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REPORT

May 2019

CITY OF
Fitchburg
MASSACHUSETTS

Combined Sewer Overflow Long-Term Control Plan

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EXECUTIVE SUMMARY

In 2012, the City of Fitchburg entered into a Consent Decree (CD) with the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP). As specified by the CD, the City is required to submit a Wastewater Management Plan (WMP) that addresses the following parameters.

- An itemized schedule of construction of facilities needed to meet a seasonal phosphorus concentration limit of 0.2 mg/L and a seasonal total phosphorus mass-based limit of 20.7 lb./day.
- An itemized schedule for investigation, rehabilitation, and construction work required for the collection system to meet the CSO conditions in the NPDES Permit by the end of 2030.

As part of the WMP, the City is submitting this Combined Sewer Overflow (CSO) Long-Term Control Plan (LTCP) to identify the CSO controls necessary to comply with state/federal water quality standards and their NPDES Permit.

EPA developed a CSO Control Policy in 1994 to address negative water quality impacts resulting from CSO discharges. The policy requires the implementation of EPA's Nine Minimum Controls (NMC) and the development of a CSO LTCP (EPA, *CSO Control Policy; Notice*, 1994). As specified in EPA's *Combined Sewer Overflow Guidance for Long-Term Control Plan* Report, a CSO LTCP should contain the following:

1. Conduct monitoring, modeling, and other tasks to create a strong background of the combined sewer system's performance.
2. Create an outlet for public participation to select appropriate CSO controls.
3. Identify environmentally and socially sensitive areas that are negatively impacted by CSOs.
4. Identify and evaluate various CSO control alternatives that will enable compliance with water quality standards.
5. Develop a cost analysis of the CSO control alternatives.
6. Update and revise the City's operation and maintenance plan to include the new CSO control alternatives.
7. Identify opportunities to maximize treatment capacity at the publicly owned treatment facility.
8. Create a schedule to implement the CSO control alternatives.
9. Develop a post-construction monitoring plan (PCMP) to verify all CSO controls have been successfully implemented.

EPA's CSO Control Policy specifies that adherence to water quality standards can be achieved through either the "Demonstration Approach" or "Presumption Approach" (EPA, *CSO Control Policy; Notice*, 1994). Since the North Nashua River does not have a finalized total maximum daily load (TMDL) to allocate pollutant concentrations in CSO discharges, the City of Fitchburg can achieve compliance through the Presumption Approach. Compliance through the Presumption Approach can be achieved through one of the following three requirements:

1. A maximum of four (4) overflows per year.
2. The capture and treatment of at least 85% of combined sewage during rain events.
3. The successful treatment of pollutants causing water quality issues through clarification, solids removal, and disinfection.

In addition to water quality standards set by EPA, MassDEP developed *Guidance for Abatement of Pollution from CSO Discharges* in 1997. The report specifies the following CSO discharge requirements for waterbody classifications:

- Class B/SB: CSOs are eliminated from the system.
- Class B (CSO): CSOs are not eliminated but are compliant with water quality standards.
- Variance: CSO mitigation is not completed through a modification of water quality standards.
- Partial Use Designation: CSO mitigation is not completed through a modification of water quality standards.
- Class C: CSO mitigation is not conducted, resulting in permanent water quality impairments.

Fitchburg's CSO overflows discharge to the Nashua River and other tributary waterbodies, which are all Class B waterbodies. As a result, all CSOs are required to be eliminated from the City to meet Class B waterbody requirements (MassDEP, *Guidance for Abatement of Pollution from CSO Discharges*, 1997).

FITCHBURG'S COMBINED SEWER SYSTEM

The combined sewer system in Fitchburg spans around 8.4 miles, and accounts for approximately 6% of the entire wastewater collection system. The combined system collects both stormwater and wastewater and contains 11 CSO regulator manholes that discharge to the North Nashua River, Punch Brook, Birch Brook, and Falulah Canal during wet-weather events. Wastewater treatment occurs at the Easterly Wastewater Treatment Facility (EWWTF), where treated effluent is discharged to the North Nashua River under the City's 2010 NPDES Permit. During wet-weather events, the EWWTF utilizes a chemically enhanced primary treatment (CEPT) process and operates a secondary system bypass.

Since the implementation of CSO mitigation projects in 1995, the City has separated over 10 miles of combined sewers and closed 47 CSO regulators through multiple sewer separation projects. The remaining CSO regulators overflow during wet-weather events and are predicted to discharge an estimated 16.3 million gallons during the five-year, 24-hour storm event (Wright-Pierce, *Capacity Assessment Report,* 2018). Fitchburg intends to remove the remaining CSO regulators from the combined sewer system to achieve water quality standards.

EPA'S WATERSHED BASED APPROACH

EPA's *Combined Sewer Overflows Guidance for Long-Term Control Plan* recommends using a Watershed Based Approach when developing a CSO LTCP. The approach uses the following tasks to identify potential sources of pollutants causing impairments across an entire watershed instead of a single location.

1. Define baseline and delineate watershed.
2. Identify and notify stakeholders.
3. Develop water quality goals.
4. Identify areas of non-attainment and other water quality concerns.
5. Identify CSO and non-CSO sources of pollution causing concerns.
6. Develop corrective action plan and/or TMDL.
7. Evaluate, select, and implement CSO and non-CSO controls.
8. Assess effectiveness.

MassDEP identifies that the North Nashua River is impaired for Escherichia coli (E. coli) caused by combined sewer overflows and illicit connections. It is important to note that a Nashua River Watershed Association (NRWA) sampling location (NN3071) located upstream of all CSO regulators still has sampling results that exceed state water quality standards for E. coli. In addition, sections of the Nashua River downstream of the North Nashua River have E. coli impairments. Other non-CSO pollutants of concern include impairments in the North Nashua River identified by aquatic macroinvertebrate bioassessments and ambient bioassays. In addition, the Nashua River is impaired for total phosphorus levels, however, Fitchburg has been adhering to interim discharge limits for phosphorus at the Easterly Wastewater Treatment Facility (EWWTF) as imposed by the CD.

To comply with state/federal water quality standards and assist in the reduction of the E. coli in the North Nashua River, additional CSO controls are planned for implementation in Fitchburg. MassDEP requires that municipalities must implement EPA's NMC and perform sewer separation as the primary CSO control method, unless proven to have "substantial and widespread social and economic impacts" (MassDEP, *Guidance for Abatement of Pollution from CSO Discharges*, 1997).

EPA'S NINE MINIMUM CONTROLS

EPA's NMC are CSO controls that are implemented to reduce the impacts of CSO discharges into a receiving waterbody. The controls are documented in EPA's *Combined Sewer Overflows Guidance for Nine Minimum Controls* and are listed below (EPA, *Combined Sewer Overflows Guidance for Nine Minimum Controls*, 1995).

1. Proper operation and regular maintenance programs for the sewer system and CSO outfalls.
2. Maximum use of the collection system for storage.
3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized.
4. Maximization of flow to the publicly owned treatment works (POTW) for treatment.
5. Elimination of CSOs during dry weather.
6. Control of solid and floatable materials in CSOs.
7. Pollution prevention programs to reduce contaminants in CSOs.
8. Public notification to ensure that the public received adequate notification of CSO occurrences and CSO impacts.
9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

The NMC are required under EPA's CSO Control Policy and the City's NPDES Permit. The City of Fitchburg has been actively working to fulfill the requirements of the NMC. To achieve compliance with the CSO Control Policy and their NPDES Permit, the City intends to optimize their wastewater collection system capacity by investigating the options available to adjust pump station discharges and water treatment plant backwash operations to mitigate discharges during wet weather events. The City also intends to implement a more aggressive catch basin cleaning program to achieve greater functionality during wet weather events. Lastly, the City intends to investigate developing a public notification system for CSO events.

EVALUATION OF SEWER SEPARATION

The City has already initiated the next prioritized sewer separation project – The CSO 039, 048, and Clarendon Street Sewer Separation Project. As part of this project, as many as 4,700 linear feet (LF) combined sewers will be separated, along with 20,400 LF of additional sanitary sewer rehabilitation/replacement. The project will also include the closure of CSO regulators 007, 039, and 048. The table below documents the remaining combined sewers to be separated in the City. CSO 007, 039, and 048 are not included in the table because the project is currently ongoing. Additional sewers have been included in the table below to account for unknown combined sewers identified during the investigation phases of each sewer separation project.

Remaining Combined Sewers				
CSO Regulator	Combined Sewer Length (LF)	Number of Services	Number of Catch Basins	Number of Combination Manholes
004	3,500	55	4	39
010	5,800	89	33	7
032	4,700	70	20	0
041*	0	0	0	0
045	14,800	149	83	4
064**	9,150	163	60	58
076*	0	0	0	21
083	2,300	23	17	0

Note:

*CSO 041 and 076 have no tributary combined sewers. Upsizing sewers downstream of each regulator will be required prior to regulator closure.

**Portions of the combined sewers tributary to CSO 064 will be separated as part of the CSO 039, 048, and Clarendon Street Sewer Separation Project.

ECONOMIC IMPACTS OF SEWER SEPARATION

EPA's *Economic Guidance for Water Quality Standards* utilizes a five (5) step process to determine if projects will result in widespread economic impacts for a community impacts by water quality projects. The steps are listed on the following page.

1. Verify Project Costs and Calculate the Annual Cost of the Pollution Control Project.
2. Calculate Total Annualized Pollution Control Costs Per Household.
3. Calculate and Evaluate the Municipal Preliminary Screener Score.
4. Apply the Secondary Test.
5. Assess where the community falls in the Substantial Impacts Matrix.

Estimated investigation costs for each separation project include CCTV inspection of sewers, manhole inspections, building inspections, and smoke and dye testing/flooding of the combined and sanitary sewers tributary to each CSO regulator for investigation work. Estimated costs for proposed sewer separation construction work includes the installation of new PVC sewers, PVC building connections and wyes, sanitary sewer manholes, and combination manhole separation. Not included in the costs are any additional sanitary sewer rehabilitation work recommendations based on the findings of the Sewer System Evaluation Summary (SSES) investigation work performed upstream of the CSO regulators. These costs and impacts are representative of sewer separation projects and do not address additional projects that may be imposed by requirements from regulatory agencies and future NPDES permits.

Following EPA's *Economic Guidance for Water Quality Standards*, the proposed sewer separation projects were found to surpass the 1% municipal screener score that estimates the financial impact of the projects on the community. The results are shown in the table below:

Fitchburg Wastewater Costs*	Value
Total Cost of Sewer Separation	$37,895,400
Annualized Sewer Separation Cost (20 Years)	$2,319,200
Current Cost of Pollution Control (2019-2028 Average)	$15,353,180
Adjusted Cost of Pollution Control	$17,672,380
Household Percentage of Cost of Pollution Control (67%)	67%
Number of Households	14,336
Number of Connections	10,127
Cost Per Household	$826
Cost Per Connection	$1,169
Median Household Income (2019-2028 Average)	$57,040
Average Municipal Preliminary Screener Score (Household)	**1.4%**
Average Municipal Preliminary Screener Score (Connection)	**2.0%**

Note:
*Not included in the costs are any additional sanitary sewer rehabilitation work recommendations based on the findings of the investigation work performed upstream of the CSO regulators.

The Municipal Preliminary Screener Score was conducted for both the number of households estimated in sewered areas and the number of connections to provide estimates for the upper and lower bounds of the estimated impact of sewer separation. The number of households impacted by the project is likely greater than the number of sewer connections as multiple households may utilize a single sewer connection. The estimated number of households utilized for the Municipal Preliminary Screener Score is based on the number of units recorded in each parcel within 10 meters of a sewer main. This number is likely an overestimate of the number of households impacted by the separation projects as some units may be vacant.

Since the Municipal Screener Scores exceeded 1%, the next step of EPA's process is to apply the secondary test, which was conducted for the City in Fitchburg's *Wastewater Financial Capability Analysis*. The Analysis concluded that the City has a Secondary Score of 2.67 (Tighe & Bond, *Wastewater Financial Capability Analysis*, 2018). When applying this value in EPA's Substantial Impacts Matrix (shown below), the sewer separation projects were found to not have significant financial impacts on the City. As a result, the City intends to separate the remaining combined sewers.

Secondary Score	Municipal Preliminary Screener Score		
	Less than 1.0%	Between 1% and 2%	Greater than 2%
Less Than 1.5	Unknown Impact	Substantial Impact	Substantial Impact
Between 1.5 and 2.5	No Impact	Unknown Impact	Substantial Impact
Greater Than 2.5	No Impact	No Impact	Unknown Impact

To fully evaluate the economic impacts of sewer separation, the City conducted a more in-depth economic analysis using estimated water usage. After completing the analysis, the estimated wastewater expenditures were found to exceed 2% in Fiscal Year 2022 and exceed 3% by Fiscal Year 2028. Fitchburg's 18.5% poverty rate is significantly higher than the 10.5% Massachusetts state-wide poverty rate, indicating that the current proposed schedule is unaffordable for the City.

To adhere to the December 31, 2030 deadline to meet CSO discharge requirements specified in the CD and achieve the largest environmental benefit, the City plans to adjust their Capital Improvement Plan (CIP) to prioritize the proposed sewer separation projects. Under the adjustments, the City plans to conduct the Tertiary Phosphorus Removal Project, if determined to be needed, after the conclusion of the sewer separation projects. Since the City is currently meeting the interim phosphorus discharge limits required by the CD, and the SSU project currently under construction includes improvements for phosphorus removal, sewer separation will result in the highest environmental benefit. This proposed schedule will still exceed a 2% screener score according to the City's in-depth rate analysis but will be more affordable for economically sensitive populations in the City.

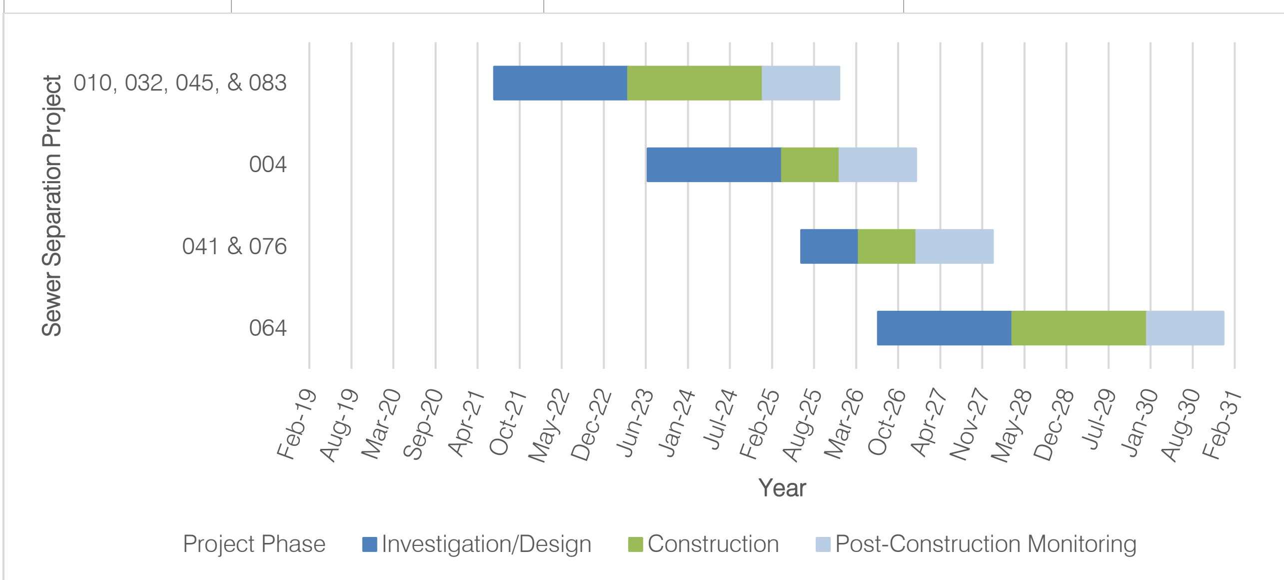
EASTERLY WASTEWATER TREATMENT FACILITY

During wet-weather events, the EWWTF utilizes a secondary system bypass when the treatment facility reaches a peak hourly flow of 15 MGD. Following the completion of the EWWTF Secondary System Upgrades, the EWWTF will have the capacity to treat up to 40 MGD of wastewater during the winter, 32 MGD of wastewater during the summer, and 20 MGD of wastewater during the month of May. Sewer separation is anticipated to reduce peak wet-weather flow rates to a rate that will receive full wastewater treatment.

IMPLEMENTATION SCHEDULE

Sewer separation projects have been prioritized based on the number of historical overflow events, overflow volumes, and based on location of the regulators in the system. CSO 064 has been identified by the City as the largest regulator. Since 9 of the other 10 regulators are located upstream of CSO 064, sewer separation of the entire tributary area (including other regulator tributary areas) is required prior to regulator closure. As a result, this project has been identified as the final sewer separation project to be conducted. The projected project scheduling for the remaining sewer separation projects is provided in the table and figure below. Regulators 007, 039, and 048 are not included in the implementation schedule. These regulators are scheduled for closure during the construction phase of the CSO 039, 048, and Clarendon Street Sewer Separation Project expected to commence in 2020.

Proposed Sewer Separation Schedule			
CSO Separation Project	Investigation/Design	Construction	Post Construction Monitoring
010, 032, 045, & 083	July 2021 – March 2023	April 2023 – December 2024	January 2025 – December 2025
004	July 2023 – March 2025	April 2025 – December 2025	January 2026 – December 2026
041 & 076	July 2025 – March 2026	April 2026 – December 2026	January 2027 – December 2027
064	July 2026 – March 2028	April 2028 – December 2029	January 2030 – December 2030



In addition, the City intends to optimize their wastewater collection system capacity by investigating the options available to adjust pump station discharges and water treatment plant backwash operations to mitigate discharges during wet weather events. The City also intends to implement a more aggressive catch basin cleaning program to achieve greater functionality during wet weather events. To help raise public awareness and improve communication between the City and downstream communities, the City intends to investigate developing a notification system to alert downstream communities during CSO discharge events.

POST CONSTRUCTION MONITORING PLAN

To determine the success of the sewer separation projects, the City plans to conduct post-construction monitoring. Included in the post construction monitoring is post-construction flow metering and an outfall sampling program. Post construction monitoring will follow EPA's 2012 *CSO Post Construction Compliance Monitoring* Guidance and the City's current EPA approved PCMP. Flow meters will be installed after construction to analyze the system for one year under various dry and wet-weather events to determine the effects of sewer separation on wastewater flows, and the outfall sampling program will help identify any illicit connections that may be connected to the new stormwater collection system. The sampling program will include three (3) dry weather and three (3) wet-weather sampling rounds.

Storm events with over 0.25 inches of total rainfall will be considered as a wet-weather event. The samples will be tested for the following: pH, temperature, dissolved oxygen, total chlorine, salinity, conductivity, surfactants, ammonia, E. coli, and Enterococcus. Sampling will be conducted at the outfalls of the closed CSO regulators that will be utilized as drain outfalls. However, if outfalls are not accessible, samples may be collected from manholes upstream of outfalls. Sampling will be conducted in accordance with 40 CFR Part 136 and the City's current EPA approved PCMP.

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1.0 BACKGROUND AND REGULATORY AGENCIES

The City of Fitchburg is located 50 miles west of Boston, 30 miles north of Worcester and is home to over 40,000 residents. In 2012, The City entered a Consent Decree (CD) with the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP). The CD requires Fitchburg to complete various sewer investigation and rehabilitation projects including sewer separation, a Sewer System Evaluation Survey (SSES), and a hydraulic model and capacity assessment. In addition, the CD requires the submittal of a Wastewater Management Plan (WMP). The WMP requires the following information under the CD (*United States, Commonwealth of Massachusetts v. City of Fitchburg*, 2012):

- An itemized schedule of construction of facilities needed to meet a seasonal phosphorus concentration limit of 0.2 mg/L and a seasonal total phosphorus mass-based limit of 20.7 lb./day.
- An itemized schedule for investigation, rehabilitation, and construction work required for the collection system to meet the CSO conditions in the NPDES Permit by the end of 2030.

To address the required CSO remediation work under the WMP, this CSO Long-Term Control Plan (LTCP) has been developed to identify areas of concern in Fitchburg's combined sewer system, potential remediation measures, and an estimated cost and schedule. The LTCP has been developed according to the standards set forth in the following documents:

- EPA's *CSO Control Policy; Notice* – April 1994
- EPA's *Combined Sewer Overflows Guidance for Long-Term Control Plan* (EPA 832-B95-002) – September 1995
- EPA's *Coordinating CSO Long-Term Planning with Water Quality Standards Review* (EPA 833-R-01-002) – July 2001
- MassDEP's *Guidance for Abatement of Pollution from CSO Discharges* – August 1997

1.1 CSO Compliance through EPA's CSO Control Policy

In 1994, EPA developed a CSO Control Policy to alleviate the environmental impacts of CSO discharges to receiving water bodies. The purpose of the Control Policy is to provide guidance towards meeting requirements of the Federal Clean Water Act (EPA, *CSO Control Policy; Notice*, 1994). The CSO Control Policy contains two major requirements for permittees: The implementation of the Nine Minimum Controls (NMC)and the development of a Long-Term Control Plan.

EPA's *CSO Control* Policy requires municipalities with combined sewer systems to adhere to water quality standards through either the Presumption Approach or Demonstration Approach. Both methods require the municipality to prove they are successfully mitigating CSOs in their combined sewer system. The Presumption Approach indicates that municipalities meeting one of three requirements are proving adherence to the Clean Water Act (EPA, *CSO Control Policy; Notice*, 1994). The requirements are listed below:

1. A maximum of four (4) overflows per year.
2. The capture and treatment of at least 85% of combined sewage during rain events.
3. The successful treatment of pollutants causing water quality issues through clarification, solids removal, and disinfection.

The Demonstration Approach indicates compliance can be determined by proving the water quality requirements are being met by meeting all the following requirements:

1. The control program successfully meets all water quality standards.
2. All active CSO discharges will not violate water quality standards or further the violation of water quality standards.
3. The control program will reduce pollution as much as feasibly possible.
4. The plan allows for cost-effective work to be completed if additional work to meet water quality standards is required.

The City of Fitchburg has been actively pursuing compliance with water quality standards and EPA's CSO Control Policy. While significant progress has been made, additional work is required in the combined system to achieve compliance with the Presumption Approach or Demonstration Approach. This CSO LTCP will focus on achieving compliance with the Presumption Approach, as a total maximum daily load (TMDL) has not been finalized for the North Nashua River to address current water quality impairments. The TMDL is necessary to determine if CSO discharges are actively resulting in the violation of water quality standards if using the Demonstration Approach.

1.1.1 EPA's Combined Sewer Overflows Guidance for Long-Term Control Plan

EPA's *Combined Sewer Overflows Guidance for Long-Term Control Plan* identifies nine (9) components in a CSO LTCP as listed below (EPA, *Combined Sewer Overflows Guidance for Long-Term Control* Plan, 1995):

1. Conduct monitoring, modeling, and other tasks to create a strong background of the combined sewer system's performance.
2. Create an outlet for public participation to select appropriate CSO controls.
3. Identify environmentally and socially sensitive areas that are negatively impacted by CSOs.
4. Identify and evaluate various CSO control alternatives that will enable compliance with water quality standards.
5. Develop a cost analysis of the CSO control alternatives.
6. Update and revise the City's operation and maintenance plan to include the new CSO control alternatives.
7. Identify opportunities to maximize treatment capacity at the publicly owned treatment facility.
8. Create a schedule to implement the CSO control alternatives.
9. Develop a post-construction monitoring plan to verify all CSO controls have been successfully implemented.

In addition to the list above, a major component in the creation and implementation of a LTCP is the Watershed Approach as defined in EPA's *CSO Control Policy*. This approach focuses attention on impairments in an entire watershed instead of smaller localized areas. Using this approach helps prioritize CSO rehabilitation work towards areas in a watershed that are found to be the major contributing factors of water quality impairments. The Watershed Approach is discussed in more detail in Section 3 of this report.

1.1.2 Coordinating CSO Long-Term Planning with Water Quality Standards Review

In 2001, EPA developed a report to assist communities in implementing CSO LTCPs that align with state and national water quality standards, titled *Guidance: Coordinating CSO Long-Term Planning with Water Quality Standards Reviews*. This document provides information on appropriately reviewing state water quality standards during the creation of a LTCP. In addition, the report provides steps detailing the process to successfully coordinate the development of the LTCP while conducting water quality standards reviews. Lastly, the document describes EPA's Watershed Approach and provides reference documents to assist with the development of the LTCP.

1.2 MassDEP's Guidance for Abatement of Pollution from CSO Discharges

MassDEP created a guidance document in 1997 for reducing and removing untreated CSO discharges, titled *Guidance for Abatement of Pollution from CSO Discharges*. In the document, MassDEP identifies that municipalities must follow EPA guidelines during the development of the CSO LTCP. In addition, the document lists the five (5) different CSO control alternatives that will be accepted as techniques to mitigate CSOs. They are listed below:

1. EPA's Nine Minimum Controls
2. Elimination/Relocation (Sewer Separation)
3. Storage Technologies
4. Treatment Technologies
5. Collection System Controls

MassDEP's *Guidance for Abatement of Pollution from CSO Discharges* requires that sewer separation is the primary method for removing CSOs and must be implemented unless the project is found to cause "widespread social and economic impacts" (CMR 314 4.03(4) (f)). To demonstrate widespread impacts, a municipality must prove that the cost of separation will have a negative impact on ratepayers, the benefits of separation are not significant, and the protection of sensitive areas can still be achieved with other CSO control alternatives. More information on the CSO control alternatives is provided in Section 5.

Massachusetts Surface Water Quality Standards are enforced through 314 CMR 4.00: *The Massachusetts Surface Water Quality Standards*. Adherence to 314 CMR 4.00 is required through a municipalities National Pollutant Discharge Elimination System (NPDES) Permit and a Massachusetts Surface Water Discharge Permit. According to MassDEP's *Guidance for Abatement of Pollution from CSO Discharges*, the following CSO abatement options are available for each waterbody classification:

Waterbody Classification	CSO Abatement
Class B or SB	CSOs are eliminated from the system.
Class B (CSO)	CSOs are not eliminated but are compliant with water quality standards.
Variance	CSO mitigation is not completed through a modification of water quality standards.
Partial Use Designation	CSO mitigation is partially completed causing intermittent water quality impairments.
Class C	CSO mitigation is not conducted, resulting in permanent water quality impairments.

The North Nashua River is considered a Class B waterbody by MassDEP, indicating that the river is suitable for aquatic life and primary and secondary recreation should all water quality requirements be met.

MassDEP's *Guidance for Abatement of Pollution from CSO Discharges* states MassDEP will only allow CSO discharges to continue if CSO controls will lead to a widespread economic and social impact on the community. The cost analysis of CSO control projects in this LTCP is provided in Section 6 of this report. Water quality standards in Fitchburg are discussed in more detail in Section 3 of this report.

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2.0 FITCHBURG'S COMBINED SEWER SYSTEM

Fitchburg is comprised of approximately 131 miles of gravity sanitary sewers, 104 miles of drain sewers, and 8.4 miles of combined sewers. The wastewater collection system in Fitchburg was constructed between 1890 and 2015, and currently includes 142 miles of gravity and force main sewers made of asbestos-cement (AC), brick, cast iron, ductile iron, polyvinyl chloride (PVC), reinforced concrete, and vitrified clay. In addition, the City operates three pump stations. A map of the sewer system is provided in Figure 1. Flow from the City is treated at the Easterly Wastewater Treatment Facility (EWWTF), located near the Fitchburg Airport. During wet weather events, EWWTF utilizes a secondary system bypass to redirect flows to the North Nashua River after primary treatment as permitted by the NPDES permit.

Fitchburg initially began investigating sewer separation as a method to remove combined sewers in 1995. In 1999, Fitchburg reported a total of 20 miles of combined sewers and 58 CSO regulators. A 1999 study estimated 16.2 million gallons of untreated combined sewage would discharge into waterbodies during a one-year design storm, and 28.5 million gallons during a five-year design storm (Dufresne-Henry, *CSO Master Plan, 1999*). Most of the 58 CSO regulators have been closed since the implementation of multiple combined sewer separation and rehabilitation projects with 11 regulators currently active in the City. During the one-year, 24-hour design storm, the system is estimated to discharge 10.1 million gallons of untreated combined sewage, and 16.3 million gallons during the five-year, 24-hour design storm (Wright-Pierce, *Capacity Assessment Report*, 2018).

2.1 Previous Combined Sewer Rehabilitation

Since 1999, Fitchburg has been performing sewer rehabilitation and separation projects to reduce the number of combined sewers in the City. Sewer separation projects have successfully removed over 10 miles of combined sewers and significantly reduced overflow volumes to the North Nashua River.

2.1.1 CSO Master Plan

A CSO Master Plan was developed in 1999 to address the collection system, main trunk line, and treatment plants. The investigation work included a SWMM model of the collection system to analyze system behavior under various storm events. The model included the analysis of the 58 CSO regulators in the sewer system. As part of the plan, 24 regulators were proposed for rehabilitation to reduce CSOs by 56% during a 3-month storm event. The proposed CSO modifications would add five (5) million gallons per day (MGD) of wet weather flow during the 3-month storm to the main trunk line and Easterly Wastewater Treatment Facility. A section of the main sewer trunk had insufficient capacity during storm events, resulting in the recommendation of constructing 2,000 linear feet (LF) of a relief sewer in the undersized area. To alleviate the increased flow entering the treatment system, the recommended improvements include a grit removal system, a wet weather flow equalization basin, and the automation of the wet weather flow bypass pump. Work for the recommendations was divided into six (6) phases for construction. (Dufresne-Henry, *CSO Master Plan, 1999*)

2.1.2 CSS-1, 2, and 3

In 2002, the City created a Combined Sewer System (CSS) Separation Program that prioritized areas for separation based on the largest CSOs. The prioritized areas were divided into 15 projects for rehabilitation, removing an estimated 713,984 cubic feet (5.3 million gallons) of CSO volume from the system (based on runoff from the 3-month storm) (Dufresne-Henry, *Combined Sewer Separation Program & Final Environmental Impact Report, 2002*).

The first project under the CSS Program prioritized project area CSS-1. Under this project, 58 manholes were inspected along with 2.1 miles of flow isolation and 4,300 LF of television inspection. Smoke testing was conducted on 10,900 LF of combined sewers. (Dufresne-Henry, *CSS-1 Infiltration/Inflow Evaluation Report,* 2002)

The second project under the CSS Program prioritized project area CSS-2. In this project, 1.5 miles of flow isolation was performed on combined sewers. Fifty-five (55) manholes were inspected, with 1,700 LF of television inspections of combined sewers. Smoke testing was also performed on 8,643 LF of combined sewers. (Dufresne-Henry, *CSS-2 Infiltration/Inflow Evaluation Report,* 2003)

The CSS-3 project area was evaluated with 24 manhole inspections, one (1) mile of flow isolation, 4,200 LF of television inspections, and 6,739 LF of smoke testing. All investigation techniques were performed on the combined sewer system. (Dufresne-Henry, *CSS-3 Infiltration/Inflow Evaluation Report,* 2003)

The design phase of CSS-1, 2, and 3 proposed the construction of new drains with catch basins in the project areas. As a result of the project, eight regulators were modified, however the four existing outfalls discharging to the North Nashua River were not modified. Construction for CSS-1, 2, and 3 was completed in 2009. (Dufresne-Henry, *Design of Combined Sewer Separation of CSS 1, 2 & 3,* 2004)

2.1.3 CSS 2B and 3C

The CSS 2B and 3C projects were initiated as a requirement of the CD. During the project, 11,780 LF of storm drains and 115 catch basins and storm water inlets were installed. Ten regulators were also closed during this project. These projects included sections of CSS 5 and 6 from the CSS Program. Construction for these projects was completed 2012. (Stantec, *Review of Work Completed, Inflow and Infiltration Sources Removed and Illicit Connections Removed or Identified*, 2013)

2.1.4 CSS 4D

The CSS 4D project area is located in eastern Fitchburg, and includes areas tributary to CSO Outfalls 072, 024, and 033. The project involved the separation of 25,000 LF of combined sewers, and the closure of CSO 023, 024, 025, 033, and 072. The initial inspections included 24,000 LF of television inspections and 128 manhole inspections. 40,000 LF of smoke testing was also conducted in both the sanitary sewers and combined sewers in the area. Smoke testing identified 88 vented manholes, 109 catch basins, one yard drain, and one roof leader connected to the sanitary sewer. Construction for CSS 4D was completed in 2015. (Wright-Pierce, *Preliminary Engineering Report for CSS 4D Sewer Separation*, 2012)

2.1.5 Beech and Hazel Street Separation

The Beech and Hazel Street Sewer Separation included 4,880 LF of television inspection, 37 manhole inspections, and 8,000 LF of smoke testing. The rehabilitation design included the separation of approximately 4,000 LF of combined sewers. Construction for the project was completed in 2017. (Wright-Pierce, *Preliminary Engineering Report for Beech and Hazel Streets Sewer Separation*, 2015)

2.2 Fitchburg's Existing Combined Sewer System

Fitchburg's combined sewer system is primarily concentrated near the center of the City. In total, 8.4 miles of combined sewers and 11 CSO regulators remain active in the City. A map of the combined sewer system is provided in Figure 2. A list of the remaining combined sewers is provided in Appendix A.

2.2.1 Active Regulators

Since the implementation of the CD, Fitchburg has submitted annual CSO monitoring reports to MassDEP and EPA estimating overflow volumes of their metered regulators. The results of the monitoring are shown below. Overflow events and overflow volumes have decreased significantly since the implementation of the CD in 2012. It should be noted that the increase in overflow volume in 2018 can be attributed to a substantial increase in rainfall.

Yearly CSO Overflow Volumes*					
Year	Number of Regulators Monitored	Number of Overflow Events	Overflow Volume (gal)	Total Yearly Rainfall (in) ***	Largest Storm Volume (in)
2012	31	472	51,537,828	46.53	3.05
2013	21	211	19,922,613	48.90	1.91**
2014	13	127	17,719,303	43.68	2.44**
2015	14	112	5,603,182	30.86	2.78
2016	12	111	8,429,956	36.44	3.17
2017	12	159	12,283,719	44.28	2.45
2018	11	182	31,253,170	57.99	3.47

Note:
* Totals for regulators, rainfall, storm volume, and overflows were obtained from Fitchburg's yearly CSO Monitoring Reports
** Storm volumes were obtained from Weather Underground.
*** The average total yearly rainfall for the Worcester area is 47.25 inches.

CSO 064 is Fitchburg's largest CSO Regulator. According to the City's Annual CSO Monitoring Reports, 60% of the City's wastewater collection system is upstream of the regulator. The remaining CSO regulators consist of tributary combined and sanitary sewers. Three (3) CSO tributary areas (CSO 041, 048, and 076) do not have combined sewers upstream. Additional information on the combined sewers upstream of each regulator is provided in the Section 5. A table of the recorded CSO overflow events for each of the active remaining CSO regulators is provided on page 2-4 of this report.

CSO	Description	Year							Total
		2012	2013	2014	2015	2016	2017	2018	
004	Overflow Events	5	12	15	0	5	5	10	**52**
	Overflow Volume (gal)	30,791	69,557	123,098	0	65,000	22,000	109,282	**419,728**
007	Overflow Events	9	1	11	0	1	0	2	**24**
	Overflow Volume (gal)	26,395	200	502,370	0	77,079	0	1,075	**607,119**
010	Overflow Events	9	10	3	7	9	21	20	**79**
	Overflow Volume (gal)	272,027	476,505	108,083	398,057	177,275	1,161,003	3,830,642	**6,423,592**
032	Overflow Events	65	29	57	32	15	34	35	**267**
	Overflow Volume (gal)	1,987,782	716,190	2,483,479	1,921,230	297,000	1,192,696	1,738,111	**10,336,488**
039	Overflow Events	7	23	1	20	14	26	28	**119**
	Overflow Volume (gal)	805,900	427,457	100,000	250,560	1,950,807	1,051,100	5,195,111	**9,780,935**
041	Overflow Events	7	6	4	0	4	3	9	**33**
	Overflow Volume (gal)	124,358	272,022	20,471	0	268,208	6,000	492,000	**1,183,059**
045	Overflow Events	Not Metered	Not Metered	Not Metered	23	27	28	31	**109**
	Overflow Volume (gal)	Not Metered	Not Metered	Not Metered	2,427,180	2,452,052	2,820,000	3,777,000	**11,467,232**
048	Overflow Events	2	5	1	0	3	1	3	**15**
	Overflow Volume (gal)	972	74,608	582	0	29,710	525	4,712	**111,109**
064	Overflow Events	Not Metered	Not Metered	Not Metered	11	14	22	24	**71**
	Overflow Volume (gal)	Not Metered	Not Metered	Not Metered	196,173	2,404,663	3,903,694	15,316,580	**21,821,110**
076	Overflow Events	7	11	3	1	5	8	5	**40**
	Overflow Volume (gal)	895,509	46,085	223,860	2,130	180,882	1,716,000	39,460	**3,103,926**
083	Overflow Events	Not Metered	Not Metered	Not Metered	7	7	11	15	**40**
	Overflow Volume (gal)	Not Metered	Not Metered	Not Metered	40,696	204,280	410,701	749,197	**1,404,874**

2.2.2 Hydraulic Model and Capacity Assessment

In September 2017, Fitchburg submitted a hydraulic model to EPA for review and approval. The model incorporated record drawings, the City's GIS data, and manhole inspections to create the base model. (Wright-Pierce, *Hydraulic Model* Report, 2017). The model report was accepted by MassDEP and EPA on March 6, 2018.

As part of the Capacity Assessment, the system was analyzed under the one-year, 24-hour storm event and the five-year, 24-hour storm event. The five-year, 24-hour storm event is required by MassDEP under 314 CMR 12.04 (2). During both storm events, 10 of the 11 regulators activated (Wright-Pierce, *Capacity Assessment* Report, 2018). CSO 048 did not activate under either storm event in the model. The table below summarizes the results in the model.

Modeled CSO Overflow Events		
CSO Regulator	One-Year, 24-Hour Storm Event Overflow Volume (gal)	Five-Year, 24-Hour Storm Event Overflow Volume (gal)
004	880,000	1,631,000
007	120,000	236,000
010	392,000	857,000
032	715,000	1,268,000
039	475,000	849,000
041	518,000	897,000
045	647,000	1,210,000
048	0	0
064	3,868,000	5,188,000
076	1,352,000	2,250,000
083	1,171,000	1,923,000
Total	10,138,000	16,309,000

According to MassDEP's *Guidance for Abatement of Pollution from CSO Discharges*, Waterbodies classified as a Class B waterbody, such as the North Nashua River, must have zero CSO discharge events. Remedial actions to reduce CSO overflow events are discussed in Section 5 of this report.

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3.0 WATERSHED BASED APPROACH

EPA's *Combined Sewer Overflows Guidance for Long-Term Control Plan* recommends using a Watershed Based Approach when developing a CSO LTCP. The Watershed Based Approach is used to identify potential sources of pollution throughout a watershed instead of in localized areas to determine the best approach towards mitigating the negative impacts of CSO discharges. For example, CSO controls may be ineffective if an additional pollution source is located upstream. Using EPA's Watershed Based Approach helps maximize the effectiveness of CSO controls and prioritizes the removal of pollution sources that may not be immediately apparent when looking at a single discharge location. The eight (8) steps of the Watershed Based Approach are provided below.

1. Define baseline and delineate watershed.
2. Identify and notify stakeholders.
3. Develop water quality goals.
4. Identify areas of non-attainment and other water quality concerns.
5. Identify CSO and non-CSO sources of pollution causing concerns.
6. Develop corrective action plan and/or TMDL.
7. Evaluate, select, and implement CSO and non-CSO controls.
8. Assess effectiveness.

3.1 The Nashua River Watershed

The City of Fitchburg is located in the Nashua River Watershed, which spans 500 square miles and drains into the Nashua River. The watershed extends from the southern New Hampshire border to the north, to the border of Worcester, Massachusetts to the south, the border of Winchendon, Massachusetts to the west, and the Merrimack River to the east. An image of the watershed is provided in Figure 3.

MassDEP classifies waterbodies in watersheds under 314 CMR 4.00: *The Massachusetts Surface Water Quality Standards*. These standards identify three classes of waterbodies based on designated use.

1. Class A – Source of Public Water Supply.
2. Class B – Designated for an aquatic habitat, primary contact recreation (swimming, wading, surfing, etc.), secondary contact recreation (fishing, boating, etc.).
3. Class C – Designated for an aquatic habitat, secondary contact recreation.

The Nashua River is the major waterbody in the Nashua River Watershed and is classified by MassDEP as a Class B water body. The Nashua River flows from Lancaster Millpond, near the Wachusett Reservoir, and ends at the confluence of the Nashua River and the Merrimack River. The North Nashua River is the major waterbody impacted by Fitchburg. The river begins at Snows Millpond in Fitchburg and ends at the confluence of the North Nashua River and the Nashua River in Clinton, MA. The North Nashua River is designated by MassDEP as a Class B waterbody.

In addition to the North Nashua River, multiple waterbodies are located within the Fitchburg City limits. They are listed in the table on the following page. Waterbodies designated with a "N/A" classification have not been classified by MassDEP.

Waterbodies Within Fitchburg City Limits			
Pond/Lake		River/Stream	
Waterbody Name	MassDEP Classification	Waterbody Name	MassDEP Classification
Greenes Pond	N/A	Baker Brook	Class B
Lovell Reservoir	Class A	Falulah Brook	Class B
Marshall Reservoir	N/A	Flag Brook	Class B
Mctaggarts Pond	N/A	Monoosnuc Brook	Class B
Mirror Lake	Class B	Nichols Brook	N/A
Nichols Pond	N/A	Pearl Hill Brook	N/A
North Nashua River	Class B	Phillips Brook	Class B
Notown Reservoir	Class A	Sand Brook	N/A
Oak Hill Pond	N/A	Scott Brook	N/A
Overlook Reservoir	N/A	Sheldon Brook	N/A
Putnam Pond	N/A	Whitman River	Class B
Saima Pond	N/A	Wymans Brook	N/A
Sawmill Pond	Class B		
Scott Reservoir	Class A		
Sheldon Pond	N/A		
Snows Millpond	Class B		
Wachusett Station Pond	N/A		

3.2 Stakeholders in the Nashua River Watershed

A stakeholder in a watershed can be defined as any organization, municipality, or group that has an interest in the preservation and improvement of the watershed. EPA recommends that all stakeholders in a watershed should be notified regarding the development of new water quality goals in the LTCP. In the Nashua River Watershed, multiple cities and towns utilize waterbodies in the watershed for recreation and drinking water. The following municipalities are located within the watershed:

Massachusetts

- Ashburnham
- Ashby
- Ayer*
- Bolton*
- Boylston
- Clinton
- Dunstable*
- Fitchburg*
- Gardner
- Groton*
- Harvard*
- Holden
- Lancaster*
- Leominster*
- Lunenburg
- Paxton
- Pepperell*
- Princeton
- Rutland
- Shirley*
- Sterling
- Townsend
- West Boylston
- Westminster

New Hampshire:

- Brookline
- Greenville
- Hollis*
- Mason
- Milford
- Nashua*
- New Ipswich
- Wilton

The Nashua River exits the Nashua River Watershed as it enters the Merrimack River watershed prior to the confluence of the two rivers. Multiple communities utilize the Merrimack River as a drinking water source, and are listed below:

- Andover, MA
- Lawrence, MA
- Lowell, MA
- Methuen, MA
- Tewksbury, MA

Note:
*These towns and cities are located along the North Nashua River and Nashua River and are downstream of CSO locations.

Although the Merrimack River is not included in the Nashua River Watershed, any change in water quality in the North Nashua River will ultimately impact the Merrimack River. As a result, the City of Fitchburg has contacted the Merrimack River Watershed Council regarding the City's ability to provide notification of CSO events.

On March 19, 2019, the proposed projects for the CSO LTCP were presented during a publicly broadcasted City Council Meeting to provide the community with a public outreach opportunity. Comments from the meeting were incorporated into this LTCP.

3.2.1 Nashua River Watershed Association

The Nashua River Watershed Association (NRWA) was created in 1969 to restore the Nashua River after years of heavy pollution. The NRWA currently performs water quality monitoring on the Nashua River and North Nashua River in multiple locations, including three locations in Fitchburg. The water quality data is used by Massachusetts for the MA Water Quality Assessment Report and New Hampshire's Volunteer River Assessment Program. In addition, the organization provides public education.

Under Nashua River Watershed Association's Water Monitoring Program, 44 sampling locations across the watershed are visited on the third Saturday of each month between April and October. NRWA volunteers conduct the sampling and bring the samples to the Pepperell and Devens wastewater treatment facilities for analysis. Volunteers are all trained prior to collecting and analyzing samples and utilize sampling and analysis techniques approved by EPA. Volunteers conducting sample testing are overseen by NRWA staff and lab staff at the treatment facilities.

In 2001, the EPA accepted NRWA's sampling program, called the *Quality Assurance Project Plan*. The program was updated and submitted in 2012 and ran until 2017. The plan outlined the goals of the volunteer program, standards and methods for sampling and testing, and sampling locations. Included in the sampling and testing was the documentation of results for temperature, dissolved oxygen, Escherichia Coli (E. coli) counts, and conductivity. This data is further discussed in Section 3.4.2.

3.3 Water Quality Goals for the Nashua Watershed

In 1995, the Nashua River Watershed Association developed a 25-year plan for the protection and restoration of the Nashua River Watershed. The vision under this plan is "a healthy ecosystem with clean water and open spaces for human and wildlife communities, where people work together to sustain mutual economic and environmental well-being" (Nashua River Watershed Association, *Quality Assurance Project Plan*, 2012). The plan encompasses three major goals: improving water quality, conserving open spaces, and careful land use.

A major goal set by the Nashua River Watershed Association in their 25-year plan is the preservation of waterbodies in the watershed as their current classification and prevent the degradation of the water bodies into lower water quality classes. The plan prioritizes the following tasks to protect and rehabilitate the watershed (Nashua River Watershed Association, *Quality Assurance Project Plan*, 2012):

1. Keep drinking water supplies clean.
2. Clean up polluted waters.
3. Protect water quality for a variety of uses, including wildlife, fish, and recreation.

3.3.1 State and National Water Quality Standards

Both MassDEP and the EPA have developed standards for the protection of waterbodies. The *Massachusetts Surface Water Quality Standards* under 314 CMR 4.00 created by MassDEP in 2013 set water quality limits based on the designated "Class" of each waterbody. National water quality standards are identified through the Clean Water Act. The table below identifies current water quality standards set by *Massachusetts Surface Water Quality* Standards for Class B waterbodies.

State Water Quality Standards	
Standard	MassDEP Class B Waterbodies
pH	6.5-8.3
Dissolved Oxygen	6.0 mg/L-cold water fisheries 5.0 mg/L-warm water fisheries
Temperature	68°F-cold water fisheries (cannot exceed a 3°F increase) 83°F-warm water fisheries (cannot exceed a 5°F increase)
E. coli	126 CFU/100 mL (no sample above 235 CFU/100 mL)
Enterococcus	33 CFU/100 mL (no sample above 61 CFU/100 mL)
Solids	None allowed that impair the Class B standards
Color and Turbidity	None allowed that impair the Class B standards
Oil and Grease	None in concentrations that affect taste or introduce toxicity to aquatic life
Taste and Odor	None allowed that impair the Class B standards

3.3.2 MassDEP's Draft Pathogen TMDL for the Nashua River Watershed

In 2009, MassDEP developed a Draft Pathogen Total Maximum Daily Load (TMDL) for the Nashua River Watershed to address the high levels of E. coli in the Nashua River. The TMDL assigned to the Nashua River Watershed indicates the maximum daily load of E. coli that will not result in the impairment of the waterbodies within the watershed. The table below identifies the TMDLs set for CSOs in the Nashua River Watershed:

Pathogen Total Maximum Daily Load Levels for CSOs in Class B Waterbodies in the Nashua River Watershed	
Pathogen	TMDL
Indicator Bacteria	Geometric Mean: <200 CFU/100 mL 10% of samples: <400 CFU/100 mL

The TMDL report is a draft, therefore the TMDL requirements have not been finalized and implemented. As part of the Watershed Approach to the LTCP, TMDLs are recommended as a form of enforcement and a notifier to municipalities and stakeholders of the progress towards reducing the negative impacts that CSOs may be having in the watershed. TMDLs also help prioritize areas for CSO controls based on each site's compliance status.

3.4 Areas of Non-Attainment and Other Water Quality Concerns

Under the Clean Water Act, MassDEP is required to submit status reports on the water quality of surface waterbodies and groundwater. As a result, MassDEP developed its Integrated List of Waters, which is revised and submitted to EPA every two years. In the Draft 2016 Integrated List of Waters, MassDEP defines five (5) categories to classify waterbody impairments (MassDEP, *Massachusetts Year 2016 Integrated List of Waters*, 2017).

Category 1: Waters attaining all designated uses.
Category 2: Attaining some uses; other uses not assessed.
Category 3: No uses assessed.
Category 4a: TMDL is completed.
Category 4b: Impairment controlled by alternative pollution control requirements.
Category 4c: Impairment not caused by a pollutant – TMDL not required.
Category 5: Waters requiring a TMDL.

Approximately half of the waterbodies in Fitchburg have been classified as either Category 2 or Category 3 waterbodies. The waterbodies in Fitchburg are shown in the table below. The waterbodies not included in the table have not been previously classified by MassDEP, and therefore are not included in the Draft 2016 Integrated List of Waters.

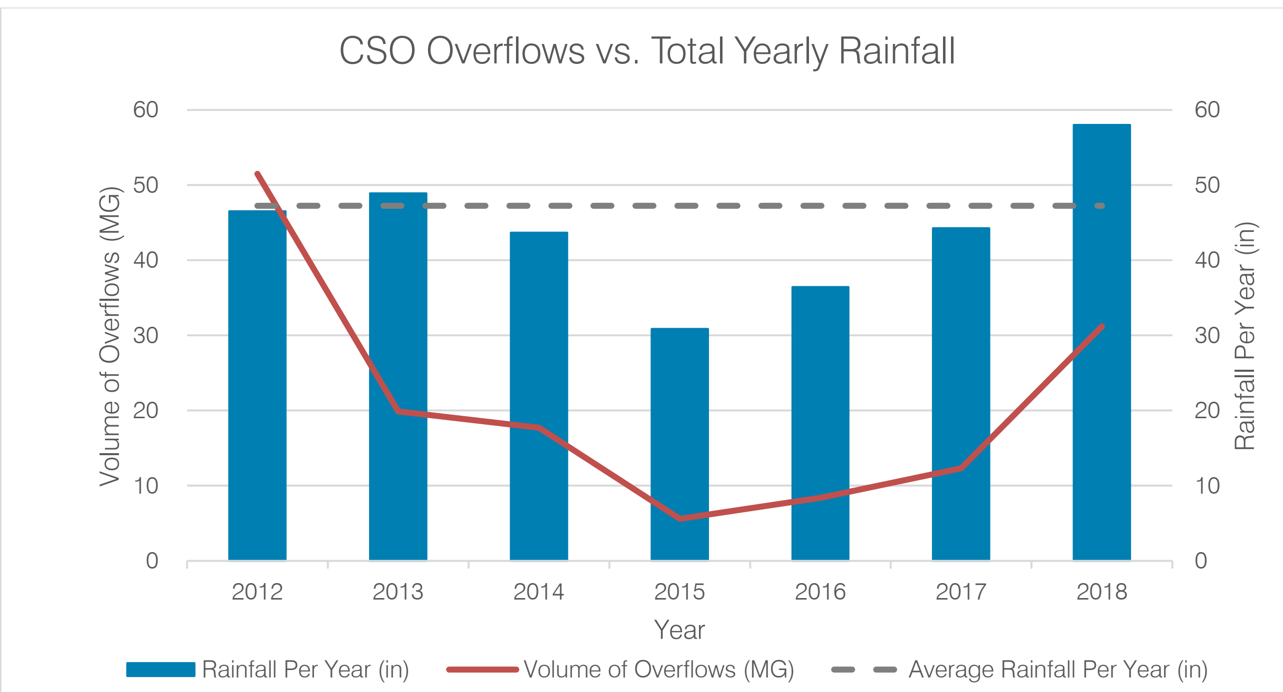
Waterbodies Near Fitchburg				
Waterbody	Waterbody Identification	MassDEP Class	MassDEP Category	Impairments
Falulah Brook	MA81-63	B	5	Escherichia coli
Baker Brook	MA81-62	B	5	Escherichia coli
Monoosnuc Brook	MA81-13	B	5	Escherichia coli
North Nashua River	MA81-02	B	5	Aquatic Macroinvertebrate Bioassessments, Ambient Bioassays-Chronic Aquatic Toxicity, Escherichia coli
North Nashua River	MA81-01	B	5	Escherichia coli
Sawmill Pond	MA81118	B	4c	Non-Native Aquatic Plants
Lovell Reservoir	MA81074	A	3	Not Assessed
Mirror Lake	MA81084	B	3	Not Assessed
Notown Reservoir	MA81092	A	3	Not Assessed
Scott Reservoir	MA81119	A	3	Not Assessed
Snows Millpond	MA81127	B	3	Not Assessed
Flag Brook	MA81-10	B	2	None
Phillips Brook	MA81-12	B	2	None
Whitman River	MA81-11	B	2	None

The North Nashua River is a Category 5 waterbody, indicating the water body is impaired and requires a TMDL to regulate pollutants entering the waterbody. The identified pollutants causing the impairments are E. coli, aquatic macroinvertebrate bioassessments used to determine the presence of pollutants, and chronic aquatic toxicity identified with ambient bioassays. CSOs, municipal point source discharges and illicit connections to the stormwater collection system have been identified by MassDEP in their *Draft 2016 Integrated List of Waters* as sources of the impairments caused by the presence of E. coli. It is important to note that a NRWA sampling location (NN3071) located upstream of all CSO regulators still has sampling results that exceed state water quality standards for E. coli.

E. coli continues to be an impairment in the North Nashua River until its confluence with the Nashua River in Lancaster. Downstream of the North Nashua River, the Nashua River is impaired with E. coli for another 14.2 miles.

3.4.1 CSO Discharges into the North Nashua River

Fitchburg has already undergone significant work to limit the effects of CSOs on the North Nashua River and other receiving waterbodies. Since the original 1999 *CSO Master Plan*, 47 of the 58 CSOs have been removed from the system, and over 50% of the combined system has been separated. After completing multiple sewer separation projects, Fitchburg has greatly reduced the total overflow events and total overflow volume each year. The figure below identifies the reduction in CSO volume each year and the yearly rainfall volume totals. It should be noted that the increase in overflow volume in 2018 can be attributed to a substantial increase in rainfall.



Note:
*Storm volumes were taken from Weather Underground.
**Totals for regulators, rainfall, storm volume, and overflows taken from Fitchburg's yearly CSO Monitoring Reports.

3.4.2 NRWA Water Quality Data

As part of the NRWA *Quality Assurance Plan*, E. coli, temperature, and dissolved oxygen data for the North Nashua River were gathered by the NRWA at the following locations in and near Fitchburg:

1. Mill No. 3 Farm Stand (NN3071) – Fitchburg, MA
2. Kimball Street Bridge/Route 12 Rotary (NN2888) – Fitchburg, MA
3. Riverfront Park (NN3021) – Fitchburg, MA
4. Hamilton Street Parking Lot (NN1905) – Leominster, MA

The Hamilton Street Parking Lot sampling site in Leominster, MA is immediately downstream of the city border between Fitchburg and Leominster. Because of its proximity to Fitchburg, it is an ideal comparison for water quality with the Mill No. 3 Farm Stand location in Fitchburg. Mill No. 3 Farm Stand is located near the confluence of Phillips Brook and the Whitman River, where the North Nashua River begins. This sampling location is located upstream of all open CSO regulators. A map of the sampling locations is shown in Figure 4.

The sampling data is located on the NRWA's website and is summarized in Appendix B. Before significant combined sewer improvements were initiated in 2012, 85% of the samples taken at Riverfront Park were found to be violating MassDEP's water quality standards for E. coli. 65% of the Kimball Street Bridge samples were found in violation during this time period. The Mill No. 3 Farm Stand samples were found to be 29% in violation. Downstream of Fitchburg, the sampling location in Leominster was found to be in violation for E. coli 81% of months that sampling was conducted.

Following the combined sewer improvements initiated in 2012, the number of violations dropped significantly. At Riverfront Park, 23% of the months were found in violation and 29% of the months at the Kimball Street Bridge were found in violation. 22% of the months were found in violation at the Mill No. 3 Farm Stand. However, due to the lack of CSOs upstream of the sampling area, CSO mitigation work has minimal effect on water quality at this location. At the downstream sampling location in Leominster, 44% of the water samples were found to be in violation for E. coli.

3.4.3 Other Nonattainment Issues

Other impairments causing nonattainment in the North Nashua River are indicated by aquatic macroinvertebrate bioassessments and ambient bioassays. Downstream of the North Nashua River, the Nashua River is impaired for total phosphorus levels. The City has been maintaining the required interim phosphorus discharge limit of 0.5 mg/L and is scheduled to meet a phosphorus limit of 0.2 mg/L following scheduled treatment facility upgrades.

3.5 CSO and Non-CSO Sources Causing Concern

The two major sources of concern specified by MassDEP that impact water quality in the North Nashua River are CSO discharges and illicit connections. Fitchburg has been actively addressing the sources of concern by removing illicit connections once identified and conducting sewer separation projects to permanently close CSO regulators to prevent future discharges.

3.6 Corrective Action Plan

In accordance with the CD, Fitchburg intends to meet water quality goals by 2030. As a result, the City intends to close the remaining CSOs to meet the North Nashua River's Class B classification. MassDEP specifies in the *Guidance for Abatement of Pollution from CSO Discharges* that sewer separation must be initially considered as the primary method of CSO closure (MassDEP, *Guidance for Abatement from CSO Discharges*, 1997). In addition, the City intends to continue the implementation of EPA's NMC. Discussions related to the City's ongoing implementation techniques for EPA's NMCs are provided in Section 4.

3.7 Evaluate, Select, and Implement CSO and Non-CSO Controls

Sewer separation is required by MassDEP to be pursued unless proven to cause "widespread social and economic impact" (MassDEP, *Guidance for Abatement of Pollution from CSO Discharges*, 1997). As a result, the feasibility of sewer separation will be evaluated according to EPA's *Economic Guidance for Water Quality Standards* in Section 6. An assessment of proposed CSO control projects is provided in Section 7.

3.8 Assess the Effectiveness of CSO and Non-CSO Controls

As CSO Control projects are completed, the City intends to conduct flow monitoring and sampling. The proposed post construction monitoring plan is discussed in Section 9. In addition, the City intends to utilize the hydraulic model when necessary in order to address future impacts and design.

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4.0 EPA'S NINE MINIMUM CONTROLS

Under EPA's CSO Control Policy, municipalities are required to implement the NMC to help mitigate CSOs. The NMC, with examples, are listed in EPA's *Combined Sewer Overflows Guidance for Nine Minimum Controls* and provided in the table below:

Nine Minimum Controls		
Minimum Control	Control Definition	Suggested Examples of Implementation
1	Proper Operation and Regular Maintenance Programs for the sewer system and CSO Outfalls	Regular regulator inspections, annual cleaning programs
2	Maximum use of the collection system for storage	Temporary storage structures, regulator adjustments, collection system inspections
3	Review and modification of pretreatment requirements to ensure that CSO impacts are minimized	Removal of commercial and industrial sources from combined sewers, implementing pretreatment systems for commercial and industrial sources connected to combined sewers
4	Maximization of flow to the POTW for treatment	Capacity Assessments, Storage facilities at the POTW
5	Elimination of CSOs during dry weather	Regulator maintenance, sewer cleaning, sewer/regulator repairs
6	Control of solid and floatable materials in CSOs	Baffles, trash racks, screens
7	Pollution prevention programs to reduce contaminants in CSOs	Street cleaning, litter reduction, trash collection, recycling
8	Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts	Sign postings, notices, letters to residents
9	Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls	Flow metering, PCMPs

4.1 Nine Minimum Controls Implementation in Fitchburg

The City of Fitchburg has been actively working to achieve compliance with EPA's NMC. Details on the City's current programs and implementation procedures are provided below.

4.1.1 NMC 1: Proper Operation and Regular Maintenance Programs for the sewer system and CSO Outfalls

The City of Fitchburg currently has multiple ongoing operation and maintenance programs that document the condition of the sewer system. The City is completing a City-wide television inspection program along with a City-wide manhole inspection program. In 2012, the City completed a Capacity, Management, Operation, Maintenance (CMOM) self-assessment to analyze the Wastewater Division's performance and operation procedures. The City has also enacted a Long-Term Sewer System Preventative Maintenance Plan, Priority Cleaning Plan, Routine Cleaning Plan, and Emergency Response Plan for employees to follow during various sewer operation events.

Long Term Sewer System Preventative Maintenance Plan (LTSSPMP)
The LTSSPMP was created in 2012. The purpose of the plan is to create a standard cleaning protocol for City employees to follow ensuring that sewer cleaning is adequately completed. The plan details the required equipment, forms, and cleaning process. In addition, the plan sets standards for the CCTV inspection of pipes completed by City employees. All inspections under the plan are required to follow NASSCO PACP and MACP standards.

Priority Cleaning Plan (PCP)
The purpose of the PCP was to create a plan that identified areas that frequently have maintenance issues and require frequent cleaning. The plan identifies that these locations are to be prioritized for cleaning and investigation and are to be inspected once a month and after heavy rain storms. In addition, the plan outlines cleaning protocols, equipment, and necessary forms for City employees to use while cleaning the problem areas. The plan was developed in 2012.

Routine Cleaning Plan (RCP)
The RCP was created in 2012 by the City to create a set of procedures for cleaning gravity sewers and a schedule to routinely clean the entire wastewater collection system. In addition, the plan identifies CCTV inspection to be included as part of the RCP. Currently, the City has the capability to clean and inspect all sewer pipes between 8-inch and 20-inch in diameter. The RCP identifies that the cleaning of pipes above 20-inches in diameter, when necessary, is conducted by an outside contractor.

Emergency Response Plan (ERP)
The ERP identifies the procedure and proper notification process in the event of SSOs and CSOs. The plan highlights required equipment, the cleaning procedure, and the chain of notification required to ensure proper state and federal protocols are followed. In addition, the plans identify the process for notifying the public about an overflow event.

All collection system operators have the LTSSPMP, PCP, RCP, and ERP documents in their vehicles for reference. These plans were updated and resubmitted to EPA and MassDEP in March 2017.

4.1.2 NMC 2: Maximum use of the collection system for storage

Multiple sewer separation projects implemented by the city have greatly improved the capacity of both the wastewater and stormwater collection systems. The City has developed a Hydraulic Model and performed a Capacity Assessment of its wastewater collection system (for pipes 12-inches and greater). In addition, the City plans to inspect the sewer interceptor between the Westerly Wastewater Treatment Facility (WWWTF) and the Easterly Wastewater Treatment Facility (EWWTF). As part of the SSES Phase I project, 10,210 LF of the sewer interceptor was inspected with CCTV, sonar, and laser. The remaining length of the interceptor will be inspected in Spring 2019. The investigation of the trunk sewer will attempt to identify any debris build-up that may cause a reduction in capacity, and limit system storage. The City also plans to conduct a siphon cleaning and evaluation project for five (5) siphons either within or immediately tributary to the interceptor. Since 2012, the City has modified multiple regulators by raising weir heights to increase system storage and reduce CSO overflow volumes.

4.1.3 *NMC 3: Review and modification of pretreatment requirements to ensure that CSO impacts are minimized*

The City of Fitchburg had their *Development of Industrial Pretreatment Technically-Based Local Limits* Report completed in August 2018. This report recommended industrial pretreatment local limits for industrial users and is currently under review by the EPA. The City intends to incorporate the recommendations of the report within one year following EPA approval of the local limits.

4.1.4 *NMC 4: Maximization of flow to the POTW for treatment*

The City investigated the capacity of the interceptor and other sewer pipes 12-inches in diameter and greater with their Hydraulic Model and Capacity Assessment. In addition, the City intends to inspect the sewer interceptor between the WWWTF and the EWWTF, clean select portions of the interceptor, and clean five (5) siphons along and immediately tributary to the interceptor to maximize the capacity of the interceptor carrying wastewater to the EWWTF.

4.1.5 *NMC 5: Elimination of CSOs during dry weather*

The 2002 *Combined Sewer Separation Program & Final Environmental Impacts* Report identified that seven (7) regulators (CSO 002, CSO 003, CSO 032, CSO 033, CSO 037, CSO 048, and CSO 060) in 1995 were undergoing dry weather overflows. The overflows were caused by insufficient weir height and debris plugging the sewer outlet. The issues were resolved before the end of 2001. The City of Fitchburg began documenting dry weather overflows in their yearly CSO Monitoring reports that were required as part of their CD. In 2012, four (4) regulators (CSO 011, CSO 032, CSO 036, and CSO 076) had dry weather overflows. These overflows were caused by blockages in the sewer system. Four (4) regulators (CSO 023 and 033, CSO 004, CSO 030, and CSO 039) had dry weather overflows in 2014. These were caused by blockages, heavy rainfall, and an unknown reason as reported to Mass DEP and EPA. Three (3) dry weather overflows occurred in 2015 at regulators CSO 002, CSO 039, and CSO 032. They were caused by blockages and snowfall/unknown reason as reported to MassDEP and EPA. In 2016, CSO 039 had a dry weather overflow that was caused by a blockage. No dry weather overflows occurred in 2017 and 2018. Once identified, the causes of dry weather overflows have been promptly resolved by the City.

4.1.6 *NMC 6: Control of solid and floatable materials in CSOs*

Solid and floatable materials in CSOs are limited through the use of catch basins with sumps and hoods throughout the City. In addition, the City has trash and recycling pick-ups, street cleaning, and has prohibited littering in the City. These techniques help prevent trash and other materials from entering catch basins and ultimately the combined sewers. In addition, raising weir heights has reduced the total number of CSO occurrences and volumes resulting in a reduction of solids and floatable materials leaving the system through overflows.

4.1.7 *NMC 7: Pollution prevention programs to reduce contaminants in CSOs*

The City utilizes trash and recycling pick-ups, street cleaning, and has prohibited littering. These programs and rules help prevent contaminants from entering the North Nashua River. In addition, industrial pretreatment local limits were recommended in the *Development of Industrial Pretreatment Technically-Based Local Limits* Report, which the City intends to implement within one year following EPA approval of the local limits.

4.1.8 NMC 8: Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts

The City is currently investigating the development of a public notification system for CSO events that includes communities downstream of the City along the North Nashua River. CSO signs are posted across the City in accordance with the City's NPDES Permit. In addition, members of the Wastewater Division in Fitchburg participate in public outreach through radio station and television interviews. The City is also in contact with the Nashua River Watershed Association and Merrimack River Watershed Association regarding public notification of CSO occurrences.

4.1.9 NMC 9: Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls

Since 2012, the City has been actively monitoring CSO regulators to record overflow volumes and occurrences. The City recently developed a Post Construction Monitoring Plan (PCMP) to monitor the CSO controls installed during CSS 1A, 2B, 3C, and 4D. In addition, the Hydraulic Model and Capacity Assessment analyzed the impacts of future rehabilitation work and projected CSO volumes during the one-year, 24 hour and five-year, 24-hour storm events. Summaries of the CSO overflow volumes, occurrences, and meter activity are provided in the City's annual CSO Monitoring Reports and sections 2.2.1 and 2.2.2 of this report.

4.2 Implementation of Additional Tasks Under the Nine Minimum Controls

To achieve full compliance with their NPDES Permit and EPA's CSO Control Policy, the City intends to continue optimizing the wastewater collection system capacity by investigating the options available to adjust pump station discharges and water treatment plant backwash operations to mitigate discharges during wet weather events (NMC #2) and implement a more aggressive catch basin cleaning program to achieve greater functionality during wet weather events (NMC #6). In addition, the City is looking into developing a public notification system for CSO discharge events.

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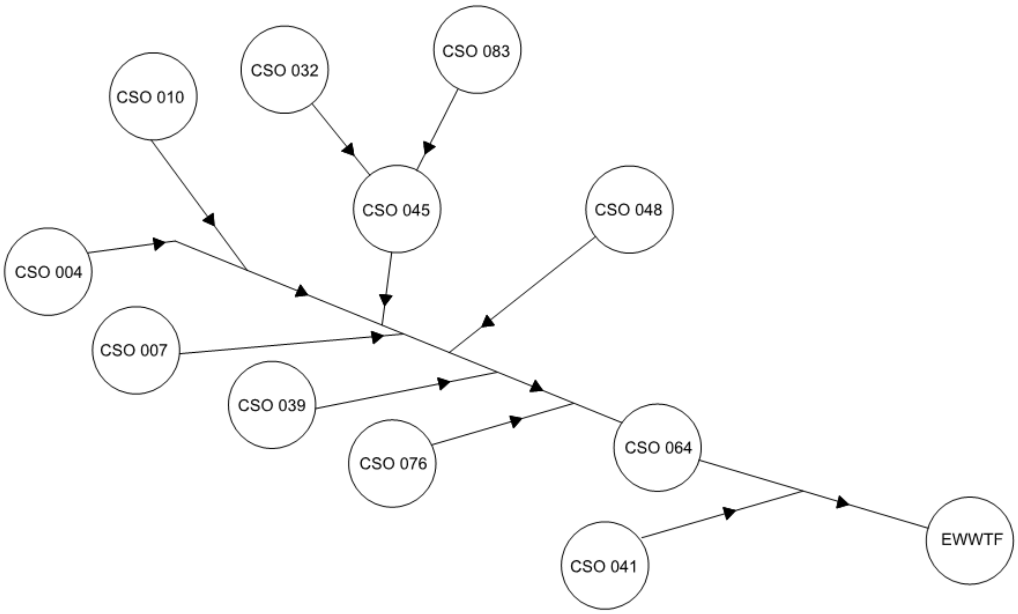
5.0 SEWER SEPARATION UPSTREAM OF CSO REGULATORS

Fitchburg will have to complete 8.4 miles of additional sewer separation to fully separate the remaining combined sewers in the City. Descriptions of the combined sewers tributary to each regulator are provided in the sections below. The following schematic shows the layout of all regulators throughout the City.



5.1 Regulator 004

CSO Regulator 004 is located near the intersection of Oak Hill Road and Oak Hill Lane. In total, there are approximately 3,436 LF of combined sewers tributary to the regulator ranging in diameter from 8-inch to 15-inch. The regulator overflows to Outfall 004, which is located under the Oak Hill Road bridge over the North Nashua River. Ten (10) overflow events occurred in 2018 at this location, discharging approximately 109,000 gallons of combined sewage into the North Nashua River. The regulator has a 55-inch by 36-inch inlet, 12-inch outlet, and 55-inch by 36-inch overflow pipe. The table below documents the combined sewers tributary to CSO 004.

Regulator 004			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Columbus Street	71	0	0
Fairmount Street	1,516	16	1
Madison Street	452	10	3
Plymouth Street	857	19	0
Saint Joseph Avenue	540	10	0
Total	3,436 LF	55	4

5.2 Regulator 007

CSO Regulator 007 is located near the Commercial Street Bridge over the North Nashua River. The regulator is near the edge of the river bank of the North Nashua River and conveys wastewater flow from South Street and Laurel Street to the interceptor located beneath the North Nashua River. Two (2) overflow events were recorded at this location in 2018, discharging approximately 1,075 gallons of combined sewage into the North Nashua River. After the completion of the Hazel Street Sewer Separation Project, no overflow events were observed at this location until 2018. These two overflow events observed in 2018 can be attributed to capacity limitations of the regulator structure. The CSO 007 structure includes a 16-inch inlet and a 12-inch inlet from Laurel Street and South Street, respectively. In addition, the structure has two 8-inch outlets to the interceptor and an 18-inch overflow that discharges through Outfall 007 into the North Nashua River. Winch Street is the only combined sewer location upstream of Regulator 007, totaling approximately 519 LF of 10- and 12-inch VC pipe. Two catch basins are connected into the sewer at this location.

Regulator 007			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Winch Street	519	15	2
Total	519	15	2

5.2.1 Regulator Closure

CSO 007 is currently scheduled for closure in conjunction with the CSO 039, 048, and Clarendon Street Sewer Separation Project, which is discussed in more detail under Regulator 039. Capacity limitations of CSO 007 will be addressed prior to the closure of this regulator. Sewer separation on Winch Street will be included as part of sewer separation upstream of CSO 064.

5.3 Regulator 010

CSO Regulator 010 is located at the intersection of River Street and Main Street. The structure has a 15-inch inlet and overflow, and a 12-inch outlet. The overflow discharges through Outfall 010 into the North Nashua River under the River Street Bridge. In 2018, 20 overflows occurred at this location, discharging approximately 3.8 million gallons of combined sewage into the North Nashua River. CSO 010 is the third largest combined sewer area in the City, with an estimated 5,737 LF of combined sewers present. The combined sewers range in diameter between 6-inch and 12-inch pipe. Information about the combined sewers upstream of CSO 010 is provided in the table on the following page.

Regulator 010			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Arlington Street	149	2	1
Bond Street	1,339	23	8
Chestnut Street	451	9	6
Gibson Place	130	2	0
Goddard Street	491	5	2
Main Street	1,939	27	13
Park Street	360	8	0
School Street	878	15	3
Total	**5,737**	**91**	**33**

5.4 Regulator 032

CSO Regulator 032 is located on Main Street south of the intersection of Main Street and Mechanic Street. This regulator is located upstream of CSO 045. The regulator structure consists of an 18-inch inlet pipe, 18-inch overflow pipe, and an 8-inch outlet pipe. The overflow discharges into a small drainage system that conveys stormwater from Main Street and Circle Street to the North Nashua River under the Circle Street bridge. The outfall discharge enters the North Nashua River through Outfall 032. In 2018, approximately 1.7 million gallons of combined sewage was discharged into the North Nashua River through 35 separate overflow events. Approximately 4,652 LF of combined sewers ranging in diameter from 10-inch to 15-inch are tributary to CSO 032. The combined sewer locations and pertinent information are provided in the table below.

Regulator 032			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Main Street	85	1	1
Mechanic Street	2,009	48	8
Prospect Street	2,252	19	6
View Street	306	2	5
Total	**4,652**	**70**	**20**

5.5 Regulator 039

CSO Regulator 039 is located at the intersection of Water Street and Walnut Street. Overflows discharge into the North Nashua River under the Water Street Bridge. In 2018, 28 overflow events occurred, culminating in approximately 5.2 million gallons of combined sewage discharging into the North Nashua River. The structure contains a 20-inch inlet pipe, 8-inch outlet pipe, and an 18-inch overflow pipe. The combined sewers range in diameter from 6-inch to 20-inch, and total approximately 2,587 LF. A table of the tributary streets to CSO 039 is provided below.

Regulator 039			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Crown Street	220	3	2
Nashua Street	1,011	14	9
Payson Street	252	3	3
Thomas Street	198	3	0
Walnut Street	347	4	3
Washington Street	413	10	0
Water Street	146	2	2
Total	**2,587**	**39**	**19**

5.5.1 Sewer Separation and Regulator Closure

In August 2018, the City of Fitchburg executed a contract for the investigation and design of the CSO 039, 048, and Clarendon Street Sewer Separation Project. This project includes the separation of up to 4,700 LF of combined sewers, including combined sewers tributary to CSO 039, 048, and combined sewers on Clarendon Street, Delisle Street, First Street, Legros Street, and Spruce Street. After construction is complete, CSO regulators 007, 039, and 048 will all be closed. SSES investigation work will be conducted on all tributary sewers prior to design and construction to identify sources of I/I upstream of the combined sewers. Construction for this project is expected to commence in 2020.

5.6 Regulator 041

CSO Regulator 041 is located at the Intersection of Benson Road and Falulah Street. There are no combined sewers upstream of the regulator. According to the City's yearly CSO Monitoring Reports, overflows at this location have been attributed to high levels of inflow. A total of 9 overflow events occurred at this location in 2018, discharging 492,000 gallons of sewage into the Falulah Canal, which flows into a small brook that leads into the North Nashua River. The regulator structure consists of a 12-inch inlet pipe, a 10-inch outlet pipe, and an 18-inch overflow pipe that discharges through Outfall 041. The tributary area of the regulator was investigated in SSES Phase II. During this investigation, a total of seven (7) catch basins were found to be connected to the sewer. These catch basins will be disconnected from the sewer and connected to the stormwater collection system during the closure of Regulator 041. The tributary area is approximately 33,105 LF of sanitary sewers ranging in diameter from 6-inch to 18-inch.

5.7 Regulator 045

CSO Regulator 045 has the largest tributary combined system with an estimated 12,682 LF of combined sewers ranging in diameter between 6-inch VC pipe and 26-inch by 39-inch egg-shaped brick pipe. In addition, both CSO 032 and CSO 083 are located upstream of this regulator. This structure also functions as a combination manhole, as it contains a 30-inch drain. Overflows from this regulator enter the Punch Brook Culvert, which flows through Outfall 045 into the North Nashua River. The Regulator is located at the intersection of Putnam Street and Main Street. The structure consists of multiple catch basin laterals, five (5) sewer inlets ranging in size from 12-inch to 26-inch by 39-inch, a 15-inch sewer outlet, a 26-inch by 39-inch overflow, and the 30-inch drain pipe. The 26-inch by 39-inch sewer inlet is bridged with a half-PVC pipe over the drain side of the structure. In 2018, 31 overflows at Regulator 045 resulted in the discharge of almost 3.8 million gallons of combined sewage.

Regulator 045			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Academy Street	788	5	5
Central Street	128	1	1
Coolidge Street	230	3	1
Elm Street	1,261	10	9
Essex Street	486	6	2
Hartwell Street	303	4	1
High Street	1,013	21	1
Johnson Street	599	11	6
Main Street	1,372	8	9
Marshall Street	1,748	25	9
Merriam Parkway	370	1	0
Mount Globe Street	162	3	2
Nutting Street	651	13	4
Oliver Street	607	8	1
Prichard Street	676	11	3
Putnam Street	245	0	0
Simonds Street	508	4	3
Spring Street	533	12	4
Taft Street	780	1	20*

Regulator 045 (Cont.)			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Wallace Avenue	222	2	2
Total	**12,682**	**149**	**83**

Note:
*Two drainage systems are tributary to the combined sewers on Taft Street. The catch basins on Taft Street include the catch basins that are part of the separated drainage systems.

5.8 Regulator 048

CSO Regulator 048 is located on Water Street near the Central Valley Plaza Shopping Center. The structure has an 18-inch inlet pipe, 12-inch outlet pipe to the sanitary sewer, and an 18-inch overflow pipe. There are no known combined sewers upstream of the regulator. In 2018, 3 overflow events occurred, discharging 4,700 gallons of untreated sewage through Outfall 048 into the North Nashua River under the Water Street Bridge. An estimated 4,251 LF of sanitary sewers are tributary to the regulator.

5.8.1 Regulator Closure

CSO 048 will be closed as part of the CSO 039, 048, and Clarendon Street Sewer Separation Project. Construction for this project is expected to commence in 2020. During the investigation and design phase of the project, tributary sanitary sewers to CSO 048 will be investigated for sources of I/I.

5.9 Regulator 064

CSO Regulator 064 is located on the interceptor near 650 Water Street. Because of its location, the regulator accepts the majority of flow from the City. CSO 041 is the only active regulator not tributary to CSO 064. The combined sewers tributary to CSO 064 vary in location due to the large tributary area and total 12,096 LF. The structure consists of a 48-inch inlet and 30-inch outlet. Overflows enter the North Nashua River from Outfall 064 through an overflow pipe with a partially plugged opening (approximately 15-inch diameter opening). CSO 064 has the largest overflow volume in 2018, with 15.3 million gallons discharged into the North Nashua River from 24 overflow events. Not including other CSO tributary areas, over 313,000 LF of combined and separated sewers are upstream of CSO 064.

Regulator 064			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Allen Place	262	0	4
Beacon Street	294	1	2
Beech Street	647	14	4
Cascade Street	252	7	1
Clarendon Street*	1,248	28	2
Cottage Square**	468	2	6
Daniels Street	354	4	2
Delisle Street*	175	0	1
First Street*	298	3	1
Franklin Road*	263	2	4
Franklin Street	637	4	4
Harugari Street	277	4	1
Highland Avenue	49	0	0
Kimball Street	1,912	17	8
Legros Street*	183	1	2
Leighton Street	997	15	8
Oak Hill Lane	750	2	0
Osgood Street	187	4	2
Pratt Street	1,451	24	5
Putnam Street	309	0	0
Senna Road	548	21	1
Spruce Street*	519	10	2
Water Street	16	0	0
Total	12,096 LF	163	60

Note:
*Streets marked with an asterisk will be separated as part of the CSO 039, 048, and Clarendon Street Sewer Separation Project.
** Streets marked with two (2) asterisks will be separated as part of the City Hall Sewer Separation Project.

Since the majority of CSO regulators are upstream of CSO 064, reduction in overflow volume will not be maximized until separation is conducted upstream of the other regulators. Separation of combined sewers solely tributary to CSO 064 should be conducted last to successfully close the regulator.

5.10 Regulator 076

CSO Regulator 076 is located at the intersection of Birch Street, Heywood Street, and Albee Street. Similar to CSO 041, there are no combined sewers upstream of the regulator. The City of Fitchburg has attributed overflow volumes at this location to high infiltration, poor sewer construction, and undersized pipes in their yearly CSO Monitoring Reports. A portion of the tributary area was investigated during Phase I of the SSES, and the remaining tributary area is not part of the planned SSES phases. Additional investigation work will need to be completed prior to regulator closure. In 2018, five (5) overflow events occurred at this location, with a total overflow volume of 39,460 gallons. Overflows enter the Birch Brook through Outfall 076.

5.11 Regulator 083

CSO Regulator 083 is located at the intersection of Prichard Street and Main Street and is upstream of CSO 045. There are 2,278 LF of combined sewers tributary to the regulator. The regulator structure has a 15-inch inlet, a 12-inch by 18-inch inlet, a 15-inch outlet, and a 12-inch overflow pipe. During overflow events, combined sewage flows to the Punch Brook Culvert, which discharges to the North Nashua River through Outfall 045. In 2018, 15 overflow events occurred at CSO 083, discharging 749,197 gallons of untreated combined sewage to the Punch Brook Culvert.

Regulator 083			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
Goodwin Street	379	0	4
Main Street	50	0	1
Pleasant Street	1,007	16	9
Prichard Street	842	7	3
Total	**2,278**	**23**	**17**

5.12 Combined Sewers Not Tributary to a Regulator

One street in the City has combined sewers that are not tributary to an active regulator – South Street. This street can be considered a source of inflow to the wastewater collection system as it has no discharge location prior to the Easterly Wastewater Treatment Facility. There have been no reported SSOs in this area. The length of the sewer on this street is provided on the following page.

Combined Sewers not Tributary to a CSO Regulator			
Street	Length of Combined Sewer (LF)	Estimated Number of Services	Estimated Number of Catch Basins
South Street	511	4	2
Total	511	4	2

5.13 Combination Manholes

Another source of combined flow in the sewer system is combination manholes. During storm events, transference may occur between the wastewater and stormwater collection systems in these manholes. The City currently investigates all the combined manholes after each storm event greater than two (2) inches in a 24-hour period to determine if transference occurred. This information is documented and reported in the City's Semi-Annual Reports. The City has 180 known combination manholes. Combination manholes that have shown signs of transference will be separated as part of a combination manhole separation program which will be developed in Spring/Summer 2019.

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6.0 ECONOMIC IMPACTS OF SEWER SEPARATION

Under the MassDEP *Guidance for Abatement of Pollution from CSO Discharges*, sewer separation is required unless proven to have "substantial and widespread social and economic impacts". As a result, sewer separation will be considered first in this LTCP, and the results of the cost analysis will determine additional CSO Control options. The MassDEP guidance document also requires that sewer separation is analyzed under EPA's *Economic Guidance for Water Quality Standards*. Under these standards, the following steps should be followed for publicly funded projects.

1. Verify Project Costs and Calculate the Annual Cost of the Pollution Control Project
2. Calculate Total Annualized Pollution Control Costs Per Household
3. Calculate and Evaluate the Municipal Preliminary Screener Score
4. Apply the Secondary Test
5. Assess where the community falls in the Substantial Impacts Matrix

6.1 Verify Project Costs

Complete sewer separation in Fitchburg involves separating 8.4 miles of combined sewers. The table below details the sewer separation projects included in the economic analysis. CSO Regulators 007, 039 and 048 are not included in the table below because the design and construction work have been scheduled and will be completed prior to the start of other separation work. In addition, CSO 032 is not included in the table below because the City has already allocated funding in their Capital Improvement Plan (CIP) to conduct sewer separation upstream of the regulator.

Remaining Combined Sewers				
CSO Regulator	Estimated Separation Length (LF)	Tributary Sanitary Sewers (LF)	Manholes	Combination Manholes
004	3,500	39,250	198	39
010	5,800	6,450	50	7
041*	0	33,100	164	0
045	14,800	21,500	167	4
064**	10,000	162,000	867	58
076***	0	9,700	32	21
083	2,300	1,320	19	0

Note:
* The tributary area of CSO 041 will be investigated as part of SSES Phase II and III.
** Tributary sewers not included will be investigated and rehabilitated/separated in the SSES Program and CSO 039, 048, and Clarendon Street Sewer Separation.
*** Approximately 20,000 LF was investigated as part of the SSES Phase 1 Report. The remaining 9,700 LF of sewers, 32 manholes, and 21 combination manholes will require investigation prior to the closure of CSO 076.

Estimated project costs for each separation project can be placed in two categories: investigation work and construction work. Investigation work includes CCTV inspection, manhole inspections, building inspections, dye testing and flooding, and smoke testing of the combined and sanitary sewers tributary to each CSO regulator. A map of the tributary areas for each CSO is provided in Figure 5. Construction work includes the installation of new PVC sewers, new PVC building connections and wyes, new sanitary sewer manholes, and the replacement of combination manholes with new twin chamber separation manholes. Estimated pipe diameters were based on available flow metering data and estimated reduction in rainfall derived I/I (RDII). The estimated construction costs assume that the existing combined sewer system will be repurposed as a stormwater collection system. Actual pipe diameters may vary and will be finalized during the design phase of each project.

Additional recommended sewer rehabilitation work based on the findings of the investigation work performed upstream of the CSO regulators is not included in the cost. Sewer separation lengths were based on the length of existing combined sewers and may vary after the separation work is complete. The opinion of probable costs for the separation projects are summarized in the table on the following page, and provided in Appendix C.

Estimated Sewer Separation Investigation Capital Costs*			
Regulator	Subtotal	Engineering and Contingency	Total
CSO 004	$390,800	$215,000	$605,800
CSO 010	$125,200	$68,900	$194,100
CSO 041	-	-	-
CSO 045	$346,600	$190,700	$537,300
CSO 064	$974,400	$536,000	$1,510,400
CSO 076	$68,000	$37,400	$105,400
CSO 083	$48,300	$26,600	$74,900
		Subtotal	**$3,027,900**
Estimated Sewer Separation Construction Capital Costs			
Regulator	Subtotal	Engineering and Contingency (Including Post Const. Monitoring)	Total
CSO 004	$2,178,700	$1,228,300	$3,407,000
CSO 010	$2,617,400	$1,439,600	$4,057,000
CSO 041	$508,300	$309,600	$817,900
CSO 045	$6,741,500	$3,747,900	$10,489,400
CSO 064	$4,948,800	$2,776,900	$7,725,700
CSO 076	$394,000	$216,700	$610,700
CSO 083	$1,016,700	$559,200	$1,575,900
		Subtotal	**$28,683,600**
		Total	**$31,711,500**

Note:
*Does not include escalation costs based on construction period between 2019 and 2028

In total, complete sewer separation present worth cost is estimated at $31,711,500. To account for changes in future escalated construction costs, the 2018 Boston Engineering News Record (ENR) Construction Cost Index (CCI) 12-month data-set was used to calculate projected costs for the projects when conducted between 2019 and 2028. The estimated costs are provided in the table on the following page. The ENR calculations are provided in Appendix D. Project start dates were based on the proposed schedule of work in located in Section 8 of this report. It should be noted that the opinion of probable cost is only representative of sewer separation projects and does not address additional projects that may be imposed by requirements from regulatory agencies and future NPDES permits.

Projected Capital Costs Based on the 2018 Boston ENR CCI 12-Month Data-Set			
Regulator	Investigation (Including Engineering/Contingency)	Construction (Including Engineering/Contingency/Post Construction Monitoring)	Total
CSO 004	$694,900	$4,103,000	$4,797,900
CSO 010	$216,400	$4,620,600	$4,837,000
CSO 041	$0	$1,011,700	$1,011,700
CSO 045	$598,800	$11,946,400	$12,545,200
CSO 064	$1,880,700	$10,061,300	$11,942,000
CSO 076	$127,800	$755,500	$883,300
CSO 083	$83,500	$1,794,800	$1,878,300
			$37,895,400

6.2 Total Annualized Pollution Control Costs Per Household

The total annualized pollution control costs per household is the total cost each household should pay to fund wastewater treatment, operation and maintenance, sewer capital costs, and other costs associated with wastewater. In 2018, Tighe & Bond completed the *Wastewater Financial Capability Analysis* for Fitchburg that projected pollution control costs through 2028. Using the average total cost of pollution control between 2019 and 2028, the average total projected cost of existing pollution control in Fitchburg is $15,353,180. Projected costs per year included in the *Wastewater Financial Capability Analysis* are provided in Appendix E.

The *Wastewater Financial Capability Analysis* utilizes the number of residential sewer connections to determine a pollution control cost per household. However, EPA's *Economic Guidance for Water Quality Standards* specifies that the number of households should be used as the basis to determine the cost per household. Using the total number of households allows for the analysis to include households that share a single sewer connection, such as households in apartment buildings. The number of households in Fitchburg was calculated through the City's Parcel GIS data. All residential parcels within 10 meters of a sewer main were assumed to be connected to the wastewater collection system. The number of units located in each parcel was assumed to equal the number of households connected to the wastewater collection system in the City, or 14,336 households. According to the *Wastewater Financial Capability Analysis*, sewer bills in Fitchburg are based on 100% of the water use per connection. Based on water metering data, 67% of water usage in the City is from residential users. As a result, households pay 67% of the costs required for pollution control (Tighe & Bond, *Wastewater Financial Capability Analysis*, 2018). Using the estimated number of households and the percentage of wastewater treatment costs funded through residential sewer rates, the estimated annual cost per household amounts to $718.

Fitchburg Wastewater Costs	Value
Current Cost of Pollution Control	$15,353,180
Household Cost Percentage	67%
Total Cost Paid by Households	$10,286,631
Number of Households	14,336
Cost Per Household	**$718**
Number of Connections	10,127
Cost Per Connection	**$1,016**

When using the estimated number of households based on parcel data, vacant houses/apartments may be incorrectly incorporated in the estimated cost per household. As a result, the estimated cost per household may be lower than the actual cost incurred on each household. In the *Wastewater Financial Capability Analysis*, the number of residential sewer connections (10,127 connections) was utilized to estimate the wastewater treatment cost per household. Using residential connections accurately represents the cost per connection, which may be higher than the cost per household. When using the average cost of pollution control between 2019 and 2028 and the number of house connections, the estimated annual wastewater treatment cost per household is $1,016. Using both the estimated cost per household and estimated cost per connection provides an upper and lower bound to address potential financial impacts of new sewer separation projects.

Under the assumption that the City receives zero grant funding, the separation projects are anticipated to be funded through loans, utilizing the MassDEP State Revolving Fund (SRF) funding. The City was recommended to adjust sewer rates based on future projects through 2028, but the rate increases were not developed in the anticipation of the remaining sewer separation work required to meet state water quality standards. Therefore, modeling pollution control costs based on loans with interest will provide a conservative estimate on the total cost of the remaining sewer separation projects. Using an estimated interest rate of 2% over 20 years, the total annualized sewer separation capital cost amounts to $2,319,200.

Fitchburg Wastewater Costs	Value
Estimated Sewer Separation Capital Costs	$37,895,400
Financing Interest Rate	2%
Financing Time Period	20 Years
Annualization Factor	0.0612
Annualized Sewer Separation Capital Costs	**$2,319,200**

The annualized sewer separation capital cost is the estimated cost per year for the remaining sewer separation projects necessary to meet water quality standards. To estimate the financial impacts of undertaking these capital projects, the annualized sewer separation capital cost should be added to the estimated current cost of pollution control derived from the *Wastewater Financial Capability Analysis*. The adjusted cost per household is then calculated using the percentage of cost paid by households (67%), and the number of households in the City. In addition, the adjusted cost per connection is calculated using the same process as shown in the table below.

Fitchburg Wastewater Costs	Value
Adjusted Cost of Pollution Control	$17,672,380
Household Cost Percentage	67%
Total Cost Paid by Households	$11,840,495
Number of Households	14,336
Adjusted Cost Per Household	**$826**
Adjusted Cost of Pollution Control	$17,672,380
Household Cost Percentage	67%
Total Cost Paid by Households	$11,840,495
Number of Connections	10,127
Adjusted Cost Per Connection	**$1,169**

6.3 Municipal Preliminary Screener Score

The municipal preliminary screener score is a percentage of the total pollution cost per household per the median household income. The median income is the average income of each household in the City, adjusted with annual inflation rates to reflect the current year. The average median income is determined by the United States Census Bureau, and inflation rates are provided by the United States Bureau of Labor Statistics. This data is shown in the following table.

Fitchburg Wastewater Costs	Value
Fitchburg Median Household Income (2016)	$50,617
2017 annual inflation rate	1.8%
2018 annual inflation rate	1.9%
2018 Median Household Income	$52,507
Estimated Inflation Rate (2019-2028)	1.5%
Average Median Household Income (2019-2028)	**$57,040**

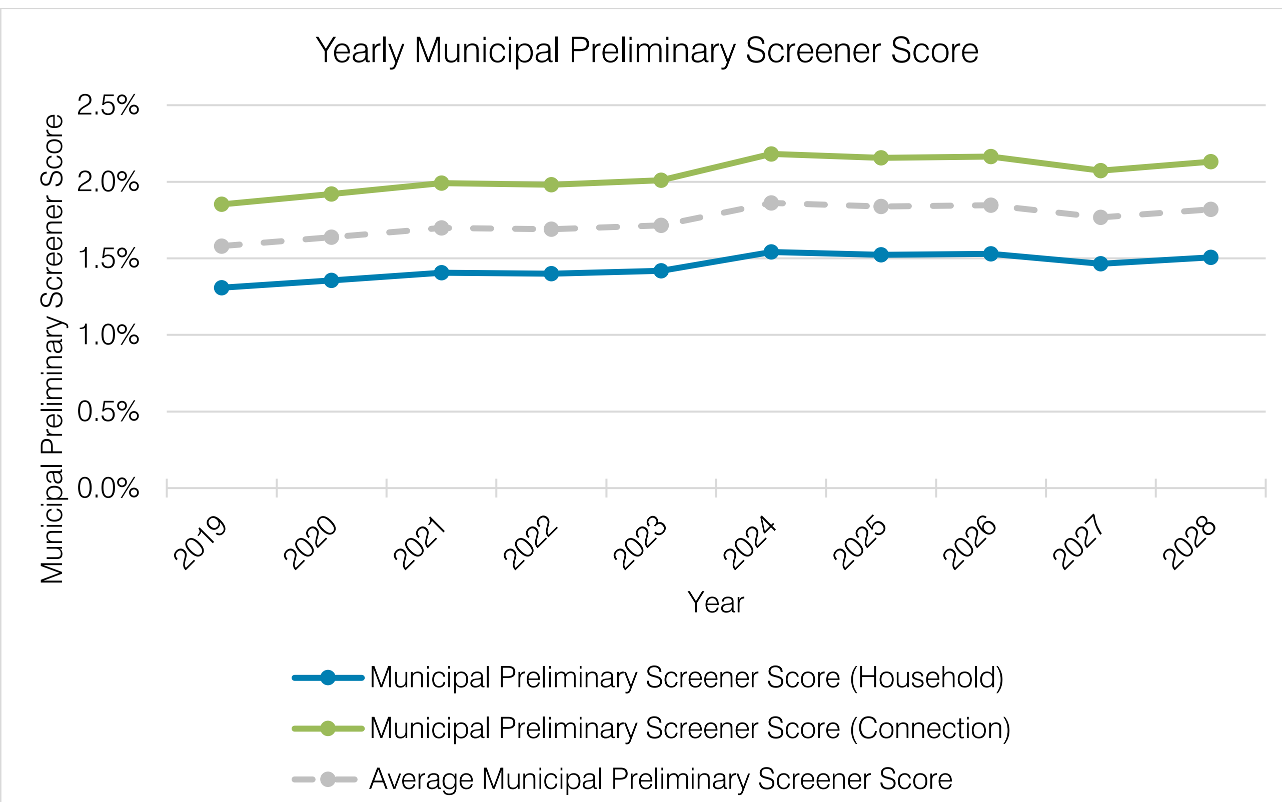
Because Fitchburg's average cost of pollution control was determined through the use of projected sewer costs between 2019 and 2028, the average median household income was averaged across the same time period to provide additional accuracy to the Municipal Preliminary Screener Score. The *Wastewater Financial Capability Analysis* estimated a projected inflation rate of 1.5% (Tighe & Bond, *Wastewater Financial Capability Analysis,* 2018). Using a 1.5% inflation rate, the average median household income in Fitchburg from 2019 to 2028 is an estimated $57,040.

According to EPA's *Economic Guidance for Water Quality Standards*, financial burden from proposed projects may have a widespread economic impact if the municipal preliminary screener exceeds 1%. Based on Fitchburg's adjusted annual sewer bill and adjusted median household income, the City's municipal screener score is as follows:

Household: $$\frac{Adjusted\ Annual\ Sewer\ Bill}{Adjusted\ Median\ Household\ Income} = \frac{\$826}{\$57{,}040} \times 100 = \mathbf{1.4\%}$$

Connection: $$\frac{Adjusted\ Annual\ Sewer\ Bill}{Adjusted\ Median\ Household\ Income} = \frac{\$1{,}169}{\$57{,}040} \times 100 = \mathbf{2.0\%}$$

The municipal preliminary screener score is not consistent throughout each year. The figure below represents the estimated municipal preliminary screener score between 2019 and 2028. Calculations are provided in Appendix E.



Both estimated municipal screener scores exceed 1%, indicating that sewer separation may have widespread economic impacts. If the 1% threshold is exceeded, EPA's *Economic Guidance for Water Quality Standards* requires the use of the Secondary Test consisting of the following three indicator categories:

1. Debt Indicators
2. Socioeconomic Indicators
3. Financial Management Indicators

6.4 The Secondary Test

The Secondary Test utilizes six indicators (in three categories) to determine the extent of financial impact identified using the Municipal Preliminary Screener Score. Each indicator is given a score between one (1) and three (3) to determine each indicator's strength as a representative of the City's ability to finance the required pollution control projects. The average score of the ratings is the City's Secondary Score. The indicator rating system is shown below:

Indicator Score	Community Rating
1	Weak
2	Mid-Range
3	Strong

The ratings of each indicator were calculated ss part of the Financial Capability Analysis. According to EPA's *Economic Guidance for Water Quality Standards*, the following scoring system is used to determine a municipality's ability to undertake the pollution control projects:

Secondary Score	Community Rating
Less Than 1.5	Weak
Between 1.5 and 2.5	Mid-Range
Greater Than 2.5	Strong

Fitchburg's Secondary Score was calculated to equal 2.67 in the *Wastewater Financial Capability Analysis*, indicating a strong ability to finance the water pollution control projects. The ratings from the *Wastewater Financial Capability Analysis* are shown in the following table.

Indicator	Indicator Score
Debt Indicators	
Bond Rating	3
Overall Net Debt as a Percent of Full Market Value of Taxable Property	3
Socioeconomic Indicators	
Unemployment Rate	2
Median Household Income	2
Financial Management Indicators	
Property Tax Revenue as Percent of Full Market Value of Taxable Property	3
Property Tax Collection Rate	3
Secondary Score	2.67

6.5 Substantial Impacts Matrix

When comparing the Municipal Preliminary Screener Score with the Secondary Score, EPA recommends using the following table from the *Economic Guidance for Water Quality Standards* to determine the widespread economic impacts of pollution control projects.

Secondary Score	Municipal Preliminary Screener Score		
	Less than 1.0%	Between 1% and 2%	Greater than 2%
Less Than 1.5	Unknown Impact	Substantial Impact	Substantial Impact
Between 1.5 and 2.5	No Impact	Unknown Impact	Substantial Impact
Greater Than 2.5	No Impact	No Impact	Unknown Impact

EPA recommends that if the Substantial Impacts Matrix falls in an unknown category, the municipality should round to the closest value shown the table above. Since the Municipal Screener Score (connection) is averaged at 2.0%, with a maximum value of 2.2%, and the Secondary Score is greater than 2.5 (2.67%), the municipal screener score (connection) is rounded down and not expected to have a financial impact.

Fitchburg's Municipal Preliminary Screener Score (household) is averaged at 1.4% with a maximum of 1.5%. With the City's Secondary Score (2.67), the pollution control projects are not expected have a substantial economic impact when calculated using the estimated number of households.

6.6 Economic Impact on Lower Income Populations

EPA's *Economic Guidance for Water Quality Standards* indicates sewer separation is not expected to cause widespread economic impact in Fitchburg. However, the impacts from the sewer separation projects are based on median household income and average wastewater expenditures. These values may not reflect the actual economic impacts on lower income households and sensitive areas of the City.

To fully evaluate the economic impacts of sewer separation, the City conducted a more in-depth economic analysis using estimated water usage. After completing the analysis, the estimated wastewater expenditures were found to exceed a screener score of 2% in Fiscal Year 2022 and exceed 3% by Fiscal Year 2028. Since the screener score is based on the median household income, approximately half the residents will experience increased economic impacts not fully represented in the screener score. Fitchburg's 18.5% poverty rate is significantly higher than the 10.5% Massachusetts state-wide poverty rate, indicating that the current proposed schedule is unaffordable for the City. In addition, the City approved a five-year rate structure on March 27, 2018. The approved rate structure is not sustainable when the proposed sewer separation projects are introduced into the City's CIP.

6.7 Revisions to the City's Capital Improvement Plan

To adhere to the December 31, 2030 deadline to meet CSO discharge requirements specified in the CD and achieve the largest environmental benefit, the City plans to adjust their CIP to prioritize the proposed sewer separation projects. Under the adjustments, the City plans to conduct the Tertiary Phosphorus Removal Project, if determined to be needed, after the conclusion of the sewer separation projects. Since the City is currently meeting the interim phosphorus discharge limits required by the CD, and the SSU project currently under construction includes improvements for phosphorus removal, sewer separation will result in the highest environmental benefit. In addition, the sewer separation projects will result in significant improvements to the wastewater collection system and will have the greatest benefit to the City's ratepayers. This proposed schedule will still exceed a 2% screener score according to the City's in-depth rate analysis but will be more affordable for economically sensitive populations in the City.

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7.0 EASTERLY WASTEWATER TREATMENT FACILITY UPGRADES

Fitchburg's EWWTF treats wastewater from the entire City as well as flow from Westminster and Lunenburg. Before recent upgrades, the EWWTF had a peak daily design flow capacity of 12.4 MGD. Flows exceeding the peak hourly flow of 15 MGD were bypassed after primary treatment, which led to violations in the NPDES Permit (Wright-Pierce, *POTW Optimization Evaluation of the Easterly Wastewater Treatment Facility*, 2012).

The 2012 report titled *POTW Optimization Evaluation of the Easterly Wastewater Treatment Facility* recommended three upgrades to the treatment facility to maximize treatment and capacity. These upgrades are listed below:

- Chemically Enhanced Primary Treatment (CEPT) Upgrade
- Secondary System Upgrade (SSU)
- Tertiary Phosphorus Removal Upgrade

However, preliminary performance results of the SSU indicate significant improvements to phosphorus removal will be achieved through the completion of the SSU. In addition, in-depth economic analyses performed by the City indicate that conducting both sewer separation and the Tertiary Phosphorus Removal Upgrade will result in unaffordable economic impacts. As a result, the City plans to re-evaluate the need for the Tertiary Phosphorus Removal Upgrade. If needed, the project will be conducted after the conclusion of the sewer separation projects.

After the implementation of the SSU, the facility would be capable of handling a peak hourly flow capacity of 32 MGD in the summer, 40 MGD in the winter, and 20 MGD during the month of May. The NPDES Permit discharge limits for total suspended solids (TSS), biological oxygen demand (BOD), and ammonia are expected be met up for flows up to 35 MGD using the CEPT and SSU upgrades and the secondary system bypass during extreme wet-weather events (Wright-Pierce, *POTW Optimization Evaluation of the Easterly Wastewater Treatment Facility*, 2012).

7.1 Treatment Capacity After Sewer Separation

In September 2015, a major storm event occurred in Fitchburg. During the storm event, a peak rainfall intensity of 0.69 in./hr. was observed through the City's rain gauges installed during their 2015 flow metering program. This storm event has a similar rainfall intensity to a five-year, 24-hour storm event (peak rainfall intensity of 0.73 in./hr.) During the storm, the EWWTF experienced a peak flow rate of 38.10 MGD.

Under the conservative assumption that the proposed sewer separation projects will successfully reduce rainfall-derived I/I (RDII) by 50% in the metered combined sewer areas, sewer separation may result in a reduction of flow during a storm event with a similar intensity to a five-year, 24-hour storm event by 18.7 MGD. As a result, this would reduce the total flow entering the EWWTF to approximately 19.4 MGD during a similar storm event. After the completion of the SSU, the EWWTF would be able to provide full treatment at this predicted flow rate during all months of operation. If flow rates exceed 20 MGD, the facility would be able to meet current NPDES Permit discharge limits for TSS, BOD, and ammonia for a flow rate up to 35 MGD when utilizing CEPT and the secondary system bypass. The table on the following page estimates the reduction in flow resulting from sewer separation.

Estimated Flow Reductions from Sewer Separation			
Regulator	Meter Basin	Peak Rainfall-Derived Infiltration/Inflow (MGD)*	Estimated Peak Flow Reduction After Separation (MGD)
CSO 004	M03	3.6	1.8
CSO 010	M07A	5.9	3.0
CSO 032**	M21	1.4	0.7
CSO 039	M12	7.9	4.0
CSO 045	M22	10.2	5.1
CSO 064***	M04	2.5	1.3
	M06	2.4	1.2
	M07B****	1.9	1.0
CSO 083	M08	1.2	0.6
			18.7

Note:
*RDII based on a storm event in September 2015 that had a peak rainfall intensity of 0.69 in./hr.
**The gross flow and RDII values for M21 and M17 were used to approximate flow values for CSO 032.
***Estimated RDII reduction for CSO 064 does not include various combined sewers in predominantly separated sewer meter basins.
****M07B includes sewers separated in the Beech and Hazel Street Sewer Separation Project.

Estimated RDII reductions after sewer separation are based on the approximate RDII values generated through the City's 2015 metering data using ADS' Sliicer Program. The reductions in RDII are conservative estimates and do not account for private inflow sources that may be present in the combined sewer areas. In addition, reductions in RDII do not account for loss of flow volume from transference from sewers into the stormwater collection system through combination manholes. As separation projects are completed, the City intends to conduct flow monitoring during Post Construction Monitoring Programs to determine the full impact of sewer separation on combined meter basins.

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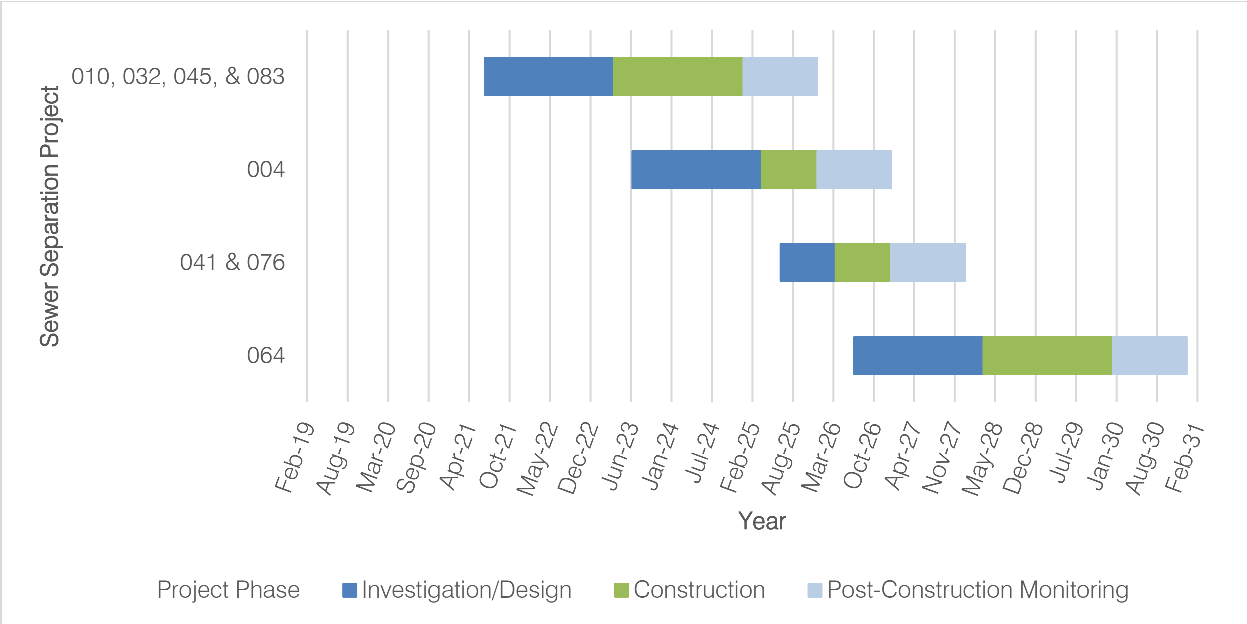
8.0 IMPLEMENTATION SCHEDULE

To achieve water quality goals prior to 2030, Fitchburg intends to implement an aggressive approach towards separating the remaining combined sewers in the wastewater collection system. The sewer separation projects have been prioritized based on the number of historical overflow events, overflow volumes, and based on location of the regulators in the system. CSO 064 has been identified by the City as the largest regulator. Since 9 of the other 10 regulators are located upstream of CSO 064, sewer separation of the entire tributary area (including other regulator tributary areas) is required prior to regulator closure. As a result, this project has been identified as the final sewer separation project to be conducted. The projected project scheduling for the remaining sewer separation projects is provided in the table below and in the figure on the following page. Regulators 007, 039, and 048 are not included in the implementation schedule. These regulators are scheduled for closure during the construction phase of the CSO 039, 048, and Clarendon Street Sewer Separation Project expected to commence in 2020.

Proposed Sewer Separation Schedule			
CSO Separation Project	Investigation/Design	Construction	Post Construction Monitoring
010, 032, 045, & 083	July 2021 – March 2023	April 2023 – December 2024	January 2025 – December 2025
004	July 2023 – March 2025	April 2025 – December 2025	January 2026 – December 2026
041 & 076	July 2025 – March 2026	April 2026 – December 2026	January 2027 – December 2027
064	July 2026 – March 2028	April 2028 – December 2029	January 2030 – December 2030

After CSO 064, the regulator with the next largest contribution in overflow volume and events is CSO 045. Since CSO 032 and 083 are located upstream of CSO 045, closure of CSO 045 may not be feasible until all three project areas have been fully separated. As a result, these three areas have been combined into a single project and prioritized as the first sewer separation project to be conducted. In addition, CSO 010 is included in the first project due to the regulator's proximity to CSO 032, 045, and 083. The remaining projects are prioritized based on the severity of CSO volumes and occurrences.



8.1 Other Tasks

In addition, the City of Fitchburg intends to continue to implement the NMC in the City. To supplement the NMC already in effect, the City intends to optimize their wastewater collection system capacity by investigating the options available to adjust pump station discharges and water treatment plant backwash operations to mitigate discharges during wet weather events. In addition, the City intends to implement a more aggressive catch basin cleaning program to achieve greater functionality during wet weather events. To help raise public awareness and improve communication between the City and downstream communities, the City intends to investigate developing a notification system to alert downstream communities during CSO discharge events. The NMC will continue to be implemented upon the acceptance of the CSO LTCP and will be implemented until the plan for sewer separation is complete.

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9.0 POST CONSTRUCTION MONITORING PLAN

With the conclusion of sewer separation, monitoring will determine that all CSO Controls have been successfully implemented and overflows will no longer occur. EPA identifies in the *2012 CSO Post Construction Compliance Monitoring Guidance* that the following aspects should be included in a Post Construction Monitoring Plan:

- Define Water Quality Impairments and Causes
- Develop a CSO Control Assessment Plan
- Create a Field Sampling Plan

The City of Fitchburg developed an EPA approved Post Construction Monitoring Plan (PCMP) in 2015. The City plans to adhere to the previously approved PCMP when conducting post construction monitoring after the completion of sewer separation projects. However, the City plans to classify 0.25 inches of rainfall as a wet-weather sample instead of the previously approved 0.5 inches of rainfall. This will allow for more storm events to be classified as wet-weather events, leading to more sampling opportunities. In addition, the City plans to utilize EPA's *Post Construction Compliance Monitoring Guidance* report as guidance when performing field sampling.

9.1 North Nashua River Water Quality Impairments

As previously defined in Section 3.4, E. coli from CSO overflows is the major impairment identified in the North Nashua River and other tributary rivers in Fitchburg. With the completion of the proposed sewer separation projects, E. coli sources from the combined sewer system will be removed along with all CSO discharge events.

9.2 CSO Control Assessment Plan

After separation, all sewer flows will be directed to the EWWTF and stormwater will be introduced into the drainage system, eventually flowing into the North Nashua River and nearby tributaries. Monitoring will be necessary to confirm that illicit connections are not present in the drainage system. Sampling of each outfall should be performed to ensure cross connections are not present after construction.

9.3 Field Sampling Plan

Obtaining sampling data for sewer separation projects includes both flow monitoring data and dedicated staff to gather water quality data from each CSO outfall after the conclusion of the respective sewer separation project. In addition, water quality sampling of the nearby tributaries should be performed. Water quality sampling of the North Nashua River will not be required, since the NRWA already conducts sampling each month between April and October for E. coli.

9.3.1 Flow Monitoring

Flow meters will be placed downstream of the newly separated sanitary sewers to record sewer flows and observe system behavior during rain events. The City of Fitchburg owns multiple flow meters that are available for use in each sewer separation project. Flow monitoring is recommended to be conducted for one year after the conclusion of construction.

9.3.2 Water Quality Sampling of CSO Overflows

Sampling of the outfalls after construction will indicate the success of CSO Controls. These samples will be taken during both dry and wet weather events for comparison. The sampling process will follow EPA's 2012 CSO Post Construction Compliance Monitoring Guidance and the City's current EPA approved PCMP.

Sampling Parameters

Sampling data will primarily include tests for pH, temperature, dissolved oxygen, total chlorine, salinity, conductivity, surfactants, ammonia, E. coli, and Enterococcus. Samples will be taken after a storm event over 0.25 inches and will be taken in accordance with 40 CFR Part 136 and the City's current EPA approved PCMP. At a minimum, six (6) sampling rounds will be conducted each year (three dry-weather samples, three wet-weather samples).

Sampling Locations

Sampling for each project will be attempted at the corresponding CSO. However, if outfalls are not accessible, samples may be collected from an upstream manhole. Testing the stormwater in each outfall during rain events will help identify illicit connections that may be connected to the new stormwater collection. The table below identifies the locations of the outfalls for each CSO tributary area.

<table>
<tr><th colspan="4">CSO Outfall Monitoring Locations</th></tr>
<tr><th>CSO Regulator</th><th>Outfall</th><th>Location</th><th>Proposed Sampling Period</th></tr>
<tr><td>CSO 004</td><td>004</td><td>Near the Oak Hill Road Bridge over the North Nashua River</td><td>2026</td></tr>
<tr><td>CSO 007</td><td>007</td><td>Near the Commercial Street Bridge over the North Nashua River</td><td>2021</td></tr>
<tr><td>CSO 010</td><td>010</td><td>Near the River Street Bridge over the North Nashua River</td><td>2025</td></tr>
<tr><td>CSO 032</td><td>032</td><td>Near the Circle Street Bridge over the North Nashua River</td><td>2025</td></tr>
<tr><td>CSO 039</td><td>039</td><td>Under the Water Street Bridge over the North Nashua River</td><td>2021</td></tr>
<tr><td>CSO 041</td><td>041</td><td>On Benson Street into the Falulah Canal</td><td>2027</td></tr>
<tr><td>CSO 045</td><td rowspan="2">045</td><td rowspan="2">At the intersection of Putnam Street and Boulder Drive into the Punch Brook</td><td rowspan="2">2025</td></tr>
<tr><td>CSO 083</td></tr>
<tr><td>CSO 048</td><td>048</td><td>Under the Water Street Bridge over the North Nashua River</td><td>2021</td></tr>
<tr><td>CSO 064</td><td>064</td><td>Near 650 Water Street into the North Nashua River</td><td>2030</td></tr>
<tr><td>CSO 076</td><td>076</td><td>Near the intersection of Birch Street, Heywood Street, and Albee Street into the Birch Brook</td><td>2027</td></tr>
</table>

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FIGURES

FIGURE 1

CITY OF FITCHBURG, MASSACHUETTS
CSO LONG-TERM CONTROL PLAN

SEWER SYSTEM

MARCH 2019 SCALE: NOTED

Weston & Sampson

FIGURE 2

CITY OF FITCHBURG, MASSACHUETTS
CSO LONG-TERM CONTROL PLAN

COMBINED SEWERS AND REGULATORS
(2018 OVERVIEW DATA)

MARCH 2019 SCALE: NOTED

Weston & Sampson

FIGURE 3

CITY OF FITCHBURG, MASSACHUETTS
CSO LONG-TERM CONTROL PLAN

NASHUA RIVER WATERSHED

MARCH 2019 SCALE: NOTED

Weston & Sampson

FIGURE 4

CITY OF FITCHBURG, MASSACHUETTS
CSO LONG-TERM CONTROL PLAN

NRWA SAMPLING LOCATIONS AND RESULTS FOR E. COLI (2009-2018)

MARCH 2019 SCALE: NOTED

Weston & Sampson

FIGURE 5

CITY OF FITCHBURG, MASSACHUETTS
CSO LONG-TERM CONTROL PLAN

PROPOSED SEWER SEPARATION
TRIBUTARY AREAS

MARCH 2019 SCALE: NOTED

Weston & Sampson

APPENDIX A

List of Combined Sewers

Appendix A: List of Combined Sewers

Street	Year of Construction	Length of Combined Sewer (LF)
Academy Street	1890	788
Allen Place	1900	262
Arlington Street	1900	149
Beacon Street	1890	294
Beech Street	1900	647
Bond Street	1890	1,339
Cascade Street	1900	252
Central Street	1890	128
Chestnut Street	1890	451
Clarendon Street	1925	1,248
Columbus Street	1925	71
Coolidge Street	1950	230
Cottage Square	1890	468
Crown Street	1900	220
Daniels Street	1900	354
Delisle Street	1925	175
Elm Street	1890	1,261
Essex Street	1890	486
Fairmount Street	1925	1,516
First Street	1900	298
Franklin Road	1950	263
Franklin Street	1915 & 1925	637
Gibson Place	1980	130
Goddard Street	1890	491
Goodwin Street	1890	379
Hartwell Street	1890	303
Harugari Street	1925	277
High Street	1890	1,013
Highland Avenue	1925	49
Johnson Street	1890	599
Kimball Street	1900 & 1925	1,912
Legros Street	1925	183
Leighton Street	1900	997
Madison Street	1925	452
Main Street	1890	3,446
Marshall Street	1890	1,748
Mechanic Street	1890	2,009
Merriam Parkway	1900	370
Mount Globe Street	1915	162
Nashua Street	1900	1,011
Nutting Street	1890	651
Oak Hill	1925	750
Oliver Street	1890	607
Osgood Street	1925	187
Park Street	1890	360
Payson Street	1900	252

Appendix A: List of Combined Sewers

Street	Year of Construction	Length of Combined Sewer (LF)
Pleasant Street	1890	1007
Plymouth Street	1925	857
Pratt Street	1900 & 1925	1,451
Prichard Street	1890	1,518
Prospect Street	1890 & 1925	2,253
Putnam Street	1890	553
Saint Joseph Avenue	1925	540
School Street	1890	878
Senna Street	1950	548
Simonds Street	1890	508
South Street	1950	511
Spring Street	1890	533
Spruce Street	1900	519
Taft Street	1890	780
Thomas Street	1925	198
View Street	1890	306
Wallace Avenue	1890	222
Walnut Street	1900	347
Washington Street	1900	413
Water Street	1900	162
Winch Street	1925	519
Total		44,498

APPENDIX B

Summary of NRWA Sampling Data

Appendix B: Summary of Nashua River Watershed Association Sampling Data

Year	Month	Mill #3 Farm Stand	Kimball Street Bridge/Route 12 Rotary	Riverfront Park	Hamilton Street Parking Lot, Leominster
		NN3071	NN2888	NN3021	NN1905
		E.coli (CFU/100mL)	E.coli (CFU/100mL)	E.coli (CFU/100mL)	E.coli (CFU/100mL)
2009	April	-	-	-	-
	May	-	201.4	1046.2	456.4
	June	-	172.5	1732.9	410.6
	July	-	298.7	601.5	1203.3
	August	-	980.4	263.4	1986.3
	September	-	1732.9	2419.6	2419.6
	October	-	-	-	2419.6
2010	April	5.2	21.1	1119.9	167
	May	21.8	2419.6	172.5	866.4
	June	42.6	920.8	290.9	191.8
	July	387.3	2419.6	1986.3	2419.6
	August	83.6	2419.8	2419.8	344.8
	September	101.9	2419.6	2419.6	1732.9
	October	1046.2	920.8	1986.3	547.5
2011	April	19.9	290.9	210.5	1732.9
	May	53.8	365.4	686.7	2419.6
	June	85.7	365.4	387.3	2419.6
	July	42.8	387.3	249.5	2419.6
	August	37.9	201.4	178.2	159.7
	September	77.6	122.3	290.9	770.1
	October	365.4	613.1	1203.3	866.4
2012	April	16.9	122.3	1046.2	162.4
	May	344.8	93.3	579.4	501.2
	June	90.6	155.3	1203.3	816.4
	July	61.3	2419.6	2419.6	2419.6
	August	547.5	2419.6	1203.3	816.3
	September	95.9	235.9	81.3	179.3
	October	290.9	224.7	248.1	1986.3
2013	April	7.4	8.3	31.5	51.2
	May	23.1	648.8	12.1	78.9
	June	52	107.6	122.3	201.4
	July	107.6	344.8	129.1	325.5
	August	31.1	75.9	44.1	93.3
	September	155.3	68.9	31.8	103.9
	October	29.2	52.9	32.7	59.4
2014	April	7.5	48.7	60.2	50.4
	May	325.5	1986.3	2419.6	2419.6
	June	77.6	151.5	75.9	95.9
	July	31.1	20.9	18.9	69.5
	August	145.5	178.2	261.3	770.1
	September	224.7	86	33.1	547.5
	October	770.1	517.2	214.2	344.8
2015	April	8.5	26.2	24.9	24.6
	May	17.5	125.9	40.2	53.7
	June	78.9	195.6	83.6	334.8
	July	238.2	913.9	944.5	524.7
	August	80.9	108.1	98.5	365.4
	September	816.4	365.4	261.3	365.4
	October	62.7	35	137.4	83.6

Year	Month	Mill #3 Farm Stand	Kimball Street Bridge/Route 12 Rotary	Riverfront Park	Hamilton Street Parking Lot, Leominster
		NN3071	NN2888	NN3021	NN1905
		E.coli (CFU/100mL)	E.coli (CFU/100mL)	E.coli (CFU/100mL)	E.coli (CFU/100mL)
2016	April	17.1	30.5	27.5	30.5
	May	50.4	59.1	110.6	128.1
	June	53.8	125	178.5	198.9
	July	285.1	727	461.1	488.4
	August	74.9	325.5	298.7	248.1
	September	1046.2	139.1	63.3	517.2
	October	2419.6	2419.6	2419.6	2419.6
2017	April	16.8	-	-	22.6
	May	46.5	114.5	290.9	248.1
	June	9.1	21.4	18.3	36.1
	July	34.1	185	196.8	249.5
	August	-	461.1	727	-
	September	73.3	59.4	118.7	222.4
	October	108.1	65.7	53.8	63.7
2018	April	14.6	-	54.6	24.6
	May	235.9	-	-	122.3
	June	65.7	-	157.6	248.1
	July	112.6	-	218.7	172.7
	August	344.8	-	-	435.2
	September	178.5	-	123.6	290.9
	October	45	-	85	133.6

APPENDIX C

2018 Estimated Sewer Separation Capital Costs

Appendix C: 2018 Estimated Sewer Separation Capital Costs
Summary

Regulator Tributary Areas	Investigation			Construction				Total Cost (Investigation and Construction)
	Subtotal	Engineering and Contingency	Total	Subtotal	Engineering and Contingency	Post Construction Monitoring	Total	
CSO 004	$ 390,800	$ 215,000	$ 605,800	$ 2,178,700	$ 1,198,300	$ 30,000	$ 3,407,000	$ 4,012,800
CSO 010	$ 125,200	$ 68,900	$ 194,100	$ 2,617,400	$ 1,439,600	**	$ 4,057,000	$ 4,251,100
CSO 041				$ 508,300	$ 279,600	$ 30,000	$ 817,900	$ 817,900
CSO 045	$ 346,600	$ 190,700	$ 537,300	$ 6,741,500	$ 3,707,900	$ 40,000	$ 10,489,400	$ 11,026,700
CSO 064	$ 974,400	$ 536,000	$ 1,510,400	$ 4,948,800	$ 2,721,900	$ 55,000	$ 7,725,700	$ 9,236,100
CSO 076	$ 68,000	$ 37,400	$ 105,400	$ 394,000	$ 216,700	***	$ 610,700	$ 716,100
CSO 083	$ 48,300	$ 26,600	$ 74,900	$ 1,016,700	$ 559,200	**	$ 1,575,900	$ 1,650,800
Total			$ 3,027,900				$ 28,683,600	$ 31,711,500*

Note:
* Does not include escalated construction costs based on a construction schedule between 2019 and 2028
** Included with CSO 045
*** Included with CSO 041

Appendix C: 2019 Estimated Sewer Separation Capital Costs
CSO 004

Investigation	Unit Cost	Quantity	Total
Light Cleaning and CCTV Inspection of 8-inch sewers	$ 4.00	35,400	$ 141,600
Light Cleaning and CCTV Inspection of 12-inch sewers	$ 4.00	4,300	$ 17,200
Light Cleaning and CCTV Inspection of 15-inch sewers	$ 6.00	690	$ 4,140
Light Cleaning and CCTV Inspection of 18-inch sewers	$ 6.00	890	$ 5,340
Light Cleaning and CCTV Inspection of 26x39-inch sewers	$ 6.00	270	$ 1,620
Light Cleaning and CCTV Inspection of 28x42-inch sewers	$ 8.00	980	$ 7,840
Light Cleaning and CCTV Inspection of 36x54-inch sewers	$ 8.00	220	$ 1,760
Smoke Testing of Sewers	$ 0.75	42,750	$ 32,063
Dye Tests	$ 100.00	20	$ 2,000
Dye Floods	$ 500.00	5	$ 2,500
CCTV of Pipes During Dye Floods	$ 1.50	5,000	$ 7,500
Manhole/Catch Basin Inspections	$ 100.00	202	$ 20,200
Building Inspections	$ 210.00	700	$ 147,000
Subtotal			$ 390,800
Engineering and Contingency			$ 215,000
Total			$ 605,800

Construction	Unit Cost	Quantity	Total
8-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 200.00	1,950	$ 390,000
12-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 250.00	1,550	$ 387,500
8x6-inch wye and tee, each	$ 500.00	38	$ 19,000
12x6-inch wye and tee, each	$ 600.00	17	$ 10,200
6-inch PVC sewer and building connections, per lin ft (20 ft per service)	$ 50.00	1,100	$ 55,000
4-foot diameter precast concrete manhole base with frame and cover, per manhole	$ 8,000.00	12	$ 96,000
Precast concrete manhole walls and cone, 4-foot diameter, per vertical foot	$ 200.00	96	$ 19,200
7' x 7' precast box manhole base	$ 15,000.00	39	$ 585,000
7' x 7' precast box manhole walls and top slab	$ 200.00	360	$ 72,000
precast concrete catch basin with frame and grate, per catch basin (50% replacement)	$ 6,000.00	2	$ 12,000
Earth Excavation and backfill above normal grade, per cubic yard (10% of total earthwork)	$ 30.00	510	$ 15,300
Earth Excavation and backfill below normal grade, per cubic yard	$ 40.00	-	$ -
Additional crushed stone, per cubic yard	$ 60.00	100	$ 6,000
Additional gravel, per cubic yard	$ 30.00	100	$ 3,000
Test Pits, per cubic yard	$ 30.00	100	$ 3,000
Rock Excavation and disposal, per cubic yard (min.) - 10% of total earthwork	$ 60.00	510	$ 30,600
Rock Excavation and disposal, per cubic yard (add'l.) - 10% of rock excavation	$ 60.00	51	$ 3,060
Relocation of existing utilities	$ 5,000.00	2	$ 10,000
dewatering, lump sum	$ 30,000.00	1	$ 30,000
Temporary Pavement, per ton (Length of Sewer x 5 feet x 4 in x 4050 lb per cu yd)	$ 150.00	440	$ 66,000
Pavement Milling, per sq yd (Length of sewer x 25 ft)	$ 15.00	9,722	$ 145,830
Permanent Binder Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	1,100	$ 110,000
Permanent Top Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	1,100	$ 110,000
Subtotal			$ 2,178,700
Engineering and Contingency			$ 1,198,300
Post Construction Monitoring			$ 30,000
Total			$ 3,407,000

Appendix C: 2019 Estimated Sewer Separation Capital Costs
CSO 010

Investigation	Unit Cost	Quantity	Total
Light Cleaning and CCTV Inspection of 6-inch sewers	$ 4.00	350	$ 1,400
Light Cleaning and CCTV Inspection of 8-inch sewers	$ 4.00	4,900	$ 19,600
Light Cleaning and CCTV Inspection of 10-inch sewers	$ 4.00	4,200	$ 16,800
Light Cleaning and CCTV Inspection of 12-inch sewers	$ 4.00	2,750	$ 11,000
Light Cleaning and CCTV Inspection of 15-inch sewers	$ 6.00	50	$ 300
Smoke Testing of Sewers	$ 0.75	12,250	$ 9,188
Dye Tests	$ 100.00	40	$ 4,000
Dye Floods	$ 500.00	20	$ 10,000
CCTV of Pipes During Dye Floods	$ 1.50	5,000	$ 7,500
Manhole/Catch Basin Inspections	$ 100.00	90	$ 9,000
Building Inspections	$ 210.00	180	$ 37,800
Subtotal			$ 125,200
Engineering and Contingency			$ 68,900
Total			$ 194,100

Construction	Unit Cost	Quantity	Total
8-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 200.00	4,600	$ 920,000
10-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 200.00	400	$ 80,000
12-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 250.00	800	$ 200,000
8x6-inch wye and tee, each	$ 500.00	71	$ 35,500
10x6-inch wye and tee, each	$ 500.00	5	$ 2,500
12x6-inch wye and tee, each	$ 600.00	15	$ 9,000
6-inch PVC sewer and building connections, per lin ft (10 ft per service)	$ 50.00	1,780	$ 89,000
4-foot diameter precast concrete manhole base with frame and cover, per manhole	$ 8,000.00	19	$ 152,000
Precast concrete manhole walls and cone, 4-foot diameter, per vertical foot	$ 200.00	152	$ 30,400
7' x 7' precast box manhole base	$ 15,000.00	7	$ 105,000
7' x 7' precast box manhole walls and top slab	$ 200.00	56	$ 11,200
precast concrete catch basin with frame and grate, per catch basin (50% replacement)	$ 6,000.00	17	$ 102,000
Earth Excavation and backfill above normal grade, per cubic yard (10% of total earthwork)	$ 30.00	830	$ 24,900
Earth Excavation and backfill below normal grade, per cubic yard	$ 40.00	30	$ 1,200
Additional crushed stone, per cubic yard	$ 60.00	100	$ 6,000
Additional gravel, per cubic yard	$ 30.00	100	$ 3,000
Test Pits, per cubic yard	$ 30.00	100	$ 3,000
Rock Excavation and disposal, per cubic yard (min.) - 10% of total earthwork	$ 60.00	850	$ 51,000
Rock Excavation and disposal, per cubic yard (add'l.) - 10% of rock excavation	$ 60.00	85	$ 5,100
Relocation of existing utilities	$ 5,000.00	2	$ 10,000
dewatering, lump sum	$ 30,000.00	1	$ 30,000
Temporary Pavement, per ton (Length of Sewer x 5 feet x 4 in x 4050 lb per cu yd)	$ 150.00	575	$ 86,250
Pavement Milling, per sq yd (Length of sewer x 30 ft)	$ 15.00	15,333.33	$ 230,000
Permanent Binder Course Pavement, per ton (30 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	2151.375	$ 215,138
Permanent Top Course Pavement, per ton (30 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	2151.375	$ 215,138
Subtotal			$ 2,617,400
Engineering and Contingency			$ 1,439,600
Post Construction Monitoring (to be included with CSO 045 as part of the CSO 010, 032, 045 and 083 Separation Project)			$ -
Total			$ 4,057,000

Appendix C: 2019 Estimated Sewer Separation Capital Costs
CSO 041

Construction	Unit Cost	Quantity	Total
12-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 300.00	1,250	$ 375,000
8x6-inch wye and tee, each	$ 500.00	4	$ 2,000
6-inch PVC sewer and building connections, per lin ft (20 ft per service)	$ 50.00	80	$ 4,000
4-foot diameter precast concrete manhole base with frame and cover, per manhole	$ 8,000.00	5	$ 40,000
Precast concrete manhole walls and cone, 4-foot diameter, per vertical foot	$ 200.00	40	$ 8,000
7' x 7' precast box manhole base, per manhole	$ 15,000.00	-	$ -
7' x 7' precast box manhole walls and top slab, per vertical foot	$ 200.00	-	$ -
precast concrete catch basin with frame and grate, per catch basin (50% replacement)	$ 6,000.00	-	$ -
Earth Excavation and backfill above normal grade, per cubic yard (10% of total earthwork)	$ 30.00	190	$ 5,700
Earth Excavation and backfill below normal grade, per cubic yard	$ 40.00	-	$ -
Additional crushed stone, per cubic yard	$ 60.00	50	$ 3,000
Additional gravel, per cubic yard	$ 30.00	50	$ 1,500
Test Pits, per cubic yard	$ 30.00	50	$ 1,500
Rock Excavation and disposal, per cubic yard (min.) - 10% of total earthwork	$ 60.00	190	$ 11,400
Rock Excavation and disposal, per cubic yard (add'l.) - 10% of rock excavation	$ 60.00	20	$ 1,200
Relocation of existing utilities	$ 5,000.00	1	$ 5,000
dewatering, lump sum	$ 10,000.00	1	$ 10,000
Temporary Pavement, per ton (Length of Sewer x 5 feet x 4 in x 4050 lb per cu yd)	$ 150.00	160	$ 24,000
Pavement Milling, per sq yd (Length of sewer x 30 ft)	$ 15.00	-	$ -
Permanent Binder Course Pavement, per ton (5 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	80	$ 8,000
Permanent Top Course Pavement, per ton (5 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	80	$ 8,000
Subtotal			$ 508,300
Engineering and Contingency			$ 279,600
Post Construction Monitoring (Includes CSO 076 as part of the CSO 041 and 076 Separation Project			$ 30,000
Total			$ 817,900

Appendix C: 2019 Estimated Sewer Separation Capital Costs
CSO 045

Investigation	Unit Cost	Quantity	Total
Light Cleaning and CCTV Inspection of 6-inch sewers	$ 4.00	550	$ 2,200
Light Cleaning and CCTV Inspection of 8-inch sewers	$ 4.00	11,400	$ 45,600
Light Cleaning and CCTV Inspection of 10-inch sewers	$ 4.00	5,450	$ 21,800
Light Cleaning and CCTV Inspection of 12-inch sewers	$ 4.00	14,150	$ 56,600
Light Cleaning and CCTV Inspection of 15-inch sewers	$ 6.00	3100	$ 18,600
Light Cleaning and CCTV Inspection of 18-inch sewers	$ 6.00	250	$ 1,500
Light Cleaning and CCTV Inspection of 26x39-inch sewers	$ 8.00	1400	$ 11,200
Smoke Testing of Sewers	$ 0.75	36,300	$ 27,225
Dye Tests	$ 100.00	50	$ 5,000
Dye Floods	$ 500.00	25	$ 12,500
CCTV of Pipes During Dye Floods	$ 1.50	5,000	$ 7,500
Manhole/Catch Basin Inspections	$ 100.00	255	$ 25,500
Building Inspections	$ 210.00	530	$ 111,300
Subtotal			$ 346,600
Engineering and Contingency			$ 190,700
Total			$ 537,300

Construction	Unit Cost	Quantity	Total
8-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 200.00	7,200	$ 1,440,000
10-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 250.00	2,000	$ 500,000
12-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 250.00	1,250	$ 312,500
15-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 300.00	2,150	$ 645,000
18-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 300.00	1,000	$ 300,000
24-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 350.00	1,200	$ 420,000
8x6-inch wye and tee, each	$ 500.00	70	$ 35,000
10x6-inch wye and tee, each	$ 500.00	30	$ 15,000
12x6-inch wye and tee, each	$ 600.00	20	$ 12,000
15x6-inch wye and tee, each	$ 600.00	20	$ 12,000
18x6-inch wye and tee, each	$ 800.00	10	$ 8,000
24x6-inch wye and tee, each	$ 800.00	10	$ 8,000
6-inch PVC sewer and building connections, per lin ft (20 ft per service)	$ 50.00	3,200	$ 160,000
4-foot diameter precast concrete manhole base with frame and cover, per manhole	$ 8,000.00	50	$ 400,000
Precast concrete manhole walls and cone, 4-foot diameter, per vertical foot	$ 200.00	500	$ 100,000
7' x 7' precast box manhole base	$ 15,000.00	4	$ 60,000
7' x 7' precast box manhole walls and top slab	$ 200.00	36	$ 7,200
precast concrete catch basin with frame and grate, per catch basin (50% replacement)	$ 6,000.00	42	$ 252,000
Earth Excavation and backfill above normal grade, per cubic yard (10% of total earthwork)	$ 30.00	3,500	$ 105,000
Earth Excavation and backfill below normal grade, per cubic yard	$ 40.00	130	$ 5,200
Additional crushed stone, per cubic yard	$ 60.00	200	$ 12,000
Additional gravel, per cubic yard	$ 30.00	200	$ 6,000
Test Pits, per cubic yard	$ 30.00	200	$ 6,000
Rock Excavation and disposal, per cubic yard (min.) - 10% of total earthwork	$ 60.00	220	$ 13,200
Rock Excavation and disposal, per cubic yard (add'l.) - 10% of rock excavation	$ 60.00	220	$ 13,200
Relocation of existing utilities	$ 5,000.00	4	$ 20,000
dewatering, lump sum	$ 50,000.00	1	$ 50,000
Temporary Pavement, per ton (Length of Sewer x 5 feet x 4 in x 4050 lb per cu yd)	$ 150.00	1,850	$ 277,500
Pavement Milling, per sq yd (Length of sewer x 25 ft)	$ 15.00	41,111	$ 616,665
Permanent Binder Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	4650	$ 465,000
Permanent Top Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	4650	$ 465,000
Subtotal			$ 6,741,500
Engineering and Contingency			$ 3,707,900
Post Construction Monitoring (Includes CSO 010, 032, and 083 as part of the CSO 010, 032, 045, and 083 Separation Project)			$ 40,000
Total			$ 10,489,400

Investigation	Unit Cost	Quantity	Total
Light Cleaning and CCTV Inspection of 6-inch sewers	$ 4.00	3,700	$ 14,800
Light Cleaning and CCTV Inspection of 8-inch sewers	$ 4.00	102,000	$ 408,000
Light Cleaning and CCTV Inspection of 10-inch sewers	$ 4.00	21,500	$ 86,000
Light Cleaning and CCTV Inspection of 12-inch sewers	$ 4.00	26,500	$ 106,000
Light Cleaning and CCTV Inspection of 14x21-inch sewers	$ 6.00	450	$ 2,700
Light Cleaning and CCTV Inspection of 15-inch sewers	$ 6.00	7,600	$ 45,600
Light Cleaning and CCTV Inspection of 18-inch sewers	$ 6.00	3,900	$ 23,400
Light Cleaning and CCTV Inspection of 18x27-inch sewers	$ 6.00	550	$ 3,300
Light Cleaning and CCTV Inspection of 20-inch sewers	$ 8.00	2150	$ 17,200
Light Cleaning and CCTV Inspection of 20x30-inch sewers	$ 6.00	2600	$ 15,600
Light Cleaning and CCTV Inspection of 22x33-inch sewers	$ 8.00	650	$ 5,200
Light Cleaning and CCTV Inspection of 24-inch sewers	$ 8.00	400	$ 3,200
Smoke Testing of Sewers	$ 0.75	172,000	$ 129,000
Dye Tests	$ 100.00	50	$ 5,000
Dye Floods	$ 500.00	25	$ 12,500
CCTV of Pipes During Dye Floods	$ 1.50	5,000	$ 7,500
Manhole/Catch Basin Inspections	$ 100.00	894	$ 89,400
Building Inspections	$ 210.00		$ -
Subtotal			$ 974,400
Engineering and Contingency			$ 536,000
Total			$ 1,510,400

Construction	Unit Cost	Quantity	Total
8-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 200.00	7,150	$ 1,430,000
8-inch PVC Sewers, per lin ft (Over 12 ft depth)	$ 300.00	500	$ 150,000
12-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 250.00	2,000	$ 500,000
8x6-inch wye and tee, each	$ 500.00	90	$ 45,000
12x6-inch wye and tee, each	$ 600.00	10	$ 6,000
6-inch PVC sewer and building connections, per lin ft (20 ft per service)	$ 50.00	2,000	$ 100,000
4-foot diameter precast concrete manhole base with frame and cover, per manhole	$ 8,000.00	33	$ 264,000
Precast concrete manhole walls and cone, 4-foot diameter, per vertical foot	$ 200.00	297	$ 59,400
7' x 7' precast box manhole base	$ 15,000.00	58	$ 870,000
7' x 7' precast box manhole walls and top slab	$ 200.00	550	$ 110,000
precast concrete catch basin with frame and grate, per catch basin (50% replacement)	$ 6,000.00	24	$ 144,000
Earth Excavation and backfill above normal grade, per cubic yard (10% of total earthwork)	$ 30.00	1,325	$ 39,750
Earth Excavation and backfill below normal grade, per cubic yard	$ 40.00	200	$ 8,000
Additional crushed stone, per cubic yard	$ 60.00	100	$ 6,000
Additional gravel, per cubic yard	$ 30.00	100	$ 3,000
Test Pits, per cubic yard	$ 30.00	100	$ 3,000
Rock Excavation and disposal, per cubic yard (min.) - 10% of total earthwork	$ 60.00	160	$ 9,600
Rock Excavation and disposal, per cubic yard (add'l.) - 10% of rock excavation	$ 60.00	16	$ 960
Relocation of existing utilities	$ 5,000.00	3	$ 15,000
dewatering, lump sum	$ 50,000.00	1	$ 50,000
Temporary Pavement, per ton (Length of Sewer x 5 feet x 4 in x 4050 lb per cu yd)	$ 150.00	1,150	$ 172,500
Pavement Milling, per sq yd (Length of sewer x 25 ft)	$ 15.00	25,500	$ 382,500
Permanent Binder Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	2900	$ 290,000
Permanent Top Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	2900	$ 290,000
Subtotal			$ 4,948,800
Engineering and Contingency			$ 2,721,900
Post Construction Monitoring			$ 55,000
Total			$ 7,725,700

Appendix C: 2019 Estimated Sewer Separation Capital Costs
CSO 076

Investigation	Unit Cost	Quantity	Total
Light Cleaning and CCTV Inspection of 8-inch sewers	$ 4.00	6,795	$ 27,180
Light Cleaning and CCTV Inspection of 10-inch sewers	$ 4.00	2,090	$ 8,360
Light Cleaning and CCTV Inspection of 12-inch sewers	$ 4.00	815	$ 3,260
Smoke Testing of Sewers	$ 0.75	9,700	$ 7,275
Dye Tests	$ 100.00	10	$ 1,000
Dye Floods	$ 500.00	5	$ 2,500
CCTV of Pipes During Dye Floods	$ 1.50	5,000	$ 7,500
Manhole Inspections	$ 100.00	46	$ 4,600
Building Inspections	$ 210.00	30	$ 6,300
Subtotal			$ 68,000
Engineering and Contingency			$ 37,400
Total			$ 105,400

Construction	Unit Cost	Quantity	Total
12-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 300.00	90	$ 27,000
8x6-inch wye and tee, each	$ 500.00	1	$ 500
6-inch PVC sewer and building connections, per lin ft (20 ft per service)	$ 50.00	20	$ 1,000
4-foot diameter precast concrete manhole base with frame and cover, per manhole	$ 8,000.00	3	$ 24,000
Precast concrete manhole walls and cone, 4-foot diameter, per vertical foot	$ 200.00	27	$ 5,400
7' x 7' precast box manhole base, per manhole	$ 15,000.00	19	$ 285,000
7' x 7' precast box manhole walls and top slab, per vertical foot	$ 200.00	152	$ 30,400
precast concrete catch basin with frame and grate, per catch basin (50% replacement)	$ 6,000.00	-	$ -
Earth Excavation and backfill above normal grade, per cubic yard (10% of total earthwork)	$ 30.00	15	$ 450
Earth Excavation and backfill below normal grade, per cubic yard	$ 40.00	-	$ -
Additional crushed stone, per cubic yard	$ 60.00	10	$ 600
Additional gravel, per cubic yard	$ 30.00	10	$ 300
Test Pits, per cubic yard	$ 30.00	10	$ 300
Rock Excavation and disposal, per cubic yard (min.) - 10% of total earthwork	$ 60.00	15	$ 900
Rock Excavation and disposal, per cubic yard (add'l.) - 10% of rock excavation	$ 60.00	2	$ 120
Relocation of existing utilities	$ 5,000.00	1	$ 5,000
dewatering, lump sum	$ 10,000.00	1	$ 10,000
Temporary Pavement, per ton (Length of Sewer x 5 feet x 4 in x 4050 lb per cu yd)	$ 150.00	12	$ 1,800
Pavement Milling, per sq yd (Length of sewer x 30 ft)	$ 15.00	-	$ -
Permanent Binder Course Pavement, per ton (5 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	6	$ 600
Permanent Top Course Pavement, per ton (5 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	6	$ 600
Subtotal			$ 394,000
Engineering and Contingency			$ 216,700
Post Construction Monitoring (to be included CSO 041 as part of the CSO 041 and 076 Separation Project			$ -
Total			$ 610,700

Appendix C: 2019 Estimated Sewer Separation Capital Costs
CSO 083

Investigation	Unit Cost	Quantity	Total
Light Cleaning and CCTV Inspection of 6-inch sewers	$ 4.00	675	$ 2,700
Light Cleaning and CCTV Inspection of 8-inch sewers	$ 4.00	645	$ 2,580
Light Cleaning and CCTV Inspection of 10-inch sewers	$ 4.00	250	$ 1,000
Light Cleaning and CCTV Inspection of 12-inch sewers	$ 4.00	545	$ 2,180
Light Cleaning and CCTV Inspection of 15-inch sewers	$ 6.00	665	$ 3,990
Light Cleaning and CCTV Inspection of 12x18-inch sewers	$ 6.00	840	$ 5,040
Smoke Testing of Sewers	$ 0.75	3,620	$ 2,715
Dye Tests	$ 100.00	25	$ 2,500
Dye Floods	$ 500.00	12	$ 6,000
CCTV of Pipes During Dye Floods	$ 1.50	5,000	$ 7,500
Manhole/Catch Basin Inspections	$ 100.00	19	$ 1,900
Building Inspections	$ 210.00	61	$ 12,810
Subtotal			$ 48,300
Engineering and Contingency			$ 26,600
Total			$ 74,900

Construction	Unit Cost	Quantity	Total
8-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 200.00	2,050	$ 410,000
10-inch PVC Sewers, per lin ft (0-12 ft depth)	$ 250.00	250	$ 62,500
8x6-inch wye and tee, each	$ 500.00	18	$ 9,000
10x6-inch wye and tee, each	$ 500.00	5	$ 2,500
6-inch PVC sewer and building connections, per lin ft (20 ft per service)	$ 50.00	460	$ 23,000
4-foot diameter precast concrete manhole base with frame and cover, per manhole	$ 8,000.00	8	$ 64,000
Precast concrete manhole walls and cone, 4-foot diameter, per vertical foot	$ 200.00	80	$ 16,000
7' x 7' precast box manhole base, per manhole	$ 15,000.00	-	$ -
7' x 7' precast box manhole walls and top slab, per vertical foot	$ 200.00	-	$ -
precast concrete catch basin with frame and grate, per catch basin (50% replacement)	$ 6,000.00	9	$ 54,000
Earth Excavation and backfill above normal grade, per cubic yard (10% of total earthwork)	$ 30.00	430	$ 12,900
Earth Excavation and backfill below normal grade, per cubic yard	$ 40.00	-	$ -
Additional crushed stone, per cubic yard	$ 60.00	100	$ 6,000
Additional gravel, per cubic yard	$ 30.00	100	$ 3,000
Test Pits, per cubic yard	$ 30.00	100	$ 3,000
Rock Excavation and disposal, per cubic yard (min.) - 10% of total earthwork	$ 60.00	430	$ 25,800
Rock Excavation and disposal, per cubic yard (add'l.) - 10% of rock excavation	$ 60.00	43	$ 2,580
Relocation of existing utilities	$ 5,000.00	2	$ 10,000
dewatering, lump sum	$ 30,000.00	1	$ 30,000
Temporary Pavement, per ton (Length of Sewer x 5 feet x 4 in x 4050 lb per cu yd)	$ 150.00	290	$ 43,500
Pavement Milling, per sq yd (Length of sewer x 25 ft)	$ 15.00	6,325.00	$ 94,875
Permanent Binder Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	720	$ 72,000
Permanent Top Course Pavement, per ton (25 ft x length of sewer x 2 in x 4050 lb per cu yd)	$ 100.00	720	$ 72,000
Subtotal			$ 1,016,700
Engineering and Contingency			$ 559,200
Post Construction Monitoring (to be included with CSO 045 as part of the CSO 010, 032, 045 and 083 Separation Project)			$ -
Total			$ 1,575,900

APPENDIX D

ENR Construction Cost Index Projections

Appendix D: ENR Construction Cost Index Projections
2018 Boston ENR CCI 12-Month Dataset

CSO	Investigation Cost 2018	January 2019 ENR	Inv. Start Date	Inv. Start Date ENR	Adjusted Investigation Cost	Construction Cost 2018	Const. Start Date	Const. Start Date ENR	Adjusted Construction Cost	Total
004	$605,800	14547.09	July 2023	16686.50	$694,900	$3,407,000	April 2025	17518.50	$4,103,000	$4,797,900
010	$194,100	14547.09	July 2021	16211.08	$216,400	$4,057,000	April 2023	16567.65	$4,620,600	$4,837,000
041	$0	14547.09	July 2025	17637.35	$0	$817,900	April 2026	17993.92	$1,011,700	$1,011,700
045	$537,300	14547.09	July 2021	16211.08	$598,800	$10,489,400	April 2023	16567.65	$11,946,400	$12,545,200
064	$1,510,400	14547.09	July 2026	18112.78	$1,880,700	$7,725,700	April 2028	18944.78	$10,061,300	$11,942,000
076	$105,400	14547.09	July 2025	17637.35	$127,800	$610,700	April 2026	17993.92	$755,500	$883,300
083	$74,900	14547.09	July 2021	16211.08	$83,500	$1,575,900	April 2023	16567.65	$1,794,800	$1,878,300
Total	$3,027,900				$3,602,100	$28,683,600			$34,293,300	$37,895,400

APPENDIX E

Estimated Expenditures for the Wastewater Division

	Fiscal Year								
	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
Annual Debt Service (Principal and Interest)*	$ 2,974,396	$ 2,754,767	$ 2,804,284	$ 2,722,003	$ 3,515,745	$ 8,265,748	$ 4,118,642	$ 4,068,914	$ 3,768,191
O&M Costs*	$ 6,446,652	$ 5,989,906	$ 5,800,334	$ 5,684,131	$ 5,123,777	$ 5,154,964	$ 6,630,123	$ 6,290,084	$ 6,395,886
Capital Costs*	$ 2,176,300	$ 11,861,597	$ 7,156,709	$ 9,868,278	$ 5,856,093	$ 960,788	$ 1,687,487	$ 2,242,284	$ 3,212,836
Total Cost*	$11,597,348	$20,606,271	$15,761,327	$18,274,412	$14,495,616	$14,465,100	$ 12,436,251	$ 12,601,282	$ 13,376,912

	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28
Annual Debt Service (Principal and Interest)*	$ 3,742,456	$ 3,711,787	$ 3,681,083	$ 3,650,311	$ 3,620,673	$ 3,544,783	$ 2,859,586	$ 2,733,740
O&M Costs*	$ 6,555,323	$ 6,720,891	$ 6,888,913	$ 7,061,136	$ 7,237,664	$ 7,418,606	$ 7,604,071	$ 7,794,173
Capital Costs*	$ 3,905,256	$ 3,936,329	$ 4,291,259	$ 5,903,906	$ 5,811,397	$ 6,073,941	$ 6,018,441	$ 6,787,881
Total Cost*	$ 14,203,035	$ 14,369,007	$ 14,861,254	$ 16,615,353	$ 16,669,734	$ 17,037,330	$ 16,482,098	$ 17,315,794

	Year												
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Median Household Income	$50,617	$51,528	$52,507	$53,295	$54,094	$54,906	$55,729	$56,565	$57,414	$58,275	$59,149	$60,036	$60,937
Annual Inflation Rate**		1.8%	1.9%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%

Average Total Projected Sewer Service Cost	$15,353,180
Average Median Household Income (2019-2028)	$57,040

Estimated Sewer Separation Capital Cost	$37,895,400
Annualization Factor	0.0612
Annualized Sewer Separation Cost	$2,319,200

	Year									
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Adjusted Cost of Pollution Control	$14,920,482	$15,696,112	$16,522,235	$16,688,207	$17,180,454	$18,934,553	$18,988,934	$19,356,530	$18,801,298	$19,634,994
Cost Paid by Household (67%)	$9,996,723	$10,516,395	$11,069,897	$11,181,098	$11,510,904	$12,686,151	$12,722,586	$12,968,875	$12,596,870	$13,155,446
Cost per Household	$697.32	$733.57	$772.17	$779.93	$802.94	$884.92	$887.46	$904.64	$878.69	$917.65
Cost per Connection	$987.14	$1,038.45	$1,093.11	$1,104.09	$1,136.65	$1,252.71	$1,256.30	$1,280.62	$1,243.89	$1,299.05
Municipal Preliminary Screener Score (Household)	1.3%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.5%	1.5%
Municipal Preliminary Screener Score (Connection)	1.9%	1.9%	2.0%	2.0%	2.0%	2.2%	2.2%	2.2%	2.1%	2.1%
Average Municipal Preliminary Screener Score	1.6%	1.6%	1.7%	1.7%	1.7%	1.9%	1.8%	1.8%	1.8%	1.8%

*Values obtained from Tighe & Bond's 2018 Wastewater Financial Capability Analysis
**Future inflation rates based on Tighe & Bond's 2018 Wastewater Financial Capability Analysis