WRIGHT-PIERCE
Engineering a Better Environment

Memorandum

Date: 4/14/2023

Project No.: 21005

To: Town of Montague, MA

From: Wright-Pierce; Lisa Muscanell-DePaola, PE; Lindsey Sylvester, PE; Meghan Otis

Subject: Millers Falls Wastewater Collection System Study - FINAL

Introduction

Background

The Village of Millers Falls, located in the Town of Montague, is served by approximately 15,000 linear feet of gravity sewer, including approximately 88 manhole structures, that conveys wastewater to the Town of Erving for treatment and disposal. The Town of Montague pays the Town of Erving for all wastewater discharged on a per-gallon basis, based on a flow meter located upstream of the pump station that receives the Millers Falls flow. For example, in 2017 and 2018, Montague discharged 29.1 million gallons and 35.4 million gallons to Erving, respectively. However, over that same period, water usage in the village was only 12 million to 12.8 million gallons per year, indicating that there is a significant amount of clean water in the Millers Falls collection system due to infiltration and/or inflow (I/I). These high flows can also overload the downstream collection system and pump station capacity.

In July 2019, the Town completed CCTV investigation work with Wright-Pierce and identified some sources of I/I in which the Town implemented a rehabilitation project to repair these sources of I/I in December 2019. Unfortunately, the sources of I/I identified in July 2019 and repaired in December 2019 did not significantly lower the flow of wastewater being conveyed to the Town of Erving. Per the Town's agreement with the Town of Erving, Montague must pay for any wastewater flow overages above the agreed upon amount, and in fiscal year 2022, the Town had to pay for overages that occurred in calendar year 2021. Thus, the Town and Wright-Pierce recommended that flow monitoring be conducted in sub-drainage basins within the collection system to determine which sub-basins are contributing the highest quantities of I/I.

Purpose

To reduce the cost associated with conveying the I/I, and increase capacity in downstream facilities, the Town of Montague retained Wright Pierce to investigate the sources of this flow and determine necessary rehabilitation to reduce these flows. Wright-Pierce has prepared this technical memorandum to present our understanding of the current situation and the results of our investigations conducted to identify the sources of I/I entering the Millers Falls collection system.

Wright-Pierce assisted the Town in applying for and receiving an Asset Management Grant through the Massachusetts Department of Environmental Protection (MassDEP). This funding covered the completion of the work in Turners Falls in addition to matching with in-kind services from the Town.

Flow, Rainfall, and Night Flow Isolation Monitoring Program

Flow Monitoring Program

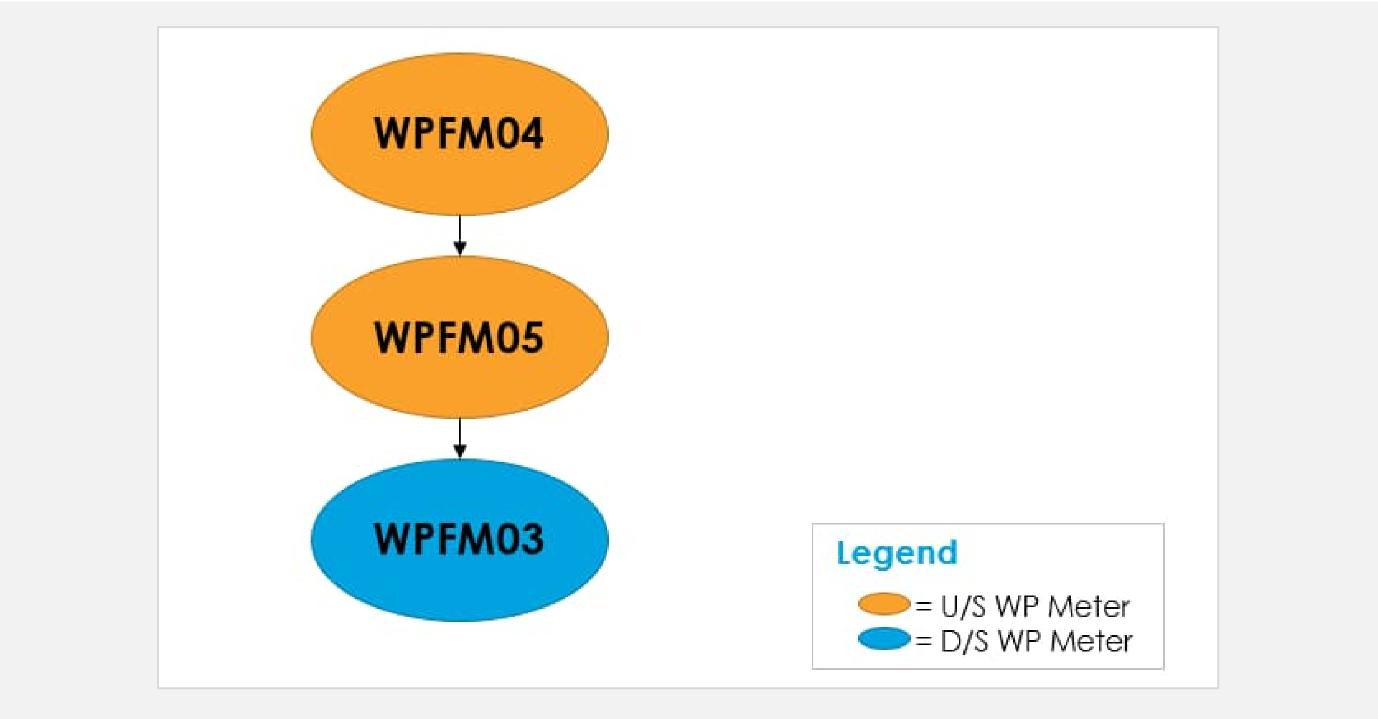
The flow metering program included the installation, maintenance, and analysis of three meters over the course of a 10-week monitoring period from March 31 through June 7, 2022. During this period, sewer data was documented at 15-minute intervals and reviewed for general trends and anomalies. The flow meter locations and results are shown in Map 1.

Wright-Pierce field technicians installed and maintained the meters. Site visits were conducted as needed to address data issues or equipment issues noted during data review. Manual depth and velocity measurements were taken periodically at site visits to check and calibrate the meters. Data was collected and automatically uploaded to Telog Enterprise, a Trimble Water data viewing portal. Wright-Pierce routinely reviewed the flow metering data on Enterprise to monitor proper data collection. Any issues were identified by Wright-Pierce and addressed in the field.

At the end of the flow monitoring period, Wright-Pierce conducted a review of the data collected and made necessary data edits before performing an infiltration and inflow (I/I) analysis.

A schematic of the meter locations shown in Map 1 is depicted in Figure 1.

Figure 1 Millers Falls Flow Meter Schematic



A summary of the flow monitoring locations is listed in Table 1.

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Table 1 Summary of Millers Falls Flow Monitoring Locations

Meter Basin	Start Date	End Date	Manhole ID	Gross Basin Size (LF)	Net Basin Size (LF)	Net Basin IDM[1]	Metered Pipe Diameter[2] (in)
WPFM03	3/31/2022	6/7/2022	NE-3	14,024	5,894	9.31	8
WPFM04	3/31/2022	6/7/2022	WM-5	3,937	3,937	5.96	8
WPFM05	3/31/2022	6/7/2022	WM-6	8,130	4,193	6.35	8

Note:

1. Inch-diameter-mile (IDM) is the relative size of each meter basin calculated from pipe diameters and lengths. Calculations do not include length of pipe for force mains or sewers outside of the project area.
2. Diameter is the average of the pipe width and height measured at meter installation.

Rain Monitoring Program

As part of this project, Wright-Pierce installed, maintained, and removed one rain gauge within the flow metering area.

The rain data was collected and automatically uploaded to Telog Enterprise. Wright-Pierce reviewed the rain data on Enterprise alongside the flow monitoring data for trends and anomalies. Rain data was reviewed to determine if suitable rain events were captured for each meter location to perform an I/I evaluation.

Rain events approximately 0.50 inches or greater were considered suitable for performing the I/I evaluation. A total of five rain events greater than 0.50 inches were recorded throughout the monitoring period. Table 2 summarizes the rain events that occurred during the flow monitoring program.

Table 2 Summary of Rain Events Greater than 0.50 Inches

Date of Rain Event	Total Rainfall (inches)
3/31/22-4/1/22	0.73
4/7/22-4/8/22	1.02
4/16/2022	0.60
4/19/2022	1.13
5/16/2022	0.51

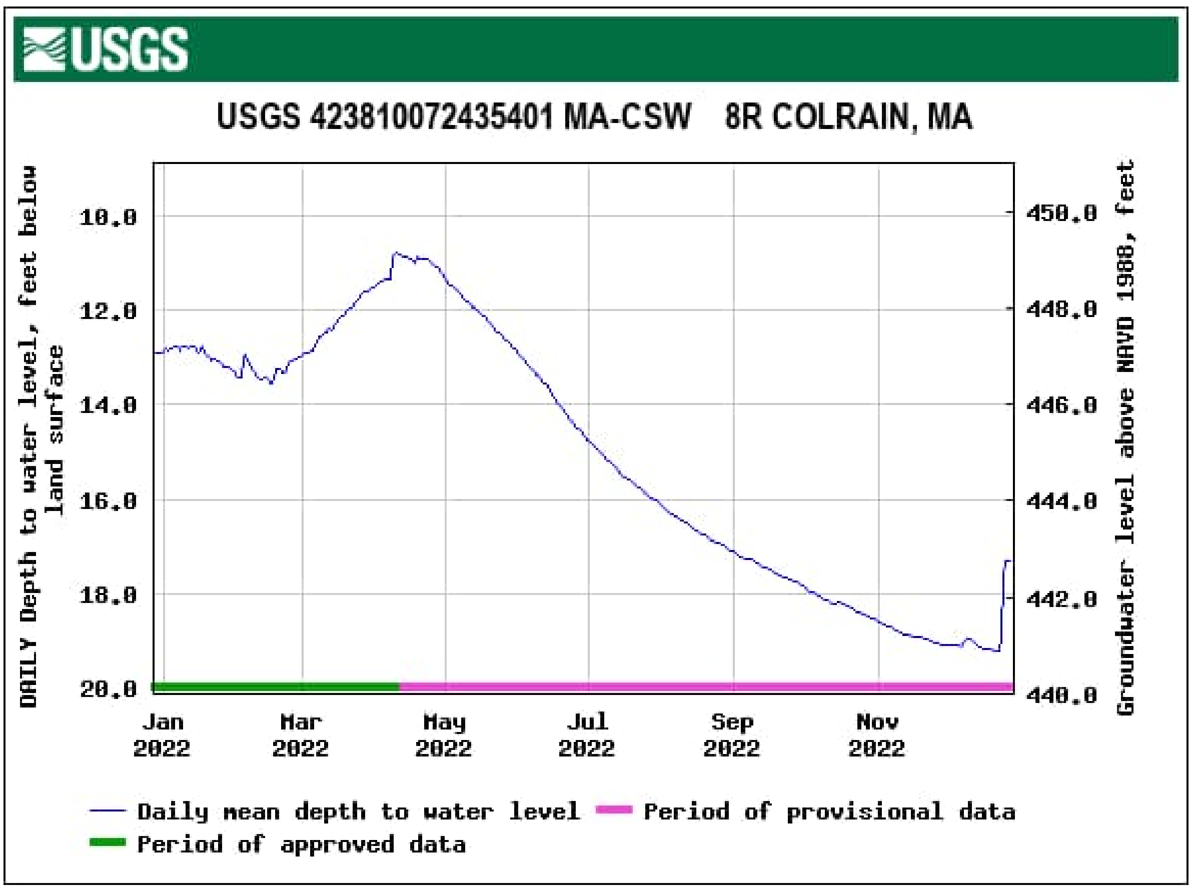
Groundwater Monitoring Program

Along with the flow meters and rain gauge, Wright-Pierce installed and maintained one groundwater piezometer. The groundwater gauge was co-located with flow meter WPFM03, and the groundwater data was collected during the same time period as the flow monitoring program. The gauge was installed in the manhole wall, above the channel. The gauge equipment was kept free of debris to allow groundwater to flow freely in the tubing. Manual depth measurements were taken during each site visit.

Wright-Pierce obtained available United States Geological Survey (USGS) groundwater data from the local well monitoring site in Colrain, Massachusetts to compare with the piezometer data. Review of the USGS data during the flow monitoring program indicates that groundwater levels were generally lowest in March (winter) and June (summer), highest in April (spring), and gradually decreased in May. This trend is typical and, per the MassDEP guidelines, preferred for this analysis. A graph of the groundwater depths at the USGS Colrain site are shown in Figure 2.

The Wright-Pierce piezometer recorded active groundwater that matched to the groundwater levels in late March, in early April, and in early June recorded at the USGS site.

Figure 2 Groundwater Levels During Flow Monitoring Period



Night Flow Isolations

Night flow isolations (NFI) were performed to supplement the flow monitoring program and to find smaller areas of excessive infiltration that can be targeted for future closed-circuit television (CCTV) pipe inspections.

On the night of Wednesday, May 18, 2022, Wright-Pierce staff performed NFIs in areas of suspected infiltration based on a preliminary I/I analysis of the flow monitoring data, which indicated that meter basins WPFM03 and WPFM05 had excessive infiltration. Instantaneous flow measurements were taken at selected manholes using a pole-mounted flow measuring device. The measurements took place between 10:00 PM and 4:00 AM, when wastewater production is expected to be the lowest. The measurements also took place during higher groundwater levels and after a rain event of 0.51 inches on May 16, 2022. This means that infiltration should have been present.

Night flows for each isolation area were normalized based on inch-diameter-mile (IDM) to compare rates more accurately across each area. A rate of 4,000 gallons per day per inch diameter mile (GPD/IDM) is considered a benchmark for areas having excessive infiltration as per the Massachusetts Department of Environmental Protection's (MassDEP) Guidelines for Performing I/I Analyses and Sewer System Evaluation Surveys (SSES) dated May 2017 (Guidelines).

Map 2 shows the areas targeted for NFIs and the infiltration rate results. Table 3 contains the results of the NFIs, ranked according to the net infiltration rate of the isolation area. None of the isolation areas in Millers Falls were found to be excessive for infiltration.

Table 3 Summary of Infiltration from Millers Falls Night Flow Isolations

Reading Number [1]	Meter Basin	Length (LF)	Net Infiltration Rate [2] (GPD/IDM)
WM-8-3:00	WPFM03	3,173	3,300
VT-1-9:00	WPFM05	2,865	3,085
WM-8-11:00	WPFM03	901	2,165
MF-5-12:00	WPFM05	1,771	1,298
WM-4-1:00	WPFM05	2,126	negligible

Note:

1. The nomenclature of the NFIs represent the number of the manhole identification and the clock position of the connecting pipe that the measurement was taken.
2. Infiltration rates ≥ 4,000 GPD/IDM are considered excessive.

Infiltration and Inflow (I/I) Analysis

I/I analysis is a process of using the flow monitoring data collected to locate and quantify additional water entering the collection system. The collection system is designed to convey wastewater for treatment. When additional water, such as groundwater or rainwater, enters the system, it is also conveyed and treated. This additional water reduces the capacity of the system for wastewater conveyance and increases the cost of treatment overall. The goal of the I/I analysis is to find out how much additional water is getting into the system and where. Once the location and extent of the I/I is determined, plans can be made to repair or replace portions of the collection system to reduce it.

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To quantify the I/I, Wright-Pierce utilized an in-house analysis application to conduct both dry and wet weather analyses on the data collected from the flow meters.

Dry Weather Analysis

The dry weather analysis is used to determine the base flow of a system during dry weather, when the only additional non-wastewater flows are assumed to be groundwater infiltration. Dry weather flow is defined as base sanitary flow (BSF) plus base infiltration (BI). BSF includes domestic, commercial, institutional, and industrial wastewater, whereas BI is infiltration that is assumed to occur in the system at all times.

Dry Days

Dry weather days for the I/I evaluation were selected based on days that met the following criteria:

- Days that do not have rainfall.
- Days that do not have preceding rainfall up to 3 days prior, based on:
    - Cumulative rainfall that is not equal to or greater than 0.10 inch up to one day prior.
    - Cumulative rainfall that is not equal to or greater than 0.40 inch up to three days prior.

The flow on these days is known as the average dry day flow (ADDF). Table 4 summarizes the resulting ADDF on weekdays in each flow meter basin. These are gross values based on the metering and include any upstream meters, as noted. Flow is divided into weekday and weekend flow to account for changes that occur throughout the course of a week due to wastewater discharges from businesses, offices, and schools.

Table 4 Summary of Gross Average Dry Day (Weekday) Flow

Meter Basin	Upstream Meters	Gross Average Dry Day Flow (ADDF) (MGD)
WPFM03	WPFM05	0.130
WPFM04	None	0.089
WPFM05	WPFM04	0.056

Meter site WPFM04 is upstream of meter site WPFM05. During the flow monitoring period, a flow imbalance occurred between these two flow meter sites, and the sites were combined to resolve the flow balance issue. In general, flow imbalances can result from such things as flow differences that are less than the sensitivity of the metering equipment, inaccurately mapped pipes, or unknown conditions such as legacy overflow weirs or combined sewer inflows. Further SSES field investigations in the meter basins with flow imbalances are recommended, such as dye testing to find potential inaccurately mapped pipes, legacy overflow weirs, or combined sewer inflows.

Base Infiltration

BI enters the wastewater collection system through pipe joints, pipe defects from main sewer lines and service laterals, and defective manhole walls, benches, and pipe seals, typically from groundwater. BI for the project area was based on analysis of the flow meter data and calculated using the Stevens-Schutzbach equation, which uses the ADDFs and minimum night flows to estimate BI. The dry day analysis considers only weekdays because these days show the most consistent flow patterns and typically higher ADDFs, making BI estimates more conservative.

Table 5 provides a summary of the BI estimated during the flow monitoring period for each of the meter basins. The gross unit rate for a basin is inclusive of all sub-areas within it. The net rate shows infiltration attributable solely to that portion of the basin not included in sub-areas.

A total of 0.027 million gallons per day (MGD) of BSF and 0.103 MGD of BI was identified in the meter basins based on analyses of the flow metering data. Per the MassDEP Guidelines, further investigation and rehabilitation may be cost-effective in basins where BI flows equal or exceed 4,000 GPD/IDM. In this table, basins with excessive infiltration are highlighted in blue. One basin is highlighted in Table 5 as having excessive BI (over 4,000 GPD/IDM).

Table 5 Summary of Base Infiltration Analysis

Meter Basin	Net ADDF[1] (MGD)	Net BI (MGD)	Net BSF (MGD)	Net Pipe Length (LF)	Net IDM[2]	Net BI Unit Rate (GPD/IDM)
WPFM03	0.074	0.060	0.014	5,894	9.31	6,445
WPFM05	0.056	0.043	0.013	8,130	12.32	3,493
Total	0.130	0.103	0.027			

Note:

1. ADDF is based on the selected dry days. It is representative of a gradually increasing flow average over the metering period since metering started when rainfall was less than normal.
2. IDM calculations do not include length of pipe for force mains or sewers outside the project area.

Wet Weather Analysis

Inflow in a wastewater collection system is defined by MassDEP as water other than sanitary flow that enters a sewer system. Inflow is a direct result of stormwater runoff and can enter the wastewater collection system through numerous sources, such as downspouts, sump pumps, area drains, and service lateral cleanouts. In the public sector, inflow enters the wastewater collection system through sources such as cross connections between sanitary and storm sewers, catch basins, and storm ditches; and sources such as manhole defects at the cover, frame seal, and corbel area. Large breaks or collapses in pipes may also become sources of inflow into the system. High inflow can be expected in any combined areas of an existing wastewater collection system.

According to MassDEP, inflow is expected to occur during wet weather and is reported as the peak inflow rate and the total inflow volume for the duration of the event. Inflow can further be separated into direct and delayed inflow. Direct inflow occurs immediately at the start of rainfall and finishes after the rainfall ends. Delayed inflow occurs after the rainfall ends and finishes after the system has stopped responding to the rainfall entirely. Direct inflow can be referred to as rain derived I/I and delayed inflow can be referred to as rainfall induced infiltration. Direct inflow can also be described as the period in which there is a rapid response to rainfall. Therefore, delayed inflow is the more gradual response to rainfall.

Per the MassDEP Guidelines, the inflow volumes calculated for the flow monitoring data were projected and evaluated for the 1-year, 6-hour design storm. None of the metered rain events were as large as the 1-year, 6-hour design storm (which produces approximately 1.67 inches). The largest metered rain event was 1.13 inches. If larger rain events occurred during the flow monitoring period, this could have changed the inflow results, potentially increasing the quantity of estimated inflow.

Unlike the infiltration results, inflow volumes within 80 percent of the total system inflow volume are considered excessive and warrant additional investigation to identify specific sources. Table 6 summarizes the results of the inflow analysis for the 1-year, 6-hour design storm, which produces approximately 1.67 inches of rain in the Millers Falls area. A total of 0.096 MG of inflow was estimated in the project area based on analysis of the flow metering data. This is slightly less than the ADDF (0.130 MGD).

Table 6 Summary of Inflow Analysis for the 1-Year, 6-Hour Design Storm

Meter Basin	Net Peak Inflow Rate[1] (MGD)	Net Total Inflow Volume (MG)	Net Direct Inflow Volume[2] (MG)	Net Delayed Inflow Volume[3] (MG)
WPFM03	0.014	0.074	0.044	0.042
WPFM05	0.026	0.022	0.004	0.018
Total	0.040	0.096	0.048	0.060

Notes:

1. Peak inflow is determined over a 1-hour period.
2. Direct inflow is calculated per MassDEP Guidelines.
3. Delayed inflow is calculated per MassDEP Guidelines

Summary of I/I Analysis

Based on the flow monitoring data, an estimated 0.103 MGD of BI and 0.096 MG of inflow were estimated in the project area. Table 7 summarizes the BI results and ranking for the meter basins. The ranking is based on the 4,000 GPD/IDM guideline per MassDEP. Any meter basin with a net BI unit rate equal to or greater than 4,000 gpd/IDM is highlighted blue.

Table 7 Summary of Base Infiltration (BI) by Meter Basin

Meter Basin	Net BI (MGD)	Net BI Unit Rate (GPD/IDM)	BI Ranking
WPFM03	0.060	6,445	1
WPFM05	0.043	3,493	2
Total	0.103		

Note:

1. Blue highlights represent meter basins prioritized for further SSES investigations.

Table 8 summarizes the inflow results and ranking for the meter basins. The ranking is based on MassDEP's 80 percent threshold, and meter basins that account for at least 80 percent of the total system inflow volume are highlighted blue.

Table 8 Summary of Inflow by Meter Basin

Meter Basin	Net Peak Inflow Rate[1,2] (MGD)	Net Total Inflow Volume[2] (MG)	Percent Total Inflow[3]	Cumulative Percent[3]	Inflow Ranking
WPFM03	0.014	0.074	77%	77%	1
WPFM05	0.026	0.022	23%	100%	2
Total	0.040	0.096	100%		

Notes:

1. Peak inflow is determined over a 1-hour period.
2. Inflow results for a 1-year, 6-hour design storm.
3. Values are rounded.

Per the MassDEP Guidelines, it is cost-effective to eliminate all sources of public and private inflow in basins that account for not less than 80 percent of the total inflow volume for a 1-year, 6-hour design storm based on the I/I analysis. However, due to the small magnitude of inflow seen for the 1-year, 6-hour design storm in Millers Falls, further SSES investigation may not yield large reductions in the inflow seen in this area. It should be noted that larger storms (e.g., 2.00 inches) may produce exponentially larger quantities of inflow, so some level of SSES investigation and/or rehabilitation should be conducted.

The meter basins prioritized for source investigation work based on excessive BI and inflow results are listed in the Infiltration and Inflow Conclusions and Recommendations section with detailed recommendations for further investigation. Some source investigation work has already been completed as part of this project. The results of this work are presented in the following section – Sewer System Evaluation Survey Investigation Results.

Sewer System Evaluation Survey Investigation Results

The sanitary sewer evaluation survey (SSES) work included: manhole inspections and closed-circuit television (CCTV) pipe inspections to better understand the sewer system condition and to identify and quantify the specific sources of I/I. SSES work was based on the results of the I/I analysis. Smoke testing was not conducted because significant amounts of inflow were not estimated from the flow monitoring data.

CCTV pipe inspections and manhole inspections can identify structural and operation and maintenance (O&M) issues within the sewer system in the public domain. In general, CCTV inspections identify infiltration sources, and manhole inspections can identify both infiltration and inflow sources.

Manhole Inspections

A National Association of Sewer Service Companies (NASSCO) Manhole Assessment Certification Program (MACP) certified Wright-Pierce employee conducted each manhole inspection following NASSCO's MACP inspection standards. The purpose of the manhole inspections was to determine the structural condition of each manhole, as well as to locate O&M issues including potential sources of I/I. Level 2 inspections can gather detailed information concerning all components of the manhole without entry. The inspector uses specialized (remote) camera equipment capable of observing and photographing defects present in the manhole.

Level 2 MACP inspections were performed at all accessible manholes in the Millers Falls area, for a total of 74 manhole inspections. All manhole inspections were performed during daytime hours between June 27, 2022 and July 1, 2022. The inspections took place during lower groundwater levels and during relatively dry weather conditions. This means that active I/I may not have been observed.

All inspections were completed at-grade. Manholes were opened and visually inspected for defects. Wright-Pierce used reporting software to collect data and produce NASSCO MACP reports and condition ratings. The completed manhole inspection reports are included in Appendix A. A Wright-Pierce MACP certified engineer then performed an independent review of ten percent of the reports and photographs to provide quality control for the manhole inspections.

There were four additional manholes that were identified in the field as stormwater structures and were not inspected. Three of these manholes are located on Bridge Street and the fourth is on Highland Street. According to the Town's GIS database, these four manholes appear to be connected to the sanitary sewer system. Further investigation was recommended to the Town of Montague in early 2023 to determine if these structures are connected to the sanitary sewer system. If these structures were connected, Wright-Pierce recommended separating these stormwater assets from the sanitary sewer system. In March 2023, the Town of Montague performed dye testing to determine if these four manholes were connected to the sanitary sewer system. The Town of Montague indicated that they were not connected, however, no photos or field notes were made available to Wright-Pierce to include in this memorandum.

The probability of an asset failing is referred to as the likelihood of failure (LoF) and is determined by the asset's physical condition. The LoF of manholes is based on the NASSCO MACP quick rating, which is calculated from the frequency and condition rating of both structural and O&M defects observed during the manhole inspection. The LoF has a range of 0 to 6, where 0 represents an absence of asset information, 1 represents the lowest LoF, and 6 represents the highest LoF.

The results from the manhole inspections are summarized in Table 9. Most manholes have an LoF of 2 and the highest LoF is 5.

Table 9 Summary of Manhole LoF Scores

Likelihood of Failure (LoF), Rounded	Number of Manholes
0	0
1	0
2	32
3	22
4	14
5	6
6	0
Total	74

Closed-Circuit Television (CCTV) Inspections

CCTV pipe inspections were performed by Town staff and Wright-Pierce on approximately 5,700 linear feet (LF) of gravity sewer pipes in the Millers Falls area. Town staff cleaned the pipes and recorded the inspection video. A NASSCO Pipeline Assessment Certification Program (PACP) certified Wright-Pierce employee coded the observations and defects using certified NASSCO PACP software.

These areas for inspection were based on the results of the night flow isolations and included isolation areas with excessive infiltration. The purpose of CCTV inspection is to determine the condition of the sewer pipes, as well as to locate and quantify any potential sources of I/I that may be entering the system. The inspections took place in 2022 on October 12 through 14 and October 19 through 21 during daytime hours. The inspections took place during lower groundwater levels and during relatively dry weather conditions, except for October 14 when approximately 1 inch of rainfall occurred and after approximately 0.50 inch of rainfall occurred on October 18. This means that active I/I may not have been observed, except for inspections completed on October 14 and 19.

Pipe inspections were conducted by flushing the sewer pipes between manholes using a high-pressure jetter to loosen any debris and provide a clear view of the infrastructure. A camera was then run through the pipe, so the operator could see the entire pipe above the water line from the inside. The camera is mounted to a robotic vehicle, which can navigate through the sewer pipes and can rotate to almost any angle to get a closer look at any defects seen by the operator. The entire inspection was recorded on video for review. Any defect in the pipe was noted as well as the distance of the defect from the camera launching manhole. A Wright-Pierce NASSCO PACP certified engineer then performed an independent review of twenty percent of the reports and videos to provide quality control for the pipe inspections. The CCTV inspection reports are included in Appendix B. Inspected pipe segments and their rehab recommendations are depicted in Map 4.

Two gravity sewer pipe segments could not be CCTV inspected in their entirety either due to joint offsets, high water levels, or debris/grease buildup preventing the camera from accessing the full pipe. These pipe segments will need to be re-cleaned to remove the debris, apply flow control to reduce the water level, and/or rehabilitated in order to inspect them.

Like manholes, the probability of an asset failing is referred to as the LoF and is determined by the asset's physical condition. The LoF of pipes is based on the NASSCO PACP quick rating, which is calculated from the frequency and condition rating of both structural and O&M defects observed during the CCTV pipe inspection. The LoF has a range of 0 to 6, where 0 represents an absence of asset information, 1 represents the lowest LoF, and 6 represents the highest LoF.

The results from the CCTV pipe inspections are summarized in Table 10. Most pipe segments have an LoF of 3, and the highest LoF is 5.

Table 10 Summary of Pipe LoF Scores

Likelihood of Failure (LoF), Rounded	Number of Pipes	Length of Pipes (LF)
0	0	0
1	5	526
2	4	567
3	17	3,278
4	8	1,326
5	1	39
6	0	0
Total	35	5,736

Summary of SSES Activities and Findings

The SSES study consisted of approximately 5,700 LF of CCTV pipe inspections and 74 manhole inspections. The field investigations resulted in identifying the following deficiencies with a high potential to contribute I/I into the sewer:

- 42 manholes with an LoF of 3 or higher.
- And 4,643 LF of sewer pipes with an LoF of 3 or higher.

Addressing the issues that have been identified by field investigations should result in a reduction of I/I.

Infiltration and Inflow Conclusions and Recommendations

This section provides the results of the I/I quantification and recommends improvements and other corrective actions to address the identified deficiencies. Improvements identified aim to reduce I/I into the sanitary sewer system. Proposed improvements are recommended for defects found during the fieldwork performed or based on regional experience and discussions with Town staff. **Appendix C** summarizes the recommended investigations.

Wright-Pierce utilized InfoAsset Planner, an asset management software developed by Innovyze, to assist with assigning rehabilitation actions and associated rehabilitation costs to each individual asset inspected during this project. The software uses a customized decision tree to produce planning level rehabilitation recommendations based on GIS and inspection data. Wright-Pierce created the customized decision tree and reviewed the planning level rehabilitation recommendation outputs. The recommendations are for planning level purposes only and are not intended as final recommendations. Other factors, including operating scheme, design standards and approaches, and natural impacts may impact the final recommendation.

Criteria

Based on the results from the flow metering and I/I analysis, preliminary recommendations for SSES work were made for each meter basin. The recommendations prioritize the meter basins for I/I investigations using the criteria set forth in the MassDEP Guidelines.

Infiltration

Per the MassDEP Guidelines, meter basins with infiltration rates equal to or greater than 4,000 GPD/IDM should be prioritized for SSES work, particularly manhole inspections, night flow isolations, and closed-circuit television (CCTV) pipe inspections. These meter basins are identified as "High Priority" and Wright-Pierce recommends completing the SSES work within a timeframe that is cost feasible to the Town.

Further investigation and/or rehabilitation is not recommended in meter basins with BI flows less than 4,000 GPD/IDM as it may not be cost-effective.

Inflow

For inflow, the MassDEP Guidelines state that initial SSES work should be performed in the meter basins that contribute to 80 percent of the total inflow volume, when analyzing inflow for the 1-year, 6-hour design storm. These meter basins are identified as "High Priority" and Wright-Pierce recommends completing the SSES work within a timeframe that is cost feasible to the Town.

A major goal of 314 CMR12.04(2) is to identify and eliminate all public and private inflow sources. This work did not include specific investigations of private inflow sources, such as lateral inspections. Private sources can be a major contributor of inflow. Thus, all areas of the wastewater collection system that are impacted by inflow shall eventually have a recommended SSES plan or additional studies to address inflow. Wright-Pierce recommends that any meter basins with inflow issues, which were not identified as "High Priority", are identified as "Low Priority" and that SSES work be completed after the “High Priority” work and within a timeframe that is cost feasible to the Town. Recommended SSES work associated with inflow typically includes smoke testing, dye testing, and building inspections.

Recommendations

Infiltration

BI for each meter basin was presented in Table 7. As previously discussed, it is considered cost-effective to investigate meter basins with BI rates of 4,000 GPD/IDM or greater. Source investigation work might include manhole inspections, further night flow isolations, and closed-circuit television (CCTV) pipe inspections. Further investigation and rehabilitation are not generally recommended in meter basins with BI flows less than 4,000 GPD/IDM as it may not be cost-effective. However, Wright-Pierce recommends that these basins be reassessed within a timeframe that is cost feasible to the Town to evaluate any changes over time.

Night flow isolations were also completed to pinpoint smaller areas of high BI within the meter basins and to collect flow information in areas that were not metered. A summary of the excessive night flow measurement was provided in Table 3. None of the isolation areas in Millers Falls were found to be excessive for infiltration.

One meter basin had excessive infiltration and that was meter basin WPFM03. This area was prioritized for infiltration source investigations, and manhole inspections and CCTV pipe inspections were completed as part of this project.

Inflow

Total inflow for each meter basin during a 1-year, 6-hour design storm was presented in Table 8. As previously discussed, it is typically considered cost-effective to investigate inflow in meter basins that contribute to the top 80 percent of total inflow. However, due to the small magnitude of inflow seen for the 1-year, 6-hour design storm in Millers Falls, further SSES investigation may not yield large reductions in the inflow seen in this area. It should be noted that larger storms (e.g., 2.00 inches) may produce exponentially larger quantities of inflow, so some level of SSES investigation and/or rehabilitation should be conducted.

A major goal of these investigations is to identify and then mitigate all public and private sources to address inflow. Thus, all areas of the wastewater collection system that are impacted by inflow should eventually have a recommended source investigation plan or additional studies to address it. Wright-Pierce recommends that these basins be reassessed within a timeframe that is cost feasible to the Town to evaluate any changes over time.

Areas that were prioritized for inflow source investigations based on wet weather flow measurements are summarized in Table 11. Additional inflow source investigations, based on field observations, are recommended in Table 13 under Immediate Corrective Actions.

Table 11 Recommendations for Investigation of Excessive Inflow

Meter Basin	Reason	Additional Information
WPFM03	Contributed 77% of the total inflow volume during a 1-year, 6-hour design storm	Due to the small magnitude of inflow seen in Millers Falls (<0.1 million gallons), further SSES investigation may not yield large reductions in the inflow seen in this area.
WPFM05	Contributed 23% of the total inflow volume during a 1-year, 6-hour design storm.	Due to the small magnitude of inflow seen in Millers Falls (<0.1 million gallons), further SSES investigation may not yield large reductions in the inflow seen in this area.

Proposed Pipe and Manhole Improvements

In making pipe and manhole rehabilitation recommendations, the cost-effective analysis (C/E/A) and the LoF of the structure were considered. It is not typically cost-effective to try to remove I/I from every identified defect, nor is it likely that a repair will be able to remove 100 percent of the estimated I/I.

In accordance with the MassDEP Guidelines, a ratio greater than 1.0 comparing the treatment and transport (T&T) cost to the estimated rehabilitation cost is cost-effective to remove.

Wright-Pierce calculated the T&T cost for the Town for Millers Falls using the Town's Actual & Budgeted Expenses & Encumbrances report for the September 2022 period and the meter flow values from the 2022 flow monitoring. Expenses for treating flows in Erving were included, and some expenses were allocated by the percentage of flow in Millers Falls. The Town's total T&T expenses ($329,688) was divided by the average daily flow of wastewater treated (131,000 GPD) resulting in a T&T cost of $2.52 per GPD.

A C/E/A was performed using T&T costs based on the 2022 flow monitoring data and the estimated rehabilitation costs. As stated in the MassDEP Guidelines, a life cycle evaluation of a 20-year planning period is suggested. Table 12 summarizes the estimated T&T costs for both present day and 20-year planning period and shows the projected 20-year C/E/A ratio. This C/E/A assumes that rehabilitation can remove 50 percent of the base infiltration as required by MassDEP Guidelines.

Table 12 Summary of Infiltration and C/E/A Results

Meter Basin	Base Infiltration (GPD)	Estimated T&T Cost [1]	Estimated 20-Year T&T Cost	Estimated Total Rehab Cost [2]	20-Year C/E/A Ratio
WPFM03	60,000	$151,100	$3,022,000	$318,821	1.65
WPFM05	43,000	$108,300	$2,166,000	$112,900	1.81
Total	103,000	$259,400	$5,188,000	$431,721	-

Notes:

1. Estimated T&T Cost is $2.52/GPD using the Town's 2022 annual budget and average daily flow from the 2022 flow monitoring.
2. Estimated Total Rehab Cost is the sum of manhole and pipe rehab costs. It does not include engineering and contingency costs.

Because the C/E/A ratio is greater than 1.00 in all basins investigated, all of the proposed pipe and manhole improvements are considered cost effective.

Inspected manholes and their rehabilitation recommendations are depicted in Map 3. Inspected pipe segments and their rehab recommendations are depicted in Map 4.

For this project, the stormwater manholes potentially contributing inflow into the sewer collection system were identified for immediate corrective action. Immediate corrective actions were also recommended for any CCTV pipe inspections that could not be completed. A summary of these actions is found in Table 13.

Millers Falls
Manhole Rehabilitation
Montague, MA

PROJ NO:	DATE:
21005	1/3/2023

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MAP: 3

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Pipe Rehabilitation Recommendations Millers Falls

Montague, MA

PROJ NO:	DATE:
21005	1/3/2023

WRIGHT-PIERCE
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FIGURE: 1

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Table 13 Summary of Recommended Immediate Corrective Actions

Recommendation	Number of Occurrences
Investigate stormwater manholes potentially connected to sanitary sewer system (Dye Testing and CCTV Pipe Inspection) [1]	4
Rehabilitate/Re-clean/Flow Control Pipe Segments	2

Notes:

1. In March 2023, the Town of Montague performed dye testing to determine if these four manholes were connected to the sanitary sewer system. The Town of Montague indicated that they were not connected, however, no photos or field notes were made available to Wright-Pierce to include in this memorandum.

Pipes and manholes that received an LoF of 3 or higher have been identified as "Priority 1 Improvements". Wright-Pierce recommends that Priority 1 Improvements are implemented for higher priority rehabilitation, repair, or replacement within a timeframe that is cost feasible to the Town. Infrastructure with high LoF ratings contribute to system I/I and are likely to fail soon. Increased I/I in the system reduces hydraulic capacity and increases the likelihood of sanitary sewer overflows (SSOs) or could create a major disruption in service and potentially impact the environment and/or public health if not addressed.

Pipes and manholes that received an LoF of less than 3 were identified as "Priority 2 Improvements". Priority 2 Improvements are recommended for cost-effective rehabilitation or repair that is lower in priority. Wright-Pierce recommends that these improvements are implemented after the Priority 1 Improvements and within a timeframe that is cost feasible to the Town.

Table 14 summarizes the priority recommendations for pipes and manholes in Millers Falls.

Table 14 Summary of Recommended Priority Improvements

Meter Basin	Priority 1			Priority 2		
	# of Manholes	# of Pipe Segments	LF of Pipe	# of Manholes	# of Pipe Segments	LF of Pipe
WPFM03	16	18	3,996	15	4	596
WPFM05	26	-	-	17	-	-

There were 42 manholes and 3,996 LF of sewer pipe found in Millers Falls requiring Priority 1 Improvements, and 32 manholes and 596 LF of sewer pipe found requiring Priority 2 Improvements at this time.

Pipes and manholes that had no recommended improvements because no defects were found during the inspections have been identified as "No Action" and are summarized in Table 15.

Table 15 Summary of Manholes and Pipes Requiring No Action

Meter Basin	# of Manholes	# of Pipe Segments	LF of Pipe
WPFM03	0	7	847
WPFM05	0	- [1]	- [1]

Notes:

1. Pipe inspections were not performed in this meter basin.

Planning Level Costs for Proposed Improvements and Recommendations

Priority Improvement Program

Structures that received an LoF of 3 or higher have been identified as the highest priority for rehabilitation, repair, or replacement. These pipes and manholes may have limited hydraulic capacity, contribute I/I in the system and have a higher likelihood of failure. They increase the possibility of an SSO occurrence and may cause a disruption in service and potentially impact the environment and/or public health if not addressed.

Unit costs provided in the following tables are based on average bid tabulations based on Wright-Pierce reviewed design projects and on Wright-Pierce estimates for services. These planning-level costs were developed using standard cost estimating procedures consistent with industry standards using unit cost information. These costs are based on a typical, pre-2022 bid climate and do not include inflation. The current bid climate and inflation should be considered when these improvements are made.

Table 16 provides the total estimated rehabilitation, repair, and replacement costs for all manholes and pipes categorized as Priority 1 Improvements.

Table 16 Priority 1 Improvement Program Costs

Corrective Action	Unit Cost	Quantity	Cost
Manhole Repairs			
Clean	$200 / EA	35	$7,000
Frame Seal Wrap	$1,000 / EA	29	$29,000
Line Chimney	$2,000 / EA	10	$20,000
Replace Cover, Frame, and Frame Seal	$2,000 / EA	3	$6,000
Point Repair	$1,300 / EA	8	$10,400
Line Manhole	$4,000 / EA	1	$4,000
Replace Chimney	$1,500 / EA	1	$1,500
Fix Pipe Seal	$1,300 / EA	25	$32,500

Corrective Action	Unit Cost	Quantity	Cost
Manhole Repair Subtotal	-	-	$110,400
Pipe Repairs			
Clean	$3 / LF	1,883	$5,700
Line (<18”)	$200 / LF	221	$44,200
Point Repair	$18,000 / EA	7	$126,000
Lateral Rehab	$6,750 / EA	10	$67,500
Test & Seal	$450 / EA	2	$900
Trenchless Rehab	LS	1	$500
Pipe Repair Subtotal			$244,800
Total			
Priority 1 Improvement Program Subtotal			$355,200
Construction Contingency (25%)			$88,800
Construction Subtotal			$444,000
Engineering and Administrative Fees (30%)			$106,600
Priority 1 Improvement Program Total			$550,600

Structures that received an LoF lower than 3, but a C/E/A ratio higher than 1 have been identified as the second highest priority for rehabilitation, repair, or replacement. These pipes and manholes are cost-effective to repair but have a lower likelihood of failure. Four of the CCTV inspected pipe segments with recommended improvements had an LoF lower than 3, so these were categorized as Priority 2 Improvements.

Table 17 provides the total estimated rehabilitation, repair, and replacement costs for all manholes and pipes categorized as Priority 2 Improvements.

Table 17 Priority 2 Improvement Program Costs

Corrective Action	Unit Cost	Quantity	Cost
Manhole Repairs			
Clean	$200 / EA	31	$6,200
Frame Seal Wrap	$1,000 / EA	17	$17,000
Line Chimney	$2,000 / EA	11	$22,000
Point Repair	$1,300 / EA	5	$6,500
Replace Chimney	$1,500 / EA	1	$1,500
Fix Pipe Seal	$1,300 / EA	20	$26,000
Manhole Repair Subtotal	-	-	$79,200
Pipe Repairs			
Clean	$3 / LF	468	$1,400
Test & Seal	$450 / EA	1	$500
Pipe Repair Subtotal			$1,900
Total			
Priority 2 Improvement Program Subtotal			$81,100
Construction Contingency (25%)			$20,300
Construction Subtotal			$101,400
Engineering and Administrative Fees (30%)			$24,300
Priority 2 Improvement Program Total			$125,700

No Action

Structures with no defects identified during inspections have been identified as requiring no action and are not recommended for improvements at this time.

List of Appendices

Appendix A Millers Falls Manhole Inspection Reports

Appendix B Millers Falls CCTV Pipe Inspection Reports

Appendix C Summary of Recommended Investigations