level. The least cost alternative for each control level was identified.

The CD requires that “the city shall screen an appropriate range of technologies for eliminating, reducing, or treating CSOs, including alternatives that will reduce the number of untreated CSOs down to a range of overflows per CSO outfall per year (such as 0, 1 to 3, and 4 to 7).”

The design storms used in this report for analyses correspond to the CD stipulation on the range of overflows per CSO outfall per year as follows:

2017 Consent Decree	LTCP
4 to 7 CSOs per year	3-Month Design Storm
1 to 3 CSOs per year	6-Month Design Storm and 1-Year Design Storm
0 CSOs per year	5-Year Design Storm or Complete Elimination

SWMM simulations were completed for each of the cost-effective design control level plans to determine the annual average CSO reduction achieved by each plan.

Development of the FLTCP

A comparison of the range of CSO control plans (with system improvements designed to achieve each level of control discussed above) showed that an appropriate level of CSO control in Haverhill was the 3-Month Control Level. The comparison showed that spending more to achieve a higher level of control did not result in any appreciable improvement in water quality or likely river uses.

Accordingly, Haverhill's FLTCP controls CSO discharges to the 3-Month design storm. The Final LTCP results in a CSO discharge frequency of four times per year on average, which meets the B_{CSO} water quality classification and MADEP CSO Control policies for the river.

ES.6 Integrated Implementation Plan

ES.6.1 Integrated Implementation

The implementation schedule for the Integrated FLTCP was developed to balance CSO control with other system priorities. Table ES-1 (page ES-7) summarizes the components and implementation schedule for Haverhill's Integrated FLTCP. The plan consists of an expenditure of $56.3 million in system improvement and maintenance projects over 13 years. The implementation plan targets improvements in each of the city's regulatory compliance initiatives. This represents the city's commitment to addressing the requirements of the November 2016 CD (with the exception of the odor control plan, which is not included in the CD).

The city has adopted a 13-year implementation period for the Integrated Plan. This schedule is necessary to allow the city to effectively assess the phased implementation of its recommended system improvements so that efficiencies and potential overall plan cost reductions can be realized. WWTP and collection system improvements that are being implemented earlier in the program may help to reduce CSO discharges. A shorter implementation period will not allow the city to recognize any potential synergies in the overall program and may result in unnecessary spending. In addition, a shorter implementation schedule creates a significant undue financial hardship on the rate payers with the lowest income levels in Haverhill, as discussed in Section 10.

The WWTP Improvements program is one of the highest priorities in this Integrated Plan to ensure that the WWTP continues to function reliably to meet its NPDES permit requirements and maximize wet weather treatment (to minimize CSO discharges). Sewer system rehabilitation and sewer pump station replacement programs in the CMOM program are also high priorities to minimize extraneous flow in the system and to avoid SSOs. These improvements will also result in additional CSO control. Finally, the SEP program is part of the CD and will be completed as part of the Integrated Plan.

For CSO control, the city will initiate immediate improvements to the combined sewer system at five CSO regulators (Middle Siphon, Bethany Avenue, Chestnut, South Webster, and Middlesex CSOs) to control these CSOs to a discharge frequency of 4 times per year. In addition, the city will optimize its real-time control system to help minimize CSO discharges to a 3-Month control level, which will take several operational seasons of evaluation and adjustment. The city expects that there may be unanticipated CSO reduction benefits at the remaining CSOs that can be achieved by the real-time control system. Accordingly, the city intends to start the Locke Street Interceptor Area Preliminary Design phase after the system is optimized and remaining CSO discharges are minimized before starting to address the last "uncontrolled" CSO discharges in the system.

The 13-year implementation period will begin when the city receives approval of the CD documents and integrated plan.

ES.6.2 Other Wastewater Division Compliance Programs

ES.6.2.1 WWTP Improvements

As discussed in Section 8, the city will complete upgrades to the activated sludge system to rehabilitate the aeration system to improve the reliability of the secondary treatment system, especially during wet weather events, when flows and loads significantly increase. This will help to provide consistent treatment, during wet weather conditions, to meet the NPDES permit limits for BOD and TSS. Under this project, the city will also implement its odor control system improvements in an iterative approach (as discussed above) achieve reasonable mitigation of odors at the facility. Finally, the city will evaluate its disinfection process, conduct further testing, and make repairs or improvements, as necessary, to improve compliance with the NDPES permit limit for Enterococci.

The city expects to implement these facility improvements in one or two construction contracts over the 13-year implementation period.

ES.6.2.2 CMOM Program

The CMOM Corrective Action Plan provides a number of system recommendations that the city should perform to enhance its operational and maintenance programs. These are included in the Miscellaneous CMOM Program Updates and discussed further in the CMOM Program Assessment and Corrective Action Plan (submitted under separate cover). The city will complete this program in five years. To improve system maintenance and to identify future sewer pipe rehabilitation needs, the city will initiate a program to perform CCTV inspections (and pipe cleaning) and sewer manhole inspections (SMH). The city has identified about $6 million in high priority sewer pipe and sewer manhole replacement or rehabilitation needs. This work will be completed in several construction contracts over the 13-year period.

Table ES-1 Integrated Final LTCP

Project	Estimated Project Cost	Fiscal Year (after EPA approval of City's Integrated Plan) 1	2	3	4	5	6	7	8	9	10	11	12	13
Phase I WWTF Improvements (NPDES Compliance Requirements)														
Secondary Treatment Improvements	$24,700,000													
(aeration improvements,replacement of RAS and influent gates, electrical, new RAS pumps and piping, primary clarifier improvements)														
Disinfection Efficiency Evaluation and System Repairs	$500,000													
Subtotal	**$25,200,000**													
CMOM Programs														
Miscellaneous CMOM Program Updates	$445,000													
Gravity Sewer CCTV and SMH Inspection ($100k/annual)	$1,300,000													
Sewer System Rehabiliation to Reduce I/I	$6,000,000													
Pump Station Reh/Replacement/SCADA (2 stations)	$1,300,000													
Subtotal	**$9,045,000**													
CSO Control Plan (3 Month)														
System Conveyance Improvements	$1,100,000													
(Cleaning of Upper, Middle, and Lower Sipons and Middle/Essex Street Interceptor and Bradford Interceptor, downstream of Middle Siphon)														
CSO Structure Dry Weather Connector Pipe *(Bethany, Chestnut, Middlesex, South Webster)*	$1,000,000													
Raise Middle Siphon weir	$40,000													
Post Construction Monitoring & System Optimization	$300,000													
Green Infrastructure Demonstration Projects	$500,000													
Locke Street Area Preliminary Design	$1,200,000													
(Evaluate Locke Street control options of storage versus sewer separation, additional monitoring and modeling)														
Locke Street Area Improvements *(currently Duncan Street Relief Pipe and Locke Stree Storage)*	$11,600,000													
Subtotal	**$15,740,000**													
Stormwater Program														
Stormwater Compliance (Revised Master Plan/Public Ed)	$150,000													
Stormwater Annual Reporting ($35k/year)	$455,000													
Illicit Discharge Detection Elimation Program Investigatior	$1,000,000													
Removal of Illict Connections	$2,000,000													
Construction Site Pre- and Post-Monitoring ($20k/yr)	$260,000													
Catch Basin Cleaning ($100k supplemental)	$1,300,000													
Street Sweeping ($23k supplemental)	$300,000													
Subtotal	**$5,465,000**													
Supplemental Environmental Project Program (SEP)														
River bank improvements	$866,000													
Grand Total	**$56,316,000**													

Design

Construction

Finally, the city identified the sewer pumping stations that will eventually need to be replaced or rehabilitated to address aging infrastructure and increasing maintenance needs. The city proposes to replace two pumping stations – the Carlton Pump Station and the North Avenue - within the first 4 years of the program. These stations are a high priority based on their continued and increasing maintenance needs.

ES.6.2.3 FLTCP

Haverhill developed this Final Long-Term CSO Control Plan (FLTCP) based on a comprehensive system assessment and alternatives analysis. Under the Integrated FLTCP, the city will complete a variety of system improvements that reduces the annual average frequency of CSO discharges to four times per year (3-Month Level of Control), which meets the B_{CSO}/SB_{CSO} Massachusetts Water Quality Standard (WQS) classification for the two rivers. It is anticipated that the FLTCP will cost approximately $16 million.

Specifically, the city will complete the following improvements:

- Clean the Upper, Middle, and Lower Siphons, Middle Siphon Interceptor (from Locke St to Middle Siphon) and Bradford Interceptor (downstream of Middle Siphon) to increase capacity and improve conveyance to the south side and the WWTP;
- Modify the dry weather connector pipe between the interceptor and four CSO regulators (Bethany Avenue, Chestnut Street, Middlesex Street, and South Webster CSOs) to increase wet-weather flow conveyance into the interceptors;
- Raise the regulator weir at the Middle Siphon CSO regulator to minimize CSO discharges;
- Complete post-construction monitoring & system optimization to ensure the successful implementation of the FLTCP;
- Implement a green infrastructure demonstration project; and
- Complete the preliminary design, final design, and construction for either separating combined sewer area and/or construct a storage facility in the Locke Street Interceptor area to reduce CSO discharges at the Lock Street Center Barrel and Winter & Hale CSOs.

The FLTCP projects will reduce annual average CSO discharges to about 11 MG per year and increase wet weather flow capture to 98.4 percent.

Haverhill's level of control will continue to be significantly better than the CSO control achieved in most of the upstream Merrimack River CSO communities.

ES.6.2.4 Stormwater Program

The stormwater program includes the city's costs for compliance activities related to the 2003 NPDES MS4 Stormwater Permit, stormwater requirements included in the CD, and anticipated costs to prepare for the 2017 MS4 Stormwater Permit. The city will have to update its Stormwater Master Plan as part of its Notice of Intent filing in 2017 for the new stormwater permit. There are also an increased number of annual stormwater report documents that have to be prepared for the CD and the new stormwater permit.

The city has initiated its Illicit Discharge Detection and Elimination Program Investigations based on the 2016 Dry Weather Stormwater/CSO Outfall Inspection Program. The city will have to continue this program, which requires a very comprehensive system investigation and sampling approach to identify the illicit sources of stormwater system pollution. The city is also budgeting about $2 million in anticipated costs to make sewer or storm system repairs, as necessary, over the next six years to remove illicit connections.

The CD and 2003 NPDES Stormwater permit require the city to adopt construction site stormwater mitigation and inspection procedures. The stormwater program budget includes the costs of these additional programs that the city will have to perform.

Finally, the city is committed to improving its catch basin cleaning and street sweeping programs to improve the quality of stormwater runoff from its system, reduce the pollutant discharges in the CSOs, and to remove floatables in stormwater and CSO discharges.

ES.6.2.5 Supplemental Environmental Project Programs (SEP)

The CD requires the city to complete a SEP program as part of its negotiated settlement. The city is proceeding with a river bank restoration program along the Merrimack River near the city's Riverside Park. This will be completed in about 2 years.

ES.7 Affordability and Rate Impacts

The CD requires the city to evaluate the impact of the integrated plan on the sewer rates and consider its affordability based on USEPA Affordability Guidelines. A comprehensive affordability analysis of the rate impacts of the complete of this plan is attached to this document.

The 13-year implementation plan was specifically developed based on the city's intention to:

- to have a spending and financing schedule that would moderate the rate increases faced by the lower income segments of the Haverhill rate-paying community, and maintain the total rate burden on this segment of the public to remain within the guidance developed by USEPA.
- have a reasonable program of system improvements that could be implemented in a phased approach that could be practically coordinated by city staff; and
- optimize system improvements, allowing the city to evaluate the benefits achieved in the preceding programs, and to make adjustments to future programs and system improvements to meet the needs of the city.

Overall the city's Integrated Plan will approximately result in the average annual household sewer bill increasing by more than double the existing bill over 20 years from $343 to $751. This program must be supported by 12 percent annual rate increases for the first 12 years and 8 percent annual rate increases thereafter.

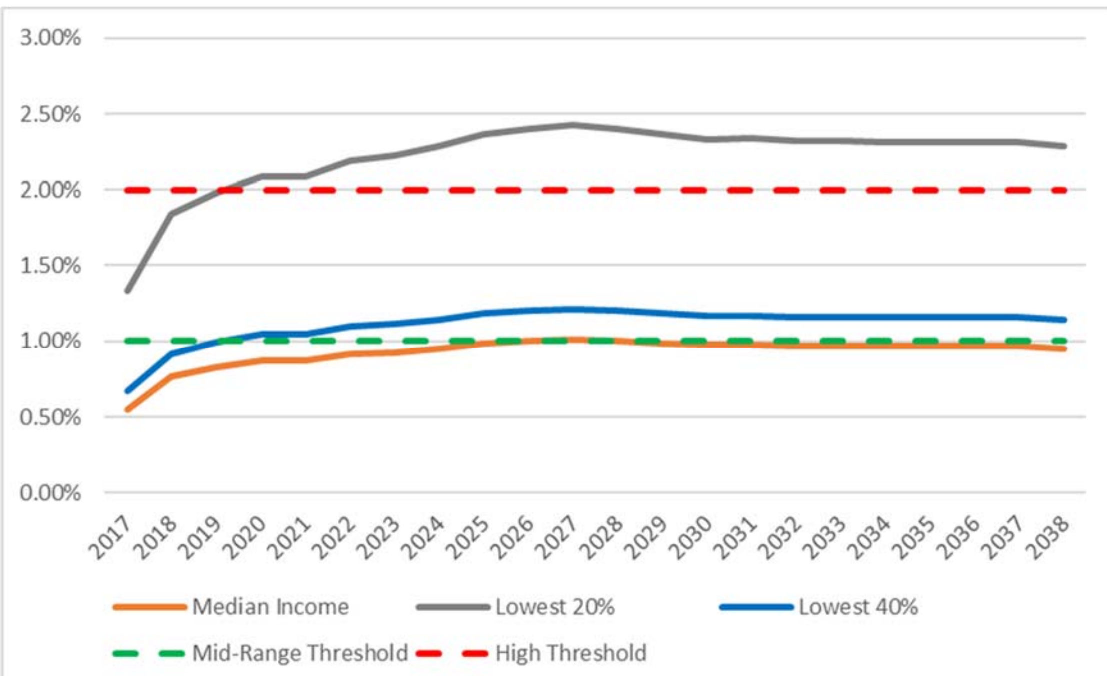
The USEPA measures sewer rate increases based on a percentage of median household income to determine the "relative burden" on the average household in a community for wastewater and stormwater capital expenditures. In relative terms, according to the USEPA, the city's program would not be a significant burden to households in the city (i.e., it does not exceed 2 percent of median household income). However, the USEPA's measure household burden estimates the long-term impact of the Integrated Capital Plan on a typical residential customer, assuming median household income. However, for the lower-income residents of the city, the increased sewer bills will have a greater relative impact on their ability to pay for basic services.

Figure ES-1 shows the estimated household burden on the lowest income residents, using the lowest quintile income levels. At the lowest quintile income level, approximately 20 percent of Haverhill households have an income of less than $25,000. The next quintile income level is $50,000, meaning that 40 percent of the households in Haverhill have an annual income less than $50,000.

Within this context, the impact of the recommended program on the residents with the lowest quintile income level results in a residential burden over the 2 percent threshold. These residents will exceed the 2 percent within the first 4 years of the program and will exceed 2.4 percent in the first 10 years.

Focusing solely on the burden at the median income level in Haverhill provides a misleading view of the ratepayers' ability to proceed with any program, as the burden of the anticipated costs of the FLTCP will have very substantial impacts on those households in the city with the least means to afford basic food and shelter needs.

Figure ES-1: Comparison of Projected Residential Indicator – Income Levels



In addition, this affordability assessment does not consider the household impact of future tax and rate burdens for other non-sewer/stormwater expenditures. The Department of Public works alone is expected to increase the burden on the city residents to pay for a comprehensive water treatment plant improvements project ($41 million), water transmission main improvements, water supply, and significant landfill closure costs.

ES.8 MEPA (EOEA No. 12088) History

In November 1999, the city filed an Environmental Notification Form (ENF) with the Massachusetts Environmental Protection Agency (MEPA) Unit of the Executive Office of Energy and Environmental Affairs (EEA) for its Phase I Long-Tern CSO Control Plan. The file number assigned to the project was EOEA No. 12088. MEPA determined that the project required the preparation of an Environmental Impact Report (EIR) (Certificate issued on December 23, 1999).

Subsequently, the city completed its Draft (Phase I) Long-Term CSO Control Plan and Draft EIR. The original Draft EIR was submitted to MEPA on October 15, 2000. The EIR has undergone several reviews by MEPA and several revisions to reflect updates and revisions of the city's long-term CSO abatement program as the city has progressed in its implementation of the plan. This document is Haverhill's Final LTCP and the city prepared a Supplemental EIR (SEIR) to be submitted with this FLTCP.

It is important to note that, based on a review of MEPA's regulations, the city's FLTCP would not exceed any of the review thresholds listed in 301 CMR 11.03. Therefore, MEPA review may not be required for the current set of improvements included in this FLTCP. The MEPA review applicability status for this project has changed as MEPA regulations and the city's CSO control plan components and complexity have changed. The city is planning to use State Revolving Funds (SRF) for the design and construction of the Integrated FLTCP.

Accordingly, an SEIR (Section 11) is being submitted to address MADEP requirements. It is fully expected that, upon review of the current project recommendations, that MEPA should be in agreement that this project no longer triggers a requirement for an EIR.

The SEIR describes the impacts associated with the Integrated FLTCP as well as impacts for the alternatives considered when selecting the Integrated FLTCP. Mitigation measures necessary to avoid and minimize these impacts are also discussed in Section 11.

Section 1

Introduction

1.1 Background

1.1.1 General

The city of Haverhill, Massachusetts owns and operates a sewer collection system that is comprised of sanitary sewers (with separate drainage piping systems for city catch basins) and combined sewers (with single pipes that convey both sewer and drain flow).

Historically, a combined sewer system (CSS) was a nationally accepted engineering standard for the design of sewerage and drainage facilities in cities in the United States. It was believed that dual-purpose (combined) pipes would result in more manageable and cost effective urban collection systems. The single pipe system was designed to convey peak sanitary flow to the wastewater treatment plant (WWTP), while excess wet weather flow, during rainstorms, was designed to discharge into receiving waters as Combined Sewer Overflows (CSOs).

Although this design approach was widely accepted years ago, more recently, federal and state regulatory agencies have placed increasing restrictions on these discharges and engaged communities in enforcement actions to bring CSO discharges under control in compliance with the Clean Water Act (CWA) and the Commonwealth of Massachusetts receiving water quality standards.

Over the last 20 years, Haverhill has worked diligently on planning and implementation of effective CSS improvements that have resulted in significant reduction of the frequency and volume of the city's annual CSO discharges. To achieve these goals, the city has expended over $34 million.

This Integrated Final CSO Long Term Control Plan (Integrated FLTCP) meets the regulatory objectives for CSO abatement.

1.1.2 Regulatory Requirements

In 1994, the Environmental Protection Agency (EPA) issued its National CSO Control Policy (Policy) through the National Pollution Discharge Elimination (NPDES) permit program in support of the requirements of the Clean Water Act (CWA). The Policy established a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities, and the public engage in a coordinated planning effort to develop and implement cost-effective CSO controls that ultimately meet appropriate environmental and health objectives. The Policy mandated that each CSO community develop and implement a Long-Term Control Plan (LTCP) to eliminate or reduce untreated CSO discharges to the nation's waterways.

The Commonwealth of Massachusetts adopted its own CSO Control Policy in August 1997. Massachusetts communities must adhere to these regulations in the development of the CSO

Control Plan, including meeting the Massachusetts Surface Water Quality Standards (314 CMR 4.00), which have specifically adopted a minimum frequency goal for CSO control in the state.

1.2 Haverhill's Regulatory Compliance Progress

1.2.1 Phase I CSO Abatement Program

In August 2002, a Final Phase I CSO Long Term Control Plan (FLTCP) was submitted to the EPA and the Massachusetts Department of Environmental Protection (MADEP). The recommended plan included improvements to increase treatment capacity at the WWTP, influent pump station upgrades to handle additional wet weather flow, and regulator modifications to the five Bradford-side CSOs on the south bank of the Merrimack River.

Specifically, these improvements included:

- Primary settling tank modifications to ensure that process equipment is reliable and capable of treating existing, future and wet weather flows as effectively as possible;
- A new grit removal facility to provide more reliable operation of the primary settling tanks and associated sludge removal equipment during wet-weather conditions;
- Upgrades to the separate WWTP influent pumping station and installation of a new modulating control gate to allow for an increase in plant wet-weather flow to approximately 60-mgd;
- Miscellaneous plant improvements including a new secondary bypass conduit and associated control gates, instrumentation, and separate disinfection diffuser in the bypass conduit; and
- Miscellaneous improvements at the Bradford-side CSO regulators to reduce CSO discharges. These improvements included modifications to the Front Street, Middlesex Street, South Main Street, Ferry Street, and South Prospect Street CSO structures.

The benefits of the Phase I CSO Abatement Program improvements included a modeled reduction of annual CSO volume from 70 million to 30 million gallons and an increase of the Percent Capture of wet weather flow from 92 percent to 97 percent.

These improvements were all implemented by 2006.

1.2.2 Haverhill's Phase II CSO Abatement Program

On September 15, 2008 and February 9, 2009, the EPA issued Administrative Orders (AOs), Docket No. 08-012 and Docket No. 09-014, respectively, to the city requiring completion of a Phase II Long-Term CSO Control Plan in conformance with the EPA's 1994 Combined Sewer Overflow Policy. It required the city to perform sewer system inspections, update the city's current Geographical Information System (GIS); incorporate Capacity, Management, Operation and Maintenance (CMOM) program assessments into CSO planning, perform flow monitoring of its collection system and update the existing Stormwater Management Model (SWMM) to help identify the frequency of CSOs, characterize the impacts of the remaining CSOs, and identify alternatives for abating CSOs. The Phase II report was to include a proposed schedule for implementing the preferred alternatives to address the remaining CSOs, a financial analysis on the recommended plan, and a Draft Environmental Impact Report (EIR) of the recommended plan.

In July 2011, the city's Phase II CSO Long Term Control Plan (LTCP) for CSO abatement was submitted to the USEPA and MADEP. As required by the AO, this plan documented the effectiveness of Phase I CSO controls and improvements and recommended a plan to address the remaining CSOs. The regulatory agencies provided comments to the plan in early 2013. The city responded to the comments with a Revised Phase II Plan on June 2013, which increased the scope of the LTCP to include a new set of system improvements designed to further increase CSO discharge control.

The following system improvements were included in the Revised Phase II CSO Abatement Plan:

- Closing and eliminating thirteen (13) CSO regulator/outfalls (bricked-up) that were inactive based on the SWMM model simulations;
- Raising the weir elevations at five of the remaining CSO regulator/outfalls to minimize CSO discharges;
- Increasing the size of the interceptor connector pipe at the Bradford Avenue CSO regulator;
- Elimination of the Marginal PS Regulator/CSO by the installation of a new sewer pipe to direct flow around the Marginal Street Pumping Station into the Middle Siphon inlet structure;
- Installation of temporary/permanent CSO flow meters at up to seven key CSO outfalls;
- Continued implementation of the Nine Minimum Controls as outlined in the CDM report entitled "City of Haverhill, Massachusetts Wastewater Division Draft Report on Nine Minimum Control Measures for CSOs" dated September 1996; and
- Continuing as an active participant in the Merrimack River Initiative and sharing in the costs necessary to ensure that a comprehensive, scientifically accurate assessment of river pollution sources is completed.

Most of these system improvements have already been implemented and will be fully completed by March 2017. The improvements should reduce annual CSO volume to approximately 20 million gallons, eliminate or reduce the frequency of CSOs from a number of outfalls, and increase the Percent Capture of wet weather flow to about 98 percent.

1.2.3 Consent Decree

In early 2014, the city of Haverhill received notice that the U.S. Department of Justice (DOJ), Massachusetts Office of the Attorney General, USEPA, and MADEP wanted to discuss enforcement actions against the city regarding alleged non-compliance with its NPDES permit for the WWTP and the requirements related to CMOM, Sanitary Sewer Overflows (SSO), CSO abatement and NPDES Municipal Separated Storm Sewer System (MS4) Phase II Stormwater policies. Over the next two years, the city negotiated a Consent Decree (CD) with the governments that provides an implementation plan and schedule to address the alleged non-compliance issues.

On August 19, 2016, the DOJ filed the CD with the U.S. District Court for the District of Massachusetts. The CD requires the city to undertake measures necessary to meet the requirements of the federal CWA and the Massachusetts Clean Waters Act, and to achieve and maintain compliance with the Small MS4 General Permit and the NPDES Permit.

The CD required the completion of the following remedial measures:

- Complete dry-weather MS4 stormwater/CSO outfall inspections;
- Submit a revised Illicit, Discharge, Detection and Elimination (IDDE) Plan and complete IDDE investigation of the stormwater catchment areas;
- Develop an IDDE enforcement manual, adopt city ordinance prohibiting non-stormwater discharge to the stormwater system, eliminate all known sources polluting the stormwater system and remove verified illicit discharge connections;
- Adopt city ordinance requiring sedimentation & erosion control at construction sites and develop and implement construction site inspection and enforcement program;
- Adopt city ordinance requiring post-construction stormwater management;
- Implement operation and maintenance practices to prevent and mitigate sanitary sewer overflows (SSO) and report SSO occurrence promptly;
- Submit an updated assessment of the collection system CMOM practices;
- Submit a CMOM Corrective Action Plan;
- Develop and submit an SSO Emergency Response Plan;
- Submit best available Geographic Information System (GIS) Map;
- Upgrade sludge dewatering equipment;
- Submit an updated O&M Manual for the Wastewater Treatment Plant;
- Submit a Comprehensive Plant Evaluation (CPE) for the WWTP;
- Start continuous monitoring of CSO outfalls and submit CSO activation reports to EPA and MADEP;
- Raise CSO regulator weirs and complete construction of the Wet Weather System Maximization & CSO Structure system improvements as recommended in the 2011 Phase II LTCP, and complete investigation of the Bethany Avenue CSO; and
- Submit a Final CSO LTCP Report.

The final Consent Decree, approved by the US District Court on November 10, 2016, is included in Appendix A.

Each of these actions or documents has a unique deliverable date. The city has already submitted documentation that it has complied with the flow metering and MS4/CSO dry-weather outfall inspections, and has completed the WWTP solids processing improvements.

1.3 Purpose of the Integrated FLTCP

The purpose of this report is to summarize the city of Haverhill's system investigations, alternatives evaluation, and proposed plan to further minimize CSO discharges in compliance with the November 10, 2016 CD, 1994 USEPA CSO Policy, 1997 MADEP CSO Policy and the Massachusetts State Water Quality Standards (WQS). Paragraph 55 (under Paragraph VII. Remedial Measures) in the CD requires this report to be submitted by January 31, 2017, which was subsequently revised, by letter, to February 28, 2017.

Other CD requirements for study, evaluation, planning, and reporting are being addressed concurrently with this report and will be submitted under separate cover within the timeframes required by the CD.

This Integrated FLTCP includes an implementation schedule that meets all of the city's wastewater and stormwater permit regulatory objectives.

1.4 Report Organization

This report is organized into ten sections as follows:

- Section 1 – Provides an introduction to the history and purpose of this study;
- Section 2 – Describes the existing collection system, pump stations and WWTP;
- Section 3 – Describes the progress the city has made in CSO abatement;
- Section 4 – Summarizes updates made to the SWMM model;
- Section 5 – Evaluates water quality impacts related to Haverhill's CSOs;
- Section 6 – Examines available CSO abatement technologies and determines those best applicable for development of Haverhill's CSO control alternatives;
- Section 7 – Provides an alternatives analysis of viable CSO abatement alternatives;
- Section 8 – Discusses other wastewater division programs necessary to meet regulatory and permit objectives
- Section 9 - Presents the city's proposed Integrated FLTCP program with an Implementation schedule;
- Section 10 – Presents the financial Affordability Analysis of the Integrated FLTCP;
- Section 11 – Presents the Supplemental Environmental Impact Report (EOEA # 12088) to present the environmental performance and benefits associated with the proposed FLTCP program.

Section 2

Existing System

2.1 General

Haverhill owns and operates the wastewater collection and treatment and stormwater drainage systems within the city's corporate boundary. The city also provides treatment to sewer flow from Groveland.

Haverhill has completed a substantial number of improvements to its combined sewer system and WWTP over the last 20 years to reduce CSO discharges. These improvements are discussed in Section 3. This section provides an overview of Haverhill's existing wastewater collection system and treatment facilities and discusses some of the system investigations (including Infiltration/Inflow reduction investigations) that have been conducted for this report.

The wastewater collection and drainage systems are operated in compliance with the Nine Minimum Control Measures, 2003 Phase II MS4 Stormwater General Permit, and 2008 NPDES/WWTP (POTW) Permit (MA0101621).

The existing collection system and wastewater treatment plant were evaluated in three different reports focusing on functional areas. In addition to this report, Woodard and Curran completed the Comprehensive Plant Evaluation (CPE, January 2017), which examined the current conditions and provided recommendations for improvements at the WWTP, and the CMOM Program Assessment and Corrective Action Plan (January 2017), which provided an assessment of existing CMOM programs and provided recommendations to address any deficiencies noted in the assessment.,

2.2 Wastewater Collection System

2.2.1 Overview

Haverhill is located in Essex County, encompassing approximately 33.3 square miles of land area and 2.3 square miles of water area. Figure 2-1 (page 2-3) shows that the city is bounded by Merrimac, Massachusetts (MA) to the northeast, West Newbury and Groveland, MA to the east, Boxford and North Andover, MA to the south, Methuen, MA to the southwest, Salem, New Hampshire (NH) to the northwest, and Atkinson and Plaistow, NH to the north.

Haverhill's system is served by separate sanitary and combined sewer systems. The wastewater collection system serves most of the community, but there are still portions of Haverhill, on the outskirts of the city, that are served by private septic systems. Figure 2-1 shows the areas served the city's piping systems.

The Merrimack River and Little River are natural boundaries in the collection system. A portion of the Little River becomes a buried box conduit (referred to as the Little River Conduit), approximately 2,000 feet from its confluence with the Merrimack River. The interceptor piping system collects flow along river banks and conveys it under the Merrimack River through three sets of large diameter siphons to the Haverhill wastewater treatment plant (WWTP), which is located on the southern bank of the Merrimack River (on the east end of the city). Excess wet weather flow is discharged into the Merrimack and Little Rivers during large storm events via thirteen (13) permitted CSO outfalls, which are shown in Figure 2-1. Wastewater flow from the adjacent community of Groveland is received and treated at the WWTP through a separate force main.

The sewer collection system network is comprised of traditional gravity pipe ranging in size from 8 to 72-inches in diameter and force mains ranging in size from 4 to 42-inches. The separate stormwater drainage piping systems are primarily located outside of the densely populated downtown areas along the Merrimack River. Portions of the collection piping system are more than 150 years old; these are predominately located in the downtown area and along the Little River. There are 36 small sewer pumping stations for local sewer conveyance and one larger flood pumping station, the Marginal Pump Station.

The city of Haverhill has worked to characterize its wastewater collection system through a series of system investigations and field operations. Combined and separated pipe reaches and system features are updated in the city's Geographic Information System on a consistent basis.

2.2.2 Tributary Drainage Areas

General

The city's collection system is divided up into fifty-six (56) separate sewersheds based on past investigations of Infiltration/Inflow (I/I). The boundaries of the sewersheds are shown on Figure 2-1 and categorized by sewershed types as follows:

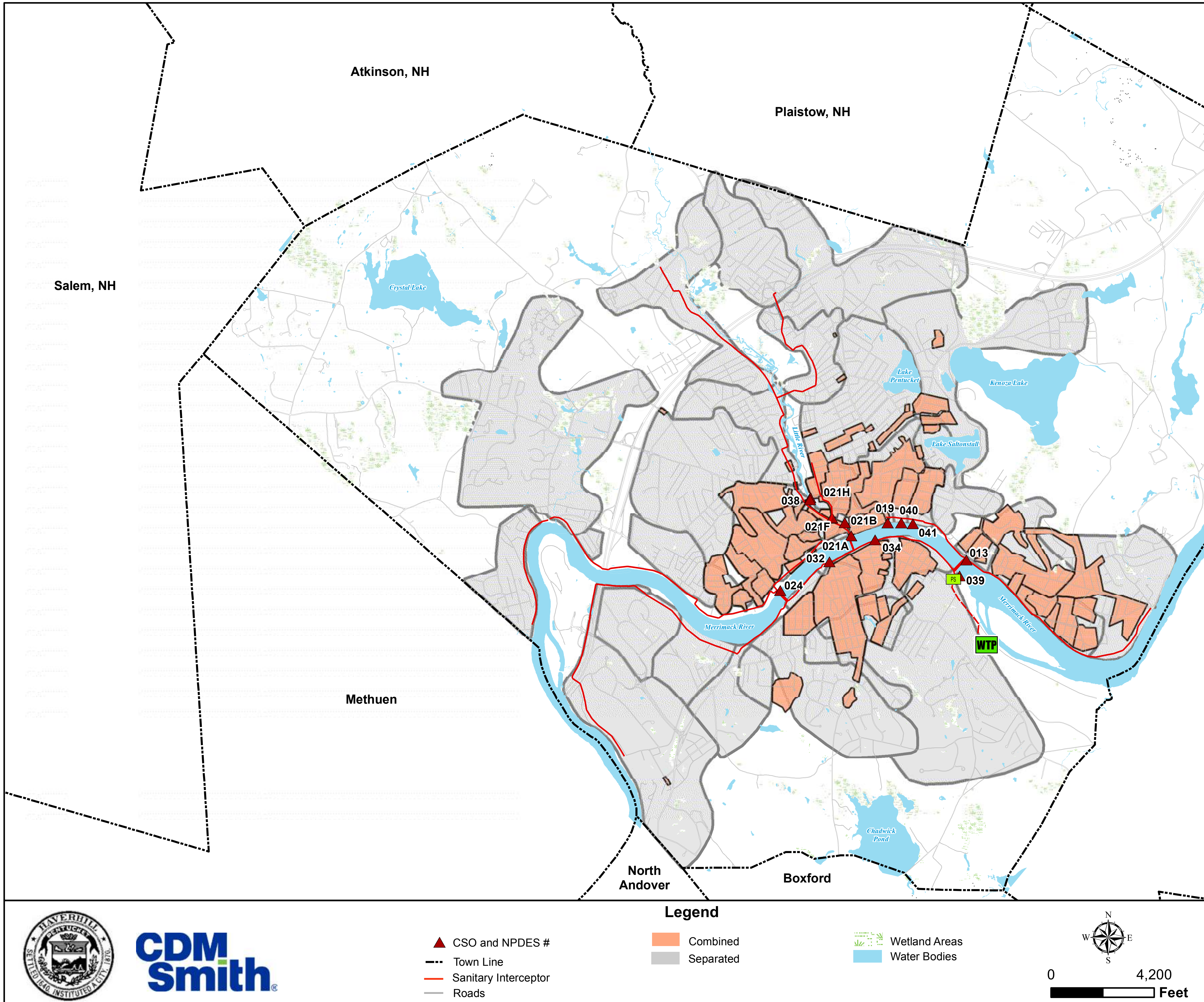
- Separated – sewershed only conveys sanitary flow. Stormwater is conveyed through a separate pipe network that discharges directly into a receiving water body.
- Combined – sewershed conveys both stormwater and sanitary flow through the same pipe network (dry weather flow and a portion of the wet weather flow are conveyed to the WWTP and excess wet weather flow is discharged out of the CSO outfalls).

The sewer collection system serves about 8,300 acres or about 39 percent of the total land area in Haverhill.

For simplification, the sewersheds were also organized by overall drainage basins, which were identified by the downstream interceptor system and major siphon crossing, as shown in Figure 2-2 (page 2-4). These five drainage basins tributary to the wastewater collection system are the Upper Siphon, Middle Siphon, Locke Street, Lower Siphon, and Bradford basins.

Separate Sewer Areas

Approximately 6,800 acres of the collection system, about 82 percent, is served by separated sanitary sewer piping systems, with separate storm drain systems with dedicated stormwater outfalls. These areas are predominately located in the outer extents of the collection system and tend to have been installed more recently. Many of the sewers within the separated sanitary sewer area are between 20 and 40-years of age.



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Sewer Area Classification
Figure 2-1

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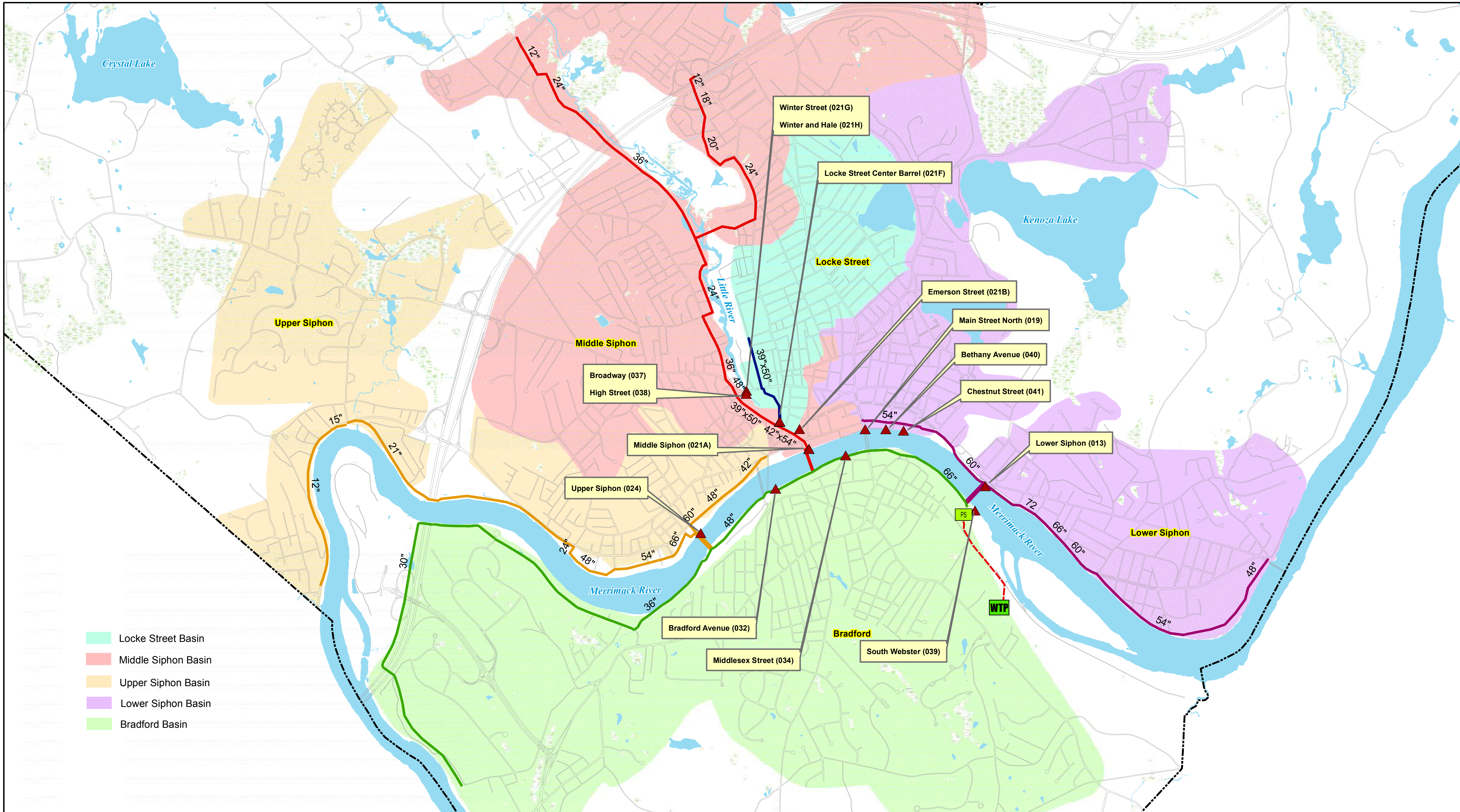

Legend

CSO and NPDES #	Bradford Interceptor	Upper Siphon Interceptor	Wetland Areas
Town Line	Lower Siphon Interceptor	Locke Street Interceptor	Water Bodies
Roads	Middle Siphon Interceptor		

N, E, S, W

0 2,400 Feet

CDM Smith

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CSO Basins, Interceptors and CSO Regulators
Figure 2-2

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Combined Sewer Drainage Area

Approximately 1,500 acres of Haverhill, or about 18 percent of the sewer system, is directly served by the combined sewer piping system. The majority of the CSS is located in the older, more densely populated downtown area, along the Merrimack River and Little River. These piping systems are older dating back to original pipe installations.

Some of the sewersheds categorized as combined have upstream areas that are separated, but the drain pipe network connects into the combined sewer at a downstream point. Sewersheds that include a separate drainage pipe network with no outfall were assumed to be a part of the downstream combined drainage area for modeling purposes.

There are separated stormwater systems, in the downtown area along Wall Street and Merrimack Street, that have separate drainage piping systems that normally discharge into the Merrimack River through several stormwater outfalls that penetrate the city's flood protection wall. These outfalls have flap gates to prevent river water from entering the drainage system. When river levels are high, due to tides or river flood conditions, the flap gates close and the drainage system can back up into the sewer system via connection manholes located behind the flood protection wall. This stormwater flow is conveyed to the Middle Siphon inlet structure and is included in the additional separated acreage noted above.

2.2.3 Major Interceptors

Wastewater collected throughout the city is conveyed to the WWTP by an interceptor piping network, comprised of five major systems located along the banks of the Merrimack and Little Rivers. The interceptors were constructed in the 1970s.

Figure 2-2 shows the location of each interceptor in the city. The name, range of pipe sizes, and the total length of each interceptor are listed in Tables 2-1 and 2-2.

Table 2-1 Interceptors North of the Merrimack River

Interceptor Name	Pipe Size (inches)	Length (feet)
Upper Siphon Interceptor (West)	48 to 66	4,150
Upper Siphon Interceptor (East)	42 to 60	3,050
Locke Street Interceptor	39 x 50 (elliptical)	3,000
Middle Siphon Interceptor	42 to 42 x 54 (elliptical)	5,000
Lower Siphon Interceptor (West)	54 to 60	3,950
Lower Siphon Interceptor (East)	36 to 72	9,750

Table 2-2 Interceptors South of the Merrimack River

Interceptor Name	Pipe Size (inches)	Length (feet)
Bradford Interceptor	36 to 72	8,750

The interceptor system also includes three major Merrimack River crossings (siphons), which convey flow from the north side of the Merrimack River to the south side of the river. Each of these major Merrimack River siphon crossings has a CSO regulator and outfall pipe attached to the siphon inlet structure.

There are also two smaller river crossings along the Little River, with siphons that convey flow from the Locke Street Basin to the Middle Siphon Interceptor, under the Little River Conduit (the box culvert portion of the Little River), along Locke Street. A third siphon under the Little River Conduit, on Wall Street, conveys flow from the Emerson Street sewer area to the Middle Siphon inlet structure.

A differing number and size of siphon pipes characterize each crossing. All siphon pipes have individual manually-operated gates to allow for barrel maintenance and system protection.

Table 2-3 lists each siphon, along with its size and number of barrels.

Table 2-3 Siphons

Crossing Name	Number of Siphon Pipes	Size of Siphon Pipes
Lower Siphon	3	30”, 18”, 20”
Middle Siphon	2	30”, 30”
Upper Siphon	3	30”, 16”, 18”
Locke Street	2	12”, 18”
Wall Street	1	24”

2.2.4 Pumping Stations

The collection system has 38 pump stations that deliver wastewater to the WWTP. Most of these are smaller local sewer pumping stations. The discussion below focuses on the two major pump stations that directly impact CSO control.

WWTP Influent Pump Station

A single pump station conveys all flow from the end of the Bradford interceptor (on the south riverbank) to the WWTP. As part of the Phase I LTCP, in 2006, various station improvements and controls were completed to increase the peak flow pumping capacity from 46 million gallons per day (mgd) to 60 mgd.

A flow control gate was installed just upstream in the influent 72-inch Bradford Interceptor to ensure that water levels in the wet well do not flood the station and damage equipment when flows exceed the pump capacity (60 mgd). The station’s four pumps were upgraded to 13,386 gallons per minute (gpm) pumps (three on duty and one standby), which operate with variable frequency drives for efficient operation. Flow enters the influent channel, passes through mechanical bar screens, and is pumped through a 42-inch pre-stressed concrete cylinder pipe (PCCP) force main, approximately 3,000 feet, to the WWTP.

The PCCP force main in Haverhill has come under some scrutiny because of failures of similar PCCP pipe around the country. The Greater Lawrence Sanitation District had a force main comprised of a similar material that was prone to intermittent failures and was eventually replaced in its entirety. It appears that Haverhill’s force main may have been fabricated in a different batch/time frame than some of the other suspect pipe. However, the city will still need to fully assess the vulnerability of this pipe to prepare for and/or avoid any catastrophic failures. This is discussed in the WWTP CPE.

Marginal Pump Station

The Marginal Pump Station (MPS) is located on the north side of the Merrimack River adjacent to the Little River Conduit (LRC) and the Middle Siphon inlet structure. The station was constructed in the late 1930s, along with the Little River Conduit and Flood Protection Wall, to protect the downtown areas and the Little River watershed from flooding when the Merrimack River stage was high.

The Little River Conduit was constructed to create a pressure conduit where the Little River flows by gravity from the upstream open channel (daylighted) portion of the river through to the Merrimack River during the highest river levels. The MPS was constructed when the sewer system had a direct discharge into the river. The direct sewer discharge was connected to the Little River Conduit and flowed freely by gravity during dry weather conditions.

When it rained and the Little River and Merrimack River levels were high, the pump station had to be used to pump sewage and stormwater, at its most downstream point, into the "pressurized" Little River Conduit. When river levels were high, the two backflow gates would close, and sewer flow was directed into the MPS. The pumps raised the flow and discharged it into a gravity conduit that flowed into the LRC (under pressure).

In 1974, the Middle Siphon river crossing was constructed to convey wastewater from the north side of the Merrimack River to the Bradford interceptor on the south side for treatment at the WWTP. The Middle Siphon CSO was constructed along the old sewer line upstream of the connection to the LRC, preserving the operation of the MPS for CSO discharges. Excess wet weather flow during rain events and high river levels would discharge from the new Middle Siphon CSO. However, if the water level in the LRC exceeds the level of the overflow pipe connection, the double backwater flap gates close, which currently directs CSO into the Marginal Pump Station. The MPS is manually operated to pump the combined flow into the LRC.

When the MPS is manually activated, flow enters the wet well passing through bar racks, into a lower conduit, pumped to an upper discharge conduit, and discharged to the LRC. The station has three pumps with a combined peak flow capacity of 12,500 gallons per minute (gpm). The station wet well is very shallow (only about 1 foot), which makes it challenging to operate on an intermittent basis.

Smaller Sewer Pump Stations

There are 36 other smaller local area sewer pumping stations in the system that serve small residential and commercial areas. The city reports that most of these stations only pump sanitary flow. Because these stations have small flow rates and there is little to no wet weather response from these stations, modifying the operation of the stations during wet weather would not provide any CSO reductions at downstream CSO regulators.

Some of the stations had been prone to pump failure due to ragging from material flushed into the sewer system; however, over time, the city has replaced the most vulnerable pumps with non-clog chopper impellers to eliminate pump binding. These stations operate with local controls and do not have remote monitoring or control.

Each of the pumping stations was assessed by the August 2016 Wright-Pierce Sewer Pumping Station Report for general conditions and replacement schedule and costs. This report serves as a guideline for the city to develop a rehabilitation or replacement schedule for the stations.

2.2.5 Combined Sewer Overflow Outfalls and Regulators

General

During dry weather, sanitary wastewater flow conveyed to CSO regulator structures is directed to the interceptor system and eventually to the WWTP. During wet weather events, flow that exceeds the capacity of the downstream piping system is hydraulically diverted from the collection system and discharged as CSO into the Little River or Merrimack River.

Haverhill currently has 15 CSO regulators/structures that are connected to 13 outfalls. Of the 13 outfalls, five discharge to the Little River, and eight discharge to the Merrimack River. Figure 2-2 shows the outfall locations. Two sets of two regulators share an outfall: Broadway and High Street CSO share the NPDES #038 outfall and Winter/Hale and Winter Street CSOs share the NPDES #021H outfall.

Each of these CSO regulators is currently monitored by a set of depth and depth/velocity flow meters. The data is reported to a website maintained by the flow metering subcontractor, who also maintains the meters to make sure good flow data is collected. The flow metering program is discussed further in Section 3.

Five of the CSO regulator structures also function as flood diversion structures. The operation of these special structures is discussed in Section 2.2.6 below. Sluice gates exist within the flood diversion structures to provide system flood protection and emergency relief to the collection system under high river flood conditions. Each sluice gate remains fully open unless the city is under a river flood condition.

Table 2-4 summarizes the physical attributes of the 15 CSO regulators. Schematic drawings of each CSO regulator is provided in Appendix B.

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Table 2-4 Combined Sewer Overflow Outfalls and Regulators

Outfall NPDES Permit No.	Regulator Name	Interceptor System	Control Elevation (ft) NGVD	Overflow Control Point (inches)	Outfall Pipe Size (inches)	Receiving Water
Upper Siphon						
024	Upper Siphon	Upper Siphon	12.00	(2) 54 x 54 (Sluice Gate)	84 Diameter	Merrimack River
Locke Street Siphon						
021H	Winter and Hale	Locke Street	18.92	Weir	54 Diameter	Little River
021H	Winter Street	Locke Street	28.63	Weir	54 Diameter	Little River
021F	Locke Street Center Barrel	Locke Street	14.36	Weir (flap gate)	39 x 50 Oval	Little River
Middle Siphon						
021A	Middle Siphon	Middle Siphon	8.24	Weir	42 x 54 Oval	Little River (LRC)
021B	Emerson Street[2]	Middle Siphon	29.70	Weir	24 Diameter	LRC
038	High Street[2]	Middle Siphon	28.39	Weir	42 Diameter	Little River
038	Broadway[1, 2]	Middle Siphon	36.19	Weir	42 Diameter	Little River
Lower Siphon						
013	Lower Siphon	Lower Siphon	11.50	(2) 30 x 30 (Sluice Gate and Flap Gate))	(2) 84 x 48	Merrimack River
041	Chestnut Street	Lower Siphon West	33.47	Weir	36 Diameter	Merrimack River
040	Bethany Avenue	Lower Siphon West	40.33	Weir	36 Diameter	Merrimack River
019	Main Street – North	Lower Siphon West	19.20	36 Diameter	36 Diameter	Merrimack River
Bradford						
032	Bradford Avenue	Bradford	15.93	Weir (Flap Gate)	48 Diameter	Merrimack River
034	Middlesex Street	Bradford	8.26	48 x 36 (Flap Gate)	36 Diameter	Merrimack River
039	South Webster	Bradford	36.90	Weir	36 Diameter	Merrimack River

(1) CSO regulator shares the same outfall as above

(2) Structure is also flood diversion structure

After the completion of the Phase II report, the city identified three previously unknown regulator structures in the system, South Webster (039), Bethany Avenue (040) and Chestnut Street (041) CSO regulators. These are still active and considered in this report.

During implementation of the Phase II LTCP improvements, Bates Bridge (001), Boardman Street (010), Fire Station (016), Railroad Bridge (022), 266 River Street (023), Beach Street (025), Front Street (031), South Prospect (033), Main Street – South (035) and Ferry Street (036) regulator structures were closed (bricked-up). In addition, the city raised the weirs at the Bradford, Locke Street North, Locke Street South, Upper Siphon and Lower Siphon CSO regulators.

As part of the Phase II LTCP, the city is finishing modifications to four of the city's existing CSO regulators (implemented as part of the Wet Weather Maximization/CSO Structure Modifications Project). This project will increase the capture of wet weather flow in the interceptor system to reduce the frequency and volume of CSO discharges to the Merrimack River and Little River. Modifications were made to the Bradford CSO Regulator; Upper Siphon CSO Regulator; Middle Siphon inlet structure; and Lower Siphon CSO Regulator. Some of the improvements include the installation of CSO outfall control gates and increasing the diameter of interceptor connector pipes. Electraulic (combined electrical and hydraulic system) sluice gate actuators, level transmitters and supervisor communication and data acquisition (SCADA) communication equipment will be added at Upper, Middle, and Lower Siphon CSO regulators to allow the city to remotely and automatically control and modulate interceptor depths during storm events. The intent of the system improvements is to allow the city to capture wet weather flow in the upstream Upper Siphon Interceptor during storm events. In addition, an existing sewer was installed at the Marginal Pump Station to eliminate the Marginal PS Weir CSO.

The Wet Weather Maximization/CSO Structure Modifications Project was bid in March 2016 and construction is expected to be completed in March 2017. A further discussion of these improvements is provided in Section 3.

During the development of this LTCP, the city also permanently closed (bricked-up) the Locke Street North (021D) CSO and Locke Street South (021E) CSO regulator structures (subsequent to the weir modifications discussed above).

A summary of each regulator structure and the modification made to the regulators in the ongoing Wet Weather Maximization/CSO Structure Modifications Project is included below. Figure 2-3 (page 2-13) shows a schematic representation of the existing interceptor system and location of the current CSO regulators. All elevations are in NGVD.

Upper Siphon Interceptor System

***Upper Siphon CSO (024)* –** The Upper Siphon CSO regulator structure is a complex three chamber structure that accepts flow from the 60-inch Upper Siphon East and 66-inch Upper Siphon West Interceptors. The structure is configured so that flows from the interceptors merge in the influent chamber and are transferred through an 18-inch x 36-inch opening with a remotely operable electraulic flow control sluice gate to the smaller siphon inlet chamber. Flow exits the structure through 18-inch, 16-inch, and 30-inch siphons. From this structure, flows in the three siphons are conveyed under the Merrimack River to the 48-inch Bradford Interceptor.

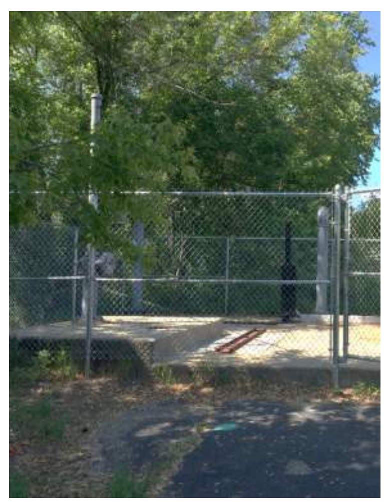
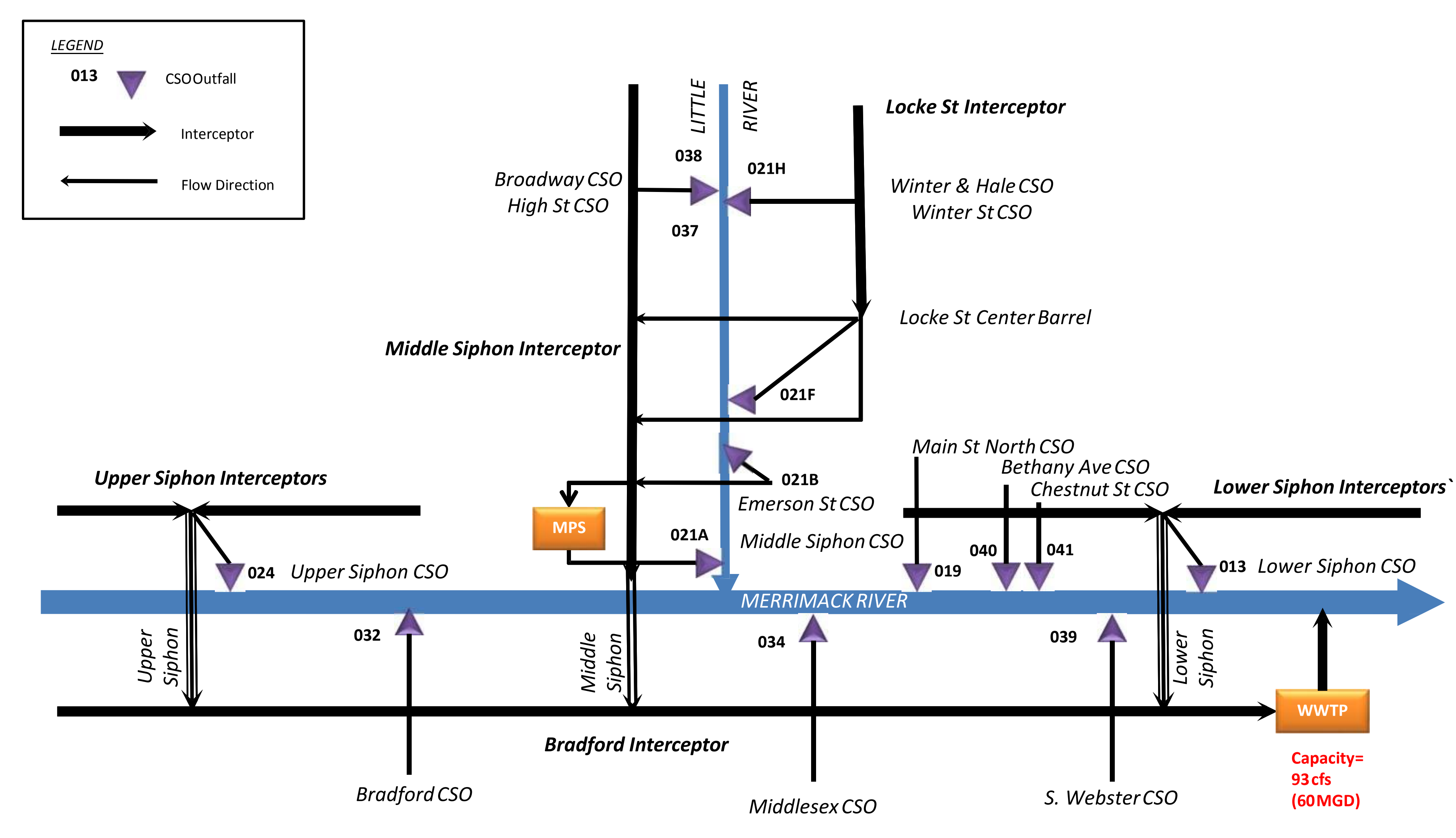


Figure 2-4
Upper Siphon CSO Regulator Structure

Up to December 2016, an overflow event to the Merrimack River occurred when flows overtopped a side weir at elevation 13.42 feet (6.42 feet above the structure invert), passing through an 84-inch x 84-inch flap valve, and existing the structure via the outfall chamber. Overflow events were automatic with no remote control. The flap gate was installed to prevent high river water from



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CSO System Schematic
Figure 2-3

entering the structure, but, occasionally, this flap gate did not totally prevent river water from getting into the sewer.

As part of the 2016 Wet Weather Maximization/CSO Structure Modifications Project, new CSO discharge control sluice gates, electraulic actuators, level transmitters, and instrumentation were installed at the Upper Siphon CSO regulator. The new CSO flow control sluice gates will typically be closed to prevent river water from entering the sewer system. The weir wall was also removed; the overflow opening is now at elevation 9.53-feet. CSOs will only be activated when wet weather flow depths are higher than river levels.

Locke Street Interceptor Area

Locke Street Center Barrel CSO Regulator (021F) – The Locke Street Center Barrel regulator, located at the intersection of Locke Street and Orchard Street, relieves the Locke Street Interceptor once the downstream siphon capacities have been exceeded. Under dry weather conditions, flows are conveyed through a 12-inch and 18-inch siphon pipe(s) under the LRC to the Middle Siphon Interceptor on Essex Street. An overflow to the LRC occurs when flows overtop a side weir at an elevation of 14.36 (3.08 feet above the pipe invert). Under overflow conditions, flows discharge through the 39-inch x 50-inch brick CSO outfall pipe, which extends 372 feet down Locke Street and connects to the northern sidewall of the LRC.

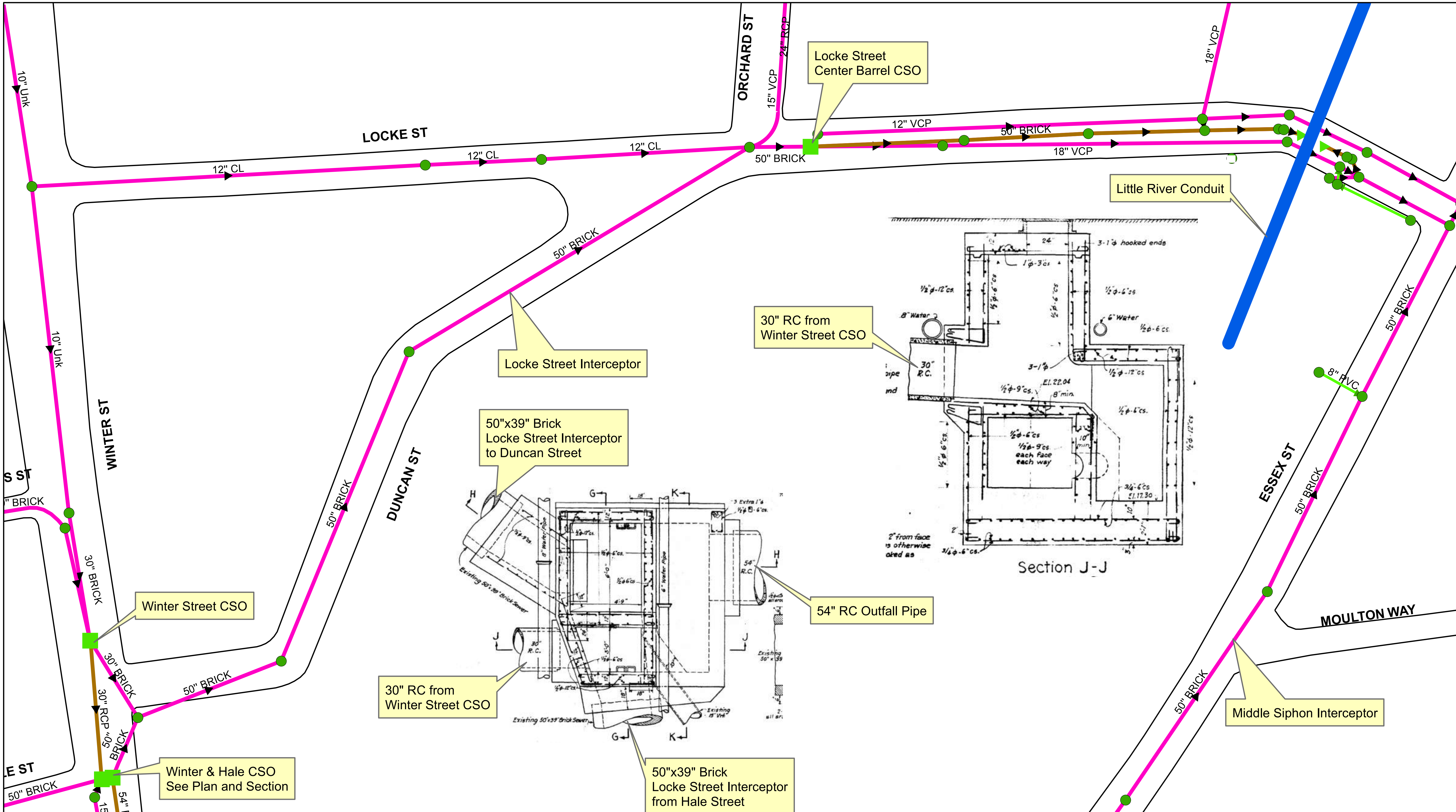
Figure 2-5 (page 2-15) shows the location of the Center Barrel CSO regulator in the Lock Street Interceptor area.

Winter and Hale (021H) and Winter Street CSO Regulators – The Winter and Hale CSO outfall receives overflow from two regulator structures - one is in Winter Street near its intersection with Hale Street and the other at the intersection of Winter Street and Duncan Street.

The Winter Street regulator contains a 4.50-foot long side overflow weir, at elevation 28.63 feet, relieving a 30-inch inlet sewer from Winter Street. Dry weather flow is directed to Duncan Street via a 30-inch pipe. Wet weather flow is conveyed by a 30-inch pipe down to the Winter and Hale CSO regulator structure.

The Winter and Hale regulator structure has a 6-foot long weir, at elevation 18.92 feet, that relieves the 39-inch x 50-inch Locke Street interceptor from Hale Street. The Winter and Hale and the Winter Street regulators share a 54-inch overflow pipe on Winter Street that drains to the west toward the Little River. The 30-inch CSO outfall from the Winter Street CSO passes over the top of the 54-inch Hale Street combined sewer before it connects to the outfall on the downstream side of the Winter and Hale CSO regulator weir. The overflow outlet is located at the Little River, approximately 500 feet north of where the LRC begins. Figure 2-5 shows the location of these two regulators with respect to the Locke Street Center Barrel CSO regulator and includes a plan and a section showing the piping arrangement within the Winter and Hale CSO regulator structure.

These regulators also function as a flood diversion structures. The regulators have sluice gates installed on their dry weather connection pipes, which can be manually closed to fully divert flow into the CSO outfall pipes. This would only occur during Merrimack and Little River flood conditions (see discussion of the flood protection system below for further information).



Legend

- CSO Regulator
- CSO Outfall
- Sewer Manhole
- Overflow Pipe
- Combined Sewer Pipe
- Sewer Pipe

0 60 Feet

CDM Smith

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Locke Street Area
Figure 2-5

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Middle Siphon/Interceptor

Emerson Street CSO Regulator (021B) – The Emerson Street regulator structure is a two chamber structure that accepts flows from a 24-inch sewer pipe on Emerson Street. Under dry weather conditions, flow exits the structure through a 24-inch pipe to Middle Siphon. During rain events, excess flow overtops a side weir at an elevation of 29.70 feet (2.12 feet above the pipe invert) and exits the structure via a 24-inch overflow pipe. The 392-foot overflow pipe connects to the LRC where it crosses Emerson Street.

The Emerson Street regulator also functions as a flood diversion structure. A manually operated sluice gates on the dry weather connector pipe, normally open, can be closed to divert all flow to the LRC under Merrimack River and Little River flood conditions.

High Street CSO Regulator and Broadway CSO Regulator (038) – A 48-inch CSO overflow pipe/outfall (038) discharges to the Little River in the Lafayette Square area serves two different CSO regulators. The Broadway regulator structure located on Broadway, within a concrete vault, has a 6.5 -foot long side overflow weir, at elevation 36.19 feet, which relieves excess flow in the 20-inch influent sewer pipe. Dry weather flow continues along the 20-inch pipe, while excess wet weather flow is connected to the downstream overflow pipe with a 42-inch pipe (1,130 feet long).

The High Street regulator is also located within a concrete vault with a 6.5-foot long side overflow weir, at elevation 28.39 feet, which relieves excess flow from a 24-inch sewer. Dry-weather flow continues along the 24-inch pipe, while wet weather flow is directed to the 48-inch combined outfall via a 42-inch CSO connector pipe. The outfall pipes from Broadway and High Street CSOs combine at Essex Street between Hillside Street and High Street and discharge to the Little River via the 48-inch outfall just south of Winter Street. The overflow outlet is located approximately 500 feet north of where the LRC begins.

The High and the Broadway Street regulators also function as a flood diversion structures. There are in-line sluice gates on the dry weather connector pipes that can be used to fully divert flows manually into the Little River during river flood conditions. The gates are normally fully open.

Middle Siphon CSO (021A) – The Middle Siphon regulator accepts flow from the 42-inch x 54-inch Middle Siphon Interceptor, including flow from the upstream Locke Street area. Under dry weather conditions, flow exits the structure through a 36-inch pipe connected to the Middle Siphon (inlet structure).

Figure 2-6 shows the location of the underground Middle Siphon CSO Structure adjacent to the Marginal Pump Station.

Figure 2-6
Middle Siphon CSO Regulator Structure

An overflow to the Little River Conduit (LRC) occurs when flows overtop a side weir at an elevation of 8.24 feet. However, if the water level in the LRC is too high (i.e., river flood conditions), CSO enters the MPS, adjacent to the LRC, and is pumped into the LRC (as discussed above in Section 2.2.4).

As part of the Wet Weather Maximization/CSO Structure Modifications Project, the existing 18-inch x 36-inch sluice gate in the Middle Siphon inlet structure was removed; and the opening to the siphons was made wider, to 36-inch x 48-inch, to convey more flow to the Bradford Interceptor. The project also included the construction of a new 24-inch sewer that directly connects the Emerson Street and Wall Street sewers to the Middle Siphon inlet structure, eliminating the old Marginal PS CSO regulator. The intention of these improvements is to maximize the flow conveyed to the Bradford Interceptor and to reduce CSO discharges at the Middle Siphon CSO.

Lower Siphon Interceptor

Main Street North CSO (019) – The Main Street-North regulator structure is a two chamber structure that accepts flow from the 36-inch sewer pipe located at Main Street. The structure is configured so that flows from the 36-inch sewer pipe discharge to the Lower Siphon West Interceptor through an 18-inch and 54-inch outlet pipe. The 54-inch Lower Siphon West Interceptor flows easterly on Water Street toward the Lower Siphon river crossing. An overflow to the Merrimack River will occur when excess wet weather flow surcharges to a high-level outlet located at 19.2 feet (7.05 feet above the structure invert) and exits through a 36-inch outfall.

The Main Street North CSO functions as the high relief outlet for the Lower Siphon Interceptor System.

Bethany Avenue CSO (040) – The Bethany Avenue regulator is in a manhole structure that accepts flows from a 36-inch sewer pipe on Ginty Boulevard. Under dry weather conditions, flow exits the manhole through a drop connection and a 12-inch dry weather connector pipe (422 feet long) to the Lower Siphon West Interceptor. An overflow to the Merrimack River occurs when excess wet weather flow overtops the weir at an elevation of 40.33 (0.66 feet above the pipe invert). Under overflow conditions, flow exits the structure via a 36-inch overflow pipe (637 feet long) to the Merrimack River.

Chestnut Street CSO (041) - The Chestnut Street regulator is in a manhole structure that accepts flows from a 24-inch sewer pipe on Ginty Boulevard and a 30-inch sewer pipe on Chestnut Street. Under dry weather conditions, flow exits the manhole through a drop connection and a 12-inch dry weather connection pipe (265 feet long) to the Lower Siphon West Interceptor. An overflow to the Merrimack River occurs when excess wet weather flow overtops the weir at an elevation of 33.47 (1.50 feet above the pipe invert). CSO is conveyed by a 36-inch overflow pipe (621 feet long) to the Merrimack River.

Lower Siphon (013) – The Lower Siphon structure is a complex three chamber structure that accepts flow from 60-inch and 72-inch interceptors in the vicinity of Water and Groveland Streets. Flow from the Lower Siphon East and West Interceptors merge in a large anti-chamber and are conveyed through an 18-inch x 36-inch opening with a remotely operable REXA-actuated sluice gate to the smaller siphon inlet chamber. Flow exits the structure through 18-inch, 20-inch, and 30-inch siphons. From this structure, flow in the three siphons is conveyed under the Merrimack River to the 72-inch Bradford Interceptor just upstream of the WWTP influent pump station. An overflow event to the Merrimack River currently occurs when excess wet weather flow overtopped the side weir at elevation 3.92 feet; then flow passed through two 120-inch x 60-inch flap valves, and entered the outfall chamber.

Merrimack River stage (and diurnal river tides) affects the operation of this structure. The dual flap gates were installed to prevent high river flows from entering the sewer system. However, these flap gates did occasionally leak. Very high river levels will also prevent or reduce the capacity of CSO discharge from this CSO. During those high river levels, CSO is discharged from other upstream CSO regulators like the Main Street North CSO.

Figure 2-7
Lower Siphon CSO Regulator Structure

As part of the Wet Weather Maximization/CSO Structure Modifications Project, new CSO flow control sluice gates, electraulic actuators, level transmitters, and PLCs will be installed at the Lower Siphon CSO regulator. Two 54-inch x 54-inch openings with flow control sluice gates will be constructed and installed to replace the existing 120-inch x 60-inch opening and flap valve to the CSO discharge chamber. The weir wall was also removed; the overflow opening is now at elevation 1.00-foot. Electraulic actuators will be installed on the new CSO sluice gates to remotely control and modulate depths in the interceptors.

After modifications to the structure are completed an overflow event to the Merrimack River would occur when flow levels in the influent chamber reach elevation 11.50 and the siphon chamber control gate is fully open. Flows would pass through one or both 54-inch x 54-inch remotely operated CSO flow control sluice gates, and enter the outfall chamber. A plan showing the modifications to the Lower Siphon regulator structure is provided in Appendix B.

The new CSO flow control sluice gates will typically be closed to prevent river water from entering the sewer system. CSOs will only be activated when wet weather flow depths are higher than river levels.

Bradford-Side

Middlesex Street CSO (034) – The Middlesex Street regulator structure is a large two chamber structure that accepts flow from a 30-inch x 30-inch stone culvert near Middlesex Street. Under dry weather conditions, flow exits the structure through a 12-inch pipe to the Bradford Interceptor. An overflow to the Merrimack River occurs when excess wet weather flow overtops the side weir at an elevation of 8.26 feet (3.20 feet above the pipe invert). Under overflow conditions, CSO exits the structure via a 36-inch overflow pipe. The Middlesex Street regulator also has a flap gate to prevent the river from entering the structure.

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Bradford CSO (032) – The Bradford regulator structure is a large, deep, one chamber structure that accepts flow from a 48-inch sewer pipe originating from Bradford Avenue. Under dry weather conditions, flow exits the structure through a 10-inch pipe to the Bradford Interceptor. An overflow to the Merrimack River occurs when excess wet weather flow overtops the side weir at an elevation of 15.93 feet (8.44 feet above the pipe inverts). Under overflow conditions, CSO exits the structure via a 48-inch overflow pipe.

Figure 2-8
Bradford Siphon CSO Regulator Structure

As part of the Wet Weather Maximization/CSO Structure Modifications Project, a second interceptor connector pipe was added to the Bradford Avenue regulator structure. An 18-inch pipe was installed through the structure floor, increasing direct dry-weather discharge capacity to the Bradford Interceptor. The existing weir wall was removed and rebuilt.

South Webster (039) – The South Webster Street regulator is in a manhole structure that accepts flows from an 18-inch sewer pipe. Under dry weather conditions, flow exits the manhole through an 8-inch pipe, which connects to the local sewer system and eventually connects to the Bradford Interceptor. An overflow to the Merrimack River occurs when excess wet weather flows overtop the weir in the 18-inch overflow pipe set at an elevation of 36.90 feet (1.50 above the pipe invert). CSO is conveyed by a 2,264-foot, 18 to 36-inch pipe to the Merrimack River.

2.2.6 Flood Protection System

The Haverhill Flood Protection System was designed to protect downtown Haverhill from flooding during a 100-year river flood event. The flood protection system includes the Merrimack River floodwall (in the downtown area along the north riverbank), the Little River Conduit, and the Marginal Pump Station. The system also included the installation of "sewer diversions" at key manholes to direct sewer flow into the Little River (where the flow could drain by gravity) during high river levels.

The floodwall and related components of the flood protection system were constructed in the late 1930's in two contracts by the United States Army Corp. of Engineers (USACE) and the city.

In 2013, in response to a USACE Deficiency Correction Report and letters from the Federal Emergency Management Agency (FEMA), the city completed improvements to the flood protection system to ensure the system would continue to function properly. These improvements included raising the height of the floodwall (by about 2.5 feet), extending the floodwall at the upstream end, cleaning and repairing the Little River Conduit and completing renovations to the sewer diversion structures and to the Upper and Lower Siphon inlet structures.

One of the deficiencies noted by the USACE was available flood pumping capacity required to discharge wet weather flow from sewer and drain systems behind the flood wall during concurrent wet weather events and high river flood conditions. The city examined the potential to increase pumping capacity at the existing Marginal Pump Station and determined that it was impractical to increase pump capacity based on the shallow wet well, new hydraulic pumping standards, limited construction area in the confined property, and the need to maintain flood pumping operations during construction. Accordingly, the city developed an alternative flood pump capacity plan (using system modeling) that relied on the use of the upstream sewer diversion structures, supplemental portable pumping systems, and maximization of the conveyance capacity of the Middle Siphon by reducing flow into the Bradford Interceptor at Upper and Lower Siphon structures.

The 2013 Flood Protection System improvements included modifications to the Upper and Lower Siphon inlet structures that allowed the city to operate the flow control sluice gates on the inlet opening to these two sets of siphons to reduce flow to the Bradford Interceptor during storm events (allowing more flow to be conveyed by the Middle Siphon to the south bank and WWTP).

The city also purchased five trailer-mounted portable pumps to supplement the capacity of the Marginal Pump Station. These pumps are temporarily installed during high river levels in anticipation of supplementing MPS pumping capacity during large storm events.

Figure 2-9 (page 2-23) provides an overview of the flood protection system components.

The Haverhill High (River) Flow Management Plan (HFMP) in conjunction with the Flood Protection Operation and Maintenance Manual is used as a guide for the city to operate the flood protection system during high flow events to prevent or minimize flooding in the downtown area.

Merrimack River Floodwall

The Merrimack River floodwall is an approximately 2,280 feet long reinforced concrete wall constructed along the north bank of the Merrimack River beginning at the Basiliere Bridge and extending upstream to Comeau Bridge. The wall protects the downtown section of the city. The wall was originally 30 feet high with a top elevation of 24.00 feet. In 2013, a 2.5-foot high concrete extension was added to the floodwall, raising the height of the wall to an elevation of 26.50 feet. The wall was also extended 170 feet at the upstream end.

Little River Conduit (LRC)

The LRC is a rectangular concrete pressure conduit constructed in the channel of the Little River. It extends a distance of about 2,000 feet from the Merrimack River to the Massachusetts Bay Transportation Authority (MBTA) Railroad bridge. The Little River Conduit permits the discharge of the Little River flow to the Merrimack River during flood periods and prevents backwater in the Little River from overflowing behind the floodwall and inundating the bordering properties. In 2013, repairs were made to the walls, columns and expansion joints of the conduit.

Marginal Pump Station (MPS)

A description of the Marginal Pump Station and how it functions is included in Paragraph 2.2.4; this section will focus on the new portable pump systems. In 2013, the city obtained five portable pumps to augment the pumping capacity of the Marginal Pump Station should flow condition warrant it. The pumps are skid mounted, 12-inch discharge self-enclosed sound-attenuated diesel driven automatic self-priming pumps with a rated capacity of 5,900 gpm. When in use, each pump is setup at defined locations in the vicinity of the MPS. The pumps discharge through five pipe penetrations in the floodwall. The suction locations for each pump is shown on Figure 2-9.

When rain is expected, the Wastewater Division staff set up the portable pumps in anticipation of the storm and the possibility of river flooding to protect the downtown area from flooding. Under most rain conditions with high river elevation, the MPS is sufficiently sized to handle all of the sewer flow. The pumps are stored at the WWTP.

When the wet well depth at the MPS reaches 6.0 feet with three of its pumps running, portable pump #2 is put into operation, and the setup is commenced for portable pumps #1 and #3. When the wet well depth at the MPS reaches 6.5 feet with two of its pumps running, portable pumps #1 and #3 are put into operation, and the setup is commenced for portable pumps #4 and #5. When the wet well depth at the MPS reaches 7.0 feet with two of its pumps running, portable pumps #4 and #5 are put into operation.

Flood Diversion Sewers

The flood diversion sewers were originally constructed in the late 1930s to intercept the sewage and storm water flows from the upstream tributary that normally would be transported to the sewage treatment plant. The intention was to divert this excess flow directly into the Little River, upstream of the LRC, during high river conditions. The flow could then discharge to the Merrimack River by gravity during high river conditions. This flood protection approach reduced the original capacity required at the MPS where all the excess flow would be pumped into the river anyways.

There are five active flood control diversion structures in the system: High Street, Broadway, Winter and Hale Street, Winter Street and Emerson Street diversion structures. These structures also function as CSO regulators. The location of the diversion structures is shown on Figure 2-9.

During periods of high river stages, sluice gates on the outlet (dry weather connector) pipes of the structures are closed and flows can be fully diverted into the Little River Conduit. The gates remain open under normal river flow conditions. In 2013, all the gates on the structures were replaced except for the gate at Winter and Hale.

The High (River) Flow Management Plan directs that when the wet well depth at the MPS reaches 7.5 feet with two of its pumps running, all five portable pumps running, and the siphon inlet gates at Upper and Lower Siphons are completely closed; then the gates of the five diversion structures will be closed. When the wet well depth at the MPS starts decreasing the sluice gates at each of the five diversion structures is opened immediately to prevent dry-weather overflows.

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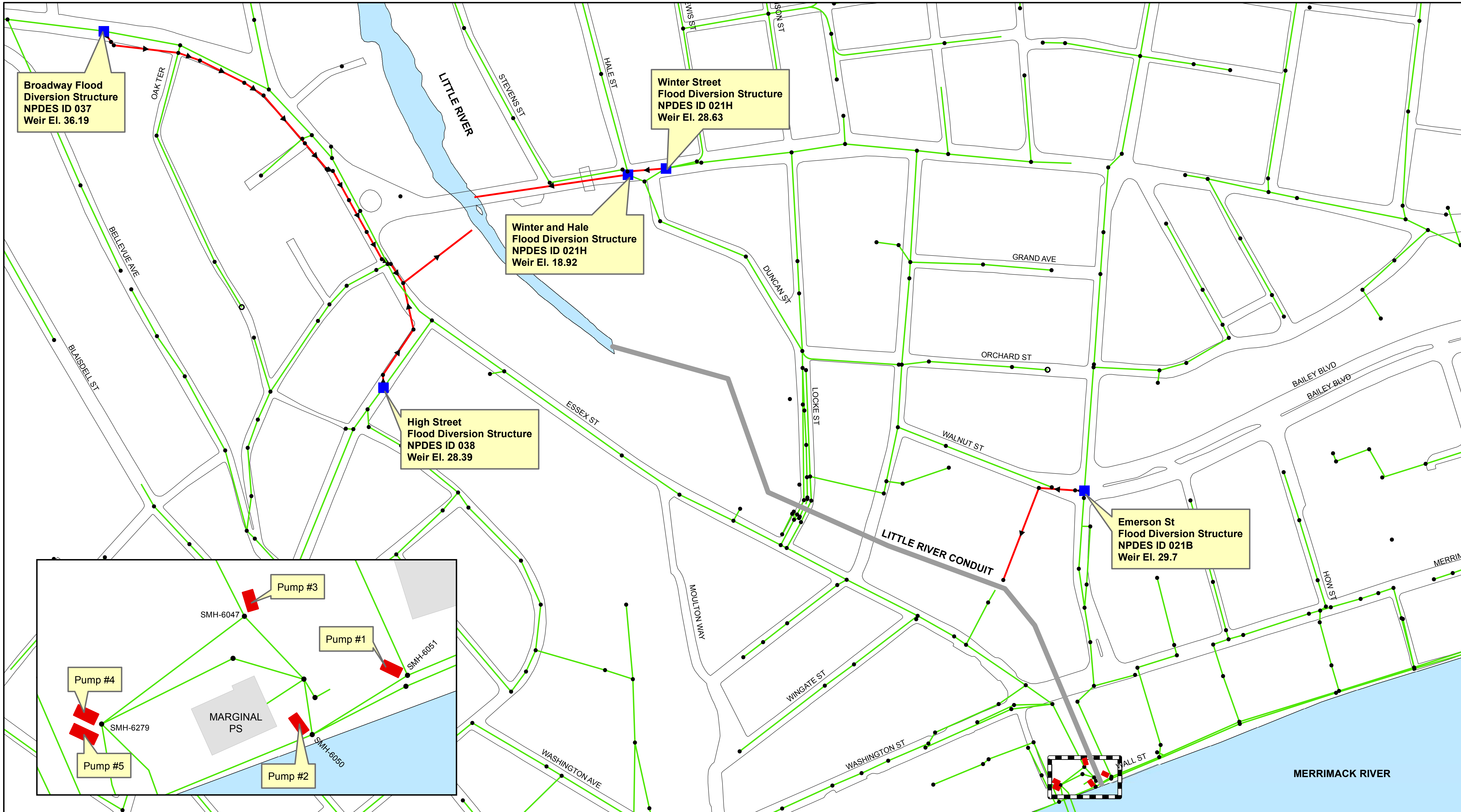

Legend

Sewer Main — Flood Diversion Structure

Sewer Manhole — Flood Diversion Pipe — Portable Pump

0 300 Feet

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Flood Diversion System
Figure 2-9

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2.3 Wastewater Treatment Plant

Treatment Process

The WWTP is located off of South Porter Street, along the Bradford side of the Merrimack River, in the southeast portion of the city. The plant became operational in 1977, it provides treatment of the sewer flow prior to discharge to the Merrimack River.

Figure 2-10
Haverhill Wastewater Treatment Plant

The city has completed periodic improvements to the plant to address system/process/ equipment rehabilitation needs and to improve and increase the reliability of the treatment process. In 2006, the city rehabilitated the WWTP Influent Pumping Station (new screens and pumps) and completed improvements at the WWTP including a new aerated grit system for preliminary treatment, new finer screens, and secondary bypass pipe system and chlorination improvements to increase the wet weather treatment capacity at the plant, and new odor control systems. Sludge processing was improved in 2016 with a new centrifuge dewatering system to handle the plant solids. In 2016, the city also completed miscellaneous repairs and system process/equipment improvements to address odor control.

Course screening of most of the wastewater flow is performed at the WWTP influent pumping station at the end of the Bradford Interceptor before flow is pumped up to the WWTP. The WWTP Influent Pump Station has a capacity of about 60 mgd. Additional flow from the Groveland pumping station enters the plant directly, matching the total capacity of the WWTP.

The plant has the following treatment processes:

- Preliminary treatment – Aerated grit removal and screening,
- Primary treatment - Primary settling,
- Secondary treatment - Activated sludge process and secondary settling, and
- Disinfection with sodium hypochlorite

Preliminary treatment at the plant consists of an aerated grit facility and influent fine screens. Flows from the 42-inch WWTP Influent force main, the Biofilter supernatant pumping station, the Maynard Street Pump Station (Groveland flow) and septage receiving facilities combines in the influent box and is directed to either of the two aerated grit chambers.

From the grit facility, wastewater flows to the screening room where a pair of step screens removes fine solids from the wastewater.

The wastewater then goes through primary treatment process where suspended solids and floating material are removed. The plant has three primary sedimentation tanks, which were designed to provide sufficient capacity to treat the average design flow of 18 mgd and the wet weather peak flow of 65 mgd. Primary effluent flows by gravity through channels to secondary treatment or the secondary bypass channel.

The plant's secondary treatment facilities consist of three aeration tanks followed by three secondary sedimentation tanks. These processes remove soluble organic material from the primary effluent. The aeration tanks promote the growth of aerobic microorganisms which use the soluble organic material as a food source, removing it from the wastewater. The microorganisms settle, form the activated sludge, and are removed in the secondary settling tank. Most of this activated sludge is returned to the aeration basins by the return activated sludge (RAS) pumps to continue the treatment process. A portion of the sludge is removed from the system or "wasted" to control the microbial population.

Effluent from the secondary settling tanks combines at the outfall junction chamber for final disinfection. Disinfection is achieved by adding liquid sodium hypochlorite solution and contact time is met in the WWTP outfall pipe. From the outfall junction chamber, chlorinated effluent enters the 102-inch pre-stressed concrete cylinder (PCC) outfall pipe. Flow next passes through the secondary bypass discharge chamber (and combines with secondary bypass flow when used during wet weather conditions). The secondary bypass discharge chamber was constructed in 2006 as a connection point for the 66-inch secondary bypass pipe.

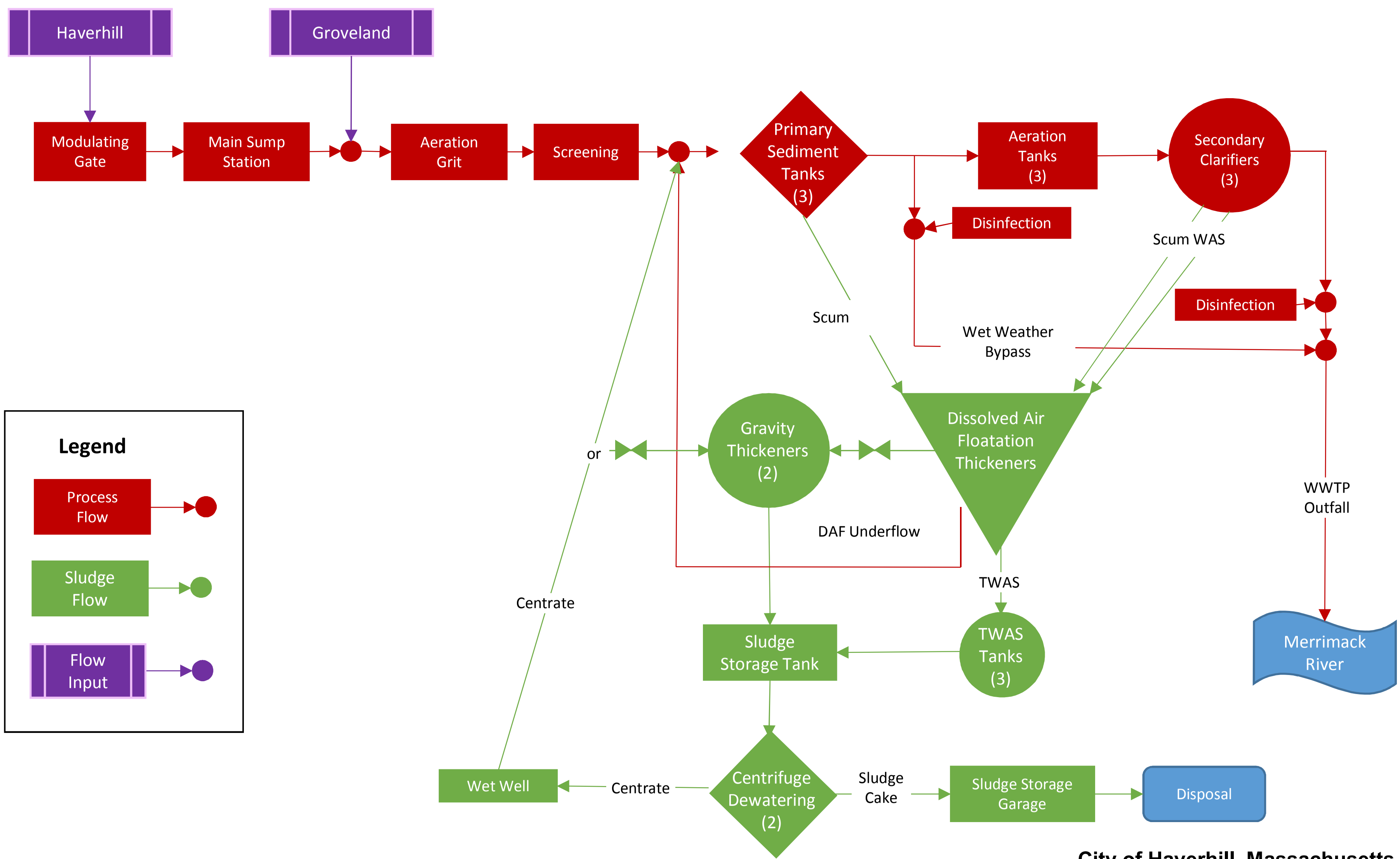
From the bypass discharge chamber, chlorinated effluent continues through the outfall pipe to an air relief and monitoring manhole on Porter Island in the Merrimack River. From the air relief manhole, disinfected effluent flows for another 850 feet through a 60-inch PCC pipe to below the main channel of the Merrimack River. Eight 18-inch PCC risers distribute flow to the river.

Figure 2-11 (page 2-27) shows the complete WWTP process flow schematic.

High Flow Management

Haverhill's wastewater treatment plant was originally designed for a maximum peak flow rate of 46 mgd. In 2006, the city completed improvements to increase the wet weather treatment capacity of the WWTP to 65 mgd using a secondary bypass pipe. The secondary bypass facilities were brought on-line in 2006 to provide controlled diversion, disinfection, sampling and monitoring of up to 46 mgd of CSO related flow. The system is only operated during wet weather events and only after operators have taken all reasonable steps to maximize flow to the secondary system.

The bypass system was designed to pass as much flow as possible through secondary treatment (estimated to be 20 to 25 mgd), and the rest of the wet weather flow would be bypassed to protect the secondary process/system. The city reports that the plant, under certain conditions, has been capable of treating as much as 65 mgd for a short period of time through the secondary process without using the secondary bypass. However, this high flow rate through the secondary cannot be maintained without causing process upsets.



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WWTP Process Flow Schematic
Figure 2-11

The bypass chamber is connected to the primary settling tank effluent channel with an isolation gate that is closed until operators elect to start bypassing based on flow and process conditions during wet weather events. Once bypassing begins, a second gate is used to control flow through the bypass. A chlorine diffuser located immediately downstream of the adjustable gate/weir is used to disinfect the bypass flows. A Parshall flume downstream of the diffuser measures bypass flow rate. Bypassed flow proceeds along the southwest side of the plant site through a 66-inch PCC pipe to the bypass junction chamber where it joins with the chlorinated secondary effluent for combined discharge.

As required by the November 2016 CD, the city is completing a Comprehensive Plant Evaluation (CPE) that will include a review of the plant's High Flow Management Plan. The updated High Flow Management Plan describes the various options available to operators for managing high flows. The CPE Report and High Flow Management Plan were completed by Woodard and Curran and will be submitted under a separate cover.

WWTP NPDES Permit Limits and Effluent Compliance

Haverhill's NPDES permit was last issued on February 1, 2008 and expired in 2013. The complete permit is included in Appendix C.

Table 2-5 shows the effluent discharge limit requirements in the Haverhill permit.

Table 2-5 Haverhill NPDES Permit Limitations

Pollutant	Discharge Limitations		
	Average Monthly	Average Weekly	Maximum Daily
Flow (mgd)	18.1		
BOD (mg/L)	30	45	
TSS (mg/L)	30	45	
Fecal Coliform (#/100 ml)	88		260
Total Residual Chlorine (mg/L)	0.40		0.70
Enterococci bacteria (#/mL)	35		276
pH range	6.5 to 8.5 SU		

The annual average flow rate at the WWTP for the period from 2010 to 2015 was about 10.4 mgd, with a minimum 7-day average flow rate of 5.9 mgd as reported in the 2017 CPE. Future anticipated system growth was projected in the 2017 CPE with a future "built out" population and average per capita flow estimates. The CPE estimates that the future annual average flow rate could be 14.6 mgd, which is less than the design capacity of the plant. From 2010 to 2015, the rolling average influent flow rate was 12.5 mgd (with wet weather flow) and is still below the 80 percent target in the NPDES permit that triggers a review of future treatment capacity.

The plant has experienced exceedances of effluent quality criteria over the period from 2010 to 2015 for BOD, TSS, Total Residual Chlorine, and Enterococci. These exceedances are discussed in more detail in the CPE and Section 8.

2.4 Field Investigations

For this report, in compliance with the CD requirements, CDM Smith, working with a subcontractor and the city, completed a manhole inspection program that included approximately 350 manholes throughout the city in 2014/2015. The manhole inspections were primarily performed in the downtown area, along the river bank, to help identify any potential unknown/unreported CSO regulators and to characterize the sanitary and combined sewer boundaries.

The city's existing GIS was used to initially identify any conflicts between sewer and drainage piping systems and connectivity with manholes to identify any potential areas where CSO regulators might have been installed but were not documented. Other manhole inspections were used to confirm drainage basin boundaries, to clarify system connectivity and to assess the existing sewer collection system.

During the inspections, the city's GIS and record drawing information were verified, including pipe connectivity, size, material (to the extent possible), and flow direction. The assessment of the collection system identified locations where there was evidence of surcharging, infiltration and structural deficiencies. Figure 2-12 (page 2-31) shows the manholes that were inspected during this program.

2.5 I/I Condition Investigations

As part of the 2011 Phase II CSO Long-Term Control Plan, the city launched a metering program to investigate I/I entering the sewer system. In spring and summer 2010 the city installed 31 meters to monitor flows and to evaluate the I/I entering the sewer system during dry weather and wet weather events. The groundwater base flows and sanitary diurnal flows during dry weather were determined at each metered location. An analysis was performed on the flow data to evaluate areas with higher extraneous flow.

Since the 2010 investigation, the city has completed discrete area I/I investigations of the top three sanitary sewer areas identified as having high extraneous flow. The investigation of each sewer area included temporary flow monitoring, spot gauging, and television inspection. The studies used the field investigations and flow data collected in these three sewer areas to provide recommendations for sewer rehabilitation and improvements.

Figure 2-13 (page 2-33) shows the three sanitary sewer areas that were investigated as discussed below.

2015 Infiltration/Inflow Study

Sewer Area 14 and 23 were investigated in 2015. These two sanitary sewer areas had the highest ratio of flow between spring and summer base flow and R-values around 0.05, which is indicative of areas with high I/I.

These two areas have approximately 39,270 linear feet and 54,000 linear feet of pipe, respectively. Sewer Area 14 is located in and around Kenoza Lake and Lake Saltonstall, near the Haverhill Water Treatment Plant. The sewers range in size from 8-inch to 24-inch in diameter and are predominantly vitrified clay (VC) with some polyvinyl chloride (PVC) and reinforced

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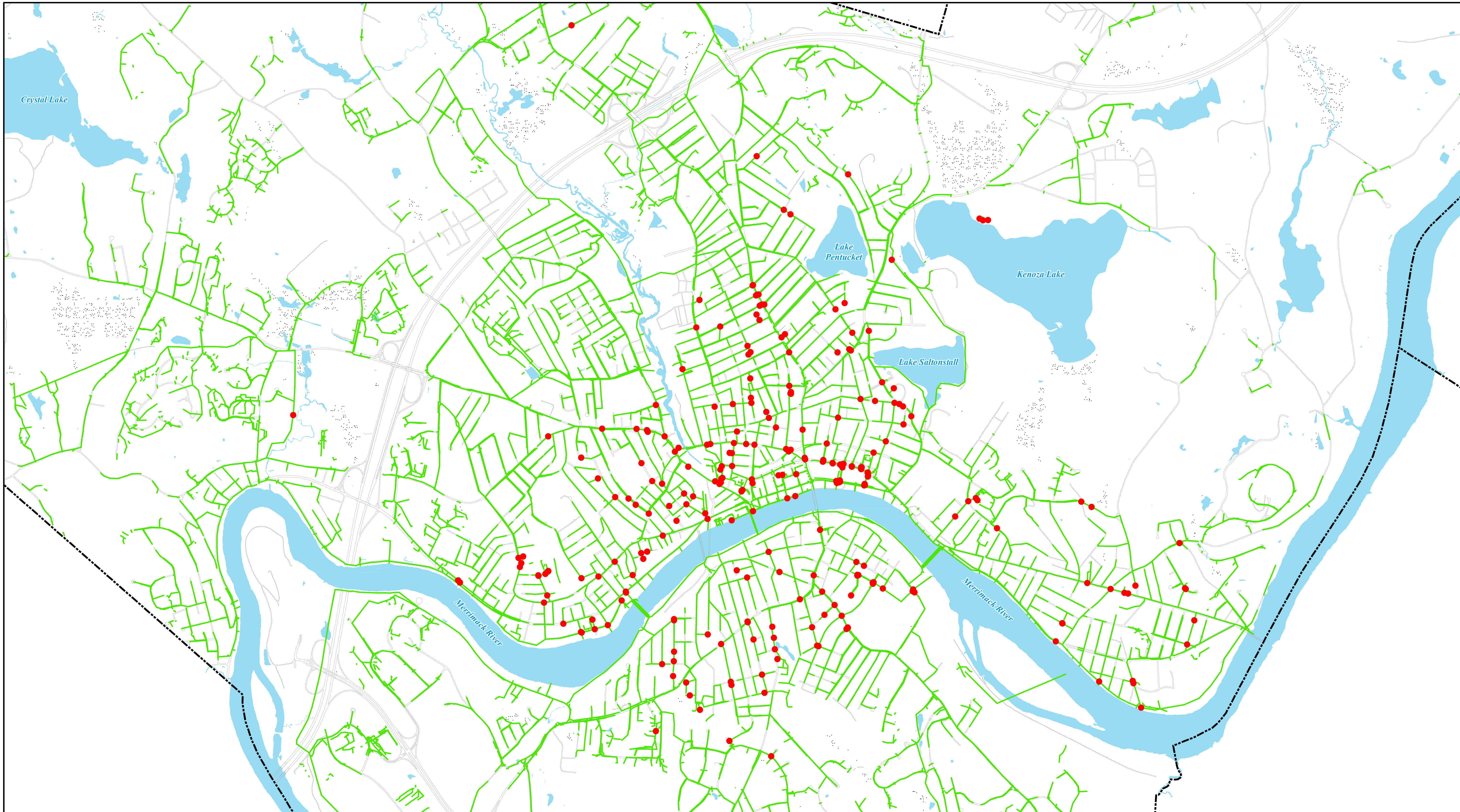

Legend

- Inspected MH
- Sewer
- Town Line
- Roads

N S E W

0 4,200 Feet

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Inspected Manholes
Figure 2-12

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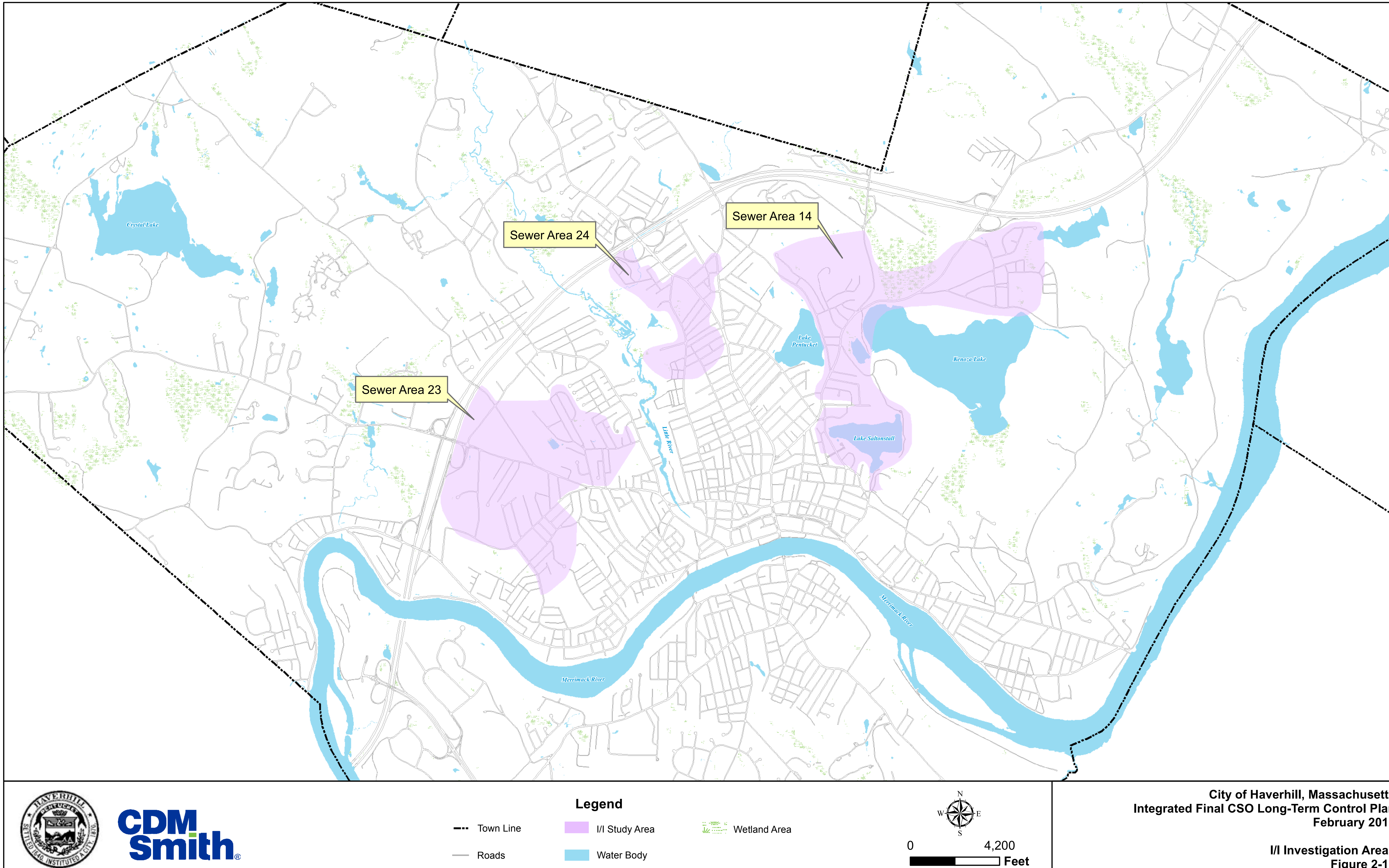

CDM Smith®

City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

I/I Investigation Areas
Figure 2-13

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concrete (RC). There are also a few combined pipes in this sewer area on Kenoza Avenue and Cliftwood Street. Sewer Area 23 is located west of the Little River, near Haverhill High School. The sewers range in size from 8-inch to 24-inch in diameter and the pipe material is predominantly VC with some PVC and RC. There are combined pipes in this sewer area located on North Broadway Street.

A total of five flow meters were installed for eight weeks. Two temporary flow meters were installed in Sewer Area 14 and three temporary sewer meters were installed in Sewer Area 23. The flow meter locations were selected to monitor flows at the downstream end of each sewer area and the remaining gauges were installed to characterize the upstream subarea collection system near the midpoint.

A rainfall-derived infiltration/inflow (RDII) analysis was performed to characterize excess flow within the sewer areas. The RDII analysis utilized the temporary flow meter data to determine the amount of extraneous flow that makes its way into the sewer system through pipe infiltration and inflow during and following a rain event. The RDII analysis indicated that extraneous flow in the two sewer areas is most prevalent as groundwater infiltration (GWI), but there is an immediate response to some rain events indicating that there may be some direct inflow sources.

Instantaneous flow measurement or spot gauging using portable weirs at select manholes during low flow conditions (night time between 12 AM and 6 AM) was also completed in this sewer areas. The flow readings were intended to identify pipe segments with an infiltration rate greater than 4,000 gallons per day per inch-mile (gpd/in-mi), which would be considered excessive by state I/I guidelines. Pipe segments with infiltration rates greater than 4,000 (gpd/in-mi) were further investigated with closed circuit television inspection.

Television inspection for each sewer area was completed following the spot gauging results. Approximately 17,000 linear feet of sewer were inspected on Sewer Area 14 and about 14,000 linear feet in Sewer Area 23. Of the inspected sewer pipes 13,200 linear feet had a Pipeline Assessment & Certification Program (PACP) structural or maintenance grade 3 or higher and could require rehabilitation.

Some pipe segments could not be investigated because of access issues due to protruding taps, roots, pipe sags, and surcharge. The study summarized a program for the city to eventually gain access to these pipes for future inspections.

2016 Infiltration/Inflow Study

As part of this Integrated FLTCP, the city completed another I/I study. This study focused on another high extraneous sanitary sewer flow area, Sewer Area 24. This area, which is located near Primrose Street, was also identified as an area with the high ratio between spring and summer flows and R-value above 0.05. The city completed further I/I investigations of this sewer area using temporary flow monitoring, spot gauging, and television inspection.

Four flow meters were installed for nine weeks, starting on March 25, 2016 and ending on May 31, 2016. Two meters were installed in the Primrose Street sewer area, Meter 1 monitored flows at the downstream end of sewer area and Meter 2 monitored flows near the midpoint of the sewer area. The other two gauges, Meter 3 and Meter 4, measured the upstream flows that enter the Primrose Street sewer area. The metering data showed immediate wet weather system response (inflow) during most rain events and some delayed inflow indicating potential sump pumps or rainfall dependent infiltration/inflow is visible at all meter locations.

Instantaneous flow measurement or spot gauging using portable weirs at select manholes during low flow conditions was also completed in this sewer area. An estimated 1,387 linear feet of pipe had a computed infiltration rates over 4,000 gpd/in-mi. They were further investigated with closed circuit television inspection. An additional 2,023 linear feet of pipe in Sewer Area 24 was inspected as part of the city's CMOM/Collection System Capital Improvement program and these inspection tapes were evaluated for the 2016 I/I Study. About 2,500 linear feet of pipe have PACP grade ratings of 3 or higher.

Sewer Rehabilitation and Recommendations

Most of the pipes that require sewer system rehabilitation based on these two I/I investigations are not in locations that have experienced sanitary sewer overflows (SSOs), so there are no pipe repairs that require immediate attention to eliminate recurrent SSOs. The television inspections were also, unfortunately, performed during relatively dry spring groundwater conditions, and not a lot visible I/I was noted or could be estimated or documented to confirm I/I reduction that could be achieved with pipe rehabilitation. There was, however, evidence of past pipe infiltration.

The lack of visible I/I and actual flow estimates in the city sewer pipes inspected for these investigations also makes it difficult to confirm how much baseline flow reduction could be achieved by doing system rehabilitation in these areas. However, it is expected that, when system rehabilitation is implemented, there could be some downstream CSO reduction.

Accordingly, the city is carefully considering the priority of completing these system repairs relative to other system improvement requirements.

2.6 Drainage System

The city completed a dry-weather MS4 Stormwater/CSO outfall inspection program in 2014 and 2015. The summary of the investigations was presented in the April 2016 report entitled "2014/2015 Dry-Weather MS4/Stormwater Outfall Inspection Program. This report completed the inspections of the stormwater outfalls in compliance with the 2003 General MS4 NPDES stormwater permit and in compliance with the CD requirements. An overall drainage system map showing the known piping systems, at the time, was presented in the report. These investigations and the sewer manhole investigations were used to refine the combined sewer areas in the city.

The field work identified some outfalls with dry weather flow with pollutant parameters that indicated the potential presence of illicit stormwater system connections. The city is currently performing the field investigations to identify and eliminate any illicit connections that are causing water quality impairments.

Section 3

LTCP Progress

3.1 General

Since the submittal of its Phase I LTCP in 2002, Haverhill has implemented many system improvements to reduce CSO discharges to the Merrimack River and the Little River. The city has spent approximately $34 million on planning, design, and construction of WWTP capacity improvements, interceptor storage maximization, CSO regulator improvements and instrumentation and controls equipment to achieve greater CSO control. The city captures 98 percent of the wet weather generated by its combined sewer system (as of March 2017).

This section provides a summary of the capital spending, planning programs, and compliance activities that the city of Haverhill has undertaken over the last 15 years since the Phase I LTCP program was first submitted to the agencies.

Table 3-1 summarizes the CSO reduction that the city has achieved.

Table 3-1 CSO Reduction Achieved by Haverhill's CSO Control Program

	Pre-Phase 1	Phase 1	Phase 2
City Expenditures		$22	$12
CSO Volume (MG)	71	30	20
Percent Capture	92%	97%	98%

3.2 Nine Minimum Control Measures

Nine minimum controls (NMC) for combined sewer systems are controls that can reduce CSOs and their effects on receiving water quality without requiring significant engineering studies or major construction and can be implemented in a short period of time. The city's NPDES permit requires the implementation of the NMCs as a first step to controlling CSO discharges. Haverhill continues to implement all aspects of the nine minimum control program submitted to the EPA in 1996. In its NPDES permit Annual Report the city summarizes any modifications to their approved NMC program and a description on the NMC to be implemented the following year.

Proper operation and regular maintenance programs for the sewer system and CSO outfalls

The city uses its Computerized Maintenance Management System (CMMS) MaintStar to track and manage the maintenance of their combined sewer system including inspection and cleaning of sewers, drains, pumping stations, CSO regulators and outfalls. Collection system inspection and cleaning is periodically done by outside contractors for the city. Sewer segments with frequent problems are added to a list in CMMS to receive more regular maintenance by the city's crew.

The city's goal is to inspect sewer pumping stations about once per week and complete preventive maintenance quarterly. Cleaning and maintenance of the interceptor system and siphons is performed on an as-needed basis. Collection system personnel perform monthly inspections of the CSO regulators and outfall. In addition, CSO regulators are monitored by flow meter that notify wastewater managers when an activation occurs. If an activation notice is received during dry weather, collection system operators are dispatched to investigate immediately.

Maximize the use of the collection system for storage

The city's CSO regulators are controlled by weirs. As recommended by 2011 LTCP, weirs were raised at six of the CSO regulators to increase the amount of wet weather flow capture. In addition, the city closed thirteen other CSO regulators since 2011, which effectively increases the use of the collection system for wet weather storage.

The city is currently installing modulating CSO control gates at the Upper Siphon and Lower Siphon CSO regulators, along with instrumentation. The instrumentation controls and new gates will give the city real-time and automatic control to maximize the use of the Upper Siphon and Lower Siphon Interceptors for inline storage of wet weather flow to minimize CSO discharges.

Review and modification of pretreatment requirements to ensure the CSO impacts are minimized

The purpose of this control is to minimize impacts of discharges in the combined sewer system from non- domestic sources during wet weather events. The city of Haverhill maintains an industrial pretreatment program (IPP) that monitors significant industrial users (SIU) that discharge to the city's sewer system. The city's sewer use regulations prohibit any discharge to the collection system that may be detrimental to the wastewater treatment process or to the receiving water. These regulations establish limits for the amount of pollutant loads that can be discharged to the sewer system. All industrial discharges to the city's sewer system are required to adhere to the requirements of the city's IPP program.

The 2017 WWTP CPE noted that the city's WWTP has experienced some adverse operating characteristics that could be the results of inappropriate industrial discharges. The city has hired a new Industrial Pretreatment Program (IPP) supervisor to enhance its efforts on control of these discharges into the sewer system. In addition, the city has engaged an engineering consultant to review the IPP program.

Maximization of flow to the publicly owned treatment works (POTW) for treatment

The fourth minimum control is focused on minimal modifications to the collection system and WWTP to enable as much wet weather flow as possible to reach the treatment facility with the ultimate goal of reducing the magnitude, frequency and duration of CSOs to receiving waters. The city has implemented many measures to maximize flow to the WWTP, including raising weirs and adding CSO control gates that will allow real time control to minimize CSO discharge. In addition, in 2006, the city increased the wet weather treatment capacity at the WWTP by increasing its influent pumping capacity and adding a secondary bypass pipe to allow for primary treatment and disinfection of wet weather flow. In 2016, the city also modified the Bradford Avenue CSO and the Middle Siphon Inlet Structure to improve the flow capacity into its interceptor system to maximize flow the WWTP.

Elimination of overflows during dry weather

Overflows from the CSO discharge outfalls are prohibited under the NPDES permit. The city's CSO regulators are monitored to ensure that there are no known dry weather overflows (DWOs). Flow meter in the regulators notify wastewater managers when an activation occurs. If an activation notice is received during dry weather, collection system operators are dispatched to investigate.

There have been five dry weather discharges from the city's CSO regulators over the last 3 years. Four occurred at Locke St South (NPDES #021D) with three occurring in June 2014 and one occurring in August 2016. These dry weather discharges were caused by debris in the downstream 12-inch siphon, which conveys flow under the Little River conduit at Locke Street. This CSO (#021D) was permanently closed in Fall 2016 and the city has increased its maintenance of the siphon. The fifth dry weather discharge occurred in August 2016 at the Chestnut Street (NPDES #041). This was due to debris in the downstream sewer pipe and the city has increased its maintenance of this pipe. An SSO report was prepared and submitted to the USEPA and MADEP for each dry weather discharge (reports SSO-14-10, SSO-14-11, SSO 14-12, SSO 16-18, and SSO 16-19.

Control of solid material and floatable material in CSOs

Under this minimum control, visible floatables and solids should be controlled from being discharged to local receiving waters in the CSOs. The minimum control requires communities to identify low-cost, easily implementable, actions that could reduce or eliminate floatables in the CSO discharges.

Under the Wet Weather System Maximization/CSO Structure Modifications project, the city is maximizing its capture of wet weather flow for eventual treatment at the WWTP, which maximizes floatables control. The city has also raised weirs to capture more wet weather flow, and floatables in the first flush, during storm events. As part of the Integrated FLTCP, CDM Smith evaluated other potential solids and floatables controls options that could be implemented at the CSO regulators. The *Solids and Floatables Control Memo* summarizes this evaluation and is included in Appendix D.

It was determined that there are no easy and cost-effective approaches to capturing solids and floatables at the city's CSO regulators for a variety of reasons including the constrained space within the regulators to install new screens, trash racks, or baffles, the lack of available land (most of the outfalls are situated directly on the river with no reasonable room for inline screens along the outfall pipe), and river/flow conditions that would preclude outfall technologies (like booms or netting systems).

The city relies on regular cleaning of catch basins and street sweeping near CSO regulators as a preventive measure for the reduction of floatables to its combined system and receiving waters. The city is also considering increasing the frequency of catch basin cleaning and street sweeping to improves its floatables capture.

Pollution prevention programs to reduce contaminants in CSOs

Pollution prevention programs can help reduce the amount of contaminants that enter the combined sewer system. Such measures include street sweeping, catch basin cleaning, litter control, public education, etc. Haverhill has adopted city ordinances that prohibit litter and debris from being deposited on the street and within the watershed area. The city also performs regular cleaning of catch basins and street sweeping near CSO regulators as a preventive measure for the reduction of pollutants into the combined system. Finally, the city has an IPP program and is developing an enhanced fat, oil, and grease (FOG) control program that will help to minimize the amount of pollutants in the city CSO discharges.

Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts

The purpose of this NMC is to inform the public of the location of CSO outfalls, the actual occurrence of CSOs, the possible health and environmental effects of CSOs and the curtailing of recreational activities due to CSO discharges. Each of the CSO regulators and outfalls has signage that identifies the CSO outfall. Within 24-hours of a CSO occurrence, an email notification is sent to downstream communities, local Board of Health, harbor master, and local drinking water authorities. The city also maintains CSO information on its website.

Monitoring to effectively characterize CSO impacts and the efficiency of CSO controls

In 2014, the city contracted with a flow metering subcontractor, to install and maintain depth and depth/velocity meters at each of its CSO regulators. These gauges monitor overflow activations and measure CSO flow rates and volumes.

3.3 CSO Improvements/Baseline Condition

Since the submittal of its first CSO Long Term Control Plan, the city has completed many improvements to reduce CSO discharges. The city has made WWTP improvements to increase wet weather treatment capacity, completed improvements to the CSO regulators to allow in-line storage and interceptor maximization, eliminated CSO regulators, and cleaned the sewers and siphons in the Locke Street area to improve conveyance in that area. The city has engaged a contractor to clean the Upper Siphon and is planning to finish cleaning its other large system siphons in a systematic schedule. To-date, the city has also closed and eliminated 13 of its CSO regulators since 2011.

These improvements should reduce the city's CSO average annual discharge to approximately 20 million gallons (MG), which equates to a capture rate of about 98 percent of the wet weather flow generated by the combined sewer system.

3.3.1 WWTP Improvements

The Haverhill Wastewater Treatment Plant was constructed in the late 1970s. The plant was designed to treat an average daily flow of 18 mgd and a peak flow of 46 mgd. In 2006 upgrades were made to the plant to increase capacity and dependability of operations during wet weather conditions. The plant was upgraded to provide primary treatment for wet weather flow up to 65 mgd. The upgrades included, modifications to the primary settling tanks, construction of a new grit facility, a new secondary bypass conduit and associated control gates, instrumentation, and separate disinfection diffuser were also constructed. Upgrades were also made to the WWTP influent pumping station to allow for an increase in plant wet-weather flow, a new modulation control gate, new screening equipment and larger pumps were installed.

These improvements lowered the average annual CSO volume from 70 MG to 30 MG (in conjunction with other improvements at the CSO regulators) in the Phase I program.

In conjunction with the Integrated FLTCP, the city also completed a CPE of the WWTP. The CPE assessed the existing physical and process conditions at the plant and made recommendations for the rehabilitation of the plant and any enhancements to improve operations. The CPE will be submitted under separate cover.

3.3.2 Wet Weather Maximization

In 2015, the city completed the design of the Wet Weather Maximization/CSO Structure Modifications Project. In this project, modifications will be made to Bradford Avenue, Upper Siphon, Lower Siphon CSO Regulator structures and Middle Siphon inlet structure. The Marginal PS Weir CSO regulator was also eliminated in this project. The Wet Weather Maximization/CSO Structure Modifications Project was bid in March 2016 and construction is expected to be completed in March 2017.

At Bradford Avenue CSO, a second interceptor connector pipe was added. An 18-inch connector pipe was installed through the structure floor to increasing discharge capacity to the Bradford Interceptor. The existing weir wall was removed and rebuilt to elevation 15.93 feet. This improvement is completed and the CSO reduction has been significant.

At the Upper Siphon and Lower Siphon CSO regulators, new CSO flow control gates and modulated gate controls were added to remotely control and modulate depths in the interceptors and maximize inline storage. At the Upper Siphon CSO, two 30-inch x 30-inch openings with sluice gates were constructed and installed to replace the existing 84-inch x 84-inch opening and flap valve to the CSO discharge chamber. At Lower Siphon two 54-inch x 54-inch openings with sluice gates are being constructed and installed to replace the existing 120-inch x 60-inch opening and flap gate. Electraulic actuators will be installed on the new CSO sluice gates for modulated control of interceptor depths at both locations.

Also, as part of this project the existing 18-inch x 36-inch sluice gate in the Middle Siphon inlet structure was removed and the opening was made wider to 36-inch x 48-inch, to convey more flow to the Bradford Interceptor.

The intent of the system improvements is to allow the city to capture wet weather flow in the upstream Upper Siphon and Lower Siphon Interceptors during storm events. When upstream inline storage is maximized, flow will be directed to the Bradford Interceptor, or when the Bradford interceptor is full, to the river as CSO. The goal is to limit CSO discharges to after the flow levels in the influent chamber reach elevation 12.00 feet at Upper Siphon and 11.50 feet at Lower Siphon and the siphon chamber inlet control gate is fully open. CSO flows would pass through one or both 30-inch x 30-inch or 54-inch x 54-inch sluice gates, and enter the outfall chamber.

The instrumentation for control includes a local programmable logic controller and a set of depth monitors (radar level transmitters). The Programmable Logic Controller (PLC) will monitor interceptor flow depths locally (at three locations in the structure) and monitor the flow depths at the Middle Siphon and along the Bradford interceptor (via the Supervisory Control and Data Acquisition System, SCADA at the WWTP). The city intends to convey the maximum flow possible from the north side of the system via the Middle Siphon and use SCADA and local instrumentation to store flow in the upstream Upper Siphon and Lower Siphon Interceptors.

Finally, a new 24-inch sewer was constructed to directly connect the Emerson Street and Wall Street sewers to the Middle Siphon inlet structure, eliminating the Marginal Pump Station CSO regulator.

Table 3-2 summarizes the modifications made to each station. These improvements cost the city approximately $2 million dollars and helped to lower the expected average annual CSO volume to 20 MG (based on modeling discussed in Section 4).

Table 3-2 Summary of CSO Regulator Modifications/Closures

Improvements	CSO Regulator
Closed	Bates Bridge, Boardman Street, Fire Station, Railroad Bridge, 266 River Street, Beach Street, Front Street, South Prospect, Main Street South, Ferry Street, Marginal PS Weir, Locke Street North and Locke Street South
Raised Weirs	Middle Siphon, Winter and Hale Street and Middlesex Street

3.3.3 CSO Regulator Weir Modification and Regulator Closures

Under the Phase I and II plans, the city has worked diligently to raise weirs or close the regulators to reduce or eliminate CSOs. Some of these modifications came in steps, where the city first raised weirs and then determined they could be raised higher and/or were eventually closed permanently. To date, since 2011, the city has closed 13 CSO regulator structures and has made weir modifications to six. Regulators that were inactive or minimally active were closed. At other regulators, CSO weir elevations were raised to maximize the use of the upstream interceptor pipes for inline storage. These modifications and closures have increased the capture of wet weather flow and have reduced the frequency and volume of CSO discharges.

Table 3-2, above, summarizes the CSO regulators that have been modified or closed.

3.3.4 Conveyance Improvements

Deposition of solids is a common problem in combined sewer systems. These systems are designed to handle peak wet weather flow, therefore, their hydraulic capacity greatly exceeds typical dry weather flow rates. Consequently, dry weather flow velocities are usually lower than and may cause solids to settle in the pipelines. Over time settled solids accumulate, decreasing the hydraulic capacity of the pipe. Siphon pipes are especially susceptible to solids accumulation.

During the development of the Integrated FLTCP, the city cleaned sewer pipes and siphons along Locke Street. This greatly improved conveyance of flow to the Essex Street Interceptor and reduced discharges from Locke Street Center Barrel CSO.

The city has executed a contract to clean the Upper Siphon and the contractor is waiting for appropriate weather conditions to start the work.

During the development of the Integrated FLTCP (I/I Reduction Studies) and the CMOM/Collection System Capital Improvement Program, the city completed CCTV inspections of more than 10 percent of its system. Prior to these pipeline inspections, many of the sewer pipes were cleaned first to accommodate the safe access for the television equipment.

The city is considering annual expenditures to continue the pipe cleaning and inspection program.

Section 4

SWMM Model Update

4.1 Introduction

The existing collection system SWMM model was updated to complete the analyses for this LTCP update. Based on field investigations and recent flow metering data the model was recalibrated to better reflect the city's CSS. On July 15, 2016, the report entitled *Haverhill, MA Combined Sewer System SWMM Model Update* was submitted to USEPA and MADEP and a meeting was later held to discuss the model updates and calibration efforts included in the report. Both MADEP and USEAP agree that the calibrated SWMM model could be used as a tool to develop and assess alternatives that further reduce CSO and achieve compliance with LTCP goals.

This section briefly summarizes model update and calibration efforts included in the July 2016 *Haverhill, MA Combined Sewer System SWMM Model Update* report.

4.2 Model Update

4.2.1 Overview

Several model updates were made since the 2011 LTCP based on the city's actions and system investigations performed for this report:

- The combined and separated areas of the sewer system were refined. This effort helped update loading points along the interceptors in the model and it also helped in sewer separation planning for the LTCP;
- Weir heights at existing CSO regulators were adjusted based on field measurements (obtained from the metering subcontractor);
- The CSO regulators configurations were verified and updated by field measurements (obtained from the metering subcontractor);
- Thirteen CSO regulators were closed;
- Three new CSO outfalls were added;
- SWMM groundwater (GW) simulation was included in the model to better represent I/I getting into the system;
- A snowmelt component was added to the model to improved annual average statistics; and
- Pipe sediment assumptions were updated based on recent field investigation.

4.2.2 Metering Program

Model metering information was also updated. In addition to the 2010 metering information, metering information from the city's 2014 metering program was used for model calibration. In 2010, thirty-one (31) area-velocity meters were installed throughout the city over six-week monitoring periods in spring and summer. In Spring 2014, seventeen (17) meters were installed to measure depth at each CSO regulator, and area-velocity meters were installed in each CSO pipe. These gages measure the active overflow locations throughout the system. Data from two separate metering periods are complementary to each other.

4.2.3 Groundwater Model Component

The 2011 model represented groundwater infiltration with a daily time series. For this model update, groundwater elevations and infiltration rates are directly simulated. Groundwater infiltration was calibrated based on long-term flow data at the wastewater treatment plant (WWTP) and regional groundwater data. Simulating groundwater in this manner better represents I/I entering the sewer system.

4.2.4 Snowfall Simulation

The model was updated to simulate snow processes. Snowfall simulation was calibrated to long-term daily snow and temperature data reported at Haverhill (USC00193505) as part of the Global Historical Climatology Network (GHCN). Simulation of snow processes helps to more accurately reflect seasonal variation in the groundwater table and more accurately reflect general system response to snow events.

4.3 Model Calibration/Verification

4.3.1 Dry Weather Calibration

The updated model was calibrated to dry weather periods based on the 2010 flow metering period and the 2014/2015 CSO metering. The 2010 dry weather calibration was based on the known configuration of the model in 2010. This calibration provides an update to the 2011 LTCP model calibration by including outfalls that were previously unknown at the time of the 2011 LTCP development, including the updated and refined separated and combined area delineation as a result of the recent field investigation conducted since the 2011 LTCP model development, and included groundwater and snow simulation capabilities, which have been enhanced since the development of the 2011 LTCP.

Calibration to 2014 initiated dry weather periods was based on the current configuration in the model, which reflect changes to system weir heights and CSO closures that have occurred since the 2011 LTCP.

For both 2010 and 2014 dry weather calibration to match the observed and simulated depth, flow, and velocity at each metered location.

4.3.2 Wet Weather Calibration

Wet weather calibration was completed using the past 2010 dataset and the more recent 2014-2016 data set. Wet weather calibration was based on one storm in 2010 and six storm events in the 2014 to 2016 period. The wet weather calibration of this model for the 2011 event was based on presumed flow through the three sets of Merrimack siphons but was generally confirmed using some interceptor flow meters. More accurate CSO regulator calibration was made using the 2014/2015 calibration data, which focused on hydraulic adjustments at system regulators. 2014/2015 metering data indicated that CSO discharges occur prior to the WWTP reaching full capacity. This represents a limit on downstream conveyance capacity at upstream CSO regulators.

For a complete discussion of the wet weather calibration analysis and calibration graphics at each regulator, please refer to the July 2016 *Haverhill, MA Combined Sewer System SWMM Model Update* report.

4.3.3 Verification

A comparison of the 2015 meter versus model overflow data was made to verify the SWMM Model calibration. The model closely matches observed CSO volume at Lower Siphon and estimates similar overflow events. The model accurately reflects the overflow frequency of the Center Barrel Locke Street (CSO 021F) regulator but overestimates the overflow volume. The model underestimates CSO volume and frequency at the Chestnut Street regulator, but it reflects the general behavior of the regulator depth. Similarly, the model underestimates CSO volume and frequency at Winter Street. Evaluation of the 2014 – 2015 calibration plots for this regulator illustrates that the model does a good job of reflecting the general behavior of the depth in the regulator, and matches peak depths well for some storms, but not for others. Metering data indicates higher CSO frequency and volume than is modeled at the Bradford regulator. Wet weather response, as illustrated in the 2014 – 2015 calibration graphics, appears to reflect the general wet weather regulator depth behavior, but may slightly underestimate peaks for some events.

4.3.4 SWMM Model Report Conclusion

The Haverhill collection system model used the best available data to develop a tool to predict future performance of the collection system and evaluate improvement alternatives. Both MADEP and USEAP agreed that the calibrated SWMM model could be used as a tool to develop and assess alternatives for CSO control.

4.4 CSO Characterization

In order to develop and evaluate alternatives the existing system, CSO discharges are characterized for various CSO control objectives. These are used to evaluate the control range that is cost-effective. As a baseline for starting this process, the SWMM model was used to determine the CSO discharge characteristics for the design storms and an average annual condition based on the historic precipitation record.

The characterization was also based on the existing system after the CSO Wet Weather Maximization and CSO Structure Improvements are completed as identified in the city's Revised Phase II LTCP and required under the CD. This will reflect system conditions after construction is completed in March 2017.

Accordingly, modulating gates (and SWMM Model operational control rules/gate modulation criteria) were added to the model operation at the Upper and Lower Siphon CSOs and the Bradford new dry weather connector pipe was added, along with the new sewer eliminating the Marginal PS CSO at the Middle Siphon Inlet Structure.

4.4.1 Design Storms

Once the model was calibrated and validated, it could then be applied to projecting flows for design storm events. The design storms (1-month, 3-month, 6-month, 1-year, 2-year, and 5-year) are select storms from the long term rainfall record that actually occurred and are not synthetic design storms. Synthetic design storms can tend to be intense at the peak of the storm causing conservative peak flow projections. Because these design events are measured storms, the CSO projections for these events will be more reflective of the events projected from the long-term rainfall simulations. The design storms were selected for the previous LTCP reports and continued for this report. The design storm hyetographs are included in Appendix E.

The design storms used in this report for analyses correspond to the CD stipulation on the range of overflows per CSO outfall per year as follows:

2017 Consent Decree	**LTCP**
4 to 7 CSOs per year	3-Month Design Storm
1 to 3 CSOs per year	6-Month Design Storm and 1-Year Design Storm
0 CSOs per year	5-Year Design Storm or Complete Elimination

CSO volumes, flow rates, and duration for the design storm simulations with the updated model are summarized in Table 4-1. The volume of CSO discharge across the system for the design events range from 0.39 MG to 29.4 MG for the 1-month, and 5-year events respectively.

With all of the new improvements recommended in the Phase II LTCP including the CSO Maximization and CSO Structure Improvements (and real-time control), the Haverhill combined sewer system has very little CSO volume during a 3-month frequency storm event. As shown in Table 4-1, only nine (9) CSO discharge during the 3-month event. Only one CSO, the Locke Street Center Barrel CSO, has any significant CSO discharge volume. All of the other CSO activations are less than 0.1 MG.

4.4.2 Average Annual CSO

Continuous simulation of the 1969 – 1973 representative period previously used in the 2011 LTCP was completed to obtain average annual CSO statistics using the updated model. Average annual CSO discharge across the system changed from a total of 30.2 MG in the 2011 LTCP to 19.6 MG under the updated model and with the Phase II improvements completed (as of March 2017).

On an average annual basis, seven (7) of the remaining 15 CSO regulators discharge more frequently than 4 times per year. But most of this discharge is of short duration and small volumes.

Table 4-1 Design Storm CSO Summary – Baseline Conditions (with Wet Weather System Maximization/CSO Structure Improvements)

		1 Month Storm			3 Month Storm			6 Month Storm			1 Year Storm			2 Year Storm			5 Year Storm			Average Annual Conditions	
Name	NPDES ID	Volume (MG)	Peak Flow (MGD)	Duration (hours)	Volume (MG)	Peak Flow (MGD)	Duration (hours)	Volume (MG)	Peak Flow (MGD)	Duration (hours)	Volume (MG)	Peak Flow (MGD)	Duration (hours)	Volume (MG)	Peak Flow (MGD)	Duration (hours)	Volume (MG)	Peak Flow (MGD)	Duration (hours)	Volume (MG)	Events
Upper Siphon CSOs																					
Upper Siphon	024				0.002	0.1	0.8	0.002	0.1	0.8	0.30	11	2	0.75	24	2.3	2.36	39	4.8	0.9	4
Middle Siphon CSOs																					
Winter Street	021G													0.09	4	1	0.45	9	2	0.3	1
Winter & Hale	021H				0.07	2.6	1.0	0.12	5	1.3	0.24	5	7.3	0.41	11	2.3	1.19	18	3.8	0.9	9
Locke Street Center Barrel	021F	0.14	3	6	0.79	12	3.3	1.02	16	5.8	1.32	17	26.3	2.01	27	6.5	4.04	35	9.8	8.0	22
Broadway (flood)	037																0.02	0.7	1.3		
High Street (flood)	038																				
Emerson (flood)	021B													0.01	1	0.5	0.11	3	1.5		
Middle Siphon	021A				0.04	2.3	0.3	0.10	4	.75	1.01	21	2.3	1.51	37	2.3	4.13	46	4.8	3.1	5
Lower Siphon CSOs																					
Main St North	019																			0	0
Bethany Avenue	040	0.008	0.5	0.7	0.06	2.2	1.5	0.113	3	2	0.18	3	2.3	0.30	7	3.5	0.76	11	4	0.9	17
Chestnut Street	041	0.004	0.3	0.4	0.04	1.5	1.3	0.075	2	1.8	0.12	2	2.3	0.20	5	3	0.51	7	3.8	0.8	15
Lower Siphon	013				0.03	2.65	0.5	0.07	6	1.3	0.97	24	2.3	1.39	95	1.8	5.83	108	5.5	3	4
Bradford CSOs																					
Bradford	032																0.07	3.5	0.8	0	0
Middlesex Street	034				0.03	1.6	0.8	0.07	3	1	0.24	6	2.3	0.56	18	2.3	1.57	27	4	0.8	10
South Webster Street	039	0.009	0.2	0.3	0.02	0.4	3.0	0.035	1	5	0.04	1	5.8	0.11	4	5.3	0.37	7	8	0.9	34
	TOTAL	**0.16**			**0.97**			**1.61**			**4.41**			**7.32**			**21.39**			**19.6**	
	FLOODING	**0.00**			**0.00**			**0.00**			**0.02**			**0.45**			**1.38**			**0.1**	

Note: Bates Bridge, Boardman Street, Fire Station, River Street, Beach Street, Front Street, South Prospect Street, Main Street South, Ferry Street CSO were closed (bricked-up) in Phase 1.
Locke Street North and Locke Street South and Marginal PS Weir CSO regulators were closed (bricked-up) in 2016.
Flooding volumes represent upstream flooding in the SWMM model simulations that results from the flow loading arrangement and may not represent accurate system surcharge to street level in reality.

Section 5

Water Quality Objectives

5.1 Introduction

All discharges to the waters within the Commonwealth of Massachusetts should meet the requirements of the federal Clean Water Act (CWA, passed in 1972) and the state's Surface Water Quality Standards (WQS) as described under 314 CMR 4.00. The water quality standards identify the anticipated recreational, fisheries, water supply and other designated uses of the receiving waters and provide numerical (and narrative) standards for key pollutants that should be achieved to maintain these designated uses.

When it rains, pollutant loads from surface water runoff are discharged to receiving waters from both point and non-point sources. Non-point sources are difficult to identify, quantify, and control. However, point source loads - such as stormwater drain outfalls and CSO outfalls – can be located and are more easily characterized. Thus, point source loads receive more regulatory attention. The USEPA regulates these point source discharges via the NPDES permit program. The Haverhill WWTP and CSO outfalls each have a unique NPDES permit number while the city's stormwater outfalls are covered under a blanket general permit as part of the Phase II Stormwater NPDES MS4 program.

Discharges are held to numeric limits in order to maintain the designated uses of the receiving water. If these uses are unattainable, given natural conditions and/or due to existing discharges that cannot be removed, the regulations allow a modification of the receiving water uses. However, the regulatory modification process requires a comprehensive review of alternatives for intermediate pollutant control levels and estimates of costs, and involves the public and interested parties.

Both federal and state agencies recognize that compliance with state quality standards for CSO discharges is costly. Accordingly, both governments have developed separate, but similar, CSO control policies to guide the abatement of CSO discharges given the technical, social, and economic challenges for each community.

This section presents a summary of the federal and state CSO policies, and the water quality standards for the Little River and Merrimack River in Haverhill. The section also includes a summary of existing river water quality data and analyses that provide an understanding of the current status of the rivers with respect to the standards and potential attainment of any impacted designated uses. This information considers the receiving water benefits that could result with the implementation of each of the various CSO control alternatives (developed and analyzed in the proceeding sections).

5.2 USEPA CSO Policy

Under the federal CSO policy, CSO discharges are subject to both the technology-based and water quality based requirements. The CSO Control Policy, issued in April 1994 (see Appendix F), provides the EPA guidance for controlling CSOs. A two-part approach to CSO control is incorporated into the policy: (1) the implementation of best management practices called the Nine Minimum Controls, and (2) the development and implementation of an LTCP provided the implementation of the NMCs are not adequate on their own to meet state water quality standards.

5.2.1 Nine Minimum Controls

The minimum technology-based controls are the nine minimum controls (NMCs). The CSO Control Policy required all communities to implement the NMCs by January 1997.

Haverhill's compliance with the NMCs was detailed in a previous CDM report entitled "City of Haverhill, Massachusetts Wastewater Division Draft Report on Nine Minimum Control Measures for CSOs" dated September 1996.

As part of this LTCP, the City contracted CDM Smith to review its nine minimum controls report and provide an update to the program based on the city's current inspection procedures, system maintenance activities, public notifications, and public educations as it relates to the combined sewer system. This discussion is included in Section 3 of this report.

Nine Minimum Control Measures:

1. Monitoring to characterize CSO impacts and the efficacy of CSO controls.
2. Proper operation and regular maintenance programs for the sewer system and the CSOs
3. Maximum use of the collection system for storage
4. Review and modification of pretreatment requirements to minimize CSO impacts
5. Maximize flow to the POTW for treatment
6. Prohibition of dry-weather CSOs
7. Control of solid and floatable materials in CSOs
8. Pollution prevention programs
9. Public notification of CSO occurrences/impacts.

5.2.2 Long-term Control Plans

The NPDES regulating authority (EPA Region 1 in the case of Haverhill) determines whether the NMCs satisfy the technology-based requirements of the CWA. If further controls are necessary to meet water quality standards, then the NPDES authority will require the development of a Long-Term Control Plan (LTCP).

EPA issued the Draft Guidance On Implementing Water Quality Based Provisions of CSO Control Policy. This document indicates that if the receiving water is on the State's 303(d) list for the development of a total maximum daily load (TMDL), then the TMDL studies and LTCP should be linked, and should include a schedule for WQS reviews. To date, however, only a draft TMDL has been developed for the Merrimack and Little Rivers, and no final TMDL is in place for either receiving water to define all point and non-point sources of pollution.

By the requirements in the Clean Water Act, CSO discharges that remain after implementation of the CSO controls must not interfere with the attainment of state's WQS. Under the CSO Control Policy, communities with combined sewer systems are expected to develop a LTCP to provide for attainment of the water quality and uses over a reasonable period of time.

The EPA CSO Control Policy presents two alternatives to selecting long term control plans for CSO's: the "presumptive approach" and the "demonstrative approach".

5.2.2.1 Presumptive Approach

The "presumptive approach" is based on the presumption that achievement of certain performance criteria will be sufficient to meet current applicable water quality standards. The presumptive approach involves meeting one of the following three criteria:

- No more than an average of 4 overflow events per year;
- Elimination or the capture of no less than 85% by volume of the combined sewage collected in the combined sewer system during precipitation events on a system-wide annual average basis; or
- Elimination or removal of no less than the mass of pollutants identified as causing water quality standards impairment.

As part of the presumptive approach, there must also be sufficient information available to indicate that these levels of control can reasonably be expected to meet the state water quality standards. Communities following the presumptive approach are also expected to conduct post LTCP monitoring to show that water quality standards are being met. If a community is at no more than 4 overflows per year or captures 85 percent of their flow, and instream water quality standards are still being exceeded, then further CSO controls are needed.

Haverhill still has CSO activations that exceed 4 times per year but the existing system (as of March 2017) does capture 98 percent of the wet weather generated by the combined sewer system.

5.2.2.2 Demonstrative Approach

The demonstrative approach (that favored by DEP and EPA Region I for Haverhill) was developed to address instances where compliance with the presumptive approach would result in greater investments in control than necessary to achieve water quality standards. Under the demonstrative approach, communities collect and present data in the LTCP that is sufficient to show that the proposed control alternative is adequate to meet appropriate state water quality standards. The CSO Control Policy lays out four criteria for successful use of the "demonstrative approach." A LTCP should show that the:

- CSO control program will protect water quality standards unless the standard cannot be met as a result of natural conditions or other pollution sources;
- Overflows remaining after implementation of the control program will not prevent the attainment of water quality standards;
- Planned control program will achieve the maximum pollution reduction benefits reasonably attainable; and
- Planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet water quality standards.

- When water quality standards cannot be met because of natural conditions or other pollution sources, a TMDL or other means should be used to apportion pollutant loads within the watershed.

5.3 Massachusetts Policy for Abatement of CSOs

In August of 1997, the Commonwealth issued its own CSO Control policy (see Appendix G). This policy is similar to the EPA policy in many ways, but also has several significant differences.

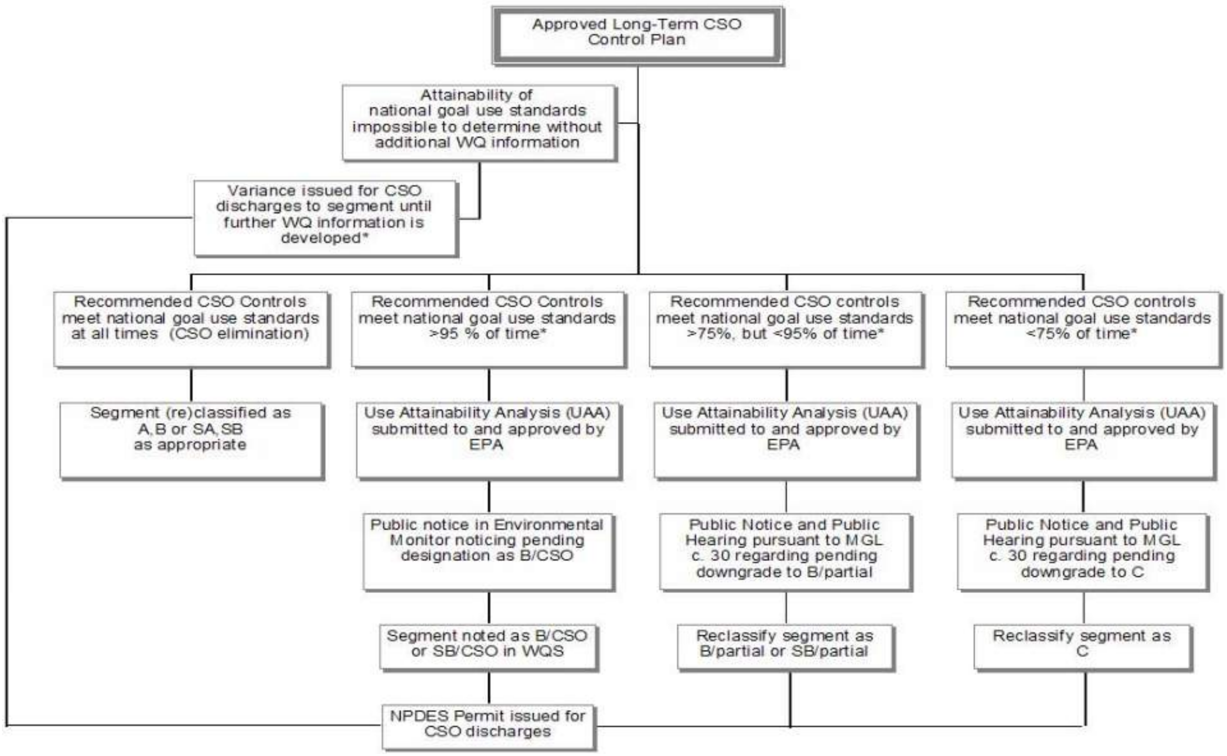
States are required to develop water quality standards applicable to their water bodies. While EPA reviews and approves these standards, the establishment of the standard is the responsibility of the state. In Massachusetts, any NPDES permit for a CSO discharge must comply with Massachusetts Surface Water Quality Standards (314 CMR 4.00). Massachusetts has chosen to designate all waters in the state as fishable and swimmable. For freshwater, all water bodies were originally designated as either Class A (drinking water source) or Class B (swimmable). For marine waters, all water bodies are either Class SA (shellfish) or Class SB (shellfish restricted).

Massachusetts' regulatory options for CSO control are implemented through different water body classifications, as follows:

- Class B or SB – No discharges are allowed that impact WQS (such as untreated CSO dischargers).
- Class B (CSO) - CSOs may remain but must be compatible with water quality goals of the receiving water. The water body must meet uses more than 95 percent of the time. DEP considers 4 overflows events per outfall per year as satisfying the 95 percent time period. Two water bodies in the state have been re-classified as B(CSO).
- Variance - CSOs may remain under a short-term modification of water quality standards. Currently, portions of the Charles River have a variance while studies are underway to determine the final designation. Also, GLSD located a few towns upstream of Haverhill, requested a variance as part of their Phase II CSO LTCP.
- Partial Use Designation - CSOs may remain with moderate impacts resulting in impairment of water quality goals. Moderate impacts are defined as short-term impairments and water quality standards would be met 75 percent of the time.
- Class C - Where the State is certain that the CSOs will prevent the attainment of national use goals more than 75 percent of the time, the water body is classified as Class C.

Under the Massachusetts program, one permanent solution to CSO control, besides river reclassification to BCSO of the water body, is the complete elimination of the CSO discharge. This has usually been interpreted to mean almost complete separation of the combined sewer system, even though there is strong evidence to suggest that untreated stormwater created by separation may itself cause exceedances of the water quality standards.

The permittees must go through a number of technical and procedural steps to permanently reclassify the receiving water, or to provide temporary modifications to the classification. The steps associated with this process are included in Figure 5-1. The procedural steps involve the notice of proposed changes in the Environmental Monitor, and the conduct of various public meetings and hearings and the official publication of the reclassification of the State's Water Quality Standards Regulations.



*One of the criteria of 314 CMR 4.03(4) must be met

Figure 5-1 CSO Controls – WQS Coordination

Underlying these procedural steps are supporting technical analyses that show that fully achieving the designated Class B uses everywhere all the time is not attainable. The studies are generally called Use Attainability Analyses (UAA). In order to permanently reclassify the receiving waters, the UAA must show that one of the following conditions exist:

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

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

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

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

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

6. Controls more stringent than those required by sections 310(b) and 306 of the Act would result in substantial and widespread economic and social impact.

According to DEP policies, the justification for a variance, which are temporary rather than permanent suspensions of the designated uses, involve the same substantive requirements as a change in use although the evaluation needed are less rigorous. As discussed later in this report, reasons 1 and 2 stated above may be applicable to the Merrimack and Little Rivers, respectively, and may warrant a variance from their intended uses.

5.4 River Classification and Uses

5.4.1 Classification

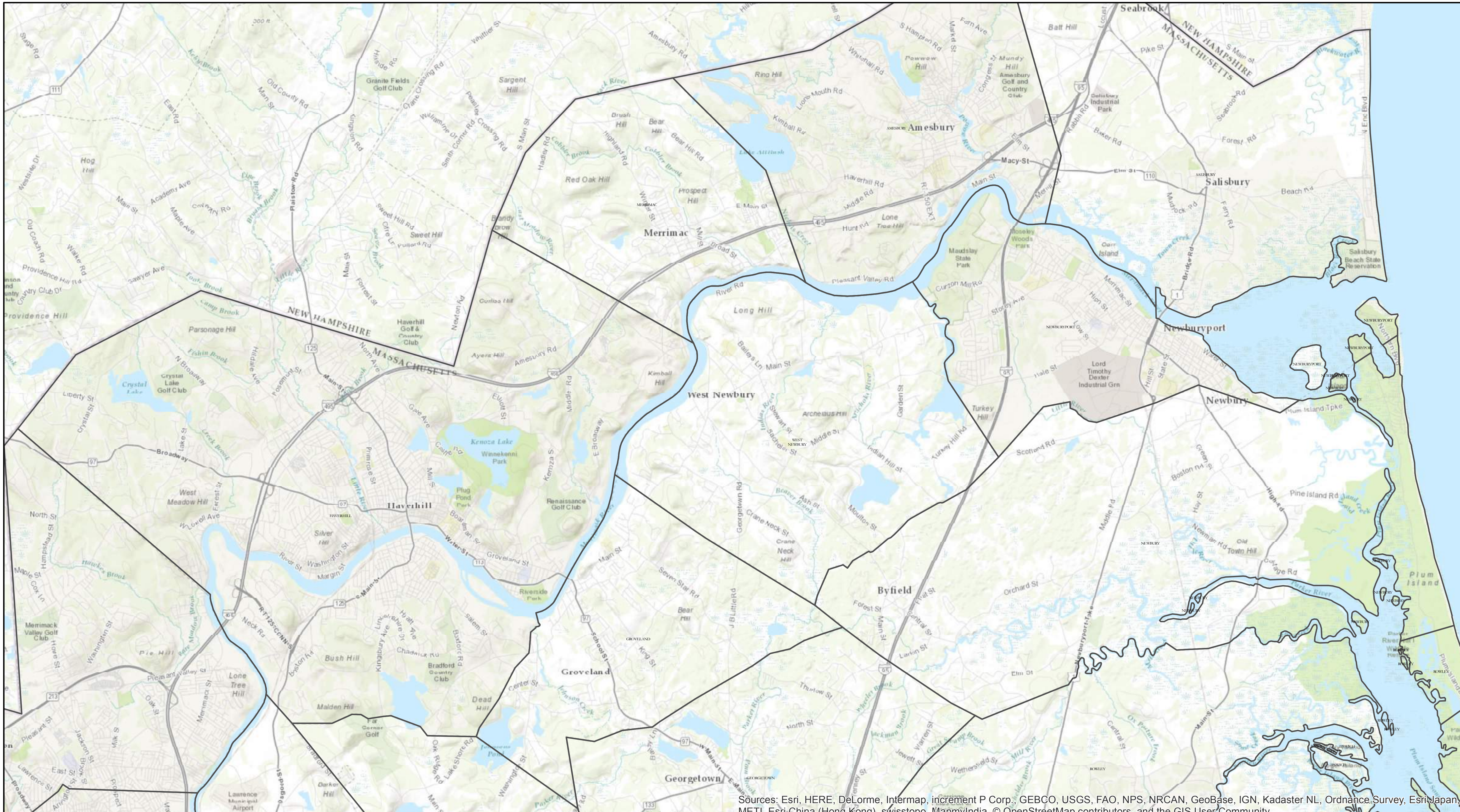
All water bodies, streams, rivers, ponds, lakes, and coastal areas in the state are classified in the Massachusetts Surface WQS 314 CMR 4.00 (December 2013). These standards designate uses of the waters such as water supply or shellfishing. To protect the designated uses, the MADEP prescribes the minimum water quality criteria required to sustain the designated uses.

The Merrimack River from the Route 495 bridge to the Atlantic Ocean at Salisbury and the lower segment of the Little River, from the state line, are the receiving waters for this study, see Figure 5-2 (page 5-7).

The lower segment of the Little River is Class B defined as:

> *Class B - These waters are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*

The Little River uses are qualified as warm water fisheries.



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City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

Haverhill CSO Receiving Waters
Figure 5-2

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The Merrimack River is Class B from the Haverhill city line to the Little River. From the Little River to the coast, the Merrimack River is Class SB. The SB designation is for marine waters; the lower segment of the Merrimack is influenced by ocean tides. Uses designated for Class SB waters in the state include:

> *Class SB - These waters are designated as a habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas). These waters shall have consistently good aesthetic value.*

The Merrimack River uses are qualified as warm water fisheries in the Class B portion of the river and for shellfishing in the SB portion of the River. However, the Merrimack River from Haverhill to Amesbury has very low salinity and does not support existing or potential shellfishing use in the Haverhill reach under Class SB.

5.4.2 Uses and Supporting WQS

There are four major categories of potential uses of the Class B and SB rivers in Haverhill – aesthetics; habitat for fish, wildlife, and aquatic life; primary (swimming) and secondary (boating) contact recreation; and water supply.

Aesthetics

The aesthetics of the river are an important asset to Haverhill. The city has urban renewal projects that focus on land adjacent to the river bank. The riverfront is also the setting for several city parks, and a future river walk and trail system that will be incorporated in the Heritage Trail system.

These state WQS indicate that the waters should be free from color and turbidity and floating, suspended, and settleable solids in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class. Oil, grease and petrochemicals that produce a visible film on the surface of the water or impact aquatic life are also prohibited.

Fishing

State and local parks provide public access for fishing. The Haverhill City River Park and Maudslay State Park (in Newbury) provide access for fishing. Additionally, numerous direct access points to the river bank and boat fishing is available. Freshwater species caught include Smallmouth Bass, Bullhead Catfish, and White Perch. The Merrimack River is also an anadromous fish run. The fish include River Herring, American Shad, and Atlantic salmon as the three main species, but also the Sea Lamprey, American Eel, and Stripe Bass. For the most recent reported year, in 2016, 417,240 River Herring, 67,528 American Shad, and 6 Atlantic salmon passed the fish lift at the Essex Dam in Lawrence. (Fish and Wildlife Service, 2016)

WQS indicate that waters shall have a temperature not to exceed 68^{o} F (20^{o} C) for cold-water fisheries and 83^{o} F (28.3^{o} C) for warm-water fisheries. Dissolved oxygen levels must also be maintained at 6.0 milligrams per liter (mg/l) for cold-water fisheries and at 5.0 mg/l for warm-water fisheries. Solids and oils and grease should be minimized to avoid benthic loadings along the river bottom, deleterious effects to aquatic organisms, and tainting or undesirable taste in edible portions of fish.

The Massachusetts Department of Public Health has issued a Freshwater Fish Advisory for mercury for the Merrimack River from above the Essex Dam in Lawrence to the state line in Tyngsborough. However, there are no reported issues based on these standards affecting fish and there are no fish advisories that exist in this project's study area, which is below the Route 495 bridge upstream of Haverhill to the ocean. The Merrimack River meets the fishing use for the section in Haverhill.

Fishing is not possible on the downstream portion of the Little River because the stream is shallow, narrow and enclosed in a concrete culvert.

Shellfishing

The Merrimack River below the Route 95 Bridge in Newburyport and Salisbury is a designated shellfish area, but the area has been closed for more than 20 years because of high bacteria counts. In March 2006, the Massachusetts Division of Marine Fisheries announced the re-classification and re-opening of the Merrimack River shellfish flats in Newburyport and Salisbury to the conditional harvesting of soft-shell clams.

Water quality testing by Marine Fisheries confirmed the river meets moderately contaminated criteria during dry weather, for a Conditionally Restricted classification. Marine Fisheries sampling also demonstrated that rainfall causes intermittent and predictable periods of bacteria counts above thresholds levels.

Consequently, only specially licensed Master and Subordinate diggers may harvest soft-shell clams for depuration (purification) at Marine Fisheries' Shellfish Purification Plant at Plum Island Point, Newburyport. At the Shellfish Plant, clams are purged of bacteria in clean seawater in a controlled, strictly monitored, process for two to three days until safe to eat. No recreational harvesting is allowed in these areas.

The sources of the bacteria are thought to be upstream untreated river discharges (CSOs, stormwater and non-point sources) and local non-point sources. Also, the area within the influence of the Newburyport wastewater treatment facility and Amesbury wastewater treatment facility remains closed to shellfishing.

Swimming

Currently, there are no designated swimming areas on the lower Little River or along the Merrimack River within and downstream of Haverhill. Swimming is not possible on the lower segment of the Little River because the stream is narrow and shallow and, in its last reach, enclosed in a concrete culvert. The Salisbury Beach State Reservation and beaches on Plum Island are located on the ocean at the mouth of the Merrimack River. Public access to the Merrimack River is available through several state and local parks.

Bacteria are used as an indicator to identify the potential health risks to swimmers. Under the WQS, no single E. coli sample shall exceed 235 colonies per 100 milliliters.

Boating

Boating, kayaking, canoeing, jet skiing, water skiing, and sail boarding are popular activities on the lower Merrimack River. Boat launches are available at Riverside Park and the Crescent Yacht Club and numerous marinas in Amesbury, Newbury, and Newburyport. Boating is not possible on the Little River because the stream is shallow, narrow and enclosed in a concrete culvert. Bacteria in the river can impact secondary recreation.

Water Supply

There are no municipal water withdrawals for drinking water along the Little River or the Merrimack River through and below Haverhill. The city of Haverhill is in the final stages of developing a new water supply, which comprises a new indirect water withdrawal from the Merrimack River using radial collector wells.

5.4.3 Status of River Water Quality

Section 303(d) of the CWA requires each state to periodically review and identify those waterbodies that are not expected to meet surface water quality standards after the implementation of technology-based controls. Water bodies and uses that are impaired by water quality issues are included on the 303(d) list, which is also referred to as the Integrated List of Waters. The CWA requires that states develop a total maximum daily loads (TMDL) assessment to determine what pollutant loads are acceptable to maintain water quality standards and/or receiving water uses.

Both the Little River and the Merrimack River are on the 2014 303(d) list, the latest list available. Table 5-1 presents the information from the state's 303(d) list. The list does not identify the source of the impairment.

Table 5-1 Water Quality Impaired Segments

River	River Segment	Size	Impairment Cause
Little River	New Hampshire state line, Haverhill to confluence with Merrimack River, Haverhill.	4.6 Miles	(Debris/Floatables/Trash*), (Habitat Assessment (Streams)*) and Escherichia coli
Merrimack River	Essex Dam, Lawrence to confluence with Little River, Haverhill.	10 Miles	Escherichia coli, PCB in Fish Tissue and Phosphorus (Total)
Merrimack River	Confluence Little River, Haverhill to confluence Indian River, West Newbury/Amesbury.	1.83 Sq. Miles	Enterococcus and PCB in Fish Tissue
Merrimack River	Confluence Indian River, West Newbury/Amesbury to mouth at Atlantic Ocean, Newburyport/Salisbury	4.46 Sq. Miles	Enterococcus, Fecal Coliform and PCB in Fish Tissue
Merrimack River	The Basin in the Merrimack River Estuary, Newbury/Newburyport.	0.17 Sq. Miles	Fecal Coliform

* TMDL not required (Non-Pollutant)
Source: Massachusetts Year 2014 Integrated List of Waters

In 2005, MassDEP completed a draft TMDL for pathogens for the Merrimack River and Little River. The draft TMDL found the sources of bacteria in the Merrimack River watershed were many and varied. Most of the bacteria sources are believed to be stormwater related, but also included failing septic systems, CSOs, sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland storm water runoff.

The draft TMDL could not accurately estimate the existing sources to determine the control approach. For the illicit connections to the stormwater system and/or direct discharges to the river, the goal is complete elimination (100 percent reduction). This should be accomplished through the Phase II NPDES Stormwater program for the municipal separate storm sewer system (MS4s) permittees along the river. The city completed dry-weather stormwater outfall inspections and flow sampling in 2014/2015 in compliance with the 2003 NPDES MS4 Stormwater Permit and is now working to identify any potential illicit connections in the stormwater system.

For wet weather conditions, target bacteria load reductions were estimated using typical storm water bacteria concentrations. This analysis indicated that a pollutant load reduction of two to three orders of magnitude (i.e., greater than 90 percent) of stormwater fecal coliform loading would be required to meet the bacteria standard. The draft TMDL determined that the goal should be accomplished through implementation of best management practices, such as those associated with the nine minimum controls and Phase II control program for stormwater.

The draft TMDL proposed a Waste Load Allocation (Limit) for CSO discharges to meet the state WQS. The TMDL targets a discharge with a bacterial level not to exceed a geometric mean of 200 organisms in any set of representative samples and shall not have more than 10 percent of the samples exceed 400 organisms. The state has not issued a final TMDL for the Merrimack River.

5.5 Existing Water Quality Data – Merrimack River Watershed Assessment

General

A comprehensive watershed-based study was undertaken by the CSO communities on the Merrimack River starting in 2002. The effort was jointly funded by the CSO communities and the federal government, through the United States Army Corps of Engineers (USACE) New England District. The five local-community sponsors are Manchester and Nashua, New Hampshire; Lowell and Haverhill, Massachusetts; and the Greater Lawrence Sanitary District (GLSD), Massachusetts. Collectively, these communities formed the Merrimack River Basin CSO Coalition (MRBC).

The overall purpose of the watershed assessment was to develop a comprehensive watershed management plan for the Merrimack River watershed. The plan could be used to guide investments in local environmental resources and infrastructure, with the goal of achieving water quality and flow conditions to support uses such as drinking water supply, recreation, fisheries and aquatic life support.

Water quality and streamflow data were collected for this study and used in the calibration and validation of water quality and hydrologic/hydraulic models. The water quality models were used to determine whether segments of the mainstem of the Merrimack River are likely to meet state water quality standards with discharge improvements.

Additional phases of the Merrimack River Watershed Assessment continue. Several phases of water quality sampling and modeling have been completed. Water quality sampling was completed in August 2016, and water quality modeling of the Lower Merrimack basin is currently in progress and will be completed in fall 2017. The data report for the 2016 sampling and current modeling results are anticipated for submittal later this year. Thus far, no more significant findings or conclusions have been made.

Sampling Program

The monitoring area for Phases I and III of the watershed assessment encompassed the lower portion of the mainstem Merrimack River from Concord, New Hampshire to its estuary in Newburyport, Massachusetts, and also included the mouths of eleven major tributaries adjoining the mainstem. Additional sampling further upstream along three of those major tributaries was also conducted in Phase III to assess any potential nonpoint source impacts to water quality. In total, over sixty mainstem sampling locations and over thirty tributary sampling locations were strategically located in-stream to measure streamflow and/or concentration of dissolved oxygen and pollutants such as bacteria and nutrients. Additionally, locations upstream and downstream of numerous storm drain outfalls and combined sewer overflow (CSO) outfalls were sampled during wet and dry-weather events to monitor contributing pollutant loads from urbanized areas. Note that Phase II of the watershed assessment focused on the Upper Merrimack River in New Hampshire, including the mainstem Merrimack and Pemigewasset Rivers from Lincoln, NH, close to the headwaters and as far south as the Massachusetts state line.

From 2003–2005, three dry-weather surveys and four wet-weather surveys were conducted in the Lower Merrimack. A continuous survey of dissolved oxygen and temperature was also conducted at two locations for a one-month period during low-flow conditions in August and September 2003. Between 2014 and 2016, one dry-weather mainstem survey, one wet-weather mainstem survey, one hybrid dry/wet-weather mainstem survey, and one dry-weather tributary survey were conducted in the Lower Merrimack.

The following conclusions were drawn from the water-quality surveys (2016 results pending):

- The mainstem of the Merrimack River from Manchester to the Atlantic Ocean is impaired with respect to bacteria standards, although many reaches exhibit satisfactory bacteria levels during dry weather.
- Many of the tributaries are impaired with respect to bacteria standards during wet weather, as measured upstream of combined sewer outfalls.
- The mainstem of the Merrimack River from Manchester to the Atlantic Ocean is not impaired with respect to dissolved oxygen standards. Measured and simulated concentrations of dissolved oxygen were always well above the regulatory threshold of 5 mg/l.
- While currently there are no regulatory requirements for nutrient levels in the river waters, levels of nutrients (phosphorus and nitrogen) in rivers can be indicative of the likelihood of excessive in-stream organic production, which can deplete oxygen levels in

the water and degrade aquatic habitat quality. Mainstem concentrations of nitrogen and phosphorus exhibited a wide range that is generally thought to be acceptable.

- Levels of chlorophyll-a, another indicator of organic productivity in the water, were generally not excessive in the New Hampshire reaches of the river. Levels in the mainstem downstream of Lowell ranged as high as 42 µg/L under 7Q10 conditions. Despite these high levels of chlorophyll-a, no impairment of dissolved oxygen was found, indicating that the river can support high levels of algae growth.

Receiving Water Quality Evaluation

One of the objectives of the Merrimack River Watershed Assessment was to complete a comprehensive analysis, using computer models, of the impacts of CSO discharges and point and non-point stormwater discharges to assess the incremental benefits that would be achieved by the complete elimination of all CSO discharges along the Merrimack River.

Model Development

A suite of hydrologic, hydraulic, and water quality models were developed as tools to assist in evaluating and comparing watershed management strategies and in prioritizing potential improvements in the watershed. The goals of the modeling effort were to:

- Simulate the generation of pollutant loads (primarily bacteria and nutrients) throughout the watershed, both from point sources and nonpoint sources.
- Simulate the water quality and flow regimes in the mainstem Merrimack River under dry weather and wet weather conditions.
- Simulate the dynamic nature of storm events as well as seasonal patterns and their effect on water quality and hydraulic conditions in the mainstem Merrimack River.

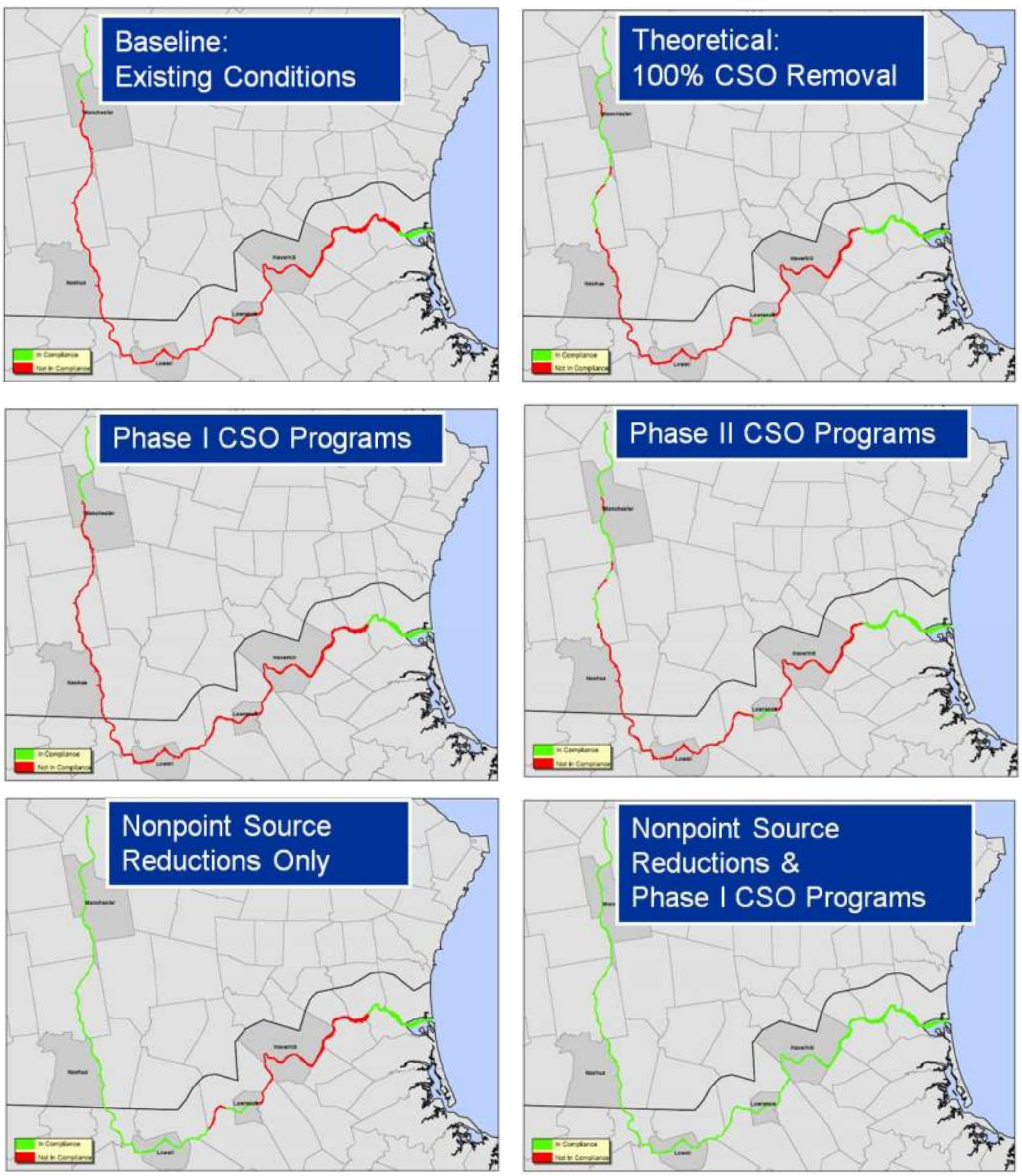
These goals were achieved by combining the strengths of several different public domain models. Existing models of combined sewer systems developed in USEPA Stormwater Management Model (SWMM) and Modeling of Urban Sewers (MOUSE) for each of the five major CSO communities in the basin were incorporated. Hydrological Simulation Program—Fortran (HSPF) was used to model watershed hydrology and nonpoint source water quality. The HSPF model represents all major tributaries to the Merrimack River, as well as non-point source loads for the basin. The CSO and HSPF flow inputs were entered into a SWMM hydraulic model of the mainstem Merrimack River. The Water Quality Simulation Program (WASP) was used to simulate dynamic concentrations of bacteria, nutrients, dissolved oxygen, chlorophyll-a, and BOD in the river.

Model Simulations

Using the hydrologic and hydraulic models, a series of discharge abatement strategies were evaluated throughout the watershed to determine the water quality benefits and river improvements that could be achieved by these options.

Figure 5-3 (page 5-14) shows a summary of the compliance status for bacteria along the Merrimack River under each scenario from the Phase I assessment. The bacteria compliance was assessed using the older version of the Massachusetts Water Quality Standards that was in effect when the Phase I assessment was completed. These criteria require that the geometric mean of any representative set of samples must be less than 200 org/100 ml and less than 10% of the samples can exceed 400 org/100 ml. For this assessment the geometric mean and 10% daily maximum bacteria criteria were evaluated using all daily fecal coliform values over the 180-day simulation period. Subsequent updates to the Massachusetts Surface Water Quality Standards use *E. coli* as the indicator pathogen for freshwater and Enterococcus as the indicator pathogen for saltwater; the Phase III modeling assessment will evaluate compliance with respect to the revised water quality standard.

Figure 5-3
Compliance Summary for Watershed-Wide Abatement



The status of each of the 140 river segments represented in the simulation model is shown as "Baseline: Existing Conditions" in Figure 5-3. This figure illustrates that the entire reach from Haverhill to the ocean exceeded bacteria limits under the existing conditions at the time of the report (2006). Under current conditions, "Phase I CSO" (as Phase I controls have been implemented by all CSO communities along the river), a portion of the river, downstream of Haverhill and all the way to the ocean, should be in compliance with bacteria standards (in Massachusetts) and should support primary and secondary contact recreation under most conditions.

The following conclusions were drawn from the analysis of the alternative discharge abatement strategies:

- An alternative strategy is to reduce nonpoint source control to reasonable levels, as defined by approximately 20 percent reduction of all runoff concentrations and reduction of background concentrations in highly polluted tributaries to 5,000 organisms/100ml (still well above standard). This is shown in "Nonpoint Source Reductions Only." This strategy will offer significant improvements in compliance with bacteria standards upstream of Haverhill but does not significantly change the downstream compliance status.

- Full separation of combined sewers, in all communities, shown as "Theoretical 100% CSO" would offer very little improvement in river water quality downstream of Haverhill. This condition exists because overflow events, taken together, occur for a very small percentage of the time in any given year. The remainder of the time, the river system is dominated by stormwater and background concentrations that often exceed bacteria standards.

- Long-Term phased CSO abatement programs (including partial separation, storage, increased treatment capacity, etc.), beyond the Phase 1 programs, offer very little additional improvement in compliance when compared to Phase I abatement alone for the river reaches downstream of Haverhill. As shown in "Phase II CSO Programs," there are very few appreciable instream benefits of Long-Term CSO control plans beyond the Phase I programs (that are almost completed). The impact of future Phase II CSO programs was also evaluated coupled with nonpoint source abatement. However, while the future Phase II long-term alternatives will reduce the occurrence of very high bacteria levels in the river, these occur during a total of just a few days during each year. Again, stormwater dominates as an impact to the water quality compliance status of the river during rainfall events based on this analysis.

- The analysis does show that Nonpoint Source (NPS) controls coupled with Phase I CSO controls implemented by the Merrimack River CSO communities will be sufficient to achieve compliance as shown in "Nonpoint Source Reductions & Phase I CSO Programs." In fact, the implementation of the nonpoint source reductions described above would actually increase the effectiveness of Phase I CSO controls by bringing the river closer to compliance and closing the gap that CSO abatement would need to bridge. Model results suggest that under normal hydrologic conditions, the river would be fully compliant with bacteria standards with the suggested nonpoint source reductions and Phase I CSO abatement. During abnormally dry and wet years, there may still be small isolated reaches that do not fully comply.

By far, the greatest value in abatement dollars can be realized with nonpoint source abatement and Phase I CSO controls implemented by all of the CSO communities. Since this report, the upstream CSO communities have continued to invest in very costly system improvements to continue to address the water quality impacts from the CSO discharges. Haverhill has already implemented its Phase II CSO measures and significantly decreased its CSO volumes by more than 25 percent. Continued implementation of system improvement results in much lower value, with regard to the benefits achieved compared to implementation costs.

In this case, value is measured in terms of river miles or days of compliance that can be achieved for every million dollars spent. Study results suggest that a balanced watershed management plan that includes modest CSO abatement coupled with reasonable levels of nonpoint source reduction should form the basis of watershed management decisions in the Merrimack Basin.

Results also suggest that such a balanced strategy would be eight times more cost-effective than full CSO separation using this same metric. In addition to being more cost-effective, the balanced approach would offer significantly more benefits than continuing with the implementation of Phase II CSO abatement improvements alone, and would result in a river that would comply with water quality standards under most conditions. Haverhill still is considering CSO work beyond Phase II, despite its very small CSO volumes. However, these future expenditures do not make holistic sense compared to other city and collection system spending priorities.

5.6 Summary

The principal receiving water for Haverhill's CSO discharges is the Merrimack River. CSO discharges are point source discharges and subject to the requirements of USEPA's CSO Policy, the state's CSO Control Strategy, and the Massachusetts WQS. The Merrimack River through Haverhill is on the 303(d) list of impaired waters based on concentrations of bacteria in the waterway. The city's CSO discharges do not meet the water quality criteria for Class B and SB waters for bacteria but the river will likely continue to exceed the bacteria standard, even with full elimination of CSO discharges, because of background point and non-point source stormwater discharges. It is important to note that there are no designated swimming areas along the river, downstream of Haverhill.

The river below Haverhill to the ocean at Salisbury/Newburyport has a multitude of uses. The river supports both fresh water fisheries and anadromous fish. Although no public swimming beaches exist on the Merrimack River in this segment, the river is used for boating and canoeing. A shellfish resource exists on the Merrimack River below the I-95 bridge in Salisbury. This shellfish area is conditionally harvested but may never be fully reopened unconditionally because of the upstream bacteria contamination and the proximity of the Newburyport and Amesbury WWTP discharges, regardless of Haverhill's CSO discharges.

CSO discharges to the Little River do not impact the designated uses of the Little River as significant portions of the river downstream of the discharges are enclosed within conduits and, thus, are not accessible for recreational or fisheries uses.

Haverhill's CSO planning is complicated by several factors, as discussed above, including a regulatory strategy that differentiates between pollutant sources within the watershed instead of a watershed-based plan. TMDLs, including a comprehensive assessment of river uses, have not yet been formally approved for the Merrimack River. Because of these complicating factors, the specific applicability of these CSO policies (and their intended water quality goals) to the city is unclear and appears to warrant a variance or reclassification of the river. What is clear is that the city must comply with EPA's Nine Minimum Controls, as these are the technology-based control requirements applicable to all CSO communities.

Beyond the nine minimum controls, the application of the CSO policies is complicated by the following factors:

- No final TMDL has been approved for the Merrimack River. Although control of CSOs in Haverhill could lead to some improved water quality downstream of the city, it has not been reasonably demonstrated that CSO control alone would serve to protect existing or future uses, or that these uses can even be achieved given reasonable assumptions concerning the impact of nonpoint sources.

- There are four CSO communities on the main stem of the Merrimack upstream of Haverhill, two in New Hampshire and two in Massachusetts. The CSO control planning and implementation for these communities continues. Most of the upstream communities are discharging significantly more frequent and larger volumes of CSO to the river (10 times the volume). Even with the continued implementation of the CSO plans for these upstream communities, it may take decades for them to provide a similar level of control of the CSO discharges that has already been achieved by the city of Haverhill.

In the following sections of this report, a range of CSO alternatives will be developed to identify the costs of incremental CSO discharge control. Haverhill's average annual CSO discharge volumes are small relative to the other CSO communities on the Merrimack River, but Haverhill will still propose additional CSO abatement improvements.

Further discussion of these CSO alternative costs will be compared to the proposed small and incremental benefits of continuing to reduce Haverhill's discharges both in volume and frequency, and the attainability of river uses. Accordingly, it is likely, given the complicating factors, that a variance, and/or reclassification of the river is warranted until a more holistic, watershed-based, program is approved.

The development of Haverhill's long-term control plan should consider the needs and concerns of their residents, including both environmental and economic concerns, while considering the results of the Merrimack River Assessment study and its conclusions regarding the overall goal of meeting water quality standards, enhancing the attainability of river uses, and improving the quality of the environment.

Massachusetts WQS recognizes that full compliance with all Class B/SB criterion may be difficult or impossible for CSO impacted waters. However, the regulators provide several options for a temporary variance and permanent changes to designated received water uses (reclassification to BCSO or SBCSO). Given the existing conditions along the river, this may be the appropriate approach for the city.

Section 6

Assessment of CSO Abatement Technologies

6.1 General

This section describes available CSO abatement technologies and assesses their applicability to achieve Haverhill's CSO control objectives. Many alternative strategies are available to control pollutants discharged from CSOs ranging from no action to complete separation of the combined sewer system into separate sanitary and stormwater systems. This assessment considers technologies presented in the EPA guidance manuals. The purpose of this assessment is to initially select appropriate technologies for further evaluation and comparison in Section 7.

6.2 Ongoing Technologies

The city of Haverhill currently performs a comprehensive program of operations and maintenance activities designed to minimize receiving water impacts from CSOs. This includes implementation of the nine minimum controls and an ongoing metering program which quantifies the frequency of overflows.

6.3 Screening of CSO Abatement Technologies

CSO abatement technologies were divided into five general categories:

- Quantity Source Control Measures
- Quality Source Control Measures
- Collection System Controls
- Storage Technologies
- Treatment Technologies.

Many of the source control measures and collection system controls are typical best management practices (BMPs) that are already performed by the city of Haverhill. Most of these CSO control technologies were already discussed and incorporated into the Nine Minimum Control (NMC) Measures Report (September 1996, CDM Smith). An overview of these controls is presented herein as part of the Long Term Plan evaluation process. Some of the BMPs are watershed/drainage basin type controls that are complemented by general public housekeeping efforts (i.e., litter control, hazardous waste collection, illegal dumping ordinances, etc.). Accordingly, a public information program regarding CSOs and the Long Term Plan in Haverhill are beneficial to the successful implementation of BMPs.

Educational materials to inform the public about CSOs, receiving water impacts and public involvement are posted on the city's website.

Each technology is described below and evaluated in general terms of effectiveness and feasibility in Haverhill. Technologies that are infeasible for implementation in Haverhill, or that offer no benefit to the CSO mitigation program were eliminated from further consideration. The remaining technologies are identified as NMC/BMP type controls or Long-term CSO Control Plan alternatives in the narrative. Technologies identified as NMC measures have already been addressed in the NMC report and Section 3 of this report. Technologies that should be considered for Haverhill's long-term CSO mitigation program alternatives are evaluated further in Section 7.

Table 6-1 lists the CSO abatement technologies considered for this report and identifies the results of the technology evaluation/screening. The following groups have identified the technologies:

- Technology Not Feasible or Appropriate. These technologies will not work effectively in Haverhill or will not reduce the water quality impacts associated with CSOs.
- Continue Current Practice. These technologies are typical best management practices and were, for the most part, addressed in the Nine Minimum Controls report submitted in September 1996. These technologies will help to optimize system operations and minimize CSO discharges and impacts to the rivers.
- Update Practices. These technologies should be considered by the city to improve existing operations and minimize flows, where appropriate.
- LTCP Technology. These technologies are feasible structural controls that will reduce and/or eliminate Haverhill's CSO discharges and impacts.

6.4 Source Control Measures

Source control techniques can be employed to either decrease the quantity of water entering the system or minimize certain pollutants from the waste stream at their source (quality control). Generally, source control techniques do not require significant structural improvements and thus, have minimal capital costs. However, these measures are labor intensive, and, therefore, have high operation and maintenance costs. The intent of implementing a source control measure is ultimately to help reduce or eliminate more capital intensive downstream (structural) CSO control facilities.

6.5 Quantity Control Measures

Quantity control measures are intended to reduce and/or eliminate portions of the wet weather flow generated in the basin tributary to the CSO regulator. Quantity control measures include the use of porous pavements, flow detention ponds, area drain and roof leader disconnection, the use of pervious area for infiltration, and catch basin modifications using flow retardation devices.

Table 6-1 CSO Abatement Technologies Assessed

CSO Control Technology	Technology Not Feasible or Appropriate	Continue Current Practice	Update/ Initiate Practices	LTCP Technology
Quantity Source Controls				
Porous Pavement			X	
Flow Detention/Retention			X	
Area Drain and Roof Leader Disconnection			X	
Utilization of Pervious Areas for Infiltration			X	
Catch Basin Modifications	X			
Quality Source Controls				
Air Pollution Reduction	X			
Solid Waste Management		X		
Fat, Oil, and Grease Control Programs (FOG)		X		
Street Sweeping		X		
Fertilizer/Pesticide Control	X			
Snow Removal and Deicing Practices		X		
Soil Erosion Control		X		
Commercial/Industrial Runoff Control		X		
Animal Waste Removal		X		
Catch Basin Cleaning			X	
Catch Basin Modifications - Hoods/Baffles		X		
Collection System Controls				
Existing System Management		X		
Regulator Modifications				X
Sewer Cleaning/Flushing		X		
Sewer Separation				X
Infiltration/Inflow Control			X	
Polymer Injection	X			
Regulating Devices and Backwater Gates		X		
Remote Monitoring and Control/Flow	X			
Relocation of CSO Outfalls	X			
Storage Facilities				
In-Line Storage		X		
Off-Line Storage				X
Surface Storage	X			
Treatment Technologies				
Wastewater Treatment Plant Improvements				X
Screening				X
Sedimentation				X
Enhanced High-Rate Clarification				X
Chemical Flocculation	X			
Dissolved Air Flotation	X			
Swirl Concentrators	X			
Biological Treatment	X			
Filtration	X			
Disinfection				X

6.5.1 Porous Pavement

The quantity of runoff that enters a combined sewer system may be reduced or attenuated through porous pavement. Porous pavement is potentially more cost effective in new developments than existing paved areas because pavement removal is expensive and disruptive to traffic. It is unlikely that wide-spread use of porous pavement would be cost effective in Haverhill. It would take a significantly long period of time and cost to regrade and pave impervious areas in order to achieve flow control. Also, typically, porous pavement on main thoroughfares is not durable and doesn't hold up well to cold weather and plowing. Thus, it is not appropriate for main streets but is good for parking lots or shoulder areas.

Porous pavement systems were considered as part of a Green Infrastructure Assessment completed for this Integrated FLTCP (memo in the appendices). The study evaluated green infrastructure practices that could be implemented on city-owned property located within the combined sewer area. Porous pavement alone would not be effective in terms of cost, reliability, and implementation for CSO control, however, it could be used in conjunction with other technologies to reduce CSOs. This is discussed further in Section 7.

6.5.2 Flow Detention

Flow detention can be achieved in a number of ways, including detention ponds, bioretention areas, and bioswale systems. A detention pond is a low lying area that is designed to temporarily hold a set amount of water while slowly draining back to the combined system. Bioretention areas are shallow, vegetated basins that collect and absorb stormwater runoff. Bioswales are vegetated, mulched, or xeriscaped channels that provide treatment and retention as they move stormwater from one place to another. Flow detention can be used to temporarily store stormwater runoff, attenuate flow peaks and minimize potential downstream treatment capacities.

Bioretention areas and bioswale systems were considered as part of a Green Infrastructure Assessment completed for this Integrated FLTCP. The study evaluated green infrastructure practices that could be implemented on city-owned property located within the combined sewer area. The majority of the combined sewer system is densely developed, which restricts the capability to implement these technologies. And the available areas are too few and too small to consider for cost effective flow detention (as compared to downstream CSO facilities). However, green infrastructure provides other benefits that make the use of it in conjunction with other technologies to reduce CSOs worth exploring. This is discussed further in Section 7.

6.5.3 Area Drain and Roof Leader Disconnection

In urban areas, such as Haverhill, roof leaders from gutters or roofs and area drains are often connected to the combined sewer system. Direct connection to the system avoids excessive surface runoff across properties to the catch basins or street drainage collection system. However, these direct inflow connections increase the peak flow rates during storm events by decreasing the time of concentration within the drainage basin.

Although the identification of roof leader and area drain connections to the combined system is relatively inexpensive to perform (by smoke testing), other costs and concerns may outweigh the benefits. These other costs include the need to develop individual disconnection plans with each building owner (to address adequate drainage concerns), and the significant effort required to deal with the public concerns and existing liabilities with such a mitigation program. It is difficult to completely eliminate this inflow in a highly impervious area as the relocation of the drain connections will likely result in more overland flow. Finally, this technology may not be cost effective when compared to the incremental costs required for downstream CSO controls. Therefore, disconnection of these inflow sources as an alternative to CSO treatment/storage technologies will not be considered further. However, the city should still attempt to remove inflow sources whenever opportunities arise, especially at large properties with substantial runoff.

6.5.4 Utilization of Pervious Areas for Infiltration

This technology in effect combines some of the aspects of the previous two strategies by attempting to maximize the use of pervious areas for infiltration. Various types of facilities include grassed swales, infiltration basins and subsurface leaching facilities. Generally, this type of control is more appropriate for new developments or redevelopment were some significant areas of well-drained, pervious soils exist. Where possible, proposed flow detention ponds could be constructed with pervious soils on the bottom to take advantage of available infiltration rates.

As previously noted the city completed a Green Assessment Study for this Integrated FLTCP. The study evaluated green infrastructure practices, such as bioretention areas and bioswale systems, that could be implemented on city-owned property located within the combined sewer area. In Haverhill. this technology is not appropriate for CSO control in the existing combined areas because these areas are densely developed with no large areas for detention. However, green infrastructure, in general, provide benefits that make the use of it in conjunction with other technologies to reduce CSOs worth exploring. This is discussed further in Section 7.

6.5.5 Catch Basin Modifications

Modifications to existing catch basins can be made to reduce peak stormwater inflows to the combined sewer system. Catch basins within a drainage area can be retrofitted with devices, such as a vortex valve, that will retard the surface water runoff entering the sewer system. This device, however, can cause the catch basin and adjacent street area to flood. This is also a concern as street flooding can be a problem during the winter with ice and snow. Accordingly, the selection of the appropriate size vortex valve is important to limit the extent of street flooding. Typically, the selection of the appropriately sized vortex valve is made through a trial and error process. In addition, based on a preliminary review of the incremental cost of downstream CSO controls, the use of vortex valves to restrict peak inflows to the combined sewer system would not be cost effective in most areas of Haverhill's combined sewer system. Accordingly, this alternative was not considered further.

6.6 Quality Source Control Measures

Quality control measures help to reduce pollutant concentrations at sources in the tributary basins and improve stormwater runoff quality before it enters the combined sewer system. Most of these measures directly address source control before the pollutant is dissolved in the rainfall and/or conveyed to the catch basin. The advantage of many of these technologies is that they can also have beneficial environmental effects in separated stormwater collection areas.

6.6.1 Air Pollution Reduction

Particulate matter in the atmosphere ultimately settles and becomes a source of stormwater runoff contamination. The "dustfall" is a result of both natural causes (fugitive dust from soils and pollen) and manmade processes (grinding and pulverizing processes, combustion, construction dust, etc.).

This source of pollution is not significant compared to other sources and therefore does not warrant further evaluation.

6.6.2 Solid Waste Management

Improper disposal of litter, including leaves, grass clippings, waste paper, wrappings, cigarettes, metal, glass, and paper containers on city streets, in parks and along vacant properties often results in these items entering the collection system and potentially being discharged to the receiving water. The floatable nature of these items can cause visible pollution.

This technology was discussed in the NMC report. The city has already implemented a number of city ordinances to control litter and manage solid waste. Generally, in urban areas, it is not expected that further enhancements to existing solid waste management programs will completely control floatables. Accordingly, recommendations to improve current procedures and policies are not warranted in Haverhill.

6.6.3 Fats, Oil, and Grease Control Programs

Fats, oil, and grease (FOG) are often improperly disposed of by pouring these items down the sink. FOG builds up in sewers over time and often causes blockages and reduces the capacity of the pipe to convey flow. EPA's August 2004 "Report to Congress on Impacts and Control of CSOs and SSOs," reports that 47-percent of sewer blockages can be attributed to grease buildup. These blockages account for nearly half of all sanitary sewer overflows (SSOs). The best way to prevent these blockages is to keep FOG from entering the sewer system.

Education programs about proper disposal of FOG can reduce the problems in the sewer system associated with FOG. At a minimum, restaurants should have and regularly maintain grease traps to remove the FOG. Grease traps slow the flow of wastewater and allow FOG to cool and float to the top, where it can be removed, so it does not get conveyed downstream in the sewer system.

Education programs can be used to inform residents and commercial establishments, such as restaurants, about the proper methods for disposal. The effectiveness of pollution prevention programs, such as educating owners about FOG, is highly dependent on individual actions. The effect of the education and removal of FOG cannot be quantified.

The city currently has a FOG program in-place, administered by its Board of Health. The city is also considering enhancements to its FOG program. Although it is a prudent practice, it will not be considered for further evaluation as a CSO control measure.

6.6.4 Street Sweeping

Street sweeping is a common practice in urban areas to improve the aesthetic environment by removing litter and debris from gutters. This practice can also improve the water quality of surface runoff by reducing the quantity of solids and floatables entering the combined sewer system. Street sweeping is performed using mechanical brooms or vacuum sweepers.

Haverhill makes every effort to ensure all streets in the city are swept at least once per year. While this is not always possible, they do sweep the streets in the downtown, combined areas frequently. Generally, many of the downtown area streets are swept weekly. The city is considering increasing the frequency of street sweeping in outer areas of the city as time permits to reduce pollutant loads and floatables in stormwater and CSO discharges.

6.6.5 Fertilizer/Pesticide Control

The use of fertilizers and pesticides can increase the pollutant levels, primarily nutrients, in stormwater runoff. Controlling chemical use and storage can help reduce this pollutant loading. Effective control of these pollutant sources is difficult.

In addition, CSO quality sampling results indicate that fertilizers and pesticides are not significant waste stream pollutants in Haverhill's CSO discharges. Since they are not an apparent source of CSO pollution, additional control of fertilizers and pesticides as an overall drainage basin program will not be considered.

6.6.6 Snow Removal and Deicing Practices

Salting roadways during the winter to reduce icing can increase surface runoff pollutant loads, particularly chloride concentrations. Improper storage of salt can also contribute to high chloride concentrations, especially if the salt is not covered or protected from rain.

Generally, salt is mixed with sand to reduce skidding on roadways. The sand can accumulate in catch basins and eventually enter the combined sewer system contributing to the solids loading in CSO discharges.

Although Haverhill uses a salt/sand mixture for deicing roads, chlorides and solids were not identified as receiving water quality issues. However, solids deposition in the sewer system may contribute to increased CSO related pollutant loads. Accordingly, the city could consider minimizing the use of salt and sand levels as long as safe travel conditions during winter storm events were not impacted. The city stores salt in a protected salt shed to avoid wash off into the combined sewer system. Deicing practices will not be considered for further study as an alternative to minimize structural CSO facilities.

6.6.7 Soil Erosion Control

Construction sites contribute to sediment in surface runoff. The city currently enforces standards established by the state for Site-Specific Permits for construction projects. The city is currently working to establish more stringent local regulations. As required by the Consent Decree, the city will adopt an ordinance requiring sedimentation & erosion control at construction sites. The city will also develop and implement construction site inspection and enforcement program. The enforcement of the ordinance and guidelines can maintain reduced suspended solids loadings to the receiving waters. Although soil erosion is not a significant source of CSO related pollution in Haverhill, erosion and sediment control practices should continue to be enforced at all construction sites. Additional controls will not be considered.

6.6.8 Commercial/Industrial Runoff Control

CSO pollutant discharge quality can be improved through the control of runoff from commercial and industrial establishments in the drainage area. Of particular concern are gas stations and other petrochemical establishments. Oil traps or permanent oil collection systems can be used to reduce the quantity of pollutants entering the system. Illegal dumping policies are enforced regularly by the city agencies such as the Highway, Police, Parks, Health, and Fire Departments.

Commercial/industrial runoff control by itself will not reduce CSO quantity but may be helpful to improve runoff quality. It is recommended continue its practices.

6.6.9 Animal Waste Removal

Animal excrement is a source of stormwater pollution, especially nitrogen and pathogenic organisms (E. Coli is an indicator). Proper disposal of the animal waste could help reduce the bacteria and nutrient concentrations in the CSO discharges by eliminating one source of pollutants (nutrients were not noted as a concern by the regulatory agencies). It is expected that Haverhill's current solid waste disposal, littering ordinances, and street sweeping programs are adequate to address this potential problem. Because the impact of this pollution source is limited and future regulations could address this problem if it becomes significant, this technology will not be considered further for CSO abatement.

6.6.10 Catch Basin Cleaning

Catch basins are installed in collection systems to collect and convey surface runoff to the sewer or drainage system. The basins are designed with a sump below the outlet pipe to capture sand, grit, and solids. Catch basins require periodic cleaning to remove the solids and floatables captured in the sump. The structures can be cleaned using a bucket or vacuum. Properly maintained catch basins can help to reduce the quantity of solids that enter the combined sewer system.

Haverhill has an active catch basin cleaning program in place. However, due to manpower constraints, the frequency of catch basin cleaning is less than annual. The city is working to increase the frequency of catch basin cleaning to further reduce pollutant loads and to reduce floatable discharges associated with stormwater and CSOs.

6.6.11 Catch Basin Modifications

Similar to the use of vortex valves, catch basins can be modified with devices, such as hoods or baffles, that help to capture floatables within the catch basin until the sump is cleaned. These devices can effectively remove floatables and coarse solids that may enter the combined system and be discharged to the receiving water. Since installing these catch basin modifications will not eliminate or significantly reduce the need for downstream structural CSO controls, this technology will not be considered further.

6.7 Collection System Controls

Collection system controls and modifications are intended to reduce CSO flows within the interceptor system by removing the inflow sources, increasing the use of existing interceptor capacity and pipeline storage, and/or optimizing the performance of the collection system. These controls include sewer line cleaning and flushing, existing system management, sewer separation, infiltration/inflow control, polymer injection (to increase pipe capacity), regulating and backflow gate modifications, real time (remote) system control, and flow diversion.

6.7.1 Existing System Management

System management techniques can improve receiving water quality by reducing CSO discharge volumes and capturing first flush pollutant loads. Regular maintenance of CSO regulators and the interceptor piping system is essential to maintain proper hydraulic conditions in the system and minimize the frequency of CSO discharges. Sediment accumulations or blockages in the regulators or interceptor pipes can reduce the hydraulic capacity of the interceptor connections increasing the frequency of CSO discharges, and in severe cases, causing dry weather overflows.

The city regularly inspects the CSO regulator structures and interceptor system. The interceptor system has reportedly not required any significant maintenance to eliminate obstructions or to remove sediment. Finally, based on the results of the model and field sampling programs, the first flush is typically captured and treated at the WWTP.

Accordingly, the current program should be adequate to identify problem areas in the system when they arise. No further recommendations are warranted.

6.7.2 Regulator Modifications

Modifications to the operation of regulators can help to reduce CSO discharges by reducing the frequency of activation. Regulators can be modified to pass more flow through to the interceptor or to take advantage of upstream pipeline storage. All of the existing regulators in Haverhill function as static flow control devices, either as weirs or orifice controls. Therefore, overflow weirs could be raised (or orifice openings increased) to decrease the potential CSO discharge.

In general, downstream conveyance and storage capacity is well utilized in the Haverhill interceptor system during most storm events. This was confirmed using the computer model of the collection system. Accordingly, the effect of passing more flow through one regulator to reduce CSO discharges locally will typically increase CSO discharges at the next regulator downstream. Upstream in-line storage is also effectively utilized. The city recently completed improvements to the Upper and Lower Siphon CSO structures to begin utilizing real-time control to store wet weather flow in the respective upstream interceptors.

There is the potential that additional regulator modifications could be used to take further advantage of the available inline pipeline storage and to force more flow into the interceptors. Therefore, regulator modifications are an LTCP technology to consider and are discussed further in Section 7.

6.7.3 Sewer Cleaning/Flushing

Deposition of solids is a common problem in combined sewer systems. These systems are designed to handle peak wet weather flow, therefore, their hydraulic capacity greatly exceeds typical dry weather flow rates. Consequently, dry weather flow velocities are usually much lower than the design (full pipe) velocity and may cause solids to settle in the pipelines. During large storms, these solids are re-suspended resulting in high pollutant concentrations during the initial period of a storm.

To avoid this “first flush" phenomenon (the resuspension of settled solids due to storm flow) sewers may be cleaned by either mechanical means (rodding or draglines) or by flushing. Either technique will flush the solids through the system during dry weather when system capacity is available to convey flow to the wastewater treatment plant. This will reduce solids discharged from CSOs to receiving waters during storm events. In severe cases of solids deposition, storm flows will not resuspend the settled materials and the settled solids will eventually accumulate, decreasing the hydraulic capacity of the pipe.

The city performs sewer cleaning, as necessary, to minimize the effects of deposition in problem sewers and within the interceptor system. During the alternatives evaluation, the model showed that the system could see capacity and conveyance benefits from cleaning the siphons and some of the interceptors. Thus, the existing programs should be continued.

6.7.4 Sewer Separation

Sewer separation is defined as the reconstruction of an existing combined sewer system into non-interconnected sanitary and storm sewer systems. The sanitary sewer system is tributary to the wastewater treatment facility, and the storm sewer system discharges directly to the receiving waters.

Typically, to separate an existing combined sewer area, either a new drainage system is constructed or new sewer pipelines are installed and the existing combined sewer is used as the sanitary or separate storm drain, respectively. If portions of the Haverhill combined sewer system were found to be susceptible to structural failure, they would likely require complete replacement and two new pipes would likely be constructed for the separate sewer and drain systems.

Unlike storage and treatment alternatives, which reduce the frequency of CSO discharges, sewer separation eliminates CSOs by diverting all sanitary flow to the wastewater treatment facility (or by diverting all stormwater directly to the river). The EPA CSO abatement policies require that combined sewer system separation be evaluated as a step in CSO facilities planning. Although separation eliminates CSOs, it may not, in all cases, be the most appropriate alternative in terms of addressing site specific water quality objectives. By removing the sanitary flow, the CSOs are essentially converted into stormwater outlets. As a result, pollutant loadings to receiving waters caused by the sanitary flow in CSOs are eliminated; however, impacts caused by stormwater borne pollutants are not.

Sewer separation is considered as a long term plan technology and will be discussed further in Section 7.

6.7.5 Infiltration/Inflow Control

To maximize the collection system's capacity, it is necessary to remove the extraneous flows caused by infiltration and inflow (to the extent possible). Infiltration is groundwater that enters the system through broken or cracked pipes, defective joints, depressed manholes, and manhole walls. Replacing or lining defective pipes and manholes can reduce infiltration.

Inflow results from direct connections to the system from roof leaders, cellar and yard drains, commercial and industrial drains, and malfunctioning tide gates. Since combined sewers are intended to carry both wastewater and stormwater, inflow cannot be entirely eliminated but can be reduced or retarded to attenuate peak flows. Control of these inflow sources can be addressed by the technologies discussed above.

I/I flow rate during wet weather conditions generally represent only a small portion of the total amount of stormwater runoff activating CSOs. Accordingly, it is not typically cost effective to address the I/I portion of the drainage basin flow for CSO reduction alone because it is insignificant compared to incremental costs of larger downstream CSO structural controls. However, the city should continue its efforts to investigate and reduce I/I through system pipeline rehabilitation.

6.7.6 Polymer Injection

Injecting polymers into a collection system can effectively decrease pipe friction and thereby increase the pipe's hydraulic capacity. A literature search was performed on the use of polymer injection in other combined sewer systems. The EPA performed most of the studies available between 1969 and 1977. According to one source, the addition of a polymer into gravity sewer lines could increase pipe flow to the treatment plant and reduce CSOs. Polymer slurry injections into gravity sewer lines have decreased hydraulic friction and increased pipeline capacities up to 144 percent.

Polymer injection requires the construction of facilities to store and inject the polymer into the pipelines. Instrumentation to monitor flow and regulate polymer dosage is also required. In addition, there are other problems that occur with the use of polymers including polymer coagulation and settling, molecular breakdown of the polymer that reduces its effectiveness, limited storage life, and high cost. Based on these issues, this technology is not considered further.

6.7.7 Regulating Devices and Backwater Gates

This technology utilizes control valves and devices to optimize system operations through the control of flow into and through the interceptor system. Regulating devices include vortex valves, inflatable dams, and motorized or hydraulically operated sluices or control valves, which are used to restrict the conveyance of flow downstream and utilized existing pipeline storage. Backwater gates, such as tide gates, flap gates, or elastomeric gates, are used to restrict the receiving water from entering the interceptor system.

During the design of the Wet Weather Maximization/CSO Structure Modifications Project it was found there was some infiltration of river water into the sewer system at the Lower Siphon and the Middle Siphon CSOs. The city corrected the problem by adjusting the flap gates on the outfall pipes to provide a better seal. All other existing flap gates are continuously inspected by the city and there have been no other reported problems with river water entering the system.

As part of the Wet Weather Maximization/CSO Structure Modifications Project new CSO control gates are being installed at Upper Siphon CSO and Lower Siphon CSO to maximize the capture of wet weather flow in the interceptor system. With the completion of this project, most of the available capacity in the interceptors will be used during significant rain events, flow-regulating valves will not be considered further.

6.7.8 Remote Monitoring and Control/Flow Diversion

Diverting flow from one drainage basin having limited hydraulic capacity to a drainage basin having excess capacity can reduce the volume and frequency of CSO discharge. Available and existing pipeline capacity may be used to convey flow or as inline storage. Components include a data gathering system to monitor rainfall, pumping rates, treatment rates and regulator positions; a central computer processing center to provide real-time control; and an instrumentation and control system to remotely regulate pumps, gates, valves, and regulators.

An initial review of the system using the SWMM model did not show any opportunities to divert flow to other basins to achieve better CSO control. Accordingly, this strategy was not considered further.

6.7.9 Relocation of CSO Outfalls

Relocation of CSO outfalls from sensitive to less sensitive discharge locations is similar to previous sections in that regulator modification and flow diversion may be involved. This solution may also involve routing overflows through a new pipe to a new discharge point, or just raising regulator weirs to force more flow downstream. It also may involve consolidation of CSO discharges to minimize the number of CSO control facilities and aid in their siting.

The sensitivity of the receiving waters is essentially the same in Haverhill. There is no water quality benefit achieved by consolidating or relocating CSO outfalls in the city. Therefore, this technology will not be considered further.

6.8 Storage Technologies

Storage of CSO flows can be performed either at a local site adjacent to a regulator or other control device or downstream at a central site that consolidates the need for several facilities. Storage facilities are typically used to store CSO discharges for eventual treatment at the WWTP after the storm. However, storage facilities can also be designed to provide some sedimentation treatment capacity for flow greater than the storage volume.

Storage technologies represent costlier structural modifications to a combined sewer system. These modifications are rarely undertaken without a complete assessment of the CSO discharges and interceptor system and the preparation of a system-wide facilities plan. These technologies are presented briefly below and include inline storage, off line storage, and surface storage.

6.8.1 In Line Storage

The use of inline storage is considered a cost effective method of reducing combined sewer overflows by utilizing available pipeline storage volume. The storage volume helps to both dampen peak flows and detain combined wastewater for later treatment at the WWTP. Control gates or other devices, such as weirs, can be used to create or optimize inline storage during a rainfall event.

Control devices are generally located in combined sewer interceptors downstream of dry weather connections. The devices, which can be remotely controlled, are normally activated to divert dry weather flows into the interceptor and store wet weather flows in the combined sewer. If flows exceed the system capacity and upstream flooding occurs, the devices are deactivated to release the stored flow.

Control gates have been used frequently in such applications and are superior to inflatable dams in terms of precision and durability. Other devices used in conjunction with inline storage are stop logs, weirs, bending weirs, and orifice type restrictions. Stop logs provide operating flexibility similar to inflatable dams but require manual insertion and removal, which is difficult during storm events. Orifice type restrictions can be used in order to store flow in pipe reaches of combined sewers upstream of the dry weather connections. Finally, vortex flow regulators can also be used with inline storage volume.

Orifice type restrictions require similar maintenance as static regulators to prevent clogging. All inline storage technologies may increase combined sewer system cleaning and maintenance requirements since the storage of flow in pipes reduces flow velocities and increases the possibility of solids deposition.

Inline storage can be a viable CSO abatement technology if the existing sewer system pipelines are large enough and deep enough to provide significant storage volume. Pipes which are steeply sloped require numerous flow control devices at regular grade changes to maximize the use of available storage. With numerous flow control devices, inline storage is more difficult to control and less cost-effective than downstream controls.

As noted above, CSO control gates are currently being installed at Upper Siphon CSO and Lower Siphon CSO. Gate controls and level transmitters were also installed to remotely monitor, control and modulate depths in the upstream interceptors, maximizing wet weather storage. With the completion of the Wet Weather System Maximization/CSO Structure Modifications Project, most of the available capacity in the city's interceptors will be used during rain events. Therefore, in line storage within the interceptors will not be considered further. Most of the remaining pipes tributary to the interceptors have a significant slope with no appreciable upstream pipeline storage either.

6.8.2 Off-line Storage

Off-line storage and pump back to the interceptor system is one of the most widely used and effective methods for CSO mitigation. Similar to inline storage, offline storage facilities temporarily store wet weather overflow volumes until the flow can eventually be conveyed and treated at the WWTP. Types of storage facilities include underground tanks, abandoned pipelines, or deep tunnels. Off-line storage is usually located at overflow points or near dry weather or wet weather treatment facilities. These facilities can be relatively simple in design and operation and can effectively reduce the frequency of overflows.

Storage facilities can also be designed to remove settleable solids, with periodic cleaning by dredging, mechanical chain and flight scrapers, or other means. In effect, some primary treatment (sedimentation) takes place due to quiescent conditions. The settled solids can be handled by:

- Collecting and pumping to the interceptor as a concentrated slurry to be handled at the WWTP during the event.
- Collecting, storing and pumping to the interceptor as a concentrated slurry to be handled at the WWTP after the event
- Collecting and dewatering at the storage site then transported to the sludge processing facilities
- Resuspended in the stored mixed flow during the pump back period for transportation to and handling at the WWTP.

Excessively long detention times can result in the settled solids causing offensive odors. Accordingly, prompt solids removal is necessary along with proper odor control equipment.

A detailed cost evaluation for off line storage facilities will be presented in Section 7.

6.8.3 Surface Storage

Storing stormwater runoff prior to entering the collection system can be accomplished through roof storage, playground storage, in natural ponds, or in manmade basins or lagoons.

Roof storage can be effective in locations with buildings having flat roofs. However, stored water can seep into the buildings and/or damage the structural integrity of the building. Roof storage is most attractive for new construction in warm climates where snow and ice will not collect on flat roofs.

Playground and recreational areas can be used to detain rainfall for a limited time to reduce peak flow in the system. Space availability, public acceptance, and potentially hazardous conditions are drawbacks associated with this approach. In addition, use of these facilities to store runoff may interfere with their intended use and increase maintenance requirements.

Depending on existing land use and the existing natural topography, temporary stormwater detention may be implemented for runoff attenuation. Stormflow retention in areas having porous soils will allow some or all of the detained flow to infiltrate into the soil instead of entering the combined sewer system.

In general, open space in densely developed urban areas such as Haverhill is limited to park and recreational areas and parking lots. Typically, use of these areas for storage of runoff would interfere with their intended use, thus, this technology is not desirable and will not be considered further.

6.9 Treatment Technologies

Technologies used for treating CSOs prior to discharge are presented and discussed below.

6.9.1 Wastewater Treatment Plant Improvements

Increasing the capacity of the WWTP to handle higher peak wet weather flows is one way to reduce the frequency and volume of untreated CSO discharges upstream in the collection system. This alternative will likely require improvements to the Main Pumping Station and force main, the headworks facilities, sedimentation tanks, sludge piping and pumping secondary clarifiers and chlorination pumps. This alternative will be evaluated further as a CSO control alternative in Section 7.

6.9.2 Screening

Screens for wastewater treatment are available in various types and sizes ranging from bar racks to coarse/fine screens or microstrainers. Screens are effective in removing large solids and floatables from the wastewater flow the effectiveness being dependent on the clear opening of the screen. The size of the screen openings determines the level of treatment achieved. Microstrainers can achieve primary treatment levels by removing 60 percent of the suspended solids.

Screens can be installed at either inline or at off-line facilities. Inline facilities must be closely monitored and cleaned to prevent loss of hydraulic capacity, which could cause flooding.

Bar screens are almost always installed at the entrance to storage and treatment facilities for removal of large objects, trash, and debris, and to protect treatment and pumping equipment. Often two sets of screens in series are used. The first set usually consists of coarse screens with 1 1/2" bar spacing. Finer screens with 1/2" to 1" spacing are located just downstream. A double screen set up also has a less tendency to be blocked than one fine screen.

In lieu of stationary fine bar screens, traveling woven wire mesh screens are sometimes used. These types of screens provide more efficient removal of floatables, however, operation and maintenance requirements are extremely high. Since the media are cleaned using a high-velocity water jet spray, handling and disposal of this sidestream would greatly increase operation complexity, as well as the required building size, operational requirements, and, consequently costs. In addition, the head loss through this unit is two to three times that of a stationary unit. Accordingly, this method of fine screening is not considered applicable for use at CSO storage or treatment facilities.

Screening is a viable treatment alternative to meet CSO control strategies. However, screening alone will remove only floatables and large solids and does not completely address coliform violations in the receiving waters. To meet all water quality goals, screening in conjunction with disinfection (as discussed below) will be considered as a potential treatment alternative.

6.9.3 Sedimentation

Gravity sedimentation using high surface overflow rates (to conserve space) can achieve 20 to 40 percent removal of BOD (Biochemical Oxygen Demand) and 50-70 percent removal of TSS in CSOs. Land requirements and residual solids handling are important considerations in determining the feasibility of sedimentation.

Sedimentation reduces solids loadings from CSOs by gravitational settling and removal of suspended solids. As a result, metals and BOD loadings are also reduced. In addition, the process is used in many wastewater treatment applications providing an extensive base of full scale operating data.

The major disadvantage of sedimentation is that the land requirements are relatively high. Because the availability of land is usually limited in urban areas, siting of CSO abatement facilities that include sedimentation basins can be an important issue.

Because experience has shown sedimentation to be a reliable, cost effective CSO abatement technology, it will be considered in developing CSO abatement plans for Haverhill. To meet all water quality objective, chlorination following sedimentation (and screening prior to sedimentation) will be included as part of the treatment process.

6.9.4 Enhanced High-Rate Clarification

Another approach for treating wet weather flow is enhanced high-rate clarification. This technology, which can be operated intermittently during storm events, is a physical-chemical process in which coagulant and polymer are added to the wastewater flow. The coagulant aggregates the suspended solids in the flow into a floc. The resulting floc particles adsorb onto either very fine sand added to the wastewater, or recirculated solids with the aid of a polymer. The fine sand (or recirculated solids) acts as ballast and increases the settling rate of the adsorbed floc. Hence, the process is also known as "ballasted flocculation".

A typical ballasted flocculation system consists of the addition of ferric chloride, polymer, and "microsand" (sand approximately 100-microns in diameter) to wastewater. The wastewater and additives are rapidly mixed (flash mixing), then slowly stirred in a maturation tank before settling in a clarifier. The sludge from settling is passed through a hydrocyclone, where the microsand is removed from the sludge and recycled.

Several suppliers provide enhanced high-rate clarification systems including Kruger's Actiflo process, which uses microsand as ballast and Degremont Technologies DensaDeg process, which uses recirculated solids as ballast.

Whichever process is selected, BOD and TSS (total suspended solids) removal rates associated with high-rate clarification have been shown to be roughly double those of traditional clarification. BOD removal is between 65 and 80-percent and TSS removal is between 70 and 95-percent according to the EPA's August 2004 "Report to Congress on the Impacts and Control of CSOs and SSOs". Other benefits of this process are:

- Area requirements are only one-tenth of traditional clarification area requirements (5 to 15-percent of the space required for conventional primary treatment);
- Can handle high hydraulic loading rates and treat rapidly varying flows; and
- Able to achieve secondary treatment concentration standards for BOD and TSS (without a biological process).

The storage of chemicals may be of concern if this technology is implemented at a satellite location, away from the WWTP. Other disadvantages of this technology include the increased operational cost relative to biological treatment and conventional clarification due to the cost of chemicals, ballasted media, and sludge disposal and the limited ability to remove soluble pollutants. Many of the technologies reviewed have limited ability in removing soluble pollutants.

In summary, enhanced high-rate clarification provides significantly higher treatment capacities than conventional primary treatment, with significantly higher BOD and TSS removals. Therefore, enhanced high-rate clarification is considered a viable alternative to evaluate further for providing higher wet weather treatment flow capacity and reducing CSOs in the city. However, the cost of this proprietary technology will have to be weighed against the benefits to determine its true viability in the project area. Furthermore, the intermittent use and potentially higher O&M requirements associated with this technology may limit its applicability. For example, enhanced high-rate clarification could be viable for implementation at the regularly staffed WWTP, but may be more difficult to support at unmanned or semi-manned satellite treatment facilities like a wet weather treatment facility. Screening is required prior to the ballasted flocculation treatment component and disinfection is required after. UV disinfection can be utilized with ballasted flocculation treatment because of the high level of suspended solids removal.

6.9.5 Chemical Flocculation

Chemical flocculation is a high-rate treatment process utilizing metal salts and polymers to aggregate particles in CSO flow. Depending on their density, the aggregate of particles, or floc, will either sink to the bottom or float to the top where it can be removed. A concentrated sludge is produced, requiring no additional thickening. Chemical flocculation can remove 40 to 80-percent BOD and 60 to 90-percent TSS. Similar to ballasted flocculation, chemical flocculation can handle high hydraulic loading rates and treat rapidly varied flow. Chemical flocculation is limited in its ability to remove soluble pollutants. There is a potential increase in sludge production due to the addition of treatment chemicals and an increased operational cost due to the cost of chemicals. Since ballasted flocculation achieves similar results to chemical flocculation but the hydraulic capacity for chemical flocculation is much less (20,000 gpd/sq. ft for chemical versus 90,000 gpd/sq. ft. for ballasted flocculation); chemical flocculation will not be further considered.

6.9.6 Dissolved Air Floatation

Dissolved air flotation has been used to treat CSOs and has proved to be relatively effective in removing up to 20 to 50 percent of the suspended solids and floatables.

Dissolved air floatation (DAF) relies on small air bubbles to suspend particulate matter to float to the surface for removal. Oil, grease, and other floatables can also be removed.

Small and light suspended matter can be removed more efficiently and quickly by this process than by sedimentation. Chemical addition (generally polymer) is usually used to improve removal efficiency. Operating costs are relatively high due to pumping costs to pressurize the water and compressed air, and chemical requirements. The process is also sensitive to operational control.

DAF has been used primarily for processing solids in municipal, industrial water, and wastewater treatment applications and most recently for water treatment. Due to the relatively high operating costs and sensitivity to operational control associated with DAF, other less costly and complex technologies have been developed that have replaced DAF in many applications.

Haverhill currently operates a DAF system at the WWTP to thicken sludge, however, it is not recommended for CSO satellite treatment because of operational demands that are characteristic of CSO technologies such as start up on short notice and highly variable flow rates.

For the above reasons, DAF is not considered feasible for CSOs and will not be considered further.

6.9.7 Swirl and Helix Concentrators

Swirl regulators/concentrators operate as a solids/liquid separator removing both suspended solids and floatables through rotationally induced forces. Swirls have been reported to remove up to 50 percent of the suspended solids from the combined sewer flow. Helical concentrators are similar in design but are more effective as an inline device (rather than an off line device). The flow is separated into overflow, which is discharged to the receiving water (typically after chlorination) and underflow (a concentrated low volume of wastewater that is intercepted for treatment at a treatment plant).

Swirl and helical bend concentrators have some limitations and potential drawbacks, including:

- The rate of underflow diversion is subject to design limitations relative to the incoming combined flow.
- The relatively short detention time will require high rate disinfection or construction of contact tanks to provide adequate detention time for bacteria kill before discharge to the receiving water.
- The configuration of the swirl concentrator results in a large hydraulic headloss requirement between the influent combined sewer and the underflow pipe.
- Relatively little long-term data on performance and reliability.

Some of the drawbacks can be satisfied by storage and pump back facilities in conjunction with a concentrator, but pumping will also require electricity, additional space, remote/automatic controls for operation and additional costs. Interceptor and treatment capacity must be available for underflow during a storm event. If underflow rates exceed the available interceptor capacity or sufficient grade is not available, the underflow may need to be stored and pump back following the storm may be required.

In order to operate effectively, most swirl concentrators need to be cleaned regularly. A maintenance schedule should be established based on solids loading and accumulation rates. Some types of swirl concentrators must be dewatered and cleaned with a vacuum truck, which will increase work demands of the city's collection system maintenance crews. Other types of systems are designed to pump out the debris that is screened out of the flow, which can potentially create sedimentation and grit accumulation in pipelines.

The uncertainty concerning solids removal efficiencies, the lack of bacteria removal, space requirements and the level of maintenance required for swirls are some of the reason why swirl concentrators are not given further consideration in this report.

6.9.8 Biological Treatment

Biological treatment processes, including contact stabilization, trickling filters, rotating biological contactors, treatment lagoons, and land application, have been most successfully used in the treatment of sanitary sewage and industrial wastewater. Their exclusive use for the treatment of combined sewer overflows has several drawbacks including:

- Difficulty maintaining biomass (used to assimilate nutrients in combined sewage) during dry weather (continuous operation is required);
- Difficulty in handling erratic loading conditions inherent to combined sewer overflows;
- Potential odors and snail population problems;
- High clogging potential;
- Costly operation and maintenance;
- Highly skilled operators are required; and
- Extensive level of treatment provided by biological treatment is not required for combined sewage.

Potentially, CSO discharge into wetlands could provide some level of biological treatment; however, this is not considered appropriate for the city's combined sewer area. Consequently, biological treatment will not be considered further in this study.

6.9.9 Filtration

Filtration is a physical treatment process that removes solids by straining wastewater through a filter medium, such as sand, charcoal (carbon adsorption), or membranes. Deep bed filtration has the ability to treat high and rapidly varying flows. Filtration can consistently achieve secondary treatment concentration standards for BOD and TSS. Its major disadvantage for the treatment of combined sewage is the tendency to clog rapidly during use, thus limiting its hydraulic capacity and ability to remove solids; or the need for frequent backwashing to prevent clogging. It can be used after sedimentation to reduce clogging, but this level of treatment is typically not required for CSO applications. Consequently, filtration will not be considered.

6.9.10 Disinfection

Disinfection is used to destroy pathogenic microorganisms. Many disinfection technologies are available including chlorination, ozonation, and ultraviolet radiation. The most common method is chlorine addition, although recently its apparent toxicity to aquatic life is a concern. For this reason, dechlorination is often required.

Disinfection agents used for wastewater and stormwater treatment include gaseous chlorine, hypochlorite (calcium and sodium), chlorine dioxide, and ozone. All of these disinfection agents are oxidizing agents, corrosive to equipment, and are highly toxic to microorganisms and other life. Ultraviolet light has been used as a disinfection agent but is sometimes ineffective for CSOs because of their turbid mixed flows.

Selecting a CSO disinfection system is based on the following considerations:

- CSOs are highly variable in quantity and quality and thus any disinfection system must have the capability to meet these fluctuations.
- Chlorine, chlorine dioxide, and ozone are all dangerous gasses that must be carefully handled by trained operators. Lesser hazards are associated with hypochlorite, which requires bulk storage.

When selecting a disinfection system, the capacity and location of the treatment facility must be considered. Use of toxic gasses is undesirable in densely populated areas and small-scale facilities that are only monitored periodically. For this reason, use of gaseous chlorine is not considered.

Case studies regarding the use of bromine chloride, ozone, and ultraviolet light for CSO disinfection are limited at this time. Ozone has been proven to be effective, although it is considered expensive. Ultraviolet light is typically only effective for flow with lower turbidities. Large particles block much of the light, rendering this technique ineffective.

Generally, chlorination (hypochlorite) is accepted as the most cost-effective and technically reliable disinfection treatment to reduce coliform levels in CSOs. Chlorination will be considered in conjunction with screening, sedimentation, and HRC. To eliminate the potential toxic effect of residual chlorine on biota, CSOs would be dechlorinated prior to discharge at the wet weather treatment facility under consideration. General dechlorination practice indicates that sodium bisulfite is a reliable and cost-effective chemical to remove chlorine residuals from the wastewater effluent. Chlorination and dechlorination will be considered further in Section 7.

6.9.11 Summary of Treatment Technologies

No treatment technology alone is adequate to meet all water quality objectives. However, various combinations of treatment methods may be used to meet CSO abatement goals. This concept is discussed further in Section 7.

6.10 Summary

This assessment has eliminated some technologies from further consideration for the Long-term CSO facilities in Haverhill. These eliminated technologies will not directly address the CSO impacts. Other technologies on this list have already been identified as recommended nine minimum control measures. These technologies incorporate good maintenance practices to ensure that system operation is maximized to the extent possible before more expensive structural controls are implemented. Other technologies, as indicated in Table 6-1 are more appropriate for the FLTCP (and effective CSO abatement) and are discussed further in Section 7, which evaluates the structural CSO mitigation alternatives for Haverhill.

Section 7

Alternatives to Reduce CSO Discharges

7.1 Introduction

Under the Phase II Wet Weather System Maximization and CSO Structure Modifications project (to be completed in March 2017), the city will utilize a real-time control system to modulate flow control gates at the Upper Siphon CSO (NPDES#024) and Lower Siphon CSO (NPDES #013) to maximize the capture of wet weather flow in the interceptor system (using in-line storage). The Middle Siphon Inlet Structure on the north bank of the interceptor system was modified (increased wall opening) to increase flow to the Middle Siphon. The Marginal Pump Station CSO (NPDES # 021M) was eliminated by the installation of a new sewer. The Bradford CSO (NPDES #032) was modified by adding a second dry weather connector pipe, which significantly reduces CSO discharges at this regulator.

Once completed, based on SWMM simulations, Haverhill will capture and treat approximately 98 percent of the city's combined wet weather flow on an average annual. CSO discharges will be reduced to 19.6 million gallons on an average annual basis.

Accordingly, the city of Haverhill has achieved a high level of CSO control and a high level of use attainment along the Merrimack River, especially compared to the CSO abatement control levels currently achieved by upstream CSO communities. The city also implements a robust program of NMCs and BMPs to help reduce extraneous flow, manage wet weather flow, and improve the quality of the potential CSO discharges.

However, although Haverhill's CSO discharges are significantly less than the other upstream Merrimack River CSO communities, the city is considering additional options to further reduce the city's CSO discharge volume and frequency for the Final CSO Long-Term Control Plan.

This section presents the full range of CSO control alternatives available to the city ranging from No Action to complete elimination of CSO discharges based on the design control levels recommended in the USEPA guidance manual for developing LTCPs. The CD requires that "the city shall screen an appropriate range of technologies for eliminating, reducing, or treating CSOs, including alternatives that will reduce the number of untreated CSOs down to a range of overflows per CSO outfall per year (such as 0, 1 to 3, and 4 to 7)."

Project costs, potential environmental impacts, and CSO benefits achieved by implementing each design storm control strategy are identified in this section and summarized at the end.

7.2 Water Quality Objectives

Based on the regulatory compliance policies and regulatory standards discussed in Section 5, the following receiving water quality objectives were considered in the development of this LTCP:

- Control of floatables to increase the aesthetic quality of the Merrimack and Little Rivers, and
- Reduce or eliminate bacteria (E. Coli or Enterococci Coliform) in the CSO discharges to minimize health risks associated with primary and secondary contact recreation along the river (i.e., boating and swimming).

7.3 Overview of CSO Alternatives Considered

A range of CSO abatement alternatives was considered for this LTCP including (listing in order of increasing control):

- No Action
- Intermediate Design Controls (6 design control levels)
- Elimination of CSOs (Sewer Separation/5-Year level of control)

An intermediate design control is defined based on the design storms identified in Section 4 (i.e., 1-Month, 3-Month, 6-Month, 1-Year, 2-Year, and 5-Year), which are based on return frequencies for the storm events and reflect the EPA's Guidance Manual on the development of LTCPs. System modifications necessary to attain each control level were developed as discussed in this section.

The CD requires that "the city shall screen an appropriate range of technologies for eliminating, reducing, or treating CSOs, including alternatives that will reduce the number of untreated CSOs down to a range of overflows per CSO outfall per year (such as 0, 1 to 3, and 4 to 7)." The design storms used in this report for analyses correspond to the CD stipulation on the range of overflows per CSO outfall per year as follows:

2017 Consent Decree	***LTCP***
4 to 7 CSOs per year	3-Month Design Storm
1 to 3 CSOs per year	6-Month Design Storm and 1-Year Design Storm
0 CSOs per year	5-Year Design Storm or Complete Elimination

7.4 No Action (Baseline Alternatives)

The No-Action alternative is to continue with the present system without structural modifications for CSO control. Haverhill would continue to capture and treat approximately 98 percent of wet weather flow annually. Untreated average annual CSO volume would remain at about 20 MG per year.

Average annual CSO characteristics, based on a representation of the historic precipitation record, under the No Action alternative would be as presented in Table 4-1.

The city could continue with its current level of spending on Best Management Practices (based on the Nine Minimum Controls Report and any other recommendations derived from the CMOM Deficiency Correction Plan report), such as for street sweeping and catch basin cleaning (for good housekeeping and floatables control), public education, and system maintenance activities. Haverhill would also continue to implement pipeline rehabilitation and replacement programs, which should reduce I/I in the system. There would be no additional annual costs associated with this alternative, no significant construction disruption, and no facility siting challenges.

Haverhill's average annual CSO discharge to the Merrimack River is much less than 5 percent of the total annual average volume of CSO discharges from other upstream CSO communities and far less than the total stormwater loading (point and non-point) to the river during storm events (based on the Merrimack River Initiative Study analysis discussed in Section 5). Accordingly, the city's CSO impact to the river under the No Action alternative is negligible considering the other sources of discharge pollution.

However, the frequency of the city's discharges will not meet the minimum proposed water activation frequency for the Merrimack River B_{CSO} Water Quality Standard (4 times per year). Accordingly, the city considered Intermediate Design Control level plans to identify a CSO abatement control plan for the Haverhill CSS, as discussed below.

7.5 Complete Elimination of CSO Discharges

As discussed in Section 5, under Massachusetts' regulations, the only permanent solution to CSO control that does not involve changing the water quality classification of receiving water bodies is the complete elimination of CSO discharges. Elimination of CSOs is accomplished by either complete separation of the combined sewer system or relocation of the CSO discharge to a different (less sensitive) receiving water. The receiving water bodies in Haverhill are similarly classified so there is no benefit to relocating any existing CSO outfalls.

Sewer separation involves constructing a new collection system so that the wastewater and stormwater will be two separate piping systems. The "old" combined sewers then generally become dedicated sanitary sewers, which convey flow to the WWTP. The new storm drains discharge untreated stormwater through outfalls to nearby receiving waters. Sometimes, the old combined sewers are converted into storm drains and a new sanitary sewer system is constructed.

It is important to note that removing all wet weather flow from the sanitary system to fully separate inflow from the sewers is a challenge. Often rain leaders, sump pumps, and yard drains on a property are connected to the sewer service upstream of the property line. To fully achieve complete separation in any area, each of these inflow sources would have to be identified through various investigative efforts and disconnected from the sewer service. This is a large task that is often made more difficult because of private property access issues.

Experience in other communities that have separated portions of their collection system has shown that as much as 15-20 percent of the original wet weather flow may still enter the sewer system because of these property inflow sewer service connections. Accordingly, as a conservative approach, when the effect of sewer separation was considered, it was assumed that separation of the area was only 80 percent effective (i.e., 20 percent of inflow may remain in the sewer system).

Sewer separation is generally thought to provide a significant benefit to the receiving water by eliminating the potential that sanitary waste is discharged during a storm. All sanitary waste in a separated area is treated at the WWTP. Accordingly, complete sewer separation eliminates CSOs and their impact to the receiving water. However, there is strong evidence to suggest that stormwater discharged created as a result of CSS separation could potentially cause exceedances of water quality standards and could become a future regulatory burden to the city.

Costs for sewer separation typically are associated with the construction of a new storm drainage system, separate from the sanitary collection system, designed to collect runoff for discharge directly to the receiving water. Sewer separation costs were developed for Haverhill based on a full range of sewer separation projects completed in New England CSO communities. In addition, for several basins in Haverhill, a preliminary separation plan was developed to help assess the potential cost of separation in the city based on piping arrangements. Based on these efforts, a cost of approximately $100,000 per acre was used to estimate the cost for sewer separation. Accordingly, the total cost of separating all 1,500 acres of combined sewer in the city to “completely eliminate” the wet weather system in the city is estimated to be about $150 million.

However, as noted above, sewer separation is not completely effective at removing all wet weather flow in the system. A SWMM simulation was performed (assuming the system conditions as of March 2017 with the System Maximization and CSO Structure Modifications complete) to identify the benefits of a full separation plan. The 5-Year design storm was used to represent the “worst-case” condition, but there are storm events greater than the 5-Year storm that could create problems in the system, even if all of the CSOs were eliminated. This simulation assumed that a typical sewer separation project is only 80 percent effective at removing wet weather flow (as discussed above).

Table 7-1 (page 7-5) shows the results of this analysis. This table shows that CSO discharges still remain in the Haverhill system during some design storm control levels. The Locke Street Center Barrel CSO is the most active. This is because there is limited pipe capacity (two small siphons) to convey flow under the Little River Conduit to the Middle Interceptor. To completely eliminate CSO discharges in Haverhill, additional wet weather control strategies would be required.

The additional control strategies to make sewer separation effective for complete elimination of CSO discharges could either be more effective sewer separation (i.e., enhanced removal of private inflow to increase sewer separation effectiveness to greater than 80 percent inflow removal), additional conveyance to bring flow downstream, or satellite storage facilities.

At a planning level, it is estimated that these additional system improvements, such as storage, to completely eliminate Haverhill’s CSO discharges with sewer separation are an additional $10 to $15 million. Accordingly, the cost to eliminate CSO discharges in Haverhill could be as high as $165 million. Costs for storage facilities are discussed later in this section.

It is important to note that there are storms greater than the 5-Year design storm used for this analysis. If the city were to eliminate and permanently close all CSO outfall to reflect a zero overflow condition (i.e., complete elimination), storms greater than the 5-Year event may still cause significant system surcharge and potentially result in SSOs. Accordingly, even further investigations are warranted to "completely eliminate" wet weather discharges, and thus, costs to achieve this goal are probably significantly higher. These costs cannot be estimated without additional (and significant) system investigations, flow monitoring, and modeling.

Table 7-1 Sewer Separation as a CSO Control Approach

				Design Storm Control Levels							
				6 Month		1 Year		2 Year		5 Year	
Name	NPDES #	Acres	Cost (M)	Vol. (MG)	Peak Flow (MGD)	Vol. (MG)	Peak Flow (MGD)	Vol. (MG)	Peak Flow (MGD)	Vol. (MG)	Peak Flow (MGD)
Upper Siphon											
Upper Siphon	024	229	$23								
Winter Street	021G	39	$3.9								
Winter & Hale	021H	62	$6.2							0.04	2
Locke Street Center Barrel	021F	22	$2.2	0.014	1.6	0.05	2.4	0.16	8	0.50	12
Middle Siphon											
Broadway (flood)	037	68	$6.8								
High Street (flood)	038	36	$3.6								
Emerson Street (flood)	021B	29	$2.9								
Middle Siphon	021A	56	$5.6							0.007	1.1
Lower Siphon											
Main St North	019	96	$9.6								
Bethany Avenue	040	30	$3.0							0.01	0.8
Chestnut Street	041	39	$3.9							0.004	0.3
Lower Siphon	013	413	$41								
Bradford Interceptor											
Bradford Aveune	032	149	$15								
Middlesex Street	034	49	$4.9							0.020	2.3
South Webster Street	039	25	$2.5							0.018	0.4
Other areas		159	$16								
Total		1501	$150	0.014		0.05		0.16		0.60	

Notes:

1. Bates Bridge, Boardman Street, Fire Station, River Street, Beach Street, Front Street, South Prospect Street, Main Street South, Ferry Street CSO were closed in Phase 1.
2. For the 1-Month and 3-Month Storm Events, there are no CSO discharges with full separation.

There are no significant long-term environmental or facility siting challenges associated with the construction of new drains or sewers to complete separation of the combined sewer system. All the work should take place on existing city streets and/or easement corridors. There could be minor environmental or facility siting challenges associated with the construction of additional piping, outfalls, or facilities to address the remaining CSOs in each design control level. Sewer separation of the downtown portions of Haverhill will be a significant challenge considering the potential conflicts with other existing underground utilities. In addition, there will be significant, short-term, construction impacts from the disruption of vehicle and pedestrian traffic in heavily urbanized areas. However, construction impacts will be temporary and could be minimized by incorporating mitigation measures to address construction vehicle traffic, detours, noise and air pollution, residential/commercial service disruptions, and wetlands.

7.6 Discussion of Intermediate Design Controls

7.6.1 Introduction

Full compliance with water quality standards typically means that CSO discharges must be eliminated. This is a costly proposition for any community and the actual benefits achieved by complete elimination need to be considered to determine if the appropriate level of control for the watershed and receiving water use goals is cost-effective. Intermediate design control levels are intended to establish a balance between meeting the Class B water quality standards and allowing occasional excursions from the standard (which the state has established as a Class B_{CSO} standard).

This section presents the range of intermediate control alternatives for Haverhill based on the six design control levels (i.e., 1-Month, 3-Month, 6 Month, 1-year, 2-year, and 5-year). Water quality exceedances may still occur with under each intermediate design control level because storms with frequencies greater than the design control level will likely result in CSO discharges. Thus, if collection system modifications were designed to the 3-Month design storm, CSO discharges would occur one every three months or four times per year on average. As noted above, the 3-Month design storm control level also coincides with the MADEP CSO Control Policy, which requires minimum control of CSO discharges 95 percent of the time.

7.6.2 System Operational Plan under the Phase II System Modifications

With the completion of the Phase II LTCP system improvements under the System Maximization/CSO Structure Modifications project in March 2017, the city will adopt a new operational plan. This plan will restrict flow at the Upper Siphon and Lower Siphon CSO control structures, storing flow in the respective upstream interceptors. This operational plan allows the city to maximize flow through the Middle Siphon (with the larger Middle Siphon Inlet Structure opening) to the Bradford Interceptor (and to the WWTP) during many storm events.

Table 4-1 shows that, under this operational plan, the most active CSOs (Locke Street/Winter & Hale, Bethany Avenue, Chestnut Street, and South Webster Street CSOs) are located away from the interceptor system, where there is not enough local pipe capacity to convey flow downstream to the interceptor system. Alternatives to address this conveyance issue are discussed later in this section.

System improvements to achieve each CSO design storm control level discussed in this section are based on this new city CSO/wet weather operating plan.

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7.6.3 System-Wide Improvements

7.6.3.1 Interceptor Conveyance Improvements

Settling of solids is a common problem in combined sewer systems. These systems are designed to handle peak wet weather flow, therefore, their hydraulic capacity greatly exceeds typical dry weather flow rates. Consequently, dry weather flow velocities are usually much lower than the design velocity and may cause solids to settle in the pipelines. Over time, settled solids accumulate decreasing the hydraulic capacity of the pipe.

During the development and analysis of CSO abatement control alternatives, SWMM model simulations showed that some limited cleaning of key conveyance pipes (interceptors and siphons) would be very beneficial to help reduce CSO discharges.

The Upper Siphons, Middle Siphons, Lower Siphons and the interceptors are integral control points in the Haverhill collection system. Flow on the north side of the Merrimack must pass through one of three siphon structures to reach the south side. Meanwhile, the Bradford Interceptor, on the south bank, conveys all the flow in the system to the WWTP.

Field investigations of Upper, Middle, and Lower Siphon indicated that there were partial blockages of the siphons at Lower and Upper Siphon. Sediment was also noted at some locations along the Bradford interceptor system and the Middle Siphon Interceptor. The city has already cleaned the two smaller Locke Street siphons.

Accordingly, cleaning the Upper Siphon (approximately 1,900 feet of 16-inch, 18-inch and 30-inch siphons), Middle Siphon (1,300 feet of twin 30-inch siphons), and Lower Siphon (2,300 feet of 18-inch, 20-inch and 30-inch siphons), Middle Siphon Interceptor (approximately 1,100 feet of 42-inch x 54-inch elliptical pipe from Locke St to Middle Siphon) and Bradford Interceptor (approximately 5,000 feet of 66-inch to 72-inch pipe downstream from Middle Siphon) will increase capacity and improve conveyance to the south side and the WWTP.

The cost to perform these planned system improvements is estimated at $1,100,000. The Intermediate Design Control Alternatives developed in this section all assume that the city will complete this cleaning.

Annual CSO volume could be reduced by 5-10 percent by completing these improvements. CSO activation frequency at the Upper and Lower Siphon CSOs and the Middle CSO could also be improved slightly. These improvements are most effective for larger storm events (when other system conveyance improvements are considered) but also provide a benefit during smaller storm events. Accordingly, the benefits of these improvements are fully realized when other intermediate design storm controls are implemented to optimize the use of the additional conveyance and storage capacity that is made available by cleaning.

There are no environmental impacts or facility siting challenges associated with these improvements. All the work will take place within existing facilities, within previously disturbed areas, or along city streets. There is no construction required for these system improvements and the work only involves maintenance work with limited impacts to vehicle traffic, detours, noise and air pollution, and residential/service disruptions. There should be no wetland impacts.

7.6.3.2 WWTP Wet Weather Capacity Improvements

The existing WWTP has a maximum hydraulic wet weather treatment capacity of about 65 mgd. The plant is designed to provide primary treatment to all wet weather flow and then excess flow is bypassed around the secondary treatment system. The bypass is activated to protect solids washout from the secondary treatment system with excessive flows. Decisions on when to bypass flows around the secondary system are based on the WWTP High Flow Management Plan (which was updated as part of the January 2017 Comprehensive Plant Evaluation by Woodard and Curran, submitted under separate cover).

Increasing the wet weather capacity of the WWTP was considered as an alternative for CSO abatement. Preliminary SWMM simulations indicated that the existing interceptor system, with the new System Maximization/CSO Structure Modifications project completed, conveys a maximum flow rate, under surcharge conditions, of about 60 mgd during the 1-Month, 3-Month, and 6-Month storm events. Accordingly, for these storm events, without other new piping improvements to convey more flow downstream, an increase in WWTP wet weather treatment capacity is not necessary. However, for larger storm events, increasing the WWTP capacity provides significant benefit.

Improvements and costs to increase WWTP wet weather treatment capacity from the current 60 mgd were considered in two increments: 80 mgd and 100 mgd to help meet 1-year, 2-year, and 5-year control level. Both treatment rates would require significant upgrades at the plant and influent pump station. A memorandum on the process/equipment upgrades necessary to achieve these two flow rates is included in Appendix H.

Table 7-2 summarizes the findings and estimated project costs including 45 percent engineering and contingencies.

Table 7-2 Summary of Modifications and Costs to Increase WWTP Wet Weather Capacity

WWTP Upgrades	Project Components/Improvements at Respective Flow Rate	
	80 mgd	100 mgd
Influent Pump Station Upgrades		
Impeller and Motor Upgrades	X	X
Full Motor Upgrades and Connection Piping		X
VFD and Electrical Upgrades	X	X
New Generator	X	X
Transformer and Power Feeds	X	X
New force main to WWTP	X	X
WWTP Upgrades		
3rd Aerated Grit Tank		X
4th Primary Tank	X	X
Channel Upgrades	X	X
Sludge Pump/Piping Upgrades	X	X
Increase height of Secondary Clarifier Walls	X	X
New chlorine injection pumps	X	X
Total Project Costs	**$31 Million**	**$51 Million**

CDM Smith

There are not significant environmental impacts or facility siting challenges associated with these improvements as the proposed modifications will all take place within existing facilities and/or previously disturbed areas. The construction impacts associated with the implementation of these improvements will be temporary and any impacts to vehicle traffic, detours, noise and air pollution, and residential disruptions can be addressed with local area mitigation measures. There may be temporary wetland impacts associated with the installation of the new force main but these could be mitigated with permitting by the Haverhill Conservation Commission.

7.6.3.3 Green Infrastructure

The use of green infrastructure to achieve intermediate levels of CSO control is now a large part of CSO control plans nationwide. Haverhill considered the potential benefits that might be achieved by the use of green infrastructure in the combined sewer system. One challenge of fully implementing this initiative is the lack of undeveloped area (i.e., green spaces or parking lots without buildings) that could be reasonably used to locate green infrastructure. Another issue for the city is the long-term maintenance needs and effectiveness of green infrastructure as compared to structural CSO abatement controls. Accordingly, the use of green infrastructure in Haverhill was not considered as a major element of the LTCP development for each CSO design control level.

The city did conduct a study to evaluate potential locations where green infrastructure could be implemented in the combined sewer areas. A memorandum is included in Appendix I, which discusses this investigation including the identification of twelve (12) candidate sites, discussion of the types of green infrastructure that could be considered at these locations, plans of the sites and proposed green infrastructure, identification of the combined sewer area that could be managed on the site, and representative costs for the proposed green technologies.

Based on this work, the city will consider a demonstration project(s) of green infrastructure at one or more of the sites that can be implemented either with other city revitalization projects or on its own so that the city can become more familiar with this green approach. In addition, the city realizes the value of green infrastructure projects in helping to increase public awareness of CSO and stormwater issues.

7.6.3.4 I/I Reduction

System rehabilitation to reduce I/I can have some benefits to CSO reduction. Haverhill has completed flow monitoring, flow isolation, and CCTV investigations of three discrete areas in the sanitary sewer system, as discussed in Section 2. These discrete areas exhibited the highest ratios of extraneous flow to base flow, based on system-wide flow metering conducted in 2010, and were good candidates for further system evaluations to identify the source of pipe infiltration. However, in both sets of investigations, CCTV work was performed during relative low groundwater periods due to relatively dry spring periods. The CCTV work identified pipes that were good candidates for rehabilitation or replacement but the potential I/I reduction achieved by these system improvements could not be readily determined.

Likewise, in its Asset Management Assessment program, the city complete CCTV inspections of another 10 percent of the piping system to identify sewer replacement or rehabilitation needs. This set of CCTV inspections also did not identify a significant amount of visible I/I in these sanitary systems. Accordingly, the city will complete the rehabilitation/replacement identified in these programs and will continue to assess its relative I/I flow rates to determine if future I/I investigations are necessary.

Several SWMM simulations were conducted to identify the potential CSO benefits achieved by a 30 percent I/I reduction in sanitary areas. Thirty-percent I/I reduction is a reasonable goal for the reduction extraneous flow that could be achieved by pipe rehabilitation and some limited inflow removal. To reduce I/I by higher levels would likely require the rehabilitation of building sewer services, which results in significant challenges and private property access issues.

The SWMM simulations indicated that if 30 percent I/I reduction was assumed, approximately 10 percent of the total volume of CSO would be reduced during the 3-Month storm event and about 20 percent of the CSO volume would be reduced during the 1-year storm event. However, in both cases, no individual CSOs were eliminated for these design control levels. Accordingly, and considering the relative cost of system rehabilitation to achieve 30 percent I/I reduction compared to direct CSO controls for 10 percent reduction of CSO volume, I/I reduction was not considered further as a system-wide alternative for CSO reduction in Haverhill.

7.6.3.5 Real-time Control System Optimization

With the completion of the Wet Weather System Maximization/CSO Structure Improvements project in March 2017, the city will be putting a real-time control system in operation. It is important to note that the city's new real-time control of the system and CSO control gates will require some time to assess the system reactions during storm events and to refine instrumentation settings and SCADA controls. SWMM model simulations represent the initial best case for operation of the flow control gates. Actual field conditions are more challenging.

The CSO control alternatives, discussed below, were developed based on SWMM simulations that represented the abatement expected over time as the city continues to assess the system reaction to storm events and makes periodic adjustments to maximize control. Accordingly, the city recognizes this continuous system/ instrumentation assessment requirement and will adopt a program over the first 3 to 5 years of operation (Weather Controls Optimization Program) to continue to fine-tune operations using real-time control and depth monitoring.

7.6.3.6 Summary

Several system-wide improvement programs were considered to either achieve individual CSO control for each of the control levels or to supplement the control level. Cleaning key interceptor and siphons should increase conveyance and in-line storage. Another program, to perform continuous assessment and optimization of the SCADA and real-time control system, will maximize the use of existing assets and CSO reduction. It is assumed that work on these two programs will be completed as soon as possible so that the city can evaluate their efficacy to reduce CSO discharges, to avoid unnecessary spending on future improvements to control CSO discharges. These two programs were considered in the alternative analysis discussed further below.

Two other system-wide improvement programs will be considered further. The city will implement a green infrastructure demonstration program to become more familiar with the technology, to increase public awareness, and to benefit from its potential stormwater quality improvement and/or CSO reduction. I/I reduction will be performed by the city as a general maintenance program. It is not anticipated that these two programs will have similar CSO reduction benefits as the structural CSO controls considered below.

7.6.4 Structural Controls of CSOs

7.6.4.1 General

After consideration of system-wide programs to help reduce CSO discharges, structural controls of individual CSO regulator were considered next. Structural controls, at satellite locations around the system, can provide CSO control for each of the design control levels by:

- treating wet weather flow to meet water quality objectives; or
- storing wet weather flow for eventual treatment at the WWTP after the storm event.

Partial separation of a CSO drainage basin was also considered during the analysis of intermediate design control levels. In this case, the SWMM model was used to determine the amount of separation (by acreage) required to control the frequency of CSOs to the design control level (including the consideration of only 80 percent effectiveness). However, partial separation of the CSOs to intermediate control levels was typically less cost-effective than the installation of structural mitigation facilities.

Consolidation of CSO discharges in some areas was considered because there are a limited number of sites available in the city. New interceptor/consolidation piping was considered, as necessary, to convey flow downstream to these available sites.

7.6.4.2 Satellite Treatment or Storage

Satellite treatment/storage facilities are designed to remove or reduce pollutants from CSO discharges to levels consistent with water quality goals. Storage facilities provide a volume that retains the combined sewer flow until after the storm event when the combined flow can be pumped back to the WWTP for treatment. Treatment facilities provide instantaneous treatment of flows to remove pollutants and then discharge treated flow to the receiving water during the storm. Various levels of treatment can be provided depending upon which treatment technology is selected. This is discussed further below. In all cases, the satellite treatment facilities must be designed for reliable and effective treatment of intermittent and highly variable influent flows and pollutant concentrations characteristic of CSOs.

In most cases, flow is diverted to the satellite facility through differential weirs or remotely modulated gates placed in the CSO regulator structures. Flows in excess of facility design capacities are typically diverted through bypass channels to avoid flooding the facility. Due to the intermittent nature of CSOs and the difficulty in forecasting events, satellite treatment facilities generally require some means of automatic activation. Staffing on a full-time basis is not considered practical. Simple float switches or other flow sensors in the influent channel are commonly used to trigger operation of the treatment equipment.

Satellite facilities are generally sited near the regulator structure (or downstream control point) to capture overflows as they occur and to take advantage of existing regulating structures to divert overflows to the satellite facility and minimize piping and possible pumping requirements.

However, facilities may be sited at alternate locations if construction impacts are lower and comparable CSO benefits are achieved at these alternate sites.

Satellite Treatment

Section 6 provided an initial assessment of potential satellite treatment technologies. Technologies selected for further consideration include screening, sedimentation, high rate clarifiers, and disinfection. None of these technologies will sufficiently treat CSOs on their own.

To meet water quality objectives, treatment must control floatables, provide disinfection (or inactivation of fecal coliform) and take advantage of the benefits of solids removal. Accordingly, combinations of the technologies identified in Section 6 are necessary to provide solids removal and fecal coliform inactivation to meet water quality goals. Treatment combinations suitable for satellite treatment of CSOs in Haverhill include 1) screening and disinfection; 2) primary treatment: screening, sedimentation, and disinfection, and 3) high rate clarification (HRC) and disinfection. Generally, these treatment options will provide increasing levels of pollutant removal.

Disinfection will entail the use of sodium hypochlorite for eliminating/reducing bacteria and viruses. The final effluent will be dechlorinated, most likely with sodium bisulfite, to remove the risk of aquatic toxicity from chlorine residuals. A storage contact tank is required for disinfection to provide the minimum contact time. Ultra-violet (UV) disinfection is alternate to hypochlorite because it can eliminate the need for a large contact tank but it is typically costlier.

Generally, CSO treatment facilities have more above-grade buildings and structures. In addition, treatment facilities have more chemical requirements than storage facilities, which may increase vehicle deliveries and maintenance requirements. Accordingly, siting treatment facilities in dense urban areas can be a challenge as these facilities are more visible.

Satellite Storage

Satellite storage facilities are designed to capture and hold overflow volumes until capacity is available in the interceptor system at which time the tanks would be dewatered back into the collection system for subsequent treatment at the WWTP. Storage facilities are often considered more advantageous from a regulatory perspective since the captured design volume is eventually conveyed to the WWTP for higher level treatment.

As described in Section 6, storage of CSO flows can be provided at a local site adjacent to CSO regulators or at a central downstream site that consolidates the need for several facilities. Alternate facility sites may also be selected if it is determined that these sites pose fewer community and environmental impacts. The facilities are relatively simple in design and operation and can effectively reduce the frequency of overflows.

In-line storage, using existing interceptor pipes, is probably the most cost-effective means of reducing CSO discharges. The city is already implementing a real-time control system to utilize available inline storage in the system upstream of the several key CSO regulators. New parallel pipelines can also be added to a system to increase the available volume of in-line storage at an additional cost.

Off-line storage achieves the same intent as the use of in-line storage (namely, the capture of flow for future treatment at the WWTP) but requires the capital cost for a new storage tank. Alternatively, new parallel interceptor pipes can be installed to provide the storage volume. Sometimes, it is more practical to construct a pipeline along an existing easement or street than obtain a private property for a storage facility. Off-line storage can also be used as a combination storage/sedimentation facility to increase the level of treatment provided (at additional cost).

For simplification of the alternatives development, this combined use of off-line storage/treatment was not considered in this evaluation but could be considered during a future preliminary design phase to help optimize CSO facility sizing (or to reduce the WWTP treatment capacity required).

The maximum use of both off-line and in-line storage is limited by the capacity of the WWTP (including the influent pump station) to treat the stored volume in a reasonable amount of time and avoid odorous conditions from aged wastewater at the storage facilities. Typically, the maximum storage dewatering period considered is about 18-24 hours. This storage dewatering period was incorporated into the model simulations to ensure that the system had the capacity to empty filled storage facilities in an appropriate period of time.

Summary

During initial discussions of treatment technologies and available sites, the city elected to minimize the use of satellite treatment facilities. Storage systems are more desirable because many components of the system could be located below grade and, in many cases, it would allow the city to make beneficial use of the property. Satellite treatment facilities require more above grade facilities that would restrict future uses, and treatment facilities require more staffing, more chemicals, and may be more prone to odors in very urban neighborhoods. Therefore, only storage facilities were considered for satellite CSO control options.

7.7 Basis of Cost Estimates

7.7.1 Satellite Facility Sizing

Sizing criteria for the CSO control alternatives were based on dynamic SWMM model conditions. As noted above, the city is committed to the use of real-time control of the interceptor system at the Upper Siphon and Lower Siphon CSO structures to maximize flow from the Middle Interceptor through the Middle Siphon. Accordingly, each CSO design control plan was developed based on a holistic plan for the system and not individual CSO regulator control plans.

7.7.2 Available Sites for Satellite CSO Facilities

Appendix J includes a summary and evaluation of the available sites for satellite CSO storage facilities in Haverhill. Sites for facilities were primarily selected for their proximity to the CSO regulators or nearby to large interceptors/collector pipes that could be used to convey flow to the CSO facility.

Facilities were then conceptually sized based on the model outputs. The approximate footprint and possible pumping requirements for each alternative were considered when preliminarily sizing facilities. For storage facilities, it was assumed that the storage tank would be below ground with a 10-foot sidewater depth. A buffer of approximately 30 percent of the facility footprint was assumed for siting requirements.

To avoid excessive construction costs for deep installation, a maximum construction depth of 30-40 feet was established for the CSO alternatives. If existing pipe inverts require a deeper facility, then influent pumping was considered in the facility costs.

7.7.3 Satellite Facility Costs

Costs for satellite facilities, both treatment and storage, were derived using USEPA cost curves, cost data from recent CSO construction projects, and other New England LTCPs. Cost curves were updated based on the latest Engineering News Record (ENR) national construction cost index available (December 2016, ENR =10530). An appropriate cost curve for each technology was selected based on the best fit of recent data and expected conditions in Haverhill. The cost curves used for this project can be found in Appendix K. Additional cost considerations/assumptions include:

- A total capital cost of each treatment alternative calculated by adding the individual processes capital costs,
- A 10 percent allowance for yard piping cost,
- Contractors overhead and profit and 25 percent construction contingency.
- Facility costs include an allowance for land acquisition, and
- Costs include a 45-percent allowance for engineering and project contingencies. This allowance includes design, permitting, construction oversight, survey work, geotechnical work, legal fees, bonding and administrative needs.
- Facility costs do not include an allowance for property investigations or hazardous waste removal.

Capital costs were typically used as the primary selection factor for identifying the least cost alternative strategy. However, where costs were close, long-term operations and maintenance costs (O&M) were considered. O&M cost estimates were developed from textbook references, USEPA reports, cost data provided from other projects, as well as cost curves from other CSO control programs around the nation. O&M cost curves are included in Appendix K.

7.8 Alternatives Development and Analysis

With the new Phase II system improvements (Wet Weather Maximization/CSO Structure Modifications) as of March 2017, the combined sewer/interceptor system will operate more dynamically with storm conditions. Accordingly, for this section, CSO abatement plans for most CSOs were developed as an integrated plan for the system as a whole.

As shown in Table 4-1, the Main Street North CSO is not active during any of the design storms. Even though the Main Street North CSO is not active during any of the design storms, the city does not want to close this regulator because it serves as an emergency relief point to the Lower Siphon West interceptor.

7.8.1 1-Month Control Plan

During the 1-Month storm event (see Table 4-1), there are four CSO regulators that activate – Locke Street Center Barrel (021F) along the Locke Street Interceptor, Bethany Avenue and Chestnut Street CSOs that contributed flow to the Lower Siphon Interceptor system, and the South Webster CSO that connects to the Bradford Interceptor.

Table 7-3 (page 7-17) shows the alternative system improvements considered to control each CSO regulator for the 1 Month Control Plan as discussed below.

7.8.1.1 Locke Street Interceptor

The Locke Street Center Barrel CSO is the largest active regulator in the Haverhill system (by volume). It discharges about 5 MG average per year. It receives flow from the upstream Winter and Winter & Hale CSO regulators, along the Locke Street Interceptor, and discharge its flow into the Middle Interceptor (on Essex Street) via the 12-inch and 18-inch sewer siphons along Locke Street that extend under the Little River Conduit. Excess flow is discharged as CSO via a 39-inch by 50-inch elliptical CSO outfall pipe. Figure 7-1 (page 7-19) shows a schematic of the piping configuration from the Locke Street Center Barrel CSO to the Middle Interceptor. The two small siphons represent a hydraulic restriction to convey Locke Street Interceptor flow downstream to the Middle Siphon.

Some of the control options considered to control the Locke Street Center Barrel CSO to the 1-Month Storm event include building a satellite storage facility, installing a third Little River Conduit siphon to the Middle Interceptor, and sewer separation.

Satellite Storage Facility

Alternative A in Table 7-3 involves the construction of a satellite storage facility on a privately owned site adjacent to Locke Street Center Barrel CSO. There is a city-owned parking lot nearby but this site is upstream and higher than the private lots, which would result in a much deeper storage facility. The private site is made up of four properties located on Locke, Orchard and Locust Street. Three of the properties are currently used as a parking lot, the fourth property has a one level building occupied by a liquor store. Not all of the properties are necessary to construct a storage facility for the Locke Street Center Barrel for the smaller storm events. Utilizing this site for a storage facility would require land acquisition (and building demolition) but the installation of a storage facility may allow the city to lease the land back for parking lots. Appendix J includes more details about the site. The entire site, with all four properties, can accommodate a facility that can store or treat CSO discharges up to 2.5 million gallons.

Figure 7-2 (page 7-21) shows a schematic of how the CSO storage facility would be arranged for the largest facility. CSOs would be diverted from the Locke Street Center Barrel CSO to the storage facility by gravity, but it would require pumping to convey flow from the storage tank into the collection system after the storm. The storage tank could be constructed with automatic or passive control systems to divert flow during storm events. Other automated features, such as dewatering and flushing tanks, could be added to the storage tank to reduce maintenance requirements. Odor control could also be added to minimize impacts to any adjacent buildings. The estimated cost of the proposed storage tank for the Locke Street Center Barrel CSO is $3.2

million, including an allowance for land acquisition. The estimated life-cycle cost of the facility, considering 20 years of O&M, is about $3.7 million.

New 24-inch Siphon

Alternative B, in Table 7-3, involves the construction of a third sewer pipe and siphon to convey flow to the Middle Interceptor, under the Little River Conduit, to control the Locke Street Center Barrel CSO to a 1-Month design storm. This new siphon would supplement the 12-inch and 18-inch diameter outlet pipes. Figure 7-3 (page 7-23) shows the route of the new pipe, which would run from Locke Street Center Barrel CSO south on Locke Street, west on an existing sewer easement (between Locke St and Locust St) and south on Locust Street, under the Little River Conduit (via a siphon) to the Middle Interceptor. It was not practical to construct a new siphon on Locke Street given the other utilities on the street and the two existing siphons.

The new siphon would convey flow to the Middle Interceptor, across the Middle Siphon to the WWTP.

The project cost of the 24-inch sewer and siphon is $4.2 million. To minimize the impact to Middle Siphon CSO this alternative would have to be combined with sewer separation of the contributory area to Winter Street and Winter and Hale CSO.

Sewer Separation

Alternative C represents sewer separation of some of the upstream combined sewer basins contributing flow to the Locke Street Center Barrel CSO. Separation of 74 acres of combined sewer area, upstream of the Winter Street and Winter and Hale CSOs, at an estimated project cost of $7.4 million could result in the control of the Locke Street Center Barrel CSO discharges to the 1 Month storm event.

7.8.1.2 Lower Siphon Interceptor

The Lower Siphon Interceptor system has three CSOs that discharge during the 1-Month event – Bethany Avenue, Chestnut Street, and Lower Siphon.

Control of the Bethany Avenue and Chestnut Street CSOs can be achieved by modifying the CSO diversion weir elevations. Weir modifications reduce both overflow volumes and frequencies. The cost to complete these modifications is estimated at $30,000 at each regulator and involves adding additional courses of brick or concrete to increase the elevation of the existing weirs. Raising the weir by 7 inches at the Bethany CSO and 8 inches at the Chestnut CSO should eliminate overflows during the 1-Month design storm.

For Lower Siphon, the SWMM model indicates that there could be minor adjustments to real-time controls on the flow control gates that will avoid discharge from this CSO. Real-time optimization is covered under the city's Wet Weather Controls Optimization Program.

Table 7-3 1-Month Control Plan Alternatives

		Alternative A Locke Street Storage		Alternative B Locke Street Conveyance		Alternative C Sewer Separation	
Name	NPDES #	Improvements	Estimated Cost	Improvements	Estimated Cost	Improvements	Estimated Cost
Upper Siphon							
Upper Siphon	024						
Locke Street Area							
Winter Street	021G					Separation of 12 acres	$1,200,000
Winter & Hale	021H					Separation of 62 acres	$6,200,000
Locke Street Center Barrel	021F	0.14 MG storage tank (Lifecyle Cost is $3.66 M)	$3,172,500	New 24" Siphon to Essex Street	$4,160,000		
Middle Siphon							
Broadway (flood)	037						
High Street (flood)	038						
Emerson Street (flood)	021B						
Middle Siphon	021A						
Lower Siphon							
Main St North	019						
Bethany Avenue	040	Raise weir to 40.9 feet	$30,000	Raise weir to 40.9 feet	$30,000	Raise weir to 40.9 feet	$30,000
Chestnut Street	041	Raise weir to 34.1 feet	$30,000	Raise weir to 34.1 feet	$30,000	Raise weir to 34.1 feet	$30,000
Lower Siphon	013						
Bradford Interceptor							
Bradford Avenue	032						
Middlesex Street	034						
South Webster Street	039	Clean 8"/10" DWC (380 feet) to S. Central Street	$5,000	Clean 8"/10" DWC (380 feet) to S. Central Street	$5,000	Clean 8"/10" DWC (380 feet) to S. Central Street	$5,000
WWTF Improvements							
Total Project Cost		**$3,240,000**		**$4,230,000**		**$7,470,000**	

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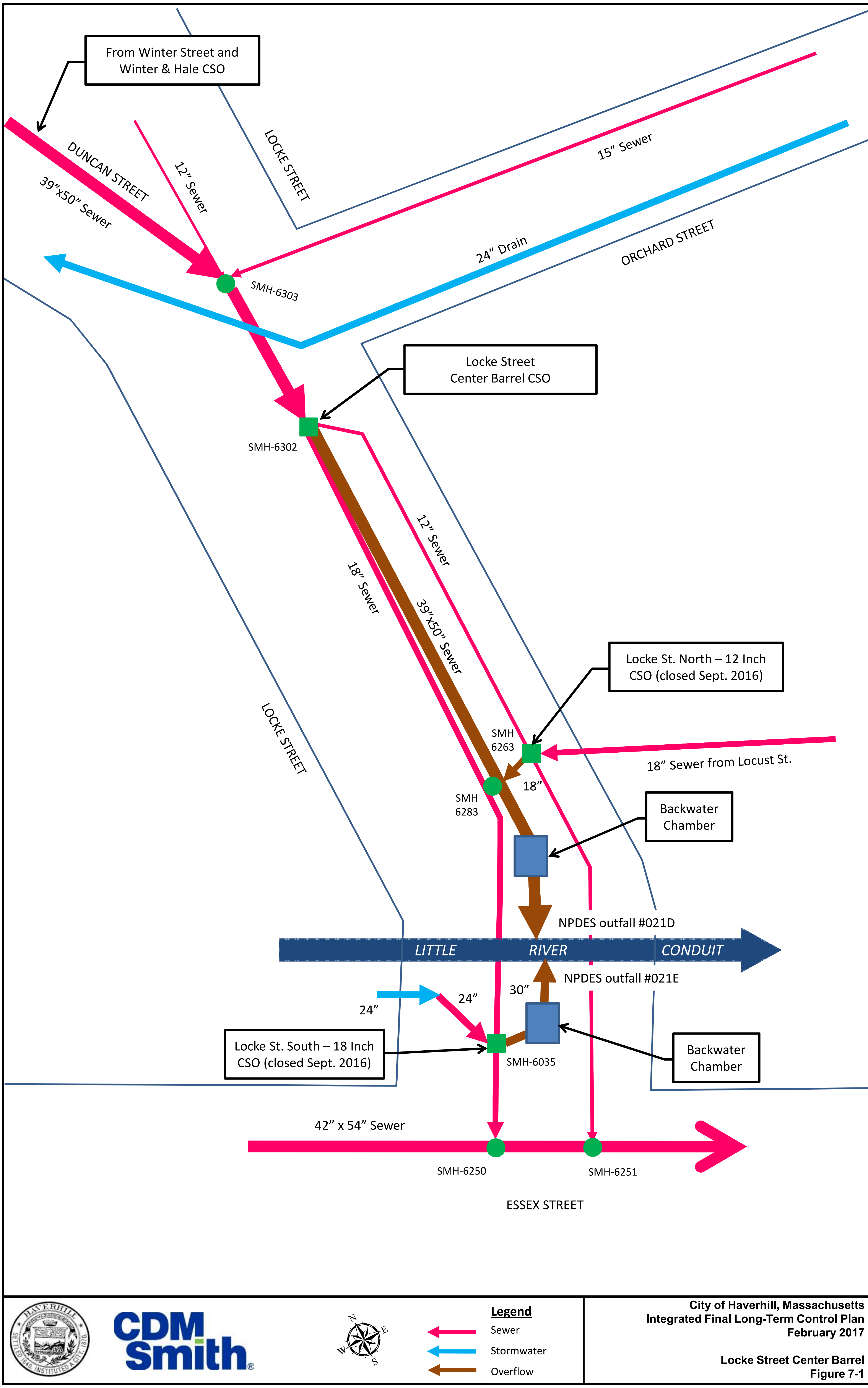

City of Haverhill, Massachusetts
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Locke Street Center Barrel
Figure 7-1

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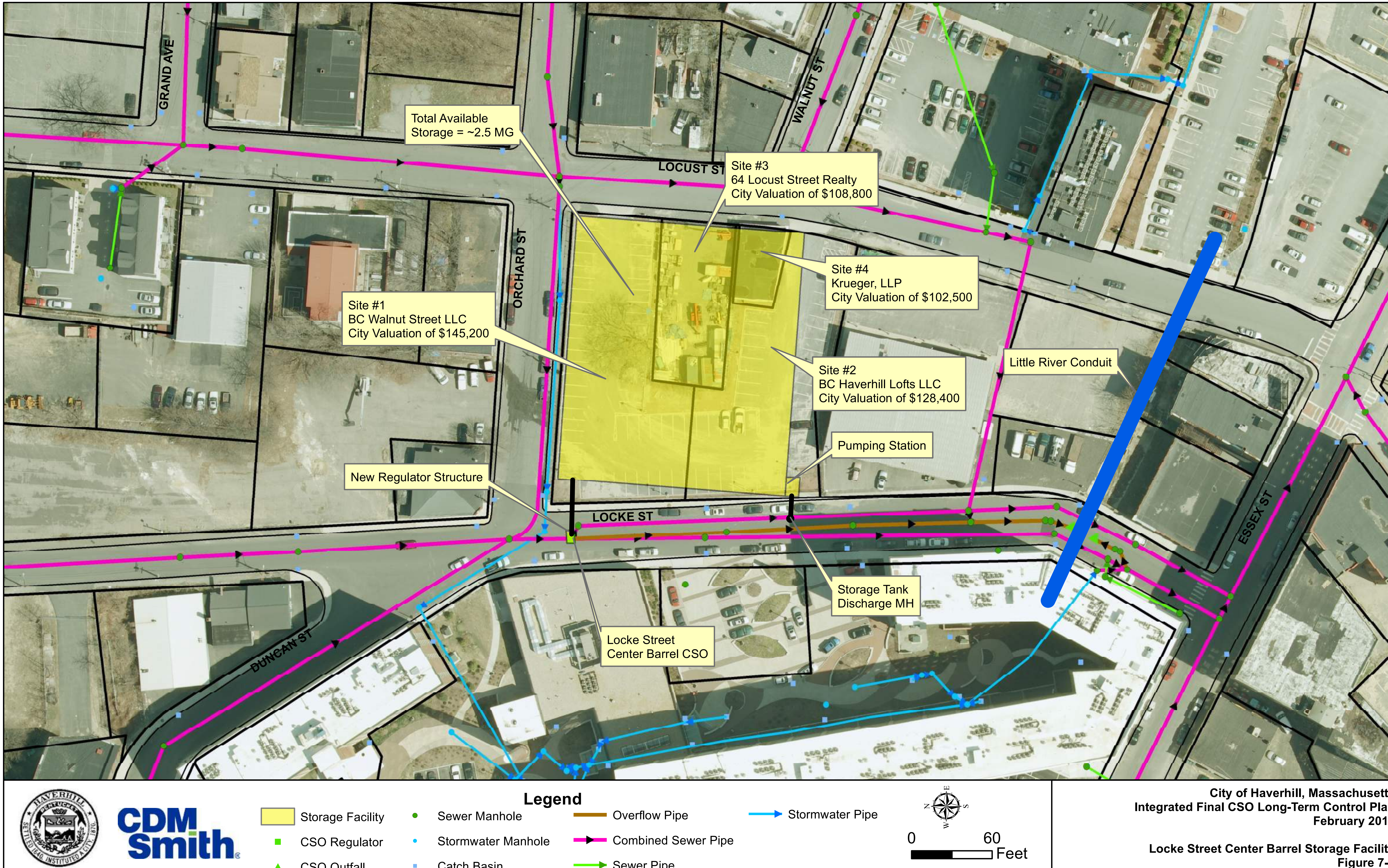

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Locke Street Center Barrel Storage Facility
Figure 7-2

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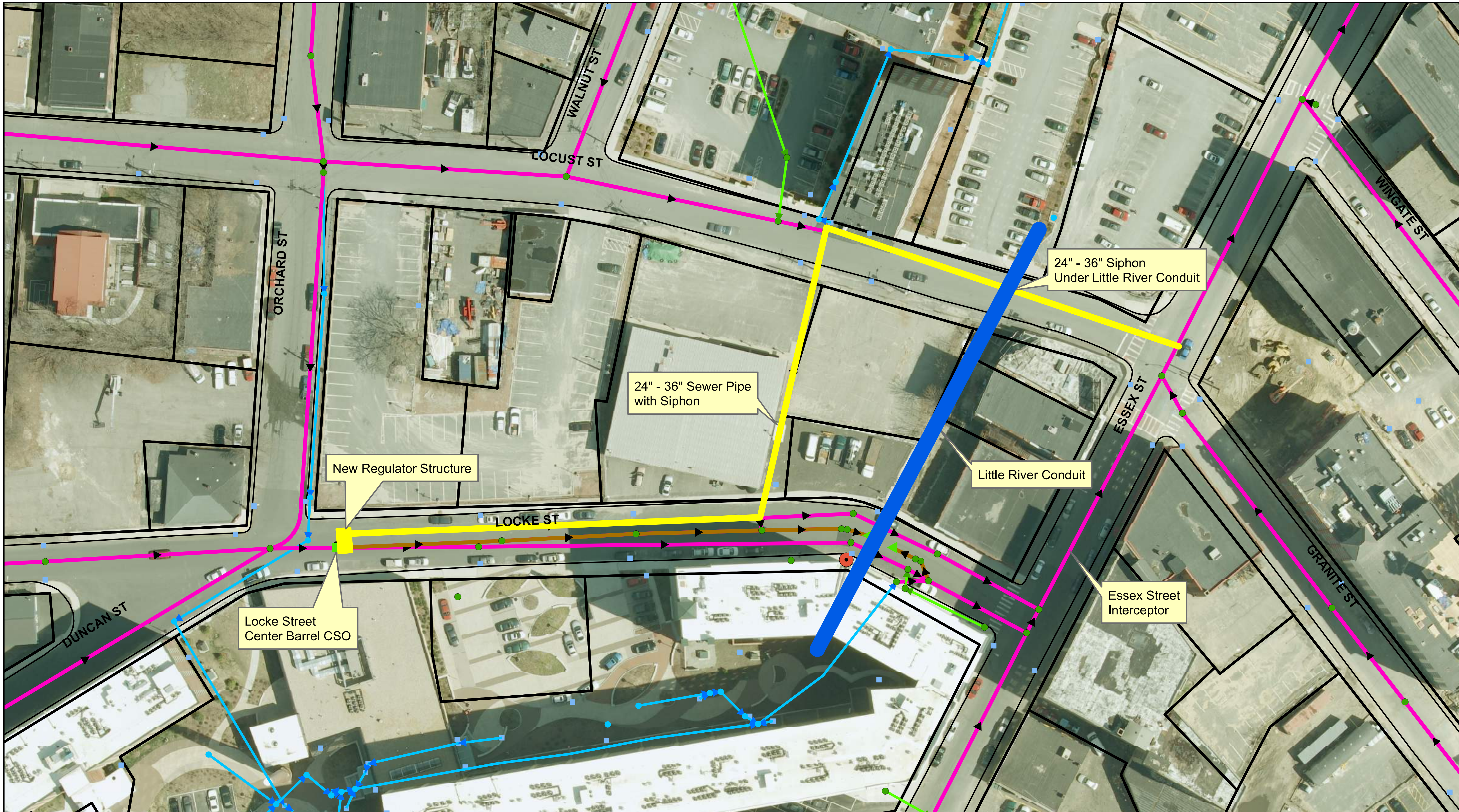

Legend

New Sewer Pipe	Sewer Manhole	Overflow Pipe	Stormwater Pipe
CSO Regulator	Stormwater Manhole	Combined Sewer Pipe	
CSO Outfall	Catch Basin	Sewer Pipe	

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City of Haverhill, Massachusetts
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Locke Street Center Barrel New Sewer w/ Siphon
Figure 7-3

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7.8.1.3 Bradford Interceptor

The South Webster CSO is located along the Bradford Interceptor and discharges during the 1-Month event. The South Webster Street CSO is the most active regulator in the Haverhill system with discharges occurring an average of 34 times per year.

The South Webster CSO has a dry-weather connector pipe that extends 2,018 feet from the CSO to the Bradford Interceptor. Cleaning the 8-inch/10-inch dry-weather connector pipe to South Central Street should eliminate overflows during 1-Month design storm. It is estimated the cleaning cost is $5,000, as shown in Table 7-3.

7.8.1.4 Potential Environmental Impacts

There are no significant environmental impacts associated with the construction of these system improvements for control of CSO discharges during the 1-Month storm event. Most of the work will take place along existing city streets and easements.

Likewise, there are no significant environmental impacts with the construction of the storage tank at this site because it is not adjacent to any wetlands. The largest disruption will occur to those that residents that currently utilize the parking lot as the parking will have to be temporarily relocated during construction. There may be other temporary construction impacts but these can be mitigated using typical best management practices.

7.8.1.5 Summary/Least Cost Plan for 1-Month Control

Table 7-3 summarizes the cost of the three alternatives considered to achieve the 1-month level of control. The least cost alternative is the construction of the storage facility adjacent to the Locke Street Center Barrel CSO, even considering its life-cycle project cost.

7.8.2 3-Month Control Plan

Table 7-4 (page 7-27) shows the most practical and cost-effective alternatives considered for the 3- Month Control Plan. Under the 3-Month storm event, there are nine CSO regulators that activate, including the four CSO activated during the 1-Month Plan. These CSOs include the Upper Siphon CSO, the Winter & Hale CSO and Locke Street Center Barrel along the Locke Street Interceptor, the Middle Siphon CSO, the Bethany Avenue CSO, Chestnut Street CSO, and the Lower Siphon CSO that contributed flow to the Lower Siphon Interceptor system, and the Middlesex Street and South Webster CSOs that connect to the Bradford Interceptor.

7.8.2.1 Upper Siphon Interceptor

The SWMM model simulations indicate that the Upper Siphon CSO discharges only minimally during the 3-month design storm. SWMM modeling indicates that elimination of these minimal discharges during the design control levels might be achieved by making adjustments to the SCADA control rules for the new flow control gates. Fine-tuning of the control rules for the new gates should minimize CSO discharges and would take further advantage of storage along the Upper Siphon interceptors. Real-time optimization is covered under the city's Wet Weather Controls Optimization Program.

7.8.2.2 Locke Street Interceptor

During the 3-month storm event, the Winter & Hale CSO and the Locke Street Center Barrel CSO activate. Some of the control options considered to control the Locke Street Interceptor CSOs to the 3-Month Storm event include building a satellite storage facility, installing a third Little River Conduit siphon to the Middle Interceptor, and sewer separation.

Satellite Storage Facility

Alternatives A and B in Table 7-4 comprise the construction of a satellite storage facility on the privately owned site adjacent to Locke Street Center Barrel CSO. Under Alternative A, the Winter Street CSOs are conveyed downstream to the Center Barrel storage facility via a new parallel 15-inch diameter Duncan Street connector (relief) pipe. The new Duncan Street relief pipe will extend 850 feet from the Winter Street CSO regulator to Locke Street. Under Alternative B, the Duncan Street relief pipe would not be constructed and instead, the weir at the Winter Street CSO would be raised to force more flow down the existing Locke Street Interceptor between the regulators. Alternative B is lower in cost than Alternative A but may cause excessive surcharge upstream of the Winter Street CSO regulator, which may affect a new proposed development in the city along Stevens Street.

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Table 7-4: 3-Month Control Plan Alternatives

		Alternative A Locke Street Storage 1		Alternative B Locke Street Storage 2		Alternative C Locke Street Conveyance 1		Alternative D Locke Street Conveyance 2		Alternative E Sewer Separation	
Name	**NPDES #**	**Improvements**	**Estimated Cost**	**Improvements**	**Estimated Cost**	**Improvements**	**Estimated Cost**	**Improvements**	**Estimated Cost**	**Improvements**	**Estimated Cost**
Upper Siphon											
Upper Siphon	024	Optimize SCADA		Optimize SCADA		Optimize SCADA		Optimize SCADA		Optimize SCADA	
Locke Street Area											
Winter Street	021G					Separation of 39 acres	$3,900,000			Separation of 39 acres	$3,900,000
Winter & Hale	021H	Duncan St. Connector Pipe (850-feet of 15" Pipe)	$740,000	Raise weir to 20.3 feet	$30,000	Separation of 62 acres	$6,200,000	Duncan St. Connector Pipe (850-feet of 15" Pipe)	$740,000	Separation of 62 acres	$6,200,000
Locke Street Center Barrel	021F	0.55 MG storage tank (Lifecyle Cost of $10.7 M)	$9,535,000	0.56 MG storage tank (Lifecyle Cost of $10.5 M)	$9,680,000	New 36" Siphon to Essex Street Interceptor	$4,640,000	New 36" Siphon to Essex Street Interceptor	$4,640,000	Separation of 15 acres	$1,500,000
Middle Siphon											
Broadway (flood)	037										
High Street (flood)	038										
Emerson Street (flood)	021B										
Middle Siphon	021A	Raise weir to 8.8 feet	$30,000	Raise weir to 8.8 feet	$30,000	Raise weir to 10.12 feet	$30,000	0.81 MG Storage Tank (Life cycle cost of $12.3 M)	$12,615,000		
Lower Siphon											
Main St North	019										
Bethany Avenue	040	Dry weather connector pipe modifications	$500,000	Dry weather connector pipe modifications	$500,000	Dry weather connector pipe modifications	$500,000	Dry weather connector pipe modifications	$500,000	Dry weather connector pipe modifications	$500,000
Chestnut Street	041	Dry weather connector pipe modifications	$390,000	Dry weather connector pipe modifications	$390,000	Dry weather connector pipe modifications	$390,000	Dry weather connector pipe modifications	$390,000	Dry weather connector pipe modifications	$390,000
Lower Siphon	013	Optimize SCADA		Optimize SCADA		Optimize SCADA		Optimize SCADA		Optimize SCADA	
Bradford Interceptor											
Bradford Avenue	032										
Middlesex Street	034	Upsize 100 feet of 12" DWC pipe to 18"	$110,000	Upsize 100 feet of 12" DWC pipe to 18"	$110,000	Upsize 100 feet of 12" DWC pipe to 18"	$110,000	Upsize 100 feet of 12" DWC pipe to 18"	$110,000	Upsize 100 feet of 12" DWC pipe to 18"	$110,000
South Webster Street	039	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$110,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$110,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$110,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$110,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$110,000
WWTF Improvements											
Total Project Cost		**$11,420,000**		**$10,850,000**		**$15,880,000**		**$19,110,000**		**$12,710,000**	

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The estimated cost of the proposed storage tank for at the Locke Street Center Barrel CSO is about $9.6 million for both Alternative A and B, including an allowance for land acquisition. The estimate life-cycle cost of the facility, considering 20 years of O&M, is about $10.5 million. Additional investigations are needed as the Stevens Street building development progresses to determine if Alternative B can be implemented.

New 36-inch Siphon

Alternatives C, in Table 7-4, involves the construction of a third sewer pipe and siphon to convey flow to the Middle Interceptor, under the Little River Conduit, to control the Locke Street Center Barrel CSO to a 3-Month design storm. This new siphon is slightly larger than the one proposed to convey flow for the 1-month storm event but would follow the same pipe route. The project cost of the 36-inch sewer and siphon is $4.6 million, including an allowance for land acquisition.

The new siphon would convey flow to the Middle Interceptor, across the Middle Siphon to the WWTP. Not all of the flow conveyed down to the Middle Siphon, under Alternative C, can be conveyed by the Middle Siphons. Accordingly, CSOs are increased at the Middle Siphon CSO and must be controlled at the CSO under this alternative approach.

Under Alternative C, the weir at the Middle Siphon CSO is raised but it can only be raised so much before it could result in excessive surcharging in the downtown Washington Square area. Accordingly, under Alternative C, it was proposed that the Winter and Winter & Hale CSO tributary areas (a total of 101 acres) be separated. [The city has some potential future plans to revitalize downtown areas along Washington Street, which could also be separated and provide some similar wet weather reduction.]

Under Alternative D, the construction of a new storage facility at the Middle Siphon was also considered, along with the new siphon, instead of a storage facility at Locke Street. The Middle Siphon CSO site is discussed in Appendix J. This storage facility size (approximately 0.8 MG) is the maximum size that can be located at this adjacent site to the Middle Siphon CSO. Figure 7-4 (Page 7-31) shows the Middle CSO Site storage facility under Alternative D. The cost of constructing two storage facilities is about $3 million more than constructing a single one at the Locke Street Center Barrel site or the Middle CSO site. Operating two CSO storage facilities that are linked hydraulically is also more challenging.

Sewer Separation

Alternative E shows the costs associated with sewer separation of all of the upstream combined sewer basins contributing flow to the Locke Street Center Barrel CSO. Separation of 116 acres of combined sewer area along the Locke Street Interceptor, at an estimated project cost of $11.6 million could result in the control of the Winter CSO and Locke Street Center Barrel CSO discharges to the 3 Month storm event. Sewer separation of this upstream area also controlled the CSO discharges at the downstream Middle Siphon CSO to the 3-Month event (by eliminating significant wet weather flow).

7.8.2.3 Middle Interceptor

As shown in Table 7-4 and as discussed above, control of the Middle Siphon CSO during the 3-Month storm event is achieved by increasing the weir elevation at the CSO, adding upstream storage or separation in the Locke Street Interceptor area, or constructing a storage facility at the

Middle CSO site. CSO control at the Middle CSO is integrally linked to the Locke Street Interceptor solutions.

7.8.2.4 Lower Siphon Interceptor

The Lower Siphon Interceptor system has three CSOs that discharge during the 3-Month event – Bethany, Chestnut, and Lower Siphon.

The Bethany Avenue CSO dry weather connector pipe to the Lower Siphon Interceptor (which extends approximately 380 linear feet from the regulator to the interceptor) changes in size from a 12-inch diameter pipe to an 8-inch diameter pipe and then again to a 12-inch diameter pipe. The outlet from this regulator is a drop connection with a 90-degree bend, which, along with the downstream pipe diameter changes, are contributing to headlosses along this segment of the sewer. These piping losses result in overflows at the Bethany Avenue CSO. Appendix B includes the schematic of the Bethany Avenue CSO that shows the drop connection.

Dry weather connector pipe improvements could be made to Bethany Ave CSO regulator to reduce overflows. These would include modifying the CSO regulator to remove the drop connection and to install a new connector pipe at the side of the SMH (keeping the new pipe at the same pipe invert as the upstream pipe). In addition, the existing dry-weather connection pipe would be replaced to the Lower Interceptor with a 15-inch diameter pipe to the Lower Siphon Interceptor (approximately 380 feet). The cost to complete these Bethany Avenue CSO regulator dry weather pipe modifications is $500,000.

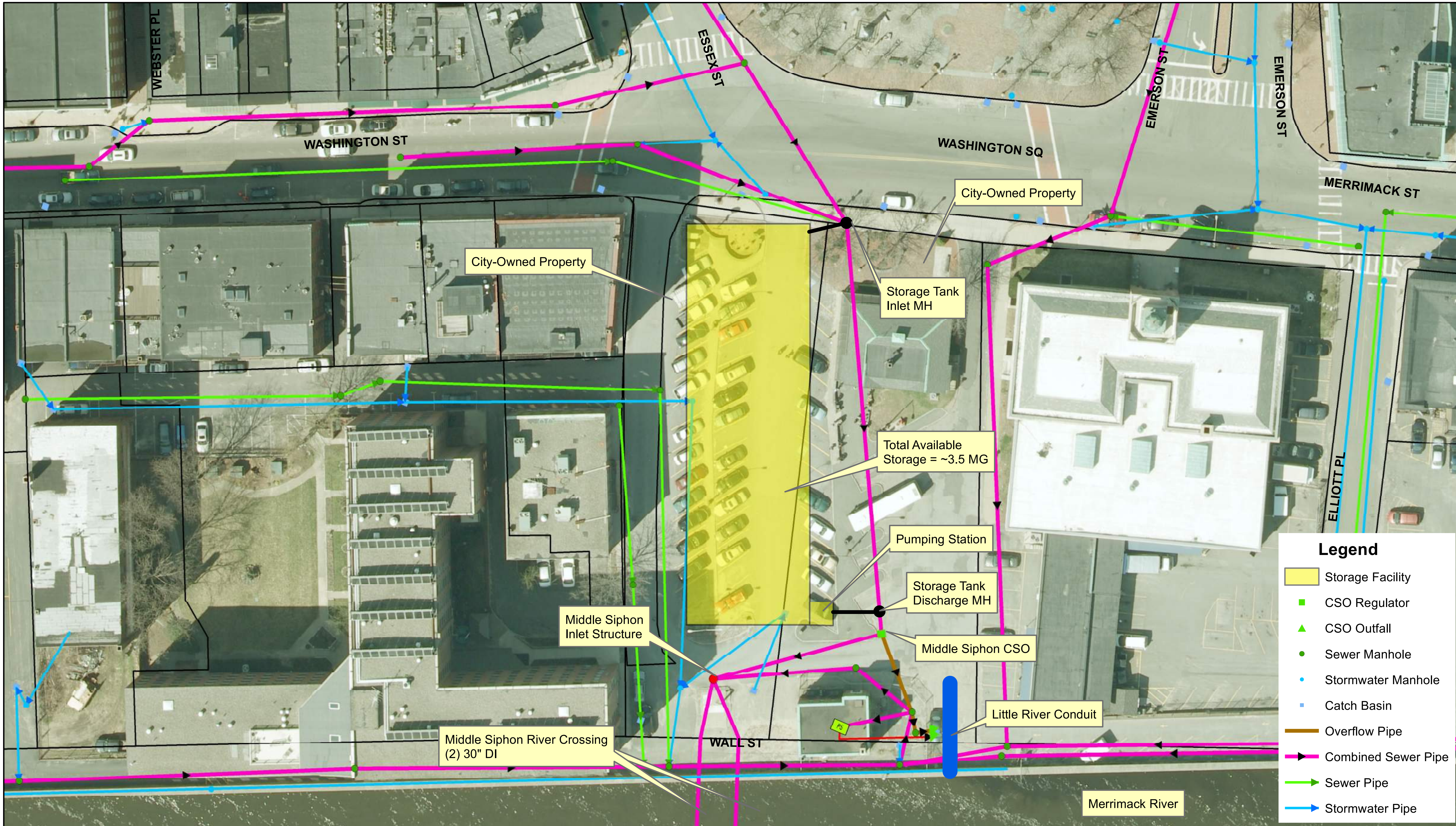
Similar to the Bethany Avenue CSO, the Chestnut Street CSO dry weather pipe to the Lower Siphon Interceptor changes size from a 12-inch diameter pipe to a 10-inch diameter pipe and it includes the same type of bottom outlet connection, which also contribute to pipe losses and result in overflows at the Chestnut Street CSO. Appendix B includes the schematic of the Chestnut Street CSO that shows the drop connection.

Accordingly, a similar set of dry weather connector pipe improvements could be made to Chestnut Street CSO regulator. These would include modifying the CSO regulator to remove the drop connection and installation of a new connector pipe to the side of the sewer manhole (SMH). In addition, the existing dry-weather connection pipe would be replaced to the Lower Interceptor with a 15-inch diameter pipe to the Lower Siphon Interceptor (approximately 265 feet). The cost to complete these Chestnut Street CSO regulator dry weather pipe modifications is $390,000.

The Bethany and Chestnut CSO regulator improvements would allow more flow to be conveyed into the Lower Siphon Interceptor but should control overflows at these two locations to the 3-Month design storm control level. The additional flow to the Lower Siphon CSO Regulator would be stored in the interceptor piping system. For the Lower Siphon CSO, the SWMM model indicates minor adjustments to real-time controls on the flow control gates that will avoid CSO discharges from this CSO during the 3-Month event. Real-time optimization is covered under the city's Wet Weather Controls Optimization Program.

7.8.2.5 Bradford Interceptor

Two CSOs along the Bradford Interceptor discharge during the 3-Month event. For both the Middlesex and the South Webster CSOs, dry weather connector pipe improvements should



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City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

Middle Siphon CSO Storage Facility
Figure 7-4

This page was intentionally left blank eliminate CSO discharges during this design storm. Table 7-4 shows the costs of these improvements.

The Middlesex CSO is located near the Bradford Interceptor. Replacement of the 12-inch dry-weather connector pipe (approximately 100 feet) with a new 18-inch diameter pipe should eliminate CSO discharges during the 3-Month event.

The South Webster CSO has an 8-inch dry-weather connection pipe that conveys flow 120 feet to a 10-inch pipe in the local sewer system on Elmwood Avenue. The local sewer system eventually connects to the Bradford Interceptor. SWMM modeling indicated that replacement of this short 8-inch pipe segment with a new 10-inch pipe would control CSO discharges at the South Webster CSO to the 3-Month storm event. In addition, the existing 10-inch pipe from Elmwood to Central Street (255 feet) should also be cleaned. These piping improvements at the South Webster CSO would cost approximately $110,000.

7.8.2.6 Environmental Impacts

There are no significant environmental impacts associated with the construction of these system improvements for control (elimination) of CSO discharges during the 3-Month storm event. Most of the work will take place along existing city streets and easements. There are no significant environmental impacts with the construction of the storage tank at the Locke Street Center Barrel site because it is not adjacent to any wetlands. The largest disruption will occur to those residents that currently utilize the parking lot as the parking will have to be temporarily relocated during construction. There may be other temporary construction impacts but these can be mitigated using typical best management practices.

7.8.2.7 Summary/Least Cost Plan for 3-Month Control

Table 7-4 summarizes the cost of the four system improvement alternatives considered to achieve the 3-month level of control. The least cost alternative is Alternative B at about $11 million, which primarily involves the construction of a storage facility adjacent to the Locke Street Center Barrel CSO and raising the weir at the Winter Street CSO. Other improvements include sewer separation of key CSOs, CSO weir elevation modifications, and CSO regulator dry weather connector pipe improvements. However, Alternative B may not be a viable alternative if the weir at the Winter Street CSO cannot be raised high enough for control to avoid surcharging an upstream building. The next least cost alternative is Alternative A, which substitutes a new conveyance pipe along Duncan Street to avoid raising the Winter Street CSO weir. However, Alternative E is also about the same cost and could be considered the least cost alternative if the long-term operational cost of the proposed Locke Street Center Barrel CSO storage facility is considered.

Accordingly, the implementation cost of all three alternatives is very similar. As part of the implementation of the Final LTCP, the city will complete a Preliminary Design to assess the best alternative for control of the Locke Street Center Barrel and Winter Street CSOs to the 3-Month control level. This Preliminary Design would provide the city with a 10 percent level project cost that should:

- consider more local flow monitoring to provide further characterization of these CSOs,
- provide better definition of the overall costs and benefits of each of these alternatives (including property acquisition and clearing costs and temporary use impairments for the storage facility),
- evaluate the local hydraulic impacts of raising the Winter Street CSO weir,
- evaluate the operation of the Winter & Hale CSO in coordination with the Winter Street CSO to evaluate whether the connectivity between these two CSOs can be improved to save costs in the control plan,
- develop preliminary piping plans and costs for sewer separation of the Locke Street Interceptor combined sewer area,
- evaluate the benefits achieved by separation of other areas along the Middle Interceptor (the city currently has plans for sewer separation along Washington Street), and
- consider if there are any benefits to implementing green infrastructure in the area.

After this Preliminary Design is complete, the city can implement the most cost-effective control plan for the Locke Street Interceptor CSOs.

7.8.3 6-Month Control Plan

Table 7-5 (page 7-35) shows the most practical and cost-effective alternatives considered for the 6-Month Control Plan. Under the 6-Month storm event, the same nine CSO regulators that activated during the 3-Month event activate during the 6-Month control storm, with slightly larger CSO volumes and longer durations.

7.8.3.1 Upper Siphon Interceptor

The SWMM model simulations indicate that the Upper Siphon CSO discharges only minimally during the 6-month design storm. SWMM modeling indicates that elimination of these minimal discharges during the design control levels might be achieved by making adjustments to the SCADA control rules for the new flow control gates. Fine-tuning the control rules of the new gates would minimize CSO discharges and would take further advantage of storage along the Upper Siphon interceptors. Real-time optimization is covered under the city’s Wet Weather Controls Optimization Program.

7.8.3.2 Locke Street Interceptor

During the 6-month storm event, the Winter & Hale CSO and the Locke Street Center Barrel CSO activate. The system improvements considered to control the Locke Street Interceptor CSOs to the 6-Month Storm event are similar to those considered for the 3-Month event and include

Table 7-5 6-Month Control Plan Alternatives

		Alternative A Locke Street Storage 1		Alternative B Locke Street Storage 2		Alternative C Locke Street Conveyance 1		Alternative D Sewer Separation	
Name	**NPDES #**	**Improvements**	**Estimated Cost**	**Improvements**	**Estimated Cost**	**Improvements**	**Estimated Cost**	**Improvements**	**Estimated Cost**
Upper Siphon									
Upper Siphon	024	Optimize SCADA		Optimize SCADA		Optimize SCADA		Optimize SCADA	
Locke Street Area									
Winter Street	021G			Separation of 39 acres	$3,900,000	Separation of 39 acres	$3,900,000	Separation of 39 acres	$3,900,000
Winter & Hale	021H	Duncan St. Connector Pipe (850 -feet of 18" Pipe); weir lowered to 17.9 ft.	$769,000	Separation of 62 acres	$6,200,000	Separation of 62 acres	$6,200,000	Separation of 62 acres	$6,200,000
Locke Street Center Barrel	021F	Weir lowered to 12.92 ft., 1.19 MG storage tank (Lifecyle Cost of $18.9 M)	$17,884,000	0.031 MG storage tank (Lifecyle Cost of $1.7 M)	$1,270,000	New 36" Siphon to Essex Street Interceptor	$4,740,000	Separation (15 acres)	$1,500,000
Middle Siphon									
Broadway (flood)	037								
High Street (flood)	038								
Emerson Street (flood)	021B								
Middle Siphon	021A	Raise weir to 9.4 feet	$29,000	Raise weir to 9.64 feet	$29,000	Raise weir to 10.2 feet	$29,000	Partial separation (20 acres)	$2,000,000
Lower Siphon									
Main St North	019								
Bethany Avenue	040	Separation of 30 acres	$3,000,000	Separation of 30 acres	$3,000,000	Separation of 30 acres	$3,000,000	Separation of 30 acres	$3,000,000
Chestnut Street	041	Separation of 37 acres	$3,700,000	Separation of 37 acres	$3,700,000	Separation of 37 acres	$3,700,000	Separation of 37 acres	$3,700,000
Lower Siphon	013	Optimize SCADA		Optimize SCADA				Optimize SCADA	
Bradford Interceptor									
Bradford Avenue	032								
Middlesex Street	034	Upsize 100 feet of 12" DWC pipe to 18"	$109,000	Upsize 100 feet of 12" DWC pipe to 18"	$109,000	Upsize 100 feet of 12" DWC pipe to 18"	$109,000	Upsize 100 feet of 12" DWC pipe to 18"	$109,000
South Webster Street	039	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$107,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$107,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$107,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$107,000
WWTF Improvements									
TOTAL PROJECT COST		**$25,600,000**		**$18,320,000**		**$21,790,000**		**$20,520,000**	

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building a satellite storage facility (with and without the Duncan Street sewer relief pipe), installing a third Little River Conduit siphon to the Middle Interceptor, and sewer separation.

Satellite Storage Facility

Alternatives A and B in Table 7-5 comprise the construction of a satellite storage facility on the privately owned site adjacent to Locke Street Center Barrel CSO. Under Alternative A, the Winter Street CSOs are conveyed down to a 1.2-million-gallon Center Barrel storage facility via a new 15-inch diameter Duncan Street relief pipe. Under the 6-Month event, the downstream Middle Siphon CSO activates. To minimize the number of individual storage facilities under this plan, the SWMM model was used to optimize the use of the Locke Street Storage Facility to avoid installing a storage facility at Middle Siphon CSO also. The Middle Siphon weir was raised to minimize CSOs also. However, there are operational challenges in providing upstream storage to control downstream CSOs that are hydraulically interdependent but separated by a large hydraulic distance.

Accordingly, under Alternative B, for comparison, upstream sewer separation was considered at the Winter Street and Winter & Hale CSO area to reduce the size of the Locke Street storage facility. Upstream area separation resulted in the need for a 0.03-million-gallon storage facility, with the same approximate weir setting at Middle Siphon CSO. Alternative B also saved significant costs, which appears to indicate that under this scenario, sewer separation may be less expensive than storage facilities. Separating the upstream area provides a $7 million cost savings between Alternative A ($25 million) and Alternative B ($18 million).

New 36-inch Siphon

Alternatives C involves the construction of a third sewer pipe and siphon to convey flow to the Middle Interceptor, under the Little River Conduit, to control the Locke Street Center Barrel CSO as discussed previously. The size of the new siphon is the same as the one for the 3-Month event. The project cost of the 36-inch sewer and siphon is $4.7 million, including an allowance for land acquisition.

The new siphon would convey flow to the Middle Interceptor, across the Middle Siphon to the WWTP. Not all of the flow conveyed down to the Middle Siphon, under Alternatives C, can be conveyed by the Middle Siphon. Accordingly, the Middle Siphon CSOs increase and the Middle Siphon CSO weir must be raised further to control CSO discharges under this approach. For Alternative C, a storage facility was considered to capture CSO at the Middle Siphon during the 6-Month Event. However, the Middle Siphon CSO site will not support the required storage facility size (greater than 0.8 MG) for the 6-month event, so under Alternative C, the Winter Street and Winter & Hale CSO areas had to be separated, based on the SWMM simulations.

Sewer Separation

Alternative D shows the costs associated with sewer separation of the upstream combined sewer basins contributing flow to the Locke Street Center Barrel CSO. Separation of 116 acres of combined sewer area along the Locke Street Interceptor, at an estimated project cost of $11.6 million could result in the control of the Winter CSO and Locke Street Center Barrel CSO discharges to the 6 Month storm event.

7.8.3.3 Middle Interceptor

As shown in Table 7-5 and as discussed above, control of the Middle Siphon CSO during the 6-Month storm event is achieved by increasing the weir elevation at the CSO, adding upstream storage or separation in the Locke Street Interceptor area. A single storage facility sized for the 6Month storm event could not be constructed on the Middle CSO site. CSO control at the Middle CSO is integrally linked to the Locke Street Interceptor solutions.

7.8.3.4 Lower Siphon Interceptor

The Lower Siphon Interceptor system has three CSOs that discharge during the 6-Month event – Bethany, Chestnut, and Lower Siphon. As shown in Table 7-5, the Bethany and Chestnut CSO combined sewer areas must be separated achieve the 6-Month control level. The Bethany Avenue CSO regulates a 30-acre combined area north of Guinty Boulevard. The Chestnut Street CSO regulates a 37-acre combined area north of Guinty Boulevard. Partial separation of the upstream area to meet intermediate design control levels was considered but is not practical as full separation provides wet weather flow reductions that benefit the downstream Lower Siphon CSO for these larger storm events. Sewer separation of the Bethany CSO area would cost approximately \$3.0 million and separation of the Chestnut area would cost approximately \$3.7 million.

For the Lower Siphon CSO, the SWMM model indicates that there could be minor adjustments to real-time controls on the flow control gates that will avoid discharge from this CSO. Real-time optimization is covered under the city's Wet Weather Controls Optimization Program.

7.8.3.5 Bradford Interceptor

Two CSOs along the Bradford Interceptor discharge during the 6-Month event. For both the Middlesex and the South Webster CSOs, dry weather connector pipe improvements, considered for the 3-Month Control Plan should eliminate CSO discharges during this design storm. Table 7-5 shows the costs of these improvements.

7.8.3.6 Environmental Impacts

There are no significant environmental impacts associated with the construction of these system improvements for control of CSO discharges during the 6-Month storm event. Most of the work will take place along existing city streets and easements. The plan to separate the areas would likely utilize the existing outfall so that a new outfall would not have to be constructed, which should eliminate any wetland impacts along the river bank.

There are no significant environmental impacts with the construction of the Locke Street storage tank because it is not adjacent to any wetlands. The largest disruption will occur to those that residents that currently utilize the parking lot as these parking spaces will have to be temporarily relocated during construction.

There may be other temporary construction impacts but these can be mitigated using typical best management practices.

7.8.3.7 Summary/Least Cost Plan for 6-Month Control

Table 7-5 summarizes the cost of the four system improvement alternatives considered to achieve the 6-month level of control. The least cost alternative is Alternative B at about $18 million, which primarily involves the construction of a small storage facility adjacent to the Locke Street Center Barrel CSO and separation of the Winter Street and Winter & Hale CSO areas. Other improvements include sewer separation of key CSOs, CSO weir elevation modifications, and CSO regulator dry weather connector pipe improvements.

7.8.4 1-Year Control Plan

Table 7-6 (page 7-41) shows the most practical and cost-effective alternatives considered for the 1-Year Control Plan. Under the 1-Year storm event, the same nine CSO regulators that activated during the 3-Month and the 6-Month event activate during the 1-Year control storm, with significantly larger CSO volumes and longer durations.

7.8.4.1 Upper Siphon Interceptor

The SWMM model simulations indicate that a storage tank is required as the Upper Siphon Interceptor system cannot store all of the flow during the 1-Year storm. To achieve the control level, a storage facility is required as indicated under Alternative A and B in Table 7-6.

There is a large site adjacent to the Upper Siphon CSO that is over 2 acres in size and is an underutilized parking lot. The site can accommodate a facility that can store or treat CSO discharges from Upper Siphon CSO through the 5-year design storm. The site is privately-owned and would require coordination with the property owner. Figure 7-5 (page 7-43) shows the site with the largest CSO storage facility that could be constructed on this site.

The estimated cost for storage facilities is included in Table 7-6. Under Alternative B, the storage facility size becomes significantly smaller because of CSO regulator improvements in other areas of the system (discussed below), which, based on SWMM simulations, appears to allow more Upper Siphon wet weather flow into the Bradford Interceptor.

Alternately, 90 acres of the upstream Upper Siphon CSO combined sewer area can be separated. If viewed discretely as a solution for the basin only, separation of the Upper Siphon area is significantly more expensive than local storage at the Upper Siphon CSO. However, separation significantly reduces wet weather flow generated by this sub-system and reduces the cost of CSO control improvements at the other CSO regulators.

7.8.4.2 Locke Street Interceptor

During the 1-Year storm event, the Winter & Hale CSO and the Locke Street Center Barrel CSO activate. The system improvements considered to control the Locke Street Interceptor CSOs to the 1-Year Storm event are similar to those considered for the 3-Month event and include building a satellite storage facility at the Locke Street Center Barrel CSO site and sewer separation. The new Little River Conduit siphon proposed for the 1-Month, 3-Month, and 6-Month control plans does not work during the 1-Year event because the new siphon conveys too much flow downstream to the Middle Siphon CSO. Middle CSO discharges increase significantly, with the new siphon, but there is no room to construct an adequately-sized storage facility.

Another alternative could be to construct a second set of siphons at the Middle Siphon CSO to the Bradford Interceptor, but this was considered impractical and too costly.

Satellite Storage Facility

Alternatives A and B comprise the construction of a satellite storage facility on the privately owned site adjacent to Locke Street Center Barrel CSO. Under Alternative A, the Winter Street and Winter & Hale CSO combined sewer areas are separated and new storage facilities are constructed at Locke Street Center Barrel CSO and the Middle Siphon CSO.

As an alternative to two storage facilities to control CSOs upstream of the Middle Siphon CSO, a single larger storage tank at the Locke Street Center Barrel site (with the Duncan Street sewer relief pipe to control the Winter Street CSO) was considered. To achieve control at the Middle Siphon CSO, using a single upstream storage facility, some sewer separation of areas adjacent t the Middle Siphon CSO was required.

The use of two storage facilities in Alternative A generally saves about $8 million, or a little less than 10 percent of the total project cost. However, as discussed previously, there are operational challenges in providing upstream storage for controlling downstream CSOs that are separated by a large hydraulic distance.

The SWMM model indicated that there are several combinations of storage at the Middle Siphon CSO and the Locke Street Center Barrel CSO, coupled with sewer separation in key areas, that would control all of the Middle Interceptor and Locke Street Interceptor CSOs to the 1 Year Storm event. If this design storm control level were selected for the Final LTCP, additional analysis, via a Preliminary Design, would be necessary to identify the right combination of CSO abatement strategies for this area.

Sewer Separation

Alternative C shows the costs associated with a sewer separation of the upstream combined sewer basins contributing flow to the Locke Street Center Barrel CSO. Separation of 116 acres of combined sewer area along the Locke Street Interceptor, at an estimated project cost of $11.6 million could result in the control of the Winter CSO and Locke Street Center Barrel CSO discharges to the 1-Year storm event.

7.8.4.3 Middle Interceptor

As shown in Table 7-6 and discussed above, control of the Middle Siphon CSO during the 1-Year storm event is achieved by integration with the Locke Street Center Barrel CSO improvements. For Alternative A, a storage facility at the Middle Siphon CSO was considered. For Alternatives B and C, sewer separation in key areas was considered, including in the tributary areas to the Broadway and High Street CSOs, which are the flood diversion CSOs. These CSOs don't activate during 1 Year event but these areas are less challenging to separate because they are removed from the downtown area. Again, if sewer separation in this area is selected as part of the control plan, the city would also like to consider the benefits of separation in other areas of the system that are being considered for urban revitalization, like the Washington Street area.

Table 7-6 1-Year Control Plan Alternatives

		Alternative A Locke Street Storage 1		Alternative B Locke Street Storage/Conveyance		Alternative C Sewer Separation	
Name	NPDES #	Improvements	Estimated Cost	Improvements	Estimated Cost	Improvements	Estimated Cost
Upper Siphon							
Upper Siphon	024	0.14 MG storage tank (Lifecyle Cost of $4.3 M)	$3,223,000	0.03 MG storage tank (Lifecyle Cost of $0.8 M)	$337,000	Separation of 90 acres	$9,000,000
Locke Street Area							
Winter Street	021G	Separation of 39 acres	$3,900,000			Separation of 39 acres	$3,900,000
Winter & Hale	021H	Separation of 62 acres	$6,200,000	Duncan St. Connector Pipe (850 - feet of 18" Pipe)	$740,000	Separation of 62 acres	$6,200,000
Locke Street Center Barrel	021F	0.13 MG storage tank (Lifecyle Cost is $3.7 M)	$3,199,000	Lower weir by 18" to 12.9 feet; 1.8 MG storage tank (Lifecyle Cost is $25.8 M)	$24,844,000	Separation (15 acres)	$1,500,000
Middle Siphon							
Broadway (flood)	037					Separation of 68 acres	$6,800,000
High Street (flood)	038			Separation of 36 acres	$3,600,000	Separation of 36 acres	$3,600,000
Emerson Street (flood)	021B						
Middle Siphon	021A	0.6 MG storage tank (Lifecycle cost of $10.7 M)	$9,947,000	Separation of 33 acres	$3,300,000	Separation of 11 acres	$1,100,000
Lower Siphon							
Main St North	019						
Bethany Avenue	040	Separation of 30 acres	$3,000,000	Separation of 30 acres	$3,000,000	Separation of 30 acres	$3,000,000
Chestnut Street	041	Separation of 37 acres	$3,700,000	Separation of 37 acres	$3,700,000	Separation of 37 acres	$3,700,000
Lower Siphon	013	Separaton of 235 acres	$23,500,000	Separation of 253 acres	$25,300,000	Separation of 131 acres	$13,100,000
Bradford Interceptor							
Bradford Avenue	032						
Middlesex Street	034	Separation of 45 acres	$4,500,000	Separation of 45 acres	$4,500,000	Separation of 45 acres	$4,500,000
South Webster Street	039	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$107,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$112,000	Upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$107,000
WWTF Improvements		80 mgd improvements	$31,000,000	80 mgd improvements	$31,000,000	80 mgd improvements	$31,000,000
Total Project Cost		**$92,280,000**		**$100,430,000**		**$87,510,000**	

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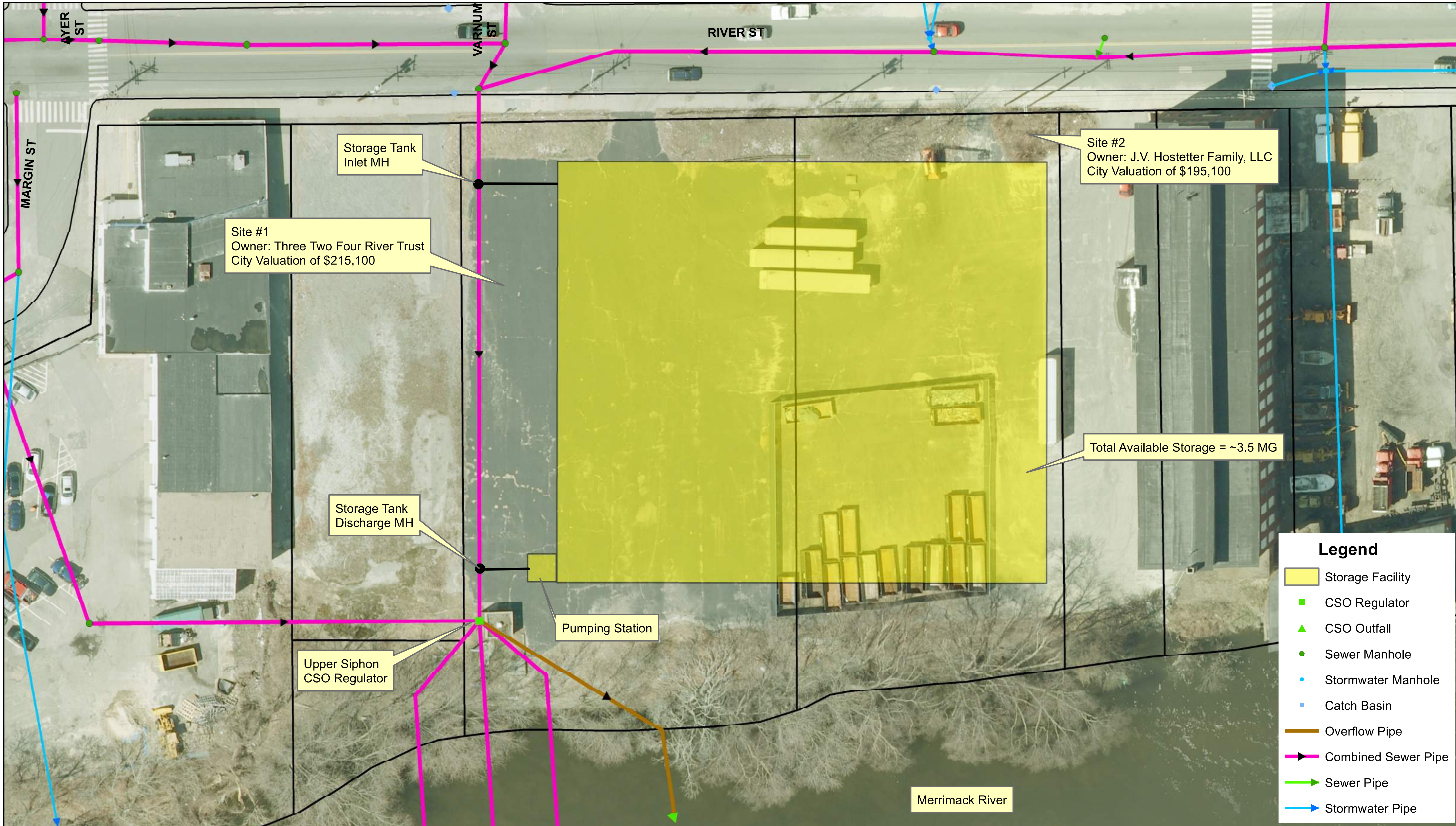

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CDM Smith

City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

Upper Siphon CSO Storage Facility
Figure 7-5

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7.8.4.4 Lower Siphon Interceptor

The Lower Siphon Interceptor system has three CSOs that discharge during the 1 Year event – Bethany, Chestnut, and Lower Siphon. For 1-Year storm control, the Bethany and Chestnut CSO combined sewer areas must be separated as shown in Table 7-6.

For the Lower Siphon CSO, the SWMM model indicates that there is significantly higher wet weather flow that cannot be captured by SCADA optimization. Sewer separation of various upstream acreage, in addition to the Bethany and Chestnut CSO areas, is required to gain CSO control, as summarized in Table 7-6. There is no site adjacent to the Lower Siphon CSO to construct a satellite CSO facility.

7.8.4.5 Bradford Interceptor

Two CSOs along the Bradford Interceptor discharge during the 1-Year event. For control of the Middlesex CSO, the combined sewer area must be separated. For the South Webster CSOs, dry weather connector pipe improvements should eliminate CSO discharges during this design storm. Table 7-5 shows the costs of these improvements.

7.8.4.6 WWTP Improvements

Under the 1-Year control level, improvements must be made to the WWTP to increase wet weather treatment capacity by about 20 mgd to a total flow rate of 80 mgd. The cost of this improvement is shown in Table 7-6. Alternately, a 20 mgd satellite treatment facility could be located at the old Paperboard Company site, adjacent to the WWTP Influent Pump Station.

If this control level were selected by the city, a preliminary design could be completed to identify the least cost option to provide this additional 20 mgd of wet weather flow treatment capacity.

7.8.4.7 Environmental Impacts

There are no significant environmental impacts associated with the construction of these system improvements for control of CSO discharges during the 1-Year storm event. Most of the work will take place along existing city streets and easements. The plan to separate the areas would likely utilize the existing outfall so that a new outfall would not have to be constructed, which should eliminate any wetland impacts along the river bank.

There are no significant environmental impacts with the construction of the Locke Street storage tank because it is not adjacent to any wetlands. The largest disruption will occur to those that residents that currently utilize the parking lot as these parking spaces will have to be temporarily relocated during construction. There may be environmental impacts with the construction of the Middle Siphon CSO storage tank because it is adjacent to the river but behind the floodwall. The largest disruption would be imposed on the bus station operations in Washington Square. These operations would have to be completely temporarily relocated during construction, which may be impractical. There may be environmental impacts with the construction of the Upper Siphon CSO storage tank and WWTP site because they are adjacent to the river but these will be temporary during construction these sites have been previously disturbed.

There may be other temporary construction impacts but these can be mitigated using typical best management practices.

7.8.4.8 Summary/Least Cost Plan for 1-Year Control

Table 7-6 summarizes the cost of the three system improvement alternatives considered to achieve the 1-Year level of control. The least cost alternative is Alternative C at about $88 million, which primarily comprises sewer separation of nearly 565 acres of combined sewer area in the city, along with the construction of 20 mgd of wet weather treatment capacity at or near the WWTP.

7.8.5 2-Year Control Plan

Table 7-7 (page 7-47) shows the most practical and cost-effective alternatives considered for the 2-Year Control Plan. Under the 2-Year storm event, the Emerson Street and the Winter Street CSOs start to activate, along with the same nine CSO regulators that activated during previous storm events.

It is important to remember that Table 7-1 showed the SWMM model results if all areas of the system were separated for a total cost of $150 million. However, there was some CSOs that still discharged and would likely require separate storage facilities to control the flow and eliminate CSOs during the 2-Year Control Plan. Accordingly, the cost of the two alternatives discussed below is less than this full system-wide separation plan cost.

7.8.5.1 Upper Siphon Interceptor

The SWMM model simulations indicate that a storage tank is required for the Upper Siphon CSO discharges. To achieve the control level, a storage facility is required as indicated under Alternative A and B in Table 7-7.

7.8.5.2 Locke Street Interceptor

During the 2-Year storm event, the Winter, Winter & Hale CSO and the Locke Street Center Barrel CSO activate. System improvements considered in Table 7-7 as alternatives to full separation of the upstream area include storage facilities at both the Locke Street Center Barrel CSO and Middle Siphon CSO.

Under Alternative A, the Winter Street and Winter & Hale CSO combined sewer areas are separated and new storage facilities are constructed at Locke Street Center Barrel CSO and the Middle Siphon CSO (with some upstream separation). Under Alternative B, the Winter Street and Winter & Hale CSO areas are not separated but the flow is conveyed downstream by the new Duncan Street sewer relief pipe and a single large storage facility is constructed at the Locke Street Center Barrel site.

Due to the dynamic hydraulic conditions linking the Locke Street Interceptor area and the Middle Siphon CSO area, there are a number of combinations of storage located at either or both sites and sewer separation of the upstream areas to control the Locke Interceptor Area and Middle Siphon CSOs. It is unlikely that a different set of combinations will have a significant impact on costs versus the alternatives shown in Table 7-7. If this design control level is accepted, a preliminary design should be completed to identify the costs, benefits, and potential disruptions of each option.

Table 7-7: 2-Year Control Plan Alternatives

		2 - Year Control Plan			
		Alternative A Locke Street Storage 1		Alternative B Locke Street Storage 2	
Name	NPDES #	Improvements	Estimated Cost	Improvements	Estimated Cost
Upper Siphon					
Upper Siphon	024	0.81 MG storage tank (Lifecyle Cost of $14 M)	$13,015,000	0.69 MG storage tank (Lifecyle Cost of $12.4 M)	$11,420,000
Locke Street Area					
Winter Street	021G	Separation of 39 acres	$3,900,000		
Winter & Hale	021H	Separation of 62 acres	$6,200,000	Lower weir 17.9; Duncan Street Connector (850 ft. of 18" pipe)	$769,000
Locke Street Center Barrel	021F	0.12 MG storage tank; separation of 15 acres upstream area (Lifecyle Cost of $5.0 M)	$4,510,000	Lower weir to 12.92 feet; 2.37 MG storage tank (Lifecyle Cost of $32.5 M)	$30,934,000
Middle Siphon					
Broadway (flood)	037				
High Street (flood)	038				
Emerson Street (flood)	021B	Separation of 29 acres	$2,900,000	Separation of 29 acres	$2,900,000
Middle Siphon	021A	Separation of 5 acres; 0.82 MG storage tank (Lifecyle Cost of $14.3 M)	$13,260,000	0.604 MG storage tank (Lifecyle Cost of $10.6 M)	$9,860,000
Lower Siphon					
Main St North	019				
Bethany Avenue	040	Separation of 30 acres	$3,000,000	Separation of 30 acres	$3,000,000
Chestnut Street	041	Separation of 37 acres	$3,700,000	Separation of 37 acres	$3,700,000
Lower Siphon	013	Separation of 375 acres	$37,500,000	Separation of 375 acres	$37,500,000
Bradford Interceptor					
Bradford Avenue	032				
Middlesex Street	034	Separation of 45 acres	$4,500,000	Separation of 45 acres	$4,500,000
South Webster Street	039	Separation of 25 acres; upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$2,607,000	Separation of 25 acres; upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$2,607,000
WWTF Improvements		80 mgd improvements	$31,000,000	80 mgd improvements	$31,000,000
TOTAL PROJECT COST		**$126,090,000**		**$138,190,000**	

7.8.5.3 Middle Interceptor

The Emerson Street CSO activates with the Middle Siphon CSO during the 2-Year Storm. As shown in Table 7-7, control of the Middle Siphon CSO during the 2-Year storm event is achieved by integration with the Locke Street Interceptor area improvements.

The Emerson Street CSO control is achieved by sewer separation.

7.8.5.4 Lower Siphon Interceptor

The Lower Siphon Interceptor system has three CSOs that discharge during the 2 Year event – Bethany, Chestnut, and Lower Siphon. For 2-Year storm control, the Bethany and Chestnut CSO combined sewer areas must be separated as shown in Table 7-7.

For the Lower Siphon CSO, the SWMM model indicates that there is significantly higher wet weather flow that cannot be captured by SCADA optimization. Sewer separation of 375 acres, in addition to the Bethany and Chestnut CSO areas, is required to gain CSO control as there is no area to construct a Lower Siphon CSO storage facility.

7.8.5.5 Bradford Interceptor

Two CSOs along the Bradford Interceptor discharge during the 2-Year event. For control of the Middlesex CSO, the combined sewer area must be separated. For the South Webster CSOs, dry weather connector pipe improvements and sewer separation (25 acres) are required to eliminate CSO discharges during this design storm. Table 7-7 shows the costs of these improvements.

7.8.5.6 WWTP Improvements

Under the 2-Year control level, improvements must be made to the WWTP to increase wet weather treatment capacity by about 20 mgd to a total flow rate of 80 mgd. The cost of this improvement is shown in Table 7-7. Alternately, a 20 mgd satellite treatment facility could be located at the old Paperboard Company site, adjacent to the WWTP Influent Pump Station. If this control level were selected by the city, a preliminary design could be completed to identify the least cost option to provide this additional 20 mgd of wet weather flow treatment capacity.

7.8.5.7 Environmental Impacts

There are no significant environmental impacts associated with the construction of these system improvements for control of CSO discharges during the 2-Year storm event. Most of the work will take place along existing city streets and easements. The plan to separate the areas would likely utilize the existing outfall so that a new outfall would not have to be constructed, which should eliminate any wetland impacts along the river bank.

There are no significant environmental impacts with the construction of the Locke Street storage tank because it is not adjacent to any wetlands. The largest disruption will occur to those that residents that currently utilize the parking lot as these parking spaces will have to be temporarily relocated during construction. There may be environmental impacts with the construction of the Middle Siphon CSO storage tank because it is adjacent to the river but behind the floodwall. The largest disruption would be imposed on the bus station operations in Washington Square. These operations would have to be completely temporarily relocated during construction, which may be impractical. There may be environmental impacts with the construction of the Upper Siphon CSO storage tank and WWTP site because they are adjacent to the river but these will be temporary during construction as these sites have been previously disturbed.

There may be other temporary construction impacts but these can be mitigated using typical best management practices.

7.8.5.8 Summary/Least Cost Plan for 2-Year Control

Table 7-7 summarizes the cost of the two system improvement alternatives considered to achieve the 2-Year level of control. The least cost alternative is Alternative A at about $126 million, which primarily comprises sewer separation of nearly 662 acres of combined sewer area in the city, along with the construction of two satellite storage facilities, and 20 mgd of wet weather treatment capacity at or near the WWTP.

7.8.6 5-Year Control Plan

Table 7-8 (page 7-51) shows the most practical and cost-effective alternatives considered for the 5-Year Control Plan. Under the 5-Year storm event, the Broadway and Bradford CSOs, along with the same eleven CSO regulators that activated during a previous storm event.

It is important to remember that Table 7-1 showed the SWMM model results if all areas of the system were separated for a total cost of $150 million. However, there was some CSOs that still discharged and would likely require separate storage facilities to control the flow and eliminate CSOs during the 5-Year Control Plan. Accordingly, the cost of the two alternatives discussed below is likely more expensive than a full separation and discrete storage facility plan ($165 million).

7.8.6.1 Upper Siphon Interceptor

The SWMM model simulations indicate that a storage tank is required for the Upper Siphon CSO discharges. To achieve the control level, a satellite storage facility is required as indicated under Alternative A and B in Table 7-8.

7.8.6.2 Locke Street Interceptor

During the 5-Year storm event, the Winter, Winter & Hale CSO and the Locke Street Center Barrel CSO activate. System improvements considered in Table 7-8 as alternatives to full separation of the upstream area include a storage tank at the Locke Street Center Barrel site.

Alternatives A and B in Table 7-8 comprise the construction of a satellite storage facility on the privately owned site adjacent to Locke Street Center Barrel CSO. Under Alternative A, the Winter Street and Winter & Hale CSO combined sewer areas are separated and new storage facilities are constructed at Locke Street Center Barrel CSO and the Middle Siphon CSO. Under Alternative B, the Winter & Hale CSO area is not separated by conveyed downstream by a new Duncan Street sewer relief pipe but the Locke Street Center Barrel Storage Facility significantly increases in size.

7.8.6.3 Middle Interceptor

The Broadway and Emerson CSOs activate with the Middle Siphon CSO during the 5-Year Storm. As shown in Table 7-8, control of the Middle Siphon CSO during the 5-Year storm event is achieved by integration with the Locke Street Interceptor area improvements. The system improvements for the Middle Interceptor are essentially the same for the 5-Year Control level, which includes separation of the Broadway, High Street, and Emerson CSO areas, portions of the Middle Interceptor area, and a storage facility at the Middle Siphon CSO site.

7.8.6.4 Lower Siphon Interceptor

The Lower Siphon Interceptor system has three CSOs that discharge during the 2 Year event – Bethany, Chestnut, and Lower Siphon. For 5-Year storm control, the Bethany and Chestnut CSO combined sewer areas must be separated, and the dry weather connection pipes must be modified, as shown in Table 7-8.

For the Lower Siphon CSO, the SWMM model indicates that there is significantly higher wet weather flow that cannot be captured by SCADA optimization. Sewer separation of various acres is required to gain CSO control as there is no area to construct a satellite CSO facility.

7.8.6.5 Bradford Interceptor

Two CSOs along the Bradford Interceptor discharge during the 5-Year event. For control of the Middlesex and South Webster CSOs, the combined sewer area must be separated and the dry weather sewer pipes must be modified. Table 7-8 shows the costs of these improvements.

7.8.6.6 WWTP Improvements

Under the 5-Year control level, improvements must be made to the WWTP to increase wet weather treatment capacity to a total flow rate of 100 mgd in Alternative A and 80 mgd in Alternative B. The cost of these improvements are shown in Table 7-8. Alternately, a 20 mgd or a 40 mgd satellite treatment facility could be located at the old Paperboard Company site, adjacent to the WWTP Influent Pump Station. If this control level were selected by the city, a preliminary design could be completed to identify the least cost option to provide this additional 20 mgd or 40 mgd of wet weather flow treatment capacity.

7.8.6.7 Environmental Impacts

There are no significant environmental impacts associated with the construction of these system improvements for control of CSO discharges during the 5-Year storm event. Most of the work will take place along existing city streets and easements. The plan to separate the areas would likely utilize the existing outfall so that a new outfall would not have to be constructed, which should eliminate any wetland impacts along the river bank.

There are no significant environmental impacts with the construction of the Locke Street storage tank because it is not adjacent to any wetlands. The largest disruption will occur to those that residents that currently utilize the parking lot as these parking spaces will have to be temporarily relocated during construction. There may be environmental impacts with the construction of the Middle Siphon CSO storage tank because it is adjacent to the river but behind the floodwall. The largest disruption would be imposed on the bus station operations in Washington Square. These operations would have to be completely temporarily relocated during construction, which may be impractical. There may be environmental impacts with the construction of the Upper Siphon CSO storage tank and WWTP site because they are adjacent to the river but these will be temporary during construction these sites have been previously disturbed.

Table 7-8: 5-Year Control Plan Alternatives

		5-Year Control Plan			
		Alternative A Locke Street Conveyance 1		Alternative B Sewer Separation	
Name	NPDES #	Improvements	Estimated Cost	Improvements	Estimated Cost
Upper Siphon					
Upper Siphon	024	1.50 MG storage tank (Lifecyle Cost of $22.9 M)	$21,235,000	1.53 MG storage tank (Lifecyle Cost of $23.3 M)	$21,670,000
Locke Street Area					
Winter Street	021G	Separation of 39 acres	$3,900,000	Separation of 39 acres	$3,900,000
Winter & Hale	021H	Separation of 62 acres; clean 51 feet of DW pipe	$6,201,000	Duncan Street Connector (850 ft. of 18" pipe)	$740,000
Locke Street Center Barrel	021F	Lower weir by to 12.9 feet; 1.24 MG storage tank; separation Locke North (Lifecyle Cost of $19.4 M)	$18,464,000	Lower weir by to 12.9 feet; 2.24 MG storage tank; (Lifecyle Cost of $30.5 M)	$29,484,000
Middle Siphon					
Broadway (flood)	037	Separation of 68 acres; Raise weir to 36.7 feet	$6,829,000	Separation of 68 acres; Raise weir to 36.7 feet	$6,829,000
High Street (flood)	038	Separation of 36 acres	$3,600,000	Separation of 36 acres	$3,600,000
Emerson Street (flood)	021B	Separation of 29 acres	$2,900,000	Separation of 29 acres	$2,900,000
Middle Siphon	021A	Separation of 22 acres; 0.41 MG storage tank; (Lifecyle Cost of $9.9 M)	$9,378,000	Separation of 18 acres; 0.49 MG storage tank; (Lifecyle Cost of $10.7 M)	$10,065,000
Lower Siphon					
Main St North	019				
Bethany Avenue	040	Separation of 30 acres; replace 380 feet of 12 DWC with 15"	$3,331,000	Separation of 30 acres; replace 380 feet of 12 DWC with 15"	$3,331,000
Chestnut Street	041	Separation of 37 acres; replace 270 feet of 12 DWC with 15"	$3,935,000	Separation of 37 acres; replace 270 feet of 12 DWC with 15"	$3,935,000
Lower Siphon	013	Separation of 413 acres	$41,300,000	Separation of 510 acres	$51,000,000
Bradford Interceptor					
Bradford Avenue	032				
Middlesex Street	034	Separation of 45 acres; upsize 100 feet of 12" DWC pipe to 18"	$4,609,000	Separation of 45 acres; upsize 100 feet of 12" DWC pipe to 18"	$4,609,000
South Webster Street	039	Separation of 25 acres; upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$2,607,000	Separation of 25 acres; upsize 120 feet of 8" DWC with 10"; clean 255 feet of 10"	$2,607,000
WWTF Improvements		100 mgd improvements	$51,000,000	80 mgd improvements	$31,000,000
TOTAL PROJECT COST		**$179,290,000**		**$175,670,000**	

There may be other temporary construction impacts but these can be mitigated using typical best management practices.

7.8.6.8 Summary/Least Cost Plan for 5-Year Control

Table 7-8 summarizes the cost of the two system improvement alternatives considered to achieve the 5-Year level of control. The least cost alternative is the full separation plan for the system as discussed in Section 7.5 with an estimated cost of $165 million.

7.9 Annual Average Characteristics of the CSO Control Levels

SWMM simulations were completed for each of the cost-effective design control level plans, using the 5-year representative precipitation period of the 40 plus years of historical precipitation record, to determine the annual average CSO reduction achieved by each plan. Table 7-9 (page 7-53) summarizes the CSO characteristics with each control level and the estimated percent capture (of wet weather flow generated by the combined sewer system).

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Table 7-9: Annual Average CSO Characteristics for Existing Conditions and Least Cost Design Control Plan (with improvements)

		Current (March 2017)		1-Month Control Plan		3-Month Control Plan		6-Month Control Plan		1-year Control Plan		2-Year Control Plan		5-Year Control Plan	
Name	**NPDES ID**	**Volume (MG)**	**Events**	**Volume (MG)**	**Events**	**Volume (MG)**	**Events**	**Volume (MG)**	**Events**	**Volume (MG)**	**Events**	**Volume (MG)**	**Events**	**Volume (MG)**	**Events**
Upper Siphon CSOs															
Upper Siphon	024	0.9	4	0.8	4	0.7	2	0.6	2	0.5	0.2	0.3	0.1	0.1	0.05
Middle Siphon CSOs															
Winter Street	021G	0.3	1	0.03	1										
Winter & Hale	021H	0.9	9	0.7	9										
Locke Street Center Barrel	021F	8.0	22	6	8	4.8	4	3.9	2	3.2	0.8	2.6	0.5	2	0.1
Broadway (flood)	037														
High Street (flood)	038														
Emerson Street (flood)	021B														
Middle Siphon	021A	3.1	5	2.5	5	2.2	3	1.9	2	1.7	1	1.2	0.5	0.8	0.1
Lower Siphon CSOs															
Main St North	019	0	0												
Bethany Avenue	040	0.9	17	0.8	11	0.6	0.4	0.5	1	0.4	0.5	0.3	0.2	0.2	0.2
Chestnut Street	041	0.8	15	0.7	11	0.5	3	0.3	1	0.2	0.5	0.1	0.2	0.05	0.2
Lower Siphon	013	3	4	2.3	4	2.2	3	1.8	2	1.6	1	1.2	0.5	0.8	0.2
Bradford CSOs															
Bradford Avenue	032	0	0												
Middlesex Street	034	0.8	10	0.6	9	0.5	2	0.5	2	0.2	0.4	0.1	0.1	0.0003	0.2
South Webster Street	039	0.9	34	0.6	7	0.5	0.8	0.5	.8	0.2	0.8	0.1	0.1	0.0003	0.2
TOTAL		**19.6**		**15.0**		**12**		**10**		**8**		**6**		**4**	
Percent Capture		**98**		**98.5**		**98.8**		**99**		**99.2**		**99.4**		**99.6**	

7.10 Selection of the Appropriate Level of CSO Control

This section evaluated a number of CSO control alternatives available to the city to reduce or eliminate CSO discharges ranging from No Action to Intermediate Controls to Complete Elimination. For each intermediate design storm control level, a set of alternatives - using storage facilities, CSO regulator modifications, and sewer separation - were evaluated and the least cost alternative for each control level was selected.

To consider costs versus the performance of a range of control alternatives in meeting water quality standards and receiving water uses, a curve(s) is developed comparing the estimated projects costs with the pollution reduction achieved by each alternative level of control. It is expected that with each design storm level of CSO reduction, proportional reductions are achieved in pollutant loadings, subsequently decreasing environmental impacts to the receiving waters. Using the curve, there is a point where pollution reduction achieved in the receiving water diminishes disproportionately with increasing costs. This analysis, known as the "knee-of-the-curve" evaluation, can be used to establish the cost-effective level of control for the community.

Figure 7-6 (page 7-55) shows the knee of the curve for the Haverhill CSO control alternatives. The start of the inflection point of the effective cost curve is at the 3-Month Control Plan with an estimated project cost of $11 million. It will cost nearly double to achieve the 6-Month Control Plan, which doesn't bring any significant annual average CSO reduction (only 2 MG per year on average).

Based on this analysis, the city should complete its Final CSO Long Term Control Plan to achieve the 3-Month Level of Control and then, working with the state, proceed to complete a use attainment analysis and initiate the process to modify the Merrimack River WQS from Class B to Class B_{CSO}.

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CDM Smith

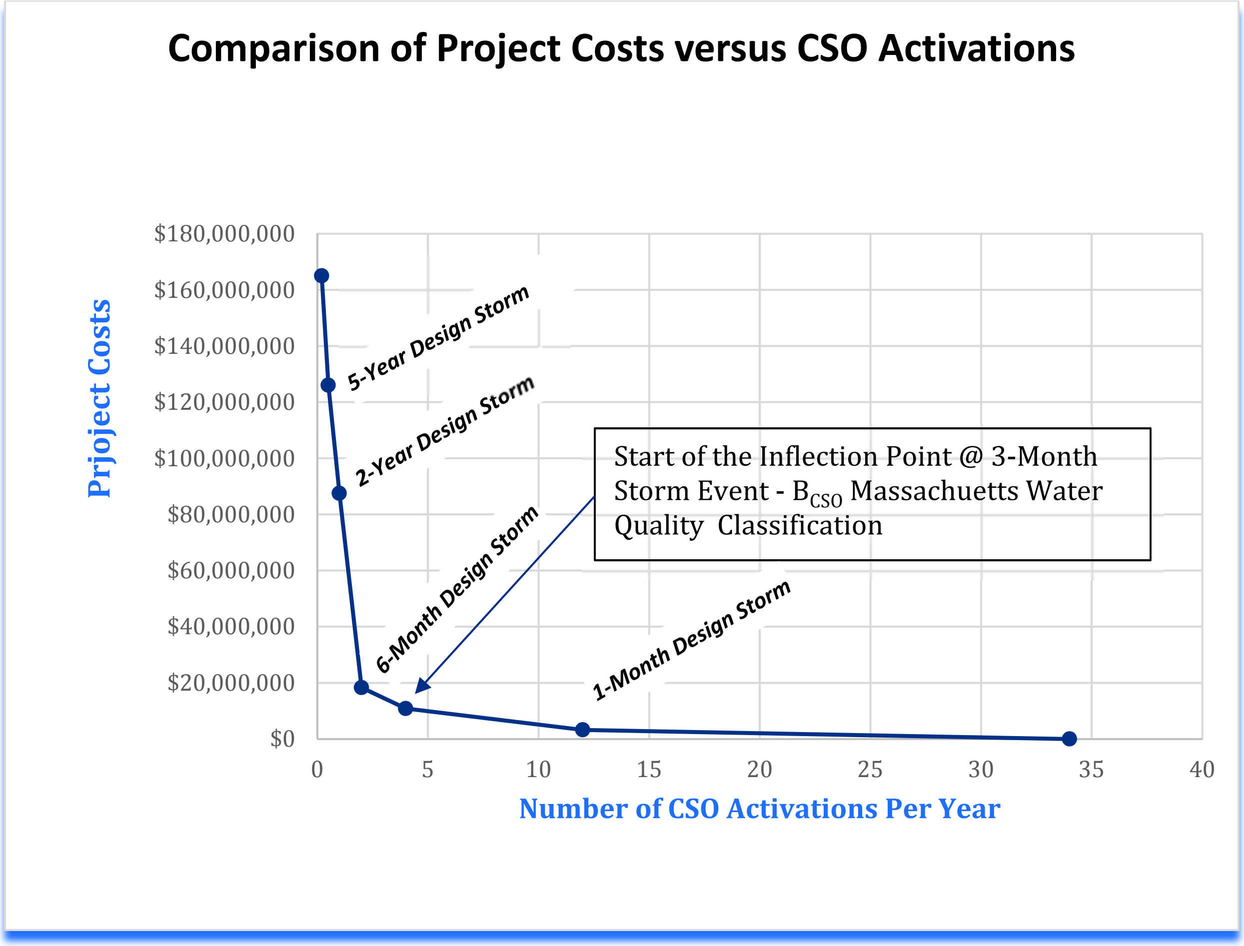


Figure 7-6 Comparison of Project Costs versus CSO Activations

Section 8

Integration with Other Wastewater Division Compliance Programs

8.1 Introduction

The city owns and operates a wastewater treatment facility and wastewater and stormwater collection system. In addition to the CSO-related compliance program, the city is also obligated to meet various other federal and state permit requirements as part of its annual operations. These include the WWTP NPDES permit, CMOM and SSO requirements, and the NPDES MS4 Stormwater permit.

8.2 Wastewater Treatment Plant NPDES Permit Compliance

Operation of the WWTP is governed by the NPDES permit effluent discharge standards. The reliability of the plant processes and equipment must be maintained to meet the daily permit standards during both dry- and wet-weather conditions. Any compromised process will affect the treatment of flows, risking the potential failure to meet effluent standards and possible federal violations of water quality standards. The WWTP also provides treatment to wet weather flow generated by the combined sewer system. This wet weather treatment capacity is instrumental in helping the city avoid untreated CSO discharges.

In recent years, the WWTP had been challenged with high headworks loadings of biochemical oxygen demand (BOD), total suspended solids (TSS), and fats, oils and grease (FOG) as well as problems with the reliability of essential equipment including blowers and centrifuges. These have led to occasional permit violations and resulted in the requirement for a CPE to assess the capital and operational improvements necessary to maintain compliance with the NPDES permit. The city engaged Woodard & Curran to perform the assessment and complete the CPE Report, which will be submitted under separate cover. A summary of the CPE Report's findings and recommendations is provided below.

8.2.1 Comprehensive WWTP Evaluation

Woodard & Curran assessed the plant's processes and equipment, including daily maintenance, to identify those areas where plant processes can be enhanced to improve the effluent quality and/or save operating costs, and to identify equipment that is becoming unreliable and must be replaced. The assessment considered replacement needs for the existing buildings and building systems.

For the evaluation, Woodard & Curran analyzed plant data from 2010 through 2016, including any exceedances of NPDES permit conditions, to identify process issues and resolutions, with the goal of providing continuous effluent quality that met the NPDES permit. WWTP records showed that the plant is subject to high, short duration peaks in influent BOD and TSS loads. These loads are attributed to intermittent discharges from the city's several large industries, which are relatively new in the city. The collection system also has significant FOG issues, which may be the result of insufficient enforcement of the city's Grease Regulations. To improve compliance with the sewer use ordinance, the city has hired a new Industrial Pretreatment (IPP) coordinator and engaged an engineering consultant to review the IPP and FOG programs. This effort should help to decrease problematic loads to the collection and treatment system.

An analysis of effluent compliance history was also completed; BOD, TSS and Enterococci bacteria violations were found. Some of these BOD and TSS violations are attributed to the conditions discussed above that are being resolved. However, some BOD and TSS violations were found to be a result of the loss of solids from the secondary settling tanks flows exceeding their critical capacity during wet-weather. Enterococci violations do not follow a discernable pattern and may be due to inadequate disinfection.

Woodard & Curran evaluated the performance of each treatment process in the Haverhill WWTP using a combination of desktop analysis, literature research, on-site investigations, and staff interviews.

8.2.1.1 Recommendations

Woodard & Curran worked with the city to identify the following near-term capital improvement recommendations:

- The existing aeration system should be replaced with a new system that may include fine bubble diffusers in all three tanks and a system of blowers connected to a common manifold in a dedicated building;
- Aeration upgrades should be made to include a new motor control center (MCC) and transformer and upgrades to the plant's electrical distribution system, including the main switchgear, generator, and feeder cables;
- The return activated sludge (RAS) pumping capacity should be increased to 20 mgd and the RAS flow split capability should be improved;
- The city should perform additional evaluation into the causes and solutions of enterococci violations, and make interim repairs, as necessary, to the existing disinfection equipment to increase disinfection efficacy to meet the permit conditions for chlorine residual and bacteria limits.

Woodard & Curran's assessment also identified other improvements to the WWTP process, equipment, and buildings that could be implemented in future implementation programs (beyond the planning horizon of this capital plan).

This report also suggests a number of operational improvements, including additional sampling for process control, and improved wet-weather management as described in the High Flow Management Plan (included in Appendix D of the CPE). The High Flow Management Plan was tailored to establish process limits and operational conditions when the WWTP operators should start secondary bypass operations during storm events. These revised operating conditions should help to avoid overwhelming the secondary clarifiers, which may have resulted in past solids carryover into the outfall (and potential BOD/TSS exceedances).

The recommendations of the CPE, combined with improvements that are already underway, will put the city's wastewater treatment facility on track for improved performance and optimal permit compliance.

8.2.2 Odors

Concurrently with the CPE investigations, but as a separate assessment program, the city engaged Woodard & Curran to develop an odor mitigation plan for the WWTP in response to recent public odor complaints reportedly emanating from the facility. Odor complaints were also partially (and subsequently) attributed to a local septage hauler, who has a storage facility in close proximity to the plant.

Woodard and Curran reviewed the current practices at the plant, identified existing odor sources, and evaluated existing odor control equipment and processes. The recent replacement of the city's centrifuges, used for dewatering the WWTP solids, was found to have a very positive benefit for odor mitigation at the plant. The Woodard & Curran evaluation built upon these system improvements and they identified a set of system improvements that would allow the city incrementally address odors through a phased implementation plan. The city has already completed the first phase of short-term improvements, which included new covers on the exposed conveyance channels between preliminary treatment and screening.

The city is continuing to assess the odor mitigation benefits achieved by this first phase program. The next phase of improvements that will likely be implemented within the next 2-5 years may include:

- Replacement/upgrade of the ventilation and odor control systems at the WWTP influent pumping station;
- Replacement/upgrade of the odor control systems serving the Sludge Processing Area (centrifuge building, sludge cake garage, and blending tank, including, potentially, a new biofilter to replace existing equipment; and
- New covers on the exposed conveyance channels on the primary effluent channels, along with ventilation to remove odorous air and direct it to the odor control systems.

The odor control improvements that may be implemented under this program will be completed in an iterative approach. The city does not consider these improvements part of the CD requirements and these should not be incorporated into the CD.

8.2.3 Summary

The CPE report estimates the total cost of the improvements discussed above to be $25.2 million. These improvements are a high priority to address NPDES exceedances.

8.3 CMOM Assessment and Corrective Action Plan

8.3.1 Assessment

Under Haverhill's NPDES permit, there are requirements to efficiently operate the wastewater collection system. The development of a CMOM program requires a very comprehensive self-assessment of the wastewater collection system including a review of the type and quantity of assets (pipes, services, manholes, pumping stations, etc.); the collection system management organization, staffing and annual budgets; staff training and safety programs; customer service and communications; emergency preparedness; pipeline capacities; and inspection, cleaning and repair programs, among other daily activities. The goal of the CMOM program is to document the existing system and to identify system management strategies to keep track of existing conditions and operational maintenance schedules; to maximize the conveyance of wastewater; and to eliminate sanitary sewer overflows (SSOs), if any.

The November 2016 CD required the city to complete:

- an assessment of its CMOM program to determine if improvements are necessary to maintain the collection system and to prevent future SSOs and sewer backups;
- a CMOM corrective action plan that lists the deficiencies identified by the CMOM program self-assessment, causes and contributing factors that led to the SSOs and private backups, specific short- and long-term actions that the city is taking, or plans to take to address deficiencies, and a schedule for implementation.

To complete the CMOM Checklist, the city engaged Woodard & Curran, who:

- reviewed past reports, interviewed city staff, and analyzed GIS, inspection, and MaintStar data provided by the city. [MaintStar is the city's Computerized Maintenance Management System (CMMS)].
- prepared a Collection System Capital Improvement Plan that provided recommendations for sewer manhole and sewer pipe rehabilitation or replacement, which was based on a comprehensive system investigation of about 10 percent of the collection system (including sewer manhole inspections and close circuit television, CCTV, sewer pipeline inspections); and
- compiled data on historic SSOs occurrences and, working with the city, identified the reasons for these SSOs, and developed a plan to enhance operations and maintenance to help reduce the occurrences.

To complete the final updated CMOM checklist, Woodard & Curran reviewed this system condition information relative to the USEPA (2005) *Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems*.

8.3.2 Corrective Action Plan

The process of self-assessment has yielded a broader understanding of the city's collection system's structural and operational deficiencies. Woodard & Curran determined that there are some system deficiencies that should be addressed to improve system maintenance and operations.

Based on the system assessment, Woodard & Curran developed the city's CMOM Corrective Action Plan, as required by the CD. This plan outlines the corrective measures the city could implement to address each of the deficiencies identified in the CMOM Checklist. The CMOM Corrective Action Plan focuses on programmatic changes and capital improvements in the following areas:

- Increased maintenance and inspection of the city's collection system;
- Increase of personnel resources available for preventative maintenance on the city's collection system and pump stations;
- Increased capital renewal via the Collection System CIP;
- Creating a formal staff training plan;
- Increased public involvement in the maintenance of the City's collection system via a public outreach plan;
- Improved implementation and enforcement of the city's Sewer Ordinances; and
- A formal program to collect and integrate field investigation data into the city's existing GIS database.

8.4 Stormwater Compliance

Haverhill is a small municipal separate storm sewer system (MS4) entity under the USEPA's Phase II Stormwater NPDES program. Under this program, the city was issued a General Phase II NPDES Stormwater Permit to operate the existing stormwater drainage and piping collection system. The first permit was issued in 2003 and required a self-assessment of the current best management practices that were being implemented in the drainage system and identification of any enhancements that could be made to improve drainage system management.

The November 2016 CD requires the city to complete a number of stormwater compliance measures including:

- Completing dry-weather and wet-weather outfall inspections;
- Submitting a revised IDDE Plan;
- Completing IDDE investigation of the stormwater catchment areas;
- Developing an IDDE enforcement manual;
- Adopting city ordinance prohibiting non-stormwater discharge to the stormwater system;
- Eliminating all known sources polluting the stormwater system; and
- Removing illicit discharge connections.

The city has completed the 2016 Dry Weather MS4/Stormwater Outfall Inspection Program and this report was submitted to the agencies in April 2016. The report identified 114 outfalls, out of a total of nearly 1,200 city outfalls, that had dry weather flow. Thirty-six of these outfalls had levels of bacteria (E. coli or Enterococcus) that exceeded the state water quality standards.

The city developed an IDDE Plan for investigating the upstream tributary areas of each of the affected outfalls to look for potential sources of stormwater contamination. The IDDE Plan was submitted to the agencies on February 8, 2017. The city has initiated the IDDE program and will continue to investigate these areas to identify the illicit sources of stormwater system pollution. Any illicit connections identified will be removed per the IDDE Plan and city ordinance. The city has already identified several illicit discharges that have been or will be eliminated.

Also, as required by the 2003 NPDES Stormwater permit, the city will adopt construction site stormwater mitigation and inspection procedures. These will be adopted and submitted to the agencies by November 2017.

Finally, the city is committed to improving its catch basin cleaning and street sweeping programs to improve the quality of stormwater runoff from its system, reduce the pollutant discharges in the CSOs, and to remove floatables in stormwater and CSO discharges.

8.5 Summary

In addition to its CSO abatement program requirements, the city must comply with the requirements of its WWTP and Stormwater NPDES permits including CMOM. The city has completed an extensive review of its collection system and WWTP maintenance and operational practices to identify potential deficiencies and has evaluated system improvements that will correct these deficiencies. Some of these proposed system improvements have equal or greater priority with respect to system-wide operations. The deficiencies noted in these other areas of the system, if not corrected, could result in more CSO discharges.

Accordingly, the city is developing an integrated plan to implement system improvements in a balanced approach to address all of the city's priorities. This is discussed further in Section 9.

Section 9

FLTCP and Integrated Implementation Plan

9.1 General

Sections 6 and 7 provide a summary of the full range of CSO mitigation strategies and technologies that could be implemented in the city, identification of those that were the most feasible, and further analysis and evaluation as to how each of the most feasible technologies could be applied to reduce Haverhill's CSO discharges as part of the FLTCP. A range of CSO abatement alternatives were evaluated from No Action to Complete Elimination, including a set of intermediate controls. Complete elimination of the city's CSO discharges is a significant financial burden to the ratepayers in Haverhill with an environmental benefit that may not be fully realized until other upstream pollutant sources in the watershed are identified and abated.

This section describes the FLTCP, based on the findings of the alternatives analysis presented in Section 7, and the city's integrated implementation schedule, considering all of its compliance programs (discussed in Section 8).

9.2 Compliance with Water Quality Standards

The report was prepared to address the requirements of the November 2016 Consent Decree (Paragraph N) and is in compliance with USEPA and MADEP CSO Control Policies and MA Water Quality Standards.

Haverhill's FLTCP controls CSO discharges to the 3-Month design storm. The Final LTCP results in a CSO discharge frequency of four times per year on average, which meets the B_{CSO} water quality classification and MADEP CSO Control policies for the river (downstream of Haverhill based on Haverhill CSO impacts).

There are other sources of pollution along the river from other community CSOs, stormwater, and other non-point sources that impact the river water quality. USEPA CSO policy and program manuals state that a review of receiving water quality standards and use objectives by state agencies, involving all stakeholders along the rivers, is the de minimis step in the setting of appropriate, reasonable, and attainable river goals that will help guide the development and implementation of CSO LTCPs and watershed initiatives.

Any further implementation of CSO abatement controls, beyond this FLTCP, by the city of Haverhill should be subject to a comprehensive watershed assessment to ensure that the city's further investment will be realized in further use attainment consistent with the objectives of the river stakeholders.

A summary of the FLTCP plan is presented below.

9.3 Final Plan

9.3.1 Overview

The implementation schedule for the Integrated FLTCP was developed to balance CSO control with other system priorities. Table 9-1 summarizes the components and implementation schedule for Haverhill's Integrated FLTCP. The plan consists of an expenditure of $56.3 million in system improvement and maintenance projects over 13 years. The implementation plan targets improvements in each of the city's regulatory compliance initiatives. This represents the city's commitment to addressing the requirements of the November 2016 CD (with the exception of the odor control plan, which is not included in the CD).

The city has adopted a 13-year implementation period for the Integrated Plan. This schedule is required so that the city can effectively assess the phased implementation of its recommended system improvements so that efficiencies and potential overall plan cost reductions can be realized. A shorter implementation period will not allow the city to recognize any potential synergies in the overall program and may result in unnecessary spending. There may be CSO reduction benefits achieved by some of the city's programs (sewer system rehabilitation and repair and pipeline cleaning) that help the city to achieve CSO control without more expensive system structural improvements. In addition, a shorter implementation schedule creates an undue financial hardship on the rate payers with the lowest income levels in Haverhill, as discussed in Section 10.

The WWTP Improvements program is one of the highest priorities in this Integrated Plan to ensure that the WWTP continues to function reliably to meet its NPDES permit requirements and maximize wet weather treatment (to minimize CSO discharges). Sewer system rehabilitation and sewer pump station replacement programs are also high priorities to minimize extraneous flow in the system and to avoid SSOs. Finally, the SEP program is part of the CD and must be completed within the first couple of years of the Integrated Plan.

The city will initiate immediate improvements to the combined sewer system at five CSO regulators (Middle Siphon, Bethany Avenue, Chestnut, South Webster, and Middlesex CSOs) to control these CSOs to a discharge frequency of 4 times per year. In addition, the city will optimize its real-time control system to minimize CSO discharges to a 3-Month control level, which will take a couple of operational seasons of evaluation and adjustment. The city expects that there may be unanticipated CSO reduction benefits that can be achieved by the real-time control system. Accordingly, the city intends to start the Locke Street Interceptor Area Preliminary Design phase after the system is optimized and CSO discharges are minimized before starting to address the last "uncontrolled" CSO discharges in the system.

The 13-year implementation period will begin after the city receives approval of the CD documents and integrated plan.

Table 9-1 Integrated FLTCP and Implementation Schedule

Project	Estimated Project Cost	Fiscal Year (after EPA approval of City's Integrated Plan)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Phase I WWTF Improvements (NPDES Compliance Requirements)														
Secondary Treatment Improvements	$24,700,000													
(aeration improvements,replacement of RAS and influent gates, electrical, new RAS pumps and piping, primary clarifier improvements)														
Disinfection Efficiency Evaluation and System Repairs	$500,000													
Subtotal	**$25,200,000**													
CMOM Programs														
Miscellaneous CMOM Program Updates	$445,000													
Gravity Sewer CCTV and SMH Inspection ($100k/annual)	$1,300,000													
Sewer System Rehabiliation to Reduce I/I	$6,000,000													
Pump Station Reh/Replacement/SCADA (2 stations)	$1,300,000													
Subtotal	**$9,045,000**													
CSO Control Plan (3 Month)														
System Conveyance Improvements	$1,100,000													
(Cleaning of Upper, Middle, and Lower Sipons and Middle/Essex Street Interceptor and Bradford Interceptor, downstream of Middle Siphon)														
CSO Structure Dry Weather Connector Pipe *(Bethany, Chestnut, Middlesex, South Webster)*	$1,000,000													
Raise Middle Siphon weir	$40,000													
Post Construction Monitoring & System Optimization	$300,000													
Green Infrastructure Demonstration Projects	$500,000													
Locke Street Area Preliminary Design	$1,200,000													
(Evaluate Locke Street control options of storage versus sewer separation, additional monitoring and modeling)														
Locke Street Area Improvements *(currently Duncan Street Relief Pipe and Locke Stree Storage)*	$11,600,000													
Subtotal	**$15,740,000**													
Stormwater Program														
Stormwater Compliance (Revised Master Plan/Public Ed)	$150,000													
Stormwater Annual Reporting ($35k/year)	$455,000													
Illicit Discharge Detection Elimation Program Investigatior	$1,000,000													
Removal of Illict Connections	$2,000,000													
Construction Site Pre- and Post-Monitoring ($20k/yr)	$260,000													
Catch Basin Cleaning ($100k supplemental)	$1,300,000													
Street Sweeping ($23k supplemental)	$300,000													
Subtotal	**$5,465,000**													
Supplemental Environmental Project Program (SEP)														
River bank improvements	$866,000													
Grand Total	**$56,316,000**													

Design

Construction

9.3.2 Phase I WWTP Improvements

As discussed in Section 8, the city will complete upgrades to the activated sludge system to rehabilitate the aeration system to improve the reliability of the secondary treatment system, especially during wet weather events, when flows and loads significantly increase. This will help to provide consistent treatment, during wet weather conditions, to meet the NPDES permit limits for BOD and TSS. Under this project, the city will also implement its odor control system improvements in an iterative approach (as discussed above) achieve reasonable mitigation of odors at the facility.

Finally, the city will evaluate its disinfection process, conduct further testing, and make repairs or improvements, as necessary, to improve compliance with the NDPES permit limit for Enterococci.

The city expects to implement these facility improvements in one or two construction contracts over the 13-year implementation period.

9.3.3 CMOM Programs

The CMOM Corrective Action Plan provides a number of system recommendations that the city should perform to enhance its operational and maintenance programs. These are included in the Miscellaneous CMOM Program Updates and discussed further in the CMOM Program Assessment and Corrective Action Plan (submitted under separate cover). The city will complete this program in five years.

To improve system maintenance and to identify future sewer pipe rehabilitation needs, the city will initiate a program to perform CCTV inspections (and pipe cleaning) and sewer manhole inspections (SMH). The city's goal is to complete the inspection of about approximately 3,000 linear feet of pipe (and all associated SMHs) per year, on average, during the 13-year implementation period (performed in multiple projects).

CDM Smith and Woodard & Curran completed CCTV inspection of about 11 percent of the sewer collection system. Based on these inspections, the city has identified about $6 million in high priority sewer pipe and sewer manhole replacement or rehabilitation needs. This work will be completed in several construction contracts over the 13-year period. Rehabilitation of the pipes will likely reduce I/I, which will help to reduce CSO discharges.

The city identified the sewer pumping stations that will eventually need to be replaced or rehabilitated to address aging infrastructure and increasing maintenance needs. The city proposes to replace two pumping stations – the Carlton Pump Station and the North Avenue - within the 13-year program. These stations are a high priority based on their continued and increasing maintenance needs.

9.3.4 CSO Control Plan

9.3.4.1 Overview

Completion of the FLTCP system improvements will minimize the city's CSO discharges to a frequency of four times per year (3-Month control level). After the FLTCP is complete, the city would discharge approximately 10 MG per year on average (based on typical rainfall patterns), which is significantly less than all upstream CSO communities. The FLTPC includes the integration of a Green Infrastructure Demonstration program to increase public awareness of CSO and stormwater issues, and Post Construction Monitoring Program to comply with the USEPA and CD requirements.

A first priority will be the completion of system conveyance improvements and CSO structure modifications to clean major interceptors and siphons to increase conveyance capacity and to raise weirs or replace dry-weather connector pipes at five CSO structures to significantly reduce CSO discharges at these locations. The improvements collectively address the frequency of CSO discharges at the five most active CSO regulators in the system. The city is installing a real-time control system that will significantly enhance its ability to store flow in the existing interceptor piping system and reduce CSO discharges. The city is committed to periodically review these automated system controls and continue to optimize the programming to maximize CSO capture. These four system improvement components will be completed in Years 1 thru 3 and the benefits achieved by these improvements will be assessed in Year 4.

After assessment of the benefits achieved by the first set of system improvements, the city will complete a Preliminary Design of the Locke Street Interceptor Area. The FLTCP identified that control of the Locke Street Area Interceptor CSOs could be controlled by either sewer separation or a storage facility and the costs for these two facilities were approximately equal. The city has plans to complete urban revitalization projects in the downtown area, which could reduce the amount of storage or sewer separation required upstream to control the Locke Street CSOs. In addition, the optimization of the real-time wet weather flow control system and CSO Dry-Weather Connector Pipe Improvements may yield additional, unanticipated, CSO control benefits that could reduce the infrastructure needed in the Locke Street basin.

Accordingly, this preliminary design will comprehensively evaluate the CSO abatement control alternatives (sewer separation or storage facilities) to reduce CSO discharges from the Locke Street Center Barrel, Winter Street, and Middle Siphon CSOs. The Preliminary Design will provide initial design plans and more refined cost estimates for the city to select the appropriate approach to control these CSO regulators. Based on the Preliminary Design, the city will implement these improvements. A six-year implementation period is planned for these system improvements.

Concurrently, the city will assess and implement green strategies demonstration projects to identify the potential long-term benefits a Green Infrastructure Program could bring to the city for CSO control and improvements in stormwater quality.

The city intends to continue its investment in the inspection and rehabilitation of the existing sewer system to address infrastructure renewal and to reduce I/I. The city is performing this work under the CMOM/Asset Management Program, which is part of the Integrated Wastewater/Stormwater Financial Plan, which is being submitted under separate cover.

The city will continue to implement its High Flow Management Plan during storm events. The plan is included in the WWTP CPE, under separate cover, and governs WWTP operations during wet weather events. The plan will be amended in the future to include wet weather collection system operations, using the real-time control system, within six months after the Wet Weather

Maximization/CSO Structure Modifications are completed and the real-time control system is optimized.

9.3.4.2 System Conveyance Improvements

Cleaning Upper, Middle, and Lower Siphons, Middle Siphon Interceptor (from Locke St to Middle Siphon) and Bradford Interceptor (downstream of Middle Siphon) will increase capacity and improve conveyance to the south side and the WWTP. The Final LTCP relies on these system conveyance improvements. The cost to perform this system improvement is $1,100,000.

9.3.4.3 CSO Regulator Dry Weather Connector Pipe Improvements

Modifying the downstream connector pipe to the interceptor at four CSO regulator locations will increase the amount of wet-weather flow that can be conveyed to the interceptors. The estimated project cost to complete all CSO regulator dry weather connector pipe improvements presented above is $1,000,000.

Bethany Avenue CSO

The Bethany Avenue dry weather connector pipe, from the CSO regulator to the Lower Siphon Interceptor, needs to be replaced. The existing pipe changes in size from a 12-inch diameter pipe to an 8-inch diameter pipe and then again to a 12-inch diameter pipe. In addition, the pipe outlets from the CSO regulator via a bottom outlet configuration that frequently blinds resulting in more frequency CSOs.

Accordingly, the existing regulator will be modified with a side outlet to replace the existing bottom outlet, the weir will be raised, and the dry weather connector pipe to the Lower Siphon (380 feet) will be replaced with a new 15-inch diameter pipe. Figure 9-1 shows a schematic of the proposed modifications. These improvements will allow significantly more flow to be conveyed into the Lower Siphon Interceptor, and ultimately down to the WWTP, significantly reducing CSO discharges from the Bethany Avenue CSO.

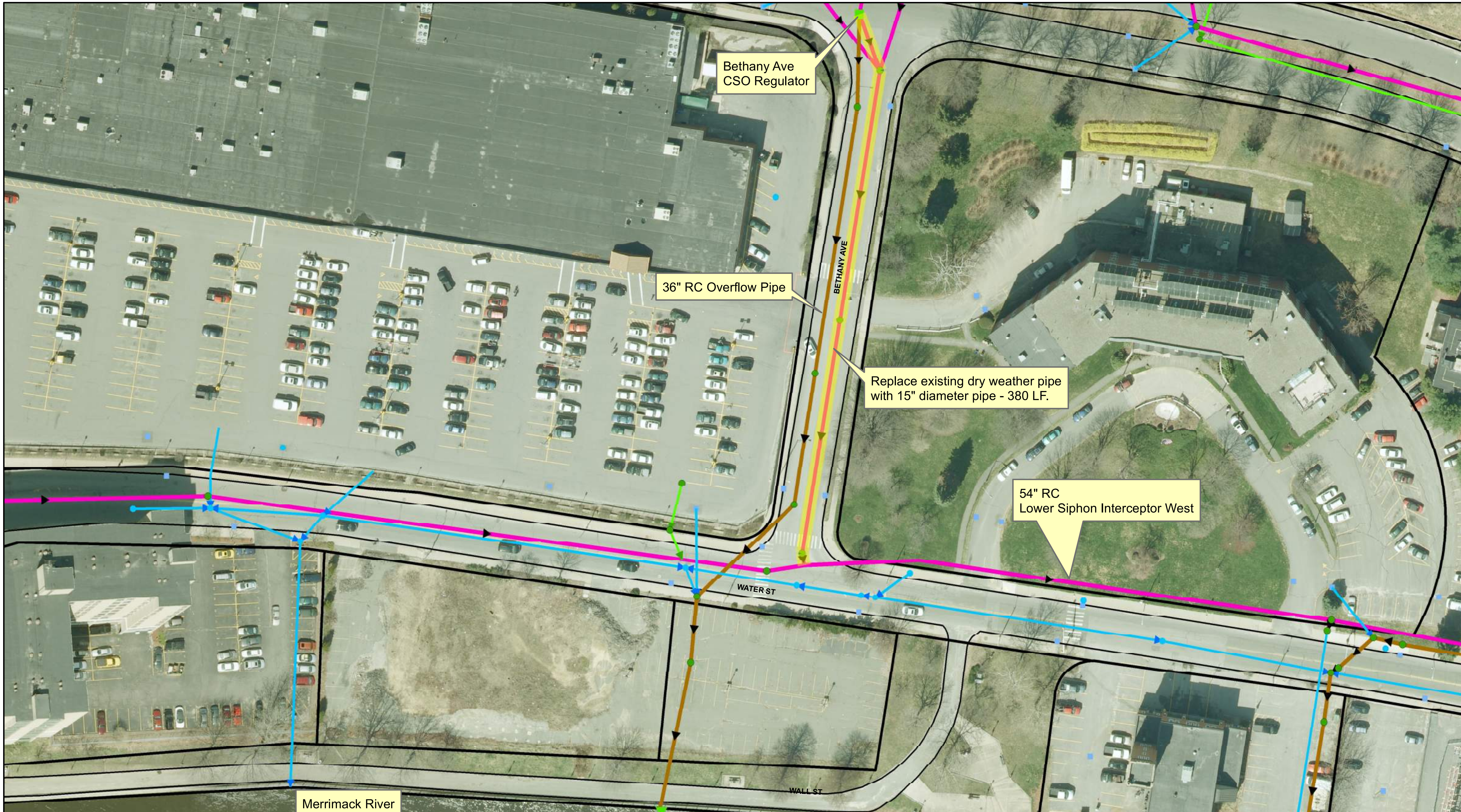
Chestnut Street CSO

Similar to the Bethany Avenue CSO, the Chestnut Street CSO dry weather connector pipe, from the CSO regulator to the Lower Siphon Interceptor, needs to be replaced. The existing pipe size needs to be increased and the existing bottom-type pipe outlet from the CSO regulator should be replaced.

Accordingly, the existing regulator will be modified with a side outlet to replace the existing bottom outlet, the weir will be raised, and the dry weather connector pipe to the Lower Siphon (265 feet) will be replaced with a new 15-inch diameter pipe. Figure 9-2 shows a schematic of the proposed modifications. These improvements will allow significantly more flow to be conveyed into the Lower Siphon Interceptor, and ultimately down to the WWTP, significantly reducing CSO discharges from the Chestnut Street CSO.

Middlesex Street CSO

To minimize CSO discharges from the Middlesex CSO, the existing dry weather connector pipe should be replaced with an 18-inch diameter pipe to allow more flow to be conveyed to the Bradford Interceptor. Figure 9-3 shows a schematic of the proposed regulator pipe replacement.



Legend

- Proposed Improvement
- CSO Regulator
- CSO Outfall
- Sewer Manhole
- Stormwater Manhole
- Catch Basin
- Overflow Pipe
- Combined Sewer Pipe
- Sewer Pipe
- Stormwater Pipe

N W E S

0 60 Feet

City of Haverhill, Massachusetts
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Bethany Avenue CSO - Dry Weather Pipe Improvement
Figure 9-1

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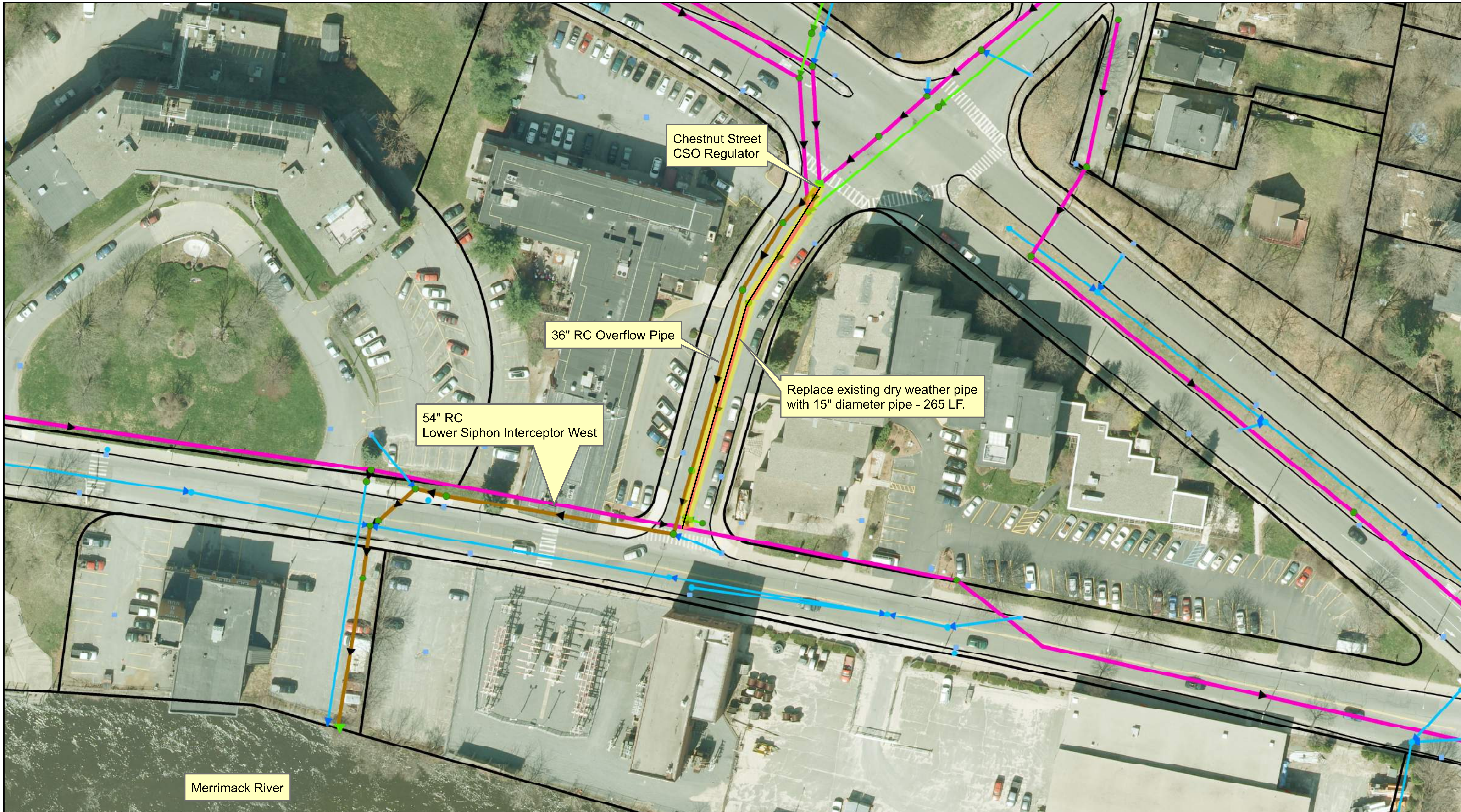

Legend

Proposed Improvement
CSO Regulator
CSO Outfall
Sewer Manhole
Stormwater Manhole
Catch Basin
Overflow Pipe
Combined Sewer Pipe
Sewer Pipe
Stormwater Pipe

0 60 Feet

CDM Smith

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Chestnut Street CSO - Dry Weather Pipe Improvement
Figure 9-2

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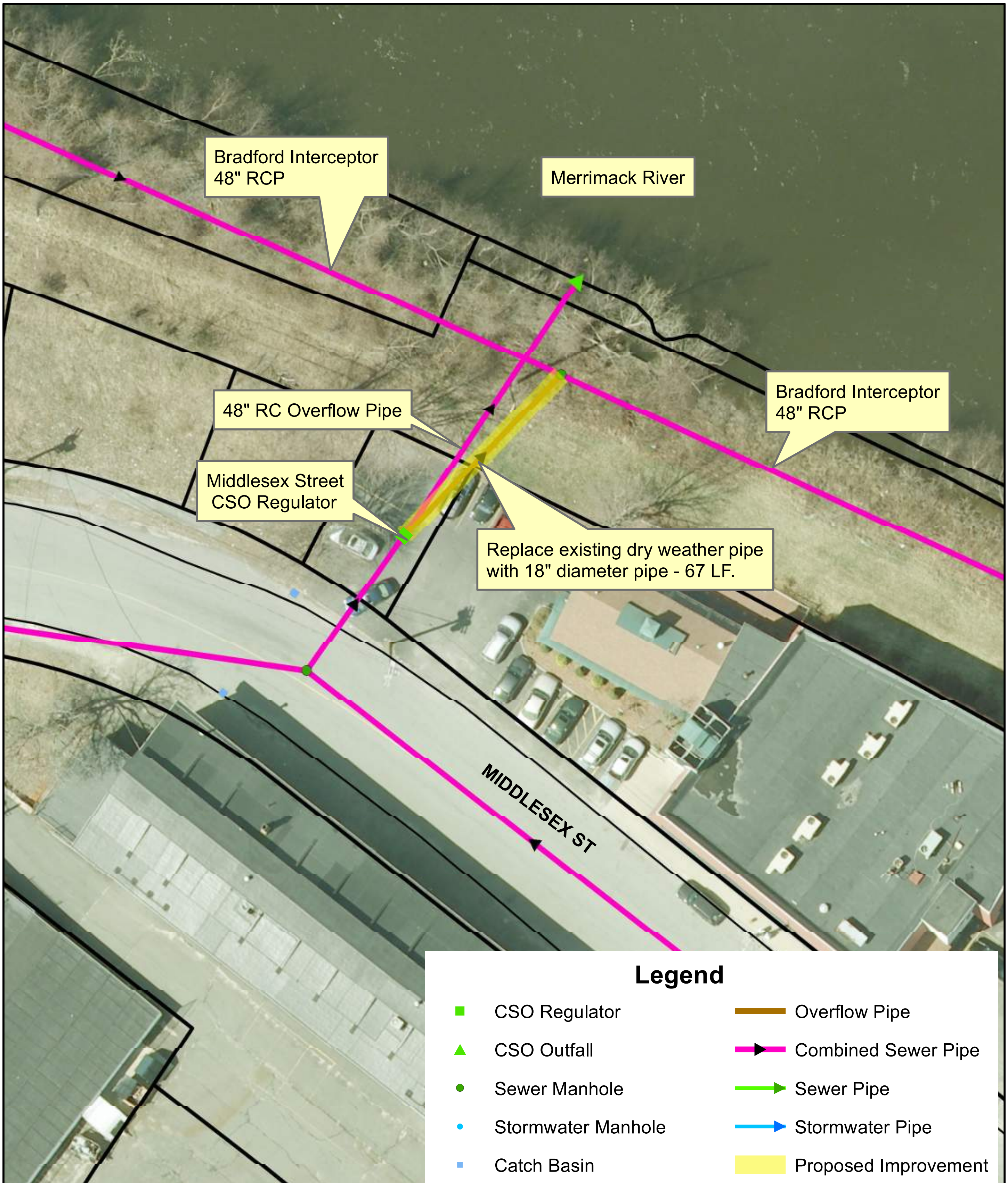

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Middlesex Street CSO - Dry Weather Pipe Improvement
Figure 9-3

South Webster Street CSO

The SWMM model showed that the 8-inch outlet pipe from the CSO regulator to Elmwood Avenue is undersized and is restricting flow at the regulator, causing frequent overflow from South Webster CSO. The dry weather connector pipe should be replaced with a larger 10-inch diameter pipe, extending 120 feet, which will relieve the existing flow restriction and allow more flow to be conveyed into the Bradford Interceptor. Figure 9-4 shows a schematic of the proposed pipe replacement.

9.3.4.4 CSO Regulator Weir Modification at Middle Siphon CSO

Modifying the weir elevations at the CSO regulators helps to maximize the use of the upstream pipes for in-line storage. Adding a courses of brick or concrete to increase the elevation of the existing weirs, reduces both overflow volumes and frequencies. Raising the Middle Siphon CSO weir elevation will reduce the frequency of discharges from this CSO regulator.

The cost to complete this modification is estimated at $40,000.

9.3.4.5 Post Construction Compliance Monitoring and Wet Weather System Controls Optimization

Under the Phase II Wet Weather System Maximization and CSO Structure Modifications Project, the city is implementing its first real-time, automated, control of the CSO discharges. It will take a period of time to assess the operation of this real-time control system and to identify areas for further enhancement, in order to maximize the use of in-line storage upstream of these CSOs.

Accordingly, it is recommended that the city continually assesses the operation of the system during wet weather and make modifications periodically to improve CSO capture (Wet Weather System Controls Optimization). This will likely entail engagement of professional engineers to help the city assess the system and make periodic modifications to the system/instrumentation controls.

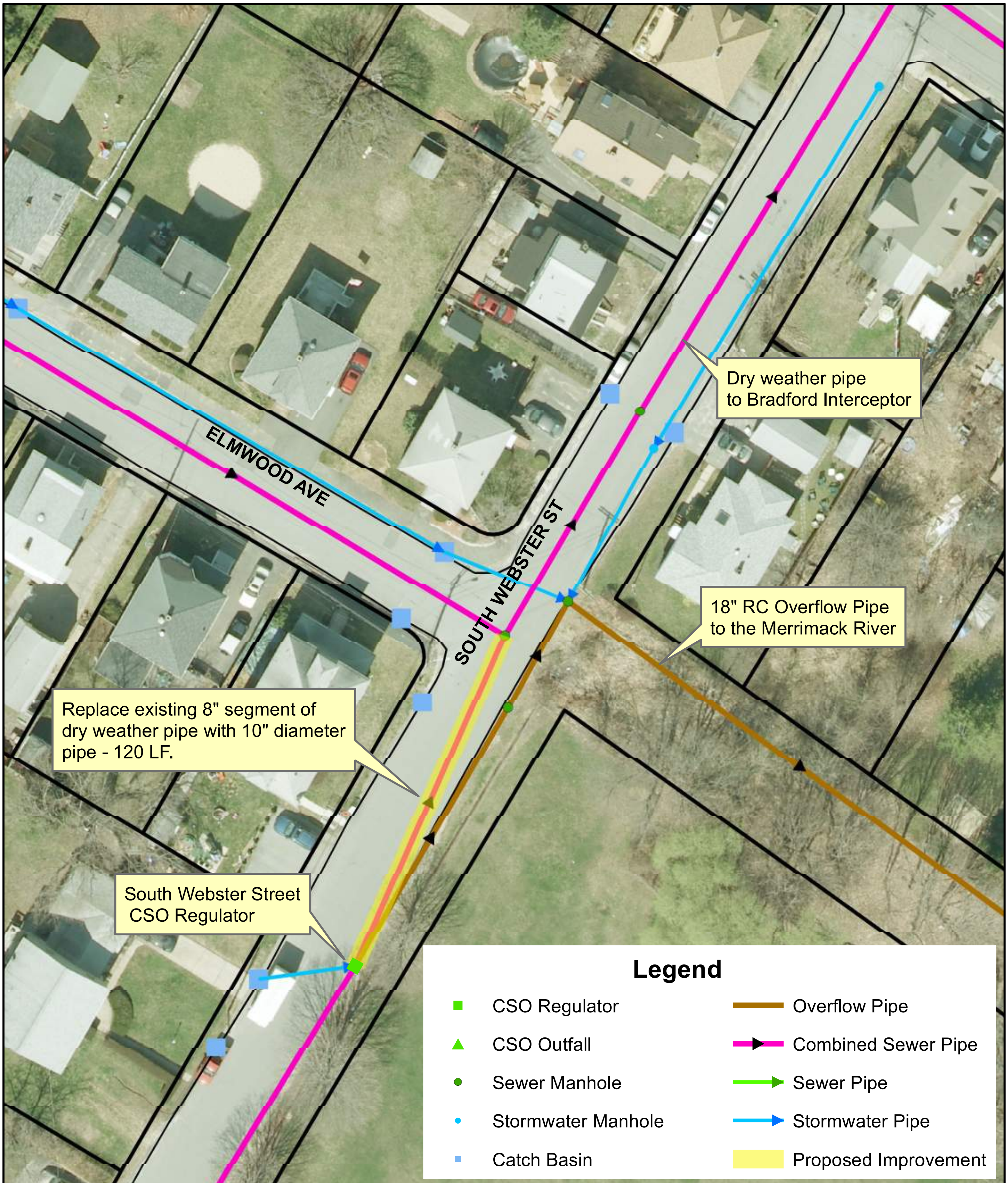
Concurrently, the city will maintain its existing CSO/flow monitoring program. The city has deployed flow/depth meters at each of its CSOs to help with monitoring and reporting. This complies with the USEPA requirement for Post Construction Flow Monitoring.

The city has included an allowance of $300,000 to assist in this continual system monitoring, reporting, and improvement effort.

9.3.4.6 Green Infrastructure Projects

As discussed in Section 7, in addition to traditional wastewater infrastructure controls, the city will implement some green infrastructure demonstration project to consider green infrastructure as an alternative to reduce the quantity of stormwater entering the combined sewer system.

Twelve city-owned properties located, within the combined sewer areas were identified as potential candidate sites for green infrastructure practices (vegetated bioretention areas, porous pavements, and bioswale systems). The city intends to continue the investigation of these sites and implement some of these projects as practical and integrated with other city projects. The city is committing $500,000 to further investigate these sites and to implement green infrastructure demonstration projects.



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South Webster St CSO - Dry Weather Pipe Improvement
Figure 9-4

Haverhill understands the importance of becoming more familiar with this green approach. In addition, the city realizes that there is a significant value of green infrastructure projects in helping to increase public awareness of CSO and stormwater issues.

9.3.4.7 Locke Street Interceptor Area Preliminary Design and Improvements

To reduce CSO discharges to four times per year (3-Month control) of the Locke Street area regulators (Winter and Hale CSO, Locke Street Center Barrel CSO, and the downstream Middle Siphon CSO), the city will either separate combined sewer area and/or construct a storage facility adjacent to the Locke Street Center Barrel CSO. Section 7 provided a planning level analysis of these alternatives and costs but further analysis is required to develop a final plan for these CSO discharges. Accordingly, it is recommended that a Preliminary Design is completed to investigate and further evaluate the Locke Street Interceptor area CSO control options.

This preliminary design effort would include additional flow monitoring and modeling of the area, 10 percent design level drawings of the storage facility and pipe sizing and routes for sewer separation of the area, property assessment for the storage facility, consideration of green infrastructure benefits, identification of any required permits, and a 10 percent design level cost estimate. This additional assessment should provide the city with the best approach for control of these CSO regulators. The estimated cost of this preliminary design is $1.2 million.

Based on this Preliminary Design, the city will implement the recommendations. It is expected that a six-year, multi-contract, approach would be most appropriate if the city elects to proceed with sewer separation of the combined service area. Adjustments to this implementation plan would be made after the Preliminary Design is completed and the final project components for system improvements is selected. A budget of $11.6 million is included in the Final LTCP, which reflects the possible range of costs for the system improvements in the Locke Street Interceptor area.

9.3.5 Stormwater

The stormwater program includes the city's costs for compliance activities related to the current NPDES MS4 Stormwater Permit, stormwater requirements included in the CD, and anticipated costs to prepare for the 2017 MS4 Stormwater Permit. The city will have to update its Stormwater Master Plan as part of its Notice of Intent filing in 2017 for the new stormwater permit. There are also an increased number of annual stormwater report documents that have to be prepared for the CD and the new stormwater permit.

The city has initiated its Illicit Discharge Detection and Elimination Program Investigations based on the 2016 Dry Weather Stormwater/CSO Outfall Inspection Program. The city will have to continue this program, which requires a very comprehensive system investigation and sampling approach to identify the illicit sources of stormwater system pollution. The city is also budgeting about $2 million in anticipated costs to make sewer or storm system repairs, as necessary, over the next six years to remove illicit connections. The city has already identified one illicit connection, a leaky sewer system, that may cost as much as $500,000 already to remove the potential stormwater system pollutant source.

The CD and 2003 NPDES Stormwater permit require the city to adopt construction site stormwater mitigation and inspection procedures. The stormwater program budget includes the costs of these additional programs that the city will have to perform.

Finally, the city is committed to improving its catch basin cleaning and street sweeping programs to improve the quality of stormwater runoff from its system, reduce the pollutant discharges in the CSOs, and to remove floatables in stormwater and CSO discharges. This cost represents the additional commitment to complete inspection of all of the city's catch basins. After that, the city will clean any catch basins, as required, and will utilize the MaintStar CMMS program to track all future maintenance needs for the catch basins (i.e., how long does it take to fill up with sediment). Likewise, the city intends to complete a full round of street sweeping along almost all city streets within 2-3 years and then will use MaintStar to track future street cleaning needs.

9.3.6 Supplemental Environmental Project Programs (SEP)

The CD requires the city to complete a SEP program as part of its negotiated settlement. The city is proceeding with a river bank restoration program along the Merrimack River near the city's Riverside Park. This will be completed in about 2 years.

9.4 Summary

Implementation of the city's Integrated FLTCP is expected to reduce CSO discharge frequencies to no more than four times per year and annual average for a year with typical rainfall patterns. CSO volume will be reduced from 20 MG to 12 MG. The city's Final LTCP will meet the Massachusetts Water Quality Standard of B_{CSO}/SB_{CSO} for the Merrimack River and Little River in Haverhill. The city's level of control continues to be significantly better than the CSO control that will be achieved in most of the upstream Merrimack River CSO communities.

The city is recommending a 13-year period for the implementation of these system improvements for CSO control. First, this will allow the city to effectively assess the phased implementation of its recommended system improvements so that efficiencies and potential overall plan cost reductions can be realized. A shorter implementation period will not allow the city to recognize any potential synergies in the overall program.

In addition, the 13-year program allows the city to address Wastewater Division initiatives to address other regulatory compliance issues. These priorities and spending requirements are discussed in Section 8.

9.5 Next Compliance Actions

Haverhill should proceed with the steps necessary to obtain a temporary variance from the requirements of the state Water Quality Standards for the Merrimack River. This variance is requested for the interim implementation period of the city's FLTCP. After the FLTCP is completed, the city/state can proceed with a reclassification of the river. A Use Attainment Analysis is required for either regulatory action but this report and the accompanying Environment Impact Report (EIR, in Section 10) provide the basis for this analysis.

The following supports the justification for this recommendation:

- The city's FLTCP meets the B_{CSO}/SB_{CSO} water quality standard,
- The Merrimack River Initiative work thus far demonstrates that CSOs are not the most significant source of pollution in the river and, therefore further abatement of CSOs alone will not achieve full attainment of the designated river uses,
- Although the rivers are designated Class B/SB, some of the uses associated with this classification may never be practiced on these rivers downstream of Haverhill,
- Haverhill's remaining CSO discharges do not significantly impact the river uses,
- Current studies have identified that stormwater contributes about the same or greater bacteria pollutant load to the Merrimack River as the Haverhill CSO discharges, and
- A TMDL analysis has yet to be completed on any of the rivers as required by Section 303(d) of the federal CWA.

Until all CSO and other water quality impacts from upstream communities are addressed, uses in the Merrimack River will not likely be attained.

A clear plan for environmental restoration of the river is what is needed through targeted investments. This plan must be based on a full understanding of all the issues facing the river. By this approach, the right investments can be made and the public will see the real benefit of these investments.

Section 10

Financial Capability Assessment

10.1 Introduction

The purpose of this report section is to evaluate the financial capability for the city consistent with USEPA guidelines. The analysis will assess the financial impact and affordability of the proposed projects outlined in the city's Integrated FLTCP and the effect of the plan on the city's ratepayers. This assessment follows the two-phase approach set forth in USEPA's *Combined Sewer Overflows — Guidance for Financial Capability Assessment and Schedule Development* as modified by USEPA's November 2014 *Financial Capability Assessment Framework*. The first phase of the USEPA financial capability assessment is used to determine the impact of the anticipated capital improvements on the average residential ratepayer. The second phase of the USEPA financial capability assessment is an evaluation of socio-economic factors as compared to USEPA benchmarks.

10.2 Methodology and Assumptions

A financial model was developed for the purpose of projecting the impact of anticipated changes in operating expenses and proposed capital projects on the future revenue requirements and projected bills for the city and its residents. The analysis relies on the data provided by the city or derived from credible, public sources.

This financial capability assessment projects financial changes over 15-years. Given the forecasting horizon, a number of assumptions are necessary and have been used in this assessment. The following lists the major assumptions utilized in the projections:

- The USEPA financial capability analysis with respect to affordability is focused only on sewer and stormwater related costs, therefore those were the only costs included in this analysis. It is assumed that stormwater expenses will continue to be funded through the sewer rate.

- Operating and maintenance costs are assumed to inflate at an annual inflation rate of 3.0 percent. Based on data from the Bureau of Labor statistics, the Consumer Price Index (CPI) for the Boston-Brockton-Nashua region has increased at an average annual rate of roughly 2.6 percent for all items over the past 20 years. Given the length of the projections and the uncertainties related to inflation over time, the city believes a 3.0 percent inflation rate for operating costs is appropriate.

- Capital costs are projected to increase at an average annual rate of 4.0 percent. The Engineering News-Record publishes a Construction Cost Index (CCI), which is a historical index that tracks the cost of labor and materials. Based on historical data for Boston, the CCI has increased at an average annual rate of roughly 3.5 percent over the past 20 years, and around 4.5 percent over the last 15 years. The city believes the use of 4.0 percent for long-term capital inflation is reasonable.

- Miscellaneous revenues are assumed to remain constant through projections. Miscellaneous and non-rate revenues can be erratic and are generally beyond the control of the city, so the city has been conservative in holding those constant at 2017 budgeted levels.
- Stormwater expenses of $1.1M are anticipated for FY 2018 to comply with permit requirements. This total is assumed to inflate at 3.0 percent annually.
- The projections include an allowance for a reserve fund to provide the city the ability to effectively meet unforeseen events eventually equal to 15 percent of the annual budget. Deposits to the reserve fund are estimated to begin in FY 2018 with a $500,000 deposit, and beyond FY 2018 the deposits are equal to the amount required to maintain a balance of 15 percent of annual expenses.
- The analysis includes an allowance for capital expenses unrelated to the proposed Integrated FLTCP. The total capital assumed based on the city's CIP is approximately $15.7M for the period FY 2017 through FY 2031, funded through a combination of cash and long-term debt.
- This analysis has been conducted assuming the city would finance its future capital costs by issuing general obligation (GO) debt, at a rate of 5.0 percent for a term of 20 years, with issuance costs of 1.0 percent.
- Additional staffing or outsourcing of costs required as a result of program implementation and the need to meet CMOM requirements has been estimated and included in the analysis. The city assumes the inclusion of seven additional staff, at an average annual cost (salary and benefits) of $95,000. The city accounts for the additional employees for FY 2018, with the costs inflating annually at 3.0 percent.
- Median household income (MHI) for Haverhill in 2015 was estimated to be $60,888, based on U.S. Census Bureau, American Community Survey (ACS) data. MHI is assumed to increase 1.5 percent annually, generally consistent with historical growth in the city over the past 15 years. In addition, based on historical Census data, since 2009 the MHI level in Haverhill has been essentially flat (estimated MHI in 2009 was $60,535). The city believes that a long-term annual inflation value of 1.5 percent for MHI is appropriate to account for stable future MHI growth.
- It is assumed that the typical residential dwelling unit consumes 80 hundred cubic feet (HCF) annually.
- The city currently charges sewer customers a volumetric rate of $4.29/HCF for FY 2017. The estimated sewer bill per typical residential dwelling unit for FY 2017 is $343.
- The projections are estimated assuming no use of reserves or funds to offset potential future rate increases. The projected rate increases generally follow the increase in revenue requirements, including the allowance for reserves.

The remainder of this section summarizes the 15-year projections and the impact of the Integrated FLTCP on a typical residential bill.

10.3 Financial Analysis

This section summarizes the projected revenue requirements for the city under the proposed $56.5M Integrated FLTCP (2017 dollars) through FY 2031. Figure 10-1 details the annual capital spending in 2017 dollars, separated by the capital costs included in the Integrated FLTCP and the additional capital the city estimates will be required for other projects to maintain the integrity of the system. A more detailed description of the projects associated with the spending totals is in Section 9.

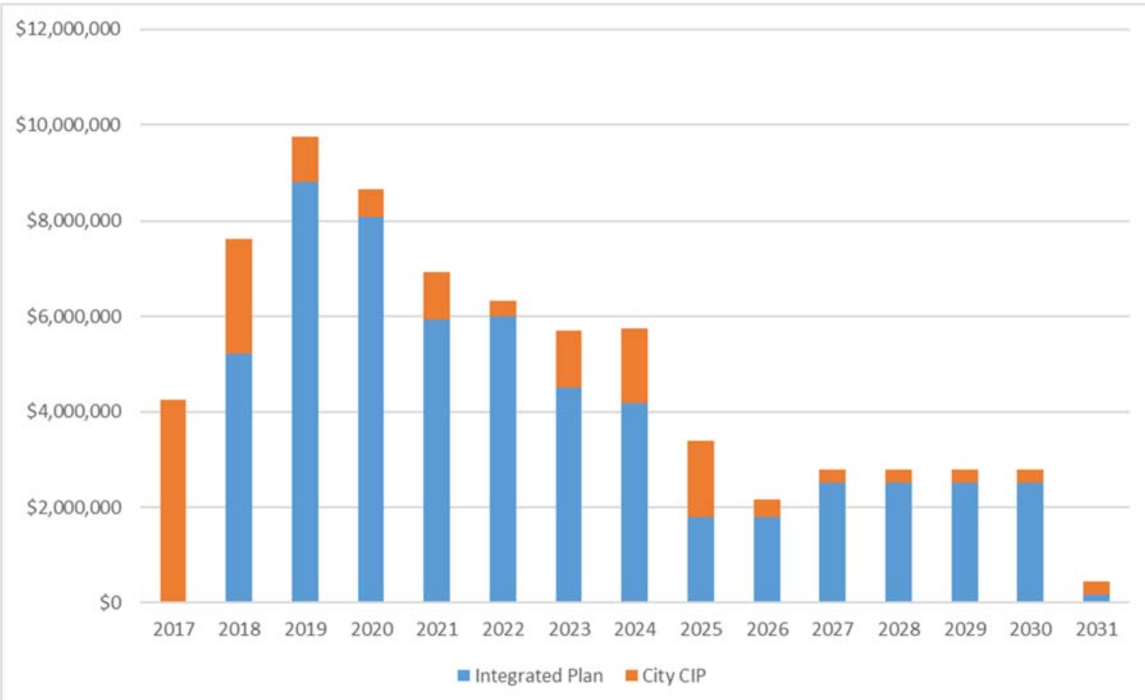

Figure 10-1 Capital Spending by Year (2017 $)

As mentioned, the approximate $56.5M in capital spending represents the recommended portion of the CIP related to the Integrated FLTCP scheduled through FY 2031. The $15.7M city CIP represents the additional projects the city expects irrespective of the Integrated FLTCP.

The impacts of the recommended CIP will be evaluated using the assumptions previously listed and within the context of the city's current sewer rate structure. Since the costs of the program displayed in Figure 10-1 are stated in constant 2017 dollars, the actual construction costs will be higher due to inflation.

Projected revenue requirements are separated into four main components:

- Sewer operations and maintenance costs (O&M)
- Stormwater expenses
- Debt service and capital expenditures
- Miscellaneous revenue.

The following sections summarize the total projected expenses and revenue requirements.

10.3.1 Sewer Operation and Maintenance Costs

The operations and maintenance expenses allocated to the city's sewer system have been separated into four main categories:

- **Salaries and Wages** — salary related costs for sewer utility employees, as well as an allocable share of highway department personnel costs for sewer related work.
- **General** – includes a variety of general sewer O&M costs, with the most significant items being utilities (e.g. electricity, gas) and sludge disposal.
- **Allocation to General Fund** — cost representing the transfer from the sewer utility to the general fund to support shared expenses.
- **Incremental O&M** — additional sewer employees or outsourced costs required to properly operate and maintain the system.

Total sewer O&M expenditures are projected to grow from $7.2 million in FY 2017 to $11.5 million in FY 2031. This represents an average annual cost increase of 3.4 percent. Anticipated sewer O&M expenses over time are summarized for select years in Table 10-1.

Table 10-1 Projected Sewer Operations and Maintenance Expenses

Category	2017	2021	2025	2029	2031
Sewer - Salaries	$3,188,214	$3,588,363	$4,038,734	$4,545,631	$4,822,460
Sewer - General	$3,468,987	$3,904,376	$4,394,409	$4,945,946	$5,247,155
Allocation to General Fund	$548,710	$599,590	$674,844	$759,543	$805,799
Incremental O&M	$0	$427,693	$481,373	$541,789	$574,784
Total Sewer O&M	**$7,205,912**	**$8,520,023**	**$9,589,360**	**$10,792,910**	**$11,450,198**

10.3.2 Stormwater Expenses

The modified USEPA guidance on affordability notes that stormwater costs may be included in the calculation of rates and household burden. As previously mentioned, it is assumed for this analysis that stormwater expenses will continue to be funded through sewer rates, so the projections of revenue requirements include both city sewer and stormwater expenses.

For FY 2017, the city budgeted for roughly $436,000 in stormwater expenses, which includes both general expenses and cash funded capital. The city expects that stormwater expenses will increase to approximately $1.1M annually as the city implements a more comprehensive proactive program. Table 10-2 summarizes the projected stormwater expenses. The table includes the existing stormwater O&M and cash funded capital and separates the additional expenses.

Table 10-2 Projected Stormwater Expenses

Category	2017	2021	2025	2029	2031
Stormwater O&M	$286,000	$282,503	$317,959	$357,866	$379,660
Stormwater Cash Funded Capital	$150,000	$832,249	$243,711	$285,107	$213,129
Additional Stormwater Employees or Outsourced Costs	$0	$320,770	$361,029	$406,342	$431,088
Additional Stormwater Expense	$0	$0	$430,162	$473,343	$591,510
Total Stormwater Expense	**$436,000**	**$1,435,522**	**$1,352,861**	**$1,522,657**	**$1,615,387**

10.3.3 Debt Service and Capital Expenditures

Capital costs can be financed through annual cash payments as cash funded capital, or through bonded debt as debt service. The debt service and capital expenditures have been separated into three categories: existing debt service, anticipated debt service, and cash funded capital.

Existing debt service represents the sewer and stormwater related debt that is outstanding as of FY 2016, with the payback schedules provided by the city. Anticipated debt service relates to the annual debt service payments projected from bonding future capital costs. Cash funded capital is annual capital projects that the city elects to fund directly through current year rate revenue without issuing debt. As mentioned, the city has formulated a preliminary schedule with potential funding source by project and has been incorporated into the analysis.

The city has assumed that the capital expenditures for stormwater improvements will be almost completely funded on a pay-as-you-go basis. Those totals have been included in Table 10-2 above, so are not reflected in Table 10-3 below. Table 10-3 shows the projected capital and debt obligations for select years through FY 2031, including the costs associated with the proposed Integrated FLTCP.

Table 10-3 Debt Service and Capital Expenditures

Category	2017	2021	2025	2029	2031
Existing Debt Service	$1,834,095	$1,822,859	$1,528,240	$0	$0
Anticipated Debt Service	$102,961	$2,780,123	$4,918,848	$5,594,564	$5,881,831
Cash Funded Capital	$647,000	$593,478	$598,486	$700,144	$584,108
Total Debt Service and Capital	**$2,584,056**	**$5,196,461**	**$7,045,574**	**$6,294,708**	**$6,465,939**

10.3.4 Reserve Transfers

The city has established a goal to maintain a reserve fund by depositing annual amounts to sustain a fund balance of 15 percent of total annual expenses to ensure the ability to offset and address unforeseen circumstances - this is one of the tenets of USEPA's Effective Utility Management initiative. The city believes maintaining a reserve fund is good practice to mitigate the impact of any unforeseen expenses. The city has not currently budgeted additional transfers to reserves for FY 2017, but assumes to phase in the contributions to meet the minimum balance by FY 2019. The city accounts for a contribution of $500,000 in FY 2018, and a contribution of $668,475 in FY 2019 to meet the minimum requirement. As noted, it is assumed that the city does not utilize these funds to offset expenses or smooth rates, so there is no withdrawal from reserves included in the analysis.

Table 10-4 shows the reserve transfers for select years through FY 2031, however, the annual deposits vary depending on the annual increase in expenses.

Table 10-4 Reserve Transfers

	2017	2021	2025	2029	2031
Total Reserve Transfers	**$0**	**$54,208**	**$116,567**	**$0**	**$0**

10.3.5 Miscellaneous Revenue

The city's miscellaneous or non-rate sewer revenue consists of all revenue generated by the city that is not directly related to customer sewer rates. Table 10-5 summarizes the miscellaneous revenues through the projection period for select years.

Table 10-5 Projected Miscellaneous Revenue

Category	2017	2021	2025	2029	2031
General Miscellaneous Revenue	$750,000	$750,000	$750,000	$750,000	$750,000
Wastewater CSO Impact Fee	$100,000	$100,000	$100,000	$100,000	$100,000
Sewer-Storm Drainage Infrastructure Fee	$10,000	$10,000	$10,000	$10,000	$10,000
Wastewater Infrastructure Fee	$35,000	$35,000	$35,000	$35,000	$35,000
Total Miscellaneous Revenue	**$895,000**	**$895,000**	**$895,000**	**$895,000**	**$895,000**

10.3.6 Revenue Requirement

The revenue requirement is the total revenue that must be generated annually through sewer rates to fund the city's sewer and stormwater expenses. The revenue requirement is calculated by subtracting non-rate revenue from total expenses.

Table 10-6 shows the total revenue requirement, which includes the projections for implementing the projects in the proposed Integrated FLTCP. The total revenue requirement is projected to grow from approximately $9.3 million in FY 2017 to approximately $18.6 million in FY 2031, equivalent to an average annual increase of 5.1 percent.

The city projects that a significant increase in rates will be required in the short term, with annual revenue requirement increases close to 12.4 percent for the next five years. The revenue requirement is projected to be nearly double the current levels by FY 2026 as a result of the recommended plan and other items described in this report.

Table 10-6 Projected Revenue Requirement

	2017	2021	2025	2029	2031
Sewer O&M	$7,205,912	$8,520,023	$9,589,360	$10,792,910	$11,450,198
Stormwater Expenses	$436,000	$1,435,522	$1,352,861	$1,522,657	$1,615,387
Debt Service and Capital Expenditures	$2,584,056	$5,196,461	$7,045,574	$6,294,708	$6,465,939
Reserve Transfers	$0	$54,208	$116,567	$0	$0
Total Expenses	**$10,225,967**	**$15,206,214**	**$18,104,363**	**$18,610,274**	**$19,531,524**
Less: Miscellaneous Revenue	($895,000)	($895,000)	($895,000)	($895,000)	($895,000)
Total Revenue Requirement	**$9,330,967**	**$14,311,214**	**$17,209,363**	**$17,715,274**	**$18,636,524**

Figure 10-2 graphically depicts the projected revenue requirement with the recommended program.

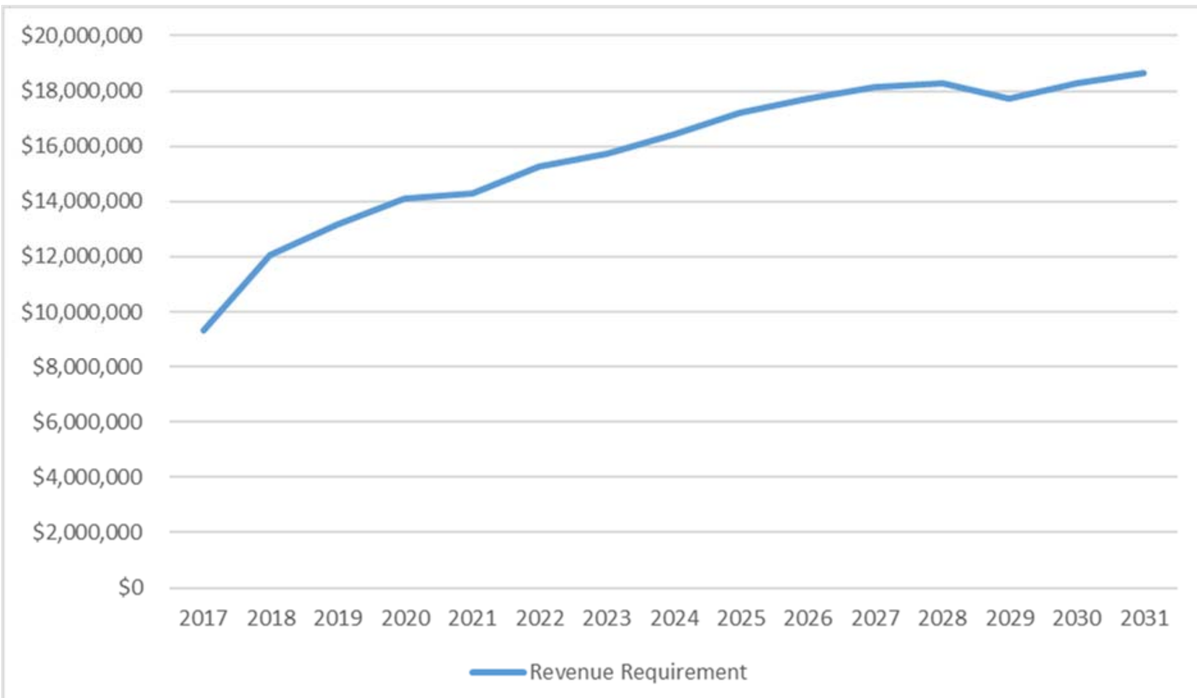

Figure 10-2 Projected Revenue Requirement

The projected revenue requirements shown in Figure 10-2 will directly translate into increased sewer rates and burden for city's households. Sewer rate increases are assumed to generally follow the same rate of annual revenue requirement increase.

The revenue requirement under the proposed program is expected to more than double over the next 10 years. Revenue requirement increases of this magnitude will translate into significant rate increases both in the short-term and into the future.

10.4 Residential Indicator

The "Residential Indicator" is defined as the typical dwelling unit sewer bill compared to median household income, and is used as a benchmark by the USEPA in assessing the affordability of a proposed capital program. The current sewer household bill in Haverhill is $343 based on the city's estimate of annual sewer use of 80 hundred cubic feet per residential dwelling unit.

The projected growth in the typical household sewer bill, MHI and the corresponding Residential Indicator are shown in Table 10-7 for the recommended program. Figure 10-3 shows graphically the increase in the household burden through FY 2031. The assumptions related to median household income growth are noted previously in Section 10.2.

For the first five years, residents will face rate increases averaging over 12 percent per year; for the first 10 years, residents will face average annual rate increases of nearly 8 percent. These are rapid and significant increases to the user base.

Table 10-7 Projected Household Bill, MHI and Residential Indicator

	2017	2021	2025	2029	2031
Estimated Household Bill	$343	$579	$696	$740	$754
MHI	$62,728	$66,578	$70,663	$74,999	$77,266
Residential Indicator	0.55%	0.87%	0.99%	0.99%	0.98%

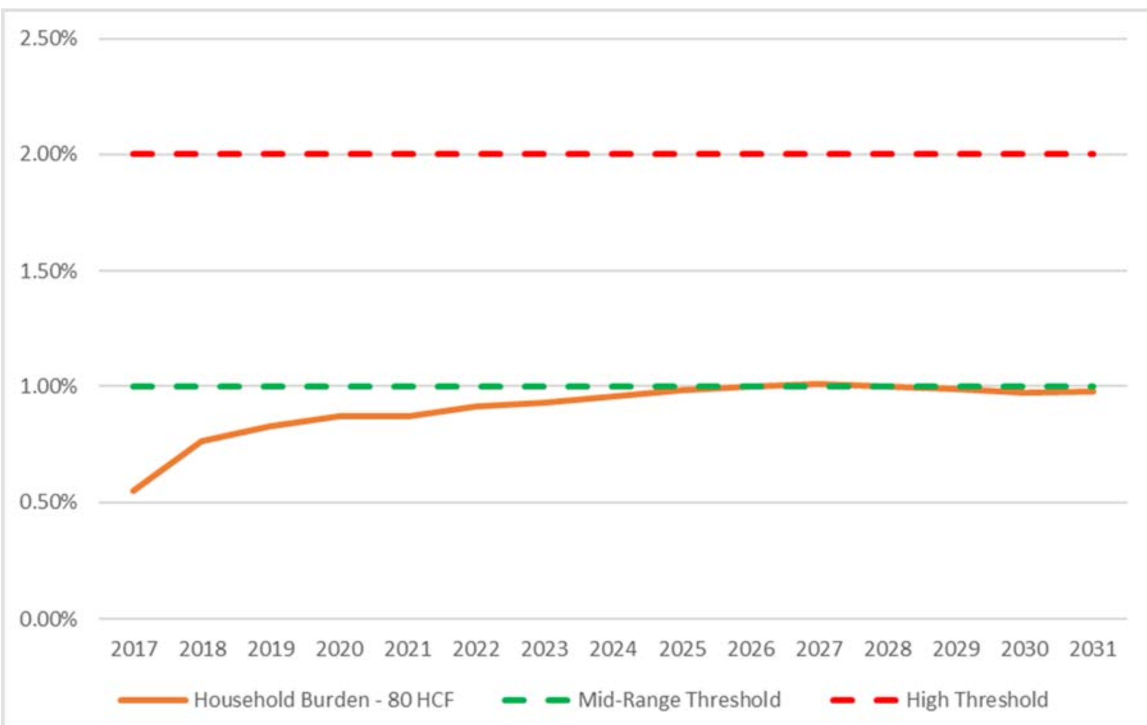

Figure 10-3 Projected Household Bill, MHI and Residential Indicator

10.5 Additional Financial and Economic Factors

In addition to the traditional impact indicators considered in the USEPA's financial capability assessment guidelines, this section expands the scope of the analysis to include information on demographic and social data, which provide additional perspective about the city's current and anticipated financial capability.

10.5.1 Burden to Low-Income Households

The household burden described in Section 10.4 of this report estimates the long-term impact of the Integrated FLTCP on a typical residential customer, assuming median household income. However, for the lower-income residents of the city, the increased sewer bills will have a greater relative impact on their ability to pay for basic services.

Figure 10-4 shows the estimated household burden on the lowest income residents, using the lowest quintile income levels. At the lowest quintile income level, approximately 20 percent of Haverhill households have an income of less than $25,000. The next quintile income level is $50,000, meaning that 40 percent of the households in Haverhill have an annual income less than $50,000.

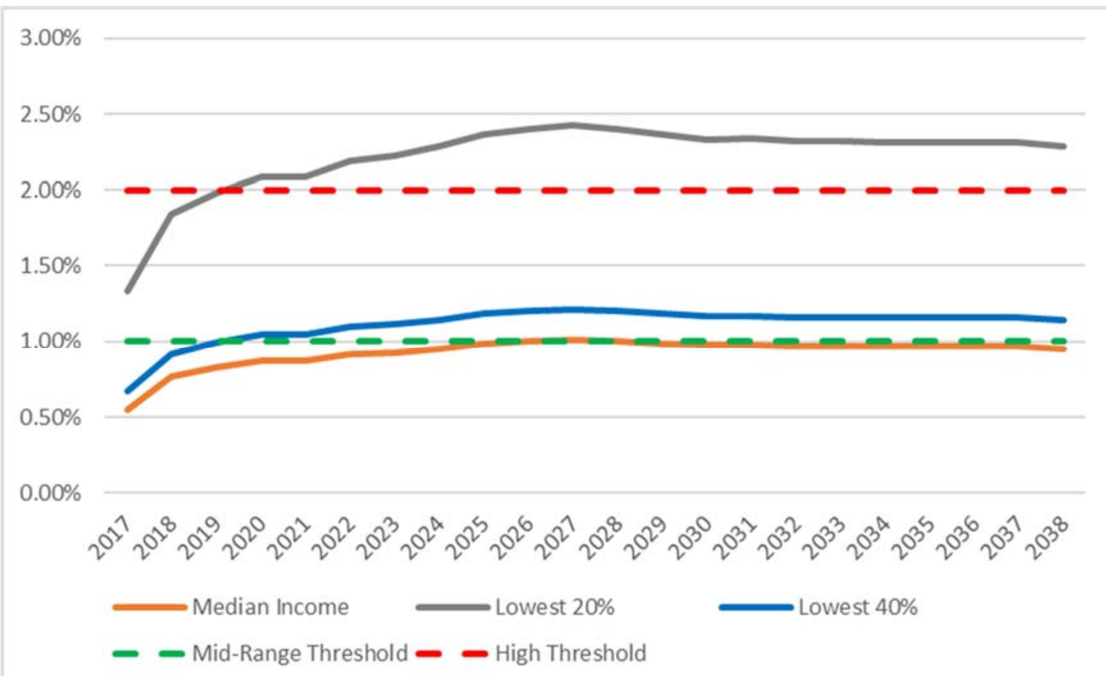

Figure 10-4 Comparison of Projected Residential Indicator – Income Levels

Within this context, the impact of the recommended program on the residents with the lowest quintile income level results in a residential burden over the 2% threshold. These household will exceed the 2% within the first 4 years of the program, exceeding 2.4% in the first 10 years.

Focusing solely on the burden at the median income level may provide a misleading view of the city's ability to proceed with any program, given the impact on these lower income households.

10.5.2 Income and Poverty

Recent trends indicate that the city has experienced relatively slow growth in income, and an increase in the percentage of its residents living below the poverty level. A comparison of the city, state and national average MHI is shown in Figure 10-5. This figure indicates that the city MHI has been growing at a slower rate than the national and state averages. Since 1989, the median household income for the nation and state have grown at an average annual rate of 2.3 and 2.4 percent, respectively. Comparatively, the MHI for the city has grown only at a rate of 1.9 percent over the same timeframe.

Between 1989 and 1999, the city median household income tracked relatively close to the state-wide average. However, since 1999 the median household income in the city has only grown at 1.3% annually, lagging behind the state-wide average annual growth of 1.9%. The city MHI is now 13 percent below the state MHI.

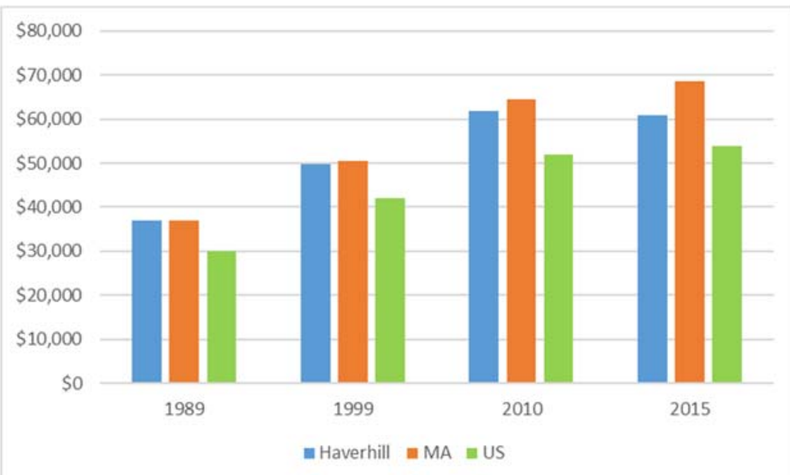

Figure 10-5 Median Household Income –Time Series

In addition, based on Census data the MHI for the city has been essentially flat in the past 5 years even as the country as a whole as experienced an economic recovery, which raises a concern about the future income growth in the city. Since 2009, the city's MHI has only increased by a total of 0.6 percent, while the state and nation have increased by a total of 6.3 percent and 4.8 percent, respectively.

Related to the concern about future income growth is the increasing level of poverty in the city over the past 25 years. In 1989, the city had roughly 8.8% of its residents living below the poverty line, which only increased to 9.1% over the next decade. Currently, the city has 12.2% of its residents living below the poverty line. The increase in the number of people living in poverty in the city, coupled with the trend of slow income growth suggests potential that long-term future sewer bill increases will create a situation more burdensome than may be captured in the current analysis.

10.5.3 Existing Housing Costs

An additional aspect to consider is the already high housing cost burden borne by Haverhill residents. While the city may have a higher median household income than the US average, a large share of that income is already devoted to basic housing costs. This is summarized in Figure 10-6 below, which depicts housing costs as a percentage of household income:

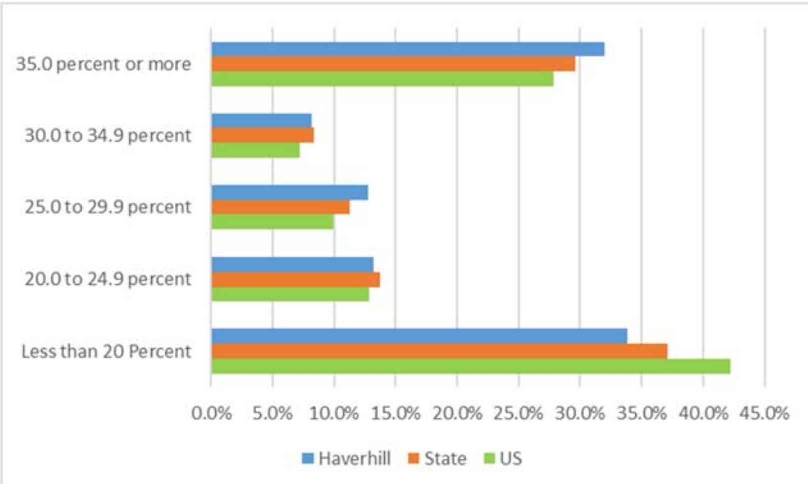

Figure 10-6 Housing Costs as Percent of Household Income

Generally, housing costs exceeding 30 percent of income is considered to be a high burden. In Haverhill, 40 percent of all housing units have housing costs exceeding 30 percent of household income. Additional sewer utility costs associated with the Integrated FLTCP will only further increase this burden.

10.5.4 Other Major City Investments

The city of Haverhill also anticipates major capital investments to its infrastructure unrelated to the wastewater and stormwater system. The following projects currently have approved loan orders, with engineering either ongoing or complete:

- Water Treatment Plant Upgrade - $41.2M
- 20" and 36" water transmission main improvements - $3.1M
- Additional drinking water supply - $17.2M

The city also has a planned $14.0M project related to a landfill closure that will be required in the near future.

These additional city investments will result in increases to the residents' water and tax bills in order to fund the projects. The increases in the tax bill mean a higher proportion of a resident's income will be allocated to these bills, and thus a lower capacity to absorb large and sustained increases to the sewer bill.

The impact of the proposed water projects on the estimated water bill is shown in Figure 10-7 and Figure 10-8. The projections include the nearly $61.5M in planned water capital improvements, and the future water costs and rates have been estimated based on current O&M costs and assumptions similar to those described in Section 10.2.

Figure 10-7 shows the projected water and sewer bill for the next 20 years.

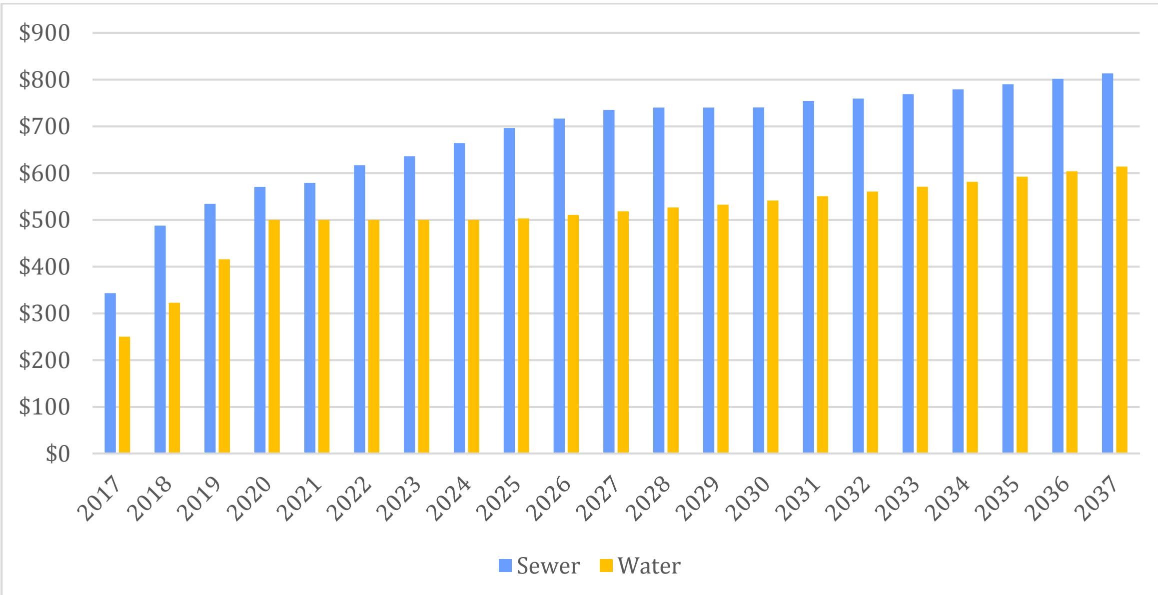

Figure 10-7 Projected Water and Sewer Bill

Figure 10-8 summarizes the projected impact of the combined water and sewer bill on the lowest quintile residents, relative to income for the next 20 years.

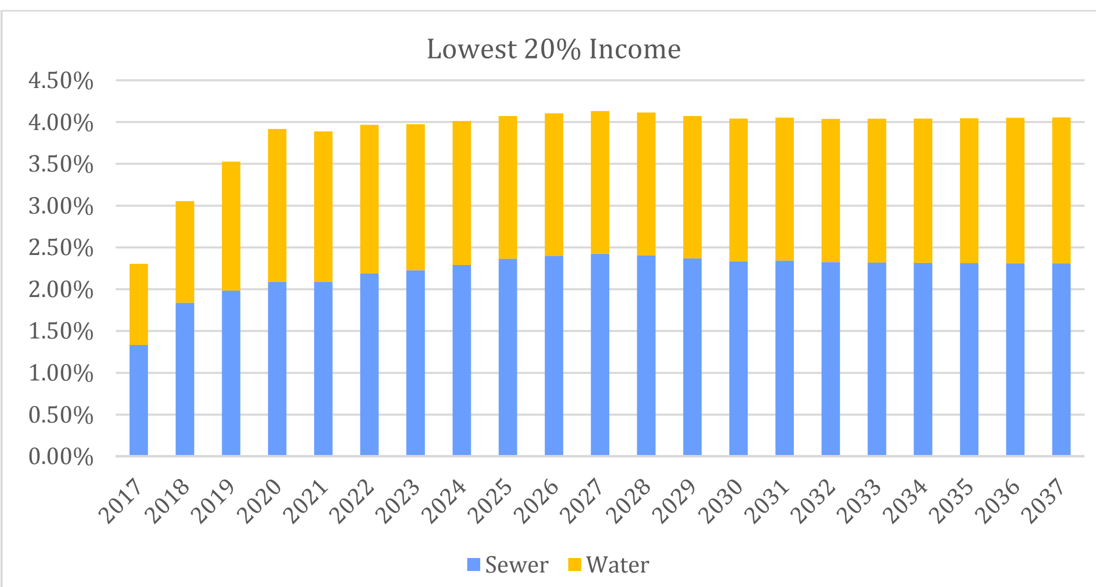

Figure 10-8 Projected Water and Sewer Burden, Lowest 20 Percent Quintile

10.6 Phase 2 – Financial Indicators

This section presents the Phase 2 financial indicators, as defined by the USEPA guidelines. These indicators evaluate ancillary factors that may have an effect on the city of Haverhill's ability to fund the proposed recommended plan outlined in the Integrated FLTCP. This assessment identifies three categories, each with two indicators as listed below:

- Debt Indicators:
  - Bond Rating
  - Overall Net Debt
- Socio-economic Indicators:
  - Median Household Income
  - Unemployment Rate
- Financial Management Indicators:
  - Property Tax Revenue
  - Property Tax Collection Rate

While the Phase 1 assessment (Residential Indicator) outlined in the previous sections is a time-series analysis, the Phase 2 assessment is a cross-sectional view of the city's financial capability. The six indicators intend to provide a better representation of the city's overall capacity to finance the recommended capital costs.

10.6.1 Debt Indicators

The two debt indicators included in Phase 2 of the financial capability assessment are bond rating and overall net debt. These indicators are indicative of the city's capacity to gain access to capital markets to raise the necessary capital to implement the recommended plan.

10.6.1.1 Bond Rating

The bond rating indicator is intended to address a general capacity to undertake debt. While rating designations vary by credit rating agencies, long-term bond ratings range from AAA/Aaa (high grade) to C/D (in default). Table 10-8 shows the most recent ratings for Haverhill from Moody's Investors Service, and Standard and Poor's. For the Phase 2 analysis, the benchmarks for this indicator with respect to the ratings are as follows:

- ***Strong (Score = 3)*** — a high grade or strong bond (e.g., Aaa or AAA, Aa or AA, A).
- ***Mid-Range (Score = 2)*** — a medium grade bond (e.g., Baa or BBB). These are the minimum "investment grade" bond ratings.
- ***Weak (Score = 1)*** – a speculative or "junk" bond (e.g. Ba or BB, or lower)

From the latest available bond ratings (2015), the city received an A1 rating from Moody's, and an AA rating from Standard & Poor's. Based on the benchmarks provided in the USEPA guidance document, the city scores a strong rating for this indicator and earns a score of 3.

Table 10-8 Current Bond Rating

Item	Value
Rating agency	Standard & Poor's
Rating	AA
Rating agency	Moody's Investors Service
Rating	A1
Bond Rating Indicator Score	3

10.6.1.2 Overall Net Debt as a Percent of Full Market Property Value

Overall net debt is the amount of tax-backed bonded debt for all taxing units not supported by revenue from sewer user fees. Indicator scores for overall net debt are based on the percentage of the full-market property value. The USEPA guidance document benchmarks for overall net debt are:

- ***Strong (Score = 3)*** — overall net debt is below two percent of the full-market property value.
- ***Mid-Range (Score = 2***) — overall net debt is two to five percent of the full-market property value.
- ***Weak (Score = 1)*** — overall net debt is more than five percent of the full-market property value.

Property value data for this indicator was estimated using data from the Massachusetts Department of Revenue (DOR), and the debt information was derived from city data. The summary of this indicator is shown in Table 10-9.

Table 10-9 Overall Net Debt Rating

Item	Value
Direct net debt (2016)	$ 81,704,595
Debt of overlapping entities (proportionate share of multi-jurisdictional debt)	$0
Overall net debt (2016)	$81,704,595
Market value of property (2016)	$5,432,029,234
Overall net debt as a percent of full market property value	1.50%
Overall Net Debt Indicator Score	3

The overall net debt for the city as of 2016 was approximately $73.2 million. The city's market value of property (equalized valuation) is calculated to be approximately $5.8 billion, which

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makes the overall net debt approximately 1.27 percent of full-market property value. This indicator is rated as a strong score using the USEPA guidelines, which equates to a score of 3.

10.6.2 Socio-economic Indicators

The two socio-economic indicators used in Phase 2 of the financial capability assessment are unemployment rate and median household income. These indicators are indicative of the city's general economic condition.

10.6.2.1 Unemployment Rate

Unemployment rate is a measure of the city's labor force that is unemployed, but seeking employment. The USEPA guidance document benchmarks for unemployment rate are:

- ***Strong (Score = 3)*** — unemployment rate is more than one percent below the national average.
- ***Mid-Range (Score = 2)*** — unemployment rate is within one percent (+/-) of the national average.
- ***Weak (Score = 1)*** — unemployment rate is more than one percent above the national average.

The unemployment rate for Haverhill, as compared to the national average, is shown in Table 10-10. The city's average unemployment rate in 2015, according to the U.S. Bureau of Labor Statistics, was 5.4 percent, which is 0.4 less than the state average rate of 5.0 percent, and 0.1 percent more than the national average rate of 5.3 percent. Since the city's unemployment rate is within one percent of the national average, it gives the city a "mid-range" rating of 2 for this indicator.

Table 10-10 Unemployment Rate Comparison

Item	Value
Haverhill Unemployment Rate (2015 Average)	5.4%
Massachusetts Unemployment Rate (2015 Average)	5.0%
National Unemployment Rate (2015 Average)	5.3%
Comparison of Haverhill with National Average	0.1% above
Unemployment Rate Indicator Score	2

10.6.2.2 Median Household Income

This indicator is related to the Residential Indicator in that they both consider median household income (MHI). While the Residential Indicator is a comparison of MHI and average annual household bills, this median household income indicator focuses solely on Haverhill's MHI by comparing it to the national median household income. Thus, this benchmark is a measure of the relative wealth or poverty of the service area. The USEPA guidance document benchmarks for median household income are:

- ***Strong (Score = 3)*** — MHI is more than 25 percent above the national average.

- ***Mid-Range (Score = 2)*** — MHI is within 25 percent (+/-) of the national average.
- ***Weak (Score = 1)*** — MHI is more than 25 percent below the national average.

The city and national MHI values, shown in Table 10-11, are based on the most recent Census Bureau, American Community Survey (ACS) data. Haverhill MHI is 13.0 percent above national MHI, which corresponds to a mid-range rating of 2.

Table 10-11 Median Household Income Comparison

Item	Value
Haverhill MHI estimate (2015 ACS)	$60,888
National MHI estimate (2015 ACS)	$53,482
Compare Permittee with Average National MHI	13.0 percent above
Median Household Income Indicator Score	2

10.6.3 Financial Management Indicators

The two financial management indicators are property tax revenues and tax collection efficiency. The indicators are used to assess a community's capacity to support debt.

10.6.3.1 Property Tax Revenues as a Percent of Full Market Property

Property tax revenue — expressed as a percent of full market property value — is an indicator of the funding capacity available to support debt, based on the wealth of the community. The USEPA guidance document benchmarks for property tax revenues are:

- ***Strong (Score = 3)*** — property tax revenue is below two percent of the full-market property value.
- ***Mid-Range (Score = 2)*** — property tax revenue is two to four percent of the full-market property value.
- ***Weak (Score = 1)*** — property tax revenue is more than four percent of the full-market property value.

In the city, property tax revenues collected in 2016 were approximately $92.2 million; based on an estimated full-market property value of $5.8 billion. As shown in Table 10-12, the calculated property tax revenue indicator for the city is 1.60 percent, which places the city in the "strong" range with a rating score of 3. However, Massachusetts' Proposition 2 ½ caps growth in property tax growth, limiting the amount of revenues that can be generated through property taxes. Since Massachusetts' communities are restricted by state law in terms of the allowable relationship of tax revenues to assessed valuation, this particular parameter likely has limited analytical value.

The city funds the operations and maintenance of the sewer and stormwater systems through rate revenue, not property taxes, so this indicator is irrelevant to the financial impact summary.

Table 10-12 Property Tax Revenues

Item	Value
Full market value of real property (2016)	$5,432,029,234
Property tax revenue (2016)	$92,638,017
Property tax revenue as a percentage of full market property value	1.71 percent
Property Tax Revenue Indicator Score	3

10.6.3.2 Property Tax Collection Efficiency

The final indicator in the Phase 2 evaluation is the property tax collection rate. This indicator represents the relationship of property taxes collected versus property taxes levied. The USEPA guidance document benchmarks for property tax collection efficiency are:

- ***Strong (Score = 3)*** — property taxes collected are above 98 percent of the property taxes levied.
- ***Mid-Range (Score = 2)*** — property taxes collected are between 94 and 98 percent of the property taxes levied.
- ***Weak (Score = 1)*** — property taxes collected are less than 94 percent of the property taxes levied.

Computation of this indicator rating is shown in Table 10-13, and is based on the 2016 tax year. The city's property tax collection rate is 99.3 percent of the taxes levied. This data is indicative of strong financial capability, yet is of limited value because the city relies on sewer rate revenue for sewer funds, not property taxes.

Table 10-13 Property Tax Collection Efficiency

Item	Value
Property tax revenue collected (2016)	$92,186,010
Property taxes levied (2016)	$92,836,780
Property tax revenue collection rate	99.3%
Tax Collection Efficiency Indicator Score	3

10.6.4 Summary of Financial Impact Indicators

Table 10-14 shows the USEPA's Phase 2 Financial Impact Indicator benchmarks used to evaluate the six indicators. The indicators are shown in the left-hand column. The corresponding USEPA benchmarks for each indicator are shown for "strong", "mid-range" or "weak" ratings. The highlighted boxes in this table indicate where the city falls within the framework of these indicators.

Table 10-14 Financial Impact Assessment Benchmarks

Indicator	Strong (Score=3)	Mid-Range (Score=2)	Weak (Score=1)
1. Bond Rating	AAA to A (S&P) or	BBB (S&P) or	BB to D (S&P) or
	Aaa to A (MIS)	Baa (MIS)	Ba to C (MIS)
2. Overall Net Debt	Below 2 percent	2 percent to 5 percent	Above 5 percent
3. Unemployment Rate	>1 percent below National Average	±1 percent of National Average	>1 percent above National Average
4. Median Household Income	>25 percent above adjusted National MHI	±25 percent of adjusted National MHI	>25 percent below adjusted National MHI
5. Property Tax Revenue	Below 2 percent	2 percent to 4 percent	Above 4 percent
6. Property Tax Collection Rate	Above 98 percent	94 percent to 98 percent	Below 94 percent

The values and scores of the six indicators for Haverhill are summarized in Table 10-15. An overall (average) score below 1.5 is considered weak and an overall score above 2.5 is considered strong. An overall score between 1.5 and 2.5 is considered mid-range. Overall, for Haverhill, the un-weighted average score for the Phase 2 evaluation is 2.7, which falls in the strong range of the financial capability scale.

As mentioned, in Massachusetts, Proposition 2 ½ caps on property tax growth, limiting the amount of revenues that can be generated through property taxes. Therefore, the inclusion of the property tax revenue as a percent of full market property value skews the Phase 2 score slightly upwards. If the property tax revenue indicator is removed, the city's overall score is 2.6.

Table 10-15 Financial Impact Assessment Summary

Financial Impact Indicator	Value	Score with Indicator Five	Score without Indictor Five
1. Bond rating	A1/AA	3	3
2. Overall net debt as a percent of property value	1.27%	3	3
3. Unemployment rate compared with national average	0.1% above	2	2
4. Median household income compared with national average	13.0% above	2	2
5. Property tax revenue as a percent of property value	1.60%	3	—
6. Property tax collection rate	99.3%	3	3
Overall Financial Impact Indicator Score		**2.7**	**2.6**

10.7 Conclusions

The city and its residents/customers face major challenges as it seeks to provide required, reliable, safe city services, comply with various regulatory initiatives and make significant investments in public facilities and infrastructure. As described, the city anticipates investing more than $72 million in renovations and upgrades to its wastewater system. In addition, to comply with CMOM requirements and MS4 permits, the city anticipates its cost to operate and maintain its sewer system will increase by approximately $2.3 million annually, an increase of nearly one-third. These requirements plus the anticipated increase in operating and maintenance costs as the system ages and cost bases increase will result in the city facing annual rate increases averaging over 12 percent through FY 2022 and 8 percent through FY 2027. The city is concerned that rate increases of this magnitude will cause material economic and financial dislocations.

Under the city's recommended schedule, all residents will have their annual bill double within 8 years and increase by approximately 120 percent in 14 years. These level of rate increases are concerning for the median household, but the impact will be felt differentially across the customer base. Households in the lowest quintile will experience rapid and sustained increases that will drive annual bills well above USUSEPA's high burden threshold of 2 percent of median household income. Obviously, these residents have the lowest ability to absorb such increases.

However, the affordability burden must be broadened beyond just the costs for sewer services. As noted, the city's residents already face a significant housing cost burden. Using the Census Bureau's benchmark that housing costs exceeding 30 percent is a high burden, currently, nearly 40 percent of residents are already experiencing a high burden; this is a 20 percent higher rate than for the country as a whole. The anticipated increases in the city's sewer rate will increase the housing burden borne by city residents and the number of households experiencing high burdens.

As noted, the city and its residents will also need to address improvements to its water system and other infrastructure and facilities. The planned water system improvements are estimated to increase the city's projected water bills by an average of $250 per year for the typical residential customer.

Given the broader challenges facing the city and the related affordability concerns, the city believes that a shorter implementation period than that recommended by the city will compound the economic and financial challenges the city faces.

Section 11

Supplemental Environmental Impact Report/Environmental Impacts

11.1 MEPA History

In November 1999, the city of Haverhill filed an Environmental Notification Form (ENF) with the MEPA Unit of the Executive Office of Energy and Environmental Affairs (EEA) for its then Phase I Long-Tern CSO Control Plan, EOEA No. 12088. MEPA determined that the project required the preparation of an Environmental Impact Report (EIR) (Certificate issued on December 23, 1999).

Subsequently, the city completed its Draft (Phase I) Long-Term CSO Control Plan and Draft EIR. The Draft EIR was submitted to MEPA on October 15, 2000, but it was later withdrawn to allow for the city's reconsideration of the recommended plan. A Revised Draft (Phase I) Long-Term CSO Control Plan and Draft EIR were completed and submitted to MEPA in January 2002. The Final EIR to the Revised Draft Long-Term CSO Control Plan was submitted August 2002. Upon review, MEPA later deemed this EIR "inadequate".

Subsequently, the USEPA and MADEP ordered the city to complete a Phase II LTCP. The Phase II CSO Long-Term Control Plan was submitted to the USEPA and MADEP in July 2011. An EIR was not completed for the Phase II LTCP.

This document is Haverhill's Final CSO Long-Term Control Plan (FLTCP) and replaces the Phase II LTCP. The development of this document was required by a November 2016 Consent Decree filed by the U.S. Department of Justice. During Consent Decree negotiations, MADEP requested that the city prepares a Supplemental EIR (SEIR) to be submitted with its FLTCP. This section is intended to meet MADEP's SEIR requirement.

It is important to note that, based on a review of MEPA's regulations, the city's FLTCP would not exceed any of the review thresholds listed in 301 CMR 11.03. Therefore, MEPA review may not be required for the current set of improvements included in this FLTCP. The MEPA review applicability status for this project has changed as MEPA regulations and the city's CSO control plan components and complexity have changed. The city is planning to use State Revolving Funds (SRF) for the design and construction of the FLTCP.

Accordingly, this SEIR is being submitted to address MADEP requirements. It is fully expected that, upon review of the current project recommendations, that MEPA should be in agreement that this project no longer triggers a requirement for an EIR.

This SEIR describes the impacts associated with the FLTCP as well as impacts for the alternatives considered when selecting the FLTCP. Each of the alternatives was reviewed using the following key assessment criteria: effectiveness in mitigating CSOs, environmental impacts, and social and institutional impacts. All the alternatives considered offer long-term environmental benefits due to improved CSO control and treatment, but they also have short-term construction-related impacts. Mitigation measures necessary to avoid and minimize these impacts are also discussed in this section.

11.2 Assessment Criteria

The following criteria consider issues related to the construction of planned facilities and the potential impacts to surrounding neighborhoods and environmental resources during the construction phase of the FLTCP and for the alternatives considered when selecting the FLTCP. In terms of construction impacts, primary items of concern include the short-term direct environmental impacts associated with construction equipment including noise, truck and construction worker traffic, and fugitive dust emissions. Other issues assessed include the proximity of work to sensitive receptors (e.g., residential areas, schools, nursing homes, and hospitals), and the potential for direct alteration to wetland resource areas and protected habitat. Discussion of the assessment is presented below in Sections 11.3 for the FLTCP and in Sections 11.4 through 11.6 for the alternatives considered. Figures 11-1 through 11-4 shows the MassGIS environmental resource layers for wetlands, floodplain, priority habitat of rare species and estimated habitat of rare wildlife, and protected open space in relation to the proposed FLTCP and the alternatives.

11.2.1 Effectiveness in Mitigating CSO

Three criteria were considered to evaluate effectiveness in mitigating CSO impacts. These typically reflect positive environmental benefits and included: impact on CSO flow volume and frequency and percent capture.

11.2.2 Environmental Impacts

Direct, typically long-term, permanent impacts (if unmitigated) associated with the alternatives would include impacts to wetland resource areas including flood plains; surface water and groundwater quality and hydrology; natural lands and potential impacts to habitat value including habitat containing rare and endangered species.

11.2.3 Social and Institutional Impacts

Social and institutional impacts considered permanent impacts to significant historical and archaeological resources, protected open space and recreation, and zoning. It also considered short-term direct impacts associated with construction and included noise, truck and construction worker traffic, and fugitive dust emissions. Other issues assessed include the proximity of work to sensitive receptors (e.g., residential areas, schools, nursing homes, and hospitals).

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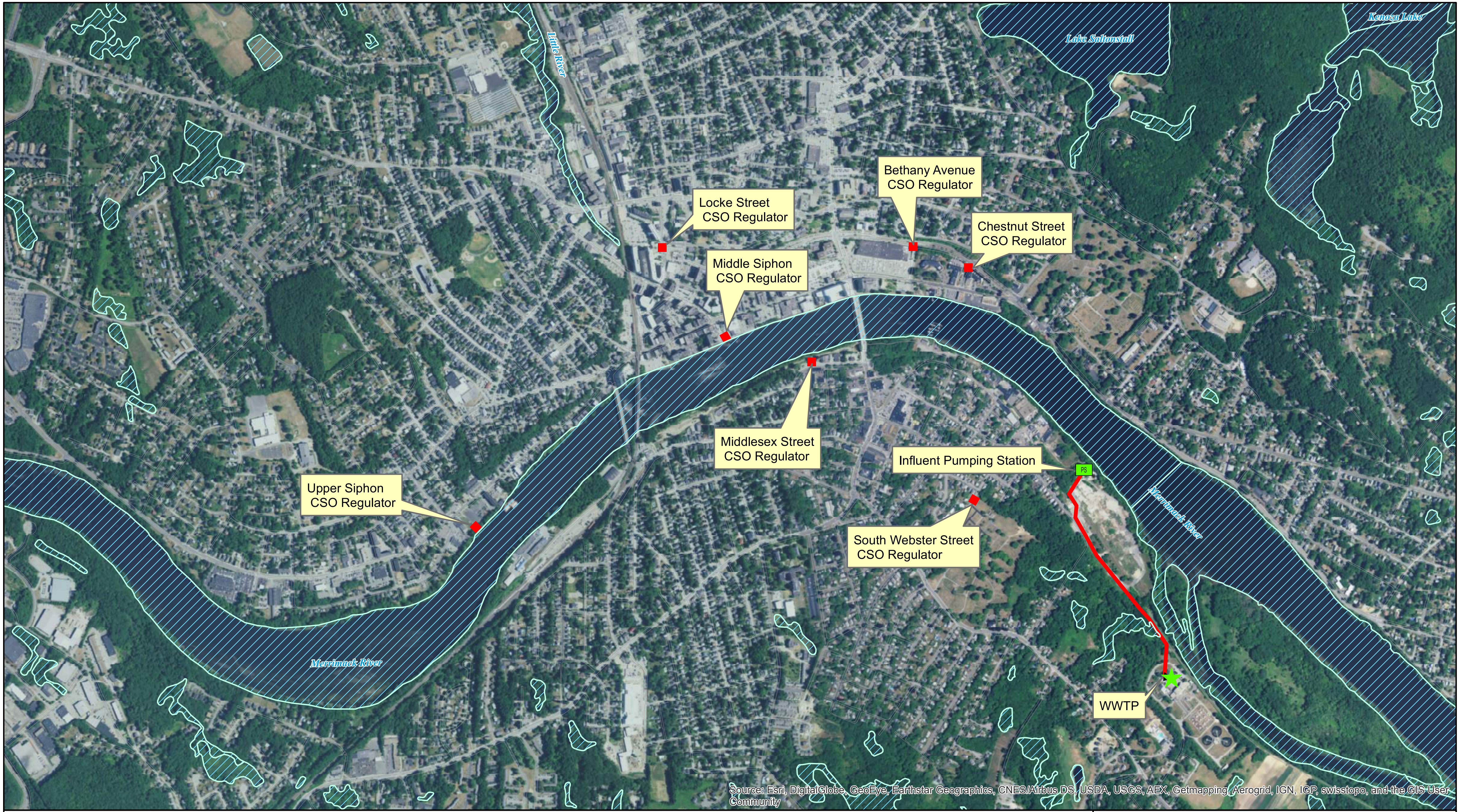

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Legend

- CSO Regulator Structure
- Influent Pumping Station
- Wasterwater Treatment Plant
- Influent Force Main
- Wetlands

0 1,080 Feet

City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

Wetlands Map
Figure 11-1

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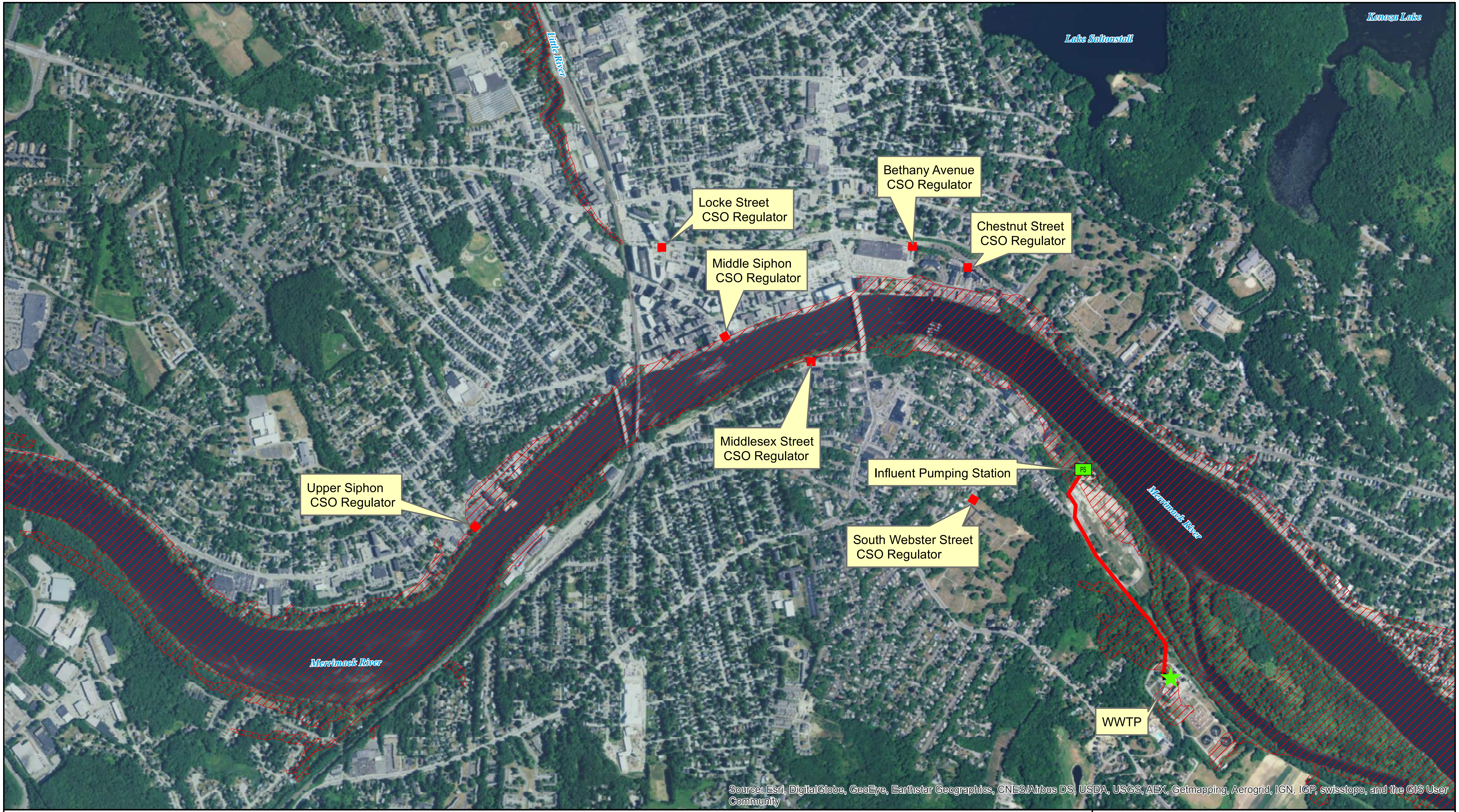

Legend

- CSO Regulator Structure
- Influent Pumping Station
- Wastewater Treatment Plant
- Influent Force Main
- 100 Year Flood Zone

0 — 1,140 Feet

City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

FEMA Flood Zone Map
Figure 11-2

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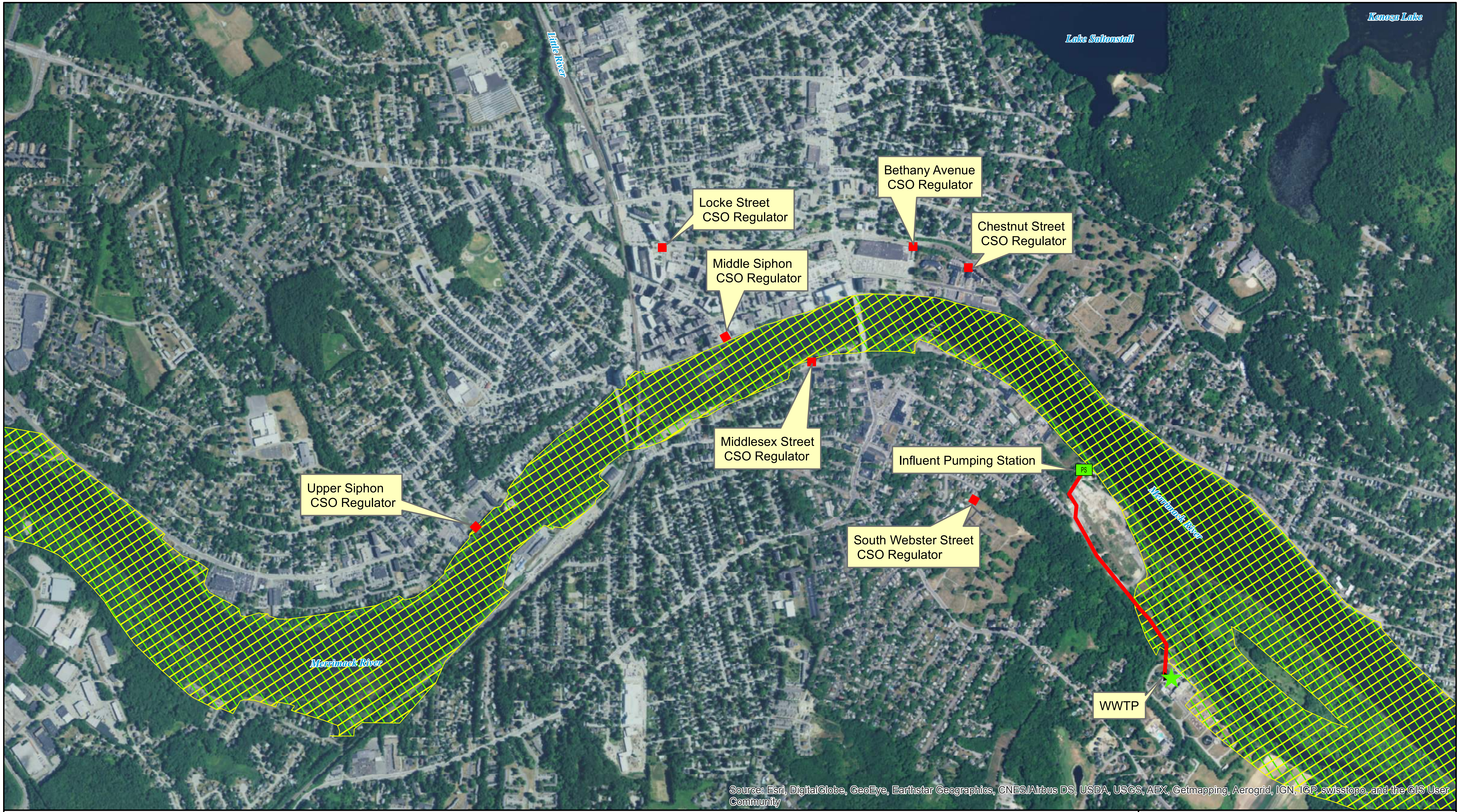

Legend

- CSO Regulator Structure
- Influent Pumping Station
- Wasterwater Treatment Plant
- Influent Force Main
- Vernal Pool
- NHESP Priority Habitats of Rare Species
- NHESP Estimated Habitats of Rare Wildlife

0 1,200 Feet

City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

Estimated Habitats Map
Figure 11-3

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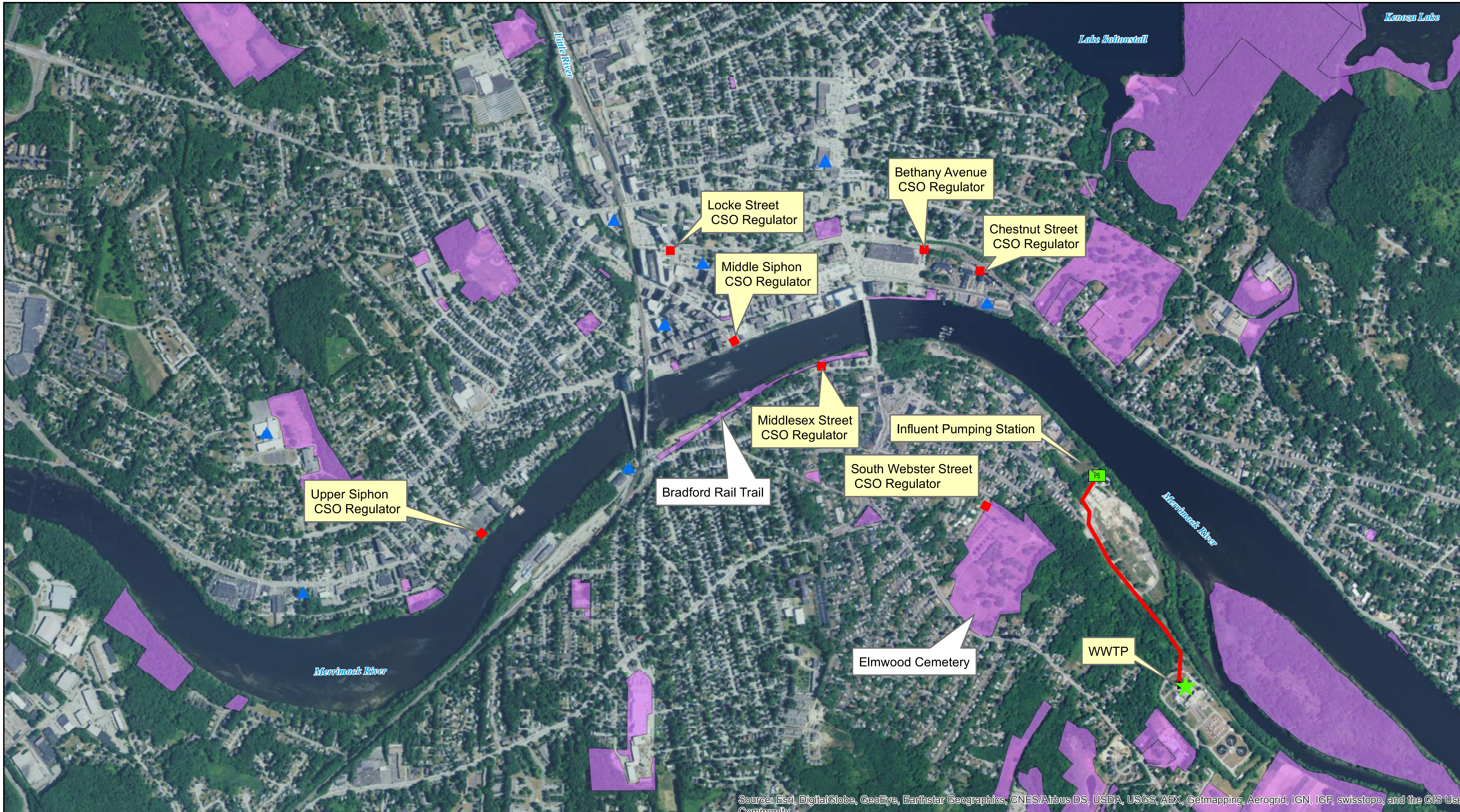

Legend

- CSO Regulator Structure
- Influent Pumping Station
- Wastewater Treatment Plant
- Influent Force Main
- C21E Site
- Protected Open Space

0 1,100 Feet

City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

Protected Open Space and C21E Sites Map
Figure 11-4

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11.3 FLTCP – Recommended Plan

Section 5 discussed the current federal and state CSO policy regulations. CSOs are subject to both the technology-based and water-quality based requirements of the CWA. The technology-based requirements are the nine minimum controls which the city of Haverhill continues to comply with. Beyond the implementation of these nine minimum controls, the city of Haverhill is committed to moving forward with a CSO abatement plan that will have a positive impact on water quality and use of the Merrimack and Little Rivers. The city is committing to proceed with the following improvements:

- Interceptor conveyance improvements;
- CSO regulator dry weather connector pipe improvements;
- CSO regulator weir modification at Middle Siphon CSO;
- Completing post construction compliance monitoring & system optimization;
- Implementing a green infrastructure demonstration project; and
- Locke Street interceptor area preliminary design and improvements, which includes upstream sewer separation and/or the construction of the Locke Street storage facility.

Figure 11-5 shows the locations of the proposed improvements of the FLTCP as well as of the alternatives. Note that the majority of the proposed work is located within or adjacent to existing facilities.

11.3.1 Effectiveness in Mitigating CSO

The city's FLTCP will reduce CSO discharge frequencies to no more than four times average per year and annual average CSO volume will be reduced from 20 MG to 12 MG. The city's FLTCP will meet the Massachusetts Water Quality Standard of B_{CSO}/SB_{CSO} for the Merrimack River and Little River in Haverhill.

11.3.2 Environmental Impacts

The FLTCP involves several construction projects throughout the city that occur primarily in or around existing facilities and/or along existing city streets. Some of the projects include pipeline and facilities construction that will require excavation, but it is expected that these projects will be in previously disturbed areas (existing facilities, paved streets and parking lots) and will not result in an increase in impervious area

Some of the work will be at existing collection system facilities located within the 200-foot Riverfront Area of the Merrimack River and the Little River, and the 100-Foot Buffer Zone to Inland Bank. However, Best Management Practices (BMPs) will be followed to protect nearby wetlands and waterways during construction. The mitigation measures to protect and restore any short-term impacts that occur near wetlands and waterways are discussed in Section 11.8.

Interceptor Conveyance Improvements

There are no environmental impacts associated with interceptor conveyance improvements. This work involves mostly pipe cleaning along city streets and CSO regulator structures.

CSO Regulator Dry Weather Connector Pipe Improvements

Dry weather pipe improvement is proposed at Middlesex Street, Bethany Avenue, Chestnut Street and South Webster Street CSOs. Most of this work will take place along existing city streets with the exception of the work at Middlesex Street CSO.

Middlesex Street CSO is located on Middlesex Street and south of the Merrimack River. The site is within Special Conservation and Residential Urban Density zoning districts. It is surrounded by vacant land, residential, and commercial properties. There are no vegetated wetlands adjacent to the Merrimack River on site, see Figure 11-1. However, the site is within the 100-foot Buffer Zone and the 200-foot Riverfront Area to the Merrimack River. Work at the Middlesex Street CSO will temporarily impact Riverfront Area and buffer zones and would require review and approval by the Haverhill Conservation Commission.

The Middlesex Street CSO is located within the 100-year floodplain elevation of 21.2 feet (NAVD88), see Figure 11-2. Part of the construction is also in close proximity to mapped Priority Habitat of Rare Species and Estimated Habitat of Rare Wildlife, see Figure 11-3. The Merrimack River corridor is known to provide overwintering habitat to bald eagles (*Haliaeetus leucocephalus*) and the river supports shortnose sturgeon (*Acipenser brevirostrum*). The new dry weather connector pipe will be installed in the same location as the existing pipe (see Figure 8-3). It will be constructed entirely underground with the land restored to pre-construction conditions. Best management practices (BMPs) will be followed to protect nearby wetlands, waterways and priority habitat during construction. The dry weather pipe improvements at the Middlesex Street CSO will not result in a "take" of a state listed protected species since there will be no work within the Merrimack River impacting the shortnose sturgeon and no tree removal impacting bald eagle overwintering habitat. The Massachusetts Natural Heritage Program (NHESP) will review the Notice of Intent filed with the Haverhill Conservation Commission as part of the 30-day streamlined review under the Massachusetts Endangered Species Act (MESA)/Mass Wetlands Protection Act (WPA).

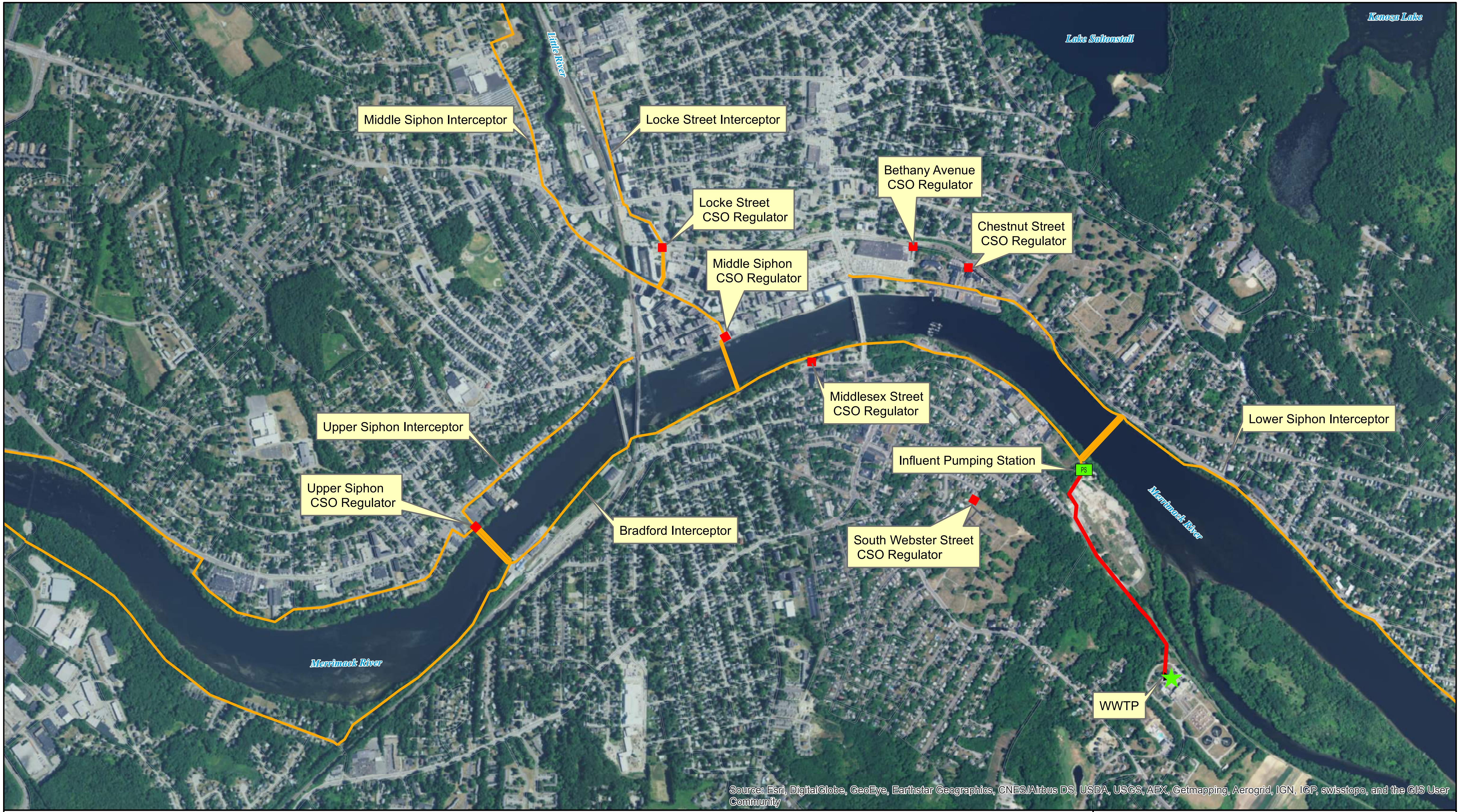
Bethany Avenue, Chestnut Street, and South Webster CSO are located on city streets. Construction at this site will not impact any natural resource. The dry weather connector pipe improvements for these regulators would be typical of other utility replacement projects and would be conducted along city streets, which are previously disturbed areas. In road construction will have minor construction impacts (i.e. traffic, noise, dust) but these would be mitigated with typical best management practices.

CSO Regulator Weir Modification at Middle Siphon CSO

Weir wall modification at Middle Siphon CSO will be completed within the existing structure. Accordingly, there are no expected environmental impacts.

Post-Construction Compliance Monitoring & System Optimization

Will not have any environmental impacts.



Legend

- CSO Regulator Structure
- Influent Pumping Station
- Wasterwater Treatment Plant
- Influent Force Main
- Interceptor Pipe

0 — 1,200 Feet

City of Haverhill, Massachusetts
Integrated Final CSO Long-Term Control Plan
February 2017

FLTCP and Alternatives Improvement Locus Map
Figure 11-5

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Green Infrastructure Projects
Implementing green infrastructure practices such as vegetated bioretention areas, porous pavers, and bioswale systems require excavation and will have some construction period impacts but these would be mitigated with typical best management practices. The sites the city has identified for potential green infrastructure locations are shown in Figure 11-6; these sites are in previously disturbed areas away from wetlands. Based on MassGIS natural resource layers' verification, none of the sites is expected to impact, wetlands, flood zones or rare species/wildlife habitat.

Locke Street Interceptor Area Preliminary Design and Improvements
There are no significant environmental impacts associated with the Locke Street Interceptor improvements. The areas around Locke Street CSO and upstream contributory areas (Winter Street, and Winter and Hale CSO) are located within the Commercial Central, Urban Density Residential and High-Density Residential zoning districts, and are made up of multi-family residential, commercial and industrial properties.

Sewer separation work will take place along existing city streets and city utility easements. The plan to separate the areas would utilize existing Winter and Hale CSO (NPDES 021H) and Locke St CSOs (NPDES 021D/021E) outfalls so that new outfalls would not have to be constructed. This would eliminate potential wetland resource area impacts along the river bank unless modifications to the existing outfall structure would be required. Sewer separation would be designed consistent with the goals of MassDEP's Stormwater Management Standards to control water quality of surface water runoff.

The construction of the Locke Street storage tank would be on a previously disturbed site, currently used a parking lot, that is not adjacent to any wetlands or other sensitive receptors, see Figures 11-1 thru 11-4. The construction impacts related to either of these projects would be temporary and could be mitigated with typical best management practices.

11.3.3 Social and Institutional Impacts

The FLTCP improvements are not expected to adversely impact neighboring areas. Most of the work in the FLTCP will be in mixed-use zoning areas with few sensitive receptors.

There is no new construction required for the interceptor conveyance system improvements as the work only involves maintenance work. Minor social and institutional impacts are expected from traffic detours, noise, and residential/service disruptions. This is also the case for the proposed weir modification at Middle Siphon CSO.

Work along city streets due to dry weather connector pipe improvements and sewer separation projects will be typical of other utility construction projects. Construction noise, traffic detours, and fugitive dust emissions associated with temporary construction impacts to residential properties adjacent to the facilities or along the access roads to these facilities would be short term and minimal. Restricting construction to daytime hours (7 a.m. to 5 p.m.) will mitigate construction noise. Truck traffic access to the project areas would be by regular street access along major thoroughfares. Construction vehicle traffic would not require mitigation as all staging and truck queuing would occur at the facility sites. In addition, the number of construction vehicles generated by the proposed work is not expected to be significant.

Project notification forms will be submitted to the Massachusetts Historical Commission (MHC) requesting their review of the proposed work in the FLTCP to make any further determination regarding the impacts to historical and archaeological sensitive resources.

The installation of the dry weather connector pipe construction at Middlesex Street CSO will temporarily impact the Bradford Rail Trail, see Figure 11-4. As noted above, the new dry weather pipe will be constructed entirely underground with the disturbed land restored to pre-construction conditions. The construction at South Webster Street CSO is adjacent to Elmwood Cemetery, but will not impact use or access to the property.

11.4 No Action

The No-Action alternative is to continue with the present system without structural modifications for CSO control. The city would continue with its current BMPs as recommended by the Nine Minimum Controls Report and the CMOM Corrective Action Plan (described in Section 3 and Section 8, respectively).

11.4.1 Effectiveness in Mitigating CSO

The city would continue to capture and treat approximately 98 percent of wet weather flow annually and the average annual CSO volume would remain at about 20 MG per year.

11.4.2 Environmental Impacts

This alternative would not result in any changes to the environment over existing conditions. There would be no impacts from construction of the new piping or facilities.

11.4.3 Social and Institutional Impacts

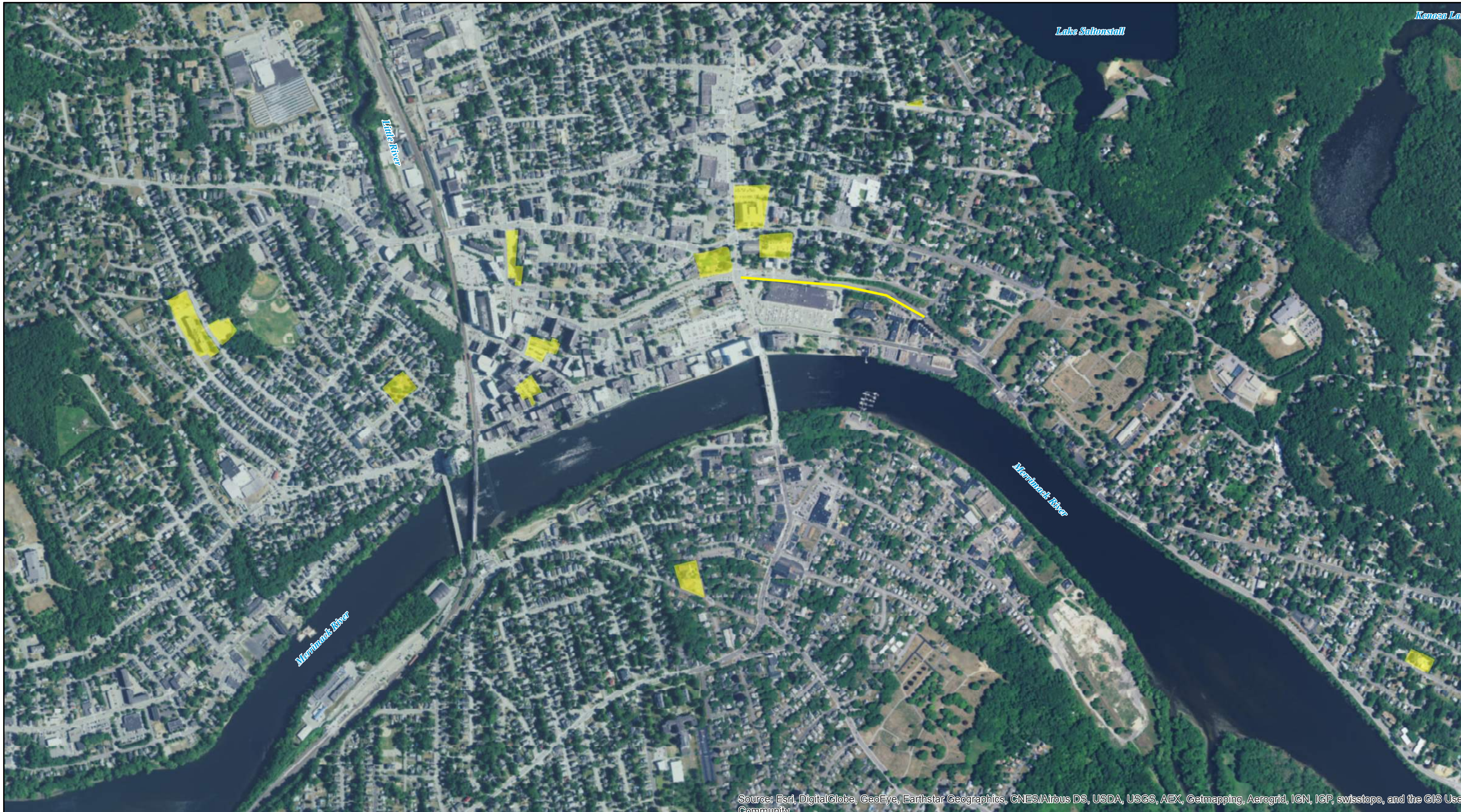
This alternative would not result in any changes to the social and institutional criteria over existing conditions. There would be no impacts from construction of the new piping or facilities.

11.5 Intermediate Design Controls

Full compliance with water quality standards typically means that CSO discharges must be eliminated. This is a costly proposition for any community. For this reason, a range of intermediate control alternatives was considered for the city. Intermediate design control levels are intended to establish a balance between meeting the water quality standards and allowing occasional excursions from the standard. Intermediate design control is based on the six design storms identified in Section 3 (i.e., 1-Month, 3-Month, 6-Month, 1-year, 2-year, and 5-year). Several control alternatives were considered to achieve the 1-month through 5-year design control level.

The city's FLTCP is based on intermediate design control, it achieves the 3-month level of control. Some of the improvement/modification projects included in the other intermediate control level plan are the same as those included in the FLTCP but in larger or smaller scale. The impact assessment for the FLTCP improvement is discussed in Section 11.3 above. The impact assessment of the remaining intermediate control improvements is discussed in the paragraphs below. These alternative improvements include:

- WWTP wet weather capacity improvements;



Legend

- CSO Regulator Structure
- Influent Pumping Station
- Wasterwater Treatment Plant
- Influent Force Main
- Interceptor Pipe

0 880 Feet

City of Haverhill, Massachusetts
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Potential Green Infrastructure Sites
Figure 11-6

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- System I/I reduction improvements;
- Real-time control system optimization; and
- Satellite storage facilities at Middle Siphon and Upper Siphon CSO facilities.

11.5.1 Effectiveness in Mitigating CSO

The annual average CSO reduction achieved by each of the intermediate control level plans is summarized in Table 7-9 in Section 7.

11.5.2 Environmental Impacts

WWTP Wet Weather Capacity Improvements
The WWTP wet weather improvements construction would occur at the existing influent pumping station, existing force main route and WWTP, see Figure 11-7. Work proposed at the influent pumping station would involve the connection of a new parallel 36-inch diameter influent force main and improvements to the existing pumps. The majority of this work would be within or in the immediate vicinity of the existing pumping station and would not impact wetlands, priority or estimated habitats, see Figures 11-1 and 11-3. The existing influent pumping station is located within the 100-year floodplain, see Figure 11-2, however since the proposed work would be the installation of below-ground piping and replacement/improvements of existing pumps it would not have a permanent effect on the levels or extent of flood flows.

The construction of the new 36-inch diameter parallel force main from the existing influent pumping station to the WWTP would involve work adjacent to wetlands, and within the 100-year floodplain (Bordering Land Subject to Flooding) and priority and estimated habitats, see Figures 11-1 through 11-3. There will not be a permanent effect on the levels or extent of flood flows since the force main will be constructed entirely underground with the disturbed land restored to pre-construction conditions. It is also not expected that the proposed construction would impact overwintering habitat of the bald eagle since the majority of the force main would be installed within or immediately adjacent to an existing 30-ft wide cleared utility easement the construction is not anticipated to require clearing of large trees. Best management practices would be followed to protect sediment from entering adjacent wetlands and the Merrimack River during construction.

Any proposed work at the WWTP would be located within the existing plant site and outside of wetland resource areas, see Figure 11-1. Portions of the existing WWTP site is, however, location within the 100-year floodplain, see Figure 11-2. Increasing treatment capacity at the WWTP would require the construction of a forth primary tank and may result in a permanent alteration to the 100-year floodplain. Compensatory flood storage would be provided for any fill placed in the 100-year floodplain. No tree clearing would be required and therefore impacts to bald eagle overwintering habitat mapped along the Merrimack River (see Figure 11-3) is not anticipated,

Since the work associated with the improvements at the WWTP, the influent pumping station, and the new 36-inch parallel force main is within the Haverhill Conservation Commission's jurisdiction (i.e. within Bordering Land Subject to Flooding, 200-foot Riverfront Area and/or Buffer Zones) an Order of Conditions under the Massachusetts Wetlands Protection Act (MWPA) and the City Wetlands Ordinance (Ordinance) would be required.

A Notice of Intent will be submitted to the Haverhill Conservation Commission describing the work, the best management practices that will be implemented to prevent impacts to wetland resources during construction, including the use of appropriate sedimentation and control measures, and showing how the design complies with the performance standards of the MWPA and the Ordinance, and

System I/I Reduction Improvements
The I/I reduction improvements would require some construction including excavation. This work would be typical of other utility replacement/rehabilitation projects and would be conducted along city streets (or utility easements) within previously disturbed areas. Necessary local permits would be obtained and mitigation measures would be followed to complete the work.

Real-time Control System Optimization
Will not have any environmental impacts.

Satellite Storage Facilities at Middle Siphon and Upper Siphon CSO
The Middle Siphon storage facility would be constructed in a municipal parking lot located in city's downtown located within the 100-foot Buffer Zone of the bank of the Merrimack River. The existing facility is separated from the river by an existing flood wall. Therefore, no impacts to the Merrimack River is expected.

The Upper Siphon storage facility would be constructed in a paved parking lot located on River Street. The site is located in a mostly commercial area. There are no vegetated wetlands on site, however, the site does borders the Merrimack River, and proposed work would temporarily alter the 100-foot Buffer Zone and 200-ft Riverfront Area. The work would also temporarily alter the 100-year flood zone located at about 23.0-feet (NAVD88).

The construction impacts related to the Middle Siphon and Upper Siphon storage facilities would be temporary and be mitigated with typical best management practices. The storage facilities will be constructed entirely underground with the land restored to pre-construction conditions resulting in no long term permanent impacts to wetland resource areas or Buffer Zones.

11.5.3 Social and Institutional Impacts

The improvements discussed above are not expected to adversely impact neighboring areas. Noise, traffic and land use issues are all on or adjacent to the existing WWTP, the influent pumping station or CSO regulator structures. Work along city streets as part of I/I reduction improvements would be typical of other similar utility construction projects. Noise, traffic and fugitive dust emissions associated with temporary construction impacts to residential properties adjacent to the project areas or along the access roads to these facilities would be short term and minimal. Restricting construction to daytime hours (7 a.m. to 5 p.m.) would mitigate construction noise. Truck traffic access to the WWTP, influent pumping station and CSO regulator structures would be via regular street access along major thoroughfares. Construction vehicle traffic would not require mitigation as all staging and truck queuing would occur on site. In addition, the number of construction vehicles generated by the proposed work is not expected to be significant.

CDM Smith

Legend

- CSO Regulator Structure
- Influent Pumping Station
- Wasterwater Treatment Plant
- Influent Force Main

0 350 Feet

City of Haverhill, Massachusetts
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February 2017

Influent Pumping Station and WWTP
Figure 11-7

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The improvements discussed would not impact any protected open space areas.

If the city decides to move forward with any of these projects MHC would be notified of the proposed work to make any further determination regarding impacts to historical and archaeological sensitive features.

11.6 Complete Elimination of CSOs

The last alternative the city considered was the complete elimination of CSOs by separation of the combined system. In order to completely eliminate the wet weather system in the city, 1500 acres of combined sewers would need to be separated. A SWMM simulation performed to consider the benefits of a full separation plan, showed that CSO discharges still remain in the Haverhill system during some design storm control levels. Table 7-1 shows the results of this analysis. To completely eliminate CSO discharges in Haverhill, additional control strategies would be required.

The additional control strategies to make sewer separation effective for complete elimination of CSO discharges could either be more effective sewer separation (i.e., enhanced removal of private inflow), additional conveyance to bring flow downstream, or satellite storage facilities.

11.6.1 Effectiveness in Mitigating CSO

Sewer separation significantly reduces the amount of wet weather flow from the sewer system, eliminating the potential that sanitary waste is discharged during a storm. All sanitary waste in a separated area is treated at the WWTP.

11.6.2 Environmental Impacts

As noted before, there are no significant long-term environmental or facility siting challenges associated with the construction of new drains or sewers to complete separation of the combined sewer system. All the work would take place within existing city streets and/or easement corridors. Existing CSO outfalls would be used so that new ones would not have to be constructed, which would eliminate potential wetland resource area impacts along the Merrimack River bank. Minor short-term construction impacts due to the sewer separation projects would be mitigated with typical best management practices.

Any additional conveyance to bring flow downstream or satellite storage facilities would be within city street and on the sites previously discussed above.

11.6.3 Social and Institutional Impacts

Sewer separation projects in most areas of the city are not expected to adversely impact neighborhoods. All the work would take place within existing city streets and/or easement corridors. Noise, traffic and fugitive dust emissions associated with temporary construction impacts to residential properties near the project areas would be short term and minimal. Sewer separation of the downtown portions of the city could be a challenge considering the potential conflicts with other existing underground utilities. In addition, there could also be significant, short-term, construction impacts from the disruption of vehicle and pedestrian traffic in heavily urbanized areas. However, construction impacts will be temporary and could be minimized by implementing mitigation measures to address construction vehicle traffic, detours, noise and air pollution, and residential/commercial service disruptions.

11.7 Statutory and Regulatory Standards and Requirements

A number of environmental permit approvals will be needed to construct and operate the FLTCP and/or the alternatives proposed in this report. This section presents an overview of the anticipated regulatory requirements.

At a minimum, it is expected that the following federal and state environmental permits and approvals will be needed:

- DEP Sewer Extension Permit for construction of new sewers;
- Order of Conditions from the Haverhill Conservation Commission under the MWPA and Ordinance for work in wetland resource areas (i.e. Riverfront Area, Bordering Land Subject to Flooding/100-yr floodplain) and within the 100-foot Buffer Zone to Inland Bank and Bordering Vegetated Wetlands;
- National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) or Dewatering General Permit (GP) for stormwater discharges or dewatering discharges during construction.
- Project Notification Form (PNF) with MHC under with Section 106 of the National Historic Preservation Act (NHPA). It is not anticipated work in the FLTCP will affect historical or archaeological significant resources since all work is within areas that are previously disturbed.
- Massachusetts Endangered Species Act (MESA) review by the Massachusetts Natural Heritage and Endangered Species Program.
- U.S. Army Corps of Engineers Massachusetts General Permit for placement of fill in Waters of the U.S. (only required if there will be outfall modifications)
- Possible highway access approval from the Mass DOT for work on state roads.

In addition to the above, there may be local approvals that must be obtained to comply with city Ordinances.

11.8 Mitigation Measures

The implementation of the FLTCP will result in long-term environmental benefits due to improved CSO control with some short-term, minor construction-related impacts. The mitigation measures listed below will avoid or minimize those impacts.

11.8.1 Siting

- Where proposed, new structures (new storage facilities) will be sited where the least visual and environmental impacts are anticipated;

- The city will continue to coordinate with MHC to assure that there will be no impacts to historical or archaeological significant resources for work proposed as part of the FLTCP;
- No work will be performed within Bordering Vegetated Wetlands, Inland Bank, or Land Under Water. Work is limited to the 100-year floodplain regulated as Bordering Land Subject to Flooding, 200-foot Riverfront Area, and the 100-foot Buffer Zone; and
- Ownership, easements, and access permits as applicable will be obtained prior to

11.8.2 Design

- If any work is performed within the 100-year floodplain (i.e. Bordering Land Subject to Flooding), the work will be designed so that there will not be a permanent effect on the levels or extent of flood flows;
- The design and construction will comply with the Massachusetts Stormwater Management Standards; and
- Applicable licenses and permits will be obtained based on which alternative is chosen prior to construction at each location, and the conditions of these licenses and permits will be followed.

11.8.3 Construction (Wetlands, Noise, and Traffic)

Wetlands

Adherence to performance standards for work within wetland resource areas, including sedimentation and erosion control measures, will be sufficient mitigation to avoid impacts to wetland resource areas. The following mitigation measures will be implemented to protect and restore any short-term impacts that occur near wetlands and waterways.

- Any work within the 200-foot Riverfront Area and the 100-Foot Buffer Zone to Inland Bank and Bordering Vegetated Wetlands will be mitigated through the use of appropriate sedimentation and erosion control measures. Staked compost logs will be installed at the limit of work prior to the commencement of work to prevent the transport of sediment to downgradient wetlands or waterways during construction. The compost log barrier will be inspected weekly and after all storm events and repaired as needed. The barrier will be left in place until the area is permanently stabilized. Compost logs will be replaced as necessary due to sediment build-up and degradation;
- If stockpiling is necessary, stockpiled soils will be enclosed within a line of compost logs to prevent erosion or siltation into resource areas;
- It is not anticipated that contaminated soils will be encountered, however, any contaminated soils encountered exceeding on-site reuse limits will be handled and disposed of in accordance with applicable federal, state, and local regulations;
- Storm drain inlet protection will be provided for all storm drains that will collect runoff from the work area. This protection will prevent sediment from entering the storm drain system and being conveyed to wetlands or waterways;

- Work will proceed as rapidly as possible. Limiting the exposure time of disturbed soils to wind and precipitation will minimize the soil erosion and subsequent sedimentation;
- All disturbed soils in will be permanently stabilized with an erosion control seed mix or paved. Grassed areas will be maintained and re-seeded to ensure that at least 80 percent ground coverage is achieved;
- The compost log barrier will not be removed until a vegetative cover dense enough to prevent erosion is established in the work area; and
- Any areas disturbed due to construction related activities will be restored to pre-construction conditions.

Fugitive Dust Control

- Dust control during construction at each location will be achieved through standard mitigation measures, including regular watering of construction sites. In addition, where necessary, construction trucks will use the paved access road to and from each site.

Noise

- Where construction will take place in close proximity to residential neighborhoods or other sensitive receptors, construction noise will be mitigated by restricting construction to daytime hours (7 a.m. to 5 p.m.).

Traffic

- Construction-related traffic will be minor. The number of construction vehicles generated by each alternative is not expected to be significant enough to warrant mitigation measures. However, if necessary, a traffic management plan will be developed by the contractor prior to construction based on the chosen alternative. Mass DOT approval will be obtained for work on state roads, as necessary.

11.9 Summary

This SEIR section has been completed as part of the development of the FLTCP as requested by MADEP. The FLTCP and each of the alternatives was reviewed using key assessment criteria to determine impacts to surrounding neighborhoods and environmental resources during the construction. Mitigation measures necessary to avoid and minimize these impacts were also discussed. If this FLTCP is approved by USEPA and MADEP, the city will move forward with the implementation of the recommended plan.

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

UNITED STATES OF AMERICA, Plaintiff, COMMONWEALTH OF MASSACHUSETTS, Plaintiff-Intervenor, v. CITY OF HAVERHILL, MASSACHUSETTS, Defendant.	CIVIL ACTION NO. 16-11698-IT

CONSENT DECREE

TABLE OF CONTENTS

WHEREAS, the City of Haverhill, Massachusetts (the "City") discharges pollutants into navigable waters of the United States from a publicly owned treatment works ("POTW") treatment plant that it owns and operates on South Porter Street in Haverhill, Massachusetts, pursuant to National Pollutant Discharge Elimination System ("NPDES") Permit No. MA0101621 (the "POTW Permit"), which was jointly reissued by the plaintiff the United States of America (the "United States" or "U.S.") and the plaintiff-intervenor the Commonwealth of Massachusetts (the "Commonwealth") on December 5, 2007, and which became effective on February 1, 2008;

WHEREAS, the City also discharges pollutants into navigable waters of the United States from combined sewer overflow ("CSO") discharge points pursuant to the POTW Permit;

WHEREAS, the City also discharges pollutants into navigable waters of the United States from a regulated small municipal separate storm sewer system ("MS4") pursuant to NPDES Permit No. MAR041197 (the "Small MS4 General Permit"), also issued jointly by the United States and the Commonwealth, effective May 1, 2003;

WHEREAS, the United States, on behalf of the United States Environmental Protection Agency ("EPA"), has filed a complaint simultaneously with this Consent Decree alleging that the City has violated the POTW Permit, the Small MS4 General Permit, and Section 301(a) of the Clean Water Act ("Act" or "CWA"), 33 U.S.C. § 1311(a);

WHEREAS, the Commonwealth, on behalf of the Massachusetts Department of Environmental Protection ("MassDEP"), has filed an assented-to motion to intervene as a plaintiff in the action brought by the United States and has filed a complaint that alleges that the City was, and is, in ongoing violation of the Massachusetts Clean Waters Act, M.G.L. c. 21,

§§ 26-53 (the “Massachusetts Act”), and provisions of both the POTW Permit and the Small MS4 General Permit;

WHEREAS, the City has implemented a number of projects and measures pursuant to two Clean Water Act Administrative Orders (Docket Nos. 08-012 and 09-014) designed to reduce the frequency, volume and duration of discharges from its Combined Sewer System and bypasses of secondary treatment at the POTW’s treatment plant, but acknowledges that additional projects and measures are called for;

WHEREAS, in conjunction with the process leading to, or during implementation of, a Final CSO Long-Term Control Plan (“FLTCP”), the City will conduct a feasibility study to evaluate potential locations and types of Green Infrastructure/Low Impact Development (“GI/LID”) that could be constructed in the City, and to evaluate the potential benefit to CSO control that could be achieved by various green initiatives;

WHEREAS, the Parties anticipate, consistent with EPA’s Integrated Planning policies, that this Consent Decree may need to be modified as the City develops, designs, submits for review and approval, and implements various projects and measures, including those involving GI/LID, as well as in the event of changes in law or regulation, changes in water quality standards, or issuance of a permit that contains new or revised requirements;

WHEREAS, EPA and MassDEP will endeavor to facilitate implementation of this Consent Decree through, in a timely manner, reviewing submissions and responding to inquiries;

WHEREAS, entry of this Consent Decree by the Court will resolve all claims in the complaint of the United States and the plaintiff-intervenor’s complaint of the Commonwealth, referred to herein collectively as the “Complaints,” and with entry, this Consent Decree will supersede Administrative Orders Nos. 08-012 and 09-014;

WHEREAS, the United States, the Commonwealth, and the City (collectively, the “Parties”) recognize, without admission of facts or law except as expressly stated herein and without admission of liability by the City, and the Court by entering this Consent Decree finds, that this Consent Decree is fair and reasonable, has been negotiated in good faith, is in the public interest, and entry of this Consent Decree without further litigation is an appropriate resolution of the disputes;

NOW, THEREFORE, it is hereby ordered, adjudged, and decreed as follows:

I. STATEMENT OF CLAIM

1. The Complaints state claims upon which relief can be granted against the City pursuant to Section 309 of the CWA, 33 U.S.C. § 1319, and pursuant to the Massachusetts Act, M.G.L. c. 21, § 42.

II. JURISDICTION AND VENUE

2. This Court has jurisdiction over the subject matter of this action pursuant to Section 309(b) of the CWA, 33 U.S.C. § 1319(b), and 28 U.S.C. §§ 1331, 1345, and 1355, and under the doctrine of pendent jurisdiction. This Court has personal jurisdiction over the Parties to this Consent Decree. Venue properly lies in this district pursuant to Section 309(b) of the CWA, 33 U.S.C. § 1319(b), 28 U.S.C. §§ 1391(b) and (c), and 28 U.S.C. § 1395. The City waives all objections it might have raised to such jurisdiction or venue.

III. APPLICABILITY

3. The provisions of this Consent Decree shall apply to and be binding upon the United States, the Commonwealth, and upon the City and its officers and employees acting in their official capacities, and its agents, successors and assigns.

4. No transfer of any ownership interest in, or any interest in the operation of, the POTW or MS4, whether in compliance with this Paragraph or otherwise, shall relieve the City of its obligation to ensure that the terms of this Consent Decree are implemented. Any transfer involving ownership or operation of the POTW or MS4, or any portions thereof, to any other person or entity must be conditioned upon the transferee's agreement to be added as a party to this Consent Decree and to be jointly and severally liable with the City to undertake all obligations required by this Consent Decree. At least 30 Days prior to such transfer, the City shall provide a copy of this Consent Decree to the proposed transferee and shall simultaneously provide written notice of the prospective transfer, together with a copy of the above-referenced written agreement, to EPA, the United States Attorney, the United States Department of Justice, MassDEP, and the Commonwealth in accordance with Section XV (Form of Notice) herein.

5. The City shall provide a copy of this Consent Decree to all of its officers and agents whose duties might reasonably include compliance with any provisions of this Consent Decree. The City shall also provide a copy of this Consent Decree to all contractors and consultants it retains to perform any obligation required by this Consent Decree on behalf of the City, and condition any such contract upon performance of the work in conformity with the terms of this Consent Decree. The City shall require that such contractors and consultants provide a copy of this Consent Decree to their subcontractors to the extent the subcontractors are

performing work subject to this Consent Decree. Such contractors, consultants and subcontractors shall be deemed agents of the City for the purposes of this Consent Decree. In an action to enforce this Consent Decree, the City shall not assert as a defense against an action by EPA or the Commonwealth the failure by any of its officers, directors, employees, agents (contractors, consultants and subcontractors), successors, and assigns to take actions necessary to comply with this Consent Decree.

IV. DEFINITIONS

6. Unless otherwise expressly provided herein, terms used in this Consent Decree which are defined in the CWA or in regulations promulgated under the CWA shall have the meaning ascribed to them in the CWA or in the regulations promulgated thereunder. Whenever the terms listed below are used in this Consent Decree, the following definitions shall apply.

a. "Act" or "CWA" shall mean the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act), as amended, 33 U.S.C. §§ 1251-1387.

b. "Approval by EPA" or "Approved by EPA" shall mean the issuance of a written approval document from EPA, after a reasonable opportunity for review and comment by MassDEP, approving and/or approving with conditions a submission in accordance with Section X (Approval of Submissions) herein.

c. "Approval by EPA and MassDEP" or "Approved by EPA and MassDEP" shall mean the issuance of a single joint written approval document, or two separate approval documents with identical operational text, from EPA and MassDEP approving and/or approving with conditions a submission in accordance with Section X (Approval of Submissions) herein.

d. "Best Management Practices" or "BMPs" shall mean schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control POTW treatment plant runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

e. "Building/Private Property Backup" shall mean any release of sanitary wastewater from the Collection System into buildings or onto private property, except (i) a release that is the result of blockages, flow conditions, or malfunctions of a building lateral or other piping/conveyance system that is not owned or operationally controlled by the City, or (ii) is the result of overland surface flooding not emanating from the Collection System.

f. "Bypass" shall mean the intentional or unintentional diversion of waste streams from any portion of a treatment facility, including, without limitation, the diversion of waste streams from a secondary treatment facility during high wet weather or significant snow melt flows.

g. "Collection System" shall mean the wastewater collection, storage and transmission system (a.k.a. sanitary and Combined Sewer System) owned or operated by the City, including, but not limited to, all devices, pump stations, force mains, gravity sewer lines, manholes, and appurtenances.

h. "Combined Sewer Overflow" or "CSO" shall mean any overflow or other discharge from the City's Combined Sewer System that results from wet weather flows in excess of the carrying capacity of the Combined Sewer System.

i. “Combined Sewer System” shall mean the pipelines, conduits, pump stations, force mains, and all other structures, devices, appurtenances, and facilities used for collecting and conveying sanitary wastewaters (domestic, commercial and industrial wastewaters) and stormwater to the POTW’s treatment plant, and hydraulically connected pipelines, conduits, pump stations, force mains, and all other structures, devices, appurtenances, and facilities that periodically convey a mixture of sanitary wastewater and stormwater to waters of the United States.

j. “Consent Decree” or “Decree” shall mean this Consent Decree and all appendices hereto. In the event of conflict between this Decree and any appendix, this Decree shall control.

k. “Construction Site” shall mean any development or redevelopment or other construction activity of a site, parcel and/or building, at least a portion of which is within the limits of the City, that is projected to disturb equal to or greater than one acre of land. Construction Site shall also include any development or redevelopment or other construction activity of a site, parcel and/or building, at least a portion of which is within the limits of the City, disturbing less than one acre of total land area, where the development or redevelopment or other construction activity is part of a larger common plan calling for the disturbance of one acre or more of land.

l. “Date of Lodging” shall mean the Day this Consent Decree is filed for lodging with the Clerk of the Court for the United States District Court for the District of Massachusetts.

m. “Day” shall mean a calendar Day. In computing any period of time under this Consent Decree, when the last Day would fall on a Saturday, Sunday, or federal or state holiday, the period shall run until the close of business of the next business Day.

n. “Effective Date” is defined as set forth in Section XVIII (Effective Date) herein.

o. “EPA” shall mean the United States Environmental Protection Agency and any successor departments or agencies of the United States.

p. “Excessive Infiltration/Inflow” or “Excessive I/I” shall mean the Infiltration/Inflow (i) that cost-effectively can be eliminated from the Collection System, as determined by an analysis that compares the cost of eliminating the I/I with the total costs of transport and treatment of the I/I (including the capital costs of increasing the POTW’s capacity and treatment operations, and the resulting operating costs), or (ii) that, with respect only to sanitary sewer overflows (“SSOs”), must be eliminated regardless of cost effectiveness to prevent SSOs that present an unacceptable risk, as determined by EPA and MassDEP, to public health and water resources.

q. “Exfiltration” shall mean the water that exits the Collection System through such means as, but not limited to, defective pipes, pipe joints, connections or manhole structures.

r. “Flow” shall mean all stormwater and sanitary (domestic, commercial and industrial) wastewater conveyed by any portion of the Collection System.

s. “Green Infrastructure/Low Impact Development” or “GI/LID” shall mean the range of stormwater control measures that use natural or engineered systems to direct stormwater to areas where it can be stored, infiltrated, evapotranspirated, or reused. GI/LID may include, but is not limited to, bioretention and extended detention wetland areas, vegetated swales, pocket wetlands, rain gardens, infiltration planters, green roofs, and porous and permeable pavements.

t. “IDDE Program” shall mean an illicit discharge, detection, and elimination program, the goal of which is to identify and eliminate unauthorized discharges of wastewater to the MS4.

u. “Infiltration” shall mean the water that enters the Collection System (including sewer service connections) from the ground through such means as, but not limited to, defective pipes, pipe joints, connections or manholes. Infiltration does not include, and is distinguished from, Inflow.

v. “Infiltration/Inflow” or “I/I” shall mean the total quantity of water from both Infiltration and Inflow into the Collection System without distinguishing the source.

w. “Inflow” shall mean all water other than sanitary flow that enters the Collection System and sewer service connections from sources such as, but not limited to, roof leaders, cellar drains, yard drains, sump pumps, area drains, foundation drains, drains from springs and swampy areas, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins or drainage structures. Inflow does not include, and is distinguished from, Infiltration.

x. “MassDEP” shall mean the Massachusetts Department of Environmental Protection and any successor departments or agencies of the Commonwealth.

y. “Municipal Separate Storm Sewer System” or “MS4” shall mean the system of conveyances owned or operated by the City, designed to collect and convey stormwater to waters of the United States, and which is not a part of the POTW.

z. “Paragraph” shall mean a portion of this Consent Decree identified by an Arabic numeral or an upper or lower case letter or letters.

aa. “Parties” shall mean the United States, the Commonwealth, and the City collectively.

bb. “Sanitary Sewer Overflow” or “SSO” shall mean any overflow, spill, diversion, or release of wastewater from the Collection System to the surface waters of the United States or to the groundwater of the Commonwealth. A CSO is not an SSO.

cc. “Section” shall mean a portion of this Consent Decree identified by a Roman numeral.

dd. “Sewershed” shall mean a major portion of the Collection System that drains to one, or a limited number of, large-diameter collection pipes.

ee. “Sub-catchment Area” shall mean the geographical area served by and drained to a distinct portion of the MS4.

V. OBJECTIVES

7. It is the express purpose of the Parties in entering into this Consent Decree to require the City to take measures necessary to meet the requirements of the CWA and the Massachusetts Act, and to achieve and maintain compliance with the Small MS4 General Permit and the POTW Permit, and all applicable federal and state regulations. The obligations that the

City assumes pursuant to this Consent Decree supersede in full those in Administrative Orders Nos. 08-012 and 09-014.

8. Engineering designs and analyses required to be performed pursuant to this Consent Decree shall be conducted using sound, generally accepted engineering practices.

VI. CIVIL PENALTY

9. Within 30 Days of the Effective Date, the City shall pay a civil penalty in the amount of $125,000 ("the Civil Penalty") to the United States and the Commonwealth of Massachusetts in satisfaction of the claims for civil penalties alleged in the Complaints. Of the total Civil Penalty, the City shall pay $62,500 to the United States and shall pay $62,500 to the Commonwealth. Such payments shall be made in accordance with the procedures set forth in Paragraphs 10 and 11 below. If any portion of the required payments is not made within 30 Days of the Effective Date, then the City shall pay interest on the unpaid amount at the rate specified in 28 U.S.C. § 1961, accruing from the Effective Date through the date that the Civil Penalty payments are fully satisfied.

10. Within 30 Days of the Effective Date, the City shall make payment of $62,500 by FedWire Electronic Funds Transfer ("EFT") to the United States Department of Justice, in accordance with written instructions to be provided to the City by the United States Attorney's Office for the District of Massachusetts, Financial Litigation Unit, Boston, Massachusetts. The costs of such electronic funds transfer shall be the responsibility of the City. At the time of payment, the City shall send a copy of the EFT authorization form, the EFT transaction record, and a transmittal letter, which shall state that the payment is for the Civil Penalty owed pursuant to this Consent Decree in United States v. City of Haverhill, Massachusetts, and shall reference

the civil action number and DOJ case number 90-5-1-1-10992 to EPA and the United States Department of Justice as specified in Section XV (Form of Notice) by email to: acctsreceivable.CINWD@epa.gov, and by mail to:

EPA Cincinnati Finance Office
26 Martin Luther King Drive
Cincinnati, Ohio 45268

11. Within 30 Days of the Effective Date, the City shall also make payment to the Commonwealth by FedWire Electronic Funds Transfer in the amount of $62,500 in accordance with current EFT procedures, referencing the Massachusetts Office of the Attorney General's Case CIV No. 14-01-27645 and referencing this action. The City shall send a copy of the EFT authorization form for this transfer, the EFT record and the transmittal letter to MassDEP and the Massachusetts Attorney General's Office as specified in Section XV (Form of Notice) herein.

VII. REMEDIAL MEASURES

A. Monitoring for IDDE Program

12. The City shall inspect and sample its MS4 outfalls in accordance with the IDDE Plan developed pursuant to Paragraph 14 of this Consent Decree.

13. Beginning December 31, 2015, at least once under dry-weather conditions (*i.e.*, less than 0.1 inches of rain in the preceding 48 hours, and no significant snowmelt), the City shall inspect each of its MS4 outfalls and CSO outfalls that convey stormwater and sample those with Flow. Outfall discharge samples shall be analyzed in accordance with the IDDE Plan developed pursuant to Paragraph 14 of this Consent Decree. The City shall maintain detailed and accurate records of the date and time that sampling was conducted and the weather conditions both during, and in the 48 hours prior to, each sampling event. Samples shall be

analyzed for the parameters outlined in the IDDE Plan developed pursuant to Paragraph 14 of this Consent Decree, using sound, generally-accepted sampling and analysis practices.

B. MS4 Sub-Catchment Area Illicit Discharge Investigations

14. Within 90 Days of the Effective Date, the City shall submit for review and Approval by EPA, and to MassDEP for review, a revised IDDE Plan for screening and monitoring, including appropriate wet-weather monitoring, of MS4 outfalls and investigation of Sub-catchment Areas as required by Part II.B.3.(c) of the Small MS4 General Permit and that is consistent with *EPA New England Bacterial Source Tracking Protocol, Draft – January 2012* (a copy of which is attached as Appendix 1) as a reference. The IDDE Plan may include a distinct process for evaluation of infrastructure that serves both as part of the MS4 and part of the Combined Sewer System.

15. Within 60 Days of Approval by EPA of the IDDE Plan submitted in accordance with Paragraph 14, above, the City shall complete investigations of all Sub-catchment Areas south of Brook Street discharging to the Little River.

16. Within 180 Days of Approval by EPA of the IDDE Plan submitted in accordance with Paragraph 14, above, the City shall submit for review and Approval by EPA and to MassDEP for review:

a. A priority ranking of all Sub-catchment Areas based on all information and data available, including any available monitoring results, consistent with Appendix 1;

b. An MS4 Sub-catchment Area map showing the revised ranking of each Sub-catchment Area;

c. A schedule for completion of investigations for all Sub-catchment Areas where all information and data available, including any available monitoring results, indicated the presence of illicit connections, which shall provide that:

i. investigations of the Sub-catchment Areas on the north side of and discharging to the Merrimack River from Comeau Bridge to Mill Street remaining after completion of the investigations required by Paragraph 15 above will be completed within 240 Days of commencement of the Sub-catchment Area investigations; and

ii. investigations of all Sub-catchment Areas discharging from the MS4 will be conducted according to the City's priority ranking order and will be completed within 5 years of the Effective Date.

C. <u>MS4 Illicit Discharge Prohibition and Removal</u>

17. Within 90 Days of the Effective Date, the City shall adopt an ordinance, bylaw, or other regulatory mechanism that prohibits non-stormwater discharges into the MS4, as required by Part II.B.3.(b) of the Small MS4 General Permit. Such ordinance, bylaw, or other regulatory mechanism, however, shall permit those discharges excepted by Part II.B.3. of the Small MS4 General Permit. Within 60 Days of the adoption of such ordinance, bylaw, or other regulatory mechanism, the City shall develop and submit for review and Approval by EPA and to MassDEP for review, a manual ("IDDE Enforcement Manual") to detect and address non-stormwater discharges into the MS4, as required by Part II.B.3.(c) of the Small MS4 General Permit.

18. Within 60 Days of the Effective Date, the City shall eliminate all sources verified (as defined in Paragraph 19 of this Consent Decree) as of the Effective Date known to be contributing any pollutant in the City's stormwater that exceeds any screening threshold

identified in the IDDE Plan; and in the event such date cannot be achieved, the City shall submit a schedule to both EPA and MassDEP to remove the illicit discharge as expeditiously as possible.

19. For purposes of this Consent Decree, the "Date of Verification" of an illicit discharge shall be the date on which the City has identified a point of entry from a specific location or address that is a source of unauthorized wastewater to the MS4 or unauthorized sanitary wastewater to the MS4. On such date, an illicit discharge shall be deemed to have been "verified."

20. The IDDE Enforcement Manual shall identify the specific and detailed procedures including enforcement actions that the City shall implement, and associated schedules and milestones to remove all illicit discharges on property owned by the City or a private property owner.

21. The IDDE Enforcement Manual shall require that an illicit discharge be removed within 60 Days of the Date of Verification; and in the event such date cannot be achieved, it shall require that the City initiate enforcement action to promptly require the removal of an illicit discharge, and concurrently submit a schedule to both EPA and MassDEP to remove the illicit discharge as expeditiously as possible.

22. The IDDE Enforcement Manual also shall require that the City perform post-removal sampling to verify the illicit discharge removal.

D. <u>SSOs & Building/Private Party Backups</u>

23. The City shall, consistent with its CMOM Program Document to be developed pursuant to Paragraph 29, below, implement operation and maintenance practices, enforce sewer

use ordinances, and manage the POTW's treatment plant to prevent SSO discharges. If SSOs and Building/Private Party Backups do occur, the City shall act to terminate the discharge as quickly as possible, and promptly mitigate impacts to public health and water resources.

24. The City shall report to EPA and MassDEP all SSOs and Building/Private Party Backups known to occur on or after the Effective Date caused by conditions in the Collection System. The City shall report every such SSO and Building/Private Party Backup event as soon as the City has knowledge of the event and no later than 24 hours after its occurrence or discovery by electronic mail to EPA and MassDEP (hilton.joy@epa.gov; kevin.brander@state.ma.us). The City shall tabulate and maintain a record of each such event in a central tracking database. The location of each SSO and Building/Private Party Backup shall be reflected on a map of the Collection System maintained by the City. Submittal of MassDEP's SSO/Bypass Reporting Form with the information requested within that form that is currently available at http://www.mass.gov/eea/docs/dep/water/approvals/year-thru-alpha/m-thru-s/ssoform.pdf will satisfy the 24-hour reporting requirement. Within 5 days of obtaining knowledge of the SSO or Building/Private Party Backup event, the City shall also provide for each SSO the additional information required below if it is not included on the MassDEP's SSO/Bypass Reporting Form:

a. The date and time that the event began and was discovered by, or reported to, the City and the date the event was stopped, or if it is continuing, a schedule for its termination;

b. The location, including nearest property address, of each such event;

c. The source of notification (property owner, field crew, police, etc.);

d. The specific cause of the event, to the extent known, including but not limited to whether it was caused by debris, fats, oils, and grease, or root blockages; collapsed pipes; mechanical, electrical, or structural failures; hydraulic overloads; equipment failures; and/or vandalism;

e. Whether the cause of the event was within, or related to, the publicly-owned portion of the Collection System or if related to privately-owned sewer laterals, sanitary sewer lines or other private facilities;

f. The estimated gallons of wastewater released and the method used to estimate the volume;

g. A clear statement of whether or not the release entered a stormwater catch basin or any other portion of the City's MS4. If the release occurred to the ground or street, regardless of whether the discharge entered any portion of the MS4, the City shall provide the location and the distance to the nearest down gradient stormwater catch basin and the name of the receiving water to which the catch basin discharges;

h. If the release did not enter a stormwater catch basin or any other portion of the City's MS4, provide a clear statement of whether the release did or did not enter any surface water. If the release entered a surface water, the City shall include the name of the surface water and a description of the location where the release entered the surface water;

i. The estimated gallons of wastewater discharged to the MS4 or surface water, and the method used to estimate the volume;

j. The measures taken and the measures that will be taken to stop the overflow and decontaminate the area affected by the overflow;

k. The measures taken to prevent future overflows at the same location; and

l. The date the overflow was reported to EPA and MassDEP.

25. The reporting requirements set forth in Paragraph 24 do not relieve the City of its obligation to submit any other reports or information as required by Section IX (Compliance Reporting) or by federal, state, or local law, regulation, or permit. Notwithstanding the foregoing, the City may use reports generated to satisfy the requirements set forth in Paragraph 24 to the extent they satisfy such other obligations.

E. Capacity, Management, Operation and Maintenance Program Assessment

26. Within 180 Days of the Effective Date, the City shall submit to EPA and MassDEP for review an updated assessment of its Collection System capacity and its operation and maintenance practices (the "CMOM Program Self-Assessment"), in accordance with EPA's Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems (EPA 305-B-05-002, January 2005) (a copy of which is attached as Appendix 2), to determine whether improvements are necessary in order to maintain the infrastructure of the Collection System and to prevent future SSOs and Building/Private Party Backups. As part of the CMOM Program Self-Assessment, the City shall complete the Wastewater Collection System CMOM Program Self-Assessment Checklist (the "CMOM Program Self-Assessment Checklist") (a copy of which is attached as Appendix 3), which is an EPA Region 1 modification of the checklist that accompanies the guidance in Appendix 2.

F. Capacity, Management, Operation, and Maintenance Corrective Action Plan

27. By January 31, 2017, the City shall submit for review and Approval by EPA, and to MassDEP for review, a capacity, management, operation, and maintenance corrective action plan (the "CMOM Corrective Action Plan") that shall include the following:

a. A list of any deficiencies identified by the CMOM Program Self-Assessment;

b. A list of causes and contributing factors that led to the SSOs and Building/Private Party Backups as identified in the CMOM Program Self-Assessment Checklist;

c. A description of the specific short- and long-term actions that the City is taking, or plans to take, to address the deficiencies identified in the CMOM Program Self-Assessment Checklist; and

d. A schedule for implementation of the CMOM Corrective Action Plan.

28. Upon Approval by EPA, the City shall implement the CMOM Corrective Action Plan, as Approved by EPA, in accordance with the schedule set forth therein.

G. Capacity, Management, Operation, and Maintenance Program Document

29. Pursuant to the schedule set forth in the CMOM Corrective Action Plan, as Approved by EPA, the City shall consolidate all of its Collection System preventative and reactive maintenance programs and capital improvement plans into an updated separate, single capacity, management, operation, and maintenance program document (the "CMOM Program Document"). The CMOM Program Document shall be maintained at a location that is readily accessible to the City's maintenance staff and construction staff, and will be made available for inspection by EPA and MassDEP. This provision will not restrict the ability of the City to

continue preparing and producing a separate capital improvement plan required for annual planning and reporting purposes beyond the scope of this Consent Decree.

H. Emergency Response Plan

30. Within 90 Days of the Effective Date, the City shall develop and submit for Approval by EPA and MassDEP an Emergency Response Plan. The City shall design the Emergency Response Plan as a reference guide for its employees to ensure that:

a. Should SSOs or Building/Private Party Backups occur, the City minimizes the volume of untreated wastewater discharged to the waters of the United States and the impact of the discharge to the environment and on public health;

b. the City responds to and halts all SSOs and Building/Private Party Backups as rapidly as possible;

c. the City employs appropriate mitigation measures; and

d. the City implements appropriate measures to prevent recurrence of SSOs and Building/Private Party Backups at the same location.

31. The Emergency Response Plan shall set forth procedures for responding to SSOs and Building/Private Party Backups to minimize the environmental impact and potential human health risk. The Emergency Response Plan shall include, at a minimum:

a. Procedures to make the public aware of SSOs and measures to prevent public access to, and contact with, areas affected by SSOs and Building/Private Party Backups;

b. Procedures to provide timely notice of SSOs and Building/Private Party Backups to EPA, MassDEP, Massachusetts Division of Marine Fisheries, and local public health officials;

c. An emergency 24-hour telephone number that can be used by the public to report SSOs and Building/Private Party Backups;

d. An annual review of the City's equipment to ensure availability of the equipment necessary to respond to SSOs and Building/Private Party Backups, and to implement the Emergency Response Plan;

e. Procedures to ensure the rapid dispatch of personnel and equipment to correct, to repair or to mitigate the condition causing or contributing to any SSO or Building/Private Party Backup;

f. Procedures to ensure the preparedness, including responsiveness training, of the City's employees and contractors necessary for effective implementation of the Emergency Response Plan;

g. A system to track SSO and Building/Private Party Backup reports and other complaints and related repairs, and to investigate the causes of any SSOs or Building/Private Party Backups;

h. Formal safety training relevant to SSO and Building/Private Party Backup response for all Collection System maintenance personnel;

i. Procedures to ensure that the City will respond to and halt or contain SSOs and Building/Private Party Backups as soon as reasonably practicable;

j. Procedures to provide information to residents experiencing Building/Private Property Backups resulting from blockages and surcharges of the Collection System regarding prevention, clean up, and disposal of wastewater pumped from buildings;

k. Procedures for investigating and documenting the causes of Building/Private Property Backups resulting from blockages of or surcharges from the Collection System; and

l. A method and schedule, with respect to SSOs and Building/Private Party Backups: (i) to publicize on local cable television, local newspapers, and on the City's internet site the importance of promptly reporting SSOs and Building/Private Party Backups, and information regarding how to report them to a single point of contact within the City; and (ii) for the City, in turn, to report SSOs and Building/Private Party Backups to EPA and MassDEP, in accordance with the requirements set forth in Section VII of this Consent Decree.

32. Upon Approval by EPA and MassDEP, the City shall immediately and continuously implement the Emergency Response Plan, as Approved by EPA and MassDEP.

I. Geographic Information System ("GIS") Map

33. Within 365 Days of the Effective Date, the City shall submit to EPA and MassDEP for review and comment the best available GIS or other digital mapping of the MS4 and the Collection System to facilitate the development and implementation of its IDDE Plan and CMOM Corrective Action Plan. The City shall submit updated maps for review and comment by EPA and MassDEP with the Compliance Reports required pursuant to Section IX (Compliance Reporting), or upon request by EPA or MassDEP. Such mapping shall provide a comprehensive depiction of key infrastructure and factors influencing Collection System operation. Mapping themes shall include: key sanitary and storm sewer infrastructure; monitoring data; impervious surface area; cleaning and repair activities; capital projects; water resource and topographic features; land owned by the City and, based on the best available

existing information, land owned by other governmental entities. The scale and detail of the maps shall be appropriate to facilitate understanding of the MS4 and the Collection System by the City, EPA, and MassDEP. In addition, the mapping shall serve as a planning tool for the City to include: the implementation and phasing of the IDDE and CMOM Corrective Action Plans; and the demonstration of the extent of completed and planned IDDE investigations and corrections. To ensure legible mapping, information shall be (i) grouped appropriately and represented thematically (*e.g.*, by color) with legends or schedules where possible, (ii) updated periodically; and (iii) reportable or available upon request. The following information and features shall be included or, where specified below, made available when needed as part of detailed investigations to be included in the GIS or other digital mapping:

a. <u>Infrastructure</u>

- MS4 (including inter-municipal and private connections where available and applicable);
- Municipal sanitary sewer system (including inter-municipal connections);
- Municipal Combined Sewer System;
- Thematic representation of sewer material, size, and age;
- Sewer flow direction and flow type (*e.g.*, pressure or gravity);
- Vertical separation between systems;
- Aerial delineations of major separate storm sewer catchment areas, sanitary Sewersheds, combined Sewersheds, and areas served by known private on-site subsurface disposal systems (*e.g.*, septic systems);
- Common/twin-invert manholes or structures (*e.g.*, structures serving or housing both separate storm and sanitary sewers);

- Sanitary and storm sewer alignments served by known or suspected underdrain systems;
- Sewer alignments with common trench construction and major crossings representing high potential for communication due to water table influence;
- Lift stations (public and known private), siphons, and other key sewer appurtenances; and
- Location(s) of known or reported SSOs and Building/Private Party Backups.

b. <u>Water Resources and Topographic Features</u>

- Water bodies and watercourses identified by name;
- Water table elevations impacting sanitary sewer alignments;
- Topography; and
- Orthophotography.

c. <u>Operation and Maintenance, Investigations, Remediation, and Capital Projects</u>

- Alignments, dates, and thematic representation of work completed (with legend) of past illicit discharge investigations (*e.g.*, flow isolation, dye testing, closed-circuit television);
- Locations of suspected, confirmed, and corrected illicit discharges (with dates and flow estimates);
- Water quality monitoring locations with representation of water quality indicator concentrations;
- Recent and planned sewer and storm drainage infrastructure cleaning and repair projects;
- Planned capital improvement projects relating to sewer and storm drainage infrastructure;
- Alignments and dates of past and planned Infiltration/Inflow investigations and sanitary sewer remediation work; and
- Proposed annual planning of future illicit discharge investigations.

34. The City shall update the mapping on a continual basis as it implements the requirements of this Consent Decree, as necessary, to reflect newly-discovered information, corrections or modifications, and remedial measures performed by the City in compliance with this Consent Decree.

J. Construction Site Stormwater

35. Within 365 Days of the Effective Date, the City shall require sediment and erosion control at Construction Sites through an ordinance or other regulatory mechanism as required by Part II.B.4.(a) of the Small MS4 General Permit.

36. Within 365 Days of the Effective Date, the City shall develop and submit for review and Approval by EPA a Construction Site program that addresses the requirements of Part II.B.4. of the Small MS4 General Permit, including but not limited to inspection procedures, enforcement procedures, and recordkeeping.

37. The City's Construction Site program shall require developers to demonstrate that they have applied for EPA's Construction General Permit, where applicable, and shall require the use and maintenance of appropriate structural and non-structural BMPs designed to minimize the discharge of pollutants from Construction Sites to the MS4.

38. Within 60 Days of receipt of the Approval by EPA of the Construction Site program submitted in accordance with Paragraph 36 and revised to be consistent with EPA's comments, if any, the City shall implement the Construction Site program.

39. Within 60 Days of receipt of the Approval by EPA of the Construction Site program submitted in accordance with Paragraph 36 and revised to be consistent with EPA's

comments, if any, the City shall develop a database, incorporating the data elements described in the Construction Site program submittal Approved by EPA, to track active Construction Sites.

40. Within 365 Days of the Effective Date, the City shall have conducted at least one inspection of each active Construction Site known to the City as of the Effective Date that has the potential to discharge to the MS4. The City shall inspect all new Construction Sites within the first three weeks after the start of work at the Construction Site.

41. Within 60 Days of receipt of the Approval by EPA of the Construction Site program submitted in accordance with Paragraph 36 and revised to be consistent with EPA's comments, if any, the City shall conduct training regarding Construction Site stormwater runoff control for City personnel responsible for implementing the City's Construction Site program. The City shall train all personnel performing Construction Site inspections within thirty (30) Days of their commencing employment or assignment to perform said inspections.

42. Within 60 Days of receipt of the Approval by EPA of the Construction Site program submitted in accordance with Paragraph 36 and revised to be consistent with EPA's comments, if any, the City shall develop, commence, and thereafter continue implementation of procedures for site plan review including consideration of potential water quality impacts from construction activities, *e.g.*, through review of a Stormwater Pollution Prevention Plan.

43. Within 60 Days of receipt of the Approval by EPA of the Construction Site program submitted in accordance with Paragraph 36 and revised to be consistent with EPA's comments, if any, the City shall develop a plan with appropriate municipal agencies to ensure notification to appropriate building permit applicants of their potential responsibilities under the

NPDES permitting program for Construction Site runoff as required by Part II.B.4. of the Small MS4 General Permit.

K. Post-Construction Stormwater Controls

44. Within 365 Days of the Effective Date, the City shall require management of stormwater runoff at post-construction development and redevelopment projects through an ordinance or other regulatory mechanism as required by Part II.B.5. of the Small MS4 General Permit.

L. POTW's Treatment Plant Planning and Improvements

45. The City shall not allow any Bypass to occur unless:

a. the Bypass is for essential maintenance to assure efficient operation and does not cause effluent limitations to be exceeded; or

b. (i) the Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(ii) there were no feasible alternatives to the Bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a Bypass which occurred during normal periods of equipment downtime or preventative maintenance; and

(iii) The City submitted notices as required under Part II.B.4.c. of the POTW Permit; or

c. For any Bypass occurring prior to approval of a new High Flow Management Plan prepared pursuant to Paragraph 48.g. being Approved by EPA and MassDEP, the City complies with following:

i. During wet-weather events and significant snow melt, the City shall process as much flow through the POTW's treatment plant as practicable prior to initiating a bypass. The flow through the secondary treatment facilities (aeration and clarification) shall be maximized. The City shall provide primary treatment to the practical limit of the primary facilities.

ii. The City is not required to include biochemical oxygen demand and total suspended solids data from days with CSO-related bypass events when calculating average monthly percent removal of these pollutants. During the CSO-related bypass events, the blended final effluent samples shall be collected below the outfall junction chamber and shall achieve the outfall 046 effluent limitations set forth in the POTW Permit.

46. By June 30, 2016, the City shall upgrade the POTW's treatment plant sludge dewatering equipment in accordance with the design plans approved by MassDEP by letter of December 29, 2014, a copy of which approval letter is attached hereto as Appendix 7.

47. By June 30, 2016, the City shall submit an updated Operation and Maintenance Manual for the POTW's treatment plant, that shall include all elements set forth in 314 CMR 12.04(1), and shall include operation and maintenance information for the new sludge dewatering equipment.

48. By January 31, 2017, the City shall submit for Approval by EPA and MassDEP a Comprehensive Plant Evaluation ("CPE") assessing the capital and operational improvements necessary to maintain compliance with the POTW Permit. The CPE shall include, at a minimum:

a. A description of each element of each of the treatment units;

b. An analysis of the compliance history of the POTW's treatment plant relative to the effluent limits included in the POTW Permit;

c. An assessment of the physical condition, hydraulic and pollutant loading capacity, and operational performance of each of the treatment units;

d. An assessment of the measures needed to optimize, repair and/or replace treatment units and ancillary equipment so that the POTW treatment plant will reliably accept, treat, and discharge treated effluent in accordance with the POTW Permit over a planning period of 20 years;

e. Assessment of the POTW treatment plant building systems, including structures, roofs, electrical and instrumentation systems, plumbing and heating systems, HVAC systems, safety equipment and monitors, and alarm systems;

f. A review and assessment of the POTW's treatment plant operations, including the number of staff and organizational structure, and recommendations for appropriate modifications;

g. A review and update of the City's High Flow Management Plan to provide, in detail, recommended operational practices to optimize treatment efficiency and minimize CSO discharges during high flow events related to wet weather and significant snow melt;

h. A review and update of the City's Operation and Maintenance Program for the POTW's treatment plant to identify alternatives for controlling plant operations, including at a minimum, the use of constant mixed liquor suspended solids, constant food/mass ratios, and constant mean cell residence time; and

i. An implementation schedule for all recommended optimization projects, capital improvements, and operational/staffing changes.

M. CSO Monitoring

49. As of April 9, 2014, the City began continuous electronic monitoring of each of its active CSO outfalls in order to record the date and time when flow from each outfall commences, the date and time when such flows cease, and the total volume released during each activation. Outfalls 024, 021E, 021D, 021A, 013, 032, and 034 shall be equipped with permanent meters until such time as the CSO outfalls are closed. Outfalls 021H, 021G, 038, 037, 021F, 021B, 019, 039, 040, and 041 shall be equipped with metering for a minimum period of one year from the date the meters are deployed and operating properly.

50. Commencing on the Effective Date, the City shall submit email notification within 24 hours of any CSO discharge to MassDEP, EPA, the Merrimack River Watershed Council, MA Division of Marine Fisheries, and Boards of Health agents for downstream communities, advising them of the discharge, and shall continue to issue email notification on successive days unless and until the discharges have ceased. The email notification shall, at a minimum, include identification of the CSO outfall which activated, and a map showing the

location of the City's CSO outfalls. The email notifications distributed pursuant to this Paragraph will be sent to the parties and other persons listed with their email addresses on Appendix 4, attached hereto.

51. By the 30th Day of April following the Effective Date and annually thereafter**,** the City shall submit a CSO activation report to EPA and MassDEP reporting on CSO activations that occurred during the previous twelve months. Each report shall include, for each activation at each CSO outfall, the date and time when flow commenced, the date and time when such flows ceased, the amount of precipitation associated with each event, and the total volume released during each activation. Each CSO activation report shall also include the total volumes discharged from each outfall and the total volume discharged through CSO outfalls from the Collection System during the reporting period.

N. CSO Planning and Plan Implementation

52. Within 30 Days of the Effective Date, the City shall raise CSO regulator weirs, as recommended in the City's July 2011 Phase II Long-Term CSO Control Plan, and further described in the City's June 17, 2013 correspondence to EPA and MassDEP (a copy of which is attached as Appendix 5), to further minimize CSOs at the Lower Siphon, Upper Siphon, Locke Street North, Locke Street South, and Bradford Avenue outfalls. Within 30 Days of the completion of each weir modification, the City shall notify EPA and MassDEP in writing of the completion of such work.

53. Within 60 Days of the Effective Date, the City shall complete investigations of the Bethany Avenue CSO discharging to the Merrimack River.

54. On or before March 31, 2017, the City shall complete all the remaining work in the System Maximization & Wet Weather Maximization Plan (Table 2) included as part of Appendix 5.

55. On or before January 31, 2017, the City shall submit for review and Approval by EPA and MassDEP a Final CSO Long-Term Control Plan ("FLTCP"). The FLTCP shall address comments from EPA and MassDEP on the July 2011 Phase II CSO Long-Term Control Plan (a copy of these comments is attached as Appendix 6), and shall specifically include:

a. An updated characterization of the Collection System that includes a description of the physical characteristics and attributes of the City's sewer system tributary to the POTW's treatment plant. The description shall be compiled from existing records with field confirmation of pipe and appurtenance characteristics, and as necessary, data shall be collected to augment existing records to produce a complete and accurate description of those portions of the Collection System to be modeled and mapped. Pipe characteristics shall include diameter, shape, length, slope, elevation and interior surface condition (*i.e.*, representative friction coefficients). Appurtenance characteristics shall include shape, size, elevation, interior condition and capacity as appropriate.

b. A description of how the Collection System and the POTW's treatment plant respond to a range of precipitation events by identifying the frequency and volumes of overflow discharged from each discharge point. Quantification of I/I from the components of the Collection System with separate sewer and drain systems shall be done as an element of this work.

c. A description and summary of the City's I/I control program, which shall include a summary of studies and assessment work planned or completed; a summary of rehabilitation or other I/I removal construction work completed to date; and a description of the City's practices in permitting new connections to the sewer system, and any associated I/I mitigation requirements.

d. A Final Alternatives Analysis in accordance with EPA's April 19, 1994 CSO Control Policy, published at 59 Fed. Reg. 18,688, to identify, screen, develop and evaluate alternatives that shall provide for measures necessary to ensure that CSOs from all CSO outfalls comply with the technology-based and water quality-based requirements of the CWA, the Massachusetts Act, and the POTW Permit. The City shall screen an appropriate range of technologies for eliminating, reducing, or treating CSOs, including alternatives that will reduce the number of untreated CSOs down to a range of overflows per CSO outfall per year (such as 0, 1 to 3, and 4 to 7).

e. A description of the CSO control measures the City proposes to implement to comply with the POTW Permit, including the construction of all Collection System and POTW treatment plant improvements necessary to ensure compliance with water quality standards, and a proposed schedule for constructing those control measures. The work must also include measures to address Excessive I/I into the areas of the Collection System that have separate sewer systems. The City also shall consider GI/LID alternatives in preparing the FLTCP. The FLTCP shall reflect the following activities and/or considerations in proposing GI/LID alternatives to traditional gray (traditional wastewater infrastructure) controls:

(1) identification of potential locations for GI/LID; (2) pilot projects; (3) design criteria; and (4) post-construction monitoring.

f. A financial impact analysis that, at a minimum, includes the methodology specified in EPA's February 1997 "Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development [Final]." In addition to using such methodology, the City may submit an additional analysis using alternative inputs that the City contends produce a more accurate calculation of financial impact, provided that such inputs are consistent with EPA guidance, including the methodology specified in EPA's November 24, 2014 guidance "Financial Capability Assessment Framework for Municipal Clean Water Act Requirements."

g. A post-construction monitoring program which will result in the assessment of the effectiveness of the completed CSO control measures for CSO outfalls that are not eliminated. This program shall be consistent with EPA's May 2012 guidance, "CSO Post Construction Compliance Monitoring Guidance." The post-construction monitoring program shall include recommendations for metering all of the City's active CSOs.

56. Upon Approval by EPA and MassDEP of the FLTCP and an implementation schedule for the recommended plan, the City shall construct the CSO control measures Approved by EPA and MassDEP in accordance with the schedule Approved by EPA and MassDEP. The schedule shall be deemed incorporated into this Consent Decree upon its Approval by EPA and MassDEP.

VIII. SUPPLEMENTAL ENVIRONMENTAL PROJECT

57. The City shall implement a Supplemental Environmental Project ("SEP") consisting of the Merrimack Riverbank Restoration Program as set forth in Appendix 8. The SEP shall be completed in accordance with the schedule set forth in Appendix 8.

58. The City is responsible for the satisfactory completion of the SEP in accordance with the requirements of this Consent Decree. "Satisfactory completion" means fulfilling the requirements described in Appendix 8. The City may use contractors or consultants in planning and implementing the SEP.

59. With regard to the SEP, the City certifies the truth and accuracy of each of the following:

a. That all cost information provided to EPA in connection with the Approval by EPA of the SEP is complete and accurate and that the City in good faith estimates that the cost to implement the SEP is at least $176,000;

b. That, as of the date of executing this Consent Decree, the City is not required to perform or develop the SEP by any federal, state, or local law or regulation and is not required to perform or develop the SEP by agreement, grant, or as injunctive relief awarded in any other action in any forum;

c. That the SEP is not a project that the City was planning or intending to construct, perform, or implement other than in settlement of the claims resolved in this Consent Decree;

d. That the City has not received and will not receive credit for the SEP in any other enforcement action; and

e. That the City will not receive any reimbursement for any portion of the SEP from any other person.

60. Within 30 Days after the date of completion of the SEP, the City shall submit a SEP Completion Report for review and Approval by EPA and to MassDEP for review in accordance with Section XV of this Consent Decree (Form of Notice). The SEP Completion Report shall contain the following information:

a. a detailed description of the SEP as implemented;

b. a description of any problems encountered in completing the SEP and the solutions thereto;

c. an itemized list of all eligible SEP costs expended;

d. certification that the SEP has been fully implemented pursuant to the provisions of this Consent Decree; and

e. a description of the environmental and public health benefits resulting from implementation of the SEP (with a qualification of the benefits and pollutant reductions, if feasible).

61. EPA may, in its sole discretion, require information in addition to that described in the preceding Paragraph in order to evaluate the SEP Completion Report.

62. After receiving the SEP Completion Report, EPA shall notify the City in writing whether or not the City has satisfactorily completed the SEP. If the City has not completed the SEP in accordance with this Consent Decree, stipulated penalties may be assessed under Section XI of this Consent Decree (Stipulated Penalties).

63. Disputes concerning the satisfactory performance of the SEP and the amount of eligible SEP costs may be resolved under Section XIII of this Consent Decree (Dispute Resolution).

64. Each submission required under this Section shall be signed by a City officer with knowledge of the SEP and shall bear the certification language set forth in Paragraph 99.

65. Any public statement, oral or written, in print, film, or other media, made by the City making reference to the SEP implemented in accordance with this Consent Decree shall include the following language: "This project was undertaken in connection with the settlement of an enforcement action, *United States of America and Commonwealth of Massachusetts v. the City of Haverhill, Massachusetts*, taken on behalf of the U.S. Environmental Protection Agency under the federal Clean Water Act and the Massachusetts Department of Environmental Protection under the state Clean Waters Act."

66. The City certifies that it is not a party to any open federal financial assistance transaction that is funding or could be used to fund the same activity as the SEP. The City further certifies that, to the best of its knowledge and belief after reasonable inquiry, there is no such open federal financial transaction that is funding or could be used to fund the same activity as the SEP, nor has the same activity been described in an unsuccessful federal financial assistance transaction proposal submitted to EPA within two years of the date of this settlement (unless the project was barred from funding as statutorily ineligible). For the purposes of this certification, the term "open federal financial assistance transaction" refers to a grant, cooperative agreement, loan, federally-guaranteed loan guarantee, or other mechanism for providing federal financial assistance whose performance period has not yet expired.

IX. COMPLIANCE REPORTING

67. Within 180 Days of or the initial April 30 following the Effective Date, and each 180 Days thereafter through complete termination of this Consent Decree, the City shall submit to EPA and MassDEP, for review and comment, a compliance report (the "Compliance Report") for the previous six-month period, each such period a "Reporting Period." Except for the reporting elements in this Paragraph associated with the requirements of any sub-section(s) of Section VII (Remedial Measures) that has (have) been terminated in accordance with the partial termination provisions of Section XXIII (Termination), each Compliance Report shall include the following:

a. IDDE Program.

i. The current revised priority listing for all Sub-catchment Areas and all outfall monitoring data collected pursuant to sub-sections VII.A. and VII.B., above, during the Reporting Period;

ii. A spreadsheet detailing the percentage of each Sub-catchment Area investigation completed during the Reporting Period and cumulative to date based on the following:

1. the number of stormwater manholes in the Sub-catchment Areas that have been systematically investigated and addressed in accordance with the City's revised IDDE Plan, as Approved by EPA and MassDEP, during the Reporting Period and cumulative to date;

2. the percentage of the Sub-catchment Areas that have been systematically investigated and addressed in accordance with the City's revised

IDDE Plan, as Approved by EPA and MassDEP, during the Reporting Period and cumulative to date. The percentage shall be based on the number of stormwater manholes addressed during each respective period divided by the total number of stormwater manholes in the Sub-catchment Areas;

3. the linear feet of storm drain piping in the Sub-catchment Areas that have been systematically investigated and addressed in accordance with the City's revised IDDE Plan, as Approved by EPA, during the Reporting Period and cumulative to date;

4. the percentage of the Sub-catchment Areas that have been systematically investigated and addressed in accordance with the City's revised IDDE Plan, as Approved by EPA, during the Reporting Period and cumulative to date. The percentage shall be based on the linear feet of storm drain addressed during each respective period divided by the total linear feet in the Sub-catchment Areas;

iii. An updated listing of all illicit discharges (separately listing illicit connections and sanitary sewer defects) verified through the end of the Reporting Period, including the following:

1. the date the illicit discharge was verified, the address or location of the illicit discharge, and the type of discharge (*e.g.*, single-family residential, multi-family residential, commercial, industrial, exfiltration from sanitary sewer);

2. the estimated flow from the illicit discharge;

3. the actions taken by the City to remove the illicit discharge;

4. the date the illicit discharge was removed;

5. the cost of removing the illicit discharge;

6. an estimate of the resulting volume removed from the MS4 under the IDDE Plan during the Reporting Period for each individual illicit discharge and each Sub-catchment Area, cumulative for the Reporting Period, and cumulative for all illicit discharges verified to date;

7. a listing of those illicit discharges verified but not removed within 60 Days of verification, with an explanation of why each outfall was not removed within 60 Days of the Date of Verification;

8. the schedule for the removal of each illicit discharge that was not removed within 60 Days of the Date of Verification and an explanation as to why the schedule is as expeditious as possible;

9. for each verified illicit discharge that is the responsibility of the property owner where the property owner has not removed the illicit discharge within 90 Days of the Date of Verification, or within 90 Days of the Effective Date for existing verified illicit discharges, a complete and accurate description of the legal actions taken by the City to address them; and

10. for each schedule listed in the report for the previous Reporting Period, specify whether the City complied with its schedule for removal; and if not, the reasons for the delay.

b. SSO and Building/Private Party Backup Events.

i. A chronological list of each of the following categories of SSO and Building/Private Party Backup events that occurred during the Reporting Period: all releases with a reasonable potential to reach surface waters such as releases to streets or areas with storm drain catch basins; and citizen reports of SSO and Building/Private Party Backup events.

ii. A GIS map or figure, consistent with the requirements of Paragraph 33, above, indicating the location of each illicit discharge, SSO event, and Building/Private Property Backup;

c. Construction Site Inspection and Enforcement Program. A chart showing the numbers of routine, complaint-response, and total Construction Site inspections and the number of each type of enforcement action taken during the Reporting Period for violations of the City's ordinance or other regulatory mechanism requiring sediment and erosion control at Construction Sites;

d. General Status.

i. A description of the activities undertaken during the Reporting Period directed at achieving compliance with this Consent Decree;

ii. An identification of all plans, reports, and other submissions required by this Consent Decree that the City completed and submitted during the Reporting Period, and copies of records developed during the Reporting Period, including Computerized Maintenance Management System work orders, in connection with the outfall inspections and monitoring required by sub-sections VII.A. and VII.B., above;

iii. An identification of any noncompliance with the requirements of this Consent Decree. If any noncompliance is reported, the notification shall include the following information:

1. a description of the noncompliance;

2. a description of any factors that tend to explain or mitigate the noncompliance;

3. a description of any actions taken or proposed by the City to comply with any lapsed requirements; and

4. the date by which the City will perform such proposed action; and

iv. A description of the activities the City plans to undertake during the six months following the Reporting Period in order to comply with this Consent Decree;

e. Bypass.

i. For each month during the previous six-month period in which a secondary treatment Bypass occurs at the POTW's treatment plant, a monthly chronological spreadsheet containing the following information for each Day a secondary treatment Bypass occurs:

1. The date(s) of the Bypass;

2. The date(s) when rainfall occurred, and the rainfall totals (inches);

3. The presence, or absence of snowmelt;

4. The total plant influent flow (MGD);

5. The total secondary treatment Bypass volume (MG);

6. The start/stop time for each Bypass event, and plant flows at both the start and stop of the Bypass event;

7. The type and number of unit operations and processes that went offline, and the reasons for each;

8. The total gallons of septage received on each Bypass event Day; and

9. During the time of Bypass, additional operations information, including: the influent and effluent total suspended solids; the mean cell residence time for each aeration tank; the sludge blanket depth in the secondary clarifiers; and the mixed liquor suspended solids in the aeration tanks.

ii. For each Bypass that occurs during the Reporting Period, submit charts developed in accordance with Item 6 of Appendix 5.

68. The reporting requirements set forth in this Section do not relieve the City of its obligation to submit any other reports or information as required by federal, state, or local law, regulation, or permit. Notwithstanding the foregoing, the City may use reports generated to satisfy the requirements set forth in this Section as part of its efforts to satisfy such other reporting obligations. EPA and MassDEP each reserves the right to require modifications to the above reporting requirements, subject to the City's right to dispute under Section XIII (Dispute Resolution).

X. APPROVAL OF SUBMISSIONS

69. After review of any plan, schedule, report, or other item that is required to be submitted for Approval by EPA or Approval by EPA and MassDEP pursuant to this Consent Decree, EPA and/or MassDEP as specified may, in writing: (a) approve the submission; (b) approve the submission upon specified conditions; (c) approve part of the submission and disapprove the remainder, directing that the City modify the submission by itemizing and specifically identifying the deficiencies; or (d) disapprove the submission. In the event of Approval by EPA or Approval by EPA and MassDEP, pursuant to (a) or (b) of this Paragraph, the plan, schedule, report, or other item, or portion thereof, as approved, or approved with conditions, shall be enforceable under this Consent Decree, and the City shall take all actions required to implement such plan, schedule, report, or other item, or portion thereof, in accordance with the issued approval, or approval with conditions.

70. Upon receipt of a written notice of disapproval pursuant to Paragraph 69(c) or 69(d), subject to the City's right to dispute the disapproval under Section XIII (Dispute Resolution), the City shall, within 30 Days, or such other time as the City, EPA or EPA and MassDEP as appropriate agree in writing, correct the deficiencies and resubmit the plan, schedule, report, or other item, or portion thereof, for Approval by EPA or EPA and MassDEP. Any stipulated penalties applicable to the original submission shall accrue during the 30-Day period or other specified period, but shall not be payable unless the resubmission is untimely and/or disapproved as provided in Paragraph 71, below.

71. Any resubmitted plan, schedule, report, or other item, or portion thereof, shall be subject to review and Approval by EPA or EPA and MassDEP, as provided under this Section.

If the City fails to resubmit a plan, schedule, report, or other item, or portion thereof after a disapproval, or if, upon resubmission, the plan, schedule, report, or other item, or portion thereof, is disapproved by EPA or EPA and MassDEP, the City shall be deemed to have failed, as of the date of such document's resubmission, to submit such plan, schedule, report, or other item, or portion thereof, timely and adequately, unless the City invokes the dispute resolution procedures set forth in Section XIII (Dispute Resolution), herein, and the City's position is upheld.

XI. STIPULATED PENALTIES

72. The City shall pay stipulated penalties to the United States and the Commonwealth for violations of, or noncompliance with, the requirements of this Consent Decree, as set forth below, unless excused under Section XII (Force Majeure), herein. A violation or noncompliance includes failing to perform an obligation required by the terms of this Consent Decree, including any plan or schedule approved under this Decree, according to all applicable requirements of this Consent Decree and within the specified time schedules or by the date(s) established by or approved under this Consent Decree. If the United States or the Commonwealth makes a demand for stipulated penalties, the City may invoke the dispute resolution procedures set forth in Section XIII (Dispute Resolution).

a. Late Payment of Civil Penalty. If the City fails to pay the Civil Penalty required to be paid under Section VI (Civil Penalty), above, when due, the City shall pay, in addition to interest as specified in Paragraph 9, above, a stipulated penalty as follows:

Penalty Per Violation Per Day	Period of Noncompliance
$750	1st through 10th Day
$1,500	11th through 20th Day
$2,500	21st Day and beyond.

b. Reporting & Notice Requirements. For every Day that the City fails to timely submit a report required by Paragraph 67, above, fails to submit the SEP Completion Report required by Paragraph 60, above, fails to provide the certification required by Paragraph 99, below, or fails to provide the notice required by Paragraphs 4 and 5, above, the City shall pay a stipulated penalty as follows:

Penalty Per Violation Per Day	Period of Noncompliance
$500	1st through 10th Day
$1,500	11th through 20th Day
$2,500	21st Day and beyond.

c. Unpermitted Discharges. For each Day that an SSO occurs, the City shall pay a stipulated penalty of $6,500. Notwithstanding the foregoing, the City shall not be liable for such a stipulated penalty for an SSO if all of the following conditions are met: (i) the City stopped the SSO as soon as reasonably practicable; (ii) the City is in full compliance with and is fully implementing the schedules and other requirements set forth pursuant to Section VII of this Consent Decree; and (iii) the City has complied with all reporting requirements for said SSO, including but not limited to those set forth in Paragraph 24 of this Consent Decree.

d. Remedial Measures. For every Day that the City fails to timely meet the requirements of Section VII (Remedial Measures) of this Consent Decree, or is delayed in completing the SEP (Section VIII) for reasons other than Force Majeure circumstances, including but not limited to, submitting an approvable plan, schedule, report, or other item, other than a report required by Paragraph 67, above, or fails to implement remedial measures in accordance with a plan, schedule, report, or other item Approved by EPA and MassDEP, the City shall pay a stipulated penalty as follows:

Penalty Per Violation Per Day	Period of Noncompliance
$750	1st through 10th Day
$1,000	11th through 20th Day
$2,500	21st Day and beyond

e. If the City satisfactorily completes the SEP but spends less than approximately $176,000, the City shall be required to pay a stipulated penalty in the amount equal to the difference between $176,000 and the actual amount spent on the SEP.

f. If the City does not satisfactorily complete the SEP for reasons other than Force Majeure circumstances, the City shall pay a stipulated penalty of $220,000.

73. Stipulated penalties shall automatically begin to accrue on the Day after performance is due or on the Day a violation occurs and shall continue to accrue each Day until performance is satisfactorily completed or until the violation or noncompliance ceases. Stipulated penalties shall accrue simultaneously for separate violations of, or instances of non-compliance with, this Consent Decree.

74. Following the United States' or the Commonwealth's determination that the City has failed to comply with a requirement of this Consent Decree, the United States or the Commonwealth will give the City written notification of the same and describe the noncompliance. The United States or the Commonwealth will send the City a written demand for the payment of stipulated penalties. If the United States or the Commonwealth makes a demand for payment of stipulated penalties, it shall simultaneously send a copy of the demand to the other Plaintiff, as applicable. However, the stipulated penalties shall accrue as provided in the preceding Paragraph regardless of whether the United States or Commonwealth has notified the City of a violation of, or noncompliance with, the requirements of this Consent Decree, or demanded payment of stipulated penalties.

75. The City shall pay stipulated penalties as specified in this Section by delivering the payment to the United States and the Commonwealth within 45 Days of the date of a demand for payment of stipulated penalties by the United States or the Commonwealth. The City shall pay one half of the total stipulated penalty amount due to the United States and one half to the Commonwealth in the manner set forth and with the confirmation notices required by Paragraphs 10 and 11, above, except that the transmittal letters shall state that the payment is for stipulated penalties and shall state for which violation(s) or noncompliance the penalties are being paid. In the event the City fails to pay stipulated penalties according to the terms of this Consent Decree, such penalty (or portion thereof) shall be subject to interest at the statutory judgment rate set forth at 28 U.S.C. § 1961, accruing as of the date payment became due. Nothing in this Paragraph shall be construed to limit the United States or the Commonwealth in seeking any remedy otherwise provided by law for the City's failure to pay any stipulated penalties.

76. Stipulated penalties shall continue to accrue as provided in Paragraph 73, above, during dispute resolution, but need not be paid until the following:

a. If the dispute is resolved by agreement of the Parties, or by a decision of EPA and/or MassDEP that is not appealed to the Court, and such agreement involves the payment by the City of any penalty amount, the City shall pay accrued penalties, if any, together with interest, to the United States and the Commonwealth within 45 Days of the agreement or the receipt of the United States' or the Commonwealth's decision or order.

b. If the dispute is appealed to the Court and the United States or the United States and the Commonwealth prevail in whole or in part, the City shall pay all accrued penalties, together with interest, within 60 Days of receiving the Court's decision or order, to the extent the United States and the Commonwealth prevail, except as provided in subparagraph c., below.

c. If any Party appeals the Court's decision, and the United States or the United States and the Commonwealth prevail in whole or in part, the City shall pay all accrued penalties, together with interest, within 15 Days of receiving the final appellate court decision, to the extent the United States and the Commonwealth prevail.

77. The stipulated penalties set forth above shall be in addition to any other remedies, sanctions, or penalties which may be available by reason of the City's failure to comply with the requirements of this Consent Decree. The United States and the Commonwealth expressly reserve any and all legal and equitable remedies, including contempt sanctions, which may be available to enforce the provisions of this Consent Decree. The United States and the

Commonwealth may, in the unreviewable exercise of their discretion, reduce or waive stipulated penalties otherwise due under this Consent Decree.

XII. FORCE MAJEURE

78. "Force Majeure," for purposes of this Consent Decree, is defined as any event arising from causes entirely beyond the control of the City, its officers or agents, including the City's consultants, and contractors, that delays or prevents the timely performance of any obligation under this Consent Decree notwithstanding the City's best efforts to fulfill the obligation.

79. The requirement that the City exercise "best efforts" includes using best efforts to anticipate any potential Force Majeure event and best efforts to address the effects of any such event (a) as it is occurring, and (b) after it has occurred, to prevent or minimize any resulting delay to the greatest extent feasible. Force Majeure does not include the City's financial inability to perform any obligation under this Consent Decree. Stipulated Penalties shall not be due for the number of Days of noncompliance caused by a Force Majeure event as defined in this Section, provided that the City complies with the terms of this Section. The City may seek relief under this Section for any delay in the performance of an obligation under this Consent Decree that results from a failure to obtain, or a delay in obtaining, any permit or approval, including Approval by EPA or Approval by EPA and MassDEP under this Consent Decree, required to fulfill such obligation, if the City has submitted timely and complete applications and has taken all other actions necessary to obtain such permits and approvals.

80. If any event occurs or has occurred that may delay or prevent the performance of any obligation under this Consent Decree, whether or not caused by a Force Majeure event, the

City shall notify EPA and MassDEP via email within three business Days after the City first knew or should have known that the event might cause a delay. Within five business Days, the City shall submit for review and Approval by EPA and MassDEP, at the addresses specified in Section XV (Form of Notice), below, a written explanation of the cause(s) of any actual or expected delay or noncompliance, the anticipated duration of any delay, the measure(s) taken and to be taken by the City to prevent or minimize the delay, a proposed schedule for the implementation of such measure(s), and a statement as to whether, in the opinion of the City, such event may cause or contribute to an endangerment to public health, welfare, or the environment. Notwithstanding the foregoing, the City shall notify EPA and MassDEP orally as soon as practicable, and in any event within 24 hours of becoming aware of any event that presents an imminent threat to the public health or welfare or the environment and provide written notice to EPA and MassDEP within 72 hours of discovery of such event. Failure to provide timely and complete notice in accordance with this Paragraph shall constitute a waiver of any claim of Force Majeure with respect to the event in question. Notifications required by this Paragraph shall be provided consistent with the contact information provided in Section XV (Form of Notice), below. Nothing in this Consent Decree should be taken to change or amend existing reporting requirements established by MassDEP for SSO events and facility upsets.

81. If EPA and MassDEP agree that a delay or anticipated delay is attributable to Force Majeure, the time for performance of the obligations under this Consent Decree that are affected by the Force Majeure event shall be extended by EPA and MassDEP for a period of time as EPA and MassDEP determine is necessary to complete these obligations. EPA and

MassDEP will notify the City in writing of the length of the extension for completion of the obligations affected by the Force Majeure event.

82. If EPA and MassDEP do not agree the delay or anticipated delay is attributable to Force Majeure, or on the number of Days of noncompliance attributable to such event, EPA and MassDEP will notify the City in writing of the decision. The City may then elect to initiate the dispute resolution process set forth in Section XIII (Dispute Resolution). If the City does not initiate the dispute resolution process set forth in Section XIII (Dispute Resolution) within 10 Days of receiving a written notice under this Paragraph from either EPA or MassDEP, then the City shall be deemed to have waived any Force Majeure claims or any rights to initiate dispute resolution with regard to such claims. In any dispute resolution proceeding, the City shall have the burden of demonstrating by a preponderance of the evidence that the delay or anticipated delay has been or will be caused by a Force Majeure event, that the duration of the delay or the extension sought was or will be warranted under the circumstances, that "best efforts" were exercised to avoid and mitigate the effects of the delay, and that the City complied with the requirements of Paragraph 80, above. If the City carries this burden, the delay at issue shall be deemed not to be a violation by the City of the affected obligation(s) of this Consent Decree.

83. Delay in performance of any obligation under this Consent Decree shall not automatically justify or excuse delay in complying with any subsequent obligation or requirement of this Consent Decree.

84. Failure of the City to obtain any state or federal grants or loans shall not be considered a Force Majeure event under this Consent Decree.

XIII. DISPUTE RESOLUTION

85. Unless otherwise expressly provided for in this Consent Decree, the dispute resolution procedures set forth in this Section shall be the exclusive mechanism to resolve disputes arising under or with respect to this Consent Decree. The City's failure to seek resolution of a dispute under this Section shall preclude the City from raising any such undisputed issue as a defense to an action by the United States or the Commonwealth to enforce any obligation of the City arising under this Consent Decree. The procedures set forth in this Section shall not apply to actions by the United States or the Commonwealth to enforce obligations that the City has not disputed in accordance with this Section.

86. Any dispute subject to dispute resolution under this Consent Decree shall first be the subject of informal negotiations. The dispute shall be considered to have arisen when the City sends the United States and the Commonwealth a written Notice of Dispute which clearly identifies the matter in dispute. Within 10 Days thereafter, the City shall, unless the parties have resolved the matter in dispute, submit to the United States and the Commonwealth a Statement of Position that shall include, but need not be limited to, any factual data, analysis, or opinion supporting that position and any supporting documentation relied upon by the City. As part of the informal negotiations, the Parties may engage in mediation with a third-party mediator in order to resolve the dispute, if all Parties mutually agree to such mediation. A Party's decision whether to mediate is not subject to dispute resolution. The period of informal negotiations (including mediation) shall not exceed 40 Days from the date written Notice of the Dispute is received by EPA, or EPA and MassDEP, as appropriate, unless that period is modified by written agreement between the Parties. EPA shall maintain an administrative record of the dispute,

which shall contain all statements of the Parties, including supporting documentation, submitted pursuant to this Section.

87. In the event that the City elects to invoke dispute resolution pursuant to this Section, the City shall do so by giving the United States and the Commonwealth written notice of the existence of the dispute within 10 Days after the occurrence of an event for which this Consent Decree provides for the invocation of dispute resolution. If the City fails to give such notice, it shall be deemed to have waived any right to invoke dispute resolution regarding such dispute, and the position advanced by the United States or the United States and the Commonwealth as appropriate shall be considered binding.

88. If the Parties cannot resolve a dispute by informal negotiations, then the position advanced by EPA, or EPA and MassDEP, as appropriate, shall be considered binding unless, within 30 Days after the conclusion of the informal negotiation period, as extended by the agreement of the Parties, the City seeks judicial review of the dispute by filing with the Court and serving on the United States, or the United States and the Commonwealth, in accordance with Section XV (Form of Notice), below, a motion requesting judicial resolution of the dispute. Any such motion shall contain a written statement of the City's position on the matter in dispute, including any factual data, documentation, analysis or opinion related to the dispute, and shall set forth the relief requested and any schedule within which the dispute must be resolved for orderly implementation of this Consent Decree.

89. The United States, or the United States and the Commonwealth, as appropriate, shall respond to the City’s motion within the time period allowed by the Federal Rules of Civil

Procedure and the Local Rules of this Court. The City may file a reply memorandum, to the extent permitted by the Federal Rules of Civil Procedure and the Local Rules.

90. Standard of Review.

a. Disputes Concerning Matters Accorded Record Review. Except as otherwise provided in this Consent Decree, any dispute brought under this Section pertaining to the adequacy or appropriateness of plans, procedures to implement plans, schedules, or any other items requiring approval by EPA and/or MassDEP under this Consent Decree; the adequacy of the performance of work undertaken pursuant to this Consent Decree; and all other disputes that are accorded review on the administrative record under applicable principles of administrative law; the City shall have the burden of demonstrating, based upon the administrative record, that the United States' or the United States' and the Commonwealth's positions are arbitrary and capricious or otherwise not in accordance with law.

b. Other Disputes. Except as otherwise provided in this Consent Decree, in any other dispute brought under this Section, the City shall bear the burden of demonstrating that its position complies with this Consent Decree, furthers the objectives of this Consent Decree more positively than the position advanced by the United States and the Commonwealth, and that the City is entitled to relief under applicable principles of law.

91. The invocation of dispute resolution procedures under this Section shall not, by itself, extend, postpone, or affect in any way any obligation of the City under this Consent Decree, unless and until final resolution of the dispute so provides. Stipulated penalties with respect to the disputed matter shall continue to accrue from the first Day of noncompliance, but payment shall be stayed pending resolution of the dispute as provided in Paragraph 76, above. If

the City does not prevail on the disputed issue, stipulated penalties shall be assessed and paid as provided in Section XI (Stipulated Penalties).

XIV. RIGHT OF ENTRY/INFORMATION COLLECTION AND RETENTION

92. EPA and MassDEP and their contractors, consultants, and attorneys shall have authority to enter any property and/or facility owned or controlled by the City, at all reasonable times, upon proper identification, for the purposes of: (a) monitoring the progress of activity required by this Consent Decree; (b) verifying any data or information submitted to EPA or MassDEP under this Consent Decree; (c) assessing the City's compliance with this Consent Decree; (d) obtaining samples and, upon request, splits of any samples taken by the City or its contractors or consultants; and (e) obtaining documentary evidence, including photographs and similar data. Upon request, EPA and MassDEP shall provide the City splits of any samples taken by EPA or MassDEP.

93. Until five years after the complete termination of this Consent Decree, the City shall retain all non-identical copies of all documents, records, or other information (including documents, records, or other information in electronic form) generated by the City, and all data collected and all reports generated by the City's consultants or contractors (including data and reports in electronic form), that relate in any manner to the City's performance of its obligations under this Consent Decree. This information retention requirement shall apply regardless of any contrary corporate or institutional policies or procedures. At any time during this information-retention period, upon request by the United States or the Commonwealth, the City shall provide copies of any documents, records, or other information required to be maintained under this Paragraph.

94. At the conclusion of the information-retention period provided in the preceding Paragraph, the City shall notify the United States and the Commonwealth at least 90 Days prior to the destruction of any documents, records, or other information subject to the requirements of the preceding Paragraph and, upon request by the United States or the Commonwealth, the City shall deliver any such documents, records, or other information to EPA or MassDEP. The City may assert that certain documents, records, or other information are privileged under the attorney-client privilege or any other privilege recognized by federal law. If the City asserts such a privilege, it shall provide the following: (a) the title of the document, record or information; (b) the date of the document, record, or information; (c) the name and title of each author of the document, record, or information; (d) the name and title of each addressee and recipient; (e) a description of the subject of the document, record, or information; and (f) the privilege asserted by the City. However, no documents, records, data, reports or other information created or generated pursuant to the requirements of this Consent Decree shall be withheld on grounds of privilege.

95. This Consent Decree in no way limits or affects any right of entry and inspection, or any right to obtain information, held by the United States or the Commonwealth pursuant to applicable federal or state laws, regulations, or permits, nor does it limit or affect any duty or obligation of the City to maintain documents, records, or other information imposed by applicable federal or state laws, regulations, or permits.

XV. FORM OF NOTICE

96. Unless otherwise specified herein, whenever notifications, submissions, or communications are required by this Consent Decree, they shall be made in writing to the

following respective addressees. Any Party may, by written notice to the other Parties, change its designated notice recipient, address, or means of notice (including the substitution of electronic notice via email instead of notice via mail). Notifications, submissions, or communications submitted pursuant to this Section shall be deemed submitted upon mailing, unless otherwise provided in this Consent Decree or by written agreement of the Parties.

As to the Department of Justice:

Chief, Environmental Enforcement Section
Environment & Natural Resources Division
United States Department of Justice
P.O. Box 7611 – Ben Franklin Station
Washington, DC 20044

As to the United States Attorney:

United States Attorney
District of Massachusetts
One Courthouse Way
John Joseph Moakley Courthouse
Boston, MA 02210
Attention: Susan Poswistilo

As to EPA:

Joy Hilton
Enforcement Officer
Water Technical Unit
U.S. Environmental Protection Agency, Region 1
5 Post Office Square – Suite 100
Mail Code OES04-4
Boston, MA 02109-3912
hilton.joy@epa.gov

Michael Wagner
Senior Enforcement Counsel
Office of Environmental Stewardship
U.S. Environmental Protection Agency, Region 1
5 Post Office Square – Suite 100
Mail Code OES04-1
Boston, MA 02109-3912
wagner.michael@epa.gov

As to MassDEP:

Kevin Brander, P.E.
Section Chief
Wastewater Management Section
MassDEP/NERO
205B Lowell Street
Wilmington, MA 01887
kevin.brander@state.ma.us

As to the Office of the Massachusetts Attorney General:

I. Andrew Goldberg
Assistant Attorney General
Environmental Protection Division
Massachusetts Attorney General's Office
One Ashburton Place, 18th Flr.
Boston, MA 02108
andy.goldberg@state.ma.us

As to the City of Haverhill:

Office of the Mayor
City of Haverhill
City Hall, Room 100
Four Summer Street
Haverhill, MA 01830
Mayor@CityofHaverhill.com

Robert E. Ward
Deputy DPW Director
City of Haverhill
40 South Porter Street
Haverhill, MA 01835
rward@haverhillwater.com

William D. Cox, Jr.
City Solicitor
145 S. Main Street
Haverhill, MA 01835
billcoxlaw@aol.com

Michael A. Leon
Nutter McClennen & Fish LLP
Seaport West
155 Seaport Boulevard
Boston, MA 02210
mleon@nutter.com

97. The City shall submit all notifications, submissions, and communications required by this Consent Decree to EPA via electronic mail no later than the due date(s) specified in this Consent Decree, in accordance with the terms of this Paragraph. The City shall provide complete copies to both Joy Hilton and Michael Wagner of all submissions and notices required to be made by the City to EPA pursuant to this Consent Decree; except that with respect to copies of reports, schedules, plans, and other items required pursuant to Sections VII (Remedial Measures) and VIII (Compliance Reporting), only copies of the transmittal letters need be provided to Michael Wagner. If a submission or notice cannot be provided via electronic mail due to its size, an electronic copy shall be provided by CD-ROM or other similar digital format.

98. The City shall provide complete copies to MassDEP of all notifications, submissions and communications required by this Consent Decree by electronic mail no later than the due date(s) specified in this Consent Decree. If a submission or notice cannot be provided via electronic mail due to its size, an electronic copy shall be provided by CD-ROM or other similar digital format. In addition, the City shall provide a single hard copy of all notifications, submissions, and communications to Kevin Brander.

99. All written reports or submissions required of the City by this Consent Decree shall contain the following certification signed by a duly authorized representative of the City:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

XVI. EFFECT OF SETTLEMENT/RESERVATION OF RIGHTS

100. This Consent Decree resolves the civil claims of the United States and the Commonwealth for the violations alleged in their respective Complaints filed in this action through the Date of Lodging.

101. This Consent Decree is neither a permit nor a modification of any existing permit under any federal, state, or local law or regulation. The City is responsible for achieving and maintaining complete compliance with all applicable federal, state, and local laws and regulations, and permits, and the City's compliance with this Consent Decree shall be no defense to any action commenced pursuant to any such laws, regulations, or permits, except as set forth herein. The United States and the Commonwealth do not, by their consent to the entry of this Consent Decree, warrant or aver in any manner that the City's compliance with any aspect of this Consent Decree will result in compliance with provisions of the CWA or the Massachusetts Act or with any other provisions of federal, state, or local laws, regulations, or permits. This Consent Decree shall not be construed to constitute Approval by EPA or Approval by EPA and MassDEP of any equipment or technology installed by the City under the terms of this Consent Decree.

102. This Consent Decree does not limit any rights or remedies available to the United States or the Commonwealth for any violation by the City of the CWA, the Massachusetts Act, or associated regulations or permit conditions other than those claims alleged in the Complaints through the Date of Lodging. This Consent Decree does not limit any rights or remedies available to the United States or the Commonwealth for any criminal violations. The United States and the Commonwealth expressly reserve all rights and remedies, legal and equitable, available to each of them for all violations of the CWA, the Massachusetts Act, or other applicable law, except with respect to violations that have been specifically resolved pursuant to Paragraph 100, and reserve all rights and remedies, legal and equitable, available to enforce the provisions of this Consent Decree, including the provisions of any plan or schedule Approved by EPA or Approved by EPA and MassDEP under this Consent Decree. Nothing herein shall be construed to limit the power of the United States or the Commonwealth, consistent with their respective authorities, to undertake any action against any person, in response to conditions which may present an imminent and substantial endangerment to the public's health or welfare, or the environment.

103. In any subsequent administrative or judicial proceeding initiated by one or more of the United States and the Commonwealth for injunctive relief, civil penalties, or other appropriate relief relating to the City's violations of federal or state law, the City shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, res judicata, collateral estoppel, issue preclusion, claim preclusion, claim-splitting, or other defenses based upon any contention that the claims raised by one or more of the United States and the Commonwealth in the subsequent proceeding were or should have been brought in the instant

case, except with respect to claims that have been specifically resolved pursuant to Paragraph 100.

104. This Consent Decree does not resolve any claims for contingent liability under Section 309(e) of the Clean Water Act, 33 U.S.C. § 1319(e). The United States specifically reserves any such claims against the Commonwealth.

105. This Consent Decree does not limit or affect the rights of the City or the United States and the Commonwealth against any third parties not party to this Consent Decree, nor does it limit the rights of third parties not party to this Consent Decree against the City, except as otherwise provided by law.

106. This Consent Decree shall not be construed to create rights in, or grant any cause of action to, any third party not party to this Consent Decree.

XVII. COSTS

107. Each Party shall bear its own expenses, costs, and attorneys' fees in this action. The City shall be responsible for all expenses, costs and attorneys' fees incurred by the United States or the Commonwealth in collecting any penalties due and payable under Sections VI (Civil Penalty) and XI (Stipulated Penalties) of this Consent Decree.

XVIII. EFFECTIVE DATE

108. The Effective Date of this Consent Decree shall be the date upon which this Consent Decree is entered by the Court or a motion to enter this Consent Decree is granted, whichever occurs first, as recorded on the Court's docket.

XIX. RETENTION OF JURISDICTION

109. The Court shall retain jurisdiction to modify and enforce the terms and conditions of this Consent Decree and to resolve disputes arising hereunder as may be necessary or appropriate for the construction or execution of this Consent Decree, and to assess any stipulated penalties that may have accrued pursuant to Section XI (Stipulated Penalties) of this Consent Decree.

XX. MODIFICATION

110. The terms of this Consent Decree, including any modifications to any schedule specified in this Consent Decree or to any appendix, may be modified only by a subsequent written agreement signed by all the Parties. Where the modification constitutes a material change to this Consent Decree, it shall be effective only upon approval by the Court. Non-material changes to this Consent Decree (including appendices) may be made by written agreement of the Parties without court approval. In the event a dispute arises concerning modification of this Consent Decree, the Party seeking the modification bears the burden of demonstrating that it is entitled to the requested modification in accordance with Federal Rule of Civil Procedure 60(b). Changes to names and addresses in Section XV (Form of Notice) may be accomplished by written notice to the other parties by the Party initiating the change.

111. It is the intention of the Parties to this Consent Decree that the City shall have the opportunity, consistent with applicable law, to conform compliance with this Consent Decree with any modification in EPA's regulations or national policies governing the frequency, volume and duration of discharges from the City's Combined Sewer System and Bypasses of secondary treatment at the POTW's treatment plant; to conform compliance with this Consent Decree with

any applicable new or revised water quality standards that have been approved or promulgated by EPA in accordance with 33 U.S.C. § 1313(c) and 40 C.F.R. §§ 131.21 and 131.22; and to conform compliance with this Consent Decree with any new or revised requirements, whether such requirements are more stringent or more lenient, that are included in the POTW Permit and the Small MS4 General Permit. Consequently, upon issuance of any new federal regulation (as promulgated in the Federal Register), whether such regulations are more stringent or more lenient than current federal law or regulation or national policy governing the frequency, volume and duration of discharges from the City's Combined Sewer System and bypasses of secondary treatment at the POTW's treatment plant; upon EPA approval or promulgation of new or revised water quality standards in accordance with 33 U.S.C. § 1313(c) and 40 C.F.R. §§ 131.21 and 131.22; or upon the issuance of a permit that contains new or revised requirements, whether such requirements are more stringent or more lenient, pertaining to the POTW's treatment plant or Combined Sewer System, the City may request modification of this Consent Decree (including requests for extensions of time) to conform compliance with this Consent Decree with such regulation, national policy, new or revised water quality standard or permit. For purposes of this Paragraph, "national policy" refers to a formal written policy statement issued by the Assistant Administrator for the Office of Water and the Assistant Administrator for the Office of Enforcement and Compliance Assurance or their designees. Upon the City's request, EPA, MassDEP and the City shall discuss the matter. If the Parties agree on a proposed modification to this Consent Decree, they shall prepare a joint motion to the Court requesting such modification.

112. If the Parties do not agree, and the City still believes that modification of this Consent Decree is appropriate, the City may file a motion seeking such modification in accordance with Federal Rule of Civil Procedure 60(b); provided, however, that nothing in this subparagraph is intended to waive the United States' or the Commonwealth's rights to oppose such motion and to argue that such modification is unwarranted.

113. Following the filing of a motion under Rule 60(b), stipulated penalties shall accrue due to the City's failure, if any, to continue performance of obligations under this Consent Decree that are necessarily the subject of the Rule 60(b) motion; provided, however, that such penalties need not be paid unless the Court resolves the motion in the United States' or the United States' and Commonwealth's favor. If the Court resolves the motion in the City's favor, the City shall comply with this Consent Decree as modified.

XXI. FUNDING

114. Performance of the terms of this Consent Decree by the City is not conditioned on the receipt of any federal or state grant funds or loans, or other financing. In addition, performance is not excused by the lack of federal or state grant funds or loans.

XXII. SEVERABILITY

115. The provisions of this Consent Decree shall be severable, and should any provision be declared by the Court to be unenforceable, the remaining provisions shall remain in full force and effect.

XXIII. TERMINATION

116. After the City completes all of the requirements of sub-sections "A" through "L" of Section VII (Remedial Measures) (such sub-sections are designated with capitalized letters),

complies with all other requirements of this Consent Decree, has paid in full the Civil Penalty, and all accrued interest thereon, if any, and all stipulated penalties, if any, and all accrued interest thereon, if any, as required by Sections VI (Civil Penalty) and XI (Stipulated Penalties) of this Consent Decree, and has paid in full the costs of litigation, and all accrued interest thereon, as required by Paragraph 107 of this Consent Decree, the City may serve upon the United States and the Commonwealth a Request for Partial Termination, stating that the City has satisfied those requirements, together with all applicable supporting documentation.

117. On or after June 1, 2031, if the City has completed all of the requirements of Section VII (Remedial Measures) through that date, has satisfactorily maintained continuous satisfactory compliance with those and all other requirements of this Consent Decree and the POTW Permit and the Small MS4 General Permit for a period of one year, has paid in full the Civil Penalty, and all accrued interest thereon, if any, and all stipulated penalties accrued to date, if any, and all accrued interest thereon, if any, as required by Sections VI (Civil Penalty) and XI (Stipulated Penalties) of this Consent Decree, has paid in full the costs of litigation, and all accrued interest thereon, as required by Paragraph 107 of this Consent Decree, and has fulfilled its obligations required by Section VIII (Supplemental Environmental Project) of this Consent Decree, the City may serve upon the United States and the Commonwealth a Request for Complete Termination, stating that the City has satisfied those requirements, together with all applicable supporting documentation.

118. Following receipt by the United States and the Commonwealth of any City Request for Termination, whether a Request for Partial Termination or Request for Complete Termination, the Parties shall confer informally concerning the Request for Termination and any

disagreement that they may have as to whether the City has satisfied the requirements for a partial or complete termination of this Consent Decree. The United States and the Commonwealth shall consult as to whether the City has satisfied the requirements for termination contained in Paragraphs 116 or 117 above. If after consultation, the Parties agree that this Consent Decree may be terminated, in part or in whole, the Parties shall submit, for the Court's approval, a joint stipulation terminating, if partial, the referenced sub-section(s) or, if complete, this Consent Decree.

119. If the United States and the Commonwealth do not agree that this Consent Decree may be terminated in part or in full, the City may invoke dispute resolution under Section XIII (Dispute Resolution). However, the City shall not seek dispute resolution of any dispute regarding termination until 60 Days after service of its Request for Termination.

XXIV. FINAL JUDGMENT

120. Entry of this Consent Decree constitutes Final Judgment under Rule 54 of the Federal Rules of Civil Procedure. The City agrees to continue to implement requirements developed under and imposed by this Consent Decree following its termination.

XXV. WAIVER OF SERVICE

121. The City hereby agrees to accept service of process by mail with respect to all matters arising under or relating to this Consent Decree and to waive the formal service requirements set forth in Rules 4 and 5 of the Federal Rules of Civil Procedure and any applicable Local Rules of this Court including, but not limited to, service of a summons.

XXVI. PUBLIC COMMENT

122. This Consent Decree shall be lodged with the Court for a period of not less than thirty (30) Days for public notice and comment in accordance with 28 C.F.R. § 50.7. The United States reserves the right to withdraw or withhold its consent if the comments received disclose facts or considerations that indicate that this Consent Decree is inappropriate, improper, or inadequate. The City consents to the entry of this Consent Decree without further notice and agrees not to withdraw from or oppose entry of this Consent Decree by the Court or to challenge any provision of this Decree, unless the United States has notified the Parties in writing that it no longer supports entry of this Consent Decree.

XXVII. SIGNATORIES

123. Each undersigned representative certifies that he or she is fully authorized to enter into the terms and conditions of this Consent Decree and to execute and legally bind the Party he or she represents to this document.

XXVIII. INTEGRATION

124. This Consent Decree may be signed in counterparts, and its validity shall not be challenged on that basis.

125. This Consent Decree constitutes the final, complete, and exclusive agreement and understanding among the Parties with respect to the settlement embodied in this Consent Decree and supersedes all prior agreements and understandings, whether oral or written, concerning the settlement embodied herein. Other than submissions that are subsequently submitted and Approved by EPA or Approved by EPA and MassDEP pursuant to this Consent Decree, no other document, nor any representation, inducement, agreement, understanding, or promise, constitutes

any part of this Consent Decree or the settlement it represents, nor shall it be used in construing the terms of this Consent Decree.

XXIX. APPENDICES

126. The following appendices are attached to and part of this Consent Decree:

a. Appendix 1 is EPA Region 1's draft Bacterial Source Tracking Protocol dated January 2012;

b. Appendix 2 is EPA's Guide for Evaluating Capacity, Management, Operation, and Maintenance Programs at Sanitary Sewer Collection Systems (EPA 305-B-05-002, January 2005);

c. Appendix 3 is the CMOM Program Self-Assessment Checklist, an EPA Region 1 modification of the checklist that accompanies the guidance in Appendix 2;

d. Appendix 4 is list of recipients of email notifications concerning CSO discharges;

e. Appendix 5 is the City's letter of June 17, 2013 to EPA and MassDEP;

f. Appendix 6 is EPA and MassDEP comments to Phase II LTCP Plan (MassDEP letter dated February 14, 2013 to the City);

g. Appendix 7 is MassDEP's letter of December 29, 2014 to the City; and

h. Appendix 8 is the SEP Plan.

APPROVED AND ENTERED THIS 10th DAY OF November, 2016.

Indira Talwani
UNITED STATES DISTRICT JUDGE
District of Massachusetts

FOR PLAINTIFF, UNITED STATES OF AMERICA:

CARMEN M. ORTIZ
United States Attorney

SUSAN M. POSWISTILO (BBO #565581)
Assistant U.S. Attorney
John Joseph Moakley U.S. Courthouse
One Courthouse Way
Suite 9200
Boston, MA 02210
(617) 748-3103
susan.poswistilo@usdoj.gov

8/19/2016
Date

FOR PLAINTIFF, UNITED STATES OF AMERICA, continued:

JOHN C. CRUDEN
Assistant Attorney General
Environment and Natural Resources Division

Brian G. Donohue/rp ________________________ 8/19/2016 ________________
BRIAN G. DONOHUE Date
Senior Attorney
Environmental Enforcement Section
Environmental and Natural Resources Division
601 D. St., N.W.
Washington D.C. 20004
(202) 514-5413

For the UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, continued:

Susan Studlien ______________________ 02/18/2016
SUSAN STUDLIEN Date
Director
Office of Environmental Stewardship
United States Environmental Protection Agency, Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

For the UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

_________________________________ 7/7/16
MARK POLLINS Date
Division Director
Water Enforcement Division
Office of Civil Enforcement
Office of Enforcement and Compliance Assurance
United States Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

For the UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, continued:

Lourdes Bufill ______________________ 6/20/2016
Lourdes Bufill
Attorney
Water Enforcement Division
Office of Civil Enforcement
Office of Enforcement and Compliance Assurance
United States Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Date

For the COMMONWEALTH OF MASSACHUSETTS:

MAURA HEALEY
Attorney General

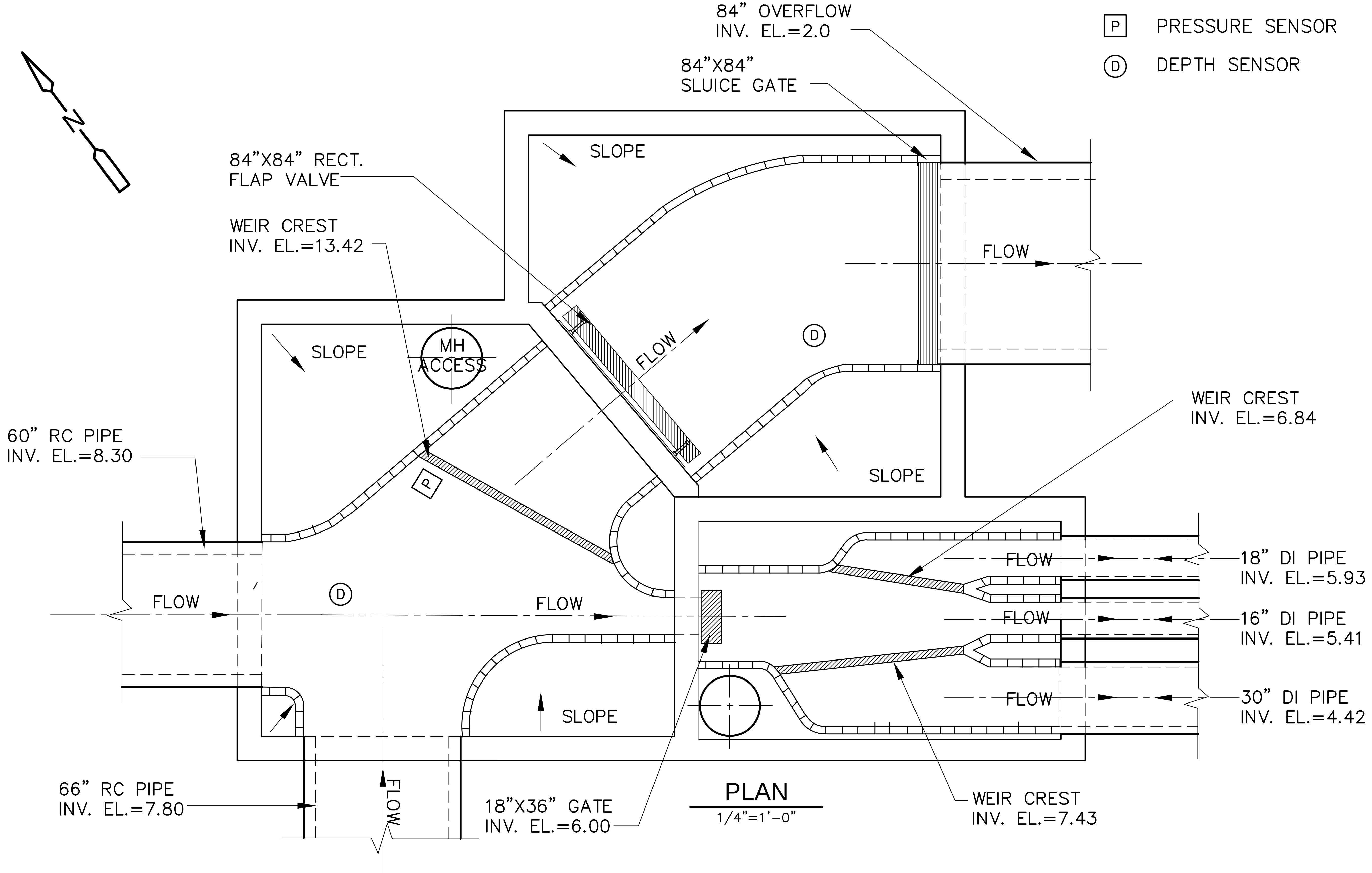
I. ANDREW GOLDBERG (BBO #560843)	8/19/16 Date

Assistant Attorney General
Environmental Protection Division
Office of the Attorney General
One Ashburton Place, 18th Floor
Boston, MA 02108
617-727-2200

For DEFENDANT CITY OF HAVERHILL, MASSACHUSETTS:

______________________________ 2/4/16
JAMES J. FIORENTINI Date
Mayor
City of Haverhill
City Hall – Room 100
4 Summer Street
Haverhill, MA 01830

Appendix B - CSO Regulator Drawings



CDM Smith

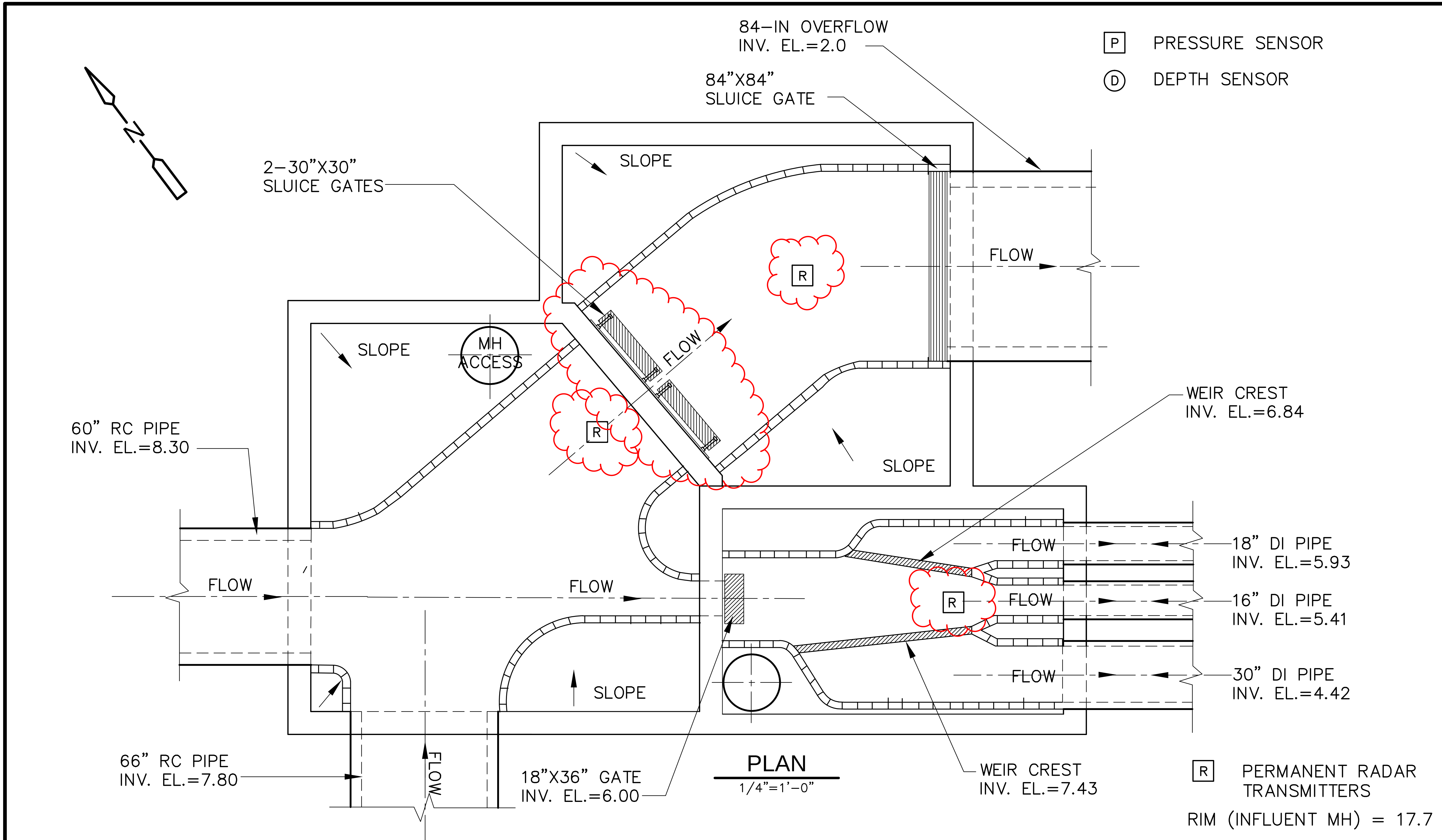
CITY OF HAVERHILL, MASSACHUSETTS

UPPER SIPHON CSO
(UPPER SIPHON AREA)

RIM = 17.7

CSO OUTFALL No. 024

FIGURE 1A



CDM Smith

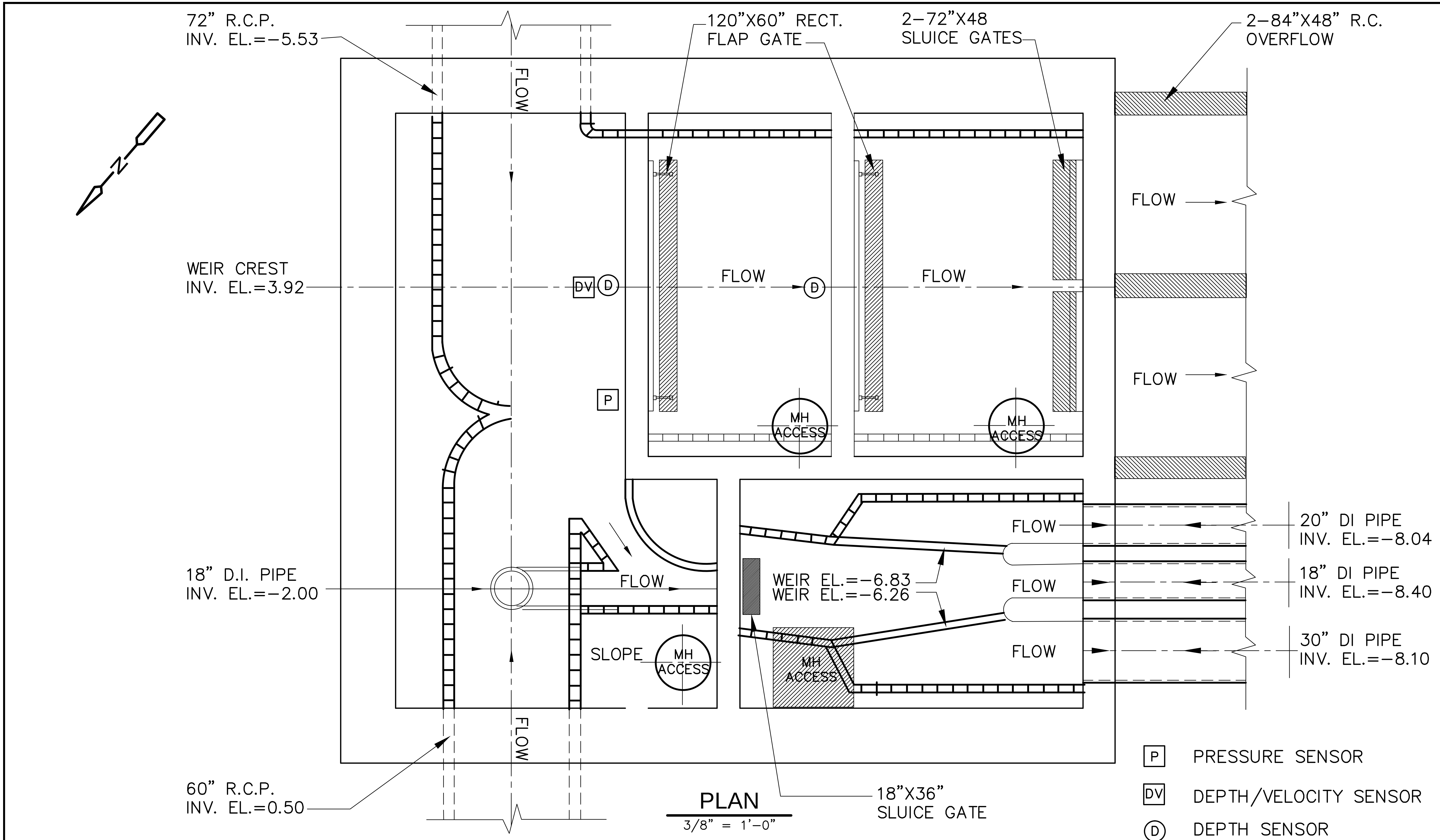
CITY OF HAVERHILL, MASSACHUSETTS

UPPER SIPHON CSO

WET WEATHER MAXIMIZATION/ CSO STRUCTURE MODIFICATIONS PROJECT IMPROVEMENTS

CSO OUTFALL No. 024

FIGURE 1B



CDM Smith

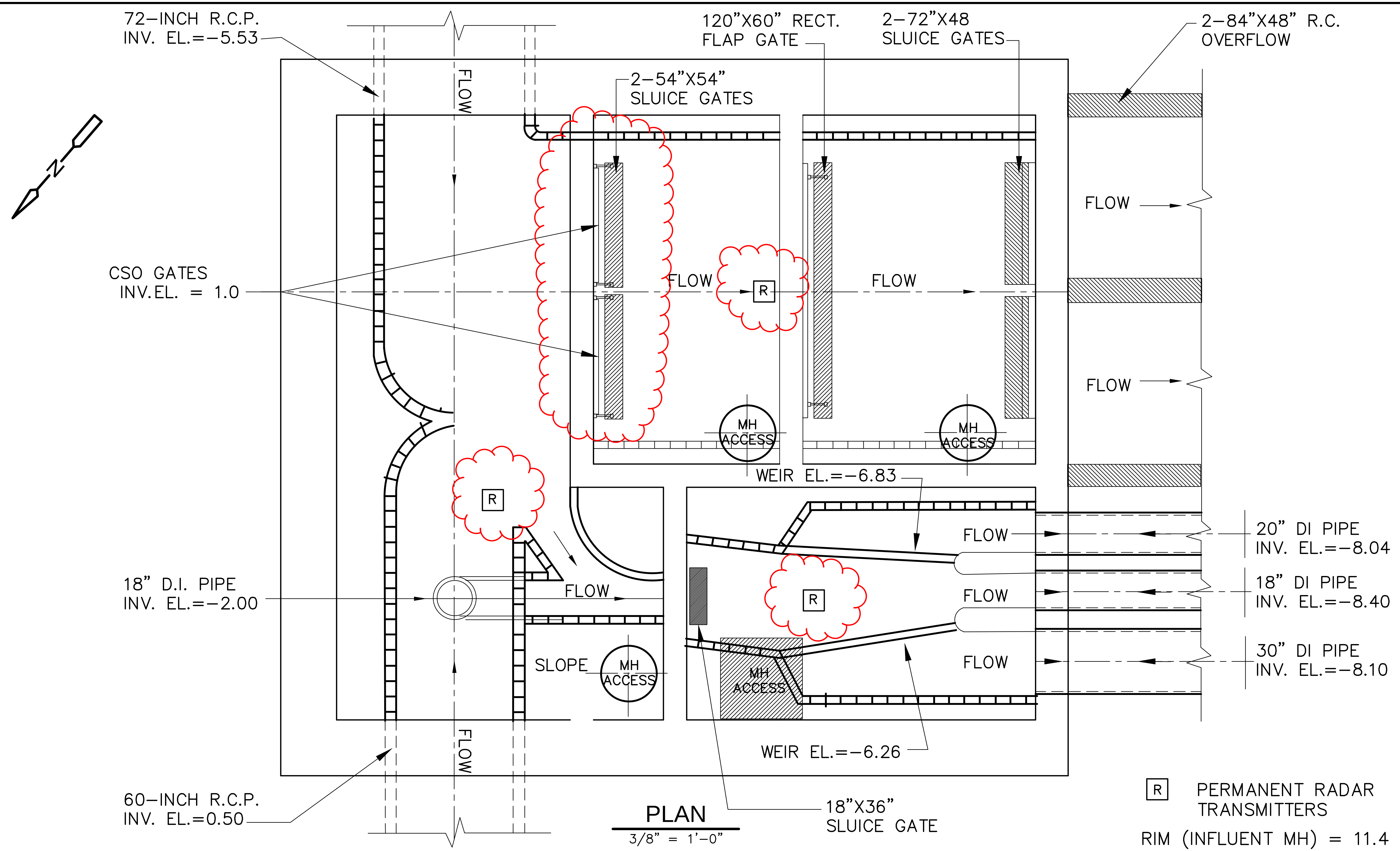
CITY OF HAVERHILL, MASSACHUSETTS

LOWER SIPHON STREET CSO
(LOWER SIPHON AREA)

RIM (INFLUENT MH) = 11.4

CSO OUTFALL No. 013

FIGURE 2A



CDM Smith

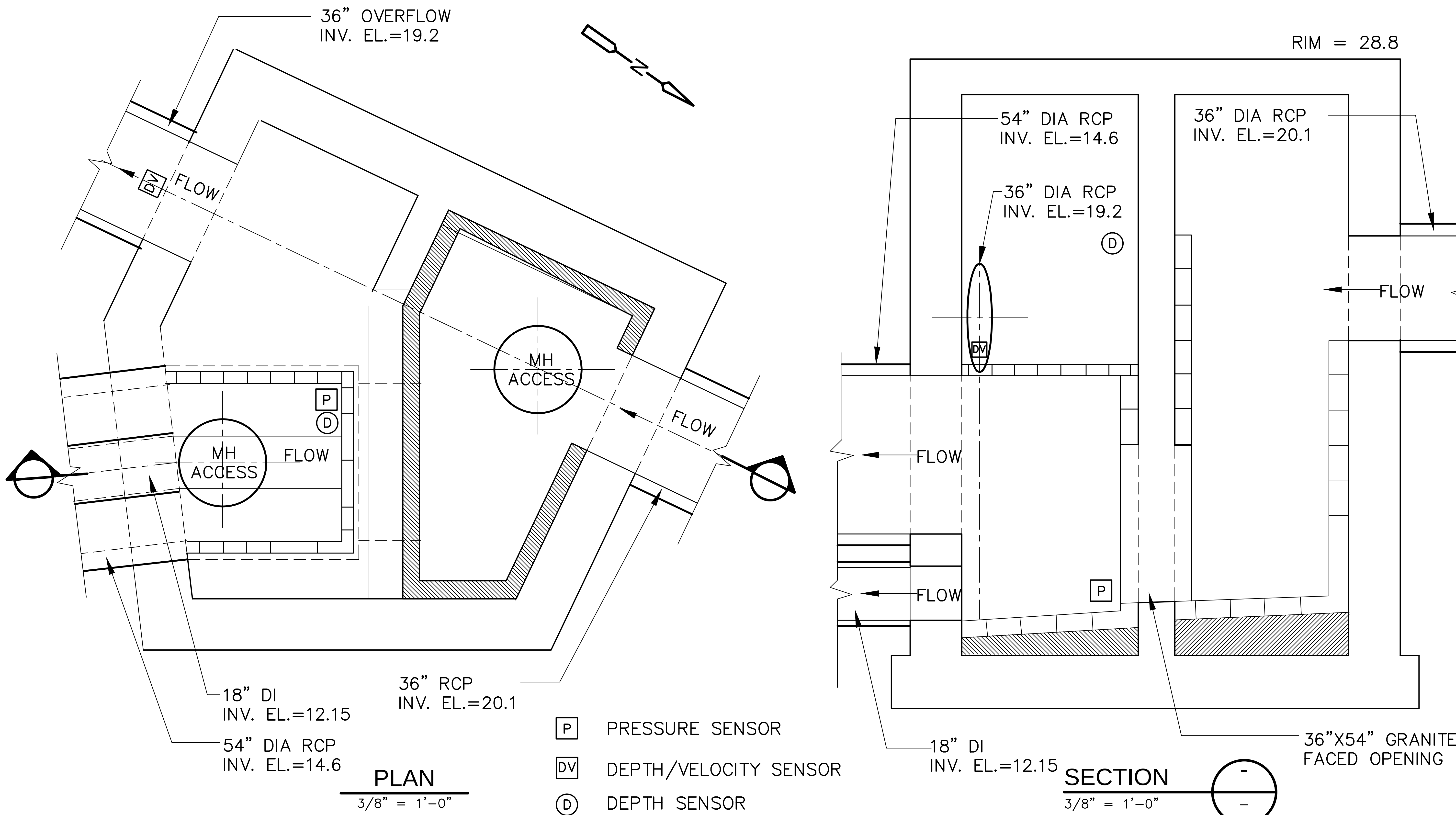
CITY OF HAVERHILL, MASSACHUSETTS

LOWER SIPHON STREET CSO

WET WEATHER MAXIMIZATION/ CSO STRUCTURE MODIFICATIONS PROJECT IMPROVEMENTS

CSO OUTFALL No. 013

FIGURE 2B



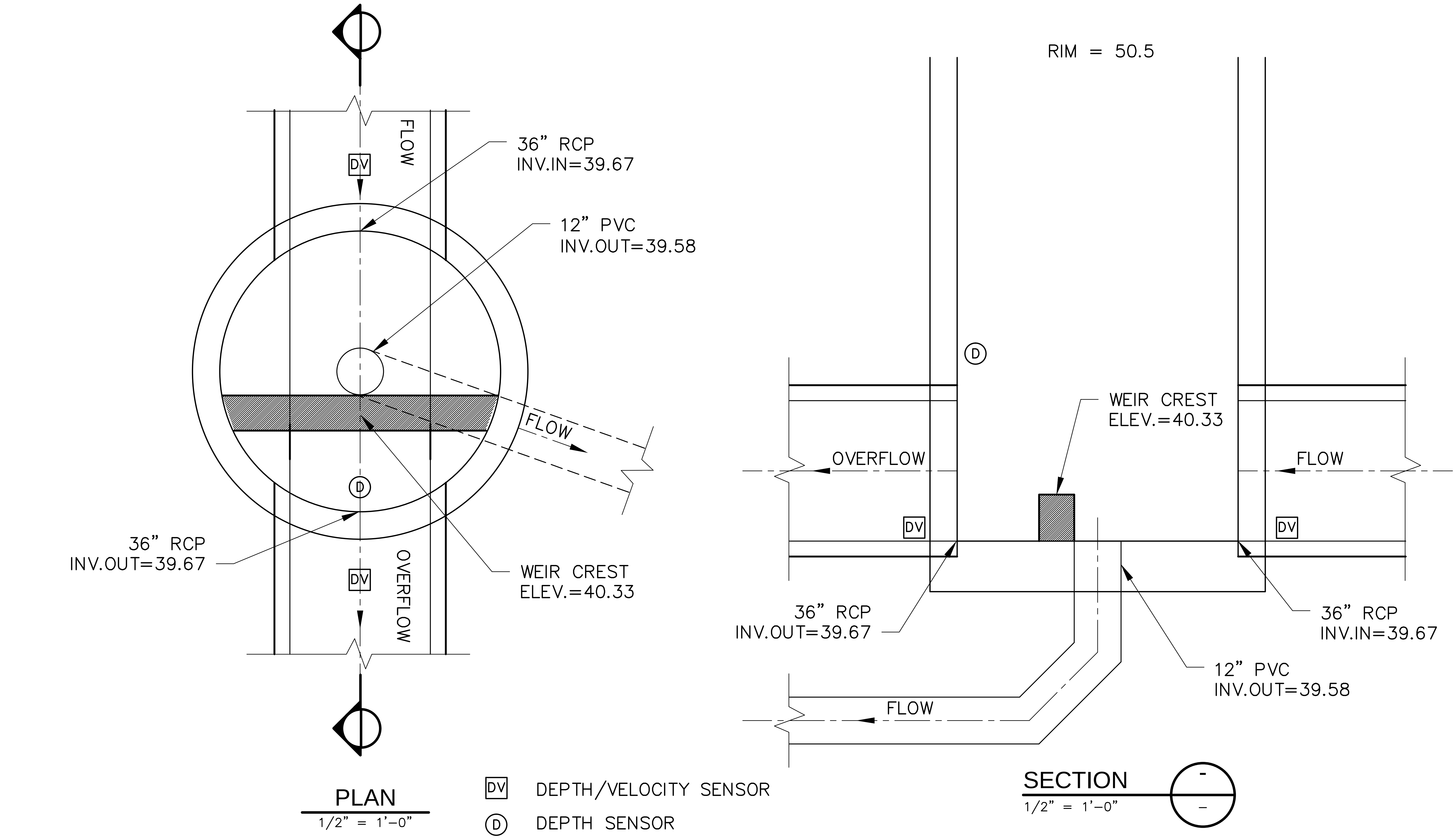
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

MAIN STREET - NORTH CSO
(LOWER SIPHON AREA)

CSO OUTFALL No. 019

FIGURE 3



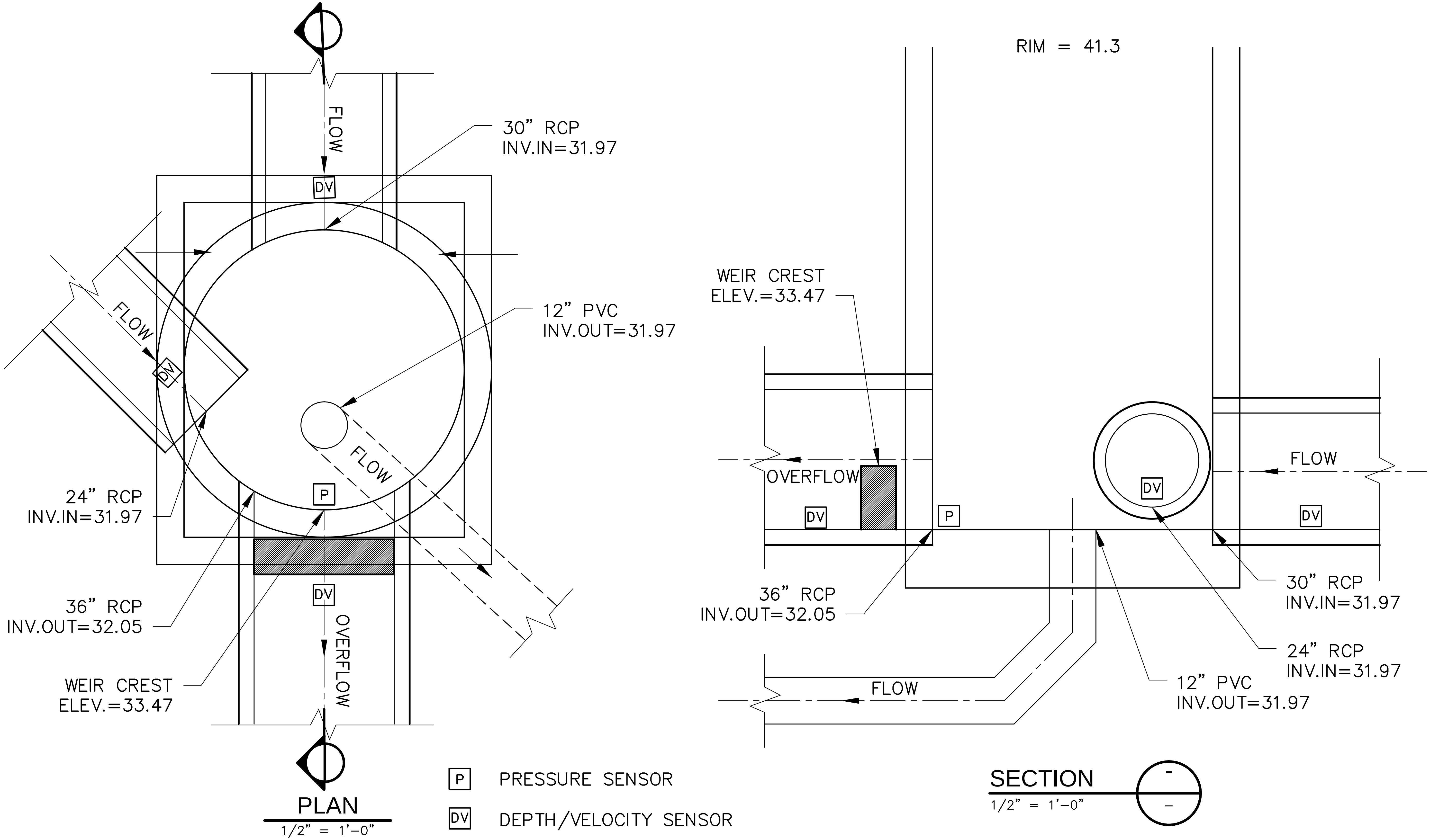
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

BETHANY AVENUE CSO
(LOWER SIPHON AREA)

CSO OUTFALL No. 040

FIGURE 4



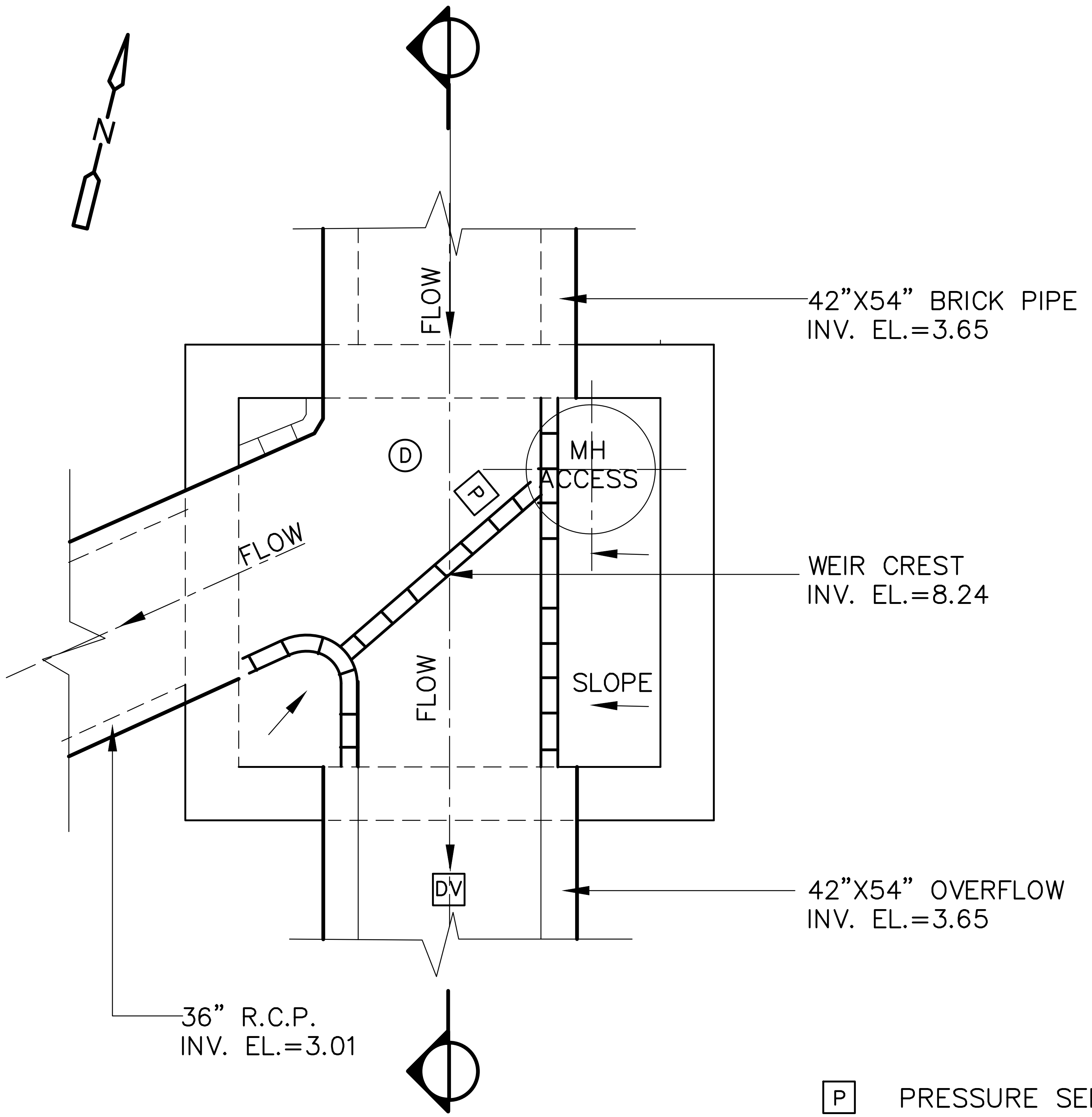
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

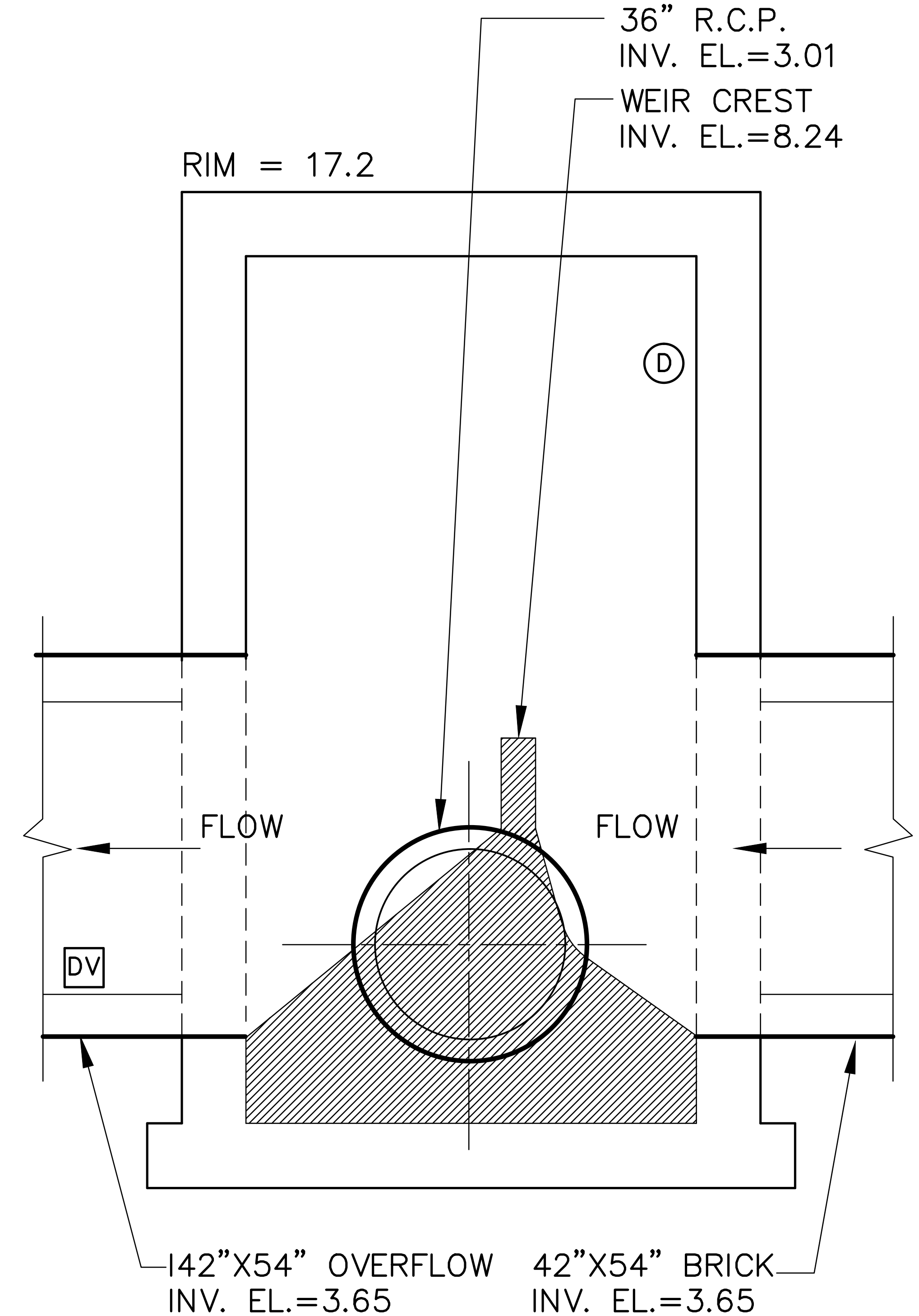
CHESTNUT STREET CSO
(LOWER SIPHON AREA)

CSO OUTFALL No. 041

FIGURE 5



PLAN
3/8" = 1'-0"



SECTION
3/8" = 1'-0"

P PRESSURE SENSOR

DV DEPTH/VELOCITY SENSOR

D DEPTH SENSOR

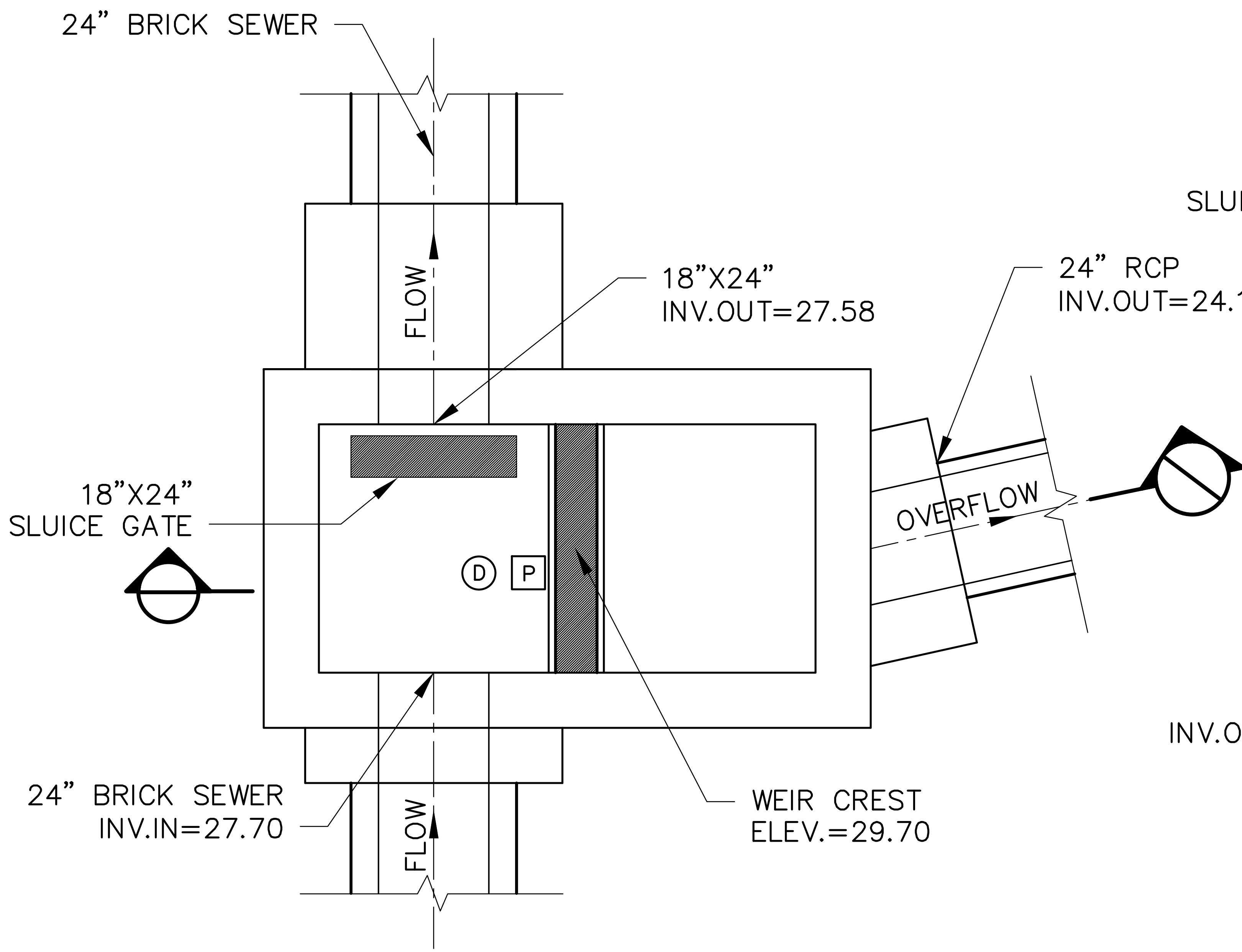
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

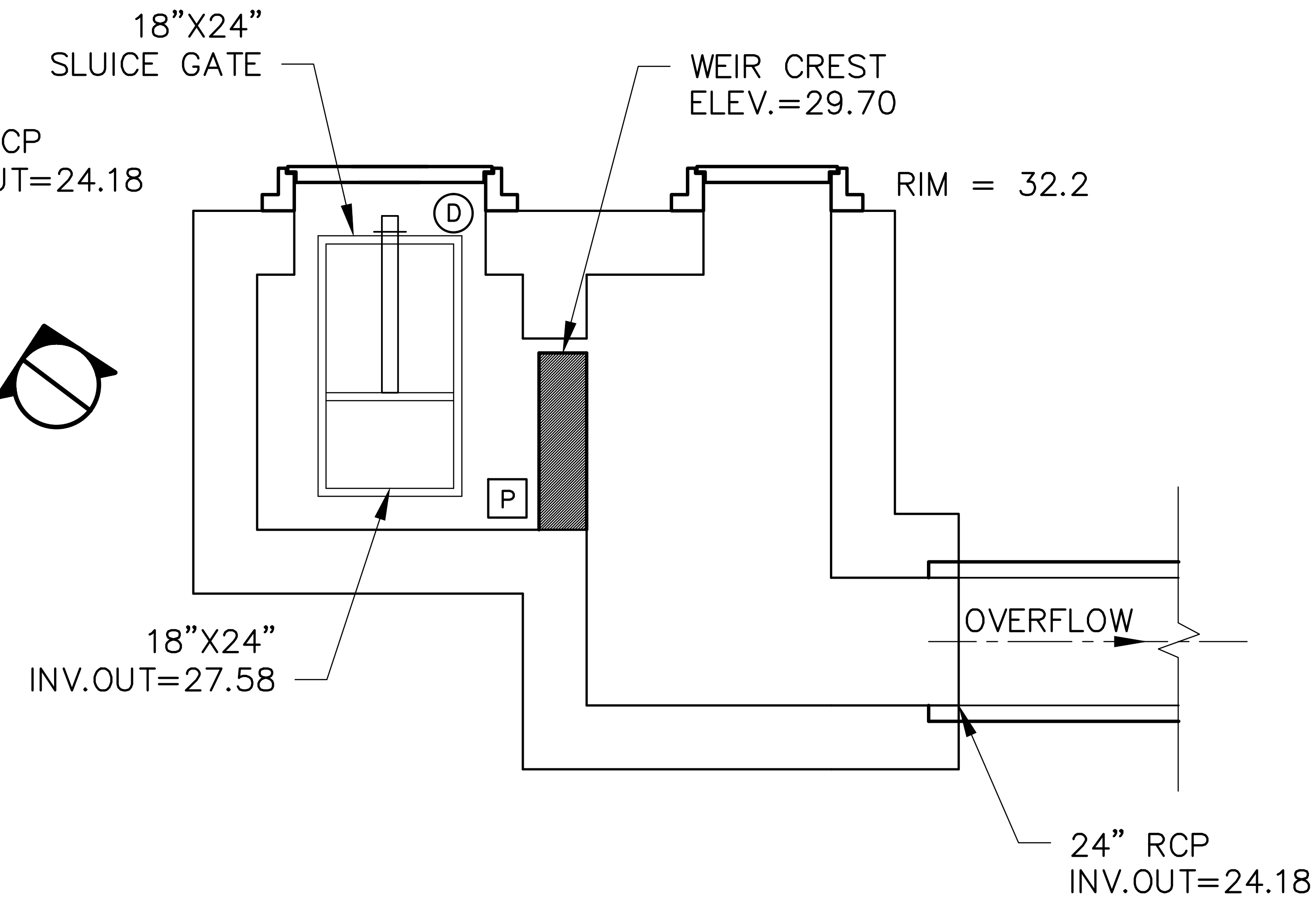
MIDDLE SIPHON CSO
(MIDDLE SIPHON AREA)

CSO OUTFALL No. 021A

FIGURE 6



PLAN
3/8" = 1'-0"



SECTION
3/8" = 1'-0"

P PRESSURE SENSOR

D DEPTH SENSOR

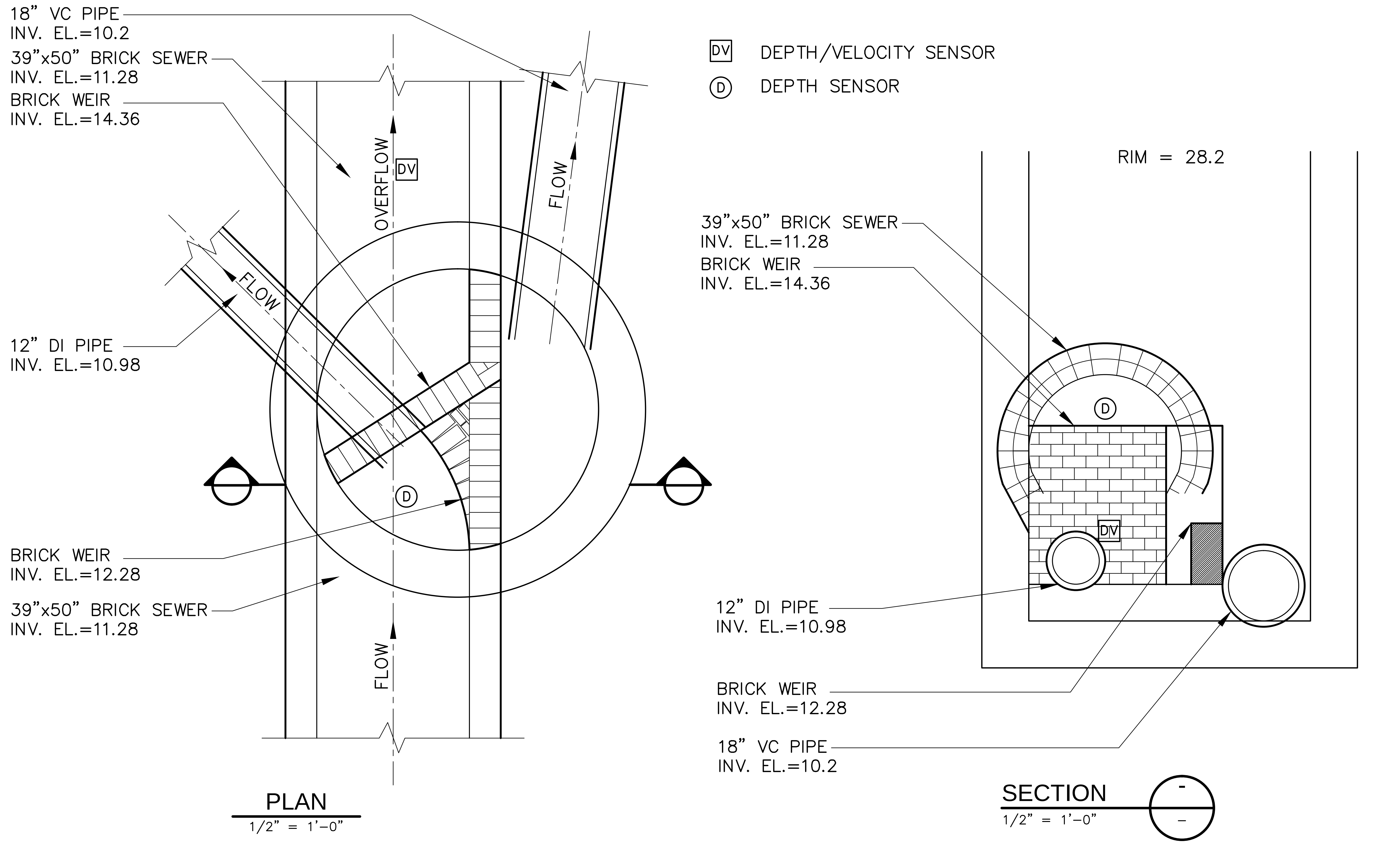
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

EMERSON STREET CSO
(MIDDLE SIPHON AREA)

CSO OUTFALL No. 021B

FIGURE 7



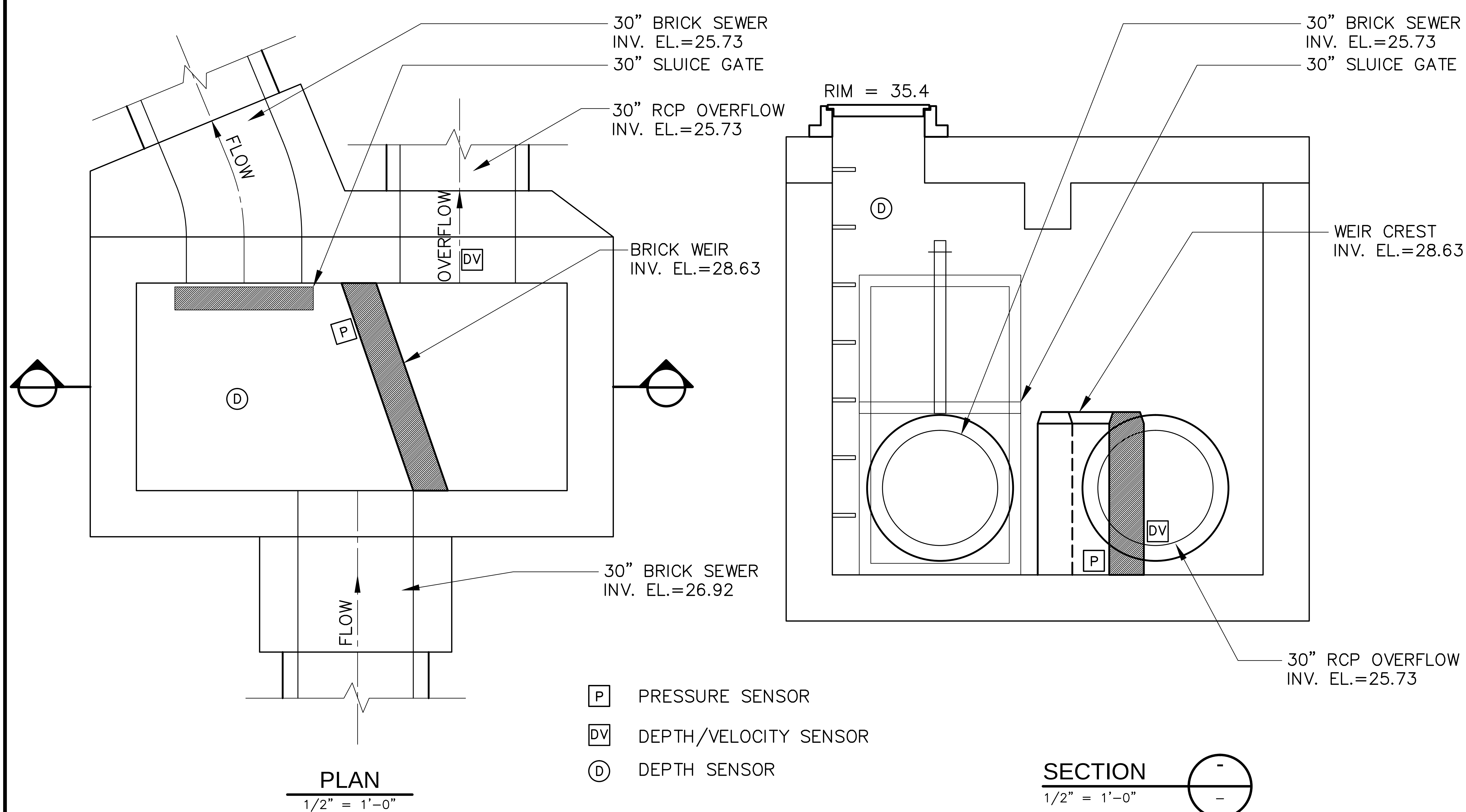
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

LOCKE STREET NORTH - ORCHARD STREET CENTER BARREL
(MIDDLE SIPHON AREA)

CSO OUTFALL No. 021D

FIGURE 8



P PRESSURE SENSOR

DV DEPTH/VELOCITY SENSOR

D DEPTH SENSOR

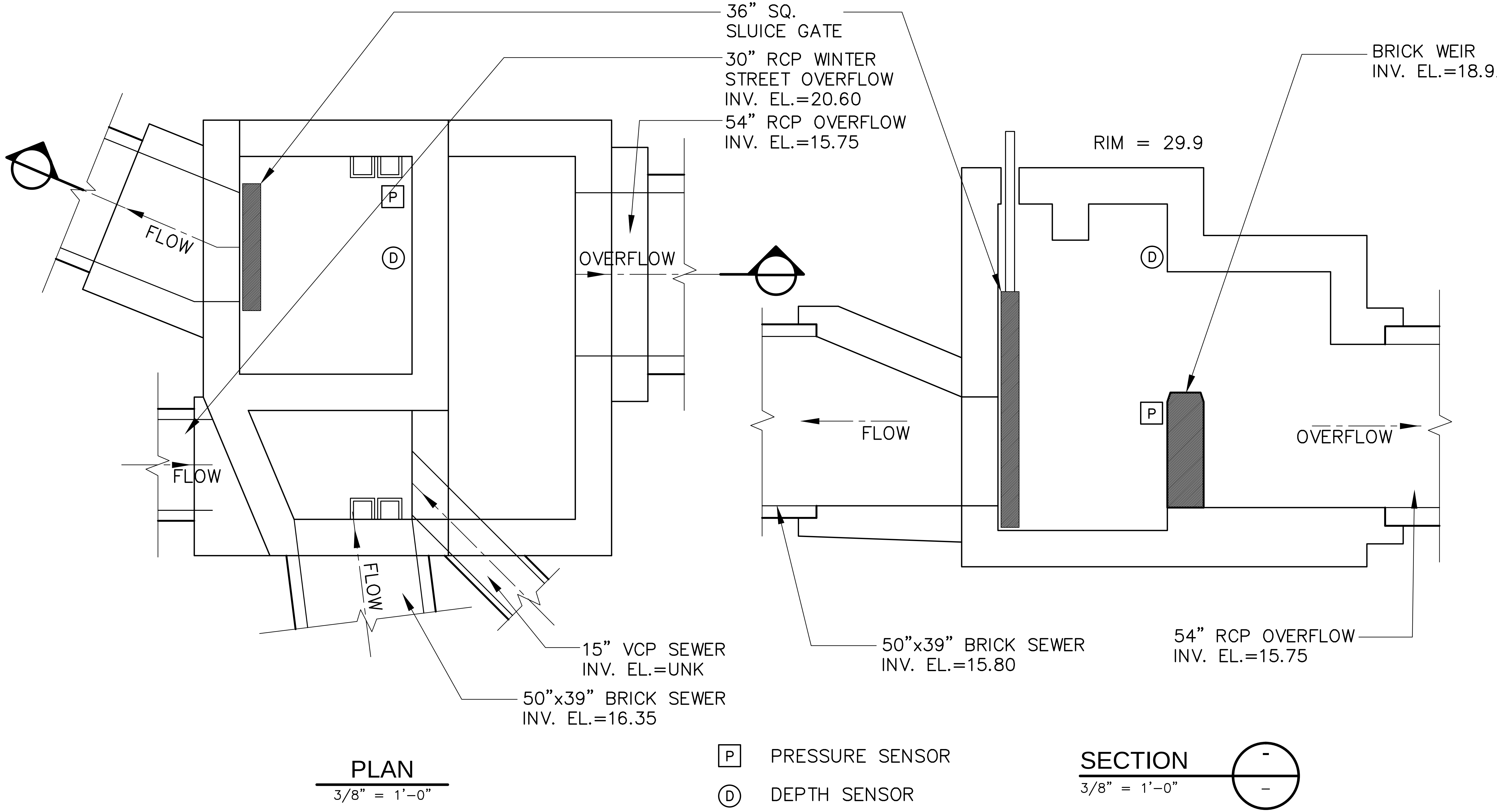
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

WINTER STREET CSO
(MIDDLE SIPHON AREA)

CSO OUTFALL No. 021H

FIGURE 9



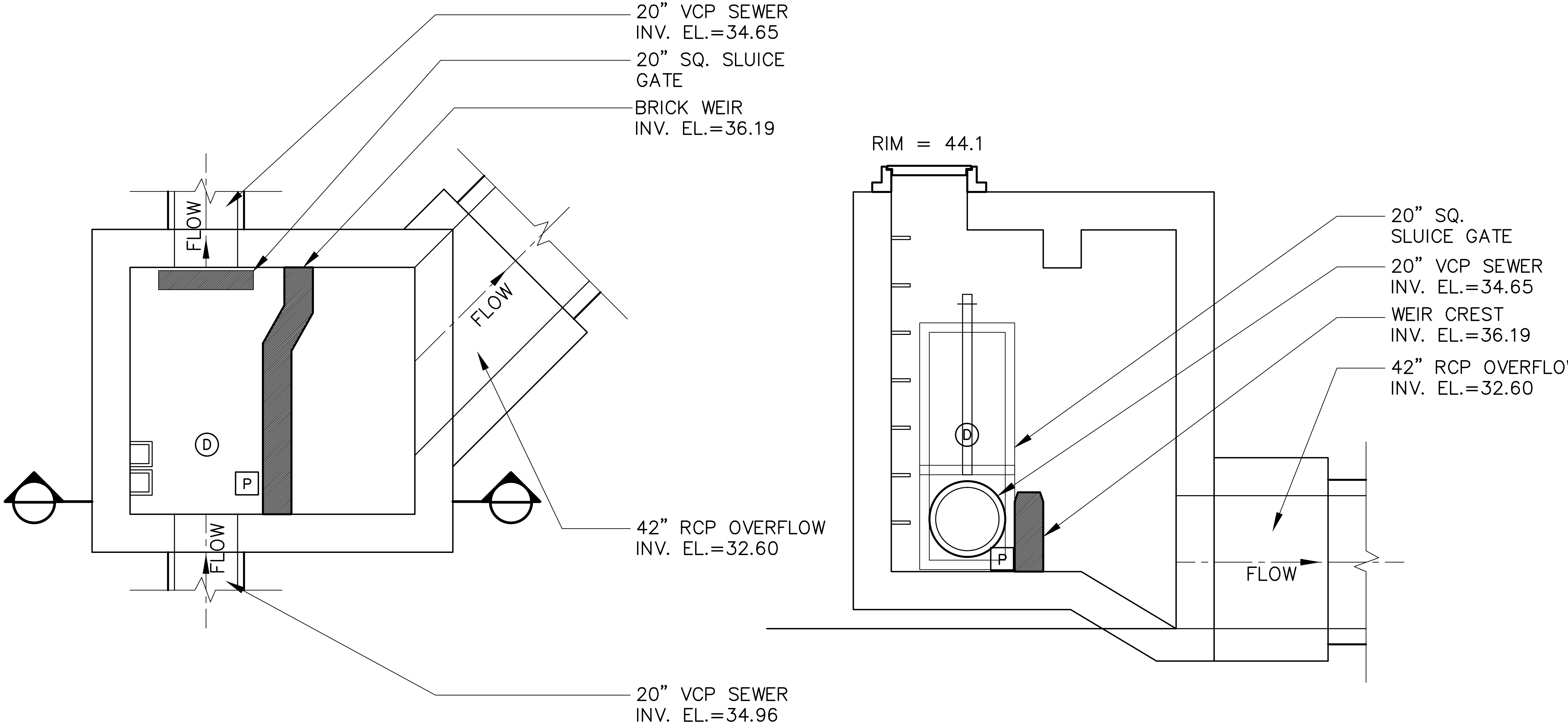
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

WINTER & HALE STREET CSO
(MIDDLE SIPHON AREA)

CSO OUTFALL No. 021H

FIGURE 10



PLAN
3/8" = 1'-0"

P PRESSURE SENSOR

D DEPTH SENSOR

SECTION
3/8" = 1'-0"

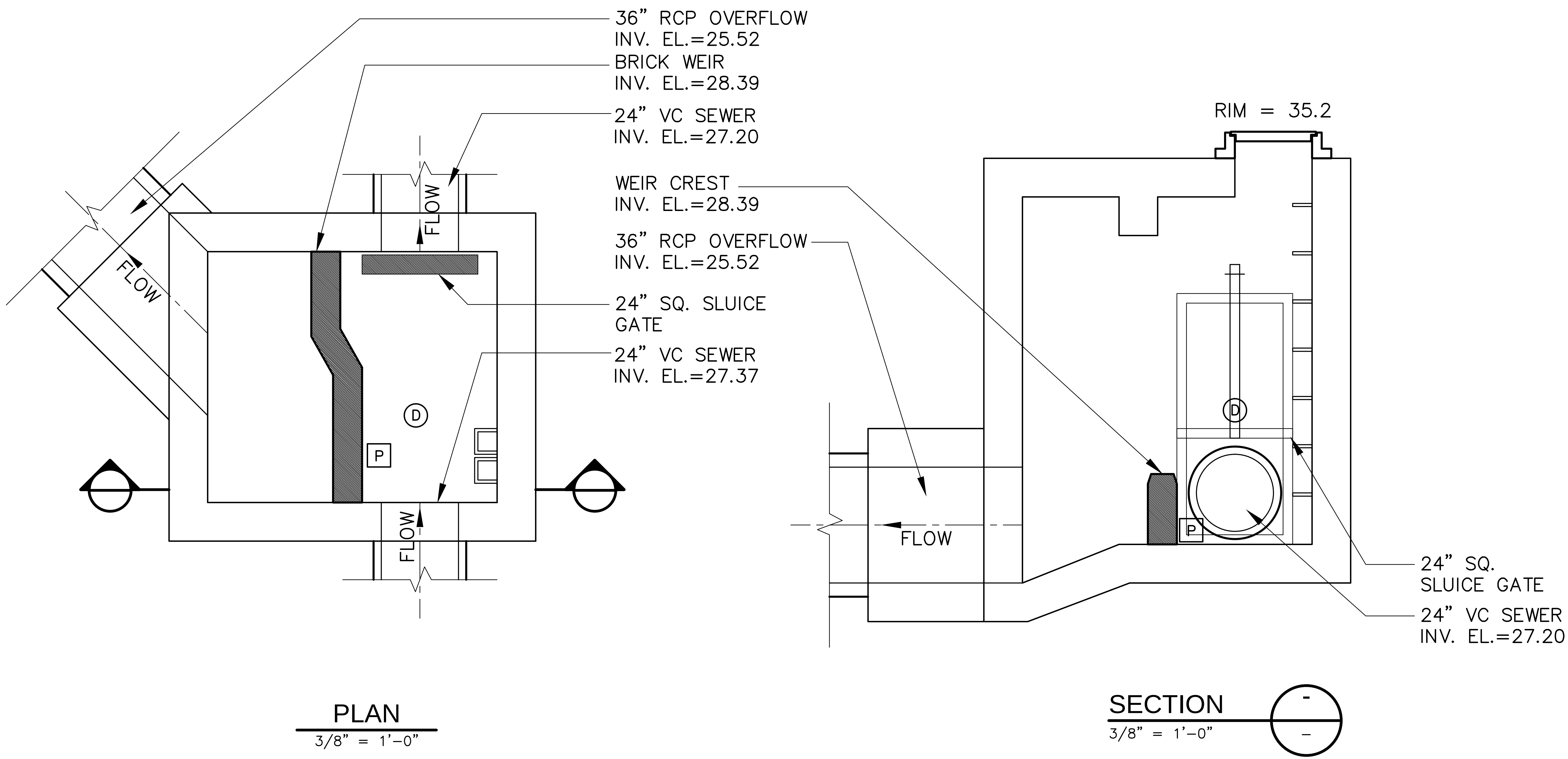
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

BROADWAY CSO
(MIDDLE SIPHON AREA)

CSO OUTFALL No. 038

FIGURE 11



P PRESSURE SENSOR

D DEPTH SENSOR

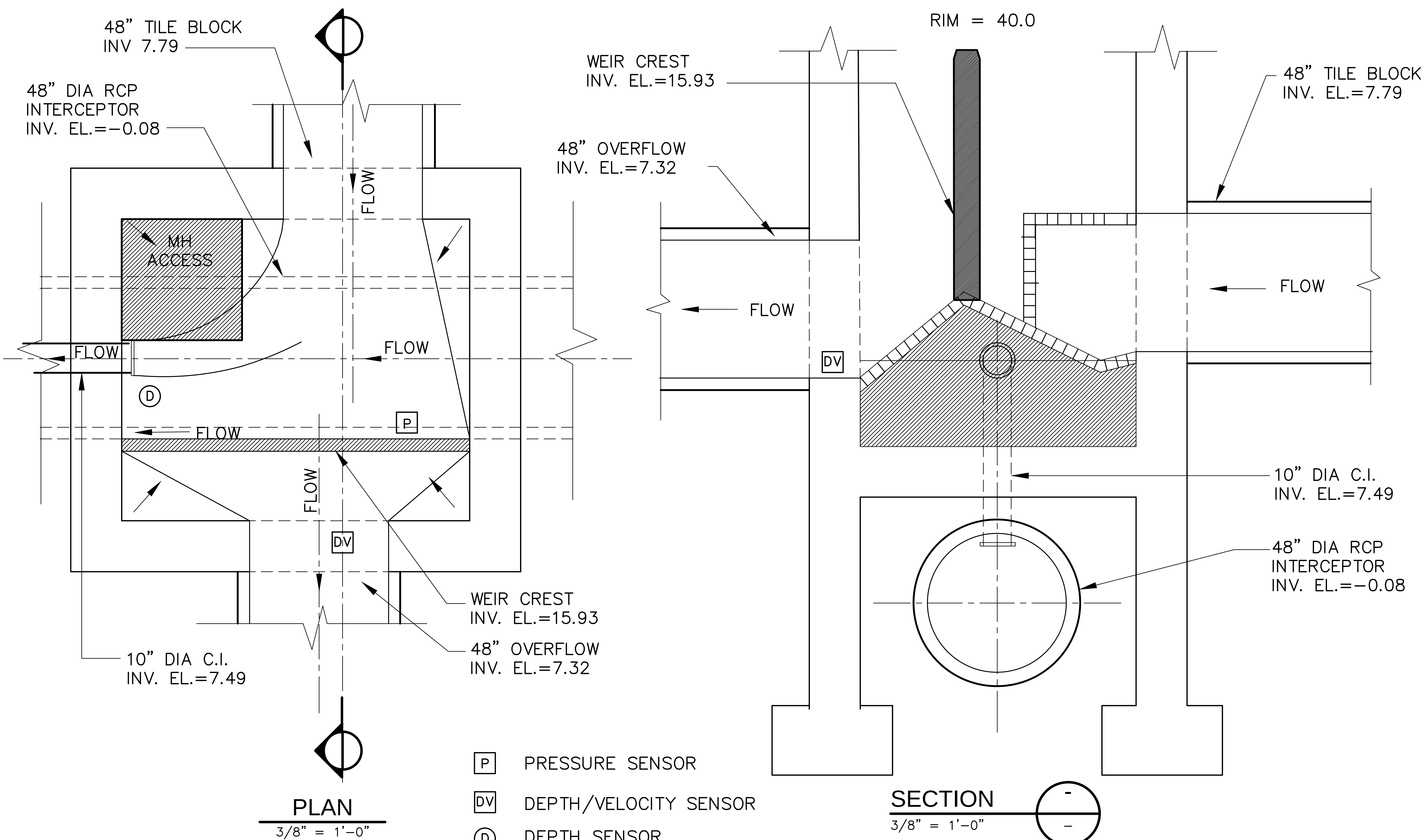
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

HIGH STREET CSO
(MIDDLE SIPHON AREA)

CSO OUTFALL No. 038

FIGURE 12



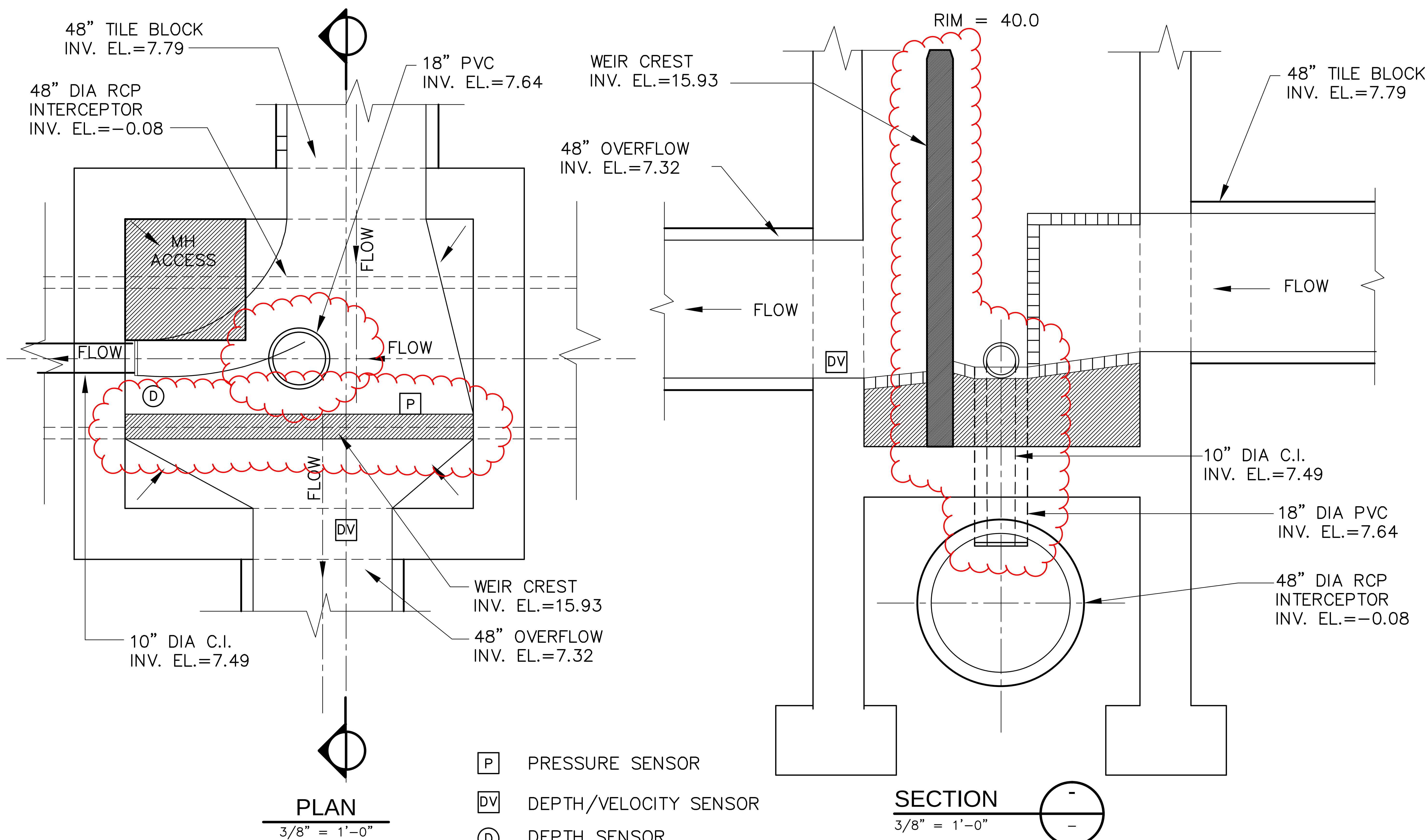
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

BRADFORD AVENUE CSO
(BRADFORD SIDE AREA)

CSO OUTFALL No. 032

FIGURE 13A



CDM Smith

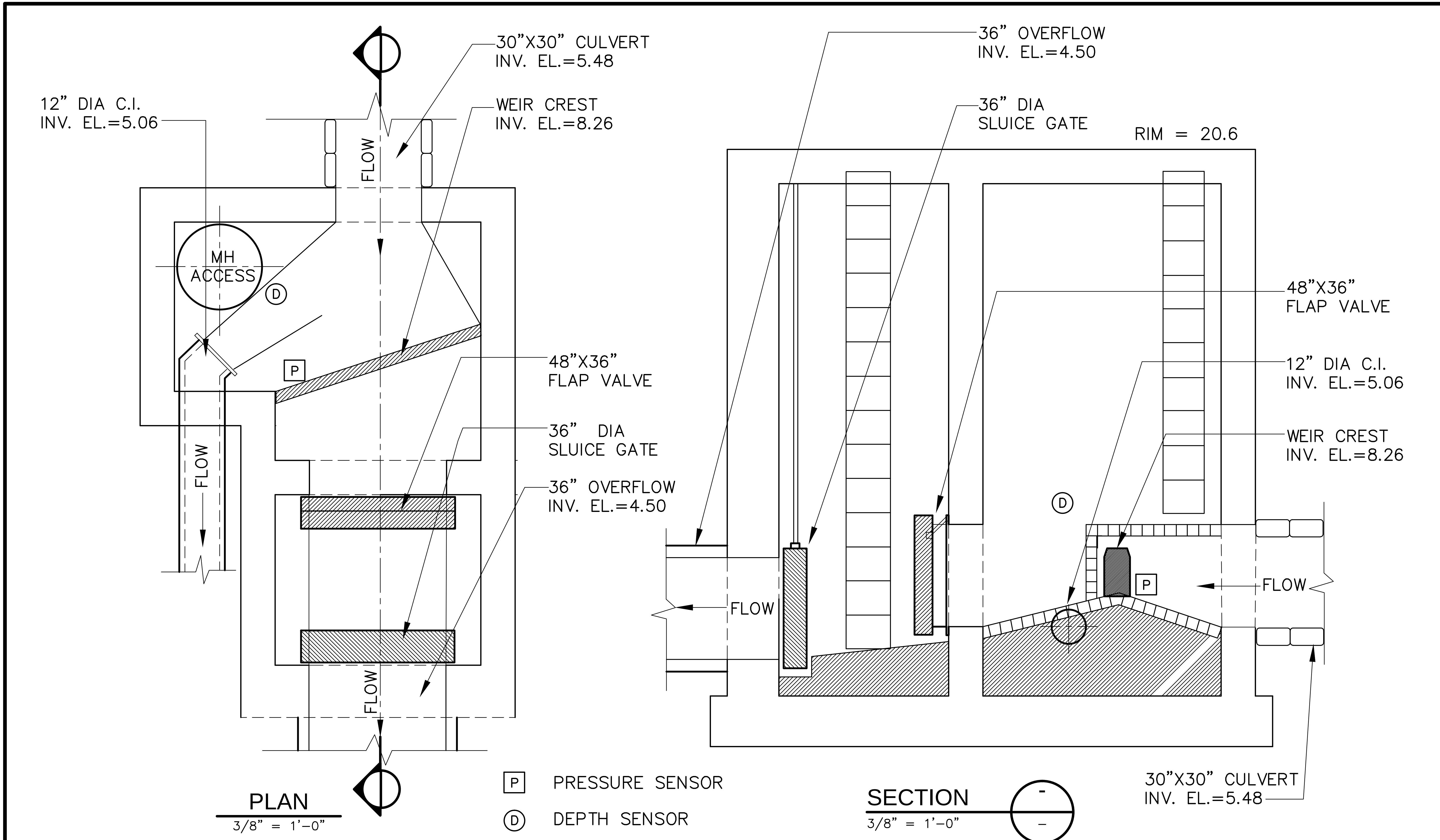
CITY OF HAVERHILL, MASSACHUSETTS

BRADFORD AVENUE CSO

WET WEATHER MAXIMIZATION/ CSO STRUCTURE MODIFICATIONS PROJECT IMPROVEMENTS

CSO OUTFALL No. 032

FIGURE 13B



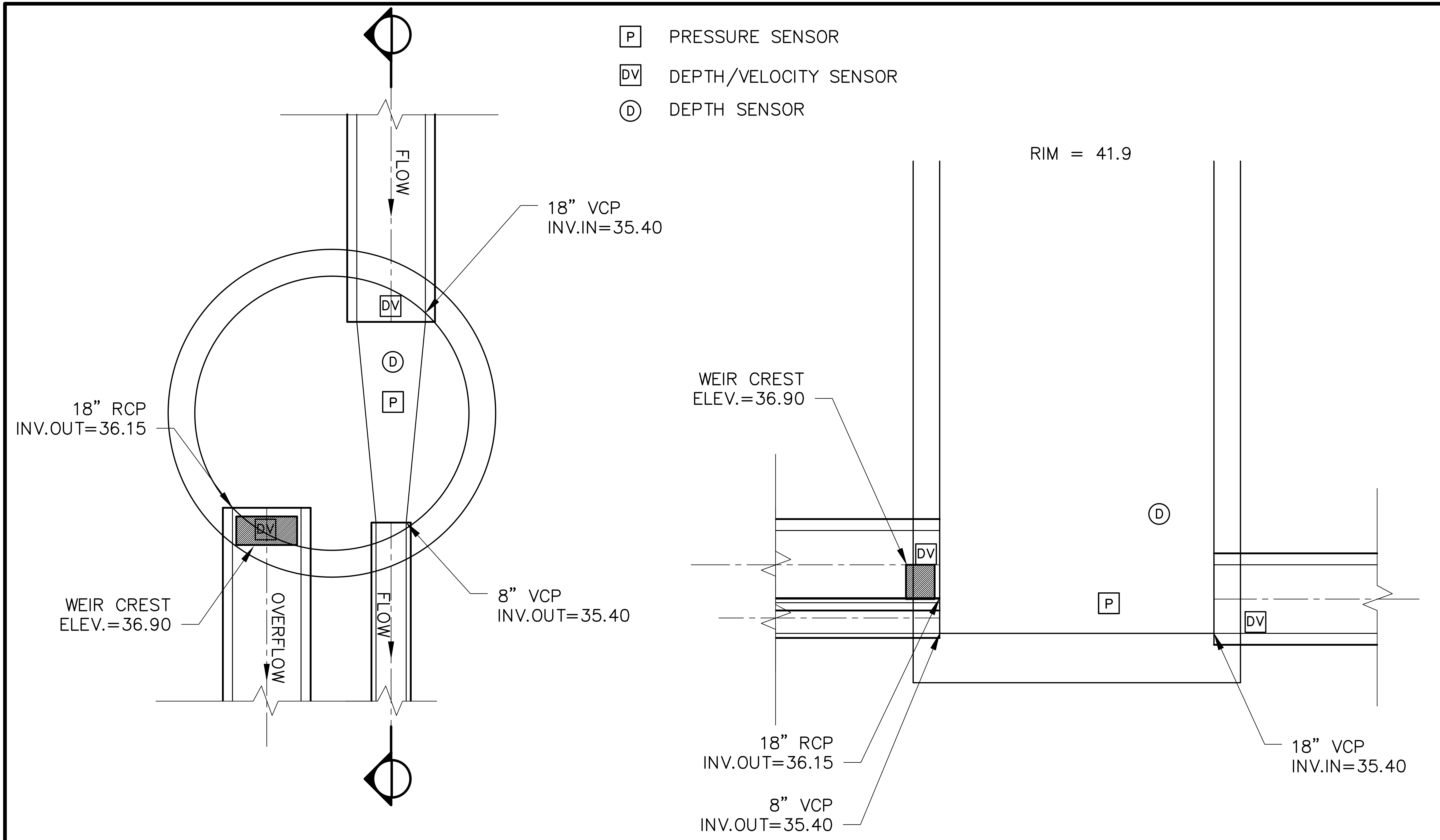
CDM Smith

CITY OF HAVERHILL, MASSACHUSETTS

MIDDLESEX STREET CSO
(BRADFORD SIDE AREA)

CSO OUTFALL No. 034

FIGURE 14



CITY OF HAVERHILL, MASSACHUSETTS

SOUTH WEBSTER STREET CSO
(BRADFORD SIDE AREA)

CSO OUTFALL No. 039

FIGURE 15

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act as amended, (33 U.S.C. §§1251 et seq.; the "CWA"), and the Massachusetts Clean Waters Act as amended, (M.G.L. Chap. 21, §§26-53), the City of Haverhill, Wastewater Division, is authorized to discharge from the facility located at

Haverhill Wastewater Treatment Facility
40 South Porter Street
Bradford, Massachusetts 01835
and twenty combined sewer overflows (CSOs) listed in Attachment F

to receiving waters named: **Merrimack River and Little River**
(Merrimack River Basin - MA84A-05 and MA84A-09)

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

The Town of Groveland is a co-permittee for Part 1.E. Unauthorized Discharges, Part 1.F. Operation and Maintenance of the Sewer System, and Alternative Power Source, which include conditions regarding the operation and maintenance of the collection system owned and operated by the Town. The responsible Town authority is:

Groveland Water Department
183 Main Street
Groveland, MA 01834

This permit shall become effective February 1, 2008.

This permit and the authorization to discharge expire at midnight on January 31, 2013.

This permit supersedes the permit issued on June 26, 2003.

This permit consists of 18 Pages in Part 1 including effluent limitations, monitoring requirements, etc., Attachments A-Sampling Locations, B-Freshwater Acute Toxicity Test Procedure and Protocol, C-Industrial Pretreatment Annual Report, D-Reassessment of TBLLs, E-Nine Minimum Controls Guidance, F-Combined Sewer Overflow List, Sludge Guidance Document, and Part II including General Conditions and Definitions.

Signed this 5th day of Dec, 2007

Director
Office of Ecosystem Protection
Environmental Protection Agency
Boston, MA

Director, Division of Watershed Management
Bureau of Resource Protection
Department of Environmental Protection
Commonwealth of Massachusetts
Boston, MA

PART I

1.A. During the period beginning the effective date and lasting through expiration, the permittee is authorized to discharge from outfall serial number **046,** treated industrial and sanitary wastewater and storm water to the Merrimack River. Such discharges shall be limited and monitored as specified below.

EFFLUENT CHARACTERISTIC	**EFFLUENT LIMITS**			**MONITORING REQUIREMENTS**	
PARAMETER	**AVERAGE MONTHLY**	**AVERAGE WEEKLY**	**MAXIMUM DAILY**	**MEASUREMENT FREQUENCY**	**SAMPLE [3]* TYPE**
FLOW	18.1 MGD[2]	********	Report MGD	CONTINUOUS	RECORDER
BOD_5 [4]	30 mg/l 4529 lb/Day	45 mg/l Report lb/Day	Report mg/l[1] Report lb/Day	5/WEEK	24-HOUR COMPOSITE[5]
TSS [4]	30 mg/l 4529 lb/Day	45 mg/l Report lb/Day	Report mg/l[1] Report lb/Day	5/WEEK	24-HOUR COMPOSITE[5]
pH RANGE[1]	6.5 to 8.5 SU	See Part I.A.1.c		1/DAY	GRAB
TOTAL CHLORINE RESIDUAL (TRC)	0.40 mg/l	********	0.70 mg/l	1/DAY	GRAB
CONTINUOUS CHLORINE ANALYZER	********	********	Report mg/l	CONTINUOUS	RECORDER (SCADA)
FECAL COLIFORM [1,6]	88 CFU /100 ml	********	260 CFU /100 ml	5/WEEK	GRAB
ENTEROCOCCI BACTERIA[1,6]	35CFU /100 ml	********	276 CFU /100 ml	1/MONTH	GRAB
WHOLE EFFLUENT TOXICITY SEE FOOTNOTES - 7, 8, and, 9	LC_{50} ≥100%			4/YEAR	24-HOUR COMPOSITE[5]

***SEE PERMIT ATTACHMENT A FOR SAMPLE LOCATIONS AND ADDITIONAL INSTRUCTIONS**

PART I Continued

1.A. During the period beginning the effective date and lasting through expiration, the permittee is authorized to discharge from outfall serial number **046,** treated industrial and sanitary wastewater and storm water to the Merrimack River. Such discharges shall be limited and monitored as specified below.					
EFFLUENT CHARACTERISTIC	**EFFLUENT LIMITS**			**MONITORING REQUIREMENTS**	
PARAMETER	**AVERAGE MONTHLY**	**AVERAGE WEEKLY**	**MAXIMUM DAILY**	**MEASUREMENT FREQUENCY**	**SAMPLE [3]* TYPE**
Total Ammonia Nitrogen, as N	REPORT mg/l	***********	REPORT mg/l	1/MONTH	24-HOUR COMPOSITE[5]
Total Kjeldahl Nitrogen	REPORT mg/l	***********	REPORT mg/l	1/MONTH	24-HOUR COMPOSITE[5]
Total Nitrate	REPORT mg/l	***********	REPORT mg/l	1/MONTH	24-HOUR COMPOSITE[5]
Total Nitrite	REPORT mg/l	***********	REPORT mg/l	1/MONTH	24-HOUR COMPOSITE[5]

***SEE PERMIT ATTACHMENT A FOR SAMPLE LOCATIONS AND ADDITIONAL INSTRUCTIONS**

Footnotes:

1. Required for State Certification.

2. For flow, report maximum and minimum daily rates and total flow for each operating date. The flow limit is an annual average. The annual average flow shall be reported each month as a rolling average and shall be calculated using the monthly average flow from the reporting month and the monthly average flows from the preceding 11 months.

3. **All required effluent samples shall be collected at the point specified in Permit Attachment A.** Any change in sampling location must be reviewed and approved in writing by EPA and MassDEP. All samples shall be tested using the analytical methods found in 40 CFR §136, or alternative methods approved by EPA in accordance with the procedures in 40 CFR §136. All samples shall be 24 hour composites unless specified as a grab sample in 40 CFR §136. The permittee shall submit the results to EPA of any additional testing done to that required herein if it is conducted in accordance with EPA approved methods, consistent with the provisions of 40 CFR §122.41(l)(4)(ii).

4. Sampling required for influent and effluent.

5. 24-hour composite samples will consist of at least twenty-four (24) grab samples taken during one consecutive 24 hour period, either collected at equal intervals and combined proportional to flow or continuously collected proportionally to flow.

6. The permittee shall achieve the enterococci limits in accordance with the compliance schedule found in Part G of the permit. Enterococci samples shall be taken concurrently with the required fecal coliform samples. The monthly average limit for fecal coliform is expressed as a geometric mean. The units may be expressed as MPN for samples tested using the Most Probable Number method, or CFU when using the Membrane Filtration method.

7. The permittee shall conduct 48 hour static, non-renewal acute toxicity tests four times per year. The permittee shall test the <u>Pimephales promelas</u> (Fathead Minnow) only. Toxicity test samples shall be collected during the second week of the months of January, April, July, and October. The test results shall be submitted by the last day of the month following the completion of the test. The results are due, February 28th, May 31st, August 31st, and November 30th, respectively. The tests must be performed in accordance with test procedures and protocols specified in **Attachment B** of this permit.

Test Dates	**Submit Results By:**	**Test Species**	**Acute Limit LC_{50}**
Second week of: January April July October	February 28th May 31st August 31st November 30th	Pimephales promelas (Fathead Minnow) See Attachment B	≥ 100%

After submitting **one year** and a **minimum** of four consecutive sets of WET test results, all of which demonstrate compliance with the WET permit limits, the permittee may request a reduction in the WET testing requirements. The permittee is required to continue testing at the frequency specified in the permit until notice is received by certified mail from the EPA that the WET testing requirement has been changed.

8. If toxicity test(s) using receiving water as diluent show the receiving water to be toxic or unreliable, the permittee shall follow procedures outlined in **Attachment B, Section IV., DILUTION WATER** in order to obtain permission to use an alternate dilution water. In lieu of individual approvals for alternate dilution water required in Attachment B, EPA-New England has developed a Self-Implementing Alternative Dilution Water Guidance document (called "Guidance Document") which may be used to obtain automatic approval of alternate dilution water, including the appropriate species for use with that water. If this Guidance document is revoked, the permittee shall revert to obtaining approval as outlined in Attachment B. The "Guidance Document" has been sent to all permittees with their annual set of DMRs and Revised Updated Instructions for Completing EPA's Pre-Printed NPDES Discharge Monitoring Report (DMR) Form 3320-1 and is not intended as a direct attachment to this permit. Any modification or revocation to this "Guidance Document" will be transmitted to the permittees as part of the annual DMR instruction package. However, at any time, the permittee may choose to contact EPA-New England directly using the approach outlined in Attachment B.

9. The LC_{50} is the concentration of effluent which causes mortality to 50% of the test organisms. Therefore, a 100% limit means that a sample of 100% effluent (no dilution) shall cause no more than a 50% mortality rate.

Part I.A.1. (Continued)

b. The discharge shall not cause a violation of the water quality standards of the receiving waters.

c. The pH of the effluent shall not be less than 6.5 nor greater than 8.5 at any time, unless these values are exceeded due to natural causes or as a result of the approved treatment processes.

d. The discharge shall not cause objectionable discoloration of the receiving waters.

e. The effluent shall contain neither a visible oil sheen, foam, nor floating solids at any time.

f. The permittee's treatment facility shall maintain a minimum of 85 percent removal of both total suspended solids and biochemical oxygen demand during dry weather. Dry weather is defined as any calendar day on which there is less than 0.1 inch of rainfall and no snow melt. The percent removal shall be calculated as a monthly average using the influent and effluent BOD_5 and TSS values collected during dry weather days.

g. If the average annual flow in any calendar year exceeds 80% of the facility's design flow, the permittee shall submit a report to MassDEP by March 31 of the following calendar year describing plans for further flow increases and discuss how the permittee will remain in compliance with the effluent limitations in the permit.

h. The permittee shall minimize the use of chlorine while maintaining adequate bacterial control.

B.1. All POTWs must provide adequate notice to the Director of the following:

a. Any new introduction of pollutants into that POTW from an indirect discharger in a primary industry category discharging process water; and

b. Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.

c. For purposes of this paragraph, adequate notice shall include information on:

(1) the quantity and quality of effluent introduced into the POTW; and

(2) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

B.2. Limitations for Industrial Users:

Pollutants introduced into POTW's by a non-domestic source (user) shall not pass through the POTW or interfere with the operation or performance of the works.

The permittee shall develop and enforce specific effluent limits (local limits) for Industrial User(s), and all other users, as appropriate, which together with appropriate changes in the POTW Treatment Plant's Facilities or operation, are necessary to ensure continued compliance with the POTW's NPDES permit or sludge use or disposal practices. Specific local limits shall not be developed and enforced without individual notice to persons or groups who have requested such notice and an opportunity to respond. Within **120 days of the effective date of this permit**, the permittee shall prepare and submit a written technical evaluation to the EPA analyzing the need to revise local limits.

As part of this evaluation, the permittee shall assess how the POTW performs with respect to influent and effluent of pollutants, water quality concerns, sludge quality, sludge processing concerns/inhibition, biomonitoring results, activated sludge inhibition, worker health and safety and collection system concerns.

In preparing this evaluation, the permittee shall complete the attached form (Attachment D) with the technical evaluation to assist in determining whether existing local limits need to be revised. Justifications and conclusions should be based on actual plant data if available and should be included in the report.

Should the evaluation reveal the need to revise local limits, the permittee shall complete the revisions within 120 days of notification by EPA and submit the revisions to EPA for approval. The Permittee shall carry out the local limits revisions in accordance with EPA Local Limits Development Guidance (July 2004).

B.3. INDUSTRIAL PRETREATMENT PROGRAM

a. The permittee shall implement the Industrial Pretreatment Program in accordance with the legal authorities, policies, procedures, and financial provisions described in the permittee's approved Pretreatment Program, and the General Pretreatment Regulations, 40 CFR 403. At a minimum, the permittee must perform the following duties to properly implement the Industrial Pretreatment Program (IPP):

   1. Carry out inspection, surveillance, and monitoring procedures which will determine, independent of information supplied by the industrial user, whether the industrial user is in compliance with the Pretreatment Standards. At a minimum, all significant industrial users shall be sampled and inspected at the frequency established in the approved IPP but in no case less than once per year and maintain adequate records.

   2. Issue or renew all necessary industrial user control mechanisms within 90 days of their expiration date or within 180 days after the industry has been determined to be a significant industrial user.

3. Obtain appropriate remedies for noncompliance by any industrial user with any pretreatment standard and/or requirement.

4. Maintain an adequate revenue structure for continued implementation of the Pretreatment Program.

b. The permittee shall provide EPA (and States) with an annual report describing the permittee's pretreatment program activities for the twelve month period ending 60 days prior to the due date in accordance with 403.12(i). The annual report shall be consistent with the format described in Attachment C of this permit and shall be submitted no later than March 1 of each year.

c. The permittee must obtain approval from EPA prior to making any significant changes to the industrial pretreatment program in accordance with 40 CFR 403.18(c).

d. The permittee must assure that applicable National Categorical Pretreatment Standards are met by all categorical industrial users of the POTW. These standards are published in the Federal Regulations at 40 CFR 405 et. seq.

e. The permittee must modify its pretreatment program to confirm to all changes in the Federal Regulations that pertain to the implementation and enforcement of the industrial pretreatment program. The permittee must provide EPA, in writing, within 120 days of the permits effective date, proposed changes, if applicable, to the permittee's pretreatment program, deemed necessary to assure conformity with current federal regulations. The permittee will inplement these proposed changes pending EPA Region 1's approval under 40 CFR 403.18. This submission is separate and distinct from any local limits analysis submission described above.

f. On October 14, 2005, EPA published in the Federal Register final changes to the General Pretreatment Regulations. The final "Pretreatment Streamlining Rule" is designed to reduce the burden to industrial users and provide regulatory flexibility in technical and administrative requirements of its industrial users and POTWs. **Within 120 days of the effective date of this permit, the permittce must submit to EPA all required modifications of the Streamlining Rule in order to be consistent with the provisions for the newly promulgated Rule.** To the extent that the POTW legal authority is not consistent with the required changes, they must be revised and submitted to EPA for review.

C. TOXICS CONTROL

1. The permittee shall not discharge any pollutant or combination of pollutants in toxic amounts.

2. Any toxic components of the effluent shall not result in any demonstrable harm to aquatic life or violate any state or federal water quality standard which has been or may be promulgated. Upon promulgation of any such standard, this permit may be revised or amended in accordance with such standards.

3. EPA or MassDEP may use the results of the toxicity tests and chemical analyses conducted pursuant to this permit, as well as national water quality criteria developed pursuant to Section 304(a)(1) of the Clean Water Act (CWA), state water quality criteria, and any other appropriate information or data, to develop numerical effluent limitations for any pollutants, including but not limited to those pollutants listed in Appendix D of 40 CFR Part 122.

D. COMBINED SEWER OVERFLOWS (CSOs)

1. EFFLUENT LIMITATIONS

a. During wet weather, the permittee is authorized to discharge storm water/wastewater from combined sewer outfalls listed in Attachment F, subject to the following effluent limitations.

i. The discharges shall receive treatment at a level providing Best Practicable Control Technology Currently Available (BPT), Best Conventional Pollutant Control Technology (BCT) to control and abate conventional pollutants and Best Available Technology Economically Achievable (BAT) to control and abate non-conventional and toxic pollutants. The EPA has made a Best Professional Judgment (BPJ) determination that BPT, BCT, and BAT for combined sewer overflow (CSO) control include the implementation of Nine Minimum Controls (NMC) specified below and detailed further in Part I.D.2. "Nine Minimum Controls, Minimum Implementation Levels" of this permit:

1. Proper operation and regular maintenance programs for the sewer system and the combined sewer overflows.

2. Maximum use of the collection system for storage.

3. Review and modification of the pretreatment program to assure CSO impacts are minimized.

4. Maximization of flow to the POTW for treatment.

5. Prohibition of dry weather overflows from CSOs.

6. Control of solid and floatable materials in CSO.

7. Pollution prevention programs that focus on contaminant reduction activities.

8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts.

9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

Implementation of these controls is required by the effective date of the permit. Documentation of the implementation of these controls has been submitted and is currently under review by EPA and the State. EPA and the State consider that approvable documentation must include the minimum requirements set forth in Part I.D.2 of this Permit and additional activities the permittee can reasonably undertake. See Attachment E.

ii. The discharges shall not cause **or contribute to** violations of Federal or State Water Quality Standards.

2. Nine Minimum Controls, Minimum Implementation Levels

a. The Permittee must implement the nine minimum controls in accordance with the documentation provided to EPA and MassDEP or as subsequently modified to enhance the effectiveness of the controls. This implementation must include the following controls plus other controls the Permittee can reasonably implement as set forth in the documentation.

b. Each CSO structure/regulator, pumping station and/or tidegate shall be routinely inspected, at a minimum of once per month, to insure that they are in good working condition and adjusted to minimize combined sewer discharges and tidal surcharging (NMC # 1, 2, and 4). The following inspection results shall be recorded: the date and time of the inspection, the general condition of the facility, and whether the facility is operating satisfactorily. If maintenance is necessary, the permittee shall record: the description of the necessary maintenance, the date the necessary maintenance was performed, and whether the observed problem was corrected. The permittee shall maintain all records of inspections for at least three years.

The State and EPA have the right to inspect any CSO related structure or outfall at any time without prior notification to the permittee.

c. Discharges to the combined collection system of septage, holding tank wastes or other material which may cause a visible oil sheen or containing floatable material are prohibited during wet weather when CSO discharges may be active (NMC# 3, 6, and 7).

d. Dry weather overflows (DWOs) are prohibited (NMC# 5). All dry weather sanitary and/or industrial discharges from CSOs must be reported to EPA and the State within 24 hours and provide a written report within 5 days in accordance with the reporting requirements for bypass (Paragraph D.1.e(1) of Part II of this permit).

e. The permittee shall quantify and record all discharges from combined sewer outfalls (NMC# 9). Quantification may be through direct measurement or estimation. When estimating, the permittee shall make reasonable efforts, i.e. gaging, measurements, to verify the validity of the estimation technique. The following information must be recorded for each combined sewer outfall for each discharge event:

- Estimated duration (hours) of discharge;
- Estimated volume (gallons) of discharge; and
- National Weather Service precipitation data from the nearest gage where precipitation is available at daily (24-hour) intervals and the nearest gage where precipitation is available at one-hour intervals. Cumulative precipitation per discharge event shall be calculated.

The permittee shall maintain all records of discharges for at least six years after the effective date of this permit.

The permittee shall implement the CSO monitoring plan which describes the methods the permittee will use to quantify CSO activations and volumes. Activation frequencies and discharge volumes required to be submitted in the annual report (see Section I.D.3) shall thereafter be reported in accordance with methods identified in the monitoring plan.

f. The permittee shall install and maintain identification signs for all combined sewer outfall structures (NMC# 8). The signs must be located at or near the combined sewer outfall structures and easily readable by the public. These signs shall be a minimum of 12 x 18 inches in size, with white lettering against a green background, and shall contain the following information:

CITY OF HAVERHILL
WET WEATHER
SEWAGE DISCHARGE
OUTFALL (discharge serial number)

3. Annual Report

By April 30 of 2008 and by April 30 each year thereafter, the permittee shall submit a report which includes the following information;

a. Activation frequency and discharge volume for each CSO during the previous calendar year. The report shall include this information for each of the CSO discharge outfalls listed on Attachment F.

b. Precipitation during the previous year for each day, including total rainfall (expressed in inches), peak intensity (highest 15 minute sample multiplied by four to convert to inches per hour), and average intensity (the total rainfall for the storm event divided by the duration of the storm, expressed in inches per hour).

c. A certification which states that the previous calendar year's monthly inspections were conducted, results recorded, and records maintained.

d. A summary of modifications to the approved NMC program which have been evaluated, and a description of those which will be implemented during the upcoming year.

In the first annual report submitted in accordance with this permit, the permittee shall update the public notification plan describing the measures actively being taken to meet NMC #8 (see NMC #8 in Part I.D.1.a.i.8) and an evaluation of further measures to enhance the public notification program, including the following:

i. Outfall signs visible from both water and land.

ii. Signs/Notices at areas where people may be using CSO-impacted waters for recreation such as swimming, boating, fishing, and places where public may gain access to the water (e.g. boat put-in areas). The notice would include information on the health risks posed by CSOs and links for additional information on CSOs and water quality.

iii. Review of the sewer system model to determine the threshold rain events which normally will cause overflows.

iv. Quarterly postings on the permittee's website and links to other relevant web-sites which would give the locations of the CSOs, and associated health risks and estimates of CSO activations and volumes. **The permittee shall update tbe CSO website within two (2) months of the effective date of the permit.**

v. Annual press release and notification to interested individuals and groups on the progress of the CSO abatement work, also noting contacts for additional information on CSOs and water quality.

vi. Notice to local health agents and other downstream public officials, including drinking water treatment plants (where appropriate), shellfish wardens, harbor masters, and the Massachusetts Division of Marine Fisheries Shellfish Management Program via FAX (617-727-3337) or via telephone (978-282-0308 extension 160) within 24 hours of activation of CSOs. The permittee shall also notify the Massachusetts Division of Marine Fisheries by the same method if the treatment plant discharges effluent without disinfection. When City of Haverhill staff is unavailable to confirm an actual discharge from a CSO during a significant precipitation event, the permittee shall report the probable occurrence of a CSO discharge in the same manner. Subsequently, the occurrence of the CSO discharge event shall be confirmed or dispelled as staff becomes available. The planned notice distribution contact list shall be provided to EPA and MassDEP.

The public notification plan shall include a schedule for implementation of enhanced public notice measures.

E. UNAUTHORIZED DISCHARGES

The permittee is authorized to discharge from POTW outfall 046 and from CSO outfalls listed in Attachment F in accordance with terms and conditions of this permit. Discharges of wastewater from any other point sources, including sanitary sewer overflows (SSOs) or other diversional structures are not authorized by this permit and shall be reported in accordance with Section D.1.e (1) of the General Requirements of this permit (Twenty-four hour reporting).

Notification of SSOs to MassDEP shall be made on its SSO Reporting Form (which includes MassDEP Regional Office telephone numbers). The reporting form and instruction for its completion may be found on-line at http://www.mass.gov/dep/water/approvals/surffms.htm#sso].

F. OPERATION AND MAINTENANCE OF THE SEWER SYSTEM

Operation and maintenance of the sewer system shall be in compliance with the General Requirements of Part II and the following terms and conditions:

1. Maintenance Staff: The permittee shall provide an adequate staff to carry out the operation, maintenance, repair, and testing functions required to ensure compliance with the terms and conditions of this permit.

2. Alternate Power Source: In order to maintain compliance with the terms and conditions of this permit, the permittee shall continue to provide an alternative power source with which to sufficiently operate its treatment works (as defined at 40 CFR §122.2).

3. Infiltration/Inflow Control Plan:

The permittee shall implement a plan to control infiltration and inflow (I/I) to the separate sewer system. The plan shall be kept onsite and shall be made available upon request by EPA or MassDEP. The plan shall describe the permittee's program for preventing infiltration/inflow related effluent limit violations, and all unauthorized discharges of wastewater, including overflows and by-passes due to infiltration/inflow.

The plan shall include:

- An ongoing program to identify and remove sources of infiltration and inflow. The program shall include the necessary funding level and the source(s) of funding.

- An inflow identification and control program that focuses on the disconnection and redirection of illegal sump pumps and roof down spouts. Priority should be given to removal of public and private inflow sources that are upstream from, and potentially contribute to, known areas of sewer system backups and/or overflows.

- Identification and prioritization of areas that will provide increased aquifer recharge as the result of reduction/elimination of infiltration and inflow to the system.

- An educational public outreach program for all aspects of I/I control, particularly private inflow.

Reporting Requirements:

A summary report of all actions taken to minimize I/I during the previous calendar year shall be **submitted to EPA and the MassDEP annually, by April 30th of each year.** The summary report shall, at a minimum, include:

- A map and a description of inspection and maintenance activities conducted and corrective actions taken during the previous year.

- Expenditures for any infiltration/inflow related maintenance activities and corrective actions taken during the previous year.

- A map with areas identified for I/I-related investigation/action in the coming year.

- A calculation of the annual average I/I, the maximum month I/I for the reporting year.

- A report of any infiltration/inflow related corrective actions taken as a result of unauthorized discharges reported pursuant to 314 CMR 3.19(20) and reported pursuant to the Unauthorized Discharges section of this permit.

G. SCHEDULE OF COMPLIANCE

1. No later than one year from the effective date of the permit, the permittee shall achieve compliance with the monthly average and daily maximum limits for enterococci. During the interim the permittee shall report the monthly average and daily maximum values.

H. SLUDGE CONDITIONS

1. The permittee shall comply with all existing federal and state laws and regulations that apply to sewage sludge use and disposal practices and with the CWA Section 405(d) technical standards.

2. The permittee shall comply with the more stringent of either the state or federal (40 CFR Part 503), requirements.

3. The requirements and technical standards of 40 CFR Part 503 apply to facilities which perform one or more of the following use or disposal practices.

   a. Land application - the use of sewage sludge to condition or fertilize the soil

   b. Surface disposal - the placement of sewage sludge in a sludge-only landfill

   c. Sewage sludge incineration in a sludge-only incinerator

4. The 40 CFR Part 503 conditions do not apply to facilities which place sludge within a municipal solid waste landfill. These conditions also do not apply to facilities which do not dispose of sewage sludge during the life of the permit but rather treat the sludge (e.g., lagoons, reed beds), or are otherwise excluded under 40 CFR 503.6.

5. The permittee shall use and comply with the attached compliance guidance document to determine appropriate conditions. Appropriate conditions contain the following elements.

- General requirements
- Pollutant limitations
- Operational Standards (pathogen reduction requirements and vector attraction reduction requirements)
- Management practices
- Record keeping
- Monitoring
- Reporting

Depending upon the quality of material produced by a facility, all conditions may not apply to the facility.

6. The permittee shall monitor the pollutant concentrations, pathogen reduction and vector attraction reduction at the following frequency. This frequency is based upon the volume of sewage sludge generated at the facility in dry metric tons per year:

less than 290	1/ year
290 to less than1500	1 /quarter
1500 to less than 15000	6 /year
15000 +	1 /month

7. The permittee shall sample the sewage sludge using the procedures detailed in 40 CFR 503.8.

8. **The permittee shall submit an annual report containing the information specified in the sludge guidance on or before February 19.** Reports shall be submitted to the address contained in the reporting section of the permit. Sludge monitoring is not required by the permittee when the permittee is not responsible for the ultimate sludge disposal. The permittee must be assured that any third party contractor is in compliance with appropriate regulatory requirements. In such case, the permittee is required only to submit an annual report by February 19 containing the following information:

- Name and address of contractor responsible for sludge disposal
- Quantity of sludge in dry metric tons removed from the facility by the sludge contractor

I. MONITORING AND REPORTING

Reporting

Monitoring results obtained during the previous month shall be summarized for each month and reported on separate Discharge Monitoring Report Form(s) postmarked no later than the 15th day of the month following the effective date of the permit.

Signed and dated originals of these, and all other reports required herein, shall be submitted to the Director and the State at the following addresses:

Environmental Protection Agency
Water Technical Unit (SEW)
P.O. Box 8127
Boston, Massachusetts 02114

The State Agency is:

Massachusetts Department of Environmental Protection
Northeast Regional Office
Bureau of Resource Protection
205B Lowell Street
Wilmington, MA 01887

Signed and dated Discharge Monitoring Report Forms and toxicity test reports required by this permit shall also be submitted to the State at:

Massachusetts Department of Environmental Protection
Division of Watershed Management
Surface Discharge Permit Program
627 Main Street, 2nd Floor
Worcester, Massachusetts 01608

Industrial Pretreatment Program reports required by section I.B.2 & 3 of this permit must be submitted to the Director at:

Environmental Protection Agency
Att: Justin Pimpare
One Congress Street
Suite 1100 - CMU
Boston, MA 02114

Industrial Pretreatment Program reports required by section I.B.2 & 3 of this permit must be submitted to the State at:

Massachusetts Department of Environmental Protection
Bureau of Waste Prevention- Industrial Wastewater Section
1 Winter Street
Boston, MA 02108

J. STATE PERMIT CONDITIONS

This Discharge Permit is issued jointly by the U. S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP) under Federal and State law, respectively. As such, all the terms and conditions of this Permit are hereby incorporated into and constitute a discharge permit issued by the Commissioner of the MassDEP pursuant to M.G.L. Chap. 21, §43.

Each Agency shall have the independent right to enforce the terms and conditions of this Permit. Any modification, suspension or revocation of this Permit shall be effective only with respect to the Agency taking such action, and shall not affect the validity or status of this Permit as issued by the other Agency, unless and until each Agency has concurred in writing with such modification, suspension or revocation. In the event any portion of this Permit is declared, invalid, illegal or otherwise issued in violation of State law such permit shall remain in full force and effect under Federal law as an NPDES Permit issued by the U.S. Environmental Protection Agency. In the event this Permit is declared invalid, illegal or otherwise issued in violation of Federal law, this Permit shall remain in full force and effect under State law as a Permit issued by the Commonwealth of Massachusetts.

Permit Attachment A
WTF Outfall 046 Sampling Locations

Parameter	Sample Type	Sample Location
Flow (Influent)	Meter	Parshall Flume
BOD (Influent)	24 Hour Composite	End of force main - Inlet rise
TSS (Influent)	24 Hour Composite	End of force main - Inlet rise
BOD (Effluent)	24 Hour Composite	Outfall Pipe 046 below outfall junction chamber
TSS (Effluent)	24 Hour Composite	Outfall Pipe 046 below outfall junction chamber
pH (Effluent)	Grab	Effluent sample pump, drawing from sample point below outfall junction chamber[1]
TRC (Effluent)[1]	Grab	Below outfall junction chamber[2]
Fecal Coliform (Effluent)[1]	Grab	Below outfall junction chamber
Enterococci Bacteria (Effluent)[1]	Grab	Below outfall junction chamber
Whole Effluent Toxicity (Effluent)	24 Hour Composite	Outfall Pipe 046 below the junction chamber

1) Samples for total residual chlorine, fecal coliform, and enterococci bacteria shall be collected at the same time.

2) Effluent grab samples shall be taken below the junction chamber. **The sample may be held in a dark environment for a period not to exceed 45 minutes in order to simulate the effluent's path through an underground pipe, prior to discharge in the Merrimack River when the treatment plant flows are at or below 18.1 MGD. When plant flows exceed 18.1 MGD, the TRC holding time is reduced to 15 minutes. Report the plant flow when the effluent sample is taken.**

The permittee shall also report the TRC data collected by the continuous TRC analyzer. The permittee will verify the calibration of the continuous effluent total chlorine residual analyzer each day by comparing the results to at least one grab sample. Copies of the continuous recording graphs from the SCADA system (1/week) will be submitted with the monthly DMRs with a record of the date and time each grab sample was collected, as well as a comparison of the grab sample results to the results from the continuous analyzer.

PERMIT ATTACHMENT B
FRESHWATER ACUTE
TOXICITY TEST PROCEDURE AND PROTOCOL

I. GENERAL REQUIREMENTS

The permittee shall conduct acceptable acute toxicity tests in accordance with the appropriate test protocols described below:

- **Daphnid (Ceriodaphnia dubia) definitive 48 hour test.**
- **Fathead Minnow (Pimephales promelas) definitive 48 hour test.**

Acute toxicity test data shall be reported as outlined in Section VIII.

II. METHODS

Methods should follow those recommended by EPA in:

Weber, C.I. et al. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Fourth Edition. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH. August 1993, EPA/600/4-90/027F.

Any exceptions are stated herein.

III. SAMPLE COLLECTION

A discharge sample shall be collected. Aliquots shall be split from the sample, containerized and preserved (as per 40 CFR Part 136) for chemical and physical analyses required. The remaining sample shall be measured for total residual chlorine and dechlorinated (if detected) in the laboratory using sodium thiosulfate for subsequent toxicity testing. (Note that EPA approved test methods require that samples collected for metals analyses be preserved immediately after collection.) Grab samples must be used for pH, temperature, and total residual chlorine (as per 40 CFR Part 122.21).

Standard Methods for the Examination of Water and Wastewater describes dechlorination of samples (APHA, 1992). Dechlorination can be achieved using a ratio of 6.7 mg/L anhydrous sodium thiosulfate to reduce 1.0 mg/L chlorine. A thiosulfate control (maximum amount of thiosulfate in lab control or receiving water) should also be run.

All samples held overnight shall be refrigerated at 4°C.

IV. DILUTION WATER

A grab sample of dilution water used for acute toxicity testing shall be collected from the receiving water at a point upstream of the discharge free from toxicity or other sources of contamination. Avoid collecting near areas of obvious road or agricultural runoff, storm sewers or other point source discharges. An additional control (0% effluent) of a standard laboratory water of known quality shall also be tested.

If the receiving water diluent is found to be, or suspected to be toxic or unreliable, an alternate standard dilution water of known quality with a hardness, pH, conductivity, alkalinity, organic carbon, and total suspended solids similar to that of the receiving water may be substituted **AFTER RECEIVING WRITTEN APPROVAL FROM THE PERMIT ISSUING AGENCY(S).** Written requests for use of an alternate dilution water should be mailed with supporting documentation to the following address:

Director
Office of Ecosystem Protection
U.S. Environmental Protection Agency-New England
One Congress Street (CAA)
Boston, MA 02114

It may prove beneficial to have the proposed dilution water source screened for suitability prior to toxicity testing. EPA strongly urges that screening be done prior to set up of a full definitive toxicity test any time there is question about the dilution water's ability to support acceptable performance as outlined in the 'test acceptability' section of the protocol.

V. TEST CONDITIONS

The following tables summarize the accepted daphnid and fathead minnow toxicity test conditions and test acceptability criteria:

EPA NEW ENGLAND RECOMMENDED EFFLUENT TOXICITY TEST CONDITIONS FOR THE DAPHNID, CERIODAPHNIA DUBIA 48 HOUR ACUTE TESTS[1]

1. Test type	Static, non-renewal
2. Temperature (°C)	$20 \pm 1°$ C or $25 \pm 1°$C
3. Light quality	Ambient laboratory illumination
4. Photoperiod	16 hour light, 8 hour dark
5. Test chamber size	Minimum 30 ml
6. Test solution volume	Minimum 25 ml
7. Age of test organisms	1-24 hours (neonates)
8. No. daphnids per test chamber	5
9. No. of replicate test chambers	4 per treatment
10. Total no. daphnids per test concentration	20
11. Feeding regime	Feed YCT and Selenastrum while holding organisms prior to initiating test as per manual.
12. Aeration	None
13. Dilution water[2]	Receiving water, other surface water, synthetic soft water adjusted to the hardness and alkalinity of the receiving water (prepared using either Millipore Milli-Q[R] or equivalent deionized water and reagent grade chemicals according to EPA acute toxicity test manual) or deionized water combined with mineral water to appropriate hardness.
14. Dilution factor	≥ 0.5

15. Number of dilutions[3]	5 plus a control. An additional dilution at the permitted effluent concentration (% effluent) is required if it is not included in the dilution series.
16. Effect measured	Mortality-no movement of body or appendages on gentle prodding
17. Test acceptability	90% or greater survival of test organisms in control solution
18. Sampling requirements	For on-site tests, samples must be used within 24 hours of the time that they are removed from the sampling device. For off-site tests, samples must first be used within 36 hours of collection.
19. Sample volume required	Minimum 1 liter

Footnotes:

1. Adapted from EPA/600/4-90/027F.
2. Standard prepared dilution water must have hardness requirements to generally reflect the characteristics of the receiving water.
3. When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

EPA NEW ENGLAND RECOMMENDED TEST CONDITIONS FOR THE FATHEAD MINNOW (PIMEPHALES PROMELAS) 48 HOUR ACUTE TEST[1]

1.	Test Type	Static, non-renewal
2.	Temperature (°C):	20 ± 1 °C or 25 ± 1°C
3.	Light quality:	Ambient laboratory illumination
4.	Photoperiod:	16 hr light, 8 hr dark
5.	Size of test vessels:	250 mL minimum
6.	Volume of test solution:	Minimum 200 mL/replicate
7.	Age of fish:	1-14 days old and age within 24 hrs of the others
8.	No. of fish per chamber	10 (not to exceed loading limits)
9.	No. of replicate test vessels	4 per treatment
10.	Total no. organisms per concentration:	40
11.	Feeding regime:	Light feeding using concentrated brine shrimp nauplii while holding prior to initiating the test as per manual
12.	Aeration:	None, unless dissolved oxygen (D.O.) concentration falls below 4.0 mg/L, at which time gentle single bubble aeration should be started at a rate of less than 100 bubbles/min. (Routine D.O. check is recommended.)

13.	dilution water:[2]	Receiving water, other surface water, synthetic soft water adjusted to the hardness and alkalinity of the receiving water (prepared using either Millipore Milli-Q^R or equivalent deionized and reagent grade chemicals according to EPA acute toxicity test manual) or deionized water combined with mineral water to appropriate hardness.
14.	Dilution factor	≥ 0.5
15.	Number of dilutions[3]	5 plus a control. An additional dilution at the permitted effluent concentration (% effluent) is required if it is not included in the dilution series.
16.	Effect measured	Mortality-no movement on gentle prodding
17.	Test acceptability	90% or greater survival of test organisms in control solution
18.	Sampling requirements	For on-site tests, samples must be used within 24 hours of the time that they are removed from the sampling device. For off-site tests, samples are used within 36 hours of collection.
19.	Sample volume required	Minimum 2 liters

Footnotes:

1. Adapted from EPA-600/4-90/027F.
2. Standard dilution water must have hardness requirements to generally reflect characteristics of the receiving water.
3. When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

VI. CHEMICAL ANALYSIS

At the beginning of a static acute toxicity test, pH, conductivity, total residual chlorine, and temperature must be measured in the highest effluent concentration and the dilution water. Dissolved oxygen, pH and temperature are also measured at 24 and 48 hour intervals. It is also recommended that total alkalinity and total hardness be measured in the control and highest effluent concentration at the beginning of the test. The following chemical analyses shall be performed for each sampling event.

Parameter	Effluent	Diluent	Minimum Quantification Level(mg/L)
Hardness*1	x	x	0.5
Alkalinity	x	x	2.0
pH	x	x	---
Specific Conductance	x	x	---
Total Solids and Suspended Solids	x	x	---
Ammonia	x	x	0.1
Total Organic Carbon	x	x	0.5
Total Residual Chlorine (TRC)*2	x	x	0.05
Dissolved Oxygen	x	x	1.0
Total Metals			
Cd	x		0.001
Cr	x		0.005
Pb	x	x	0.005
Cu	x	x	0.0025
Zn	x	x	0.0025
Ni	x	x	0.004
Al	x	x	0.02
Mg, Ca	x	x	0.05

Superscripts:

*1 Method 2340 B (hardness by calculation) from APHA (1992) Standard Methods for the Examination of Water and Wastewater. 18th Edition.

*2 Total Residual Chlorine

Either of the following methods the 18th Edition of the APHA Standard Methods for the Examination of Water and Wastewater must be used for these analyses.
-Method 4500-CL E Low Level Amperometric Titration Method (the preferred method); or
-Method 4500-CL G DPD Colorimetric Method
or use USEPA Manual of Methods Analysis of Water and Wastes, Method 330.5

VII. TOXICITY TEST DATA ANALYSIS

LC50 Median Lethal Concentration (Determined at 48 Hours)

Methods of Estimation:

- Probit Method
- Spearman-Karber
- Trimmed Spearman-Karber
- Graphical

See the flow chart in Figure 6 on p. 77 of EPA 600/4-90/027F for appropriate method to use on a given data set.

No Observed Acute Effect Level (NOAEL)

See the flow chart in Figure 13 on p. 94 of EPA 600/4-90/027F.

VIII. TOXICITY TEST REPORTING

A report of the results will include the following:

- Description of sample collection procedures, site description;
- Names of individuals collecting and transporting samples, times and dates of sample collection and analysis on chain-of-custody; and
- General description of tests: age of test organisms, origin, dates and results of standard toxicant tests; light and temperature regime; other information on test conditions if different than procedures recommended. Reference toxicant test data should be included.
- All chemical/physical data generated. (Include minimum detection levels and minimum quantification levels.)
- Raw data and bench sheets.
- Provide a description of dechlorination procedures (as applicable).
- Any other observations or test conditions affecting test outcome.

ATTACHMENT C

NPDES PERMIT REQUIREMENT

FOR

INDUSTRIAL PRETREATMENT ANNUAL REPORT

The information described below shall be included in the pretreatment program annual reports:

1. An updated list of all industrial users by category, as set forth in 40 C.F.R. 403.8(f)(2)(i), indicating compliance or noncompliance with the following:
   - baseline monitoring reporting requirements for newly promulgated industries
   - compliance status reporting requirements for newly promulgated industries
   - periodic (semi-annual) monitoring reporting requirements,
   - categorical standards, and
   - local limits;

2. A summary of compliance and enforcement activities during the preceding year, including the number of:
   - significant industrial users inspected by POTW (include inspection dates for each industrial user),
   - significant industrial users sampled by POTW (include sampling dates for each industrial user),
   - compliance schedules issued (include list of subject users),
   - written notices of violations issued (include list of subject users),
   - administrative orders issued (include list of subject users),
   - criminal or civil suits filed (include list of subject users) and,
   - penalties obtained (include list of subject users and penalty amounts);

3. A list of significantly violating industries required to be published in a local newspaper in accordance with 40 C.F.R. 403.8(f)(2)(vii);

4. A narrative description of program effectiveness including present and proposed changes to the program, such as funding, staffing, ordinances, regulations, rules and/or statutory authority;

5. A summary of all pollutant analytical results for influent, effluent, sludge and any toxicity or bioassay data from the wastewater treatment facility. The summary shall include a comparison of influent sampling results versus threshold inhibitory concentrations for Haverhill's Wastewater Treatment System and effluent sampling results versus water quality standards. Such a comparison shall be based on the sampling program described in the paragraph below or any similar sampling program described in this Permit.

At a minimum, annual sampling and analysis of the influent and effluent of the Haverhill Wastewater Treatment Plant shall be conducted for the following pollutants:

a.) Total Cadmium
b.) Total Chromium
c.) Total Copper
d.) Total Lead
e.) Total Mercury
f.) Total Nickel
g.) Total Silver
h.) Total Zinc
i.) Total Cyanide
j.) Total Arsenic

The sampling program shall consist of one 24-hour flow-proportioned composite and at least one grab sample that is representative of the flows received by the POTW. The composite shall consist of hourly flow-proportioned grab samples taken over a 24-hour period if the sample is collected manually or shall consist of a minimum of 48 samples collected at 30 minute intervals if an automated sampler is used. Cyanide shall be taken as a grab sample during the same period as the composite sample. Sampling and preservation shall be consistent with 40 CFR Part 136.

6. A detailed description of all interference and pass-through that occurred during the past year;

7. A thorough description of all investigations into interference and pass-through during the past year;

8. A description of monitoring, sewer inspections and evaluations which were done during the past year to detect interference and pass-through, specifying parameters and frequencies;

9. A description of actions being taken to reduce the incidence of significant violations by significant industrial users; and,

10. The date of the latest adoption of local limits and an indication as to whether or not the City is under a State or Federal compliance schedule hat includes steps to be taken to revise local limits.

PERMIT ATTACHMENT D
REASSESSMENT OF TECHNICALLY BASED LOCAL LIMITS (TBLLs)

POTW Name & Address: ______________________________

NPDES PERMIT # : ______________________________

Date EPA approved current TBLLs : ______________________________

Date EPA approved current Sewer Use Ordinance: ______________________________

ITEM I.

In Column (1) list the conditions that existed when your current TBLLs were calculated. In Column (2), list current conditions or expected conditions at your POTW.

	Column (1) EXISTING TBLLs	Column (2) PRESENT CONDITIONS
POTW Flow (MGD)		
Dilution Ratio or 7Q10 (from NPDES Permit)		
SIU Flow (MGD)		
Safety Factor		N/A
Biosolids Disposal Method(s)		

ITEM II.

EXISTING TBLLs			
POLLUTANT	NUMERICAL LIMIT (mg/l) or (lb/day)	POLLUTANT	NUMERICAL LIMIT (mg/l) or (lb/day)

ITEM III.

Note how your existing TBLLs, listed in Item II., are allocated to your Significant Industrial Users (SIUs), i.e. uniform concentration, contributory flow, mass proportioning, other. Please specify by circling.

ITEM IV.

Has your POTW experienced any upsets, inhibition, interference or pass-through from industrial sources since your existing TBLLs were calculated?

If yes, explain.

____

____

____

Has your POTW violated any of its NPDES permit limits and/or toxicity test requirements?

If yes, explain.

____

____

ITEM V.

Using current POTW influent sampling data fill in Column (1). In Column (2), list your Maximum Allowable Industrial Headwork Loading (MAIHL) values used to derive your TBLLs listed in Item II. In addition, please note the Environmental Criteria for which each MAIHL value was established, i.e. water quality, sludge, NPDES etc.				
Pollutant	Column (1) Influent Data Analyses Maximum (lb/day)	Average (lb/day)	Column (2) MAHL Values (lb/day)	Criteria
Arsenic				
Cadmium				
Chromium				
Copper				
Cyanide				
Lead				
Mercury				
Nickel				
Silver				
Zinc				
Other (List)				

ITEM VI.

Using current POTW effluent sampling data, fill in Column (1). In Column (2A) list what the Water Quality Standards (Gold Book Criteria) were at the time your existing TBLLs were developed. List in Column (2B) current Gold Book values multiplied by the dilution ratio used in your new/reissued NPDES permit.

Pollutant	Column (1) Effluent Data Analyses		Columns Water Quality Criteria (Gold Book)	
	Maximum (ug/l)	Average (ug/l)	(2A) From TBLLs (ug/l)	(2B) Today (ug/l)
Arsenic				
*Cadmium				
*Chromium				
*Copper				
Cyanide				
*Lead				
Mercury				
*Nickel				
Silver				
*Zinc				
Other (List)				

*Hardness Dependent (mg/l - CaCO3)

ITEM VII.

In Column (1), identify all pollutants limited in your new/reissued NPDES permit. In Column (2), identify all pollutants that were limited in your old/expired NPDES permit.			
Column (1) NEW PERMIT		Column (2) OLD PERMIT	
Pollutants	Limitations (ug/l)	Pollutants	Limitations (ug/l)

ITEM VIII.

Using current POTW biosolids data, fill in Column (1). In Column (2A), list the biosolids criteria that was used at the time your existing TBLLs were calculated. If your POTW is planing on managing its biosolids differently, list in Column (2B) what your new biosolids criteria would be and method of disposal.			
Column (1) Pollutant Biosolids Data Analyses		Columns Biosolids Criteria	
	Average (mg/kg)	(2A) From TBLLs (mg/kg)	(2B) New (mg/kg)
Arsenic			
Cadmium			
Chromium			
Copper			
Cyanide			
Lead			
Mercury			
Nickel			
Silver			
Zinc			
Molybdenum			
Selenium			
Other (List)			

Attachment E

NINE MINIMUM CONTROLS

DOCUMENTATION AND IMPLEMENTATION GUIDANCE

The following guidance is for communities preparing documentation to demonstrate adequate implementation of the nine minimum technology based control measures for combined sewer overflows. For further information see *Combined Sewer Overflows: Guidance for Nine Minimum Controls (EPA MAY 1995) (EPA 832-B-95-003)*.

EPA has made a Best Professional Judgment (BPJ) determination that adequate implementation of technology based requirements, Best Practicable Control Technology Currently Available (BPT), Best Conventional Pollutant Control Technology (BCT) to control and abate conventional pollutants, and Best Available Technology Economically Achievable (BAT) to control and abate non-conventional and toxic pollutants, must include implementation of the nine minimum controls.

Documentation Requirements

Documentation should provide sufficient information to demonstrate:

- that alternatives were considered for each of the nine minimum control measures.
- the reasoning for the alternatives that were selected.
- that the selected alternatives have been implemented.
- that the permittee has developed a schedule for actions that have been selected but not yet fully implemented.

Nine Minimum Controls (NMC)

The following is a summary of specific information which must be included in the documentation of each of the NMCs.

1. **Proper operation and regular maintenance programs for the sewer system and combined sewer overflow points.**

a. An organizational chart showing the staff responsible for operation and maintenance (O&M) of the combined sewer system. Document that organization and staffing levels are adequate.

b. The funding allocated for O&M of the combined sewer system. Document that funding is adequate.

c. A list of facilities and structures that are critical to the performance of the combined sewer system, including all regulators, tide gates, pumping stations, and sections of sewer lines which are prone to sedimentation or obstruction. Include an inspection plan which identifies the locations, frequency, procedures, documentation, and reporting of periodic and emergency inspections and maintenance. Document that these facilities are adequately operated and maintained.

d. A summary of safety training and equipment provided to inspection and maintenance personnel. For instance, workers entering sewers must be trained and equipped for confined space entry. Document that training listed is adequate.

e. A summary of technical training and maintenance equipment provided to inspection and maintenance personnel. Document that training and equipment are adequate to maintain the facilities identified in item 1.c. above.

2. Maximum Use of the Collection System for Storage

a. Collection system inspection: This should focus on the identification of maintenance or design deficiencies that restrict the use of otherwise available system capacity. This evaluation should document that inadequate regulators, piping bottlenecks, and pumping deficiencies have been identified and corrected, or scheduled for correction. Where increased inspection and/or maintenance is proposed, this shall be reflected in the inspection plan required in item 1.c.

b. Tide gate maintenance and repair: Tide gates prevent significant volumes of water from entering the conveyance system, thereby freeing up system storage capacity during wet weather periods. Where appropriate, document that tide gate maintenance and repair procedures are adequate.

c. Adjustment of regulator settings: Adjustment of regulating devices can increase in-system storage of CSO flows and maximize transport to the POTW. Care should be taken to ensure that the regulator adjustment will not result in unacceptable surcharging of the system. Document that regulators have been adjusted to optimum settings. The method by which the community determined the optimum regulator setting (e.g. modeling, trial and error) shall be included in the documentation.

d. Removal of obstructions to flow: Document that accumulations of debris which may cause flow restrictions are identified, and debris is removed routinely. Documentation shall include a summary of the locations where sediment is removed, the number of times each year the sediment is removed and the total quantity of material removed each year.

3. **Review and Modification of the Industrial Pretreatment Program to assure CSO impacts are minimized.**

a. Review legal authority: Review the community's legal authority (i.e. pretreatment program, sewer use ordinance) to regulate non domestic discharges to its collection system. Identify those activities for which the community has or can obtain legal authority to address CSO induced water quality violations. For example, does the community have legal authority to require non domestic dischargers to store wastewater discharges during precipitation events or can the community require non domestic dischargers to implement runoff controls?

b. Inventory non domestic dischargers: Identify those non domestic discharges that may, through quantity of flow or pollutant concentration or loadings, contribute to CSO induced water quality violations,

c. Assess the significance of identified dischargers to CSO control issues: Assess whether the identified non domestic sources cause or contribute to CSO induced water quality standards by using monitoring, dilution calculations or other reasonable methods.

d. Evaluate and propose feasible modifications: Identify, evaluate, and propose site-specific modifications to the pretreatment program which would address the non domestic dischargers identified as significant. Modifications which shall be considered include;
Volume-related controls: Document that detaining wastewater flows (sanitary, industrial, and/or storm water) within the industrial facility until they can be safely discharged to the POTW for treatment was considered and implemented where reasonable.

Pollutant Load-related controls: Document that reduction of concentrations of pollutants that enter the collection system during storm periods was considered and implemented where reasonable. Methods to be considered for reducing pollutant concentrations from storm water runoff controls include structural and non-structural controls such as covering material storage areas, reducing impervious area, detention structures, and good housekeeping.

4. Maximization of flow to the POTW for treatment

It is recognized that most of the actions recommended for maximization of the collection system for storage will also serve to maximize flow to the POTW. In addition to optimizing those controls to maximize flow to the POTW, the following specific controls should be evaluated and implemented where possible;

a. Use of off-line or unused POTW capacity for storage of wet weather flows.

b. Use of excess primary treatment for treatment of wet weather flows. If the use of excess primary capacity will result in violations of the community's NPDES permit limits, the community shall get approval of the proposed bypass from the permitting authority prior to implementation.

5. Prohibition of CSO discharges during dry weather

a. Document that the community's monitoring and inspections are adequate to detect and correct dry weather overflows(DWOs)in a timely manner.

b. Document that DWOs due to inadequate sewer system capacity have been eliminated. If elimination is scheduled but not yet completed, the documentation shall include the schedule.

c. Document that DWOs due to clogging of pipes and regulators or due to other maintenance problems have been eliminated to the maximum extent practicable. Increased inspection and maintenance of problem areas must be considered as well as modification or replacement of existing structures.

6. Control of Solid and Floatable Material in CSO Discharges

Document that low cost control measures have been implemented which reduce solids and floatables discharged from CSOs to the maximum extent practicable. Alternatives which shall be considered include;

a. baffles in regulators or overflow structures.

b. trash racks in CSO discharge structures.

c. static screens in CSO discharge structures.

d. catch basin modifications.

e. end of pipe nets.

f. outfall booms (on surface of receiving water)

7. **Pollution prevention programs that focus on contaminant reduction activities.**

a. Prevention: through public education or increased awareness. For example, a water conservation outreach effort could result in less dry weather sanitary flow to the POTW and an increase in the volume of wet weather flows that can be treated at the POTW.

b. Control of disposal: through the use of garbage receptacles, more efficient garbage collection, or again, through public education.

c. Anti-litter campaigns: Campaigns through public outreach and public service announcements can be employed to educate the public about the effects of littering, overfertilizing, pouring used motor oil down catch basins, etc.

d. Illegal dumping: Programs such as law enforcement and public education can be used as controls for illegal dumping of litter, tires, and other materials into water bodies or onto the ground. Free disposal of these products at centrally located municipal dump sites can also reduce the occurrence of illegal dumping.

e. Street cleaning

f. Hazardous waste collection days: Communities are encouraged to schedule one or two days a year where household hazardous wastes can be brought to a common collection area for collection and environmentally safe disposal.

8. **Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts.**

The objective of this control element is to ensure that the public receives adequate notification of CSO impacts on pertinent water use areas. Of particular concern are beach and recreational areas that are affected by pollutant discharges in CSOs.

Where applicable, the permittee shall provide users of these types of areas with a reasonable opportunity to inform themselves of the existence of potential health risks associated with the use of the water body (bodies). The minimum control level, found in Section C.2.f. of the permit is posting of CSO discharge points.

9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

As stated in the permit, in Section C.2.f. the minimum requirement is quantification and recording at the outfall. If possible, the permittee shall initiate monitoring, measuring and/or inspection activities above and beyond the minimum control levels specified in the permit. The purpose of these additional monitoring and/or inspection events is to better characterize quality of the CSOs and their impacts on all receiving waters. Examples of such events include CSO monitoring or receiving water monitoring for pollutants of particular concern.

NPDES Permit No. MA0101621 - Attachment F

City of Haverhill Combined Sewer Overflows

(Grouped By Subsystem, from Upstream to Downstream)

CSO Locations	Outfall	Number of Discharges 2005	Receiving Water
Upper Siphon System			
BEACH STREET	**025**	**0**	**Merrimack River**
UPPER SIPHON- VARNUM ST.	**024**	**30**	**Merrimack River**
266 RIVER STREET	**023**	**0**	**Merrimack River**
RAILROAD BRIDGE	**022**	**0**	**Merrimack River**
Middle Siphon System			
WINTER AND HALE The Winter and Hale and Winter Street regulators share a 54-inch outfall into the Little River near Lafayette Square.	**021H**	**18**	**Little River**
HIGH STREET DIVERSION The High Street regulator shares the same outfall as the Broadway regulator	**038**	**0**	**Little River**
LOCKE STREET SOUTH	**021E**	**20**	**Little River**
LOCKE STREET NORTH Center Barrel regulator shares this outfall.	**021D**	**17**	**Little River**
MIDDLE SIPHON – ESSEX ST.	**021A**	**39**	**Merrimack River**
Lower Siphon System			
MAIN ST NORTH	**019**	**0**	**Merrimack River**
FIRE STATION	**016**	**0**	**Merrimack River**
LOWER SIPHON- BUTTONWOOD AVE	**013**	**25**	**Merrimack River**
BOARDMAN ST	**010**	**0**	**Merrimack River**
BATES BRIDGE	**001**	**0**	**Merrimack River**
Bradford System			
FRONT STREET	**031**	**11**	**Merrimack River**
BRADFORD AVE	**032**	**28**	**Merrimack River**
SOUTH PROSPECT STREET	**033**	**10**	**Merrimack River**
MIDDLESEX STREET	**034**	**12**	**Merrimack River**
SOUTH MAIN ST	**035**	**20**	**Merrimack River**
FERRY STREET	**036**	**30**	**Merrimack River**

Memorandum

To: *File*

From: *Milagros A. Puello, P.E.*

Date: *February 20, 2017*

Subject: *Solids and Floatables Control Study*

The City of Haverhill, MA has contracted CDM Smith to investigate potential solids and floatables controls opportunities to implement at all the active Combined Sewer Overflow (CSO) regulators. This study is being completed as part of the City's update to its Nine Minimum Controls (NMC) program and CSO Long-Term Control Plan. The implementation of Nine Minimum Controls (NMC) measures have been identified by the U.S. Environmental Protection Agency's (EPA's) as a step to controlling CSO discharges and are an important component of the CSO Control Policy. The control of solids and floatables in CSO discharges addresses aesthetic quality and environmental impact of the receiving water.

Solids are waterborne waste material and debris which consist of sand, gravel, silts, clay, and other organic matter. Solids are a visual nuisance and can affect turbidity, dissolved oxygen and carry pathogens in the receiving water. Solids can also affect the combined sewer system by causing decreased hydraulic capacity, which could increase overflows. Solids can enter the system through domestic and industrial wastewater, and stormwater runoff.

Floatables are waterborne waste material and debris which float at or below the water surface. Floatables are aesthetically undesirable in receiving waters. They can cause beach closings, interfere with navigation, water intake systems and impact wild life. Floatables can enter the system through sanitary wastewater and stormwater runoff.

NMC measures require communities to identify low-cost, easily implementable, actions that could reduce or eliminate floatables in the CSO discharges. There are various technologies that can be used to control solids and floatables in CSOs. These technologies range from simple devices and measures that prevent floatables and solids from entering the combined system (source controls), devices that remove the materials from the CSO flow stream (in-system controls) and devices that remove the materials from the receiving water after they are discharged (end of pipe controls). Some of the technologies considered to control solids and floatables discharge at the City's CSO regulators are:

- Source Controls: street sweeping, catch basin inserts and catch basin modifications.
- In System Controls: baffles, bar racks, screens, hydrodynamic separators and nets (inline).

Due to access limitation to most of the CSO outfalls in Haverhill, end of pipe controls such as end of pipe netting, booms and skimmer vessels were not considered further in this study.

Source Controls

Street Sweeping

It has been found that most solids and floatables in CSOs originate as street litter. Street sweeping is an effective way to collect and dispose of solids and floatables before they enter the sewer system. A municipal street cleaning program would not only enhance the aesthetic appearance of streets, but also improves the water quality of surface runoff by reducing the quantity of solids and floatables entering the combined sewer system. Street sweeping is commonly done with manual, mechanical and vacuum sweepers.

Street sweeping in Haverhill is performed by the Highway Department. Streets near most CSO structure are swept throughout the year. More frequent street sweeping is performed in more densely developed, commercial and business areas of the city. More frequent street sweeping will not eliminate solids and floatables from the combined system, but it has been found effective in removing floatables when it is combined with a good catch basin cleaning program.

Sweeper units come in many different sizes: Smaller units used for small parking lots and sidewalks, small truck sweepers for parking lots and small streets and standard municipal street sweepers. Street sweepers range in price from $9,500 for the smaller units to approximately $180,000 for the standard units. In addition, street sweeping costs include operator's labor and the sweeper unit maintenance and service requirements.

Catch Basin Inserts

Catch basin inserts can also be effective in preventing solids and floatables from entering the sewer system. Catch basin inserts, usually a screen or filter, are available in sizes to fit in a standard catch basin. Inserts typically have a high flow bypass to prevent flow backups, should the insert be blinded. They must be frequently cleaned to prevent blinding, maintain effectiveness and not reduce hydraulic capacity. Catch basin inserts are typically serviced 2 to 3 times per year, using a vacuum truck. Depending on the areas hydrology, rainfall, land use and season more frequent servicing may be required. There are many catch basin inserts in the market today. Simple stainless steel baskets, without filter, range in costs from around $600 to $1100 per unit, depending on the size. Inserts with media filter are costlier.

Catch Basin Modifications

Catch basin configuration has a considerable impact on its ability to prevent solids and floatables from entering the sewer system. A catch basin with the outlet pipe above the invert and without a curb inlet is better at containing solids and floatables than a catch basin that have either of these features. Installing hoods, submerged outlets and vortex valves keeps floatables from entering the combined sewer system by keeping the outlet pipe below the surface. Similar to catch basin with inserts, retained material can clog the outlet if cleaning is not performed on a regular basis. The catch basin must also have a sump deep enough to accommodate the device.

Catch basin hoods/traps are available in a variety of materials and sizes. Their cost range from $250 to $6,000 depending on the size.

In-System Controls

Baffles

Baffles are simple floatables control devices installed inside regulators structures. Baffles are installed along with weirs. They consist of vertical steel plates or concrete beams that extend from the top of the structure to below the overflow elevation. The baffle is submerged prior to the water reaching the top of the weir. The submerged baffle retains floatables preventing their discharge over the weir. When the flow recedes below the bottom of the baffle, floatables are conveyed to the interceptor sewer. The applicability and effectiveness of the baffle depends on the configuration and hydraulic conditions at the regulators structure. They can be installed in a retrofit application or new installation and their maintenance requirement are typically low. When designing baffles flow velocities and headloss must be consider. High velocities may cause solids and floatables to be pulled under the baffle and too much headloss may impact the system upstream. A new type of baffle, a floating baffle, has been develop and is being used in Germany. The floating baffle functions the same as a standard baffle except that it is held in place by hinged arms that allow it to float on the water surface. Cost of standard baffles depend on the type and size of installation. Simple wood or PVC installation can cause a few hundred dollars; larger concrete baffle structures are costlier.

Bar Racks

Bar racks are vertical or horizontal bars placed in front of the CSO structure or before the outfall pipe. Bar racks trap large objects from the overflow while letting the water pass through. They typically spaced 1-3 inches apart and are manually cleaned. Bar racks are simple and can be utilized on many structure in different configurations. When designing bar racks, hydraulics conditions, structure configuration and accessibility for maintenance should be considered. Bar racks require frequent inspection and cleaning to assure that it does not become blinded, causing upstream flooding or dry weather overflows. It is recommended they get cleaned after every storm. The cost of bar racks depends on material and size, small racks can be fabricated and installed for less than $1,000.

Screens

Similar to bar racks, trap objects from the overflow while letting water pass through; But screens come in many more configurations, are usually mechanically cleaned and have smaller screen sizes. They can be located within inline CSO chambers or on the outfall. Screens used for CSO control come in various types such as vertical bar screens, horizontal screens and rotary drum screen. Normal maintenance for screens include regular inspections for obstructions and mechanical upkeep. Screen costs vary, depending on size and configuration.

Hydrodynamic Separators

Hydrodynamic separators are solids separation devices that remove debris by imparting a swirl or vortex within the flow. Flow enters the unit and is directed around the perimeter causing a vortex flow pattern that caused solids and floatables to drop out to the bottom of the unit. The units typically have a high flow bypass that allows flows in excess of the unit's capacity. Hydrodynamic separators maybe installed inline or offline. Headloss through the unit must be considered during design to limit impact upstream system hydraulics. Maintenance typically involves cleaning the unit with a vacuum truck once the sump fills up. Offline units may require maintenance after each storm.

Nets

Netting systems are a system of disposable mesh bags installed either in line with the outfall pipe (in-line netting) or in the water way at the end of the outfall (floating units). In-line netting is typically installed in concrete vaults containing one or more nylon mesh bags and a metal frame and guide system to support the nets. The mesh is sized according to the volume and type of floatables targeted for capture. Floating units consist of an in-water containment area the funnels CSO flow through large nylon mesh nets. Similar to in-line nets, mesh size depends on volume and type of floatables. After every storm bags are removed and replaced; and the accumulated debris taken to a disposal site.

In-line system controls will be evaluated for each CSO regulator structure and site in the section below.

Site-Specific CSO Evaluation

Two criteria were used to evaluate the control technology at each regulator: the structure configuration and site space available. CSO regulators in the Haverhill system range from deep, multi-chamber structures to simple regulator manholes. They are located throughout the city along the Little River and the Merrimack River. Some regulators are in the street and others are in easement properties. Structure configuration and sitting requirements may impact whether or not a technology is feasible.

When possible, baffles should be placed perpendicular to the direction of flow and extended across the full with of the flow channel. To minimize adverse hydraulic effects upstream, the area underneath and behind the baffle is recommended to be equal or greater than the existing area. Bar racks and screens are the simplest and most prevalent form of solids and floatables control. They can be installed in the structures in many configurations based on hydraulic conditions, structure configuration, depth and dimension of the structure. They can also be located in a separate structure along the outfall. Hydrodynamic separator units and inline netting systems require a separate structure upstream or downstream of the CSO structure. For all these technologies the design must include sufficient space for storage of solids and floatables and accessibility for regular required maintenance.

Upper Siphon CSO – is located on an easement property off of River Street, on the edge of the Merrimack River. It is a three chamber structure with an 84-inch RCP outfall approximately 14.5 feet long. Due to its configuration installing baffles is not feasible. This site is also limited in space, installing a netting system or hydrodynamic separator unit is not feasible either. Bar racks or static screens could potentially be installed in the outfall chamber upstream of the outfall pipe. The existing 9-ft x 3-ft opening can be used to access the screens for maintenance with a vacuum truck.

Lower Siphon CSO –is located on Water Street on the edge of the Merrimack River. It is a four chamber structure with a 7-ft x 4-ft twin box outfall approximately 13.5 feet long. Similar to Upper Siphon CSO, Lower Siphon has limited space onsite and its configuration makes it difficult to implement solids and floatables control technologies. Bar racks or static screens could potentially be installed in the second outfall chamber upstream of the outfall pipe. The existing 12-ft x 2-ft opening can be used to access the screens for maintenance. It should be noted that vehicle access to the lower chamber of the Lower Siphon CSO regulator is through a path along the edge of the river.

Main Street North CSO – is located at the intersection of Water Street and Main Street. It is a two chamber structure with a 36-inch outfall approximately 254 feet long to the Merrimack River. The configuration of the Main Street North CSO regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the existing structure or the construction of a separate structure upstream or downstream of the regulator.

Bethany Avenue CSO – is located at the intersection of Bethany Avenue and Ginty Boulevard. It is a manhole structure with a 36-inch outfall approximately 637 feet long to the Merrimack River. The configuration of the Bethany Ave. CSO regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the existing structure or the construction of a separate structure downstream of the regulator.

Chestnut Street CSO – is located at the intersection of Chestnut Street and Ginty Boulevard. It is a manhole structure with a 36-inch outfall approximately 643 feet long. The configuration of the Chestnut Street CSO regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the existing structure or the construction of a separate structure downstream of the regulator.

Middle Siphon CSO – is located on a city-owned property on Washington Square. It is a single chamber, square structure with a 36-inch outfall approximately 57 feet long to the Little River Conduit. The configuration of the Middle Siphon CSO regulator does not allow for installation of solids and floatables control inside the structure. Solids and floatables control for this regulator would require building a structure on the outfall downstream of the regulator and upstream of the Marginal PS weir.

Marginal PS Weir – this regulator will be eliminated with the completion of the Wet Weather CSO Modifications Project. Solids and floatables control was not considered for this regulator.

Emerson Street CSO – is located at the intersection of Emerson Street and Walnut Street. It is a two chamber structure with a 24-inch outfall approximately 367 feet long to the Little River Conduit. Bar racks or screens could potentially be installed in the outfall chamber, which has an access manhole for maintenance with a vacuum truck. Also, a netting system or a hydrodynamic separator unit could be installed in a separate structure upstream or downstream of the regulator. Special consideration should be taken when designing solids and floatables control for Emerson CSO. This regulator also functions as a diversion structure in the City's flood protection system.

Locke Street North CSO and Orchard Street Center Barrel CSO – The Locke Street-North and Orchard Street Center Barrel regulators are located are in separate manholes on Locke Street. They discharge through a common outfall pipe (39-in x 50-in brick) that penetrates the northern side wall of the Little River Conduit. The configuration of either of these regulators does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the Locke Street North CSO structure or the construction of a separate structure between the existing regulator and backwater structure.

Locke Street South CSO – is located on Locke Street. It is a manhole structure with a 39-in x 50-in outfall that penetrates the southern side wall of the Little River Conduit. Similar to Locke Street North CSO, the configuration of this regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the Locke Street South CSO structure. The construction of a separate structure is not feasible due to the proximity of the backwater structure to the regulator.

Winter Street CSO – is a two chamber structure located on Winter Street. It has a 30-inch outfall to Winter and Hale Street CSO which then discharges to the Little River. Bar racks or screens could potentially be installed in the outfall chamber, but it would require the construction of a new access manhole for maintenance. Special consideration should be taken when designing solids and floatables control for this regulator. It also functions as a diversion structure in the City's flood protection system.

Winter and Hale Street CSO – is located at the intersection of Winter Street and Hale Street. It is a two chamber structure with a 54-inch outfall approximately 423 feet long to the Little River. Bar racks or screens could potentially be installed in the outfall chamber, which has an access manhole for maintenance. A netting system or a hydrodynamic separator unit could be installed in a separate structure downstream of the regulator. Special consideration should be taken when designing solids and floatables control for Winter and Hale Street CSO. This regulator also functions as a diversion structure in the City's flood protection system.

Broadway CSO – is a single chamber, square structure with a 42-inch outfall approximately 1130 feet long to the Little River. The configuration of Broadway CSO regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the existing structure or the construction of a separate structure upstream or downstream of the regulator. Special consideration should be taken when designing solids and floatables control for this regulator, it also functions as a diversion structure in the City's flood protection system.

High Street CSO – is a single chamber structure with a 36-inch outfall approximately 550 feet long to the Little River, which it shares with Broadway CSO. The configuration of the High Street CSO regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the existing structure or the construction of a separate structure upstream or downstream of the regulator. Special consideration should be taken when designing solids and floatables control for this regulator, it also functions as a diversion structure in the City's flood protection system.

Bradford Avenue CSO – is located on an easement property off of Bradford Avenue, on the edge of the Merrimack River. It is a deep, single chamber structure with a 48-inch outfall approximately 56 feet long. The configuration and depth of the Bradford Ave. CSO regulator does not allow for installation of solids and floatables control inside the structure. Solids and floatables control for this regulator would require building a separate structure upstream of the regulator.

Middlesex Street CSO – is located on an easement property off of Middlesex Street. It is a two chamber structure with a 36-inch outfall approximately 92 feet long to the Merrimack River. The configuration of the Middlesex Street CSO regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the existing structure or the construction of a separate structure upstream or downstream of the regulator.

South Webster Street CSO –is a manhole structure with an 18-inch outfall approximately 2000 feet long. The configuration of the So. Webster St. CSO regulator does not allow for installation of solids and floatables control inside the structure. Adding solids and floatables control to this regulator would require the replacement of the existing structure or the construction of a separate structure upstream or downstream of the regulator.

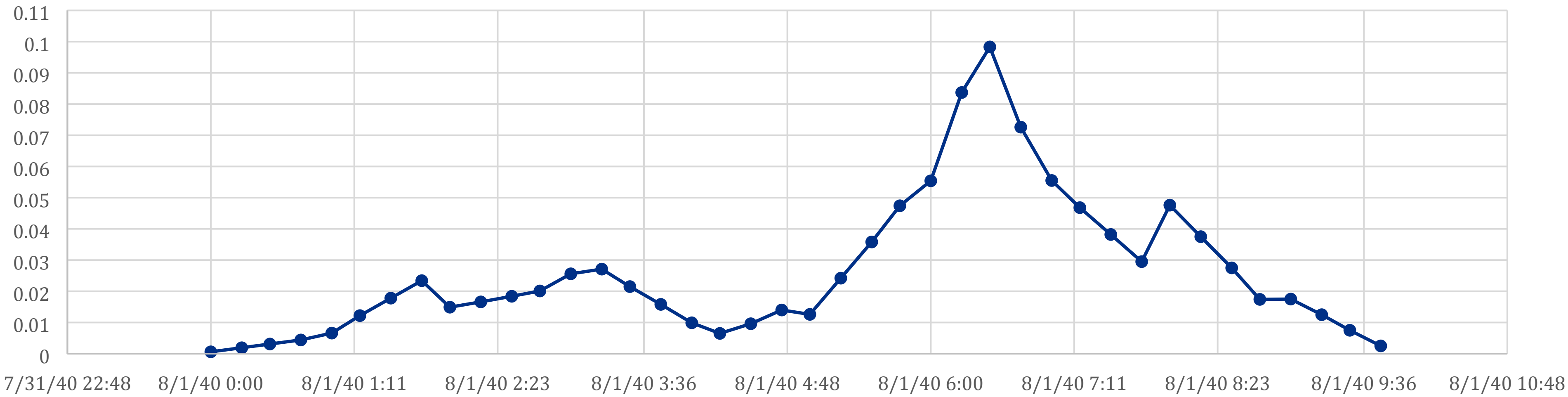
Conclusions

As discussed above due to the physical constraints and layout of most of the CSO regulator structures in Haverhill, the control of floatables through available technologies discussed herein do not represent low cost, easily implementable strategies. Implementing solids and floatables controls at many of the regulators would require the replacement of the existing structure with structure designed with the implementation of hydraulics control and solids and floatables control in mind. Or space permitting the construction of new structures dedicated for control of solids and floatables at the CSO regulator site. Neither of these options would be low cost.

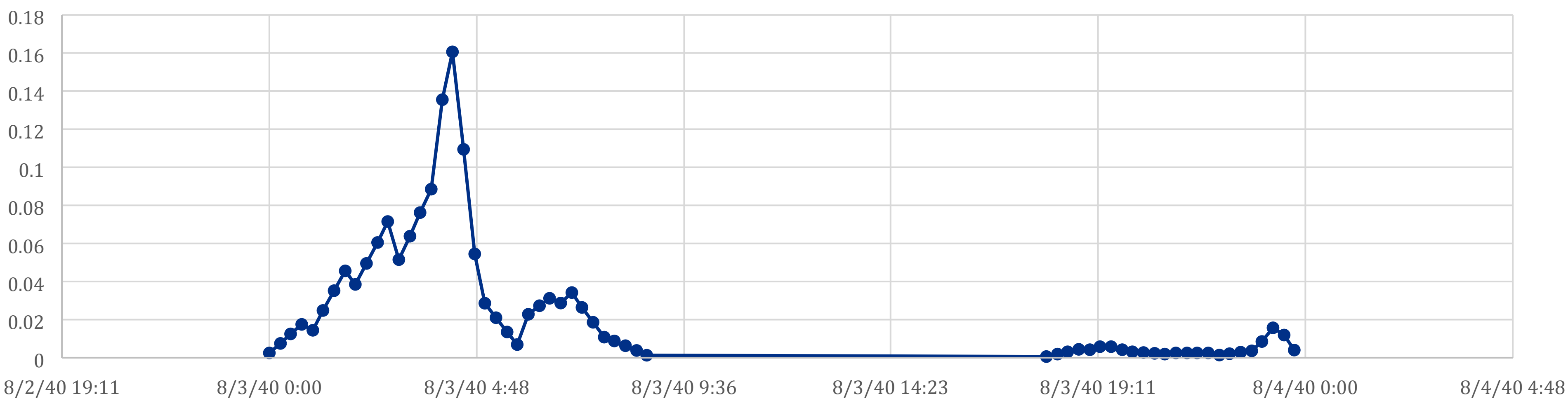
The city of Haverhill performs a comprehensive program of operation and maintenance activities to minimize CSO discharges. These programs have minimized receiving water impacts from discharges. The city has received very few reports or complaints of CSO discharges related floatables sightings at the outfall locations. Through the implementation of the Phase II LTCP the city will continue its efforts of further reducing CSO discharge.

cc: [Click here to enter name]

1-Month Design Storm Hyetograph

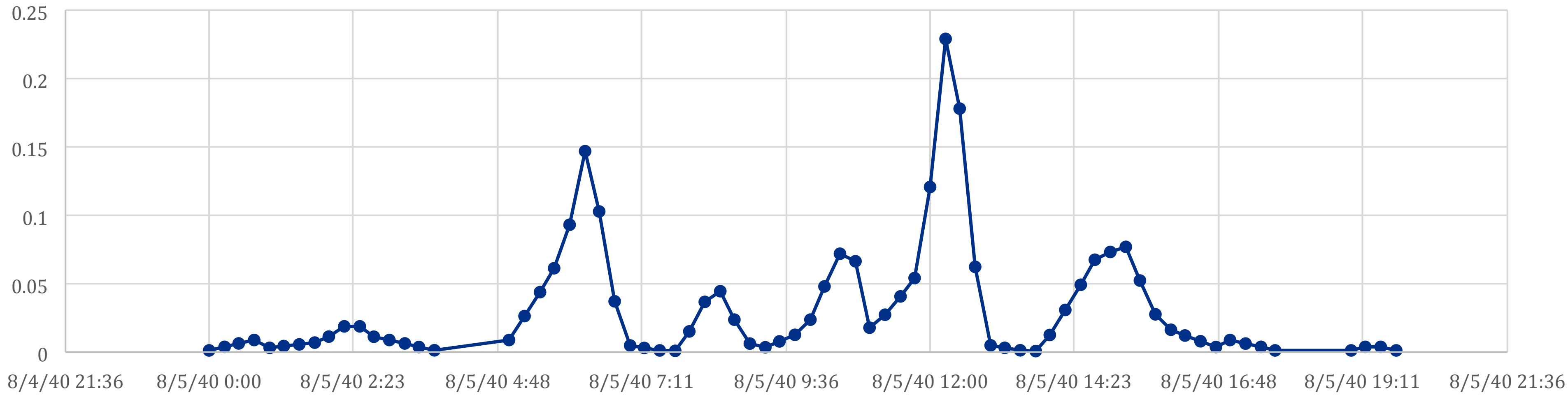


3-Month Design Storm Hyetograph

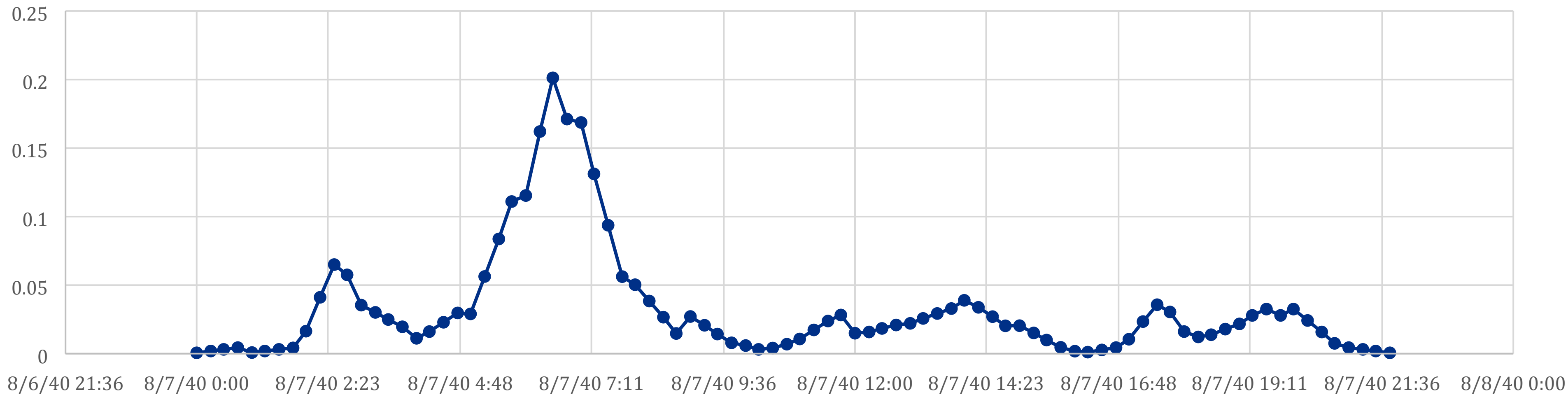


CDM Smith

6-Month Design Storm Hyetograph

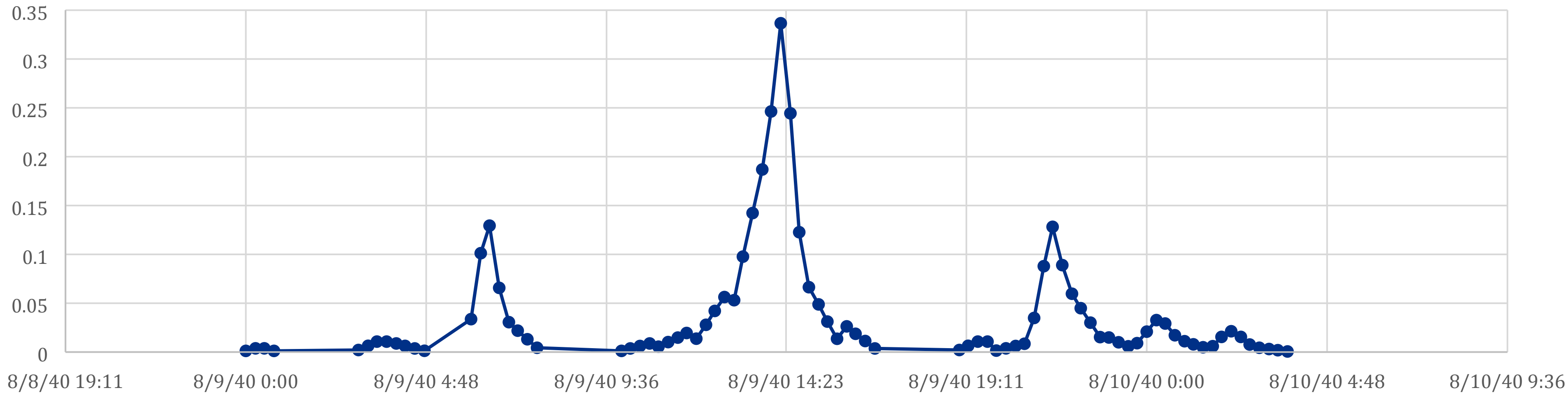


1-Year Design Storm Hyetograph

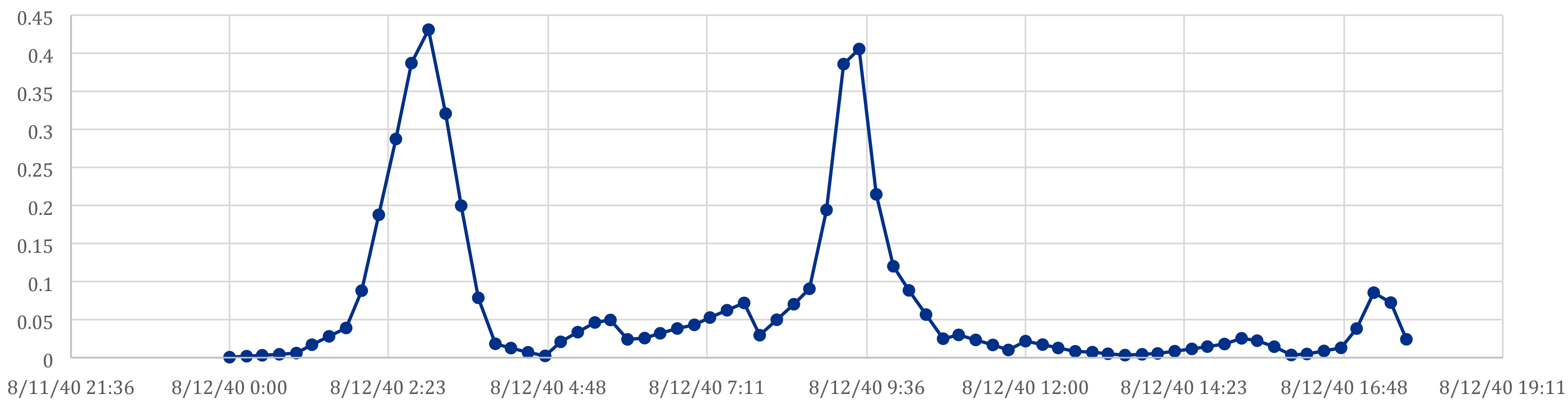


CDM Smith

2-Year Design Storm Hyetograph



5-Year Design Storm Hyetograph



federal register

Tuesday
April 19, 1994

Part VII

Environmental Protection Agency

Combined Sewer Overflow (CSO) Control Policy; Notice

ENVIRONMENTAL PROTECTION AGENCY

[FRL-4732-7]

Combined Sewer Overflow (CSO) Control Policy

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final policy.

SUMMARY: EPA has issued a national policy statement entitled "Combined Sewer Overflow (CSO) Control Policy." This policy establishes a consistent national approach for controlling discharges from CSOs to the Nation's waters through the National Pollutant Discharge Elimination System (NPDES) permit program.

FOR FURTHER INFORMATION CONTACT: Jeffrey Lape, Office of Wastewater Enforcement and Compliance, MC-4201, U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (202) 260-7361.

SUPPLEMENTARY INFORMATION: The main purposes of the CSO Control Policy are to elaborate on the Environmental Protection Agency's (EPA's) National CSO Control Strategy published on September 8, 1989, at 54 FR 37370, and to expedite compliance with the requirements of the Clean Water Act (CWA). While implementation of the 1989 Strategy has resulted in progress toward controlling CSOs, significant public health and water quality risks remain.

This Policy provides guidance to permittees with CSOs, NPDES authorities and State water quality standards authorities on coordinating the planning, selection, and implementation of CSO controls that meet the requirements of the CWA and allow for public involvement during the decision-making process.

Contained in the Policy are provisions for developing appropriate, site-specific NPDES permit requirements for all combined sewer systems (CSS) that overflow as a result of wet weather events. For example, the Policy lays out two alternative approaches—the "demonstration" and the "presumption" approaches—that provide communities with targets for CSO controls that achieve compliance with the Act, particularly protection of water quality and designated uses. The Policy also includes enforcement initiatives to require the immediate elimination of overflows that occur during dry weather and to ensure that the remaining CWA requirements are complied with as soon as practicable.

The permitting provisions of the Policy were developed as a result of extensive input received from key stakeholders during a negotiated policy dialogue. The CSO stakeholders included representatives from States, environmental groups, municipal organizations and others. The negotiated dialogue was conducted during the Summer of 1992 by the Office of Water and the Office of Water's Management Advisory Group. The enforcement initiatives, including one which is underway to address CSOs during dry weather, were developed by EPA's Office of Water and Office of Enforcement.

EPA issued a Notice of Availability on the draft CSO Control Policy on January 19, 1993, (58 FR 4994) and requested comments on the draft Policy by March 22, 1993. Approximately forty-one sets of written comments were submitted by a variety of interest groups including cities and municipal groups, environmental groups, States, professional organizations and others. All comments were considered as EPA prepared the Final Policy. The public comments were largely supportive of the draft Policy. EPA received broad endorsement of and support for the key principles and provisions from most commenters. Thus, this final Policy does not include significant changes to the major provisions of the draft Policy, but rather, it includes clarification and better explanation of the elements of the Policy to address several of the questions that were raised in the comments. Persons wishing to obtain copies of the public comments or EPA's summary analysis of the comments may write or call the EPA contact person.

The CSO Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost effective CSO controls that ultimately meet appropriate health and environmental objectives. The Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. Major elements of the Policy ensure that CSO controls are cost effective and meet the objectives and requirements of the CWA.

The major provisions of the Policy are as follows.

CSO permittees should immediately undertake a process to accurately characterize their CSS and CSO discharges, demonstrate implementation of minimum technology-based controls identified in the Policy, and develop long-term CSO control plans which evaluate alternatives for attaining compliance with the CWA, including compliance with water quality standards and protection of designated uses. Once the long-term CSO control plans are completed, permittees will be responsible to implement the plans' recommendations as soon as practicable.

State water quality standards authorities will be involved in the long-term CSO control planning effort as well. The water quality standards authorities will help ensure that development of the CSO permittees' long-term CSO control plans are coordinated with the review and possible revision of water quality standards on CSO-impacted waters.

NPDES authorities will issue/reissue or modify permits, as appropriate, to require compliance with the technology-based and water quality-based requirements of the CWA. After completion of the long-term CSO control plan, NPDES permits will be reissued or modified to incorporate the additional requirements specified in the Policy, such as performance standards for the selected controls based on average design conditions, a post-construction water quality assessment program, monitoring for compliance with water quality standards, and a reopener clause authorizing the NPDES authority to reopen and modify the permit if it is determined that the CSO controls fail to meet water quality standards or protect designated uses. NPDES authorities should commence enforcement actions against permittees that have CWA violations due to CSO discharges during dry weather. In addition, NPDES authorities should ensure the implementation of the minimum technology-based controls and incorporate a schedule into an appropriate enforceable mechanism, with appropriate milestone dates, to implement the required long-term CSO control plan. Schedules for implementation of the long-term CSO control plan may be phased based on the relative importance of adverse impacts upon water quality standards and designated uses, and on a permittee's financial capability.

EPA is developing extensive guidance to support the Policy and will announce the availability of the guidances and other outreach efforts through various means, as they become available. For example, EPA is preparing guidance on the nine minimum controls, characterization and monitoring of CSOs, development of long-term CSO control plans, and financial capability.

Permittees will be expected to comply with any existing CSO-related requirements in NPDES permits, onsent decrees or court orders unless evised to be consistent with this Policy.

The policy is organized as follows:

List of Subjects in 40 CFR Part 122

Water pollution control.

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

Dated: April 8, 1994.

Carol M. Browner,

Administrator.

Combined Sewer Overflow (CSO) Control Policy

I. Introduction

A. Purpose and Principles

The main purposes of this Policy are to elaborate on EPA's National Combined Sewer Overflow (CSO) Control Strategy published on September 8, 1989 at 54 FR 37370 (1989 Strategy) and to expedite compliance with the requirements of the Clean Water Act (CWA). While implementation of the 1989 Strategy has resulted in progress toward controlling CSOs, significant water quality risks remain.

A combined sewer system (CSS) is a wastewater collection system owned by a State or municipality (as defined by section 502(4) of the CWA) which conveys sanitary wastewaters (domestic, commercial and industrial wastewaters) and storm water through a single-pipe system to a Publicly Owned Treatment Works (POTW) Treatment Plant (as defined in 40 CFR 403.3(p)). A CSO is the discharge from a CSS at a point prior to the POTW Treatment Plant. CSOs are point sources subject to NPDES permit requirements including both technology-based and water quality-based requirements of the CWA. CSOs are not subject to secondary treatment requirements applicable to POTWs.

CSOs consist of mixtures of domestic sewage, industrial and commercial wastewaters, and storm water runoff. CSOs often contain high levels of suspended solids, pathogenic microorganisms, toxic pollutants, floatables, nutrients, oxygen-demanding organic compounds, oil and grease, and other pollutants. CSOs can cause exceedances of water quality standards (WQS). Such exceedances may pose risks to human health, threaten aquatic life and its habitat, and impair the use and enjoyment of the Nation's waterways.

This Policy is intended to provide guidance to permittees with CSOs, National Pollutant Discharge Elimination System (NPDES) permitting authorities, State water quality standards authorities and enforcement authorities. The purpose of the Policy is to coordinate the planning, selection, design and implementation of CSO management practices and controls to meet the requirements of the CWA and to involve the public fully during the decision making process.

This Policy reiterates the objectives of the 1989 Strategy:

1. To ensure that if CSOs occur, they are only as a result of wet weather;
2. To bring all wet weather CSO discharge points into compliance with the technology-based and water quality-based requirements of the CWA; and
3. To minimize water quality, aquatic biota, and human health impacts from CSOs.

This CSO Control Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost-effective CSO controls that ultimately meet appropriate health and environmental objectives and requirements. The Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. Four key principles of the Policy ensure that CSO controls are cost-effective and meet the objectives of the CWA. The key principles are:

1. Providing clear levels of control that would be presumed to meet appropriate health and environmental objectives;
2. Providing sufficient flexibility to municipalities, especially financially disadvantaged communities, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements;
3. Allowing a phased approach to implementation of CSO controls considering a community's financial capability; and
4. Review and revision, as appropriate, of water quality standards and their implementation procedures when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

This Policy is being issued in support of EPA's regulations and policy initiatives. This Policy is Agency guidance only and does not establish or affect legal rights or obligations. It does not establish a binding norm and is not finally determinative of the issues addressed. Agency decisions in any particular case will be made by applying the law and regulations on the basis of specific facts when permits are issued. The Administration has recommended that the 1994 amendments to the CWA endorse this final Policy.

B. Application of Policy

The permitting provisions of this Policy apply to all CSSs that overflow as a result of storm water flow, including snow melt runoff (40 CFR 122.26(b)(13)). Discharges from CSSs during dry weather are prohibited by the CWA. Accordingly, the permitting provisions of this Policy do not apply to CSOs during dry weather. Dry weather flow is the flow in a combined sewer that results from domestic sewage, groundwater infiltration, commercial and industrial wastewaters, and any other non-precipitation related flows (*e.g.*, tidal infiltration). In addition to the permitting provisions, the enforcement and Compliance section of this Policy describes an enforcement initiative being developed for overflows that occur during dry weather.

Consistent with the 1989 Strategy, 30 States that submitted CSO permitting strategies have received EPA approval or, in the case of one State, conditional approval of its strategy. States and EPA Regional Offices should review these strategies and negotiate appropriate revisions to them to implement this Policy. Permitting authorities are encouraged to evaluate water pollution control needs on a watershed management basis and coordinate CSO control efforts with other point and nonpoint source control activities.

C. Effect on Current CSO Control Efforts

EPA recognizes that extensive work has been done by many Regions, States, and municipalities to abate CSOs. As such, portions of this Policy may already have been addressed by permittees' previous efforts to control CSOs. Therefore, portions of this Policy may not apply, as determined by the permitting authority on a case-by-case basis, under the following circumstances:

1. Any permittee that, on the date of publication of this final Policy, has completed or substantially completed construction of CSO control facilities that are designed to meet WQS and protect designated uses, and where it has been determined that WQS are being or will be attained, is not covered by the initial planning and construction provisions in this Policy; however, the operational plan and post-construction monitoring provisions continue to apply. If, after monitoring, it is determined that WQS are not being attained, the permittee should be required to submit a revised CSO control plan that, once implemented, will attain WQS.

2. Any permittee that, on the date of publication of this final Policy, has substantially developed or is implementing a CSO control program pursuant to an existing permit or enforcement order, and such program is considered by the NPDES permitting authority to be adequate to meet WQS and protect designated uses and is reasonably equivalent to the treatment objectives of this Policy, should complete those facilities without further planning activities otherwise expected by this Policy. Such programs, however, should be reviewed and modified to be consistent with the sensitive area, financial capability, and post-construction monitoring provisions of this Policy.

3. Any permittee that has previously constructed CSO control facilities in an effort to comply with WQS but has failed to meet such applicable standards or to protect designated uses due to remaining CSOs may receive consideration for such efforts in future permits or enforceable orders for long-term CSO control planning, design and implementation.

In the case of any ongoing or substantially completed CSO control effort, the NPDES permit or other enforceable mechanism, as appropriate, should be revised to include all appropriate permit requirements consistent with Section IV.B. of this Policy.

D. Small System Considerations

The scope of the long-term CSO control plan, including the characterization, monitoring and modeling, and evaluation of alternatives portions of this Policy may be difficult for some small CSSs. At the discretion of the NPDES Authority, jurisdictions with populations under 75,000 may not need to complete each of the formal steps outlined in Section II.C. of this Policy, but should be required through their permits or other enforceable mechanisms to comply with the nine minimum controls (II.B), public participation (II.C.2), and sensitive areas (II.C.3) portions of this Policy. In addition, the permittee may propose to implement any of the criteria contained in this Policy for evaluation of alternatives described in II.C.4. Following approval of the proposed plan, such jurisdictions should construct the control projects and propose a monitoring program sufficient to determine whether WQS are attained and designated uses are protected.

In developing long-term CSO control plans based on the small system considerations discussed in the preceding paragraph, permittees are encouraged to discuss the scope of their long-term CSO control plan with the WQS authority and the NPDES authority. These discussions will ensure that the plan includes sufficient information to enable the permitting authority to identify the appropriate CSO controls.

E. Implementation Responsibilities

NPDES authorities (authorized States or EPA Regional Offices, as appropriate) are responsible for implementing this Policy. It is their responsibility to assure that CSO permittees develop long-term CSO control plans and that NPDES permits meet the requirements of the CWA. Further, they are responsible for coordinating the review of the long-term CSO control plan and the development of the permit with the WQS authority to determine if revisions to the WQS are appropriate. In addition, they should determine the appropriate vehicle (i.e., permit reissuance, information request under CWA section 308 or State equivalent or enforcement action) to ensure that compliance with the CWA is achieved as soon as practicable.

Permittees are responsible for documenting the implementation of the nine minimum controls and developing and implementing a long-term CSO control plan, as described in this Policy. EPA recognizes that financial considerations are a major factor affecting the implementation of CSO controls. For that reason, this Policy allows consideration of a permittee's financial capability in connection with the long-term CSO control planning effort, WQS review, and negotiation of enforceable schedules. However, each permittee is ultimately responsible for aggressively pursuing financial arrangements for the implementation of its long-term CSO control plan. As part of this effort, communities should apply to their State Revolving Fund program, or other assistance programs as appropriate, for financial assistance.

EPA and the States will undertake action to assure that all permittees with CSSs are subject to a consistent review in the permit development process, have permit requirements that achieve compliance with the CWA, and are subject to enforceable schedules that require the earliest practicable compliance date considering physical and financial feasibility.

F. Policy Development

This Policy devotes a separate section to each step involved in developing and implementing CSO controls. This is not to imply that each function occurs separately. Rather, the entire process surrounding CSO controls, community planning, WQS and permit development/revision, enforcement/compliance actions and public participation must be coordinated to control CSOs effectively. Permittees and permitting authorities are encouraged to consider innovative and alternative approaches and technologies that achieve the objectives of this Policy and the CWA.

In developing this Policy, EPA has included information on what responsible parties are expected to accomplish. Subsequent documents will provide additional guidance on how the objectives of this Policy should be met. These documents will provide further guidance on: CSO permit writing, the nine minimum controls, long-term CSO control plans, financial capability, sewer system characterization and receiving water monitoring and modeling, and application of WQS to CSO-impacted waters. For most CSO control efforts however, sufficient detail has been included in this Policy to begin immediate implementation of its provisions.

II. EPA Objectives for Permittees

A. Overview

Permittees with CSSs that have CSOs should immediately undertake a process to accurately characterize their sewer systems, to demonstrate implementation of the nine minimum controls, and to develop a long-term CSO control plan.

B. Implementation of the Nine Minimum Controls

Permittees with CSOs should submit appropriate documentation demonstrating implementation of the nine minimum controls, including any proposed schedules for completing minor construction activities. The nine minimum controls are:

1. Proper operation and regular maintenance programs for the sewer system and the CSOs;
2. Maximum use of the collection system for storage;
3. Review and modification of pretreatment requirements to assure CSO impacts are minimized;
4. Maximization of flow to the POTW for treatment;
5. Prohibition of CSOs during dry weather;
6. Control of solid and floatable materials in CSOs;
7. Pollution prevention;
8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts; and
9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

Selection and implementation of actual control measures should be based on site-specific considerations including the specific CSS's characteristics discussed under the sewer system characterization and monitoring portions of this Policy. Documentation of the nine minimum controls may include operation and maintenance plans, revised sewer use ordinances for industrial users, sewer system inspection reports, infiltration/inflow studies, pollution prevention programs, public notification plans, and facility plans for maximizing the capacities of the existing collection, storage and treatment systems, as well as contracts and schedules for minor construction programs for improving the existing system's operation. The permittee should also submit any information or data on the degree to which the nine minimum controls achieve compliance with water quality standards. These data and information should include results made available through monitoring and modeling activities done in conjunction with the development of the long-term CSO control plan described in this Policy.

This documentation should be submitted as soon as practicable, but no later than two years after the requirement to submit such documentation is included in an NPDES permit or other enforceable mechanism. Implementation of the nine minimum controls with appropriate documentation should be completed as soon as practicable but no later than January 1, 1997. These dates should be included in an appropriate enforceable mechanism.

Because the CWA requires immediate compliance with technology-based controls (section 301(b)), which on a Best Professional Judgment basis should include the nine minimum controls, a compliance schedule for implementing the nine minimum controls, if necessary, should be included in an appropriate enforceable mechanism.

C. Long-Term CSO Control Plan

Permittees with CSOs are responsible for developing and implementing long-term CSO control plans that will ultimately result in compliance with the requirements of the CWA. The long-term plans should consider the site-specific nature of CSOs and evaluate the cost effectiveness of a range of control options/strategies. The development of the long-term CSO control plan and its subsequent implementation should also be coordinated with the NPDES authority and the State authority responsible for reviewing and revising the State's WQS. The selected controls should be designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS, including existing and designated uses.

This policy identifies EPA's major objectives for the long-term CSO control plan. Permittees should develop and submit this long-term CSO control plan as soon as practicable, but generally within two years after the date of the NPDES permit provision, Section 308 information request, or enforcement action requiring the permittee to develop the plan. NPDES authorities may establish a longer timetable for completion of the long-term CSO control plan on a case-by-case basis to account for site-specific factors which may influence the complexity of the planning process. Once agreed upon, these dates should be included in an appropriate enforceable mechanism.

EPA expects each long-term CSO control plan to utilize appropriate information to address the following minimum elements. The Plan should also include both fixed-date project implementation schedules (which may be phased) and a financing plan to design and construct the project as soon as practicable. The minimum elements of the long-term CSO control plan are described below.

1. Characterization, Monitoring, and Modeling of the Combined Sewer System

In order to design a CSO control plan adequate to meet the requirements of the CWA, a permittee should have a thorough understanding of its sewer system, the response of the system to various precipitation events, the characteristics of the overflows, and the water quality impacts that result from CSOs. The permittee should adequately characterize through monitoring, modeling, and other means as appropriate, for a range of storm events, the response of its sewer system to wet weather events including the number, location and frequency of CSOs, volume, concentration and mass of pollutants discharged and the impacts of the CSOs on the receiving waters and their designated uses. The permittee may need to consider information on the contribution and importance of other pollution sources in order to develop a final plan designed to meet water quality standards. The purpose of the system characterization, monitoring and modeling program initially is to assist the permittee in developing appropriate measures to implement the nine minimum controls and, if necessary, to support development of the long-term CSO control plan. The monitoring and modeling data also will be used to evaluate the expected effectiveness of both the nine minimum controls and, if necessary, the long-term CSO controls, to meet WQS.

The major elements of a sewer system characterization are described below.

a. Rainfall Records—The permittee should examine the complete rainfall record for the geographic area of its existing CSS using sound statistical procedures and best available data. The permittee should evaluate flow variations in the receiving water body to correlate between CSOs and receiving water conditions.

b. Combined Sewer System Characterization—The permittee should evaluate the nature and extent of its sewer system through evaluation of available sewer system records, field inspections and other activities necessary to understand the number, location and frequency of overflows and their location relative to sensitive areas and to pollution sources in the collection system, such as indirect significant industrial users.

c. CSO Monitoring—The permittee should develop a comprehensive, representative monitoring program that measures the frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters. The monitoring program should include necessary CSO effluent and ambient in-stream monitoring and, where appropriate, other monitoring protocols such as biological assessment, toxicity testing and sediment sampling. Monitoring parameters should include, for example, oxygen demanding pollutants, nutrients, toxic pollutants, sediment contaminants, pathogens, bacteriological indicators (e.g., Enterococcus, E. Coli), and toxicity. A representative sample of overflow points can be selected that is sufficient to allow characterization of CSO discharges and their water quality impacts and to facilitate evaluation of control plan alternatives.

d. Modeling—Modeling of a sewer system is recognized as a valuable tool for predicting sewer system response to various wet weather events and assessing water quality impacts when evaluating different control strategies and alternatives. EPA supports the proper and effective use of models, where appropriate, in the evaluation of the nine minimum controls and the development of the long-term CSO control plan. It is also recognized that there are many models which may be used to do this. These models range from simple to complex. Having decided to use a model, the permittee should base its choice of a model on the characteristics of its sewer system, the number and location of overflow points, and the sensitivity of the receiving water body to the CSO discharges. Use of models should include appropriate calibration and verification with field *measurements*. The sophistication of the model should relate to the complexity of the system to be modeled and to the information needs associated with evaluation of CSO control options and water quality impacts. EPA believes that continuous simulation models, using historical rainfall data, may be the best way to model sewer systems, CSOs, and their impacts. Because of the iterative nature of modeling sewer systems, CSOs, and their impacts, monitoring and modeling efforts are complementary and should be coordinated.

2. Public Participation

In developing its long-term CSO control plan, the permittee will employ a public participation process that actively involves the affected public in the decision-making to select the long-term CSO controls. The affected public includes rate payers, industrial users of the sewer system, persons who reside downstream from the CSOs, persons who use and enjoy these downstream waters, and any other interested persons.

3. Consideration of Sensitive Areas

EPA expects a permittee's long-term CSO control plan to give the highest priority to controlling overflows to sensitive areas. Sensitive areas, as determined by the NPDES authority in coordination with State and Federal agencies, as appropriate, include designated Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species and their habitat, waters with primary contact recreation, public drinking water intakes or their designated protection areas, and shellfish beds. For such areas, the long-term CSO control plan should:

a. Prohibit new or significantly increased overflows;

b. i. Eliminate or relocate overflows that discharge to sensitive areas wherever physically possible and economically achievable, except where elimination or relocation would provide less environmental protection than additional treatment; or

ii. Where elimination or relocation is not physically possible and economically achievable, or would provide less environmental protection than additional treatment, provide the level of treatment for remaining overflows deemed necessary to meet WQS for full protection of existing and designated uses. In any event, the level of control should not be less than those described in Evaluation of Alternatives below; and

c. Where elimination or relocation has been proven not to be physically possible and economically achievable, permitting authorities should require, for each subsequent permit term, a reassessment based on new or improved techniques to eliminate or relocate, or on changed circumstances that influence economic achievability.

4. Evaluation of Alternatives

EPA expects the long-term CSO control plan to consider a reasonable range of alternatives. The plan should, for example, evaluate controls that would be necessary to achieve zero overflow events per year, an average of one to three, four to seven, and eight to twelve overflow events per year. Alternatively, the long-term plan could evaluate controls that achieve 100% capture, 90% capture, 85% capture, 80% capture, and 75% capture for treatment. The long-term control plan should also consider expansion of POTW secondary and primary capacity in the CSO abatement alternative analysis. The analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance as described in Section II.C.5. Because the final long-term CSO control plan will become the basis for NPDES permit limits and requirements, the selected controls should be sufficient to meet CWA requirements.

In addition to considering sensitive areas, the long-term CSO control plan should adopt one of the following approaches:

a. "Presumption" Approach

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

i. No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment specified below; or

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

iii. The elimination or removal of no less than the mass of the pollutants, identified as causing water quality impairment through the sewer system characterization, monitoring, and modeling effort, for the volumes that would be eliminated or captured for treatment under paragraph ii. above. Combined sewer flows remaining after implementation of the nine minimum controls and within the criteria specified at II.C.4.a.i or ii, should receive a minimum of:

- Primary clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification.);
- Solids and floatables disposal; and
- Disinfection of effluent, if necessary, to meet WQS, protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary.

b. "Demonstration" Approach

A permittee may demonstrate that a selected control program, though not meeting the criteria specified in II.C.4.a. above is adequate to meet the water quality-based requirements of the CWA. To be a successful demonstration, the permittee should demonstrate each of the following:

i. The planned control program is adequate to meet WQS and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;

ii. The CSO discharges remaining after implementation of the planned control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribute to their impairment. Where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation and a load allocation, or other means should be used to apportion pollutant loads;

iii. The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and

iv. The planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

5. Cost/Performance Considerations

The permittee should develop appropriate cost/performance curves to demonstrate the relationships among a comprehensive set of reasonable control alternatives that correspond to the different ranges specified in Section II.C.4. This should include an analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs. This analysis, often known as knee of the curve, should be among the considerations used to help guide selection of controls.

6. Operational Plan

After agreement between the permittee and NPDES authority on the necessary CSO controls to be implemented under the long-term CSO control plan, the permittee should revise the operation and maintenance program developed as part of the nine minimum controls to include the agreed-upon long-term CSO controls. The revised operation and maintenance program should maximize the removal of pollutants during and after each precipitation event using all available facilities within the collection and treatment system. For any flows in excess of the criteria specified at II.C.4.a.i., ii. or iii and not receiving the treatment specified in II.C.4.a, the operational plan should ensure that such flows receive treatment to the greatest extent practicable.

7. Maximizing Treatment at the Existing POTW Treatment Plant

In some communities, POTW treatment plants may have primary treatment capacity in excess of their secondary treatment capacity. One effective strategy to abate pollution resulting from CSOs is to maximize the delivery of flows during wet weather to the POTW treatment plant for treatment. Delivering these flows can have two significant water quality benefits: First, increased flows during wet weather to the POTW treatment plant may enable the permittee to eliminate or minimize overflows to sensitive areas; second, this would maximize the use of available POTW facilities for wet weather flows and would ensure that combined sewer flows receive at least primary treatment prior to discharge.

Under EPA regulations, the intentional diversion of waste streams from any portion of a treatment facility, including secondary treatment, is a bypass. EPA bypass regulations at 40 CFR 122.41(m) allow for a facility to bypass some or all the flow from its treatment process under specified limited circumstances. Under the regulation, the permittee must show that the bypass was unavoidable to prevent loss of life, personal injury or severe property damage, that there was no feasible alternative to the bypass and that the permittee submitted the required notices. In addition, the regulation provides that a bypass may be approved only after consideration of adverse effects.

Normally, it is the responsibility of the permittee to document, on a case-by-base basis, compliance with 40 CFR 122.41(m) in order to bypass flows legally. For some CSO-related permits, the study of feasible alternatives in the control plan may provide sufficient support for the permit record and for approval of a CSO-related bypass in the permit itself, and to define the specific parameters under which a bypass can legally occur. For approval of a CSO-related bypass, the long-term CSO control plan, at a minimum, should provide justification for the cut-off point at which the flow will be diverted from the secondary treatment portion of the treatment plant, and provide a benefit-cost analysis demonstrating that conveyance of wet weather flow to the POTW for primary treatment is more beneficial than other CSO abatement alternatives such as storage and pump back for secondary treatment, sewer separation, or satellite treatment. Such a permit must define under what specific wet weather conditions a CSO-related bypass is allowed and also specify what treatment or what monitoring, and effluent limitations and requirements apply to the bypass flow. The permit should also provide that approval for the CSO-related bypass will be reviewed and may be modified or terminated if there is a substantial increase in the volume or character of pollutants being introduced to the POTW. The CSO-related bypass provision in the permit should also make it clear that all wet weather flows passing the headworks of the POTW treatment plant will receive at least primary clarification and solids and floatables removal and disposal, and disinfection, where necessary, and any other treatment that can reasonably be provided.

Under this approach, EPA would allow a permit to authorize a CSO-related bypass of the secondary treatment portion of the POTW treatment plant for combined sewer flows in certain identified circumstances. This provision would apply only to those situations where the POTW would ordinarily meet the requirements of 40 CFR 122.41(m) as evaluated on a case-by-case basis. Therefore, there must be sufficient data in the administrative record (reflected in the permit fact sheet or statement of basis) supporting all the requirements in 40 CFR 122.41(m)(4) for approval of an anticipated bypass.

For the purposes of applying this regulation to CSO permittees, "severe property damage" could include situations where flows above a certain level wash out the POTW's secondary treatment system. EPA further believes that the feasible alternatives requirement of the regulation can be met if the record shows that the secondary treatment system is properly operated and maintained, that the system has been designed to meet secondary limits for flows greater than the peak dry weather flow, plus an appropriate quantity of wet weather flow, and that it is either technically or financially infeasible to provide secondary treatment at the existing facilities for greater amounts of wet weather flow. The feasible alternative analysis should include, for example, consideration of enhanced primary treatment (e.g., chemical addition) and non-biological secondary treatment. Other bases supporting a finding of no feasible alternative may also be available on a case-by-case basis. As part of its consideration of possible adverse effects resulting from the bypass, the permitting authority should also ensure that the bypass will not cause exceedances of WQS.

This Policy does not address the appropriateness of approving anticipated bypasses through NPDES permits in advance outside the CSO context.

8. Implementation Schedule

The permittee should include all pertinent information in the long term control plan necessary to develop the construction and financing schedule for implementation of CSO controls. Schedules for implementation of the CSO controls may be phased based on the relative importance of adverse impacts upon WQS and designated uses, priority projects identified in the long-term plan, and on a permittee's financial capability.

Construction phasing should consider:

a. Eliminating overflows that discharge to sensitive areas as the highest priority;

b. Use impairment;

c. The permittee's financial capability including consideration of such factors as:

i. Median household income;

ii. Total annual wastewater and CSO control costs per household as a percent of median household income;

iii. Overall net debt as a percent of full market property value;

iv. Property tax revenues as a percent of full market property value;

v. Property tax collection rate;

vi. Unemployment; and

vii. Bond rating;

d. Grant and loan availability;

e. Previous and current residential, commercial and industrial sewer user fees and rate structures; and

f. Other viable funding mechanisms and sources of financing.

9. Post-Construction Compliance Monitoring Program

The selected CSO controls should include a post-construction water quality monitoring program adequate to verify compliance with water quality standards and protection of designated uses as well as to ascertain the effectiveness of CSO controls. This water quality compliance monitoring program should include a plan to be approved by the NPDES authority that details the monitoring protocols to be followed, including the necessary effluent and ambient monitoring and, where appropriate, other monitoring protocols such as biological assessments, whole effluent toxicity testing, and sediment sampling.

III. Coordination With State Water Quality Standards

A. Overview

WQS are State adopted, or Federally promulgated rules which serve as the goals for the water body and the legal basis for the water quality-based NPDES permit requirements under the CWA. WQS consist of uses which States designate for their water bodies, criteria to protect the uses, an anti-degradation policy to protect the water quality improvements gained and other policies affecting the implementation of the standards. A primary objective of the long-term CSO control plan is to meet WQS, including the designated uses through reducing risks to human health and the environment by eliminating, relocating or controlling CSOs to the affected waters.

State WQS authorities, NPDES authorities, EPA regional offices, permittees, and the public should meet early and frequently throughout the long-term CSO control planning process. Development of the long-term plan should be coordinated with the review and appropriate revision of WQS and implementation procedures on CSO-impacted waters to ensure that the long-term controls will be sufficient to meet water quality standards. As part of these meetings, participants should agree on the data, information and analyses needed to support the development of the long-term CSO control plan and the review of applicable WQS, and implementation procedures, if appropriate. Agreements should be reached on the monitoring protocols and models that will be used to evaluate the water quality impacts of the overflows, to analyze the attainability of the WQS and to determine the water quality-based requirements for the permit. Many opportunities exist for permittees and States to share information as control programs are developed and as WQS are reviewed. Such information should assist States in determining the need for revisions to WQS and implementation procedures to better reflect the site-specific wet weather impacts of CSOs. Coordinating the development of the long-term CSO control plan and the review of the WQS and implementation procedures provides greater assurance that the long-term control plan selected and the limits and requirements included in the NPDES permit will be sufficient to meet WQS and to comply with sections 301(b)(1)(C) and 402(a)(2) of the CWA.

EPA encourages States and permittees jointly to sponsor workshops for the affected public in the development of the long-term CSO control plan and during the development of appropriate revisions to WQS for CSO-impacted waters. Workshops provide a forum for including the public in discussions of the implications of the proposed long-term CSO control plan on the water quality and uses for the receiving water.

B. Water Quality Standards Reviews

The CWA requires States to periodically, but at least once every three years, hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards. States must provide the public an opportunity to comment on any proposed revision to water quality standards and all revisions must be submitted to EPA for review and approval.

EPA regulations and guidance provide States with the flexibility to adapt their WQS, and implementation procedures to reflect site-specific conditions including those related to CSOs. For example, a State may adopt site-specific criteria for a particular pollutant if the State determines that the site-specific criteria fully protects the designated use (40 CFR 131.11). In addition, the regulations at 40 CFR 131.10(g), (h), and (j) specify when and how a designated use may be modified. A State may remove a designated use from its water quality standards only if the designated use is not an existing use. An existing use is a use actually attained in the water body on or after November 28, 1975. Furthermore, a State may not remove a designated use that will be attained by implementing the technology-based effluent limits required under sections 301(b) and 306 of the CWA and by implementing cost-effective and reasonable best management practices for nonpoint source controls. Thus, if a State has a reasonable basis to determine that the current designated use could be attained after implementation of the technology-based controls of the CWA, then the use could not be removed.

In determining whether a use is attainable and prior to removing a designated use, States must conduct and submit to EPA a use attainability analysis. A use attainability analysis is a structured scientific assessment of the factors affecting the use, including the physical, chemical, biological, and economic factors described in 40 CFR 131.10(g). As part of the analysis, States should evaluate whether the designated use could be attained if CSO controls were implemented. For example, States should examine if sediment loadings from CSOs could be reduced so as not to bury spawning beds, or if biochemical oxygen demanding material in the effluent or the toxicity of the effluent could be corrected so as to reduce the acute or chronic physiological stress on or bioaccumulation potential of aquatic organisms.

In reviewing the attainability of their WQS and the applicability of their implementation procedures to CSO-impacted waters, States are encouraged to define more explicitly their recreational and aquatic life uses and then, if appropriate, modify the criteria accordingly to protect the designated uses.

Another option is for States to adopt partial uses by defining when primary contact recreation such as swimming does not exist, such as during certain seasons of the year in northern climates or during a particular type of storm event. In making such adjustments to their uses, States must ensure that downstream uses are protected, and that during other seasons or after the storm event has passed, the use is fully protected.

In addition to defining recreational uses with greater specificity, States are also encouraged to define the aquatic uses more precisely. Rather than "aquatic life use protection," States should consider defining the type of fishery to be protected such as a cold water fishery (e.g., trout or salmon) or a warm weather fishery (e.g., bluegill or large mouth bass). Explicitly defining the type of fishery to be protected may assist the permittee in enlisting the support of citizens for a CSO control plan.

A water quality standard variance may be appropriate, in limited circumstances on CSO-impacted waters, where the State is uncertain as to whether a standard can be attained and time is needed for the State to conduct additional analyses on the attainability of the standard. Variances are short-term modifications in water quality standards. Subject to EPA approval, States, with their own statutory authority, may grant a variance to a specific discharger for a specific pollutant. The justification for a variance is similar to that required for a permanent change in the standard, although the showings needed are less rigorous. Variances are also subject to public participation requirements of the water quality standards and permits programs and are reviewable generally every three years. A variance allows the CSO permit to be written to meet the "modified" water quality standard as analyses are conducted and as progress is made to improve water quality.

Justifications for variances are the same as those identified in 40 CFR 131.10(g) for modifications in uses. States must provide an opportunity for public review and comment on all variances. If States use the permit as the vehicle to grant the variance, notice of the permit must clearly state that the variance modifies the State's water quality standards. If the variance is approved, the State appends the variance to the State's standards and reviews the variance every three years.

IV. Expectations for Permitting Authorities

A. Overview

CSOs are point sources subject to NPDES permit requirements including both technology-based and water quality-based requirements of the CWA. CSOs are not subject to secondary treatment regulations applicable to publicly owned treatment works (*Montgomery Environmental Coalition vs. Costle*, 646 F.2d 568 (D.C. Cir. 1980)).

All permits for CSOs should require the nine minimum controls as a minimum best available technology economically achievable and best conventional technology (BAT/BCT) established on a best professional judgment (BPJ) basis by the permitting authority (40 CFR 125.3). Water quality-based requirements are to be established based on applicable water quality standards.

This policy establishes a uniform, nationally consistent approach to developing and issuing NPDES permits to permittees with CSOs. Permits for CSOs should be developed and issued expeditiously. A single, system-wide permit generally should be issued for all discharges, including CSOs, from a CSS operated by a single authority. When different parts of a single CSS are operated by more than one authority, permits issued to each authority should generally require joint preparation and implementation of the elements of this Policy and should specifically define the responsibilities and duties of each authority. Permittees should be required to coordinate system-wide implementation of the nine minimum controls and the development and implementation of the long-term CSO control plan.

The individual authorities are responsible for their own discharges and should cooperate with the permittee for the POTW receiving the flows from the CSS. When a CSO is permitted separately from the POTW, both permits should be cross-referenced for informational purposes.

EPA Regions and States should review the CSO permitting priorities established in the State CSO Permitting Strategies developed in response to the 1989 Strategy. Regions and States may elect to revise these previous priorities. In setting permitting priorities, Regions and States should not just focus on those permittees that have initiated monitoring programs. When setting priorities, Regions and States should consider, for example, the known or potential impact of CSOs on sensitive areas, and the extent of upstream industrial user discharges to the CSS.

During the permittee's development of the long-term CSO control plan, the permit writer should promote coordination between the permittee and State WQS authority in connection with possible WQS revisions. Once the permittee has completed development of the long-term CSO control plan and has coordinated with the permitting authority the selection of the controls necessary to meet the requirements of the CWA, the permitting authority should include in an appropriate enforceable mechanism, requirements for implementation of the long-term CSO control plan, including conditions for water quality monitoring and operation and maintenance.

B. NPDES Permit Requirements

Following are the major elements of NPDES permits to implement this Policy and ensure protection of water quality.

1. Phase I Permits—Requirements for Demonstration of Implementation of the Nine Minimum Controls and Development of the Long-Term CSO Control Plan

In the Phase I permit issued/modified to reflect this Policy, the NPDES authority should at least require permittees to:

a. Immediately implement BAT/BCT, which at a minimum includes the nine minimum controls, as determined on a BPJ basis by the permitting authority;

b. Develop and submit a report documenting the implementation of the nine minimum controls within two years of permit issuance/modification;

c. Comply with applicable WQS, no later than the date allowed under the State's WQS, expressed in the form of a narrative limitation; and

d. develop and submit, consistent with this Policy and based on a schedule in an appropriate enforceable mechanism, a long-term CSO control plan as soon as practicable, but generally within two years after the effective date of the permit issuance/modification. However, permitting authorities may establish a longer timetable for completion of the long-term CSO control plan on a case-by-case basis to account for site-specific factors that may influence the complexity of the planning process.

The NPDES authority should include compliance dates on the fastest practicable schedule for each of the nine minimum controls in an appropriate enforceable mechanism issued in conjunction with the Phase I permit. The use of enforceable orders is necessary unless Congress amends the CWA. All orders should require compliance with the nine minimum controls no later than January 1, 1997.

2. Phase II Permits—Requirements for Implementation of a Long-Term CSO Control Plan

Once the permittee has completed development of the long-term CSO control plan and the selection of the controls necessary to meet CWA requirements has been coordinated with the permitting and WQS authorities, the permitting authority should include, in an appropriate enforceable mechanism, requirements for implementation of the long-term CSO control plan as soon as practicable. Where the permittee has selected controls based on the "presumption" approach described in Section II.C.4, the permitting authority must have determined that the presumption that such level of treatment will achieve water quality standards is reasonable in light of the data and analysis conducted under this Policy. The Phase II permit should contain:

a. Requirements to implement the technology-based controls including the nine minimum controls determined on a BPJ basis;

b. Narrative requirements which insure that the selected CSO controls are implemented, operated and maintained as described in the long-term CSO control plan;

c. Water quality-based effluent limits under 40 CFR 122.44(d)(1) and 122.44(k), requiring, at a minimum, compliance with, no later than the date allowed under the State's WQS, the numeric performance standards for the selected CSO controls, based on average design conditions specifying at least one of the following:

i. A maximum number of overflow events per year for specified design conditions consistent with II.C.4.a.i; or

ii. A minimum percentage capture of combined sewage by volume for treatment under specified design conditions consistent with II.C.4.a.ii; or

iii. A minimum removal of the mass of pollutants discharged for specified design conditions consistent with II.C.4.a.iii; or

iv. performance standards and requirements that are consistent with II.C.4.b. of the Policy.

d. A requirement to implement, with an established schedule, the approved post-construction water quality assessment program including requirements to monitor and collect sufficient information to demonstrate compliance with WQS and protection of designated uses as well as to determine the effectiveness of CSO controls.

e. A requirement to reassess overflows to sensitive areas in those cases where elimination or relocation of the overflows is not physically possible and economically achievable. The reassessment should be based on consideration of new or improved techniques to eliminate or relocate overflows or changed circumstances that influence economic achievability;

f. Conditions establishing requirements for maximizing the treatment of wet weather flows at the POTW treatment plant, as appropriate, consistent with Section II.C.7. of this Policy;

g. A reopener clause authorizing the NPDES authority to reopen and modify the permit upon determination that the CSO controls fail to meet WQS or protect designated uses. Upon such determination, the NPDES authority should promptly notify the permittee and proceed to modify or reissue the permit. The permittee should be required to develop, submit and implement, as soon as practicable, a revised CSO control plan which contains additional controls to meet WQS and designated uses. If the initial CSO control plan was approved under the demonstration provision of Section II.C.4.b., the revised plan, at a minimum, should provide for controls that satisfy one of the criteria in Section II.C.4.a. unless the permittee demonstrates that the revised plan is clearly adequate to meet WQS at a lower cost and it is shown that the additional controls resulting from the criteria in Section II.C.4.a. will not result in a greater overall improvement in water quality.

Unless the permittee can comply with all of the requirements of the Phase II permit, the NPDES authority should include, in an enforceable mechanism, compliance dates on the fastest practicable schedule for those activities directly related to meeting the requirements of the CWA. For major permittees, the compliance schedule should be placed in a judicial order. Proper compliance with the schedule for implementing the controls recommended in the long-term CSO control plan constitutes compliance with the elements of this Policy concerning planning and implementation of a long term CSO remedy.

3. Phasing Considerations

Implementation of CSO controls may be phased based on the relative importance of and adverse impacts upon WQS and designated uses, as well as the permittee's financial capability and its previous efforts to control CSOs. The NPDES authority should evaluate the proposed implementation schedule and construction phasing discussed in Section II.C.8. of this Policy. The permit should require compliance with the controls proposed in the long-term CSO control plan no later than the applicable deadline(s) under the CWA or State law. If compliance with the Phase II permit is not possible, an enforceable schedule, consistent with the Enforcement and Compliance Section of this Policy, should be issued in conjunction with the Phase II permit which specifies the schedule and milestones for implementation of the long-term CSO control plan.

V. Enforcement and Compliance

A. Overview

It is important that permittees act immediately to take the necessary steps to comply with the CWA. The CSO enforcement effort will commence with an initiative to address CSOs that discharge during dry weather, followed by an enforcement effort in conjunction with permitting CSOs discussed earlier in this Policy. Success of the enforcement effort will depend in large part upon expeditious action by NPDES authorities in issuing enforceable permits that include requirements both for the nine minimum controls and for compliance with all other requirements of the CWA. Priority for enforcement actions should be set based on environmental impacts or sensitive areas affected by CSOs.

As a further inducement for permittees to cooperate with this process, EPA is prepared to exercise its enforcement discretion in determining whether or not to seek civil penalties for past CSO violations if permittees meet the objectives and schedules of this Policy and do not have CSOs during dry weather.

B. Enforcement of CSO Dry Weather Discharge Prohibition

EPA intends to commence immediately an enforcement initiative against CSO permittees which have CWA violations due to CSOs during dry weather. Discharges during dry weather have always been prohibited by the NPDES program. Such discharges can create serious public health and water quality problems. EPA will use its CWA Section 308 monitoring, reporting, and inspection authorities, together with NPDES State authorities, to locate these violations, and to determine their causes. Appropriate remedies and penalties will be sought for CSOs during dry weather. EPA will provide NPDES authorities more specific guidance on this enforcement initiative separately.

C. Enforcement of Wet Weather CSO Requirements

Under the CWA, EPA can use several enforcement options to address permittees with CSOs. Those options directly applicable to this Policy are section 308 Information Requests, section 309(a) Administrative Orders, section 309(g) Administrative Penalty Orders, section 309 (b) and (d) Civil Judicial Actions, and section 504 Emergency Powers. NPDES States should use comparable means.

NPDES authorities should set priorities for enforcement based on environmental impacts or sensitive areas affected by CSOs. Permittees that have voluntarily initiated monitoring and are progressing expeditiously toward appropriate CSO controls should be given due consideration for their efforts.

1. Enforcement for Compliance With Phase I Permits

Enforcement for compliance with Phase I permits will focus on requirements to implement at least the nine minimum controls, and develop the long-term CSO control plan leading to compliance with the requirements of the CWA. Where immediate compliance with the Phase I permit is infeasible, the NPDES authority should issue an enforceable schedule, in concert with the Phase I permit, requiring compliance with the CWA and imposing compliance schedules with dates for each of the nine minimum controls as soon as practicable. All enforcement authorities should require compliance with the nine minimum controls no later than January 1, 1997. Where the NPDES authority is issuing an order with a compliance schedule for the nine minimum controls, this order should also include a schedule for development of the long-term CSO control plan.

If a CSO permittee fails to meet the final compliance date of the schedule, the NPDES authority should initiate appropriate judicial action.

2. Enforcement for Compliance With Phase II Permits

The main focus for enforcing compliance with Phase II permits will be to incorporate the long-term CSO control plan through a civil judicial action, an administrative order, or other enforceable mechanism requiring compliance with the CWA and imposing a compliance schedule with appropriate milestone dates necessary to implement the plan.

In general, a judicial order is the appropriate mechanism for incorporating the above provisions for Phase II. Administrative orders, however, may be appropriate for permittees whose long-term control plans will take less than five years to complete, and for minors that have complied with the final date of the enforceable order for compliance with their Phase I permit. If necessary, any of the nine minimum controls that have not been implemented by this time should be included in the terms of the judicial order.

D. Penalties

EPA is prepared not to seek civil penalties for past CSO violations, if permittees have no discharges during dry weather and meet the objectives and schedules of this Policy. Notwithstanding this, where a permittee has other significant CWA violations for which EPA or the State is taking judicial action, penalties may be considered as part of that action for the following:

1. CSOs during dry weather;
2. Violations of CSO-related requirements in NPDES permits; consent decrees or court orders which predate this policy; or
3. Other CWA violations.

EPA will not seek penalties for past CSO violations from permittees that fully comply with the Phase I permit or enforceable order requiring compliance with the Phase I permit. For permittees that fail to comply, EPA will exercise its enforcement discretion in determining whether to seek penalties for the time period for which the compliance schedule was violated. If the milestone dates of the enforceable schedule are not achieved and penalties are sought, penalties should be calculated from the last milestone date that was met.

At the time of the judicial settlement imposing a compliance schedule implementing the Phase II permit requirements, EPA will not seek penalties for past CSO violations from permittees that fully comply with the enforceable order requiring compliance with the Phase I permit and if the terms of the judicial order are expeditiously agreed to on consent. However, stipulated penalties for violation of the judicial order generally should be included in the order, consistent with existing Agency policies. Additional guidance on stipulated penalties concerning long-term CSO controls and attainment of WQS will be issued.

Paperwork Reduction Act

The information collection requirements in this policy have been approved by the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq* and have been assigned OMB control number 2040–0170.

This collection of information has an estimated reporting burden averaging 578 hours per response and an estimated annual recordkeeping burden averaging 25 hours per recordkeeper. These estimates include time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Chief, Information Policy Branch; EPA; 401 M Street SW. (Mail Code 2136); Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and

Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA."

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MASSACHUSETTS

DEPARTMENT OF ENVIRONMENTAL PROTECTION

GUIDANCE FOR ABATEMENT OF POLLUTION FROM CSO DISCHARGES

August 11, 1997

Summary

1. This guidance is provided to assist permittees in assessing CSO impacts and developing CSO control alternatives which comply with the Clean Water Act and the Massachusetts Water Quality Standards.

2. As an initial and continuous control measure, Permittees are required to implement CSO controls known as the Nine Minimum Controls (NMC) as a minimum technology-based limitation. These controls provide for minimizing CSO impacts through optimizing use of existing CSO and wastewater facilities, as well as through implementation of pollution prevention, public notification, and monitoring programs.

3. All permittees are responsible for developing and implementing Long-Term CSO Control Plans (facilities plans) that will ultimately result in compliance with the Clean Water Act (CWA). The plan must evaluate the cost and performance of a range of CSO control alternatives including elimination, relocation, storage, and treatment, and also must include a public participation plan. Abatement plans may involve phased work plans with the most cost effective control given the highest priority.

4. It is the goal of the Department to eliminate the adverse impacts of CSOs. Where elimination is not feasible or would cause substantial widespread economic and social impact, the impacts of CSO discharges shall be minimized to achieve the highest water quality attainable. Highest priority will be given to eliminating or otherwise controlling CSO discharges to sensitive use areas.

5. In accordance with the EPA National CSO Policy, CSO controls which will result in achieving compliance with national goal use standards at least 95% of the time will be presumed to meet the water-quality based requirements of the Clean Water Act, provided that such a presumption is reasonable in light of existing information. Affected receiving water quality segments in this case will be identified as B_{cso} or SB_{cso} in the Water Quality Standards to note that these segments are subject to a subcategory use restriction and will be subject to minor CSO discharges. Lesser CSO controls will only be allowed where there are no sensitive uses and where CSO controls meeting this classification have been shown to be infeasible or to cause substantial widespread economic and social impact.

6. If insufficient information exists to determine the attainability of national goal use standards, permittees will be required to implement the NMC and any further controls shown to be cost-effective; a variance may then be issued for a specified period of time to allow for the development of additional water quality information where one of the criteria for removal of a use (314 CMR 4.03(4)) is met.

I. Introduction

Combined sewers are collection systems that convey both sanitary sewage and stormwater runoff. These collection systems convey dry weather flows and those portions of wet weather flows which do not exceed the capacity of the downstream interceptors or wastewater treatment facilities. Regulator structures allow excess flows to discharge to an adjacent waterbody; these discharges are considered combined sewer overflows (CSOs). Research has failed to define a best practicable technology (BPT) for these sources of pollution. Therefore best professional judgement must be used to determine abatement measures. Solutions must be site-specific in order to address a wide variety of technical and economic constraints. This guidance is adopted to define the Department's general goals; interpret water quality standards and criteria in relation to CSO abatement projects; and specify uniform evaluation procedures for facilities planning. The Department regulates CSO discharges in accordance with the Massachusetts Water Quality Standards (WQS), 314 CMR 4.00, under the statutory authority provided by MGL c.22 s.21.

Section V of this guidance is excerpted from the DEP CSO Policy and establishes the regulatory framework associated with different CSO control alternatives. This policy applies to segments impacted by the discharge of CSOs. A list of these waterbodies is included in the WQS. The list will be updated every three years as part of the scheduled readoption of the WQS and Classification of Waterbodies pursuant to the Federal Clean Water Act.

II. Goals

The Department has the following goals with regard to CSO abatement measures.

1. Elimination of receiving water impacts is the primary goal.

2. Where elimination of CSOs is not feasible, the goal is minimization of impacts to the maximum extent feasible and attaining the highest water quality achievable. In these areas the identification and protection of critical uses is essential.

III. Nine Minimum Controls (NMC)

In accordance with the 1994 EPA national CSO policy, permittees must as soon as practical implement and evaluate the effectiveness of the Nine Minimum Controls as the minimum technology-based requirement of the Clean Water Act.

The Nine Minimum Controls are

1. Proper operation and regular maintenance programs for the sewer system and the CSOs;
2. Maximum use of the collection system for storage;
3. Review and modification of the pretreatment program;
4. Maximization of flow to the Publicly Owned Treatment Works (POTW) for treatment;
5. Prohibition of CSOs during dry weather;
6. Control of solids and floatable materials from CSOs;
7. Pollution prevention programs;
8. Public notification to ensure that the public receives adequate notification of CSO discharges and their impacts, and;
9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

Permittees will be required to submit information detailing the implementation of actual control measures and subsequently additional information on the degree to which the NMC achieve compliance with water quality standards. Additional guidance on the NMC is contained in the EPA *Guidance for Nine Minimum Controls.*

IV. Long-term CSO Control Plan

A. General

Permittees are responsible for the development of a Long-Term CSO Control Plan which must ultimately result in compliance with the Clean Water Act and applicable Water Quality Standards (WQS). This CSO Plan is the critical vehicle for determining appropriate CSO controls and will also form the basis for any necessary administrative reclassifications of receiving waters. The planning effort should include considerable stakeholder input and the permittee should work closely with regulatory agencies so that the plan will be consistent with basin-wide watershed management efforts. The Department does not attempt to specify uniform treatment levels for CSO discharges. Instead, in accordance with the 1994 EPA National CSO Policy, the Department requires an evaluation of potential CSO controls and their impacts in the long-term plan. The long-term plan must include the following elements:

1. Characterization, monitoring and modeling of the CSO system and the receiving waters as the basis of selection and design of effective CSO controls. The characterization should be watershed-based to the extent possible, so that it presents a site-specific determination of the relative impacts of CSO and non-CSO discharges on water quality.

2. A public participation process which includes at a minimum one public meeting to discuss CSO control alternatives and one public hearing on the recommended plan. The permittee must also satisfy the requirements of the Massachusetts Environmental Policy Act (MEPA), 301 CMR 11.00, regarding public review of the project. Additional public participation is often warranted in major and complicated projects.

3. Consideration of sensitive use areas as the highest priority for eliminating or otherwise controlling CSOs.

4. A detailed evaluation of CSO control alternatives which will enable the permittee in consultation with regulatory agencies and the public to select CSO controls which will meet CWA requirements.

5. Cost/Performance considerations to compare and evaluate the cost-benefit of a range of CSO control alternatives. Performance of CSO control alternatives should be based on pollutant reductions to be achieved and water quality benefits.

6. An Operation and Maintenance Plan to minimize CSO impacts from recommended control facilities where CSOs will not be eliminated.

7. Maximization of treatment at the existing POTW for wet weather flows.

8. An implementation schedule, which reflects the adverse impacts from CSOs upon WQS and designated uses, and the cost-benefit of recommended CSO controls.

9. A post-construction compliance monitoring program adequate to verify compliance with water-quality based requirements of the Clean Water Act and ascertain the effectiveness of CSO controls.

As noted in section III of this CSO guidance, each permittee will be required initially to minimize discharges from CSOs and their resultant impacts on water quality by implementation of the Nine Minimum Controls.

B. CSO Control Alternatives

As the ultimate goal of the plan is to achieve compliance with the CWA, the permittee should work with regulatory agencies and the public during the planning process to establish receiving water quality goals and associated CSO control goals based on the use designations and regulatory options contained in the water quality standards. The planning effort should be consistent with the Department's watershed-based approach to assessing and managing water resources, and the cost/benefit analysis of a range of CSO control alternatives should be evaluated considering their relative impacts on water quality and impairment of uses. The range of CSO control alternatives considered should include the following alternatives.

a) Nine Minimum Controls

The NMC, which include collection system and source controls, are required for all CSO permittees and therefore constitute the baseline level of CSO control. In some areas, the NMC may be significant in eliminating or controlling CSOs to the extent that water quality goals and uses can be attained. While this is not normally the case, the long-term plan should evaluate the degree to which the NMC achieve compliance with standards to establish a baseline from which to compare the costs and benefits of higher level CSO controls.

b) Elimination/Relocation

Since there is no finite limit to the magnitude and duration of a precipitation event, CSO controls can only lower the probability of untreated overflows, not eliminate them entirely. CSO discharges therefore can only be eliminated by complete sewer separation. Sewer separation <u>must</u> be considered initially in all CSO-impacted areas and evaluated to determine if it is feasible. Once it has been demonstrated to the Department that elimination of CSO discharges is not feasible, the relocation of CSOs should be evaluated. Relocation alternatives must be examined on a system-wide basis so that the maximum recovery of water uses is achieved, including the protection of critical uses.

c) Storage Technologies

Storage technologies include in-line storage (in the existing collection system), off-line near surface storage with construction of tanks or other facilities, and deep tunnel storage. In each instance, flows are stored until the storm event is over and the stored flows are then pumped to the treatment facility when capacity is available to treat these flows. A range of storage volumes should be considered based on flows from a number of different storm events (3-month, 6-month, 1-year, etc.) and the hydraulic capacity of the combined sewer system. Physical constraints at storage sites should also be considered. The level of CSO control necessary to meet receiving water goals and uses and the overall cost/benefit of alternatives are critical factors in determining appropriate storage alternatives.

d) Treatment Technologies

Treatment technologies for CSO discharges are intended to reduce pollutant loadings to receiving waters from remaining CSO discharges and include screening, solids removal, disinfection, and other associated unit operations. Treatment alternatives, like storage, need to be sized in relation to the flows from different storm events and hydraulic conditions, and as noted above, a range of storms and flows should be considered in evaluating the design and performance, as should any siting constraints as well. Again, the critical factor in assessing these alternatives is evaluating the cost and the extent to which the treatment alternatives serve to achieve water quality goals and uses.

e) Collection System Controls

Collection system controls include interceptor relief, partial sewer separation, or other system modifications which reduce CSO volume and frequency by removing or diverting runoff, maximizing the volume of flow stored in the collection system, or maximizing the capacity of the collection system to convey flow to a treatment facility. These controls can significantly reduce CSO impacts and are often used in combination with other CSO controls to optimize the long-term control plan.

C. Evaluation of Alternatives

(1) *Sewer Separation*

Permittees will be required to eliminate CSOs through sewer separation in all areas where such action is determined to be feasible and will not cause "widespread social and economic impact" as noted in CMR 314 4.03(4)(f). The Department shall base a determination of widespread social and economic impact on the following factors:

- Costs of Separation: The costs of separation must be evaluated to determine if the impacts on ratepayers are excessive using EPA's *Economic Guidance for Water Quality Standards.*

- Benefits of Separation: The water quality benefits of the sewer separation program should be quantified with the goal of attainment of designated uses. When determining the benefits to be achieved, potential interactive and overlapping pollution sources such as discharges from the storm drain system after separation may be taken into account. This assessment of benefits should include a site-specific assessment of the impacts of the separation program and shall include a reasonable estimation of stormwater and other non-CSO pollutant loads.

- Protection of Sensitive Uses: Sensitive uses, including bathing areas, shellfishing areas, water supply sources, and endangered species habitats should be afforded maximum protection. If CSOs are not completely eliminated in these areas, other alternative CSO controls or combinations of controls must provide an equivalent or higher level of environmental benefit, and result in greater attainment of national goal use standards.

In general, the department will make a finding that sewer separation will cause widespread social and economic impact when a project exceeds the affordability guidelines included in the EPA *Economic Guidance for Water Quality Standards*; or when costs are determined to be excessive when compared to water quality benefits to be achieved; or where alternative CSO controls are demonstrated to provide superior environmental benefits to a receiving water in supporting existing and proposed uses and associated water quality standards. In these instances, the alternative CSO controls will normally provide significant abatement of not only CSO loads, but stormwater loads as well, which have in some areas been identified as a major cause of water quality standard violations.

(2) *Cost Benefit of Alternatives*

A key aspect of evaluating the range of CSO control alternatives is quantifying the water quality benefits and costs of each alternative. Quantification of the benefits of any CSO control alternative should reflect the extent to which the controls allow or contribute to attainment of national goal use standards and existing uses. Such a quantification normally relies on an assessment of CSO and non-CSO loads to the impacted receiving waters and a sewer system/receiving water model to predict the water quality impacts of the various CSO control alternatives. The following methods can be used to demonstrate the benefits of CSO control alternatives:

- a presentation of the average annual duration and volume of CSO discharges for each alternative.

- model outputs which estimate the duration of violations of water quality standards (e.g. fecal coliform, dissolved oxygen) for a range of storm events as well as on an annual average for each alternative.

- model outputs which estimate the frequency and duration of beach closures or shellfish bed closures or loss of other uses for each alternative, where these uses are impacted by CSO discharges.

- a presentation of the average annual pollutant loads removed and associated costs for the range of CSO control alternatives.

The level of CSO control provided in each case should be the highest feasible CSO control, and achieve the highest water quality classification reasonably attainable. The evaluation should include a comparison of the costs, performance, and technical considerations of all alternatives or combination of alternatives. In complex situations, the abatement plan should identify the most critical resources and the cost/benefit of the controls in establishing an implementation plan which affords the greatest improvement in water quality. This often involves a phased implementation plan.

(3) *Sensitive Use Areas*

While this guidance includes a description of the general procedures to be used in evaluating CSO controls, it is not intended to replace best professional judgement when considering site-specific factors in the determination of reasonable, feasible, and appropriate CSO controls. The most important site-specific factors governing these judgements are the actual and projected receiving water uses in a segment. The Department expects that each permittee will afford the highest priority in its long-term CSO control plan for eliminating or otherwise controlling CSOs in any receiving waters where critical uses have been identified. These include water uses that relate to public health or welfare, such as public water supply sources, shellfish harvesting areas, public bathing areas, endangered species habitats, and other areas of ecologic or economic concern which are identified as critical uses through the facilities planning and public participation process. In each case the goal shall be to eliminate the CSOs in these areas and where this is infeasible, to minimize their impacts.

In many instances, these sensitive use areas will also fall within the purview of other state agencies, who may also impose regulatory requirements. These agencies include, but are not limited to: DEP Division of Water Supply; Department of Public Health; and the Department of Fisheries, Wildlife, and Environmental Law Enforcement. Where CSO impacts fall within the purview of these or other state agencies, these agencies must be included in the review of the long-term CSO control plan, and DEP will consult these agencies during the review and approval process.

V. Regulatory Framework

CSO discharges are regulated by the Commonwealth in several ways. Like any discharge of pollutants, CSOs must have an NPDES/MA Surface Water Discharge Permit under federal regulations and 314 CMR 3.00. Permit procedures are described in 314 CMR 2.00. Municipalities and districts seeking funding for wastewater treatment, including CSO abatement, must comply with the facilities planning process at 310 CMR 41.00. Entities obtaining funding or exceeding specific thresholds must also comply with the Massachusetts Environmental Policy Act regulations at 301 CMR 11.00. Each of these regulations contain substantive and procedural requirements. Because both MEPA and facilities planning require the evaluation of alternatives, these processes are routinely coordinated.

Any permit for a CSO discharge must require compliance with Massachusetts Surface Water Quality Standards at 314 CMR 4.00. States are responsible for promulgating water quality standards under the federal Clean Water Act and parallel state laws. Water quality standards contain classifications of water bodies, designation of uses, criteria to protect the uses, and antidegradation provisions.[1] The water quality standards establish goals for waters of the Commonwealth, and provide the basis for water quality-based effluent limitations in NPDES permits. Any discharge, including CSO discharges, is allowed only if it meets the criteria and the antidegradation standard for the receiving segment.

Regulatory Options for CSOs

The CSO Policy describes a hierarchical "menu" of options within the Surface Water Quality Standards to accommodate the range of situations in which CSOs are found. The appropriate regulatory option for each CSO will be chosen based on the frequency and impact of each overflow, with public participation as an integral part of permit issuance. The Policy encourages cost-effective options that promote progress toward water quality goals while avoiding, where possible, the downgrading of water bodies on a permanent basis. Regulatory options for CSOs include:

- Class B or SB - CSOs are eliminated.
- Class B(CSO) - CSOs remain but must be compatible with water quality goals.
- Variance - CSOs remain when allowed under a short term modification of water quality standards through an NPDES/MA permit.
- Partial Use Designation - CSOs remain with moderate impacts resulting in intermittent impairment of water quality goals.

[1] Water bodies are classified as A, B, or C (SA, SB, or SC for marine waters). All waters in Massachusetts are currently classified either Class A (source of public water supply) or Class B ("fishable/swimmable"). Numeric or narrative criteria are established for each water body. Antidegradation provisions protect the designated and existing uses of waters. Uses of water bodies include habitat, recreation, fishing, or water supply.

- Class C - CSOs remain, causing permanent and sustained impairment so that Class B water quality goals cannot be met.

Revisions to DEP's Surface Water Quality Standards were made in 1995 to establish this system for efficient and effective regulation of CSOs. The "menu" enhances flexibility for permittees, minimizes demands on the Department's administrative resources, provides equivalent environmental protection with less process, and ensures the highest level of public health and environmental protection consistent with the realities of CSO abatement.

The Department will base its decision to identify a segment as B(CSO), to issue a variance, to issue a partial use designation, or to change the classification to Class C, on one or more of the reasons stated at 314 CMR 4.03(4)[2]. Generally, a decision to allow CSO discharges to continue will only be made if the Department finds that more stringent controls would lead to substantial and widespread economic and social impact as determined by a cost/benefit analysis. The Department may, but is not required to, allow CSO discharges when a facility can demonstrate its eligibility based on one or more of the reasons stated in the regulations.

The public notice and hearing requirements that apply to all Department regulatory changes will be observed prior to the promulgation of any additional revisions to the Surface Water Quality Standards for implementation of the Policy. Revisions to the Water Quality Standards will be required to establish a partial use designation or downgrade to Class C.

Relationship to EPA CSO Control Strategy and the NPDES Regulations

EPA's 1994 CSO Control Policy revised some features of its 1989 version to provide greater flexibility by allowing a minimal number of overflows which are compatible with the water quality goals of the Clean Water Act. DEP's 1995 regulatory revisions correspondingly decreased reliance on partial use designation as the sole regulatory vehicle to support CSO abatement plans[3].

In all cases, NPDES/MA permits will require the nine minimum controls necessary to meet technology-based limitations as specified in the 1994 EPA Policy. The nine controls may be summarized as; operate and maintain properly; maximize storage, minimize overflows, maximize flows to Publicly Owned Treatment

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[2] 314 CMR 4.03(4) allows the removal of a use that is not an existing use, a partial use designation, or a variance if the applicant demonstrates that:
"(a) Naturally occurring pollutant concentrations prevent the attainment of the use; or
(b) Natural, ephemeral intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met; or
(c) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
(d) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or
(e) Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
(f) Controls more stringent than those required by sections 310(b) and 306 of the Federal Water Pollution Control Act (33 USC § 1251 et seq.) would result in substantial and widespread economic and social impact."

[3] DEP's 1990 CSO Policy was based on EPA's 1989 CSO Control Policy and established the goal of eliminating adverse impacts from CSOs, using partial use designation where removal or relocation was not feasible. The three month design storm was identified as the minimum technology-based effluent limitation, which would result in untreated overflows an average of four times a year. Abatement measures to meet these minimum standards were necessary for a CSO discharge to be eligible for partial use designation. Presumably, all CSOs exceeding this standard required downgrading to Class C or SC status. No partial use designations or downgrades to Class C were actually made, but the process was perceived as administratively cumbersome.

Works (POTW), prohibit dry weather CSO's, control solids and floatables, institute pollution prevention programs, notify the public of impacts, and observe monitoring and reporting requirements. The nine minimum controls may be supplemented with additional treatment requirements, such as screening and disinfection, on a case-by-case basis.

EPA allows the issuance of a variance or the removal of a use in certain circumstances, which were incorporated into the Department's regulations in 1995 (see footnote 2). EPA regulations also generally govern the content of, and establish an approval process for, state water quality standards.

The Department's goal is to eliminate adverse CSO impacts and attain the highest water quality achievable. Separation or relocation of CSOs will be required wherever it can be achieved based on an economic and technical evaluation. The facilities planning process is designed to provide the requisite technical and economic analysis to determine whether elimination of CSOs is feasible, to provide a basis for determining which abatement measures should be implemented for CSOs which will not be eliminated, and for determining an appropriate schedule for all CSO abatement activities.

*** Class B or SB**

Where CSO discharges are eliminated through sewer separation or relocation, receiving waters may be designated as B or SB.

*** Class B (CSO) or SB (CSO)**

Where elimination of CSOs is not economically feasible and the impacts from remaining CSO discharges will be minor, the segment will be identified as B(CSO). Although a high level of control will be achieved, Class B standards may not be met during infrequent, large storm events. Overflow events may be allowed without a variance or partial use designation, provided that certain conditions are met. The 1995 revisions to the regulations created the B(CSO) water quality category by establishing regulatory significance for the notation "CSO" shown in the "Other Restriction" column at 314 CMR 4.06 for impacted segments. When the conditions have been met, the B(CSO) identification is given regulatory force[4].

An identification of B(CSO) will be made only after the Department has approved a facilities plan showing that minor CSO discharges are the most environmentally protective and cost-effective option available. Generally, eligibility for Class B (CSO) status is limited to discharges which can meet national goal use standards more than 95% of the time, but the highest level of control must always be achieved for each case as determined in the facilities plan through a cost/benefit analysis. The Department will prepare a Use Attainability Analysis[5], based on the facilities plan, to document that achieving a higher level of CSO control is not feasible or appropriate. Priority will be given to relocating or eliminating CSOs in sensitive areas such as Outstanding Resource Waters, bathing areas, water supply intakes, endangered species habitat and shellfish beds.

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[4] 314 CMR 4.06(1)(d)(10) notes that waters have been individually identified as impacted by CSOs in the water quality standards. Overflow events may be permitted without a variance or partial use designation provided that four conditions are met: "a. an approved facilities plan under 310 CMR 41.25 provides justification for the overflows; b. the Department finds through a use attainability analysis, and EPA concurs, that achieving a greater level of CSO control is not feasible for one of the reasons specified at 314 CMR 4.06(3);
c. existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected; and
d. public notice is provided through procedures for permit issuance or facility planning under M.G.L. c. 21 §§ 26 through 53 and regulations promulgated thereunder pursuant to M.G.L. c. 30A. In addition, the Department will publish a notice in the Environmental Monitor."

[5] A Use Attainability Analysis (UAA) scientifically assesses physical, chemical, biological, and economic factors affecting a use. The analysis also evaluates whether a designated use could be attained if CSO controls were implemented (e.g. reduction of sediment loading from CSOs to prevent burial of spawning areas).

Public notice of the identification of B(CSO) segments will be provided through the public participation process that is already an important component of permit issuance. In addition, whenever a facilities plan is prepared for CSO facilities, the public participation procedures of 310 CMR 41.00 will be followed. Each includes notice of the project and an opportunity for a public hearing. In addition, a notice will be provided in the Environmental Monitor. The Department may provide other means of affording public comment at its discretion, whether upon its own initiative or upon request from interested parties.

* **Variances**

Variances are short term modifications in water quality standards. Unlike partial use designations, variances are both discharger and pollutant specific, are time-limited, and do not forego the currently designated use. A variance allows the NPDES permit to be written to the "modified" water quality standard as analyses are conducted and as progress is made to improve water quality. A variance will be used were long-term attainability of the standard is uncertain, the CSO abatement plan includes phased implementation and/or the Department believes the standards may ultimately be attained. With a variance, NPDES/MA permits may be written such that reasonable progress is made toward attaining the standards without violating section 402(a) (1) of the federal Clean Water Act, which requires that NPDES permits meet the applicable water quality standards. Where a variance is issued, permittees will be required to implement the Nine Minimum Controls and any additional controls shown to be cost-effective in the cost/benefit analysis.

The justification for a variance involves the same substantive requirements as apply to a permanent change in the standard (see footnote 2), although the showings needed are less rigorous. However, unlike a downgrade to partial use or Class C, variances maintain the currently designated use. Therefore, a variance does not require a formal Use Attainability Analysis under EPA's water quality program. Additionally, the standard for the segment will be modified only for the permittee receiving the variance, while clearly maintaining the higher standard for other discharges. By maintaining the standard rather than changing it, the state will assure that further progress is made in improving water quality and attaining the standard, particularly when there is uncertainty about the success of a proposed control strategy.

The Department will use the permit as the vehicle to grant the variance. Notice of the permit will clearly state that the variance temporarily modifies the state's water quality standards. Variances are normally reviewed every three years, and may be codified in the water quality standards at the next triennial review. In comparison, the partial use designation is also reviewable during each triennial review, but reflects the state's determination based on a higher degree of certainty that uses cannot consistently be achieved.

* **Partial Use Designation**

Where the Department is certain that uses or standards cannot, and will not, be met on a permanent but intermittent basis, a partial use designation may be granted for specific segments through a regulatory revision. Partial use is the term used to describe waters occasionally subject to short-term impairment of uses, but which generally support those uses. Generally, short-term impairment means that the standards are met at least 75% of the time, but the permissible level will be determined through the facilities planning process on a case-by-case basis. Partial use can be defined by season or a particular storm event when a use such as swimming will be unattainable in CSO impacted waters. The use must be fully protected downstream, in other seasons, or smaller storm events.

The Department may find that an applicant has demonstrated that a use is not attainable under circumstances identified in the regulations at 314 CMR 4.03(4) (see footnote 2). Information to support a designation will be developed largely in the Environmental Impact Report or the Facilities Plan. The information contained in the facilities plan and available watershed plans will include most information necessary for the Use Attainability Analysis (see footnote 4) which must be submitted to EPA prior to the designation.

* **Class C**

Some CSOs may discharge to segments where designated uses cannot and will not be achieved on a permanent basis in the foreseeable future. These segments are candidates for a change in classification from Class B or SB to Class C or Class SC. A Use Attainability Analysis would be required for the change in classification. Downgrade to Class C is the undesirable option of last resort.

VI. Administrative Procedures

A. NPDES Permitting

As CSO discharges are defined as a point source under the Clean Water Act and the Massachusetts Water Quality Standards, an NPDES Permit must be issued jointly by EPA and DEP for these discharges. The NPDES Permit will set forth the requirements for implementation and assessment of the Nine Minimum Controls (NMC) and the requirement for developing a Long-Term CSO Control Plan. These permitting requirements will normally be carried out in two phases. The Phase I Permit will require the permittee to implement and document the NMC and develop a Long-Term CSO Control Plan. The Phase II

Permit will require continued implementation of the NMC and also implementation of the Long-Term Control Plan. Where necessary and appropriate, permits will include water-quality based effluent limits to comply with receiving water classifications. The permit provisions may include a maximum number of overflows, effluent limits, a specification of minimum treatment or capture, or other measures to ensure compliance with water quality standards. These permit limits may be conditioned on storm events so as to account for the possibility of multiple extreme storm events in a single year. NPDES permits for CSO discharges will continue to be required in all areas where CSOs are not elimintated, regardless of receiving water classification. The public participation requirements set forth in 314 CMR 2.00 are a necessary and important part of the permitting process.

B. Receiving Water Classifications

As indicated in the regulatory framework, there are a range of potential classifications for waters impacted by CSO discharges. The Long-Term CSO Control Plan, which includes a public participation process, is the critical step in determining water quality-based control measures that are technically feasible, affordable, and which comply with state water quality standards. The selection of the appropriate regulatory option will be based on information compiled in the long-term plan and other watershed information, which must demonstrate that the plan will achieve compliance with specific classifications. If a change in classification is necessary for implementation of the recommended plan, the permittee must request such action from the Department, and the requisite level of CSO control must be documented in the plan. The department will work with the stakeholders and permittee throughout the process to provide guidance.

Figure 1 summarizes the administrative procedures necessary for regulatory classification of CSO-impacted receiving waters. In all cases where CSOs will remain active, a NPDES permit will be required as noted above. In addition, a Use Attainability Analysis (UAA) is also required where CSO discharges will remain except where a variance for CSO discharges will be issued. The substance of the UAA, which presents a scientific and socio-economic assessment of factors affecting a use, must be developed in the Long-Term CSO Control Plan. The UAA is prepared by the Department, submitted to EPA and must be approved prior to any further action to reclassify a segment.

Where the permittee requests that a receiving water be downgraded to a $B_{partial}$ or C classification, the permittee must additionally demonstrate that meeting the B(CSO) level of control is unfeasible based on an evaluation of the costs, benefits to be achieved, and in consideration of existing and projected uses of the receiving water. The Department in this case shall provide public notice and the opportunity for a public hearing in accordance with MGL c. 30A.

C. Public Participation

Participation by stakeholders is an important part of the administrative requirements of CSO control programs. DEP has established procedures for public participation in the following areas:

(1) Long Term CSO Planning

Public participation during the long-term CSO planning is critical since development of the long-term plan will encompass a technical, financial, and environmental evaluation of CSO control alternatives, and information in the plan will form the basis of most of the regulatory decisions. DEP requires a minimum of one public meeting to discuss CSO control alternatives and one public hearing on the recommended plan. However, most, if not all, CSO planning efforts include substantially greater public participation, including frequent progress meetings, citizens advisory groups, and other public meetings to educate and inform stakeholders on CSO planning issues. DEP strongly encourages permittees to have extensive public participation opportunities in the planning process since acceptance by stakeholders is a critical factor in the implementability of any CSO control alternative.

(2) Water Quality Standards/Regulatory Changes

Where a change in classification of a receiving water is proposed, DEP will allow for public comment. In the case of B(CSO), notice will be made in the *Environmental Monitor*. In the case of a formal downgrade to $B_{partial}$ or C, DEP must also hold a public hearing pursuant to MGL c. 30 for a regulatory revision.

Additionally, EPA requires that DEP review and update the state water quality standards every three years. An important part of this process is holding a public hearing to receive public comment on the regulatory standards and designations for all receiving waters statewide. In cases where DEP is proposing significant changes associated with CSO impacts, DEP will hold public hearings in the areas of impact.

(3) NPDES Permits

Where CSO discharges will not be eliminated, a NPDES/MA Surface Water Discharge Permit is required under federal regulations and 314 CMR 3.00. DEP will issue public notice of all permit proceedings and will hold a public hearing on draft permits for CSO permittees to allow for public comment. At the time of issuance of the final permit, DEP shall also issue a response to comments.

(4) MEPA

CSO control programs are also subject to the requirements of the Massachusetts Environmental Policy Act (MEPA). The MEPA regulations, 301 CMR 11.00, specify a public review process for projects which may have environmental impacts. In nearly all cases, proponents of a CSO control plan will need to file an Environmental Notification Form (ENF) and subsequently an Environmental Impact Report (EIR) to provide an evaluation of impacts and an opportunity for public comment. Where DEP proposes to downgrade a receiving water, to $B_{partial}$ or C, DEP will make a MEPA filing in this regard as well.

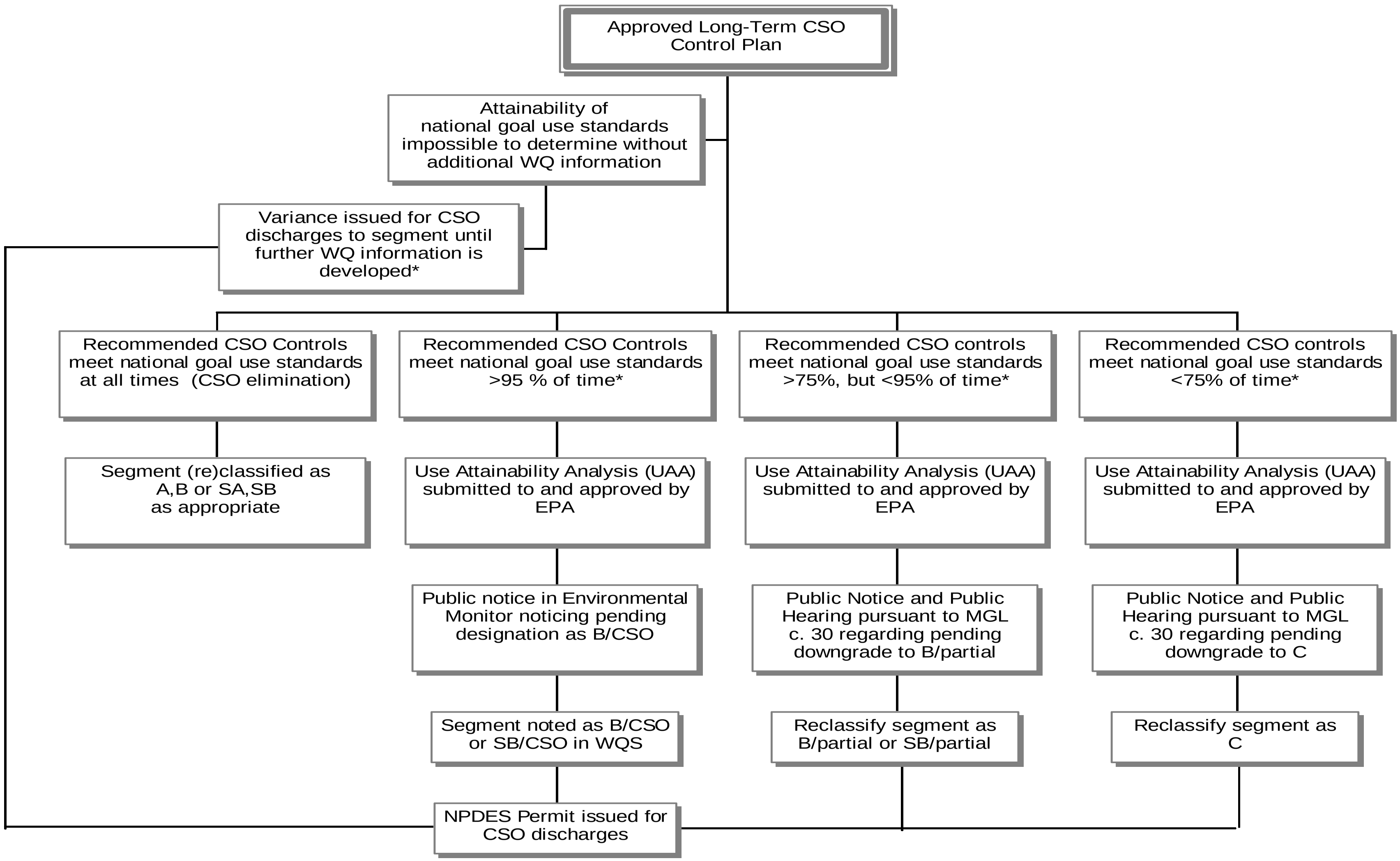
VII Contacts

Permittees and stakeholders may contact the following agencies for additional information and guidance on CSO regulatory issues:

MA Department of Environmental Protection
Bureau of Resource Protection
One Winter Street
Boston, MA 02108
(617) 556-1172

Environmental Protection Agency - Region 1
Office of Ecosystem Protection
One Congress Street
Boston, MA 02202
(617) 565-3478

Figure 1
CSO Controls - WQS Coordination



*One of the criteria of 314 CMR 4.03(4) must be met

REFERENCES

1. Massachusetts Surface Water Quality Standards, 314 CMR 4.00

2. Massachusetts Surface Water Discharge Permit Program/Permit Procedures 314 CMR 2.00 - 3.00.

3. EPA Combined Sewer Overflow Policy, Federal Register Vol. 59, No. 75 Environmental Protection Agency, April 19, 1994.

4. Guidance for Long-term Control Plan, Environmental Protection Agency, August 1995.

5. Guide to Comprehensive Wastewater Management Planning, Department of Environmental Protection, January 1996.

CDM

Memorandum

Project *Haverhill MA, Long Term CSO Control Plan Alternatives Evaluation*

Task: *Wastewater Treatment Facility Wet Weather Hydraulic Capacity Increase Evaluation*

Date: *July 15, 2011*

Purpose

This memorandum summarizes the condition and capacity of the existing facilities, and presents recommended improvements for each unit process and facility required to allow the WWTF to accept and treat the additional wet weather flow resulting from collection system CSO improvements.

Evaluation of major process and electrical equipment was performed to determine the reliability of the equipment and the need for immediate replacement. This evaluation was based on professional judgment, the reported maintenance history of the equipment, the availability of spare parts, the anticipated demand for future maintenance, and how critical the equipment is to the continued functioning of the plant.

This covers the evaluation of the process mechanical equipment at the Influent Pump Station and WWTF. Technical memorandums dealing with process mechanical issues are separately referenced in appropriate sections below.

Design Flows

This memorandum summarizes the existing hydraulic capacity of the wastewater pumping and treatment facilities, and presents recommended improvements for each treatment process required to increase the peak hour wet weather hydraulic capacity to 80 and or 100 mgd from the current peak hour flow of 65 mgd.

Evaluation of equipment was performed to determine the reliability of the equipment and the need for replacement. This evaluation was based on professional judgment, the reported maintenance history of the equipment, the anticipated demand for future maintenance, and how critical the equipment is to the continued functioning of the plant.

A hydraulic profile analysis was also completed as part of this investigation to ascertain the hydraulic impact of increased plant flows on existing process tanks, weirs, conduits, and other structures in terms of hydraulic capacity and max operating water levels. The analysis concluded that existing tanks, channels, and structures have sufficient capacity to accommodate up to 80 mgd wet weather flow. For wet weather flows exceeding 80 mgd, some modifications of tanks and junction boxes would be required.

The facilities capacity assessment assumed that flows would increase and be distributed within the plant as listed in the table below:

Design Flows	**Existing (mgd)**	**Proposed Future (mgd)**
Influent Flows		
Average	8	8
Maximum	39.2	39.2
Peak Hour (wet weather)	65	80 / 100
Secondary Treatment Flows		
Average	8	8
Peak Hour (wet weather)	20-25	20-25
By-Pass Flow		
Peak Hour (wet weather)	45	60 / 80

Facilities Evaluation:

Influent Pumping Station

Background:

The existing Wastewater pumping station, constructed in 1973 is responsible for pumping over 95% (60 mgd) of flow to the Haverhill WWTF. The pumping station is located approximately 4,000 feet from the treatment facility along the Merrimack River. The pump station consists of a main pumping building which houses mechanical screening equipment, screenings washer compactors and 4 vertical centrifugal extended shaft pumps. The pump station underwent an upgrade in 2006 that included replacement of screening equipment, pumps, electrical distribution and switchgear, standby power generator, HVAC and Instrumentation and controls equipment.

Facility Capacity Evaluation:

- Screening Equipment – The existing coarse wastewater screening equipment manufacturer (Vulcan) was contacted to confirm if the screens had sufficient surplus capacity to be able to hydraulically pass an additional 25-45 mgd of flow without resulting is excessive headloss or damaging the screening equipment. The manufacturer has confirmed that the screens do have enough capacity to accept up 50 mgd of additional flow if both screens are operated. With only one screen operating the manufacturer recommends no more than 30 mgd of additional flow be passed through the screens as the maximum approach velocity at the screens would exceed the 4.5 ft/s recommend for a ¾" bar screen for CSO type flows.

- Wastewater Lift Pumps - The existing pumps were installed in 2006 and consist of 3 duty and 1 standby non clog centrifugal pumps with extended shaft motors. The pumps are currently rated at 13,386 gpm @ 85 ft TDH each. The pump manufacturer Flowserve was contacted to determine if the existing pumps can be modified to increase flow and head to pass 80-100 mgd with three pumps. According to the Manufacturer, the pumps are currently at their max operating limit and any increase in pump flow and head would require full replacement of the impellers, motor stands, drives, couplings and gearboxes.

- 80 MGD Wastewater Lift Pumps – In order to increase station capacity to 80 mgd, Flowserve is recommending that the pump impellers be replaced with larger units, however this will also require an increase in pump horsepower requiring new 500 hp rated motors, gearboxes, shafts and VFD drives be provide.

- 100 MGD Wastewater Lift Pumps –A station capacity increase to 100 mgd would require full replacement of the entire pump and drive assembly with a 30 inch pump. Installation of a 30 inch pump would require extensive modifications and replacement of suction and discharge piping as the current piping is sized based on a 24 inch pump. Electrically the new pumps would also require new VFDs rated for 500 HP each.

- Force Main – The pump selections all assumed that the existing 42 inch force main will be replaced in-kind. Previous CDM evaluations and memorandums prepared during the Phase I design upgrades, all recommended replacement of the force main with parallel dual 36-inch force mains to help reduce detention time, increase velocity, reduce head loss, and increase reliability of the system vs. the current single force main option being operated. A detailed discussion of the force main replacement evaluation is presented in the next section.

- Electrical Distribution – Main distribution of power within the pumping station is via 480V switchgear. The equipment is reportedly in good condition and has sufficient capacity to accommodate the additional electrical load resulting from the increase in pump horsepower. The variable frequency drives for the existing pumps are currently rated at 400 hp each and would need to be replaced with larger 500 hp rated units to match the pump motors. It appears that adequate room is available within the Electrical Room to accommodate the new VFD equipment for either pump option being considered.

- Electrical Primary Service Transformer - The existing pad mounted transformer at the station is currently rated for 1500 kVa, 22.9kV primary and 480V secondary. The transformer is owned and maintained by the electric utility Mass Electric. Based on the potential pump horsepower increase required to accommodate the new pumps, the transformer may need to be replaced with a larger 2000 KVa unit. Typically the utility will pay for transformer installation and replacement, however since this unit was recently replaced as part of the 2006 facility upgrade it is highly likely that customer would be asked to pay for the transformer upgrade partially or in whole by the Utility.

- Standby Power - Based on our analysis, the emergency load that the standby generator would need to support is 1600 kW (excluding building loads such as lighting and ventilation that would also need to be taken into account). The existing generator is rated at 1500 kW, which would be insufficient.

Upgrade Recommendations:

- Screening Equipment - No work required at this time for this equipment.

- Wastewater Lift Pumps - Replace all 4 wastewater pumps in kind with new higher capacity pumps rated at 26.67 – 33.33 mgd each. Final pump sizing should be coordinated with force main replacement to minimize head loss and pump horsepower required.

- Electrical Primary Service Transformer - Recommend replacement of the existing transformer with a larger capacity unit matching the new pump electrical loads.

- Electrical Distribution – Recommend replacement of existing VFDs with larger 500 hp rated units to match pump drives.

- Standby Power - Install a new 2000-kW generator with a double-contained base fuel tank.

Influent Force Main

Background:

The piping system associated with the wastewater pumping station consists of internal pump suction and discharge piping and discharge header leading to an external buried force main. The internal station suction and discharge piping is specified as schedule 20 cement lined steel. As the 36-inch steel pump discharge header reaches the west wall of the station dry well, the pipe transitions to a 42-inch Prestressed Concrete Cylinder Pipe (PCCP). The 42-inch wall casting in the west wall is PCCP with flanged connection to the buried PCCP pipe on the outside.

The buried force main piping is all PCCP. There is a short section of about 68ft of 36-inch force main at the pumping station site that gives an approximate length of 3,148 ft of force main. The PCCP pipe was manufactured by Interpace Corporation in 1974. PCCP pipe manufactured by Interpace Corporation during this period has been known to have reported problems and resulted in failures of the piping.

The original pipe specifications defined the operating pressure as 40 psi and the test pressure of the pipe as 100 psi. Currently the typical operating pressure with one pump in service will be about 22-25 psi depending on the pump operating speed. With two pumps in service, the pressure rises to about 26-27 psi. With three pumps online the operating pressure increases to about 35-38 psi.

Capacity Evaluation:

- If the pump station capacity is increased to 80 /100 mgd respectively the typical operating pressure in the existing force main will increase as follows; the typical operating pressure with one pump in service would be about 26/29 psi at max pump speed. With two pumps in service, the pressure rises to about 32/35 psi. With three pumps online the operating pressure in the force main would increase to over 39/44 psi.

- The original pipe specifications defined the operating pressure at 40 psi and test pressure at 100 psi. The proposed flow increases associated with the pumping station capacity increase from 65 mgd to over 80 to 100 mgd will exceed the allowable pipe operating pressure.

- The existing PCCP piping would not be suitable for continued use if the pumping station hydraulic capacity is increased above 60 mgd, for flows above 60 mgd the force main should be replaced with a new force main as previously recommended in a technical memo prepared as part of the Phase I design improvements by CDM.

Upgrade Recommendations:

- A twin 36-inch parallel force main was previously recommended by CDM as providing increased system reliability, decreased operating costs, lower overall head loss, and decreased maintenance concerns vs. a single 42 inch force main. For both an 80 mgd and 100 mgd station capacity increase, a dual force main option would still provide all the benefits as previously cited, however due to the increase in total flow the recommended force main sizing is being revised from 36 to 42 inches.

Preliminary Treatment

Background:

Raw wastewater is pumped to a junction box at the headworks building where flow is distributed into a common channel that conveys wastewater for preliminary treatment consisting of mechanical fine screening and grit removal via aerated grit tanks.

Screening consists of two mechanical step screens. Typically the plant operates one only step screen at a time, however during wet weather flows, both sets of screens must be placed into service to pass the full wet weather flow of 65 mgd.

Grit removal is provided by a pair of aerated grit tanks. The aerated grit tanks were installed as part of the last plant upgrade in 2006. Typically only one aerated grit tank is required to be online at a time to pass all plant flows through 65 mgd.

Capacity Evaluation:

- The influent junction box does not have sufficient room to allow the proposed dual force mains to be connected to the structure as there is not enough physical room to make the mechanical connection to the structure with the large diameter force mains.

- The existing mechanical fine screening equipment currently consists of two operating step /stair screens with ¼" screen openings. Each screen is hydraulically rated for passing ½ the peak hour plant flow of 65 mgd with an 8 inch headloss.

- The screen manufacturer (Vulcan) was contacted to determine the maximum allowable hydraulic capacity of each screen. According to the manufacturer the step screens can hydraulically pass up to 42.5 mgd each with a clean water headloss of 14 inches.

- If 100 mgd total flow is required to be passed through the two step screens, Vulcan recommends that the screens be operated in a continuous clearing mode to minimize headloss across the screen. While operating in a continuous clearing mode, the effective screenings capture performance of the screen will be reduced since the screenings mat will no longer be present.

- The proposed increase in wet weather flow will adversely impact the grit removal performance of the aerated grit tanks. A hydraulic analysis of the aerated grit tanks determined that at 80 mgd flow one aerated grit tank would have sufficient minimum detention time however at 100 mgd, one grit tank would not be able to provide the minimum recommend detention time required for grit removal.

Peak Hour Flow	80 MGD	100 MGD
Actual Detention Time 1 tank in service: 2 tanks in service:	3.1 Minutes 6+ Minutes	1.5 minutes 3 minutes
Minimum Required	3+ Minutes	3 Minutes

Upgrade Recommendation:

- Mechanical Fine Screens - No major improvement are required to pass either 80 or 100 MGD flow through the screening equipment. For flows in excess of 80 mgd, it is being recommended that the screens be placed into a continuous clearing mode to minimize headloss.

- Aerated Grit Tanks - For flows in excess of 80 mgd it is being recommended that a second aerated grit tank be brought online to enhance grit removal system performance during periods of high flow. This will also require the installation of a third aerated grit tank to comply with N-1 requirements to provide process redundancy in the event that an aerated grit tank is offline or unavailable during a wet weather event.

Primary Clarifiers

Background:

After preliminary treatment, screened and degritted wastewater is conveyed by gravity to three rectangular primary clarifiers, each 25 feet by 100 feet, with a 12-foot side water depth and a volume of 225,000 gallons. Each clarifier is rated to handle a peak flow of 32.5 mgd with a detention time of about 1.4 hours. The scum and sludge collection mechanisms were replaced recently in 2004 and are in good operating condition.

Currently only two of three primary clarifiers are operated by plant staff. The third clarifier is routinely offline and only used in the event of high flows or as required by maintenance.

Capacity Evaluation / Deficiencies:

- Primary Clarifier scum troughs should be repositioned to minimize the potential of flooding during wet weather flow.

- The maximum recommended peak hour Surface Overflow Rate for primary clarifiers is 3,100 gpm/sf. At 65 mgd the SOR for each clarifier is approximately 2950 gpm/sf each.

Each clarifier is currently operating at 95% max recommended capacity during wet weather flows.

- In order to accommodate an increase in plant capacity to 80 MGD, a third clarifier would need to be brought online during wet weather events. This would require utilizing the third standby clarifier or construction of a new fourth clarifier tank.

- In order to accommodate an increase in plant capacity to 100 MGD, a fourth clarifier would need to be brought online during wet weather events. This would require of a new fourth clarifier tank.

- Limited room is available onsite for construction of a fourth clarifier and supporting sludge pumping station support equipment.

- The existing 66 inch wet weather bypass conduit installed in 2006 was found to have sufficient hydraulic capacity to accommodate up to 80 mgd of additional flow. However in order to effectively split and monitor flow to the bypass conduit during wet weather events, modifications to the leveling weir and flume structure are required to ensure proper flow distribution occurs. Additionally, the flume and weir structure will require to be relocated if a fourth primary settling tank is required since the current location of the structure would be in the future primary clarifier proposed expansion area.

Upgrade Recommendation:

- Reposition Primary Clarifier Scum Trough - Reposition the scum troughs in Primary Clarifier so the elevation of the trough is ½" above the maximum wet weather water level in the clarifier.

- Utilize and Place Primary clarifier No. 3 into service during wet weather events

- Consider chemically enhanced primary treatment (CEPT) options to allow the existing primary clarifiers to be rerated at a higher rate during wet weather events to avoid construction of a fourth primary clarifier required for flows in excess of 80 MGD.

- Modify bypass conduit control leveling weir to improve hydraulic flow splitting and control of flow during wet weather flows.

- A new 9-feet long weir gate is required to effectively control and split dry weather flow from wet weather flow in the primary clarifier effluent channel.

- Modify the bypass flume channel to eliminate headloss to prevent surcharging grit tanks and primary clarifiers.

Gravity Thickeners

Background:

Primary sludge is designed to be thickened in two 30-foot diameter, 12-foot side water depth gravity thickeners.

Primary sludge is pumped from the primary settling tanks to one of the gravity thickeners for thickening prior to blending with waste activated sludge and dewatering via centrifuges. Currently plant operators only utilize 1 of the 2 available gravity thickener units.

Facility Evaluation / Deficiencies:

- The Gravity Thickeners were found to have sufficient capacity for the average day dry weather flows and wet weather flows up to 65 mgd at the plant.

- A hydraulic plant analysis determined that the Gravity Thickeners would be susceptible to flooding from high water surface levels at the headwork's during peak flows in excess of 80 mgd. This would result in the effluent weirs in each GT becoming surcharged.

Upgrade Recommendations:

- Operating Level Change – In order to prevent flooding out the GT's during peak wet weather flows (80+ mgd), it is being recommended that GT effluent weirs and scum skimmer mechanism, and scum pipe be raised to allow the GT to be operated during high flow periods.

- Isolation Valves – Consider installation of an isolation valve on the GT overflow drain line to allow operators to manually isolate an unused GT from the plant drain system.

Chlorination Facilities

Background:

Chlorination and effluent disinfection at the plant is currently accomplished utilizing liquid sodium hypochlorite solution being fed directly to junction chamber prior to the plant outfall pipe. The outfall pipe is used a contact chamber to provide the 30 minute minimum contact time at peak hour flow. A newly constructed chlorine equipment building is also located onsite and houses chemical feed equipment and bulk storage facilities for storing sodium hypochlorite solution.

Sodium hypochlorite solution is added to secondary effluent at the junction chamber immediately downstream of the existing secondary tanks where secondary and bypass flows combine. Sodium hypochlorite solution is also injected into the wet weather bypass conduit to provide additional contact time for wet weather wastewater flow.

Facility Capacity Evaluation:

- Contact Time - The total available contact time provided for the proposed future wet weather flow that is bypassed around secondary treatment would be less than industry recommended 30 min at peak hour flow.

- Existing chemical storage and feed equipment is adequately sized for the current dry weather flow disinfection loads. No increase in storage capacity is required for the wet weather flow chemical demands as the number of wet weather events exceeding 65 MGD in the future will be limited to less than a dozen all consisting of short duration periods that will not deplete available chemical storage inventories.

Upgrade Recommendations:

- Replace the wet weather chlorination feed pumps with high capacity units to match the increase in plant wet weather flow.

- Relocate chlorine feed location immediately downstream of the primary settling tank effluent weir and prior the wet weather bypass control weir to increase the overall contact time for wet weather flow.

Memorandum

Project: *Haverhill MA, Long Term CSO Control Plan Alternatives Evaluation*

Task: *Hydraulics Analyses for 80-mgd & 100-mgd Haverhill WWTF*

Date: *July 7, 2011*

The review of the hydraulics for the Haverhill WPAF was done for 80-mgd with 55-mgd of the plant flow bypassing secondary treatment; and, 100-mgd with 75-mgd of the plant flow bypassing the secondary treatment. For both conditions, the RAS flow was 6-mgd. All units were presumed in service (only two aeration tanks are operational at any given time). Also, a fourth primary settling tank was assumed constructed and operating. The 25 year river level of 16.8 was used. The criterion upon which the plant capacity was based was to maintain no less than a freeboard of 1.5-ft at the various plant structures. The calculations and HGL sheet are attached.

The screen head loss was based on the 2004 CDM Drawing's HGL sheet at 32.5-mgd per screen inducing a head loss of 0.68-ft and prorating it to 40-mgd and 50-mgd based on Q^2 and (1/y)^2. The resulting head loss is presumed to represent a 50% clogged screen. The respective screen head losses for 40-mgd and 50-mgd are 1.28-ft and 1.41-ft. This likely provides for no clogging. The use of the 50% clogged head loss is conservative and used on the hydraulic gradeline sheet attached. The actual head loss must be obtained by the screen vendors.

The analysis for the 80-mgd condition indicated that the plant can pass this flow which includes 55-mgd bypass flow through the plant without causing the freeboard at the various structures to be equal or greater than 1.5-ft. The only significant weir surcharging was calculated to be 0.46-ft at the grit tanks which translated to an increase in the tanks' water level of 0.08-ft. The bypass weir elevation was lowered to its minimum value of 25.00-ft to pass 55-mgd.

Flow measurement at each flow condition at the bypass Parshall flume likely records flows more than are actually occurring because of the "bulking action" caused by the air entrained by the free falling water over the fairly close upstream bypass weir. Also, the heavy turbulence caused by the free falling water is likely affecting flow measurement. For each flow condition, the inlet Parshall flume has measuring Ha depths that are 4.44-ft and 5.12-ft, respectively. The

100-mgd flow condition far exceeds the capacity of the plant which is about 80-mgd. The hydraulics analysis for the 100-mgd condition was based on proceeding upstream to the a hydraulic problem location, resetting the level to a proper elevation, then proceeding upstream to the next problem location and so forth. The problem locations and the head deficiencies are:

1) Air Vent Manhole along the outfall where the a downstream head loss reduction of 1.64-ft is needed to provide a 1.5-ft freeboard at the structure;

2) Bypass Parshall flume where an additional 1.68-ft head loss reduction is needed to not surcharge the flume;

3) A 9-ft long weir gate is needed in the 9-ft wide primary effluent channel to bypass 75-mgd over the bypass weir (set at its minimum elevation of 25-ft). The grit tanks' weir will be surcharged by 1.43-ft which translates to a rise in the tanks' water level of 0.52-ft.

The head loss for the inlet ports to the secondary sedimentation tanks was based on assuming the area of the ports is equal to the annular area and total perimeter of the center column and the internal RAS pipe. While this cannot be known without physically measuring the ports, the current CDM specification calls for the ports being 135% of the annular area. The assumption used in the analysis could, therefore, be conservative. For the analysis, the head loss is based on a 48-in diameter center column and a 20-in diameter RAS pipe.

Assuming that improvements are made along the bypass and outfall, a 9-ft long weir gate (at an approximate elevation of 27.16-ft for the analyzed flow conditions) would need to be located in the 9-ft wide primary effluent channel to sufficiently increase the water level at the bypass weir to provide enough head to drive the 75-mgd flow over the weir. The required weir gate would need to be adjustable for bypass flows over 80-mgd with the bypass weir at its lowest elevation of 25-ft. This 25-ft weir elevation is required for both flows conditions in the analyses. The proposed 9-ft long weir would be used to limit the secondary flow to 25-mgd. Because of the hydraulic complexity of the bypass weir hydraulics, the gate if also installed for this 80-mgd flow conditions, may be useful to overcome any uncertainties of the estimates of the bypass weir analysis.

Memorandum

To: *File*

From: *Michael Dodson, RLA and Milagros Puello, PE*

Date: *January 24, 2017*

Subject: *Green Assessment for CSO Control*

1.0 Introduction

Green infrastructure is another approach to managing wet weather impacts to reduce combined sewer overflow (CSO) discharges. While the conventional CSO abatement approach has been the installation of new piping and/or storage and treatment systems, which tend to move wet weather flows away from the urban environment, green infrastructure (GI) reduces and treats stormwater at its source while delivering environmental, social, and economic benefits. These benefits have made green infrastructure an attractive CSO abatement alternative in some areas. At the national level, green infrastructure is typically included in major CSO plans as a complementary option to traditional gray CSO control alternatives.

For Haverhill, this feasibility study was performed to determine if green infrastructure practices within the combined sewer areas would benefit CSO control by either reducing the size of some recommended improvements or possibly eliminating the need for others. Its effectiveness will be compared to traditional gray CSO controls in the Long-Term Control Plan (LTCP) report.

2.0 Candidate Sites

Properties (private and city owned) with large impervious areas and/or flat roofs were identified within the combined sewer areas. It was determined that about 51 percent of the combined sewer area is impervious, with the highest concentration being in the downtown area. During a project workshop, the city requested that initial GI efforts focus first on city-owned properties. Public-private partnerships to develop GI in the city would be considered at a later time if and when appropriate. Twelve sites were selected to evaluate GI practices to reduce the quantity of stormwater entering the combined sewer system. The sites selected are all city-owned properties located within a combined sewer area.

The properties and the CSO area it is located in, are listed below.

- Greenleaf Elementary School – Middlesex Street CSO

- Tilton Elementary School – Upper Siphon CSO
- Wingate Street Parking Lot – Middle Siphon CSO
- Essex Street Parking Lot – Middle Siphon CSO
- City Hall – Main Street North CSO
- Grand Army of the Republic Park (G.A.R.) – Main Street North CSO
- Haverhill Library – Main Street North CSO
- Wysocki Park – High Street CSO
- Ginty Boulevard – Bethany Avenue CSO and Chestnut Street CSO
- Crowell Kindergarten Center – Lower Siphon CSO
- Triangle at Arlington Street and Windsor Place – Main Street North CSO
- Locke Street Parking Lot – Locke Street Center Barrel CSO

2.1 Site Considerations

Each site was analyzed to determine overland runoff routes and the locations of nearby catch basins. GI is very effective when they are located on the uphill side of existing catch basins so the greatest amount of area can be used to reduce flows from entering the combined sewer system. Stormwater practices are typically located at least 10 feet away from adjacent buildings to avoid infiltration into basements.

Subsurface soil conditions are important to the design of GI. No green practices should be installed in locations with a shallow depth to bedrock or in locations with seasonal high water table. Ground water should be at least 4-feet below the bottom of all GI. Soils with low permeability are not recommended for GI as good infiltration is necessary. It is standard practice to size each GI practice to capture the first 1-inch of rainfall during a storm event and to avoid standing water visible 24 hours after the storm event. This sizing criterion allows stormwater flow to be captured from about 90% of storms in this region of the United States.

For this feasibility study, no subsurface assessments were performed. This assessment was performed to identify candidate sites for possible future consideration and to identify potential stormwater abatement that could be achieved to reduce CSO discharges. Should the city decide to move forward with any of the GI discussed herein, it is important to perform soil testing to determine soil permeability rates, locations of bedrock and groundwater elevation to confirm the feasibility of any of these sites.

3.0 Types of Green Infrastructure for Haverhill

The GI practices considered for Haverhill included bioswale systems located within the right-of-way of city-owned streets, porous pavements, and vegetated bioretention areas located on city-owned property. Green roofs were not considered because existing building roofs typically cannot handle the additional load from stormwater, soils, and other components of these systems. Blue roofs, which include stormwater collection features which are intended to collect stormwater and release slowly to roof drains, were also not considered because of the additional load. These existing roofs would require retrofitting for structural reinforcement and this would add substantial costs.

The practices considered are described below.

3.1 Vegetated Bioretention Areas

Vegetated bioretention areas are depressions in the ground that collect stormwater and can be constructed with or without a stone layer below the soil layer. A stone layer adds storage to the system if additional volume is needed. Vegetation is then planted in the depression. The soil layer would be a minimum of 1-foot layer for perennials and a 2-foot layer for trees and shrubs. Bioretention areas could be designed to also collect runoff from roofs of existing buildings. This is a more cost-effective approach to collecting runoff from roofs rather than installing green or blue roofs. The cost for vegetated bioretention areas varies greatly depending on size, location, and complexity. For planning purposes, the installed cost of $40 per square foot was used.

3.2 Porous Pavement Systems

There are many types of porous pavement systems available in the industry today. Some of these systems include porous asphalt, pervious concrete, and permeable pavers. In each system, a stone layer below the porous pavement stores stormwater and allows it to infiltrate into the ground. Parking lots present great opportunities for installing porous pavement systems. It is recommended that porous pavements be located in parking spaces because porous pavements installed at drive aisles can be damaged by turning wheels. It is important to design the bottom of stone layer at a depth of 65 percent of the frost depth to ensure maximum strength of the system. The cost for porous pavements can vary greatly depending on size of area and type of system used. For planning purposes, the installed cost of $30 per square foot was used.

3.3 Bioswale Systems

Bioswale systems can provide a great opportunity to capture and treat street runoff. Bioswales can be installed in walkways and street medians and provide pedestrians aesthetic interest to the streetscape. These systems typically include a soil layer, stone layer, and vegetation enclosed in a short fence to discourage pedestrians from entering the system. It is important to consider the impact of these systems on pedestrian and vehicular safety. The cost for bioswales varies depending on size and location. For planning purposes, the installed cost of $150 per square foot was used.

4.0 GI Potential and Estimated Costs

It is important to consider the relative effectiveness of GI to manage stormwater and reduce CSO discharges. However, it is also important to note that GI has other socio-economic benefits to the community at large that are hard to quantify. These are intangible benefits ranging from greening the urban area and improving the aesthetics in neighborhoods to improve/replenish the groundwater in the local watershed by direct infiltration versus conveying stormwater away from the area entirely.

For this evaluation, an estimate of the combined sewer area managed by each possible green practice provides a way to consider the effectiveness (by cost) of the GI. To calculate area managed by GI practices and to determine a cost per acre managed for the selected sites, a dynamic volume calculation was performed. For vegetated bioretention areas and bioswale systems, the area of green infrastructure practice was calculated using a 2-foot soil layer with 20 percent void space and a 1-foot stone layer with 35 percent void space. A 6-inch ponding depth was included to increase the storage. Also included in the storage calculation is an assumption that the existing soils will allow half an inch to infiltrate each hour. This is conservatively estimated and based on a soils description stated in The City of Haverhill Open Space and Recreation Plan (page 32 of 257, October 2008-October 2015). Volume for porous pavement was calculated similarly but uses a stone depth of 30-inches and does not include a soil layer or ponding depth. Using the area managed calculated, the annual CSO reduction was estimated for each site.

When treating one acre of existing impervious area using the parameters described above, vegetated bioretention areas cost approximately $145,000, porous pavements cost approximately $203,000, and bioswale systems cost approximately $490,000 for each impervious acre managed. These costs include a 45-percent allowance for engineering and project contingencies including design, permitting, construction oversight, survey work, geotechnical work, legal fees, bonding and administrative needs.

The following paragraphs identify the potential locations for GI installations at each of the 12 identified sites, estimate the quantity of the first 1-inch of stormwater runoff captured for each GI practice, estimate the annual CSO reduced and present likely installed costs. These costs will then be used in the CSO Long-term Control Plan to evaluate the cost-effectiveness of removal of this flow when comparing alternatives for CSO abatement.

5.0 Proposed Green Sites

A Preliminary Plan for each candidate site for green infrastructure is attached to the end of this memorandum and described below.

5.1 Greenleaf Elementary School

The Greenleaf Elementary School is located on a relatively level sloped lot on the corner of South Elm Street and Chadwick Street. Existing drainage patterns on this site allow stormwater runoff to flow toward Chadwick Street. Impervious areas on the site include the school's roof, a paved playground, and paved vehicular and pedestrian walkways.

In order to reduce flow to Chadwick Street, runoff could be collected from the existing roof by redirecting roof drains to a new bioretention area located on the northeast corner of the site. This practice would be located away from play areas so there would be no interference with student's activities. The paved vehicular drive could be replaced with porous pavement surfacing which would reduce the area of impervious surfaces from the site and collect some of the runoff from the existing paved playground.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 0.86 acres, which would reduce annual CSO by about 0.03 MG. The estimated cost to install GI at this site is $144,000. The average cost per acre managed on this site is approximately $167,000.

5.2 Tilton Elementary School

Tilton Elementary School is located between Grove Street and Hancock Street. Existing drainage patterns on this site allow stormwater runoff to flow toward Grove Street and to Hancock Street. Impervious areas on the site include the school's roof and paved walkways, drive aisles, and parking.

In order to reduce flows to Grove Street and Hancock Street, runoff could be collected from the existing roof by redirecting roof drains to new bioretention areas located in existing lawn areas on the northwest and southeast corners of the site. An additional bioretention area could be located adjacent to Grove Street in a lawn area and collect runoff from Grove Street on the uphill side of an existing catch basin. Porous pavement could replace parking spaces on the downhill side of the southern parking area. It would not be required to replace the entire parking area with porous pavement because the quantity of stormwater could be contained in the area of parking spaces.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 1.97 acres, which would reduce annual CSO by about 0.08 MG. The estimated cost to install GI at this site is $297,000. The average cost per acre managed on this site is approximately $151,000.

5.3 Wingate Street Parking Lot

Wingate Street Parking Lot is a large paved parking area located between Wingate Street and Washington Street. Existing drainage patterns on this site allow stormwater to flow toward catch basins on Wingate Street and to catch basins on the adjacent lot. All flow is directed to a combined sewer line on Essex Street. There are no pervious areas on this site to reduce quantity of stormwater entering the combined system.

In order to reduce flows to the combined sewer line in Essex Street, porous pavement could replace the parking spaces in the lot. It's recommended that only the parking spaces are retrofitted with porous pavement because there is less potential for damage to system. The quantity of stormwater could also be managed by the storage area of the porous pavement. Another option could be to include vegetated bioretention areas to the site by reducing the number of parking spaces. However, from a site analysis, it is known that at times all parking spaces are utilized. To add vegetated bioretention areas without reducing parking spaces, the lot's parking space configuration could be manipulated to provide adequate space for the bioretention areas.

By installing porous pavement, the total volume of the first 1-inch of runoff managed by GI on this site is approximately 1.70 acres, which would reduce annual CSO by about 0.07 MG. The estimated cost to install GI at this site is $345,000. Average cost per acre managed on this site is approximately $203,000.

5.4 Essex Street Parking Lot

Essex Street Parking Lot is a large paved parking area located between Locust Street and Essex Street. Existing drainage patterns on this site allow stormwater to flow toward catch basins on and adjacent to the site. All flow is directed to a combined sewer line on Essex Street. There are no pervious areas on this site to reduce quantity of stormwater entering the combined system.

In order to reduce flows to the combined sewer line in Essex Street, porous pavement could replace the parking spaces in the lot. It's recommended that only the parking spaces are retrofitted with porous pavement because there is less potential for damage to system. The quantity of stormwater could also be managed by the storage area of the porous pavement. Another option could be to include vegetated bioretention areas to the site by reducing the number of parking spaces. However, from a site analysis, it's known that at times all parking spaces are utilized. To add vegetated bioretention areas without reducing parking spaces, the lot's parking space configuration could be manipulated to provide adequate space for the bioretention areas.

By installing porous pavement, the total volume of the first 1-inch of runoff managed by GI on this site is approximately 2.98 acres, which would reduce annual CSO by about 0.12 MG. The estimated cost to install GI at this site is $605,000. Average cost per acre managed on this site is approximately $203,000.

5.5 City Hall

City Hall is located between Main Street, Summer Street, and Newcomb Street and has a large flat roof. Existing drainage patterns on this site allow stormwater to flow toward catch basins on the surrounding streets, which are all connected to the combined sewer system. Impervious areas on the site include the roof, pedestrian walkways, drive aisles and parking spaces as well as a large parking lot north of the building.

In order to reduce flows to the combined system, runoff could be collected from the existing roof by redirecting roof drains to new vegetated bioretention areas located in existing lawn areas on the south side of the building. This could be a demonstration area and provide a viewing area to pedestrians on the adjacent walkway. Paved parking spaces on site and connected to Newcomb Street could be replaced with porous pavement and collect water flowing downhill on the street. Flows entering the combined system from the large parking lot located north of City Hall could be reduced by installing a vegetated bioretention area at one of the lot’s three entrances. Parking space markings would need to be manipulated to reconfigure the traffic patterns through the lot if a bioretention area was installed. Another option is to replace parking spaces with porous pavement.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 1.85 acres, which would reduce annual CSO by about 0.07 MG. The estimated cost to install GI at this site is $290,000. Average cost per acre managed on this site is approximately $157,000.

5.6 Grand Army of the Republic Park (G.A.R.) Park

G.A.R. Park is located between Winter Street, Main Street, and Bailey Blvd. The site is comprised of mostly lawn with some imperious pedestrian walkways. Existing drainage patterns from G.A.R. Park flow to Bailey Boulevard, which is not located in the combined sewer area. However, drainage from Winter Street and Main Street flow to a combined sewer line on Main Street.

In order to reduce flows to the combined sewer line in Main Street, runoff from Winter Street and from Main Street could be collected by new vegetated bioretention areas in the existing lawn area. These bioretention areas would be located on the uphill side of the existing catch basins to reduce or eliminate stormwater from entering the combined system.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 0.65 acres, which would reduce annual CSO by about 0.03 MG. The estimated cost to install GI at this site is $92,000. Average cost per acre managed on this site is approximately $142,000.

5.7 Haverhill Library

Haverhill Library is located adjacent to Summer Street and a large paved parking lot is located to the east of the library, south of Summer Street and west of Stage Street. Existing drainage patterns from the large parking lot flow toward the combined sewer line in Stage Street. Drainage patterns on Summer Street flow into existing catch basins that are connected to the combined sewer line on Main Street.

In order to reduce flows to the combined sewer line in Stage Street, porous pavement could replace the parking spaces in the lot. It's recommended that only the parking spaces are retrofitted with porous pavement because there is less potential for damage to system. The quantity of stormwater could also be managed by the storage area of the porous pavement. Another option could be to include vegetated bioretention areas to the site by reducing the number of parking spaces. However, from a site analysis, it's known that at times all parking spaces are utilized. To add vegetated bioretention areas without reducing parking spaces, the lot's parking space configuration could be manipulated to provide adequate space for the bioretention areas.

In order to reduce flows to the combined sewer line in Main Street, runoff from Summer Street could be collected by new vegetated bioretention areas in the existing lawn area. These bioretention areas would be located on the uphill side of the existing catch basins to reduce or eliminate stormwater from entering the combined system.

The total volume of the first 1-in of runoff managed by GI on this site is approximately 3.86 acres, which would reduce annual CSO by about 0.15 MG. The estimated cost to install GI at this site is $608,000. Average cost per acre managed on this site is approximately $158,000.

5.8 Wysocki Park

Wysocki Park is located between Tremont Street, Park Avenue, Beacon Street, and Central Street. This park is mostly impervious, but the adjacent streets are connected to the combined sewer system.

In order to reduce flows to the combined sewer lines in Tremont Street, Park Avenue, and Beacon Street, runoff could be collected by new vegetated bioretention areas in the existing lawn area. These bioretention areas would be located on the uphill side of the existing catch basins to reduce or eliminate stormwater from entering the combined system.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 0.61 acres, which would reduce annual CSO by about 0.02 MG. The estimated cost to install GI at this site is $86,000. Average cost per acre managed on this site is approximately $141,000.

5.9 Ginty Boulevard

Ginty Boulevard is located on the east side of Main Street and is connected to the combined sewer system. The combined sewer line in Ginty Boulevard collects runoff from surface flow from the north as well as existing combined sewer lines in nearby streets.

In order to reduce flows from entering the combined sewer lines in Ginty Boulevard, runoff could be collected by bioswale systems located in the right-of-way. These bioswales would be located on the uphill side of existing catch basins to reduce or eliminate stormwater from entering the combined system.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 0.57 acres, which would reduce annual CSO by about 0.02 MG. The estimated cost to install GI at this site is $283,000. Average cost per acre managed on this site is approximately $496,000.

5.10 Crowell Kindergarten Center

Crowell Kindergarten Center is located on Belmont Avenue and includes a paved playground. Existing drainage patterns on this site allow stormwater runoff to flow toward Belmont Avenue which is connected to the combined system. Impervious areas on the site include the school's roof, a paved playground, and paved vehicular access and parking spaces, and pedestrian walkways.

In order to reduce flows from entering the combined sewer line in Belmont Avenue, runoff could be collected in porous pavement located at the playground area. Using porous pavement in this area will not restrict the children from using the space and will not reduce the size of the playground. A small vegetated bioretention area could be located on the west side of the porous pavement and collect runoff from Belmont Avenue. This bioretention area could also provide interpretive signage for the children or pedestrians to learn about the purpose of these green infrastructure practices.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 0.54 acres, which would reduce annual CSO by about 0.02 MG. The estimated cost to install GI at this site is $105,000. Average cost per acre managed on this site is approximately $194,000.

5.11 Triangle at Arlington Street and Windsor Place

An existing grass and landscaped triangle located between Windsor Place, Windsor Street, and Arlington Street. This space is mostly impervious and includes a sidewalk along Arlington and Windsor Street. The combined sewer line in Windsor Place and Arlington Street connect to a combined sewer line on Highland Avenue.

In order to reduce flows from entering the combined sewer line in Windsor Place and Arlington Street, runoff could be collected by new vegetated bioretention areas in the existing lawn area. These bioretention areas would be located on the uphill side of the existing catch basins to reduce stormwater from entering the combined system.

The total volume of the first 1-inch of runoff managed by GI on this site is approximately 0.38 acres, which would reduce annual CSO by about 0.02 MG. The estimated cost to install GI at this site is $54,000. Average cost per acre managed on this site is approximately $142,000.

5.12 Locke Street Parking Lot

Locke Street Parking Lot is a large paved parking area adjacent to Locke Street. Existing drainage patterns on this site allow stormwater to flow toward catch basins on Locke Street. All flow is directed to the combined sewer system. There are no pervious areas on this site to reduce quantity of stormwater entering the combined system.

In order to reduce flows to the combined sewer line in Locke Street, porous pavement could replace the parking spaces on the downhill side of the lot. It's recommended that only the parking spaces are retrofitted with porous pavement because there is less potential for damage to system. The quantity of stormwater could also be managed by the storage area of the porous pavement. Another option could be to include vegetated bioretention areas to the site by reducing the number of parking spaces. To add vegetated bioretention areas without reducing parking spaces, the lot's parking space configuration could be manipulated to provide adequate space for the bioretention areas.

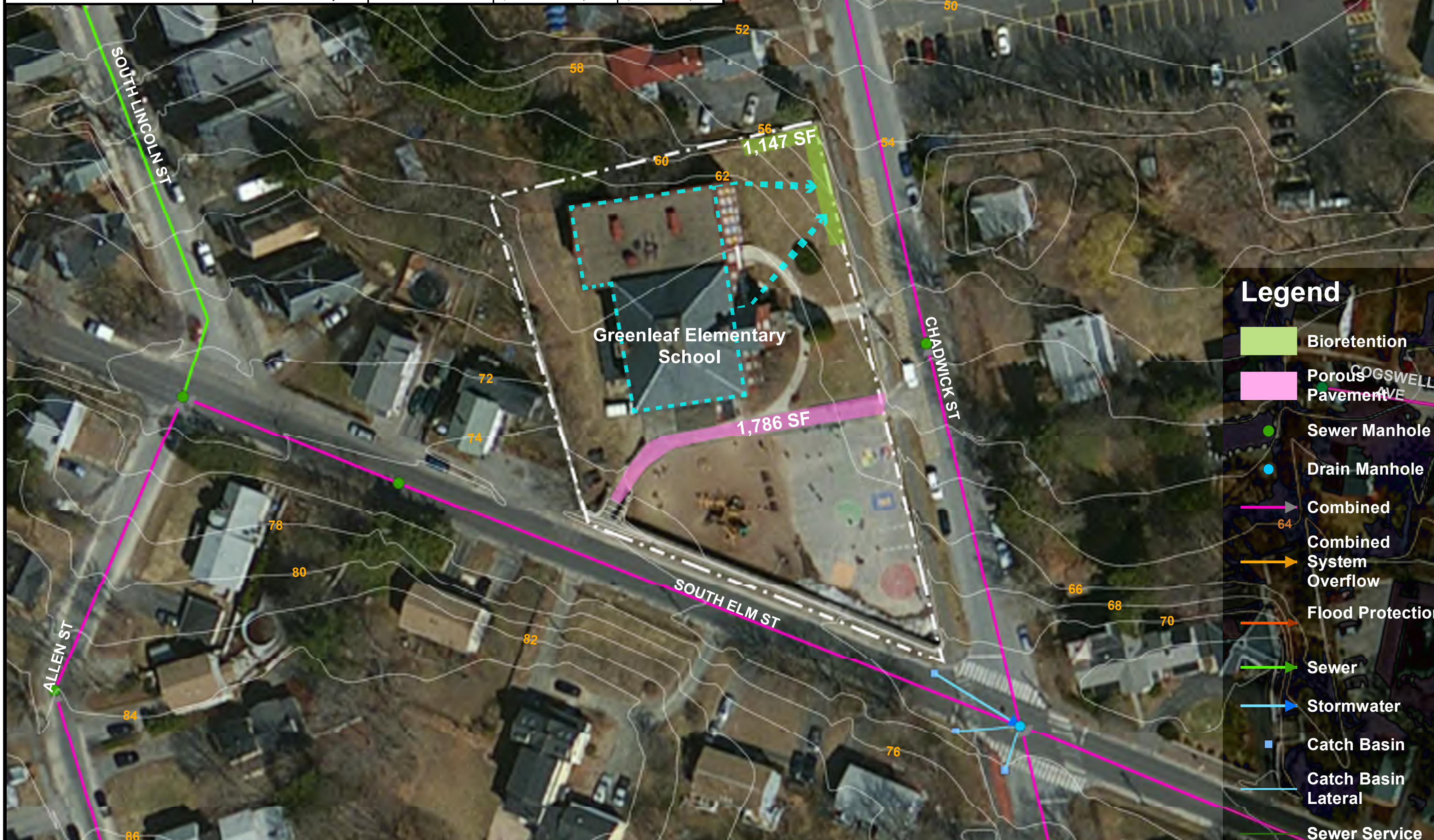
The total volume of the first 1-inch of runoff managed by GI on this site is approximately 1.27 acres, which would reduce annual CSO by about 0.05 MG. The estimated cost to install GI at this site is $256,000. Average cost per acre managed on this site is approximately $202,000.

6.0 Conclusion

Twelve sites within the combined sewer areas were considered for potential GI installation to benefit CSO control. The types of GI that could be implemented, the combined sewer area that could be managed, the annual CSO discharge reduction and installation cost was determined for each site. Based on this study the city will evaluate and pick the best representative projects based on the budget.

cc: [Click here to enter name]

Greenleaf Elementary School					
Type of GI Practice	Area of GI Practice (SF)	Calculated Volume of 1" Runoff Managed (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	1,147	1,707	0.47	$ 66,526	$ 141,545
Porous Pavement	1,786	1,377	0.39	$ 77,691	$ 199,208
TOTALS:		3,083	0.86	$ 144,000	$ 167,000

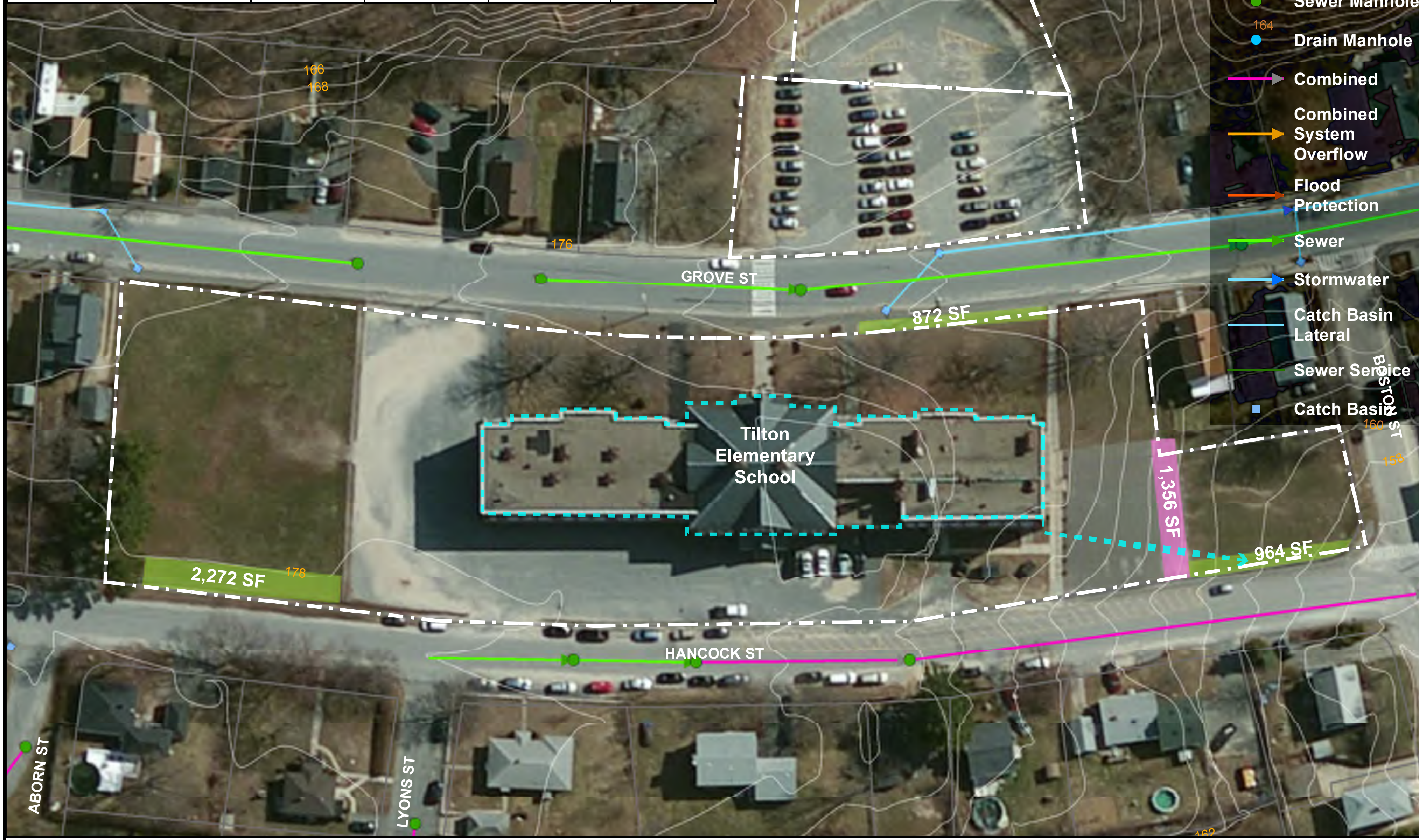


CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Greenleaf Elementary School

Tilton Elementary School

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	4,108	6,055	1.67	$ 238,264	$ 142,673
Porous Pavement	1,356	1,045	0.30	$ 58,986	$ 196,620
TOTALS:	7,100		1.97	$ 297,000	$ 151,000



City of Haverhill, MA
Green Infrastructure Assessment
Tilton Elementary School

Wingate Street Parking Lot

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Porous Pavement	7,932	6,114	1.70	$ 345,042	$ 202,966
TOTALS:		**6,114**	1.70	$ 345,000	$ 203,000

CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Wingate Street Parking Lot

Essex and Locust Street Parking Lots

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Porous Pavement	13,912	10,724	2.98	$ 605,172	$ 203,078
TOTALS:	**10,724**		2.98	$ 605,000	$ 203,000

CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Essex and Locust Street Parking Lots

0 25 50 Feet

N S E W

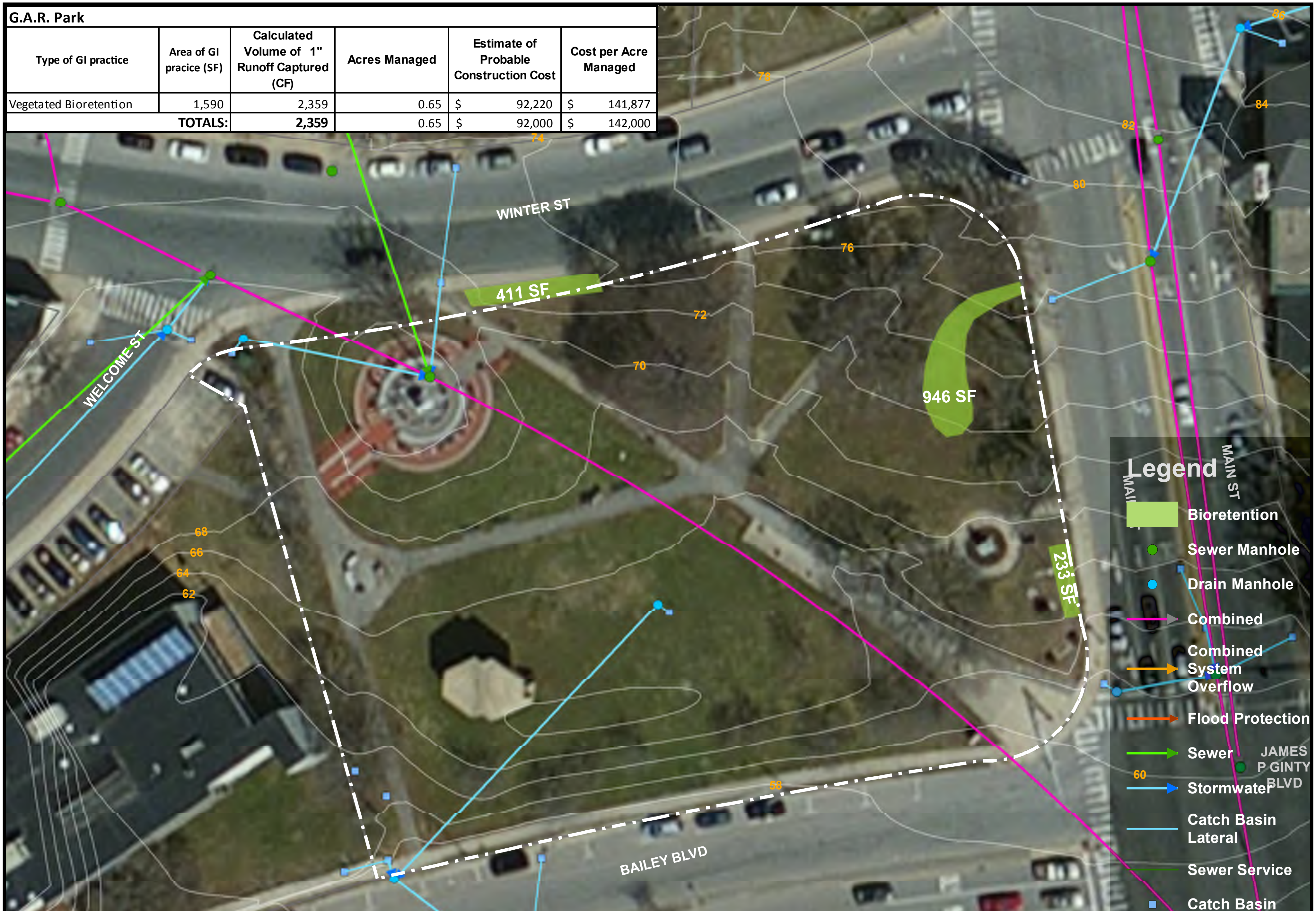
City Hall					
Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	3,414	5,037	1.39	$ 198,012	$ 142,455
Porous Pavement	2,114	1,630	0.46	$ 91,959	$ 199,911
TOTALS:		6,666	1.85	$ 290,000	$ 157,000

CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
City Hall

G.A.R. Park

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	1,590	2,359	0.65	$ 92,220	$ 141,877
TOTALS:		**2,359**	0.65	$ 92,000	$ 142,000



CDM Smith

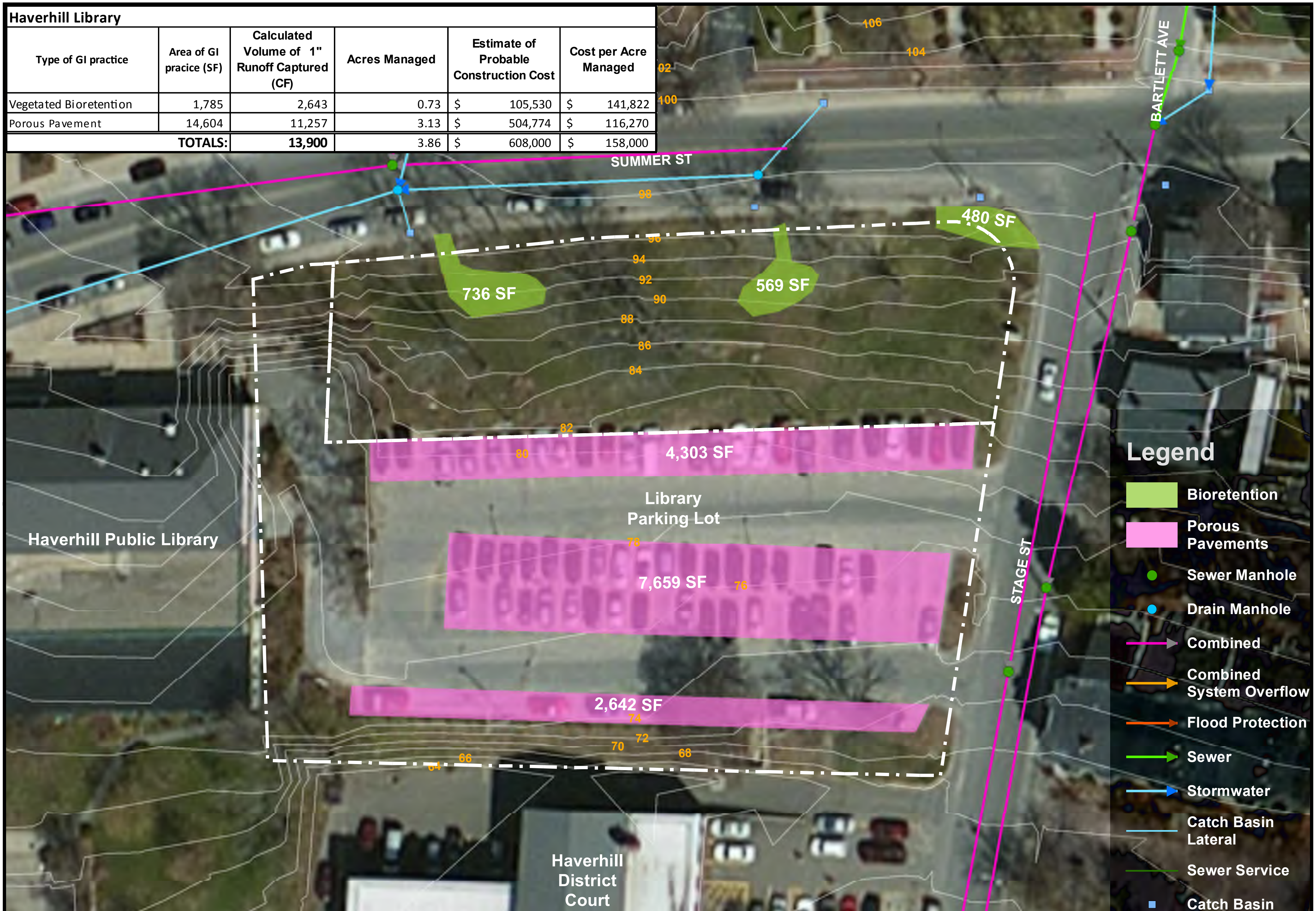
City of Haverhill, MA
Green Infrastructure Assessment
G.A.R. Park

0 25 50 Feet

N W E S

Haverhill Library

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	1,785	2,643	0.73	$ 105,530	$ 141,822
Porous Pavement	14,604	11,257	3.13	$ 504,774	$ 116,270
TOTALS:		13,900	3.86	$ 608,000	$ 158,000



CDM Smith

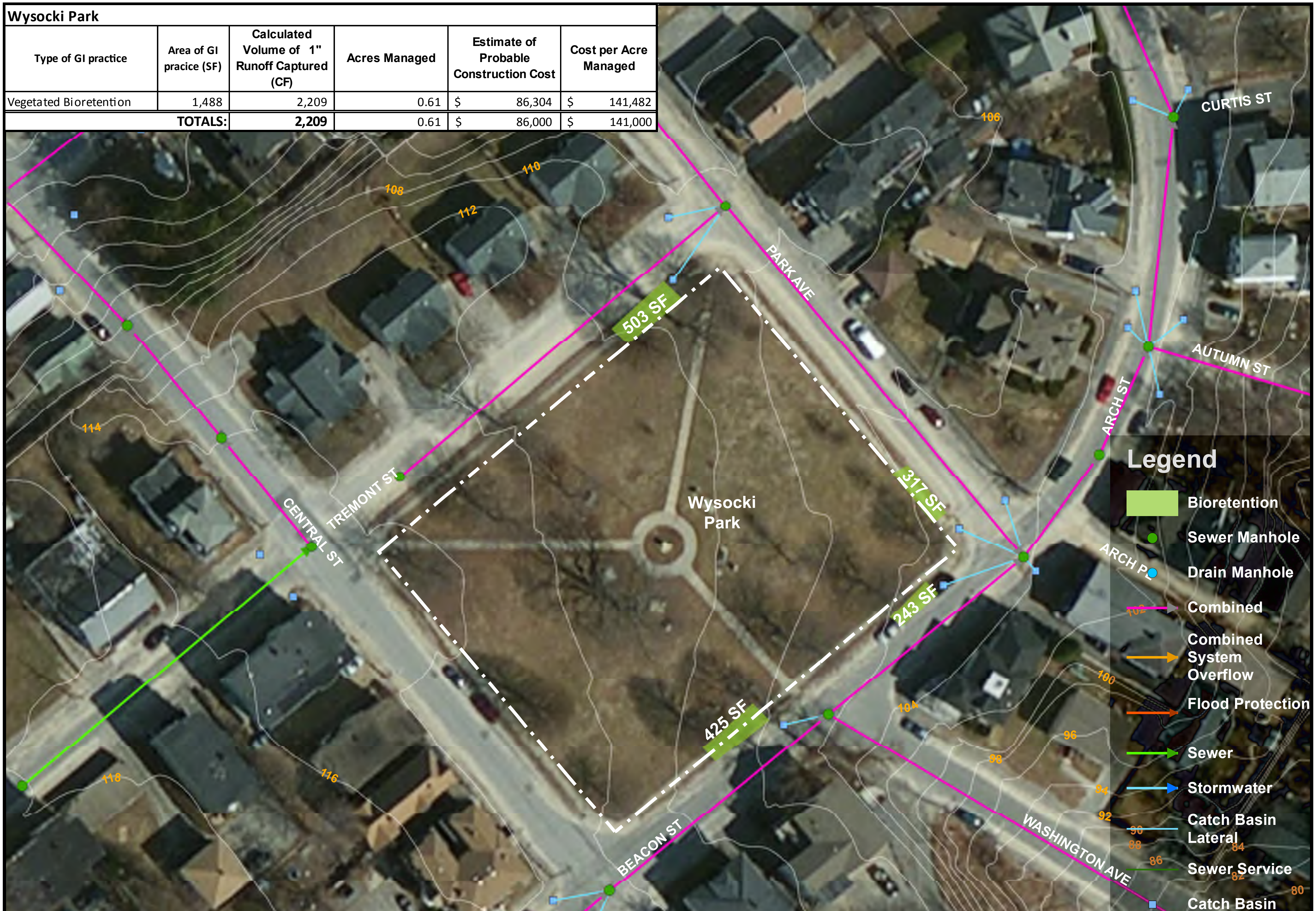
City of Haverhill, MA
Green Infrastructure Assessment
Haverhill Library

0 25 50 Feet

N W E S

Wysocki Park

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	1,488	2,209	0.61	$ 86,304	$ 141,482
TOTALS:		**2,209**	0.61	$ 86,000	$ 141,000



CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Wysocki Park

Ginty Blvd 1

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Bioswale	700	1,136	0.31	$ 152,250	$ 486,422
TOTALS:		**1,136**	0.31	$ 152,000	$ 486,000

CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Ginty Blvd 1

Feet 0 50 100

Ginty Blvd 2

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Bioswale	600	960	0.26	$ 130,500	$ 501,923
TOTALS:		**960**	0.26	$ 131,000	$ 504,000

CDM Smith

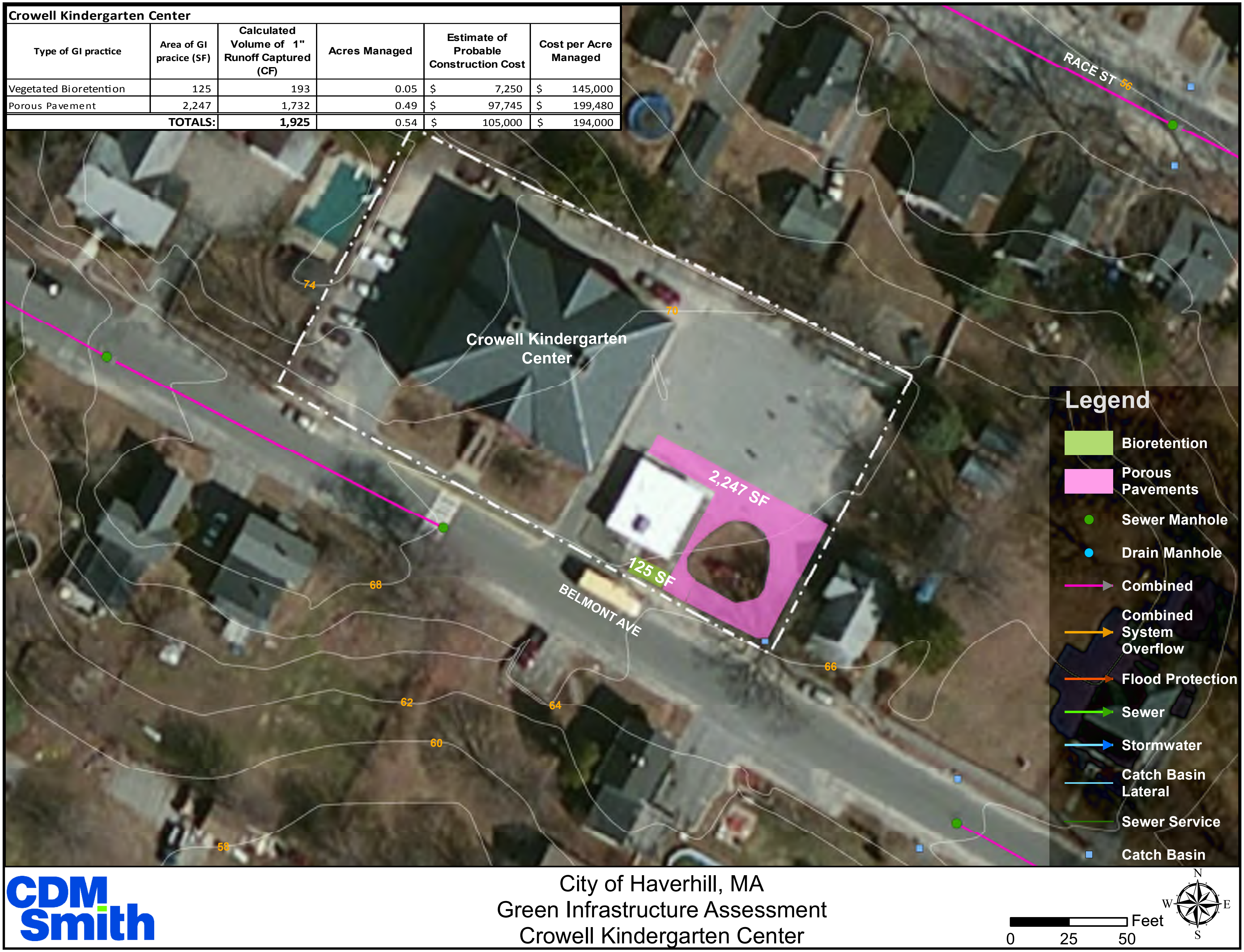
City of Haverhill, MA
Green Infrastructure Assessment
Ginty Blvd 2

Feet
0 50 100

N
W E
S

Crowell Kindergarten Center

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	125	193	0.05	$ 7,250	$ 145,000
Porous Pavement	2,247	1,732	0.49	$ 97,745	$ 199,480
TOTALS:		1,925	0.54	$ 105,000	$ 194,000



CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Crowell Kindergarten Center

Arlington Street and Windsor Place

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Vegetated Bioretention	937	1,397	0.38	$ 54,346	$ 143,016
TOTALS:		**1,397**	0.38	$ 54,000	$ 142,000

CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Arlington St and Windsor Pl

Feet
0 25 50

N
W E
S

Locke Street Parking Lot

Type of GI practice	Area of GI pracice (SF)	Calculated Volume of 1" Runoff Captured (CF)	Acres Managed	Estimate of Probable Construction Cost	Cost per Acre Managed
Porous Pavement	5,882	4,534	1.27	$ 255,867	$ 201,470
TOTALS:		**4,534**	1.27	$ 256,000	$ 202,000

CDM Smith

City of Haverhill, MA
Green Infrastructure Assessment
Locke Street Parking Lot

Memorandum

To: *File*

From: *Milagros Puello, P.E.*

Date: *December 16, 2016*

Subject: *Haverhill, MA*
Final CSO Long-Term Control Plan
Satellite Storage and Treatment Facility Site Evaluation

Introduction

As part of the Final CSO Long-Term Control Plan a siting evaluation was performed to identify available sites for potential satellite treatment/storage facilities in Haverhill. In general, satellite facilities are most effective if they can be constructed within close proximity to a regulator structure to capture overflows as they occur and to take advantage of existing regulating structures to divert overflows to the satellite facility and minimize new piping and pumping requirements.

Haverhill has 15 active CSO regulators in its CSO system. Some CSO regulator location did not have an available site or the area required to reach a level of control. Other regulators discharged small CSO volume that constructing satellite facility did not make economic sense and were not considered. Other CSO control technologies were considered for these CSO regulators during alternatives evaluation.

Locke Street Center Barrel CSO, Middle Siphon CSO and Upper Siphon CSO do have sites available to accommodate a satellite facility. A forth site, Haverhill Paperboard Company, was also identified to potentially locate a treatment facility near the influent pumping station. The sites identified vary in size and were primarily selected for their proximity to the CSO regulators or nearby to large interceptor/collector pipes.

Middle Siphon and Upper Siphon site information is based on a site analysis that was performed for the Phase I CSO LTCP Report. (March 2000) It included location, area, ownership, elevation, zoning, site access and traffic, current land use, surrounding land use, environment and historic features information for each site. The Locke Street and Haverhill Paperboard Company site are newly identified sites. The same information that was included in the March 2000 site analysis was obtained for these site. Their information is based on data (datalayers) obtained from MassGIS and field investigations. Also based on MassGIS, information included in the 2000 analysis was updated as necessary.

A detailed analysis of the four sites is included below.

Locke Street Center Barrel CSO (Locke Street Storage Facility)

Location

The Locke Street storage facility site is located on Locke, Orchard and Locust Street, see attached Figure 1. The site is made up of four properties: (#1) 304-59-10, (#2)304-59-13, (#3) 304-59-11 and (#4)304-59-12.

Area

The total site area is about 1 acre.

Ownership

- Property #1 is owned by BC Walnut Street LLC and it is valued at $145,200 (based on MA Assessors GIS Layer).
- Property #2 is owned by BC Haverhill Lofts LLC and it is valued at $128,400 (based on MA Assessors GIS Layer).
- Property #3 is owned by 64 Locust Street Realty and it is valued at $108,800 (based on MA Assessors GIS Layer).
- Property #4 is owned by Krueger, LLP and it is valued at $102,500 (based on MA Assessors GIS Layer).

Elevation

The elevation of the overall site varies from 24 to 34 feet (NGVD29).

Zoning

This site is located in the CC-Commercial Central District.

Site Access and Traffic

Access to the property is obtained via Locke, Orchard and Locust Street. Construction activities should not impact local traffic and neighborhoods, although parking availability in the parking lots may be no be available during construction. Vehicle traffic to the facility after construction should not impact the neighborhood.

Current Land Use

Two of the properties are currently used as parking lots for apartment building across the street. Another is a storage yard and the fourth property has a one level building occupied by a liquor store.

Surrounding Land Used

In the vicinity of the site area there are residential, commercial, and industrial establishments. These establishments include a food market, motorcycle repair shop and an apartment complex.

Environment

There are no wetlands on or near this site, and the site does not fall within the 200-foot buffer zone to the Merrimack River established by the Riverfront Act.

According to the Federal Emergency Management Agency (FEMA) flood maps, the site does not fall within the 100-year flood zone.

According to the Massachusetts Department of Environmental Protection (MA DEP)-Tier Classified Oil and/or Hazardous Material Sites datalayer the site nor any of its abutters is not a hazardous waste site.

There are no endangered species habitats within this site as indicated by the National Heritage and Endangered Species Program datalayers (NHESP Priority Habitats of Rare Species, NHESP Estimated Habitats of Rare Wildlife and NHESP Certified Vernal Pools).

The site is not a protected or recreational open space.

Historic Features

According to the Massachusetts Cultural Resource Information System (MCRIS) datalayer the site does not contain items of historic interest. A project notification forms will be submitted to the Massachusetts Historical Commission (MHC) requesting their review of the proposed work at the site to make any further determination regarding the impacts to historical and archaeological sensitive resources.

Middle Siphon CSO (Middle Siphon Storage Facility)

Location

The Middle Siphon storage facility is located in the municipal parking lot next to the United States Post Office in Washington Square, see attached Figure 2. The site is made up of two properties: (#1) 308-1-1 and (#2) 308-1-10.

Area

The site is about 1 acre, but only portion of the site can be used, the Middle Siphon Interceptor (42-inch x 54-inch pipe) runs north to south through the east side of the site.

Ownership

Both properties are owned by the City of Haverhill.

Elevation

The elevation of the overall site varies from 18 to 24 feet (NGVD29).

Zoning

This site is located in the CC-Commercial Central District.

Site Access and Traffic

Access to the property is obtained directly from Washington Square. Project activities would impact the use of the parking lot and limit the availability of parking during construction activities. Both vehicle and pedestrian traffic in the Washington Square area may be affected by construction related vehicles traveling in and out of the site area. Vehicle traffic to the facility after construction should not impact the neighborhood.

Current Land Use

The potential facility location at this site is consists of a paved parking lot that services the downtown Washington Square area. There is a Merrimack Valley Regional Transit Authority (MVRTA) bus terminal adjacent to the site. The Marginal Sewer Pumping Station is located to the south of the proposed site area.

Surrounding Land Used

The site area is surrounded by commercial properties. A United States Post Office directly abuts the site to the east while several multi-level commercial/residential buildings lie to the north and west of the site. These buildings include a six-story senior housing complex (Bethany Homes) and a four-story commercial/industrial building to the west, and a commercial music center to the northwest of the site. Numerous commercial establishments are located on the opposite site of Washington Square to the north of the site including the Haverhill Housing Authority, law offices, and a Bank of America building.

Environment

No Wetlands were observed on the site, however, the site does border the Merrimack River, and would fall within the 200' buffer zone established by the Riverfront Act. Additionally, a part of the site falls within the 50-foot no disturb zone set by the Haverhill Conservation Commission.

According to the Federal Emergency Management Agency (FEMA) flood maps, the site is not located within the 100-year flood zone.

According to the Massachusetts Department of Environmental Protection (MA DEP)-Tier Classified Oil and/or Hazardous Material Sites datalayer, the site is not a hazardous waste site. None of the abutters to the site are hazardous waste sites.

There are no endangered species habitats within this site as indicated by the National Heritage and Endangered Species Program datalayers (NHESP Priority Habitats of Rare Species, NHESP Estimated Habitats of Rare Wildlife and NHESP Certified Vernal Pools).

The site is not a protected or recreational open space.

Historic Features

According to the Massachusetts Cultural Resource Information System (MCRIS) datalayer two sites of historic interest are located near Middle Siphon CSO: The U. S. Post Office - Haverhill Main Branch, Inventory No. HVR.249, located at 2 Washington Square and the Washington Square Comfort Station, Inventory No. HVR.248, located at 10 Washington Square. A project notification forms will be submitted to the Massachusetts Historical Commission (MHC) requesting their review of the proposed work at the site to make any further determination regarding the impacts to historical and archaeological sensitive resources.

Upper Siphon CSO (Upper Siphon Storage Facility)

Location

The Middle Siphon storage facility is located in a parking lot on the south side of River Street adjacent to the Merrimack River and between 266 and 306 River Street, see attached Figure 3. The site is made up of two properties: (#1) 503-227-3 and (#2) 503-227-3A.

Area

The total site area is about 2 acres.

Ownership

- Site #1 is owned by Three Two Four River Trust and it is valued at $215,100 (based on MA Assessors GIS Layer).

- Site #2 is owned by J.V. Hostetter Family, LLC and it is valued at $195,100 (based on MA Assessors GIS Layer).

Elevation

The elevation of the overall site varies from 6 to 26 feet (NGVD29).

Zoning

This site is located in the IG -Industrial General District.

Site Access and Traffic

Access to the property is obtained directly from River Street. Construction activities should not impact local traffic and neighborhood. Vehicle traffic to the facility after construction should not impact the neighborhood.

Current Land Use

The site is presently an underutilized parking lot.

Surrounding Land Used

The site area is abutted by the Merrimack River to the south. A Toyota car dealership is located directly west of the site and a 4-story industrial/commercial building lies to the east. Two commercial buildings and one industrial building (Pope Machine) are across River Street to the north of the site.

Environment

No Wetlands were observed on the site, however, the site does border the Merrimack River, and would fall within the 200' buffer zone established by the Riverfront Act. Additionally, a part of the site falls within the 50-foot no disturb zone set by the Haverhill Conservation Commission.

According to the Federal Emergency Management Agency (FEMA) flood maps, the site is located within the 100-year flood zone. The flood elevation for the site is about 24 feet (NGVD29).

According to the Massachusetts Department of Environmental Protection (MA DEP)-Tier Classified Oil and/or Hazardous Material Sites datalayer, the site is not a hazardous waste site. None of the abutters to the site are hazardous waste sites either.

The National Heritage and Endangered Species Program datalayers (NHESP Priority Habitats of Rare Species, NHESP Estimated Habitats of Rare Wildlife and NHESP Certified Vernal Pools) shows that part of the site is within endangered species habitats.

The site is not a protected or recreational open space.

Historic Features

According to the Massachusetts Cultural Resource Information System (MCRIS) datalayer two sites of historic interest are located adjacent to Upper Siphon CSO: The Westerly Shoe Manufacturing Factory (demolished), Inventory No. HVR.288, located at 306 River Street and the Thom's Building, Inventory No. HVR.195, located at 266 River Street. A project notification forms will be submitted to the Massachusetts Historical Commission (MHC) requesting their review of the proposed work at the site to make any further determination regarding the impacts to historical and archaeological sensitive resources.

Haverhill Paperboard Company (WWTP Treatment Facility)

Location

The Haverhill Paperboard Company site is located on South Kimball St., see attached Figure 4. The site is on property 728-708-2.

Area

The total site area is about 21 acres.

Ownership

The site is owned by Barrow Development Group and it is valued at $3,690,900 (based on MA Assessors GIS Layer).

Elevation

The elevation of the overall site varies from 6 to 28 feet (NGVD29).

Zoning

This site is located in the IG -Industrial General District.

Site Access and Traffic

Access to the property is obtained directly from South Kimball Street. Construction activities should not impact local traffic and neighborhood. Vehicle traffic to the facility after construction should not impact the neighborhood.

Current Land Use

It is the former site of the Haverhill Paperboard Company which closed in 2008. Buildings on the property (shown on Figure 4) have been demolished and now is a vacant lot.

Surrounding Land Used

The site area is abutted by the Merrimack River and the influent pumping station to the north, a residential neighborhood to the southwest, a commercial building to the west and the WWTP to the east.

Environment

No Wetlands were observed on the site, however, the site does border the Merrimack River, and would fall within the 200' buffer zone established by the Riverfront Act. Additionally, a part of the site falls within the 50-foot no disturb zone set by the Haverhill Conservation Commission.

According to the Federal Emergency Management Agency (FEMA) flood maps, the site is located within the 100-year flood zone. The flood elevation for the site is about 24 feet (USGS).

According to the Massachusetts Department of Environmental Protection (MA DEP)-Tier Classified Oil and/or Hazardous Material Sites datalayer, the site is not a hazardous waste site. None of the abutters to the site are hazardous waste sites either.

The National Heritage and Endangered Species Program datalayers (NHESP Priority Habitats of Rare Species, NHESP Estimated Habitats of Rare Wildlife and NHESP Certified Vernal Pools) shows that part of the site is within endangered species habitats.

The site is not a protected or recreational open space.

Historic Features

According to the Massachusetts Cultural Resource Information System (MCRIS) datalayer the Haverhill Paperboard Company building (Inventory No. HVR.193) was a point of historical (architectural, commercial and industrial) interest. The building was demolished in 2012. A project notification forms will be submitted to the Massachusetts Historical Commission (MHC) requesting their review of the proposed work at the site to make any further determination regarding the impacts to historical and archaeological sensitive resources.

cc: [Click here to enter name]

City of Haverhill, Massachusetts
Final CSO Long-Term Control Plan
January 2017

Locke Street Storage/Treatment Facility Site
Figure 1

0 30 60
Feet

City of Haverhill, Massachusetts
Final CSO Long-Term Control Plan
January 2017

Middle Siphon Storage/Treat Facility Site
Figure 2

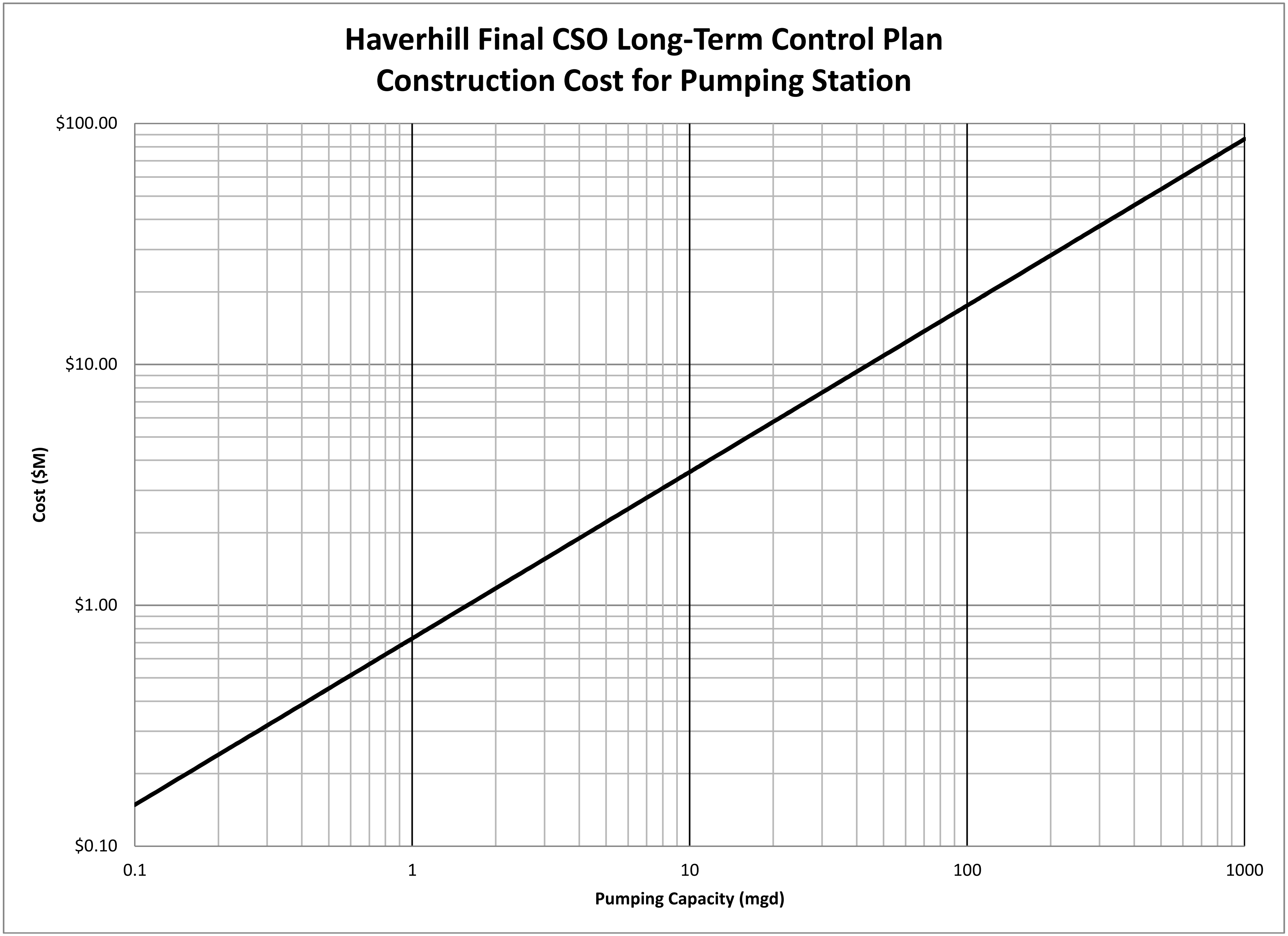
0 30 60 Feet

City of Haverhill, Massachusetts
Final CSO Long-Term Control Plan
January 2017

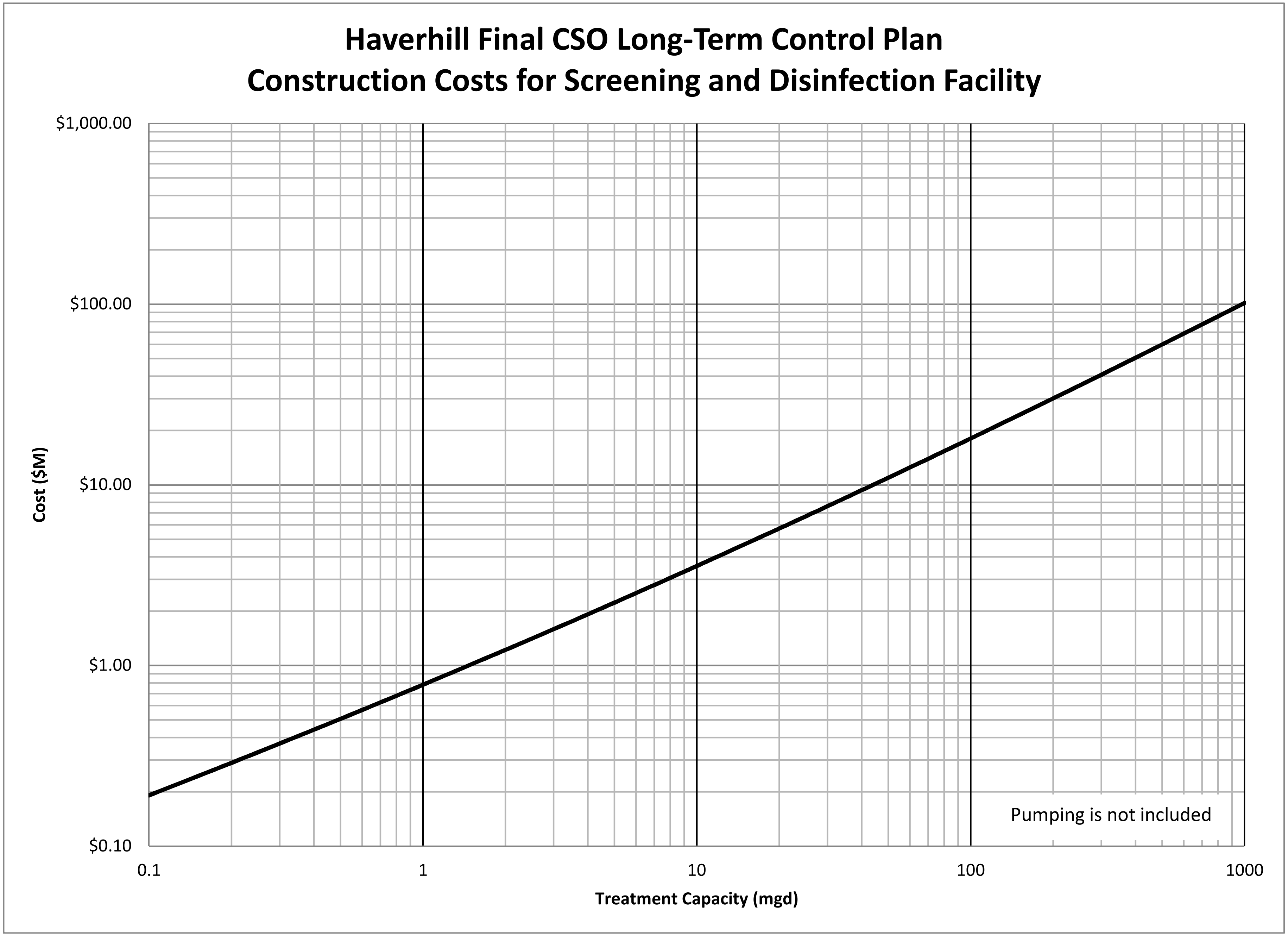
Upper Siphon Storage/Treatment Site
Figure 3

City of Haverhill, Massachusetts
Final CSO Long-Term Control Plan
January 2017

Haverhill Paperboard Company Treatment Facility Site
Figure 4

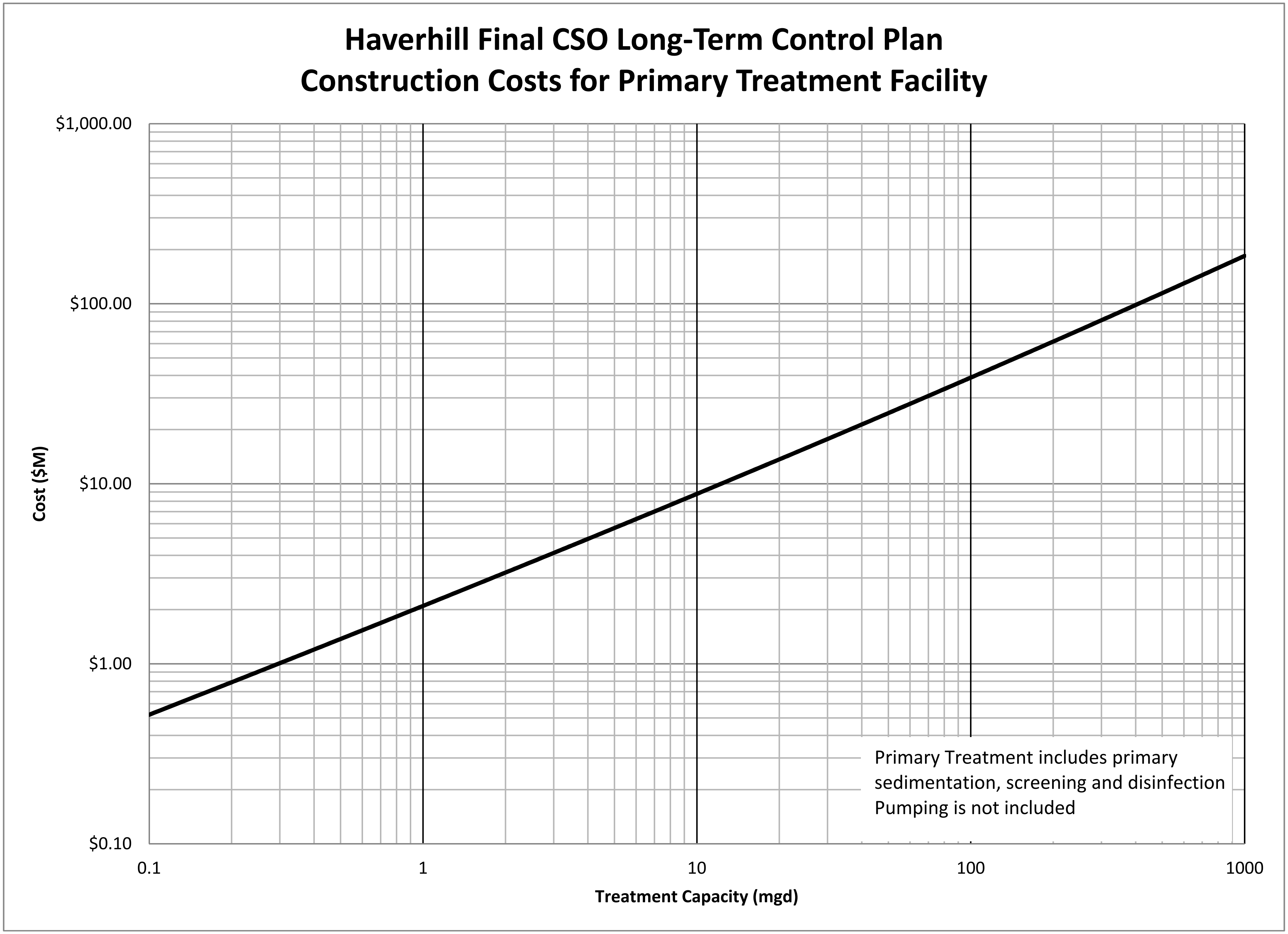

Haverhill Final CSO Long-Term Control Plan
Construction Cost for Pumping Station
$100.00
$10.00
$1.00
$0.10
Cost ($M)
0.1
1
10
100
1000
Pumping Capacity (mgd)

2/9/2017



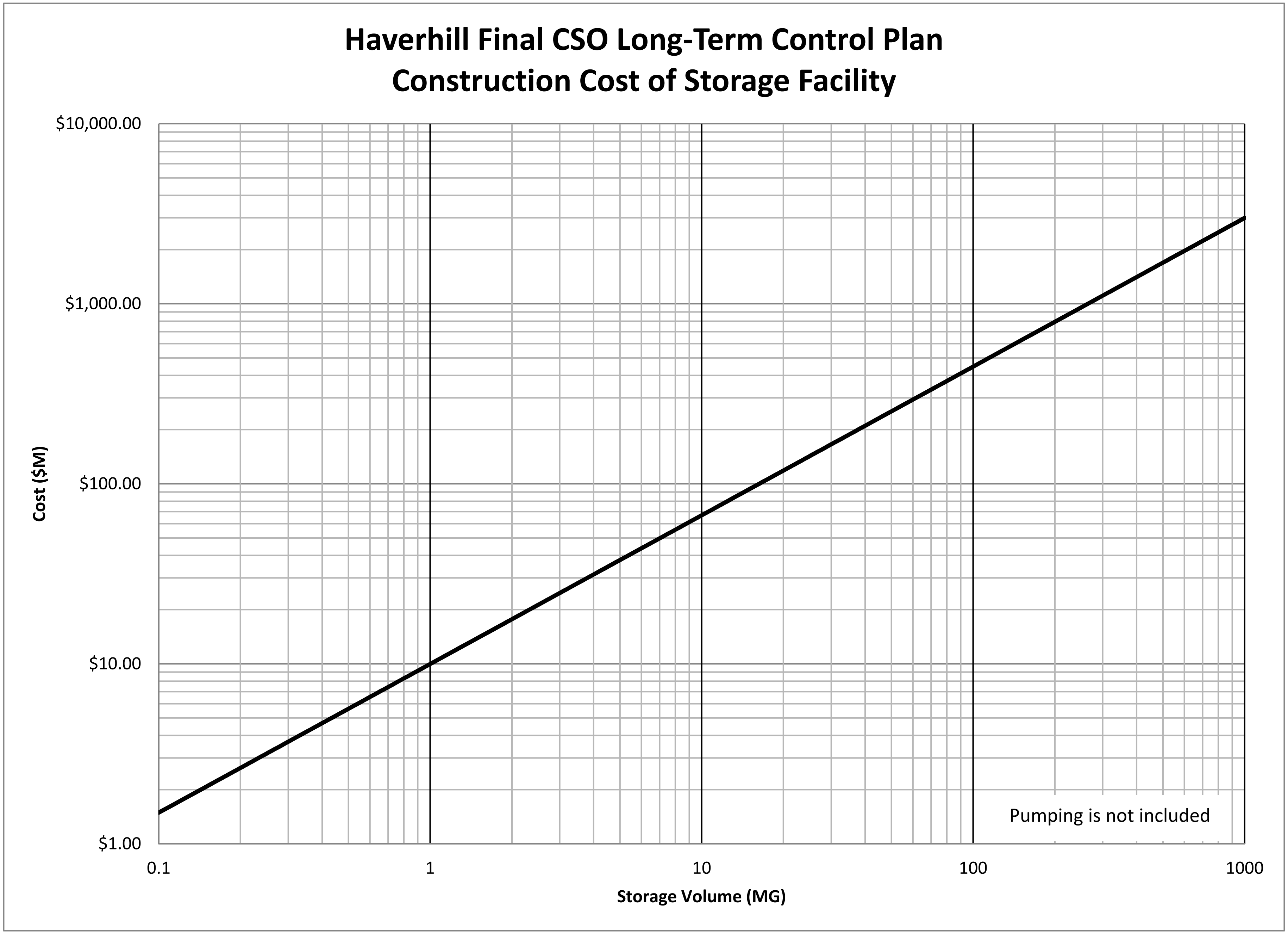
Haverhill Final CSO Long-Term Control Plan
Construction Costs for Screening and Disinfection Facility
$1,000.00
$100.00
$10.00
$1.00
$0.10
Cost ($M)
0.1
1
10
100
1000
Treatment Capacity (mgd)
Pumping is not included

2/9/2017

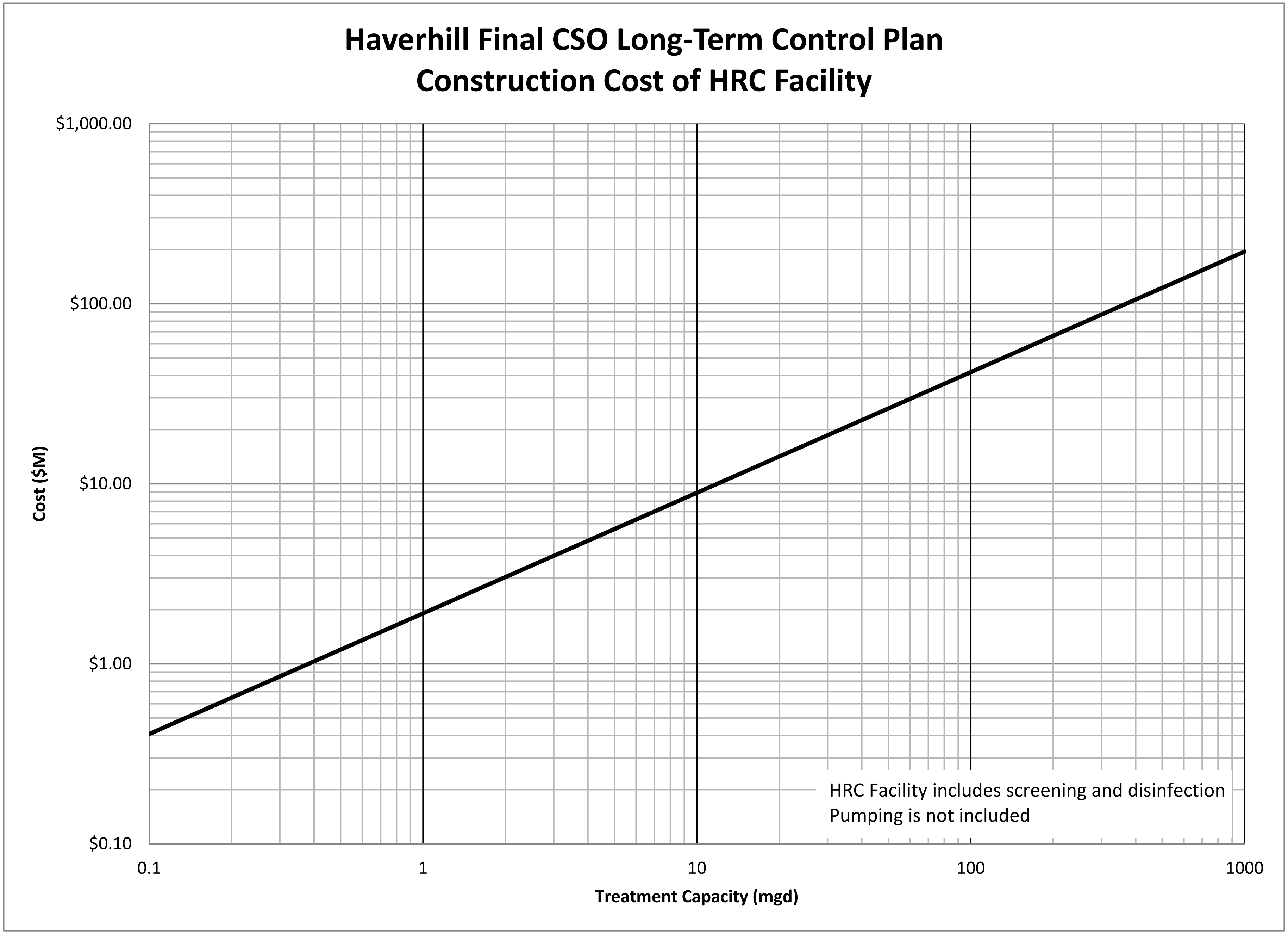


Haverhill Final CSO Long-Term Control Plan
Construction Costs for Primary Treatment Facility
$1,000.00
$100.00
$10.00
$1.00
$0.10
Cost ($M)
0.1
1
10
100
1000
Treatment Capacity (mgd)
Primary Treatment includes primary
sedimentation, screening and disinfection
Pumping is not included

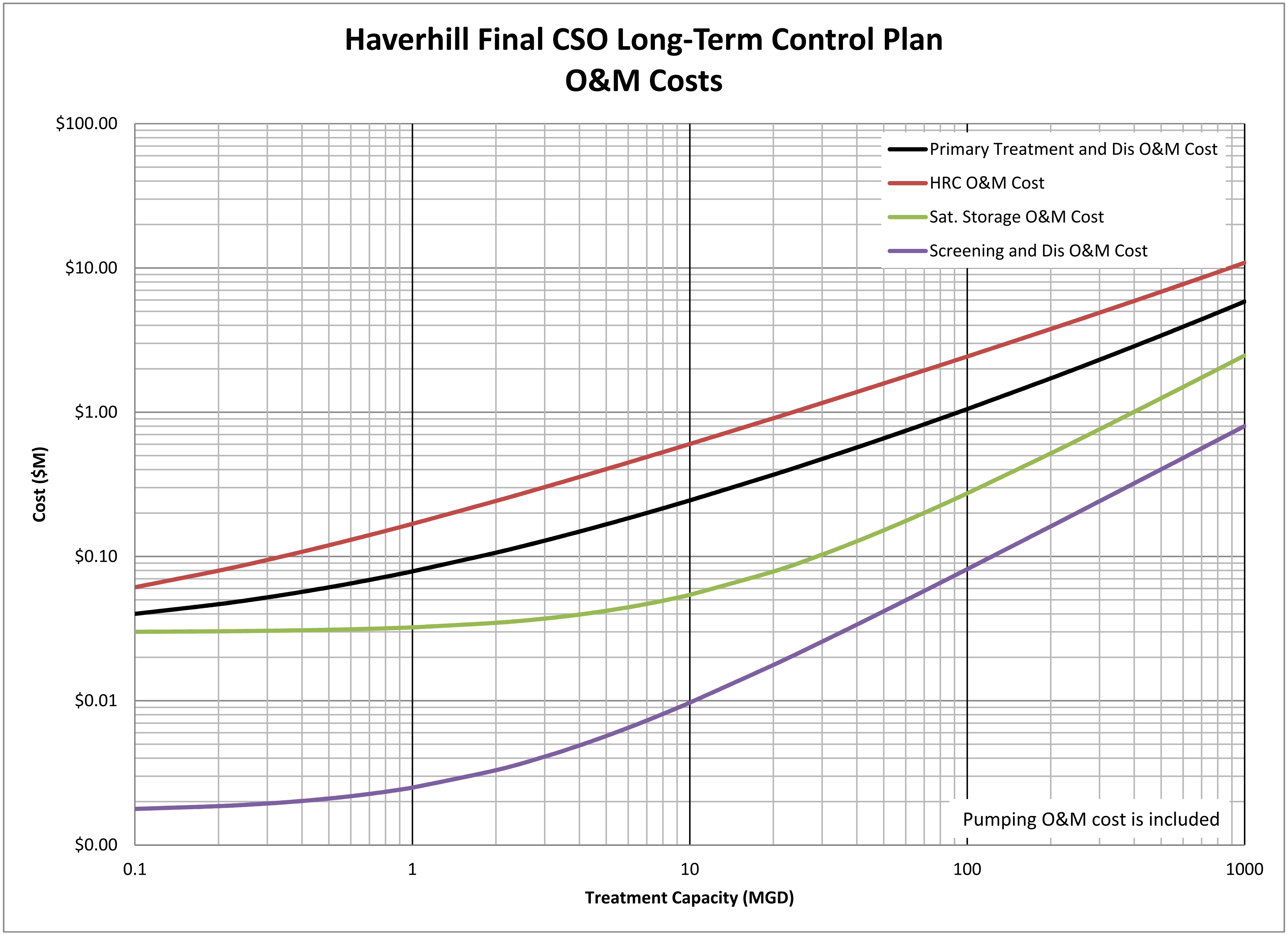
2/9/2017


Haverhill Final CSO Long-Term Control Plan
Construction Cost of Storage Facility
$10,000.00
$1,000.00
$100.00
$10.00
$1.00
Cost ($M)
0.1
1
10
100
1000
Storage Volume (MG)
Pumping is not included

2/9/2017


Haverhill Final CSO Long-Term Control Plan
Construction Cost of HRC Facility
$1,000.00
$100.00
$10.00
$1.00
$0.10
Cost ($M)
0.1
1
10
100
1000
Treatment Capacity (mgd)
HRC Facility includes screening and disinfection
Pumping is not included

2/9/2017


Haverhill Final CSO Long-Term Control Plan
O&M Costs
$100.00
$10.00
$1.00
$0.10
$0.01
$0.00
Cost ($M)
0.1
1
10
100
1000
Treatment Capacity (MGD)
Primary Treatment and Dis O&M Cost
HRC O&M Cost
Sat. Storage O&M Cost
Screening and Dis O&M Cost
Pumping O&M cost is included

2/9/2017

cdmsmith.com