# Annual CSO and CMOM Report

# CY 2017

Required by NPDES Permit #MA0103331
for Springfield Regional Wastewater Treatment Facility and Combined Sewer Overflow Systems

March 2018

Springfield Water and Sewer Commission

**SPRINGFIELD WATER AND SEWER COMMISSION**

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*Established*

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March 30, 2018

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**Subject: Springfield Water and Sewer Commission Annual CSO and CMOM Report**

To Whom It May Concern:

Pursuant to NPDES Permit No. MA0103331, attached please find the 2017 Combined Sewer Overflow (CSO) Annual Report for the Springfield Water and Sewer Commission (Commission). In addition, pursuant to Administrative Order Docket No. 14-007 this submittal also includes the Annual Capacity, Management, Operation, and Maintenance (CMOM) Program Report which documents the ongoing implementation of the Commission's CMOM program and its integration with the Nine Minimum Control elements of the CSO program.

The Commission's Integrated Wastewater Plan (IWP) continues to serve as the roadmap for responsibly maintaining regulatory compliance and operational sustainability. The Commission continued in 2017 with its implementation of the IWP. Once again this report has been formatted and enhanced to provide a more comprehensive collection of information pertaining to the operation, maintenance, re-investment, and planning for the wastewater collection system and CSOs.

In CY 2017, the Commission continued to advance components of the approved IWP as it relates to all wastewater infrastructure. The Commission continued the rehabilitation of the Main Intercepting Sewer (MIS). The successful bypassing of flows from the MIS allowed for the completion of the lining of the main interceptor in early 2017. As part of the MIS Project, the Commission included the repair and replacement of outfall structures at CSO 012, CSO 013, and CSO 018. After initial delays with permitting and unforeseen geotechnical issues at CSO's 12 & 13, the rehabilitation, replacement, and renewal of these critical assets (MIS pipe and CSO Outfalls) was completed in 2017.

In September 2017 the Commission progressed from preliminary design into the final design of the Connecticut River Crossing and York Street Pump Station Improvements Project. The Commission anticipates final design to be complete by May 2019. This project was identified in the LTCP and IWP as a significant infrastructure project not only to address CSO flows but to provide redundancy to critical buried assets.

As in previous years the Commission undertook a variety of system improvement projects to replace, rehabilitate, or renew existing water and sewer system components. In 2017 the Commission was in various stages of design and construction of several prioritized local projects with failing collection system components.

For the eighth successive year, the Commission continued its comprehensive Collection System Asset Management Program. As noted in this report, over 690,000 linear feet of collection system was cleaned and over 54,000 linear feet of the collection system was assessed. The asset condition information obtained through this effort provides critical information used in prioritizing work related to not only CSO's but to local buried infrastructure to prevent failures and discharges from the collection system.

The Commission continued its CSO metering program to further assist in fine tuning of the calibration of the Collection System Model. Data from this effort as well as the Collection System Asset Management Program has been integrated with VUEWorks, the Commission's work order management, document control, asset inventory, and collection system asset management and risk reduction program. Initiated in 2015, VUEWorks has become an integral tool in Commission operations.

If you have any questions or comments concerning the attached information, please do not hesitate to contact me at 413-452-1333.

Respectfully

Springfield Water and Sewer Commission

Joshua Schimmel
Executive Director

cc: William Fuqua, SWSC
Ryan Wingerter, SWSC

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# Glossary

**AGCA .** Accelerated Grease Cleaning Areas

**AO .** Administrative Order

**BoDR .** Basis of Design Report

**CAP .** Corrective Action Plan

**CCTV .** Closed-circuit Television

**CIP .** Capital Improvements Plan (or Program)

**CIWEM .** Chartered Institution for Water and Environmental Management

**CMMS .** Computerized Maintenance Management System

**CMOM .** Capacity, Management, Operations and Maintenance

**CMR .** Code of Massachusetts Regulations

**CRI .** Connecticut River Interceptor

**CSO .** Combined Sewer Overflow

**CY .** Calendar Year (CY 2017 is January 1, 2017 through December 31, 2017)

**DWO .** Dry Weather Overflow

**EPA .** Environmental Protection Agency

**FM .** Flow Meter

**FOG .** Fats, Oils, and Grease

**FY .** Fiscal Year (FY 2018 is July 1, 2017 through June 30, 2018)

**I/I .** Inflow and Infiltration

**IOPS.** Indian Orchard Pump Station

**IPP .** Industrial Pretreatment Program

**IWP .** Integrated Wastewater Plan

**LTCP .** Long Term Control Plan

**MACP .** Manhole Assessment Certification Program

**MADEP .** Massachusetts Department of Environmental Protection

**MGD .** Million Gallons per Day

**MIS .** Main Intercepting Sewer

**MRS .** Mill River Interceptor System

**MUCI .** Maintenance Utility Condition Index

**NASSCo .** National Association of Sewer Service Companies

**NMC .** Nine Minimum Controls

**NOAA .** National Oceanic and Atmospheric Administration

**NPDES .** National Pollution Discharge Elimination System

**PACP .** Pipeline Assessment Certification Program

**PIIR .** Pipeline Infrastructure Improvements Ranking

**PLC .** Programmable Logic Controller

**POTW .** Publicly Owned Treatment Works

**RDII .** Rainfall-Derived Infiltration and Inflow Analysis

**RG .** Rain Gauge

**SRWTF .** Springfield Regional Wastewater Treatment Facility

**SUCI .** Structural Utility Condition Index

**SSO .** Sanitary Sewer Overflow

**SWSC .** Springfield Water and Sewer Commission

**YSPS .** York Street Pump Station

# Executive Summary

The Annual CSO and CMOM Report for calendar year 2017 (January 1, 2017 through December 31, 2017) provides a comprehensive review of the Springfield Water and Sewer Commission's (SWSC's) integrated Combined Sewer Overflow (CSO) system and Capacity, Management, Operation, and Maintenance (CMOM) Program. The integrated CSO system includes the sewage collection system, CSO facilities (i.e. regulators and overflow pipes/outfalls), and the treatment system at the Springfield Regional Wastewater Treatment Facility (SRWTF). As a result of the integration of CMOM with the combined sewer system, this report also provides the annual review for the CMOM Program, thereby addressing the reporting requirements for both programs.

This annual report documents the performance of the CSO control and treatment system, as well as the CMOM Program activities over the past calendar year. The report includes a review of the major storm events that caused CSO to be discharged. In addition, the report documents the ongoing implementation of the SWSC's CMOM Program, which overlaps with the SWSC's Nine Minimum Control (NMC) elements of the CSO Program.

For the purposes of completeness and to facilitate an understanding of the data, this integrated CSO and CMOM Annual Report will present performance results and data to recognize trends from established baselines for many parameters from previous reports. The trends will be utilized to demonstrate improvements or highlight areas requiring additional attention. The goal of the integrated CSO and CMOM program is to keep wastewater in the collection system and deliver it to the wastewater treatment plant.

**Integrated CSO System Performance.** The total rainfall for calendar year 2017 in Springfield was comparable with the 1976 Typical Precipitation Year. Springfield received approximately 42.0 inches of rainfall and the Typical Precipitation Year is 42.2 inches per year. The Typical Precipitation Year was previously identified to be the actual measurements from 1976 and represents the SWSC's median annual rainfall series after analysis of historical rainfall records. It is regarded as the baseline for comparing the magnitude and impact of all annual rainfall series.

In total, the CSO system was activated a total of 269 times discharging 195.71 MG of CSO volume to the Connecticut River, Mill River and Chicopee River.

**Nine Minimum Controls and CMOM Program.** This report provides documentation of the on-going implementation activities involving the NMCs and CMOM Programs. In examining the requirements for NMC #1, proper operations and maintenance of the sewer system and CSO outfalls, it is clear that the CMOM Program is the best way to fulfill EPA's requirements for managing the combined sewer system.

The SWSC's CMOM Program has been designed to ensure that components of the collection system are cleaned and inspected at the appropriate frequency and that preventative maintenance and repairs are performed to cost-effectively reduce the number of sewerage releases, extend the useful life of the SWSC's sewer infrastructure, and properly manage collection system operations. In CY 2017, the SWSC's crews, consultants and contractors were able to:

- Inspect 54,273 linear feet of sewer pipe, or about 2.2% of the mainline sewer system
- Clean 690,542 linear feet of sewer pipe or about 27.9% of the mainline sewer system
    - This total includes 310,828 linear feet of unique sewer pipe cleaning in addition to a total of 379,714 linear feet of repeated cleaning in areas requiring ongoing regular maintenance.
- Complete 19 mainline sewer repairs
- Repair 104 service laterals totaling about 1,690 linear feet of pipe
- Treat 16,230 linear feet of pipe for roots using chemical root treatment and root saws
- Treat 15,996 linear feet of pipe for grease using chemical treatment
- Clean 1,924 manholes and complete an assessment of 1,427 manholes

The priorities for the SWSC's NMC and CMOM work are based on Asset Management principles that prioritize actions to reduce risks to public health, sensitive receptors, and the environment. This approach continues to result in a balanced approach to capital and operations and maintenance-related projects:

- Capital expenditures in pipe rehabilitation, renewal, and replacement programs remain steady and appropriate. The SWSC continues to implement its pipeline rehabilitation, renewal and replacement program to reduce structural risks and extraneous inflow and infiltration (I/I) in the sewer system. Due to the success of this program, it is anticipated this trend will continue for the next several years, reflecting the SWSC's focus on risk-based priorities for sewer capacity and condition.

**Monitoring.** As shown in this report, the SWSC continues to carry out system monitoring and overflow monitoring to ensure that permit requirements are achieved, public health is protected, and water quality is improved in receiving water bodies, to the extent possible.

# Section 1 Introduction

The SWSC's Annual CSO and CMOM Program Report provides an assessment of the combined sewer overflow (CSO) control system performance during the past calendar year (CY 2017: January 1, 2017 through December 31, 2017), along with a summary of the sanitary sewer overflow (SSO) control performance and accomplishments through the Capacity, Management, Operation, and Maintenance (CMOM) program.

The SWSC's National Pollutant Discharge Elimination System (NPDES) permit requires the SWSC to submit annual CSO reports to the Massachusetts Department of Environmental Protection (MADEP) on the performance of the overall CSO system. The Annual CSO and CMOM report covers CSO capture, conveyance, overflow characteristics, treatment efficiencies, and on-going implementation of the Nine Minimum Controls (NMC).

Several of the NMC overlap with elements of the SWSC's CMOM Program. Together, these two programs provide a comprehensive approach and view of how combined and sanitary sewerage is managed, collected, conveyed, treated and discharged throughout the SWSC's wastewater systems. The topics and overlap between the NPDES Permit, the CSO Program, and CMOM Program is displayed in Table 1-1. To efficiently and comprehensively address these overlapping topics, the SWSC reports on the annual CSO performance and the CMOM program together in this integrated document.

*Table 1-1 NPDES Permit, CSO, and CMOM Program Overlap*

| | Regulatory Document | | |
|---|---|---|---|
| | NPDES Permit | EPA CSO Policy | CMOM Guidance |
| System | Treatment Plant | CSO Control System | Collection System |
| Regulatory Requirements Addressed by Regulatory Documents | Outfall Effluent Limits | | |
| | Dry Weather Treatment | | |
| | Wet Weather Treatment | Wet Weather Treatment | |
| | | CSO Event Control Levels | |
| | | *Nine Minimum Controls* | |
| | | NMC#1: Proper O&M | Maintenance Practices |
| | System Operating Plan | NMC#2: Maximize Storage | Operations |
| | Pretreatment Requirements | NMC#3: Pretreatment Requirements | |
| | System Operating Plan – High Flow Management Plan | NMC#4: Maximize Flow to POTW | Operations |
| | Sewerage Overflow Prohibition | NMC#5: Eliminate DWOs | Minimize SSOs |
| | | NMC#6: Controls of Solids and Floatables | |
| | | NMC#7: Pollution Prevention | |
| | | NMC#8: Public Notification | Spill Response & Notification |
| | Monitoring | NMC#9: Monitoring | |

# 1.1 Purpose

This report is intended to meet the CSO-related reporting requirements in the SWSC's NPDES permit and the annual reporting requirements contained in the EPA *Administrative Order Docket No. 08-037*. This annual report documents the performance of the CSO capture, conveyance, and treatment systems over the past calendar year, as well as the activities performed by the SWSC to improve its level of CSO and already high level of SSO control. The report also examines the major storm events that caused CSO to be discharged. In addition, the report documents the on-going implementation of the SWSC's NMC's program, especially those controls that overlap with CMOM. The NMC program consists of appropriate and cost-effective best management practices that make up the EPA-specified NMCs, which have been integrated into the SWSC's CSO Control Program.

**CSO Control Program.** The CSO Control Program is designed and operated to control the magnitude, frequency, and duration of wet-weather CSO discharges in compliance with State and Federal water quality standards. CSO discharges are controlled as required:

- Mill River: 1 discharge, per regulator, during the design storm (Typical Precipitation Year storm series).
- Chicopee River: 2 discharges, per regulator, during the design storm (Typical Precipitation Year storm series).
- Connecticut River: 8 discharges, per regulator, during the design storm (Typical Precipitation Year storm series) and per the accepted LTCP/IWP Level of Control for completed CSO projects.

**CMOM Program.** The purpose of the CMOM program is to reduce the risk to public health and safety, sensitive receptors, and the environment due to sewerage releases from the wastewater collection system. It ensures that the collection system is managed cost-effectively to address other potential risks of failure.

# 1.2 Regulatory Background for Report

The Annual CSO and CMOM Report provides a summary of performance measures derived from six CSO and CMOM regulatory and program documents:

- *NPDES Permit # MA0103331*
- *SWSC's NMC Program Document,* April 1997 and updated April 2010
- *USEPA Combined Sewer Overflow Guidance for Nine Minimum Controls,* May 1995
- *Administrative Order Docket No. 08-037 (AO)*
- *USEPA Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems,* January 2005
- *SWSC's FLTCP and IWP,* May 2012 and May 2014 respectively

These documents include components of the LTCP, IWP and asset management elements that SWSC has demonstrated in the past that it is committed to proactively addressing.

**2009 SWSC NPDES Permit.** The SWSC's NPDES Permit (effective November 1, 2009) is the primary regulatory document that prescribes most of the Annual CSO Performance report content. Permit requirements include:

- Annual Report (purpose of this report)
- Nine Minimum Controls (Section 3 through Section 8 of this report)

**2010 Updated NMC Report.** Implementation of CSO Controls along the Mill River and Chicopee River is complete. Implementation of CSO Controls along the Connecticut River is underway. In areas where CSO Controls have been fully implemented, the NMCs continue to be practiced and adjusted to complement and enhance the control provided by the grey and sustainable infrastructure developed as part of the CSO Control Program.

A focus of this annual report is to integrate the CSO control information represented in the NMCs with the overlapping CMOM program elements for the collection system's management, operations, and maintenance. The major overlap between the CMOM and NMC components occurs with NMC#1 – Proper Operation and Maintenance, however there is also overlap with:

- NMC#2 – Maximize use of collection system for storage (operations controlled)
- NMC#4 – Maximize flow to the POTW (operations controlled)
- NMC#5 – Eliminate dry weather overflows (part of SSO reduction)
- NMC#8 – Public notification

This CSO and CMOM annual report provides summary tables and graphs for each of the NMCs to document their on-going implementation.

## Administrative Order Docket 08-037 (AO) CMOM Program Report.

Over several years, the SWSC has implemented a CMOM program to help reduce the likelihood of sewerage releases by improving the overall reliability of the sanitary and combined sewer systems. The *CMOM Program Report* was developed to comply with the conditions of Administrative Order Docket 08-037 (AO).

The CMOM program specifically addresses proper operation and regular maintenance of the sewer system (NMC#1). The SWSC's wastewater collection system includes mainlines, trunk lines, interceptors, pump stations, and force mains. The SWSC is not responsible for service laterals. Property owners own and maintain the sewer service laterals from the mainline to the house/building. The SWSC's sewer collection system consists of 469 miles of collection system piping (321 miles of sanitary sewer including force mains and 148 miles of combined sewer) and 11,166 sewer manholes. The system also includes the Springfield Regional Wastewater Treatment Facility (SRWTF) at Bondi's Island in Agawam, MA and 33 pump stations.

The effectiveness of the SWSC's risk-based asset management approach to collection system operation and maintenance will be evaluated in this annual review of CMOM program actions and key performance indicators.

# Section 2 Integrated CSO System Performance for CY 2017

The integrated CSO system consists of the combined sewer collection system; the CSO collection, inline storage, and pumping system and the SRWTF. This section reports on the performance of the overall integrated CSO system during CY 2017.

Section 2 summarizes the findings of the comparison between the 2017 Annual Rainfall and CSO Flow Meter Data Review. This section incorporates findings from the analysis of the four permanent rain gauges and the 23 permanent flow meters sited in the Springfield catchment.

Section 2.2.1, Rainfall Data Collection and QA/QC, presents a breakdown of the annual rainfall events recorded at all four local gauges and how they compare to the Springfield Typical Precipitation Year, when applying standard categorizations. The comparison to 1976 provides context as to how wet or dry the year 2017 has been with respect to the typical annual rainfall. The thorough understanding of the relative nature of the annual precipitation provides helpful context when analyzing the annual CSO results.

In addition to the thorough review of the 2017 rainfall data, Section 2 includes a comparison between the 2017 Springfield CSO overflow meter data and the CSO results simulated by the sewer system hydraulic and hydrologic model (using InfoWorks CS software) and using the observed 2017 rainfall data, as well as a comparison versus the CSO predictions from the Typical Precipitation Year rainfall series.

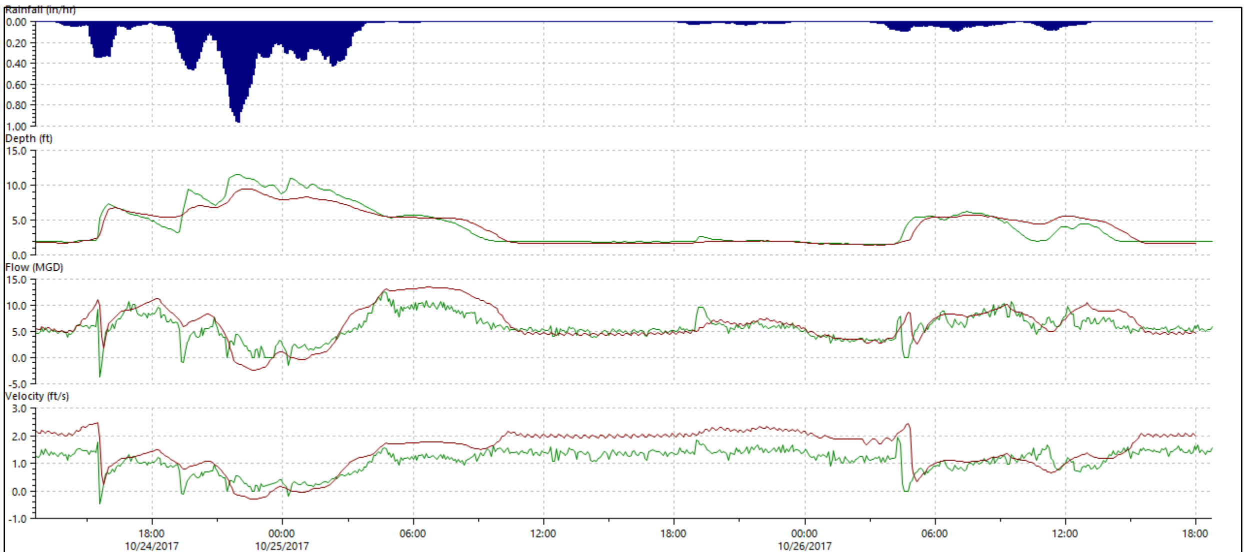
## 2.1 Hydraulic Model Updates

During the 2017 calendar year several adjustments were made to the hydraulic model. Updates were limited to corrections and improvements based on new information collected during the calendar year from ongoing construction projects, system cleaning and inspection, and temporary metering.

The CY2016 model was used as the starting point for this analysis. Updates were then made to CSO 012, including corrections to the CSO 012 underflow pipe length and to the underflow's invert elevations, based on record drawings. Temporary metering data along the Connecticut River Interceptor (CRI) was collected during the fall of 2017. This metering data included several meters along the CRI between CSO 010 and CSO 016 which were used to validate the model's representation of depth, velocity and flow along this critical length of the interceptor, where 8 of the CRI CSOs are located.

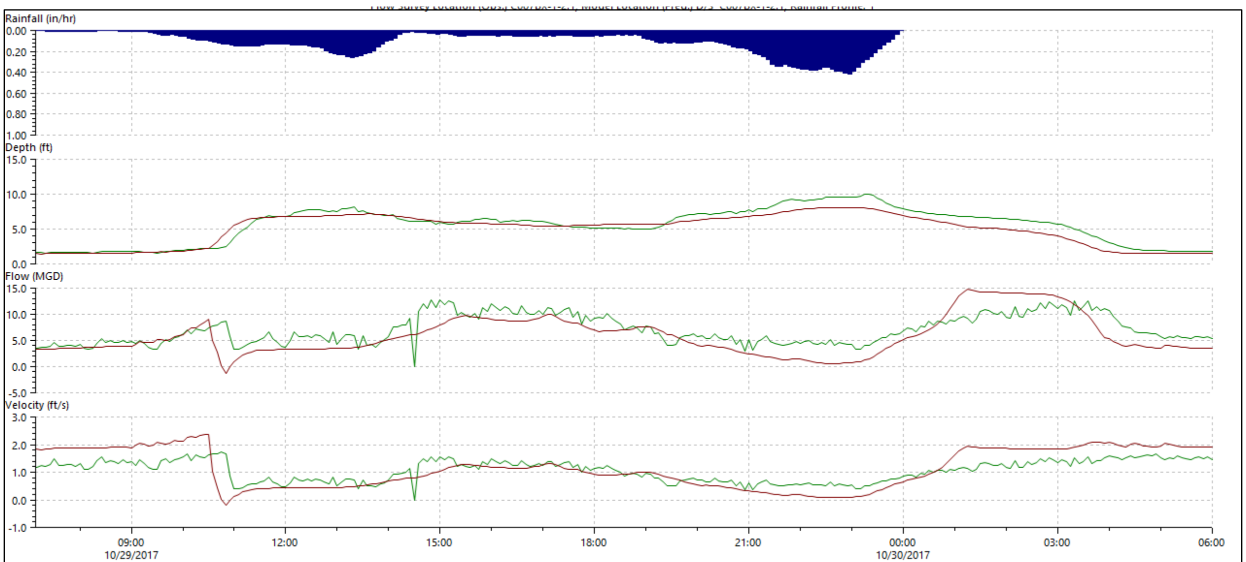
Review of the temporary metering data for two major storm events during October, October 24 and October 29, 2017, indicated good correlation between the modeled and metered depth, velocity and flow in the CRI. Figure 2.1-1 and 2.1-2 present the validation plots for the two storm events at Meter C-1, located on the CRI between CSO 010 and CSO 011.

*Figure 2.1-1: CRI Temporary Meter Validation-October 24, 2017*




| | Rainfall | | | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Depth (in) | Peak (in/hr) | Average (in/hr) | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Rain | 4.200 | 0.960 | 0.078 | | | | | | | |
| Obs. | | | | 1.545 | 11.549 | -3.781 | 12.615 | 13.083 | -0.466 | 1.948 |
| ...417 Trial6 CHOKE>Oct 2017 | | | | 1.386 | 9.502 | -2.408 | 13.443 | 14.330 | -0.309 | 2.471 |

*Figure 2.1-2: CRI Temporary Meter Validation-October 29, 2017*




| | Rainfall | | | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Depth (in) | Peak (in/hr) | Average (in/hr) | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Rain | 2.010 | 0.420 | 0.119 | | | | | | | |
| Obs. | | | | 1.573 | 10.000 | 0.000 | 12.809 | 6.758 | 0.000 | 1.740 |
| ...917 Trial6 CHOKE>Oct 2017 | | | | 1.457 | 8.102 | -1.324 | 14.795 | 5.638 | -0.176 | 2.382 |

The network model comparisons to the CRI temporary meter data all met the CIWEM (Chartered Institution of Water and Environmental Management) Urban Drainage Group tolerances for wet weather flow calibration in its Code of Practice for the Hydraulic Modeling of Sewer Systems. Those include the following;

- Timing of the peaks and troughs shall be similar to the event durations.
- Peak flows at each significant peak shall be in the range -15% to +25%.
- Volume of flow shall be in the range -10% to +20%.
- Surcharged flow depths shall be in the range -0.32 ft to +1.64 ft.
- Unsurcharged flow depth shall be within the range ±0.33 ft

The model-simulated CSO results presented in the following report include the CSO 012 underflow change and represent the spill counts and volumes from the model used to validate the CRI meter data. This model will be used as the 2018 CSO Annual Report analyses begin during the first quarter of this year.

# 2.2 Data Collection and QA/QC

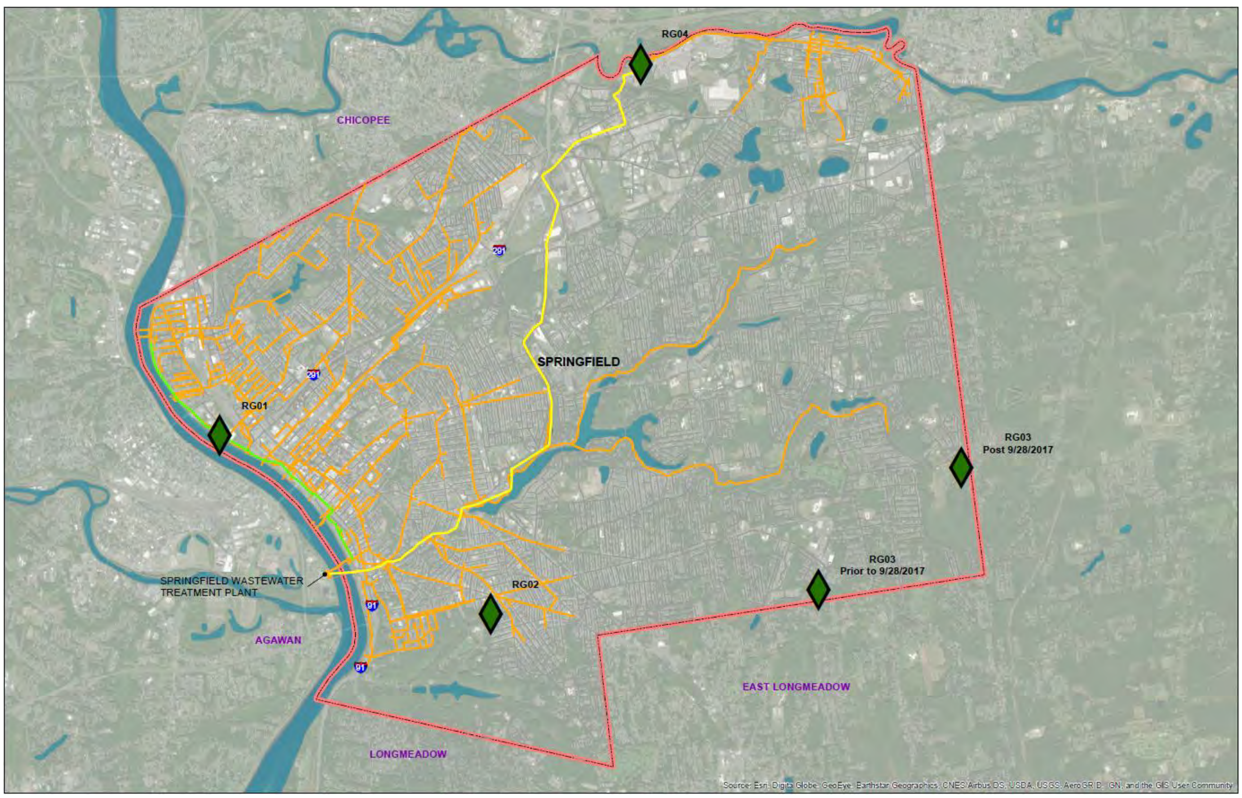
ADS Environmental (ADS) was retained by the Commission (the Springfield Water and Sewer Commission) as its flow metering subcontractor. ADS provides rain gauge monitoring services as well as CSO measurements at each permitted CSO outfall, as described in the following sections.

# 2.2.1 Rainfall Data Collection and QA/QC

**Rain Gauge Locations.** Rainfall data was collected from the four local ADS-maintained rain gauges located within Springfield. The local rain gauges are positioned at the following locations in Springfield and as shown in Figure 2.2-1 below:

- RG01, stationed along the Connecticut River in the northwest portion of Springfield;
- RG02, stationed in the southwest portion of Springfield;
- RG03, stationed in the southeast portion of Springfield; and
- RG04, stationed in the northeast portion of Springfield.

*Figure 2.2-1: Permanent Rain Gauge Locations in Springfield, MA*




**Rainfall Data Categorization.** The Commission has standardized it's categorization of rainfall for reporting purposes; the last three annual reports have included these standardized results and for comparative purposes this TM follows the same approach. The first stage to reviewing the rainfall data recorded was to compare the measured rainfall depth at each of the four rain gauge sites. The gauges are spread throughout Springfield and therefore are susceptible to the spatial and temporal effects of rainfall. This is demonstrated by the varying total depths returned when compared across an entire year.

To better understand the nature of the rainfall that was recorded in Springfield during 2017, the annual hyetographs for the four rain gauges were disaggregated into both depth and intensity ranges. The ranges are designed to offer a breakdown as to the frequency of the individual rainfall events that comprise the annual hyetograph. The results of the breakdown of the annual rainfall total depth are contained in Table 2.2-1.

*Table 2.2-1: 2017 Rainfall Disaggregation by Total Depth*

| Data Set | Total Rainfall (inches) | Total No. of Storms | Number of Storms by Total Precipitation (inches) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0.01 to 0.13 | 0.14 to 0.25 | 0.26 to 0.50 | 0.51 to 1.0 | 1.01 to 2.0 | 2.0 |
| **ADS RG01** | 42.0 | 76 | 27 | 12 | 10 | 12 | 11 | 4 |
| **ADS RG02** | 40.8 | 80 | 31 | 10 | 15 | 13 | 9 | 2 |
| **ADS RG03*** | 19.6 | 62 | 49 | 8 | 5 | 7 | 1 | 2 |
| **ADS RG04** | 43.3 | 78 | 26 | 12 | 10 | 17 | 10 | 3 |
| *Instrumentation performance has been impacted for a portion of 2017 but was later corrected. | | | | | | | | |

It should be noted that during the 2017 calendar year, RG03 consistently measured less rainfall than all other meters, or no rainfall at all, for the majority of storms from January through September. The annual hyetographs and storm breakdowns for RG03, therefore, are appreciably lower than those at the other three gauges (RG01, RG02 and RG04). As a result, during the annual rainfall correlation analysis RG03 was not included in the calculations. The missing RG03 rainfall data is further discussed in Section 2.3, as it relates to the model CSO calculations and comparisons.

The 2017 Annual Rainfall and CSO Flow Meter Data Review identified this concern regarding the RG03 rain data. ADS revisited the site and found that shrubs had grown too tall around RG03, creating a rain shadow. Thus, the meter was moved to a new location on September 28$^{th}$, resolving the issue for the remainder of 2017 (see Figure 2.2-1).

The largest number of total storms occurred at RG02 (80), versus the lowest number of storms, 76, at RG01 (median of 78 among the three working gages, versus 82 in typical year). The difference in the total depth between RG02, the lowest, and RG04, the highest, is 2.4 inches; a variance of 6% when considered across the entire annual hyetograph. This low variance should be reflected in the comparison between simulated CSO results and the metered data, where full meter data is available.

Looking deeper into the breakdown of total precipitation in the annual series, the following variability among the rain gauge results was also noted:

- There is the greatest percentage of variability in rainfall recordings in the 0.25-0.5-in category, which is around the activation threshold of many of the CSOs (for the CRI system, in particular). This category had a maximum variability of 5 storms, between RG02

(15 events) and RG04 (10 storms). This may introduce lower confidence in the CSO predictions;

- Rainfall events in the 0.51-in to 1.0-in categories varied by 5 events between RG02 and RG04/RG01. Because these rainfall categories tend to activate CSOs, this variability may lead to lower confidence in the CSO predictions.

- The remaining three categories did not show a great deal of variability. There was a peak difference of two storms (11 at RG01 as compared to 9 at RG03) in the 1.01-in to 2.0-in, which would only be expected to have a minor effect on variability in CSO predictions.

Overall, variability in rainfall measurements (if due to rainfall recording inconsistencies or errors) in the 0.26-0.50 in category could be expected to contribute to discrepancies in the predictions of CSOs versus the measurements since the quality of model prediction output is reliant on the quality of data input. The variability in these rainfall results is consistent with the variability observed over the past several years, though the variability shifts amongst the storm categories.

To obtain a more complete picture of the 2017 rainfall recorded, the data was also considered from a peak intensity perspective to better understand the rainfall characteristics, as this is an important factor in determining the extents to which CSOs activate. Details of rainfall distributions broken down by intensity are summarized in Table 2.2-2.

*Table 2.2-2: 2017 Rainfall Disaggregation by intensity*

| Data Set | Total Rainfall (inches) | Total No. of St orms | Number of Storms by Peak Intensity (in/hr.) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 0.01 to 0.10 | 0.10 to 0.25 | 0.25 to 0.50 | 0.50 to 1.0 | > 1.0 |
| **ADS RG01** | 42.0 | 76 | 35 | 22 | 12 | 7 | 0 |
| **ADS RG02** | 40.8 | 80 | 39 | 24 | 11 | 3 | 3 |
| **ADS RG03*** | 19.6 | 62 | 42 | 12 | 5 | 2 | 1 |
| **ADS RG04** | 43.3 | 78 | 33 | 23 | 15 | 4 | 3 |
| **Instrumentation performance has been impacted for a portion of 2017 but was later corrected. | | | | | | | |

As previously described, the discrepancy in total rainfall and number of storms recorded at RG03, and the identification of obstructions to rainfall measurement at that site lead to the removal of RG03 data from consideration in the review of peak intensity correlation amongst the gauges.

Variance amongst the gauges is most significant in the 0.50-in to 1.0-in range and the highest range, >1.0-in. The highest categories are most likely to trigger CSO activations; thus, this variance will impact confidence in predictions.

It is clear that the use of four discrete gauges across a city the size of Springfield may introduce some variability across the collected rainfall totals. Corrective action for RG03 was taken on September 28$^{th}$, 2017, however, RG03 2017 data could not be used during annual rainfall analysis. For the 2018s annual report, RG03 will have been in place and operational in its new location, and therefore the data should be more dependable for the full 2018 calendar year. Discounting the occasional gauge failure, the spatial and temporal effects of rainfall cause localized storms to occur which are not always captured at all gauges, resulting in variable depth totals.

The irregular effects of rainfall passing across the city differ for every storm and this unpredictability is not currently reflected in the model. The subcatchments generating flow in the model are assigned an index so that the model reads the closest rainfall hydrograph and applies that rainfall to the given subcatchment. Model simulations, therefore, depend on a depth of rainfall at a particular gauge to be distributed across an entire CSO catchment. Each rain gauge is assigned to between 3,000 and 6,000 acres of subcatchment area. Therefore, the rainfall variability observed in reality throughout the subcatchments tributary to each CSO is missed. For example, CSO 012 has 1,564 acres of contributing area assigned to either RG01 or RG04 with RG04 located approximately 3.85 miles from the CSO. There exists the potential for high variability in the spatial distribution of the rainfall in such a large subcatchment area, possibly resulting in fluctuating comparison between actual CSO overflow and model predicted overflows. It is recommended that additional rain gauges be installed, particularly in the subcatchments currently assigned the RG01 and RG02 hydrographs. The area of influence for these two rain gauges extends from the Connecticut River several miles northeast into the network. Based on a review of radar rainfall data over the past several years, it is evident that the nature of rainfall along the Connecticut River (at RG01 and RG02) can be highly variable as you move northeast into the network, away from the river. A denser layout of rain gauges in these areas might improve correlation between the metered and modeled CSO performance. While more rain gauges would not eliminate variance among the gauges it would provide more granularity in the results and, therefore, increased confidence in the representation of the spatial variation in rainfall throughout the city.

**Comparison with the Typical Precipitation Year (1976).** One of the objectives of this TM is to compare the 2017 rainfall with the typical year (1976) rainfall. Before analyzing the annual CSO results, a thorough understanding of the rainfall data provides valuable context as to how wet or dry the year was, as compared to the typical year. Table 2.2-3 shows the total depth comparison and rainfall event range breakdown between the 2017 and 1976 series.

*Table 2.2-3: 1976 Rainfall Disaggregation by Total Depth*

| 1976 v 2017 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Data Set | Total Rainfall (inches) | Total No. of St orms | Number of Storms by Total Precipitation (inches) | | | | | |
| | | | 0.01 to 0.13 | 0.14 to 0.25 | 0.26 to 0.50 | 0.51 to 1.0 | 1.01 to 2.0 | > 2.0 |
| **Typical year (1976)** | 42.2 | 82 | 28 | 15 | 11 | 14 | 11 | 3 |
| | | | | | | | | |
| **ADS RG01** | 42.0 | 76 | 27 | 12 | 10 | 12 | 11 | 4 |
| **ADS RG02** | 40.8 | 80 | 31 | 10 | 15 | 13 | 9 | 2 |
| **ADS RG04** | 43.3 | 78 | 26 | 14 | 10 | 17 | 10 | 3 |
| **2017 Median** | **42.0** | **78** | **27** | **12** | **10** | **13** | **10** | **3** |

Comparison between the 2017 gauges with the 1976 series, shows 2017 is comparable to a typical year. Firstly, 2017 (median depth=42.0 inches) was approximately the same as 1976 in terms of total rainfall depth (0.5% drier). The median storm count in 2017 (78 storms) is slightly lower (5%) than the 1976 storm count (82 storms).

It is evident that variance in total number of storms from a typical year within each range could affect CSO modelling results, even though during 2017, the total number of storm events is similar to a typical year. The largest difference between the 2017 data and the typical year shows a lower incidence of storms (20%) in the second lowest range (0.14 to 0.25-in) with 12 storms during 2017 versus 15 storms during the typical year. This range tends to have rainfall events that are either just under or over the CSOs activation thresholds (for the CRI system); therefore, it is possible that this variance could skew the results of CSO modelling when considering long periods of data.

For completeness the comparison between the 2017 and 1976 rainfall series was also analyzed for peak intensity, and the results are shown in Table 2.2-4.

*Table 2.2-4: 1976 Rainfall Disaggregation by Intensity*

| 1976 v 2017 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Data Set | Total Rainfall (inches) | Total No. of storms | Number of Storms by Peak Intensity (in/hr.) | | | | |
| | | | 0.01 to 0.10 | 0.10 to 0.25 | 0.25 to 0.50 | 0.50 to 1.0 | > 1.0 |
| Typical year (1976) | 42.2 | 82 | 48 | 17 | 12 | 4 | 1 |
| | | | | | | | |
| ADS RG01 | 42.0 | 76 | 35 | 22 | 12 | 7 | 0 |
| ADS RG02 | 40.8 | 80 | 39 | 24 | 11 | 3 | 3 |
| ADS RG04 | 43.3 | 78 | 33 | 23 | 15 | 4 | 3 |
| **2017 Median** | **42.0** | **78** | **35** | **23** | **12** | **4** | **3** |

Even though the total number of storms is only slightly lower than in 1976, the comparison of peak intensity storms shows appreciable variation in two storm intensity ranges. The lowest peak intensity range (0.01 to 0.10-in) shows fewer storm events (35 during 2017 versus 48 during the typical year). This 27% variance in the lowest range of peak intensities would not be expected to influence the CSO comparison, given that this low range does not generally cause CSOs to activate.

The number of storms in the next largest range (0.10 to 0.25-in) is higher (35%) during 2017 (23) as compared to the typical year (17). Because storms in this range typically cause CSO activation or are just below the CSO activation threshold, depending on the recorded intensity of the storms, this variability could increase frequency or volume of 2017 CSO activations. There is good correlation between the typical year and 2017 data in the three highest ranges, all of which are more likely to trigger CSO activations.

**2017 Rainfall Analysis Conclusions.** The rainfall analysis findings indicate that the variability among the 2017 rainfall gauge data is highest in the total precipitation range of 0.14 to 0.25-in, and in the peak intensity range of 0.50 to 1.0-in/hr, the second to highest range. The total precipitation range is either over or under CSO activation thresholds (for the CRI system); thus, the variability of rain gauges could lead to discrepancies in modeled CSO activations. On the other hand, the highest peak intensity ranges reach the CSO activation threshold (for the CRI system). This peak intensity variability amongst the rainfall gauges, therefore, may cause discrepancies in modeled CSO activations.

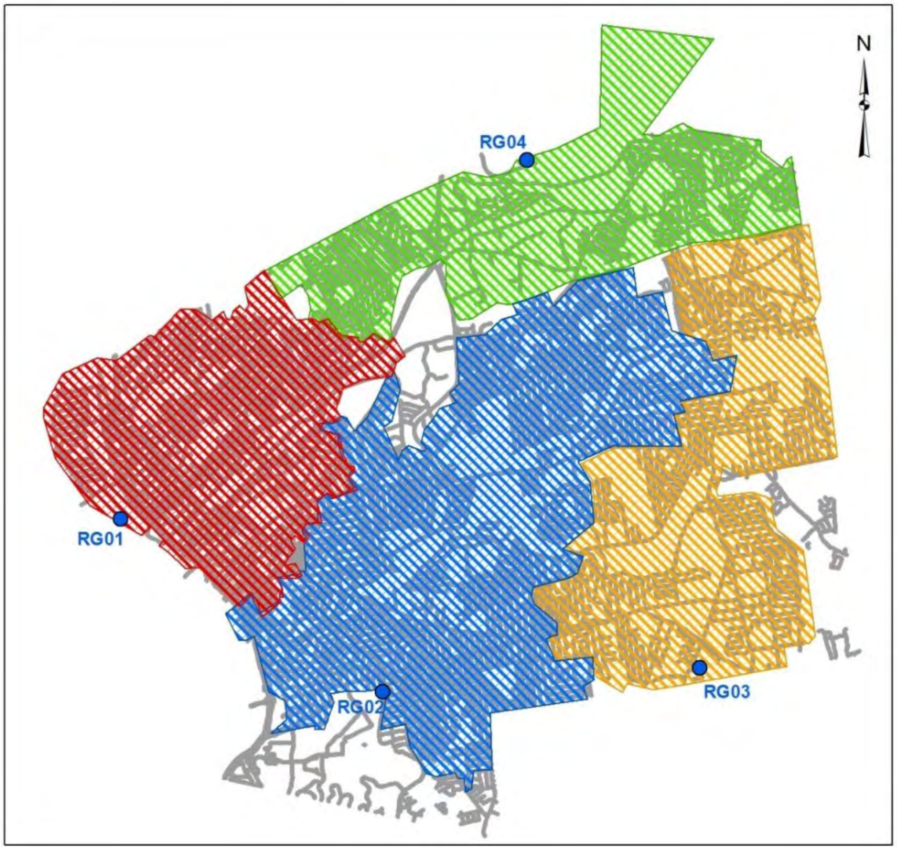
From the rain gauge data collected, it is evident that the 2017 rainfall data shows a total precipitation depth similar to 1976. The reduction in storms (4 storms fewer in 2017), however, was concentrated in the 0.14 to 0.25-in range for precipitation depth. For peak intensities, the reduction of storms is concentrated in the lowest range, 0.01 to 0.10-in/hr. The 2017 rainfall data shows a decrease in the 0.14 to 0.25-in storm depth range, as well as an increase in peak intensity in the 0.10 to 0.25-in/hr range. These ranges are the tipping point for CSO activations and therefore are likely to affect CSOs (on the CRI system); however, the decrease in depth and increase in peak intensity of storms will have the opposite effect on CSOs. Therefore, it is difficult to predict the model's results.

It should also be noted that the rainfall gauges capture all forms of precipitation, but do not distinguish between precipitation that falls as rainfall versus snowfall. Similar to previous annual reviews, variability in the CSO results may be a result of the effects of precipitation falling as snowfall during the winter, which does not translate to direct runoff rainfall since snow melt provides a delayed and irregular response. In addition, the NOAA weather station at Bradley International Airport (the closest NOAA data point) was also referenced as the record of precipitation at this site, which distinguishes between snowfall and rainfall, and also provides a measure of accumulated snow on the surface. These two sources were referenced during the months when it was suspected that the precipitation recorded fell as snow. However, the potential for over-prediction of surface runoff (due to the model treating all precipitation as rainfall) and resulting CSO activations and volumes are inherent to the model predictions. The monthly comparisons presented in Section 2.3 provide an overview of months where snowfall was suspected to be affecting the model results.

Correlation between the model results and the observed flow data may also be impacted by the failures at Rain Gauge RG03 and the resulting substitution of proximate rain gauge data. During the January through September of the 2017 metering program, RG03 often did not measure precipitation during rainfall events. As a result, data from a proximate gauge was used to supplement missing RG03 data during model simulations. RG04 was considered the most reasonable substitution for the RG03 data, as both gauges are located north/west of the Connecticut River, whereas gauges RG01 and RG02 are located close to the River, where there tends to be higher rainfall amounts based on previous annual rainfall data.

The model rain gauge distribution for Springfield is presented in Figure 2-2. The RG03 area of influence is located predominantly in catchments contributing to the Main Interceptor System (MIS), therefore, any effects of local variability in the rainfall that fell at RG03 versus RG04 would be expected to primarily have an impact on the MIS catchment model results. In addition, RG02 failed on January 23$^{rd}$ through 24$^{th}$ during which data from RG01 was substituted. This discrete change (during the month of January) would be expected to impact the model results in the Mill River System (MRS), if the effects were observed anywhere.

*Figure 2.2-2: Permanent Rain Gauge Areas of Influence*




# 2.2.2 Wet Weather Reporting Enhancements

Similar to annual reporting conducted in 2016, the Commission requested an enhanced data set from ADS and from its wastewater treatment plant operator, Suez. Supplemental data continues to be reported as follows:

- Daily total rainfall from all four rain gauges maintained (from Suez & ADS);
- Daily total rainfall from a rain gauge at the Springfield Regional Wastewater Treatment Facility, SRWTF (from Suez);
- Daily average and daily peak influent flow rates to the SRWTF (from Suez); and
- Daily minimum and maximum temperatures recorded at the SRWTF (from Suez).

The supplemental data is provided to better enable characterization of the collection system response to rainfall and better understand any difference between model prediction and actual CSO recordings. For example, the recordings of CSO volume at an individual or group of CSO regulators on a winter day without recorded precipitation, together with observations of elevated SRWTF influent flows and above-freezing temperatures, would suggest that snowmelt is causing CSO discharges. While this does not waive a CSO occurrence it is important to understand when evaluating predictive hydraulic model performance against actual observations.

# 2.3 Hydraulic Model Predictions vs. ADS Regulator Flow Meter Measurements

This section reviews the results of simulating the sewer network model with the 2017 measured rainfall and comparing the model performance against the CSO regulator meter observations. Comparisons were made for the number of activations and the total overflow volumes on both a monthly and annual basis.

All CSO regulators within Springfield were included in the analysis and were classified in the Connecticut River Interceptor (CRI), Mill River System (MRS) and Chicopee Systems.

## 2.3.1 CSO Regulator Results Comparisons

**Monthly Tabular Comparisons – Meter Recordings vs Model Predictions.** The results summarized in Table 2.3-1 show the comparisons between the flow meter recordings and the hydraulic model predictions for CSO performance. In reviewing the rainfall data collected, an intermittent antecedent dry period of 24 hours was used to quantify whether a precipitation measurement is considered a single continuous event or two discrete rainfall events. This antecedent dry period is consistent with the dry period used to categorize the typical year rainfall events and is standard practice in CSO reporting across the U.S., in keeping with the EPA's CSO Long Term Control Plan guidance.

Several years of analyzing CSO flow data and comparing data to the SWSC collection system model has provided insight into the difficulties of metering depth and velocity data within CSO outfall pipes. The quality of the raw data collected determines whether the data can be compared to modeled results and, in turn, improve confidence in the model's ability to predict a range of flow conditions. When the observed raw data is of poor quality, the data cannot be used for correlation with the model simulations. Variability in raw data quality requires the use of thresholds and filters when compiling the raw data and comparing the data to modeled results;

- Metered CSO discharges on days when functional float switches did not substantiate an overflow were reviewed to assess their validity by reviewing rainfall.

- During 2017, float switches on the CRI, MRS and the Chicopee systems functioned for less than 35% of the time. This was a result of a change in float switch equipment by ADS across the regulators.
- Modeled CSO discharges of less than 3,000 gallons are not included in the comparison tables as they are below the lower confidence envelope for accurate reporting;

The following sections present the model-to-meter comparisons of the CSO spills and volumes throughout the SWSC system.

**Monthly Comparisons – Connecticut River Interceptor (CRI).** The 2017 comparison between the model prediction and observed data for aggregated annual spill-count and volume along the CRI (Table 2.3-2) shows the model predictions higher than the ADS spill count and volume data. The meters at CSO 012 and 013 were both inoperable for the duration of 2017; CSO 015A was offline during September through December; CSO 015B was offline from January through May and October through December; and CSO 018 was offline from July through December. Both CSO 012 and 013 meters were removed for outfall repairs. CSO 013 was reinstalled on January 8th, 2018 and CSO 012 will be installed before the first week of March, 2018, therefore both will be evaluated in the 2018 annual report. CSO 015A was removed for Northern Construction's casino work and CSO 015B was removed due to NWMCC manhole rehabilitation as part of the Commission's capital improvements projects. Due to these data gaps in metering, the total annual spill volume comparison shows the model predicts over double the volume the ADS CSO data reports along the CRI system.

Given the extensive amount of meter data missing during the calendar year 2017, a comparison of model predictions versus meter observations during periods of time when meters were online is presented in Table 2.3-3. That is, for a month where a given meter was offline, any model predicted spills from that meter's catchment were removed from the dataset. Table 2.3-3 reflects varying months with offline meters. When offline meter data was excluded from the dataset, the correlation between modeled and metered data improves, with the model predicted spill counts higher by 7% and overflow volume greater by 36%.

*Table 2.3-1: CRI Catchment Meter Recording vs Model Prediction Results*

| CSO | Months Offline | 2017 ADS Spill Report | | 2017 Model Results | | Model Results for Typical Year (1976) Rainfall Series | |
|---|---|---|---|---|---|---|---|
| | | Total Spills* | Volume (MG) | Total Spills | Volume (MG) | Total Spills | Volume (MG) |
| | Connecticut River System (CRI) | | | | | | |
| **CSO 007** | - | 3 | 0.17 | 2 | 0.88 | 6 | 1.17 |
| **CSO 008** | - | 4 | 0.68 | 14 | 13.33 | 15 | 11.47 |
| **CSO 010** | - | 34 (1) | 71.73 | 49 | 69.27 | 44 | 69.66 |
| **CS0 011**** | - | 3 | 0.32 | 0 | 0.00 | 1 | 0.02 |
| **CS0 12** | Jan-Dec | 0 | 0.00 | 51 | 142.05 | 54 | 129.55 |
| **CSO 13** | Jan-Dec | 0 | 0.00 | 11 | 2.59 | 9 | 8.16 |
| **CSO 014** | - | 29 | 7.27 | 35 | 21.60 | 37 | 20.41 |
| **CSO 015A** | Sept-Dec | 18 | 5.20 | 15 | 10.07 | 15 | 10.70 |
| **CSO 015B** | Jan-May & Sept-Dec | 7 (1) | 0.86 | 4 | 4.10 | 6 | 0.63 |
| **CSO 016** | - | 27 | 59.67 | 33 | 51.33 | 31 | 43.27 |
| **CSO 018** | July-Dec | 0 (3) | 0.004 | 3 | 0.12 | 1 | 0.05 |
| **CSO 049** | - | 16 | 6.10 | 7 | 0.41 | 7 | 0.68 |
| **Totals** | | **141 (5)** | **152.01** | **216** | **320.58** | **226** | **295.76** |

** Numbers in parentheses reflect the removal of spills below the reporting limit of 3,000 gallons*
*** Spill count and volume reported by ADS are using a weir equation. The meter is located on the upstream side of the weir so this data is not a direct measurement of overflow occurrences.*

*Table 2.3-2: CRI Catchment Meter Recording vs Model Prediction Results – Online Months Only*

| CSO | Months Offline | 2017 ADS Spill Report | | 2017 Model Results | |
|---|---|---|---|---|---|
| | | Total Spills* | Volume (MG) | Total Spills | Volume (MG) |
| **CSO 007** | - | 3 | 0.17 | 2 | 0.88 |
| **CSO 008** | - | 4 | 0.68 | 14 | 13.33 |
| **CSO 010** | - | 34 (1) | 71.73 | 49 | 69.27 |
| **CSO 011**** | - | 3 | 0.32 | 0 | 0.00 |
| **CSO 12** | Jan-Dec | 0 | 0.00 | 0 | 0.00 |
| **CSO 13** | Jan-Dec | 0 | 0.00 | 0 | 0.00 |
| **CSO 014** | - | 29 | 7.27 | 35 | 21.60 |
| **CSO 015A** | Sept-Dec | 18 | 5.20 | 11 | 4.14 |
| **CSO 015B** | Jan-May & Sept-Dec | 7 (1) | 0.86 | 4 | 4.10 |
| **CSO 016** | - | 27 | 59.67 | 33 | 51.33 |
| **CSO 018** | July-Dec | 0 (3) | 0.00 | 0 | 0.00 |
| **CSO 049** | | 16 | 6.10 | 7 | 0.41 |
| **Total** | | **140 (5)** | **121.34** | **155** | **165.06** |

** Numbers in parentheses reflect the removal of spills below the reporting limit of 3,000 gallons*
*** Spill count and volume reported by ADS are using a weir equation. The meter is located on the upstream side of the weir so this data is not a direct measurement of overflow occurrences.*

Analysis of the 2017 data and calibration of the network model using the October 2017 temporary metering data greatly improved the model to meter correlation at CSO 010, in contrast to previous years when the model was consistently over-predicting CSO 010 spill count and volume. With the full year of data at this meter, the modeled and metered spill volumes at this location differ by under 4%. The modeled and metered spill count and volumes at CSO 016 also showed good correlation, differing by 22% and 14%, respectively.

**Seasonal Variability.** Similar to the analyses conducted in previous years, variability in spills and volume indicates a potential imbalance between the rain falling on the catchment, the generation of runoff, and the flows within the sewer network. This is particularly true during the months of January and February, when snow accumulation would be expected to be highest. In addition, the rain gauge measurements do not distinguish between precipitation falling as rainfall versus snowfall. The effects of snowfall and snow accumulation on runoff, which might be most pronounced during the months of January and February, may influence the modeled versus metered correlations. Review of the metered and modeled spills during the winter months, therefore, includes a review of the temperature during each storm event, as well as a review of the snow accumulation data for the nearest NOAA weather station (Bradley International Airport).

In addition to the effects of snow fall and accumulation, the Connecticut River levels may also be having  effect on the correlation between metered and modeled CSO data on the CRI. Figure 2.3-1 presents the measured river level at the closest USGS river gauge, just upstream of the SWSC collection system network (USGS 01172010 Connecticut R at I-391 Bridge at Holyoke, MA), showing the seasonal variability in levels. During these periods of lower river level, the river is consistently below the invert of the CRI outfall pipes, therefore backwater conditions on the CRI outfall pipes should not be present and better correlation between metered and modeled CSO spills would be expected.

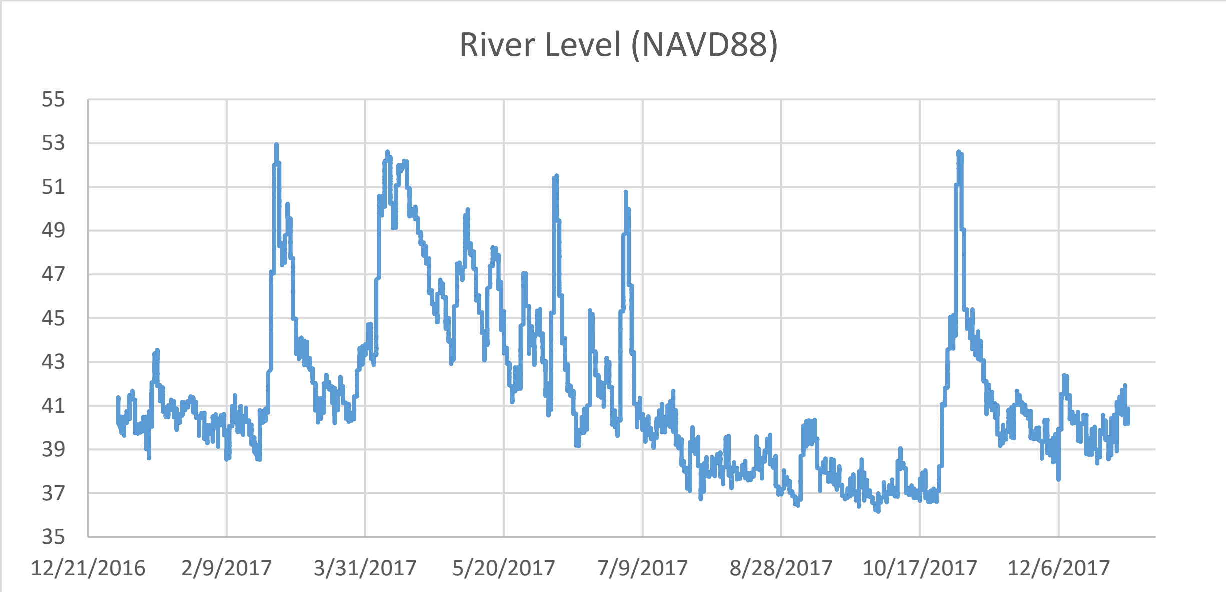
During July through September and November through December, the Connecticut River level was relatively low. During these months, the effects of snow accumulation and snow melt would not be expected to have an influence on runoff in the SWSC system. Table 2.3-3 displays spills during these months at active meters along the CRI. The model remains conservative when predicting number and volume of spills, however the model is predicting higher spill frequency and volume by 5% and 25%, respectively, which is a better correlation than for the full year of data, where the spill count and volume on the CRI varied by 7% and 36%, respectively, during months when meter data was available (Table 2.3-3).

In order to understand the potential effects of Connecticut River level on the model-simulated CSO results, the SWSC network model was run through various iterations which included;

- Gauged river levels being applied to the outfall pipes;
- Real Time Control (RTC) actuation of the outfalls based on river levels; and
- Simulation with neither river level variability nor RTC limitations, hence assuming fully free outfalls throughout the year.

A sensitivity analysis of the model indicated that the model-simulated CSO spill counts and volumes along the CRI do not vary appreciably with river level variability. The difficulty in correlating modeled and metered data during periods of high river level, therefore, is most likely associated with CSO monitoring on outfall pipes with the presence of backwater.

*Figure 2.3-1: Connecticut River Level at I-391 Bridge at Holyoke, MA (2017)*




Standing water in the outfall pipes is measured by the ADS meters, however, the collection of velocity data used to calculate flow and, hence, spill volume, can be complicated by backwater conditions. A number of instances of erroneous velocity data were identified at CSOs 014 and 016, particularly during periods of high river level. Those included; CSO-014: 4/6, 4/15, 6/6, 6/19, 7/12-13, 10/24-25, 10/29-30 and CSO-016: 6/6, 6/19, 6/27, 6/30, 7/24, 10/24-25. Spills were modeled and metered during each of these events; however, in most cases the modeled spill volumes were higher than the metered volumes. These events were reviewed in the model and the depths noted in the model were similar to those recorded by the meter, however in all cases the observed velocities were lower, on average, than the modeled velocities. In addition, the velocity data during these high river level periods appeared to have some gaps.

Figure 2.3-2 presents a sample comparison of modeled versus metered velocity at CSOs 014 and 016 for two storm events (6/6/17 and 6/19/17).

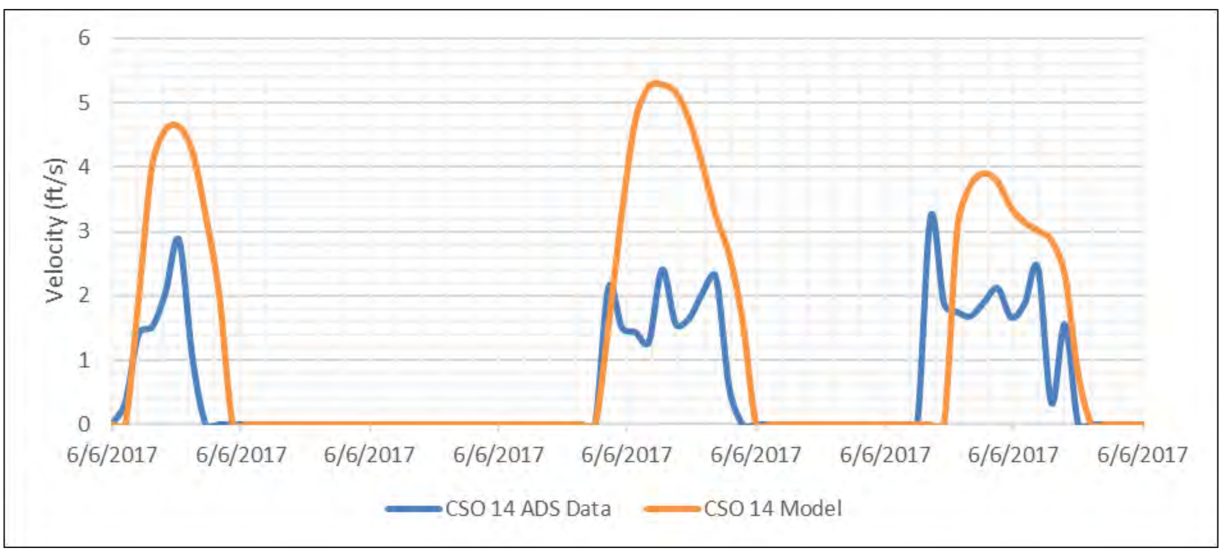
Gauged river level will continue to be reviewed to more thoroughly understand which events may be prone to lower observed velocity data due to backwater effects. This discrepancy appears to be particularly related to CSO 014 and CSO 016, however during the 2018 review, CSOs 012, 013 & 015A/B will also be reviewed as these meters will be back online, generating metered data to compare with the model simulations.

*Table 2.3-3: CRI Results for July-September & November-December*

| CSO | 2017 ADS Spill Report | | 2017 Model Results | |
|---|---|---|---|---|
| | Total Spills | Volume (MG) | Total Spills | Volume (MG) |
| **CSO 007** | 0 | 0.00 | 0 | 0.00 |
| **CSO 008** | 2 | 0.52 | 4 | 1.30 |
| **CSO 010** | 13 | 25.51 | 19 | 34.06 |
| **CS0 011** | 2 | 0.05 | 1 | 0.13 |
| **CSO 014** | 11 | 0.78 | 16 | 10.17 |
| **CSO 015A*** | 4 | 3.37 | 1 | 2.55 |
| **CSO 015B**** | 3 | 0.27 | 1 | 0.20 |
| **CSO 016** | 12 | 17.16 | 16 | 15.39 |
| **CSO 049** | 9 | 3.63 | 1 | 0.12 |
| **Total** | **56** | **51.28** | **59** | **63.92** |

** CSO 015A was offline for August through December*
**CSO 015B was offline for September through December*

*Figure 2.3-2: Modeled versus Metered Velocity Example – June 6, 2017 – CSO 014*




Focusing first on the CRI system, the following sections summarize the model results and the meter recording comparison for each month. The analysis has been organized by interceptor, given the independent nature of the CRI, MRS and Chicopee systems, including the layout of the CSO regulators and the interconnected nature amongst regulators on a given interceptor system, particularly the CRI regulators. In addition, the analysis is presented monthly, given the effects of seasonal variability on rainfall data including the breakdown between rainfall and snow during a precipitation event, the presence of snow on the ground during a storm event, as well as the possible effects of Connecticut River level on the metered versus modeled CSO correlation. The monthly CSO comparisons are presented in Appendix A for the three major system areas CRI, MRS and the Chicopee System.

**CRI – January 2017.** During the month of January, the model predicted more total CSO volume (9.2 MG predicted, 6.31 MG observed), not including the 11.06 MG simulated volume at CSO 012, because the CSO 012 flow meter was offline during January. CSO 015B and CSO 013's meters were also offline during January, however the model did not simulate spills at either location during the month of January.

On January 24th, there was 2-in of snow on the ground and there is some indication from the NOAA weather station (Bradley International Airport NOAA Data) that the precipitation fell as snow during this event. The model's prediction of higher overflow volume at CSOs 010 and 014, as compared to the metered data, on January 24th may be due to snow cover and snowfall. The model-to-meter volume correlations at these two meters improve when the January 24th spill event is removed from the analysis.

**CRI – February 2017**. In February, the model predicted 15 overflows, whereas ADS reported eleven spills. CSOs 012, 013, and 015B's meters remained offline during February, while the model predicted 6 spills at these offline meters.

At CSOs 010, 014, 015A, and 016 the model estimated higher spill count and volume. The higher estimation on February 1st and 13th might be a result of snow having fallen on those days, as the low temperature during those two precipitation events was 21 degrees and a majority of the precipitation was recorded as snowfall by NOAA (source: Bradley International Airport NOAA Data). In addition, on February 1st there was 2-in of snow on the ground and on the 13th there was 13-in of snow on the ground.

**CRI – March 2017**. During the month of March meters at CSOs 012, 013, and 015B remained offline. Discounting the five spills and 4.44 MG of volume simulated at CSO 012, the model simulated 6 spills, totaling in 2.07 MG spilled, whereas there were 4 overflows observed that produced a total spill volume of 0.92 MG along the CRI.

The model predicted a higher number of spills at CSOs 010, 014, and 016, however the three extra modeled spills were small, ranging between .009 MG and 0.224 MG (averaging .116 MG). One of the spills simulated by the model at CSO 010, but not recorded, was on March 15, 2017. According to the NOAA Bradley International Airport weather station there was over 11-in of snow accumulated on the ground, which might explain the higher prediction on this date. As previously discussed, the river level during the month of March began to increase around the middle of the month. The lack of correlation between the two spill events modeled on March 27 and March 28 and not observed in the metered data may be a result of the high river level effecting velocity measurements.

**CRI – April 2017.** The meters at CSOs 012, 013, and 015B remained offline during the month of April. No including results from CSOs with offline meters, the model predicted 17 spills at CSOs with active meters, while 12 spills were observed along the CRI at those same meters.

The month of April had the highest average river level throughout 2017 which may account for the lack of correlation between the higher modeled spill volumes throughout the CRI during this month. A small spill of 0.01 MG was observed on April 6th at CSO 049; however, the model did not predict any spills.

**CRI – May 2017.** Along the CRI, the model simulated 33 spills, 10 of which were at CSOs whose meters were offline during May (CSO 012, 013 and 015B). Thus, at active meter locations, there were 23 simulated spills and 15 observed spills.

The river level remained high during the entire month of May, with river levels hovering around the inverts of the CRI outfall pipes. At CSO 014 the spill counts correlated, however the total volume was higher in the model than in the metered data. It is probable that the effects of river level on the metered velocity values may be affecting the model-to-meter correlation during the month of May at CSO 014 and 016.

**CRI – June 2017.** In June, the model predicted one more overflow than was observed. Meters at CSOs 012 and 013 remained offline for the month of June. Apart from spills simulated at offline CSOs (8 overflows), there was a total spill volume of 18.90 MG simulated by the model and 22.43 MG of observed volume.

The river level remained high during the first half of the month of June and during two spill events (6/6/17 and 6/19/17) there were discrepancies noted in the observed velocity data which may be responsible for the lack of correlation during the three storms at the beginning of the month (additional detail provided in the Seasonal Variability portion of this section).

**CRI – July 2017.** During the month of July, the CSO 012 and 013 meters continued to be offline. The river level during this time period had decreased and remained below the CRI outfall inverts for the entire month. Unlike the previous 6 months of 2017, the model predicted fewer spills and a smaller volume of overflows in July. Discounting the offline meters, 27 spills with total overflow volume of 32.5 MG were observed and 22 spills totaling 20.94 MG were predicted.

**CRI – August 2017.** During the month of August the model simulated 15 overflows and 8.79 MG volume spilled in (discounting the offline meters, CSO 012 and 013), while 6.45 MG of volume was observed at the same meters.

The meter at CSO 015A was taken offline on August 7th. One overflow was measured at CSO 015A on August 5th, resulting in 0.23 MG spilled, whereas two spills were simulated at 0.26 MG and 0.11 MG on August 5th and August 23rd, respectively. The 8/23/17 spill may have occurred, however, the meter was offline during this time.

**CRI – September2017**. During the month of September, meters at CSOs 012, 013 and 015A remained offline. Discounting the offline meters, the model predicted 6.02 MG during 6 overflows, whereas 9.29 MG during 9 spills was observed.

The model correlated well with metered spill counts and volumes at CSO 010. At CSOs 014 and 016, the spill counts correlated well with observed spills.

**CRI – October 2017.** During the month of October, the Connecticut River level began to increase again and there were high river levels at the end of the month from October 24 through the end of the month (Figure 2.3-1). During the month of October, the CSO 012, 013 and 015A meters continued to be offline.

The largest monthly volume of spills was both modeled and metered during the month of October, most likely due to the combination of high river levels and two particularly large storm events on October 24th and October 29th. These two spills accounted for a majority of the volume during the month across the CRI meters. The spill count and volume in the online meters during the month of October showed good correlation with differences of approximately 16% and 10%, respectively. The model predicted spills correlated well with the measured number of spills at online meters at CSOs 008, 010, 014, 015B and 016.

**CRI – November 2017**. November was a dry month in which only 3 spill events were observed along the CRI, resulting in a total spill volume of 0.41 MG. Similarly, 2 spills were simulated by the model with 0.09 MG total volume. Meters at CSOs 012, 013, 015A and 015B, were all offline for the duration of November.

**CRI – December 2017.** Meters at CSOs 012, 013, 015A and 015B remained offline for the duration of December. Not including predicted overflows at offline meters, the model simulated 5 spills resulting in 1.97 MG spilled, while ADS reported 8 spills resulting in 3.32 MG spilled along the CRI.

At CSO 010 the model-to-meter correlation was good with the model simulating the same 3 spills as the metered data and the difference in total volume of these three spills only 3%. The model, however predicted both lower spill count and smaller volume at CSOs 014 and 016. Two of the modeled spills at CSO 016, however, were below the 3,000 gallon threshold, therefore the difference at CSO 016 may be a result of the smaller spills being observed and simulated.

**CRI System Review – 2017.** Table 2.3-1 includes model predictions of the 2017 collection system configuration with the typical year (1976) precipitation series. It is evident that across the entirety of the CRI system, there is general similarity between the model predictions for 2017 versus the typical year (1976), both on a regulator-by-regulator basis, as well as on the sum of CSO frequency and volume. Generally the 2017 rainfall series produced slightly fewer CSO spills versus 1976 (4.4% difference) versus 1976, while concurrently the 2017 rainfall series produced more CSO volume (8.3% difference) versus 1976. The CSO activations and spill volumes are similar between the 2017 and 1976 simulations and any variability can be attributed to the nature of the 2017 results being simulated with spatially and temporally variable rainfall data (from the three active gauges), whereas the typical year simulation utilizes the on 1976 rainfall hydrograph for the entire system. The positive correlation between the 2017 and typical year CSO results can be attributed to the lack of appreciable variability in the observed rainfall event categories for both total precipitation and peak intensity, summarized in Section 2.2.

**Comparisons – Mill River Interceptor System (MRS).** The results of the comparison for the Mill River System (MRS), presented in Table 2.3-4, are similar to previous annual reviews, in that in many cases the size of the overflows at the regulators in the MRS are close to the model's lower threshold for spills. There were 6 spills observed by ADS that were lower than the 3,000 gallon threshold. In 2017, a significant number of spills were not predicted by the model. Similar discrepancies in spill count and total volume were also observed in the 2014, 2015, and 2016 annual CSO reviews. This may be due to the skeletal nature of the network model of the Mill River System, in contrast to the CRI network which has significantly more detail included. The bulk of the CSO activations occurred during the summer months June-October.

Many of these regulators (CSOs 017, 025, 045, 046, and 048) contain sensitive underflow control equipment (vortex valves). Vortex valves are represented in the model per the best available information, but in conditions of small overflow magnitudes such as the case in the MRS system, the differences between observed and predicted are magnified due to the sensitivities of the equipment.

A review of the model-to-meter comparisons since 2014 at these five vortex regulator structures indicates that the model has been consistently predicting lower spill count and volume. These five regulator structures include floatables control baffles, weirs, as well as vortex throttles on the regulator underflows to the combined sewer. In addition, the incoming pipes to these structures have higher-than average slopes, averaging between 1.9-8.3%, whereas the average slope of pipes throughout the system as a whole is approximately 1.4% and the average slope of flow into the CRI regulator structures, for context, is approximately 0.4%. These factors complicate modelling of flow through the vortex regulators, therefore a pilot-scale depth monitoring program is recommended in these 5 MRS regulators. Depth sensor data could be used in conjunction with the permanent flow metering data in order to validate the model's representation of flow balance across the regulator structures.

*Table 2.3-4: Mill River System (MRS) CSO Catchment Meter Recording vs Model Prediction Results*

| CSO | 2017 ADS Spill Report | | 2017 Model Results | | Model Results for Typical Year (1976) Rainfall Series | |
|---|---|---|---|---|---|---|
| | Total Spills* | Volume (MG) | Total Spills | Volume (MG) | Total Spills | Volume (MG) |
| **CSO 017** | 12 (2) | 1.25 | 4 | 0.45 | 2 | 0.17 |
| **CSO 019**** | 5 | 7.41 | 1 | 0.03 | 0 | 0.00 |
| **CSO 024** | 4 (1) | 0.07 | 0 | 0.00 | 0 | 0.00 |
| **CSO 025** | 11 (1) | 0.85 | 0 | 0.00 | 0 | 0.00 |
| **CSO 045** | 10 | 9.48 | 0 | 0.00 | 0 | 0.00 |
| **CSO 046** | 11 | 2.00 | 6 | 0.66 | 6 | 0.26 |
| **CSO 048** | 13 (2) | 5.24 | 2 | 0.25 | 1 | 0.03 |
| **Total** | **66 (6)** | **26.30** | **13** | **1.39** | **10** | **0.50** |

** Numbers in parentheses reflect the removal of spills below the reporting limit of 3,000 gallons*
*** Spill count and volume reported by ADS are using a weir equation. The meter is located on the upstream side of the weir so this data is not a direct measurement of overflow occurrences*

Table 2.3-4 also includes model predictions of the 2017 collection system configuration with the typical year (1976) precipitation series. The 2017 rainfall series produced greater numbers of high intensity storms versus 1976. However, as in the 2017 analysis above, many of the overflows at the regulators in the MRS in the analysis of the 1976 storm series are close to the model's lower threshold for spills. The 2017 CSO frequency and volume results on the MRS were slightly higher than the 1976 results, as would be expected given that 2017 experienced more frequent high intensity storms and slightly higher volume storms.

**Comparisons – Chicopee River System.** The results of the comparison for the Chicopee System are presented in Tables 2.3-5. Many of the issues described in the MRS results summary are equally applicable for the Chicopee system. For example, in many cases the size of the overflows at the regulators in the Chicopee system are close to the model's lower threshold for spills. The small upstream catchments for the CSOs and the reported large number of small spills (eleven spills below the model reporting limit of 3,000 gallons) do contrast with the model results when aggregated over the entire year.

Previous annual reviews have noted that at CSO 035 and CSO 036 there are stormwater catchments that are not represented in the model influencing the meter measurements. More specifically, due to the configuration of the system at these regulators, there are inopportune locations for direct combined sewer overflow measurements. The CSO 035 meter is on a drain pipe that is vulnerable to storm flows from a local catch basin as well as a 36-in drain. The meter is not directly downstream of these drain flows but they could contribute to backwater conditions that may impact measured volume calculations. The CSO 036 meter is directly measuring stormwater measurements on a 48-in RCP drain downstream of a CSO overflow weir but which also receives tributary separated drainage flows from two 36-in drains so the reported CSO volume is deemed to be conservative for this reason. CSO frequency at each of the CSO locations is substantiated by float switch activity so reported frequency is less questionable. Discounting the effects of stormwater on the CSO volume at the above two locations, there is reasonable correlation in CSO frequency and volume across the Chicopee system over the year, when considering that the size of the overflows at the regulators in the Chicopee system are close to the model's lower threshold for spills and the aggregate CSO volume is small.

*Table 2.3-5: Chicopee River CSO Catchment Meter Recording vs Model Prediction Results*

| CSOs | 2017 ADS Spill Report | | 2017 Model Results | | Model Results for Typical Year (1976) Rainfall Series | |
|---|---|---|---|---|---|---|
| | Total Spills* | Volume (MG) | Total Spills | Volume (MG) | Total Spills | Volume (MG) |
| **CSO 034** | 7 (3) | 0.29 | 2 | 2.73 | 3 | 0.22 |
| **CSO 035** | 15 (1) | 1.81 | 2 | 1.78 | 2 | 0.19 |
| **CSO 036** | 10 | 5.57 | 2 | 1.28 | 1 | 0.05 |
| **CSO 037** | 7 (7) | 0.29 | 1 | 0.31 | 0 | 0.00 |
| **Total** | **39 (11)** | **7.96** | **7** | **6.10** | **6** | **0.46** |

* *Numbers in parentheses reflect the removal of spills below the reporting limit of 3,000 gallons*

Table 2.3-5 also includes model predictions of the 2017 collection system configuration with the typical year (1976) precipitation series. As previously stated, the 2017 rainfall series produced greater numbers of high intensity storms versus 1976, but similar numbers of high volume storms versus 1976. However, as in the 2017 analysis above, many of the overflows at the regulators in the Chicopee in the analysis of the 1976 storm series are close to the model's lower threshold for spills. The 2017 CSO frequency and volume results on the Chicopee River System were slightly higher than the 1976 results, as would be expected given that 2017 experienced more frequent high intensity storms and slightly higher volume storms.

The 2017 CSO frequency and volume results on the Chicopee were slightly higher than the 1976 results, as would be expected given that 2017 experienced more frequent high intensity storms and slightly higher volume storms.

Similar to the results on the MRS system, review of the model-to-meter comparisons since 2014 at the four Chicopee regulator structures indicates that the model has been consistently predicting lower spill count and in some cases volume at these locations. Modelling of these four Chicopee system regulators is complicated by the relatively small magnitude of flow at these locations, particularly at CSOs 034 and 035, where the average spill volumes are approximately 26,000-113,000 gallons. The proposed pilot-scale depth monitoring program mentioned previously for the MRS should also be implemented in the four Chicopee regulators. Depth sensor data would be used in conjunction with the permanent flow metering data at CSOs 034-037 to validate the model's representation of flow balance across these regulator structures.

# 2.4 Conclusions

An analysis of the rainfall measured in 2017 indicated moderate correlation across all of the rainfall gauges among most of the total rainfall depth and intensity categorizations. As previously stated, the results of RG03 were removed from the analysis, given the significant discrepancy in its reported rainfall as compared to gauges 1, 2 and 4.

The variance in the median number of rainfall events at RG01, RG02 and RG04 (78) and the typical year (82) was 6% overall in 2017. The variance in the lower two peak intensity storm event categories, however, ranged between -35% and 27%. The CSO response to rainfall in these two, lower intensity rainfall categories, particularly along the CRI, is less certain than the higher intensity categories. Therefore, the high variability would suggest the potential for high uncertainty in the simulation of spills.

Comparing the 2017 rainfall data with the typical year (1976) rainfall showed 2017 to be similar in terms of total median rainfall depth, with the 2017 depth 0.5% lower than the typical year. The total number of storms was not appreciably different with a median number of 78 storms, compared with the typical year storm count of 82. What was noticeable from analysing the rainfall was that the rainfall difference was concentrated in the lowest total depth and peak intensity ranges, rainfall which typically does not cause CSO activation. The 2017 rainfall data also shows a decrease in total depth for storms in the 0.14 to 0.25-in range, as well as a decrease in the second intensity range. These two ranges, depending on the storm event, are able to trigger CSOs (especially on the CRI system).

Recent annual analyses including multiple iterations of flow metering review and CSO performance have found that the Springfield sewer system responds to shorter, more intense rainfall. The instances of observed storms in the 0.10 to 0.25-in/hr range, was higher than the typical year, therefore it is possible that wet weather responses likely to activate CSO regulators may be more common.

The 2017 CSO annual review indicated that compared with the ADS flow metering data, the collection system model predicts higher total spill volumes at CSOs 008A, 014, 015A and 016. However, with multiple meters being out of service, for between six months and the full year, a system-wide assessment count cannot be made. Having the meters fully operational during 2018, in conjunction with a better understanding of the hydraulic grade line in the Connecticut River Interceptor through the temporary metering data collected in October and November 2017, will allow for a more thorough CSO review during 2018.

The eight temporary meters installed in the collection system from October through November 2017 were for two purposes. Four were to check the model predictions along the CRI, in particular the flow balance between CSOs. The remaining four were sited upstream of the recently constructed Washburn CSO (CSO 008) to confirm the post construction system performance in this part of the system. The CRI flow data was used to validate the model's representation of flow in the CRI, per the discussion provided in Section 2.1, and improved the correlation between modeled and metered results from CSO 010 to CSO 016, where metered data was available, particularly at CSO 010. The lack of CSO 012 and CSO 013 meter data during the calendar year, however, prevented a thorough analysis of the CRI between CSO 010 and CSO 016 (at York Street).

The Washburn data is currently being reviewed and the network model representation of this area is being validated; early indications are good with close alignment between the model and the meter data. Discussion of the temporary metering results in the Washburn area will be included in the 2018 report.

With respect to the MRS, an analysis of overflow measurements versus the model predictions indicate that in many cases the size of the overflows at the regulators in the MRS are close to the model's threshold for identifying spills and hence the difference in overflow activations. Furthermore, the sensitivity of the vortex valves magnifies differences in overflows particularly when magnitudes are small as is the case in the MRS system.

The spill count throughout the Chicopee system remains low in the model predictions, and many reported CSO occurrences fall below or are near to the model's lower threshold for identifying spills. Furthermore, CSO volume at two locations is influenced by stormwater connections unaccounted for in the model predictions, which explains much of the CSO volume disparity in this system measurements versus predictions.

The quality of the measured data in recent annual CSO reports has been hindered at times by poor data returns. Instances where observed CSO flow data was of poor quality or missing were restricted for particular events and although these omissions were not helpful in drawing parallels between actual data and the model results, in many cases there remained some correlation. The 2017 annual review found many of the same depth and velocity measuring problems but on a wider scale. The nature of outfall pipes being dry for a majority of the year and then prone to large, fast flow wet weather events introduces practical difficulties in depth and velocity measurements. In addition to the high variability in flow conditions, at some outfalls during periods of high river level, standing water in the outfall pipes leads to depth measurement recorded by the meters with no attributable velocity. The velocity data is essential to calculate flow and, in turn, spill volume, and these backwater conditions serve to complicate readings. A number of instances of erroneous velocity data were identified during the 2017 review and unless the previously measured data is used to inform future data recording, the 2018 review will continue to be affected by the same area-velocity data anomalies.

Flow data collection on the outfall pipes is further complicated by periodic outfall construction, as well as cleaning and maintenance activities which all increase the instances of missing flow data. Technology updates at the float switches also lead to gaps in CSO outfall flow data during 2017. Migration of meters and depth sensors to locations upstream of the regulator structures, at inflows to the regulators and in the tributary pipes in the upstream network, would help avoid these pitfalls associated with data collection on the outfall pipes.

# 2.5 Recommendations

The recommendations for this annual report are made using the data collected during 2017 and also the learning from previous year's annual reporting.

- It is recommended that additional rain gauges be installed throughout the system. Additional rain gauge data would provide more spatial and temporal resolution in rainfall data, improving the model's representation of the system's response to high-intensity, short-duration storm events, which tend to be fast-moving. The Springfield system covers approximately 33 square miles. The 4 existing rainfall gauges are assigned to approximately 8 square miles each, whereas NEXRAD radar rainfall data has a cell size of approximately 1.2 square miles. More rainfall gauges, distributed throughout the system would provide improved resolution and would allow for review and validation of the available radar rainfall data. Improved understanding and confidence in the radar data available for the City of Springfield would then allow the Commission to migrate toward the use of radar data in future CSO monitoring and reporting;

- The construction, operation and maintenance and technological limitations associated with standard area-velocity meters installed on outfall pipes should be mitigated by migrating the Commissions monitoring program into the upstream network and onto regulator inflow lines, with more flow meters and depth-only sensors distributed throughout the system. The Commission should begin to consider more extensive monitoring locations, combined with data collection points that are less vulnerable to data anomalies and meter down time;

- Data from the temporary metering program conducted on the CRI and at Washburn PS during the fall of 2017 will be used to further validate the model in the along the CRI and upstream from Washburn CSO. A corresponding review of the CSO changes at Washburn will be conducted during the 2018 annual CSO review;

- The difference between the observed and model predicted results found during the analysis of the MRS and Chicopee systems warrants further investigation. To help bridge the gap between CSO results the recommendation is for additional depth monitoring at the MRS and Chicopee regulators. Installation of up to ten long-term, fixed depth sensors in the MRS and Chicopee regulators would provide regulator depth data to be used concurrently with the permanent CSO overflow data, to validate the model representation of flow balance across the MRS and Chicopee CSO structures;

- To improve confidence in reporting and review CSO performance that as a result of meter removal was hindered in 2017, undertake an end of first quarter 2018 analysis of meter results for the CRI to review flow balance among the CSOs on the CRI;
- First quarter review of the new RG03 location and data being collected, to ensure functionality of the new RG03 location;
- First quarter review of float activations for the CRI, MRS, and Chicopee meters to ensure activation during overflows;
- Continued periodic field inspection of the vortex throttle structures on the MRS system (CSO 017, 025, 045, 046 and 048) and cleaning maintenance as necessary;
- Review 2018 maintenance locations to incorporate any findings into the network model's representation of the system; and
- Review of 2017 results with 2017 metering results after model extension up to pipes 18" diameter and larger under the system assessment program.

*Table 2.5-1: Summary of 2017 CSO Performance Observed v Model Results (January – June 2017)*

| CSO | January | | | | February | | | | March | | | | April | | | | May | | | | June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ADS | | Model | | ADS | | Model | | ADS | | Model | | ADS | | Model | | ADS | | Model | | ADS | | Model | |
| | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume |
| **CSO 007** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 008A** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.201 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.015 | 0 | 0.000 | 3 | 1.454 | 0 | 0.000 | 3 | 1.014 |
| **CSO 010** | 4 | 3.159 | 5 | 5.165 | 1 | 0.040 | 3 | 1.752 | 2 | 0.650 | 3 | 1.576 | 4 | 3.070 | 5 | 6.582 | 3 | 9.110 | 6 | 12.385 | 5 | 10.570 | 5 | 8.774 |
| **CSO 011** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 12** | 0 | 0.000 | 4 | 11.061 | 0 | 0.000 | 4 | 4.921 | 0 | 0.000 | 5 | 4.439 | 0 | 0.000 | 7 | 16.234 | 0 | 0.000 | 7 | 24.544 | 0 | 0.000 | 4 | 16.539 |
| **CSO 13** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.208 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 2 | 1.178 | 0 | 0.000 | 4 | 1.414 |
| **CSO 014** | 3 | 0.840 | 2 | 1.419 | 1 | 0.170 | 2 | 0.622 | 0 | 0.000 | 2 | 0.338 | 3 | 0.193 | 5 | 1.468 | 5 | 0.080 | 5 | 3.443 | 3 | 1.680 | 5 | 3.268 |
| **CSO 015A** | 0 | 0.000 | 2 | 0.394 | 1 | 0.060 | 1 | 0.260 | 1 | 0.010 | 0 | 0.000 | 3 | 0.240 | 2 | 0.346 | 4 | 0.490 | 3 | 2.261 | 4 | 0.800 | 1 | 0.630 |
| **CSO 015B** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.040 | 1 | 0.048 | 2 | 0.030 | 1 | 0.027 |
| **CSO 016** | 3 | 2.314 | 2 | 2.221 | 1 | 0.330 | 2 | 1.162 | 1 | 0.260 | 1 | 0.156 | 1 | 0.230 | 4 | 1.872 | 2 | 2.430 | 4 | 5.188 | 4 | 8.480 | 4 | 5.075 |
| **CSO 017** | 0 | 0.000 | 0 | 0.000 | 1 | 0.001 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 2 | 0.030 | 0 | 0.000 | 4 | 0.170 | 0 | 0.000 |
| **CSO 018** | 0 | 0.000 | 0 | 0.000 | 1 | 0.001 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 2 | 0.003 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 019** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 2 | 0.189 | 0 | 0.000 |
| **CSO 024** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 025** | 0 | 0.000 | 0 | 0.000 | 1 | 0.005 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 3 | 0.040 | 0 | 0.000 |
| **CSO 034** | 0 | 0.000 | 0 | 0.000 | 1 | 0.004 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.010 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 035** | 0 | 0.000 | 0 | 0.000 | 1 | 0.006 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 5 | 0.191 | 0 | 0.000 | 2 | 0.040 | 0 | 0.000 |
| **CSO 036** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.050 | 0 | 0.000 | 2 | 0.380 | 0 | 0.000 |
| **CSO 037** | 5 | 0.030 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.030 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 045** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.010 | 0 | 0.000 | 2 | 0.008 | 0 | 0.000 | 2 | 1.180 | 0 | 0.000 |
| **CSO 046** | 0 | 0.000 | 0 | 0.000 | 1 | 0.090 | 0 | 0.000 | 1 | 0.010 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.090 | 0 | 0.000 | 0 | 0.000 | 1 | 0.028 |
| **CSO 048** | 0 | 0.000 | 0 | 0.000 | 1 | 0.020 | 1 | 0.015 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 3 | 0.021 | 0 | 0.000 | 2 | 0.220 | 0 | 0.000 |
| **CSO 049** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.010 | 0 | 0.000 | 0 | 0.000 | 2 | 0.099 | 3 | 0.870 | 3 | 0.108 |
| **Monthly Total** | **15** | **15.786** | **15** | **20.260** | **11** | **0.727** | **15** | **9.141** | **5** | **0.930** | **11** | **6.509** | **14** | **3.763** | **24** | **26.517** | **32** | **12.573** | **33** | **50.601** | **38** | **24.649** | **39** | **36.878** |

*Table 2.5-2 Summary of 2017 CSO Performance Observed v Model Results (July – December 2017)*

| CSO | July | | | | August | | | | September | | | | October | | | | November | | | | December | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ADS | | Model | | ADS | | Model | | ADS | | Model | | ADS | | Model | | ADS | | Model | | ADS | | Model | |
| | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume | Count | Volume |
| **CSO 007** | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 3 | 0.174 | 2 | 0.879 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 008A** | 1 | 0.280 | 3 | 0.886 | 1 | 0.238 | 1 | 0.404 | 0 | 0.000 | 0 | 0.000 | 2 | 0.166 | 2 | 9.355 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 010** | 4 | 16.644 | 6 | 7.337 | 3 | 3.406 | 5 | 3.413 | 2 | 3.621 | 2 | 3.730 | 4 | 19.623 | 4 | 16.702 | 1 | 0.015 | 2 | 0.085 | 3 | 1.822 | 3 | 1.766 |
| **CSO 011** | 2 | 0.049 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.268 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 12** | 0 | 0.000 | 2 | 13.667 | 0 | 0.000 | 5 | 8.117 | 0 | 0.000 | 2 | 7.814 | 0 | 0.000 | 4 | 28.728 | 0 | 0.000 | 4 | 1.166 | 0 | 0.000 | 3 | 4.816 |
| **CSO 13** | 0 | 0.000 | 1 | 1.399 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 2 | 2.402 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.832 |
| **CSO 014** | 5 | 0.865 | 4 | 2.621 | 1 | 0.080 | 4 | 1.019 | 2 | 0.135 | 2 | 1.054 | 3 | 3.015 | 3 | 5.586 | 1 | 0.023 | 0 | 0.000 | 2 | 0.192 | 1 | 0.760 |
| **CSO 015A** | 4 | 3.367 | 1 | 2.043 | 1 | 0.229 | 2 | 0.371 | 0 | 0.000 | 1 | 0.233 | 0 | 0.000 | 1 | 0.308 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 3.224 |
| **CSO 015B** | 3 | 0.266 | 1 | 0.065 | 0 | 0.000 | 0 | 0.000 | 1 | 0.000 | 0 | 0.000 | 1 | 0.526 | 1 | 3.957 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 016** | 4 | 9.218 | 6 | 7.981 | 2 | 1.049 | 4 | 3.582 | 2 | 5.192 | 2 | 1.239 | 3 | 28.476 | 3 | 22.645 | 1 | 0.376 | 0 | 0.000 | 3 | 1.318 | 1 | 0.210 |
| **CSO 017** | 5 | 0.466 | 2 | 0.077 | 1 | 0.005 | 1 | 0.118 | 0 | 0.000 | 0 | 0.000 | 1 | 0.577 | 1 | 0.257 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 018** | 0 | 0.000 | 1 | 0.014 | 0 | 0.000 | 1 | 0.036 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.071 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 019** | 1 | 2.234 | 0 | 0.000 | 1 | 1.888 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 3.097 | 1 | 0.034 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 024** | 3 | 0.066 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 0.005 | 0 | 0.000 | 1 | 0.001 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 025** | 3 | 0.031 | 0 | 0.000 | 2 | 0.220 | 0 | 0.000 | 1 | 0.020 | 0 | 0.000 | 2 | 0.536 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 034** | 1 | 0.054 | 1 | 0.102 | 2 | 0.076 | 0 | 0.000 | 1 | 0.025 | 0 | 0.000 | 4 | 0.121 | 1 | 2.625 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 035** | 2 | 0.178 | 1 | 0.085 | 2 | 0.235 | 0 | 0.000 | 1 | 0.005 | 0 | 0.000 | 3 | 1.157 | 1 | 1.696 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 036** | 3 | 0.387 | 1 | 0.019 | 2 | 0.398 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 3.027 | 1 | 1.261 | 0 | 0.000 | 0 | 0.000 | 1 | 1.324 | 0 | 0.000 |
| **CSO 037** | 3 | 0.037 | 0 | 0.000 | 2 | 0.134 | 0 | 0.000 | 2 | 0.002 | 0 | 0.000 | 1 | 0.053 | 1 | 0.311 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 045** | 3 | 2.922 | 0 | 0.000 | 1 | 0.526 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 1 | 4.836 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 046** | 4 | 0.997 | 3 | 0.209 | 2 | 0.204 | 1 | 0.096 | 0 | 0.000 | 0 | 0.000 | 2 | 0.609 | 1 | 0.331 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 048** | 4 | 1.251 | 0 | 0.000 | 2 | 0.437 | 1 | 0.019 | 0 | 0.000 | 0 | 0.000 | 2 | 3.268 | 1 | 0.212 | 1 | 0.021 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **CSO 049** | 4 | 1.843 | 1 | 0.007 | 3 | 1.452 | 0 | 0.000 | 2 | 0.337 | 0 | 0.000 | 3 | 1.588 | 1 | 0.198 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| **Monthly Total** | **59** | **41.155** | **35** | **35.924** | **28** | **10.579** | **23** | **16.297** | **14** | **9.337** | **9** | **13.570** | **39** | **71.121** | **32** | **97.559** | **5** | **0.437** | **6** | **1.251** | **9** | **4.656** | **10** | **11.607** |

# Section 3 CMOM Program Implementation

The SWSC's CMOM Program has been designed to help ensure that components of the collection system are cleaned and inspected at the right frequency and that preventative maintenance and repairs are performed to cost-effectively reduce the number of sewer releases (SSOs), extend the useful life of the SWSC's collection system infrastructure and properly manage collection system operations.  Pursuant to Administrative Order Docket No. 08-037 (AO), the SWSC submits the following CMOM Program Implementation Report for 2017. This annual summary will provide a brief overview of collection system operation and maintenance programs and practices as a context for evaluation of the effectiveness of CMOM activities.

## 3.1 Collection System – Gravity Sewer Operation and Maintenance

The SWSC has programs in place to help ensure that gravity sewers pipelines, siphons and manholes are properly inspected, cleaned, and repaired.  Closed-circuit television (CCTV) inspection activities are key for an accurate determination of the structural and operational condition of the SWSC's collection system assets.  Cleaning helps maintain asset condition and hydraulic capacity, enhances effectiveness of assessments, and helps control odors.  Repairing structural deterioration protects the rate payer's investment and reduces the potential for catastrophic failures.

### 3.1.1 SWSC Wastewater Services Staffing

At the end of 2017, The SWSC Wastewater Collection Services Organization consisted of 40 full-time employees. As of 12/31/17, there were 5 vacant positions/employees absent on workers compensation. The organization consists of 4 divisions: assessment, construction, maintenance and customer service. A schematic of the SWSC Wastewater Collection Services Organization is provided in Appendix H.

# 3.1.2 Sewer Inspections and Cleaning

The SWSC's inspection and cleaning program contains both preventative maintenance and unplanned work.

In CY 2017, the sewer inspection program included the inspection of approximately 54,273 linear feet of mainline sewer pipe by the SWSC and its sub-contractors, which corresponds to approximately 2.1 percent of the mainline sewer system. In total, since the SWSC's Pipeline Cleaning and Assessment Program began in 2009, approximately 1,969,000 linear feet of unique mainline sewer pipe, corresponding to approximately 80.8 percent of the mainline sewer system, has been assessed to date including CY 2017. This figure does not include the assessment of recently installed or rehabilitated pipes that require assessment as part of their post installation acceptance.

The CY 2017 SWSC's Pipeline Cleaning and Assessment Program focused on the cleaning and inspection of unassessed siphons, easement pipelines, and previously unassessed high risk pipelines located in roadways. The SWSC was able to successfully complete the cleaning and assessment of the majority of the remaining easement pipelines and siphons in the sewer collection system. The two remaining siphons and the easement pipelines that are located on Springfield College's campus will be cleaned and assessed in CY 2018. Preliminary permitting and planning is underway for the cleaning and assessment of the critical pipelines located within the limits of the railroad property owned by CSX Transportation.

The greatest challenge of cleaning and accessing the sewer siphons and easement pipes, despite vegetation clearing efforts, continued to be the contractor's inability to obtain direct access to the work areas with the vacuum trucks. In this scenario, the contractor must manually extract the grit from manholes during cleaning operations with buckets and transport the grit with utility vehicles to a vacuum truck on a nearby street. In addition to the challenge of extracting the grit from these siphon and easement pipes, they typically contain a larger volume of grit than pipes located within the streets of the SWSC wastewater collection system, which further delays the cleaning and assessment operation in these areas. These hard to reach assets continued to take longer to clean and thus reduced productivity and the total annual footage of pipe cleaned and assessed as shown in Figure 3-1 on the following page.

*Figure 3-1 Total Tons of Grit Removed Vs Linear Feet of Pipe Assessed by Contractors 2012-2017*

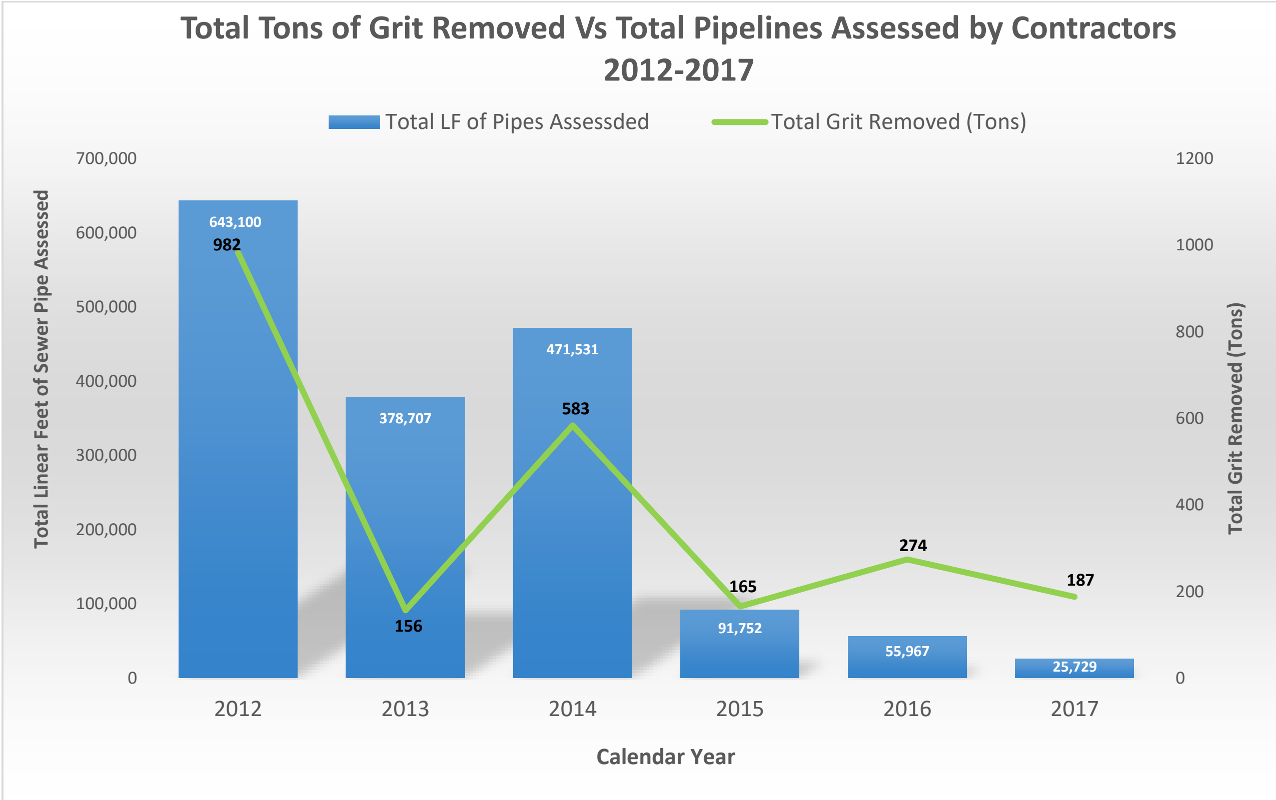



*Figure 3-2 Grit Extracted from Cross Country Easement Pipes*

In 2017 the high volume of grit in the easement pipelines was comparable to 2016 on a linear foot basis, as shown in Figure 3-1. Additional obstacles in easement pipelines and siphons such as large diameter rocks, grease and roots were encountered frequently and required significant efforts to remediate. Examples of these obstacles are illustrated in Figures 3-3 – 3-7 below.

*Figure 3-3 Debris Removed from Siphon SX049 (before/after)*


*Figure 3-4 Large Diameter Rocks Removed from Pipeline in Easement 187*

*Figure 3-5 Grease Removed from Siphon SX045 (before/after)*

*Figure 3-6 Grease Removed from Pipe in Easement 189 (before/after)*

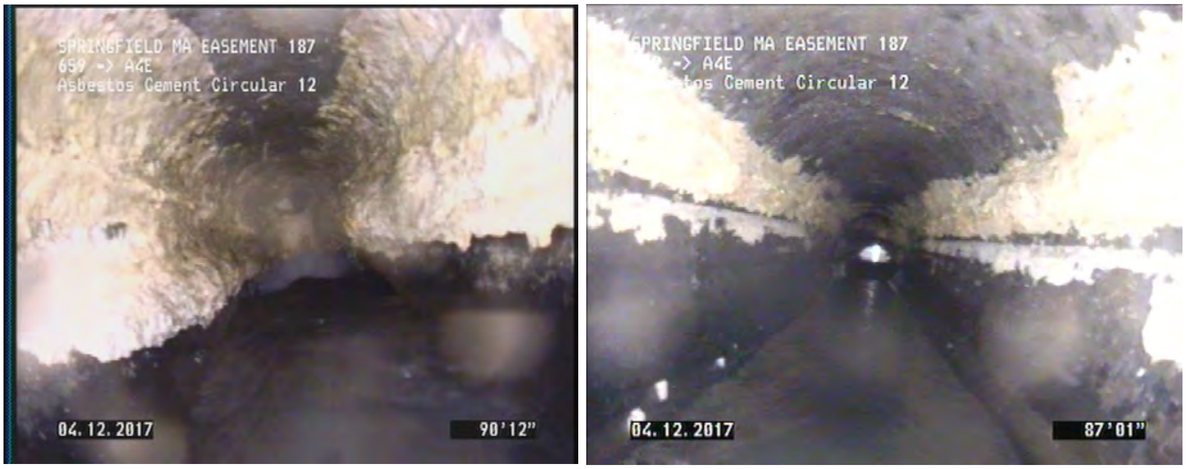


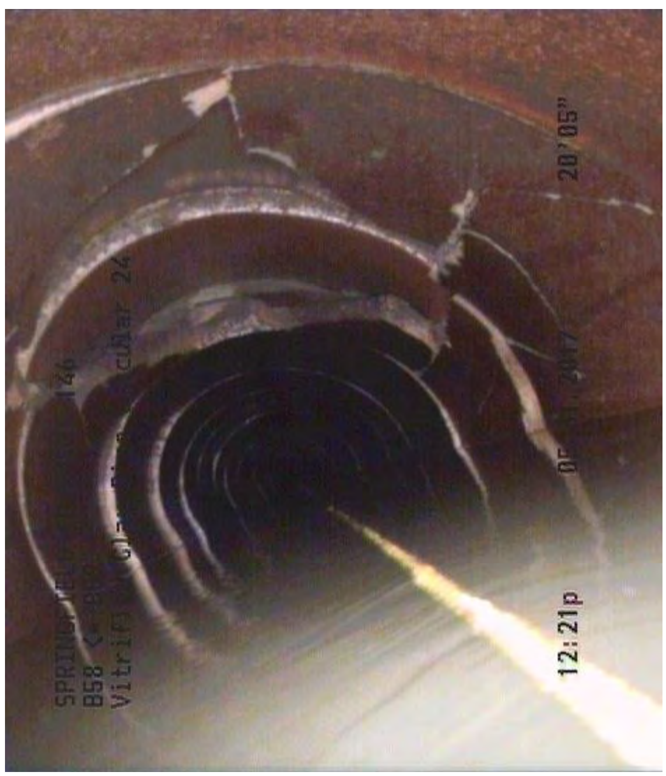

*Figure 3-7 Large Root Ball Removed from Pipeline on Veterans Golf Course*

An additional challenging pursuit of the inspection and cleaning program in 2017 was the execution of the cleaning and assessment of the easement pipelines on Veterans Golf Course. This effort required extensive coordination with representatives of the gold course to perform the work during a time period that would minimize the disruption to their business operation and damage to the course grounds. From February through March, timber mats were installed to allow the mobilization/demobilization of cleaning and assessment equipment to complete the work (see Figure 3-8 below). The work was successfully executed with minimal impact to the grounds of the golf course.

*Figure 3-8 Timber Mats at Veterans Golf Course for Cleaning and Assessment Equipment Mobilization*

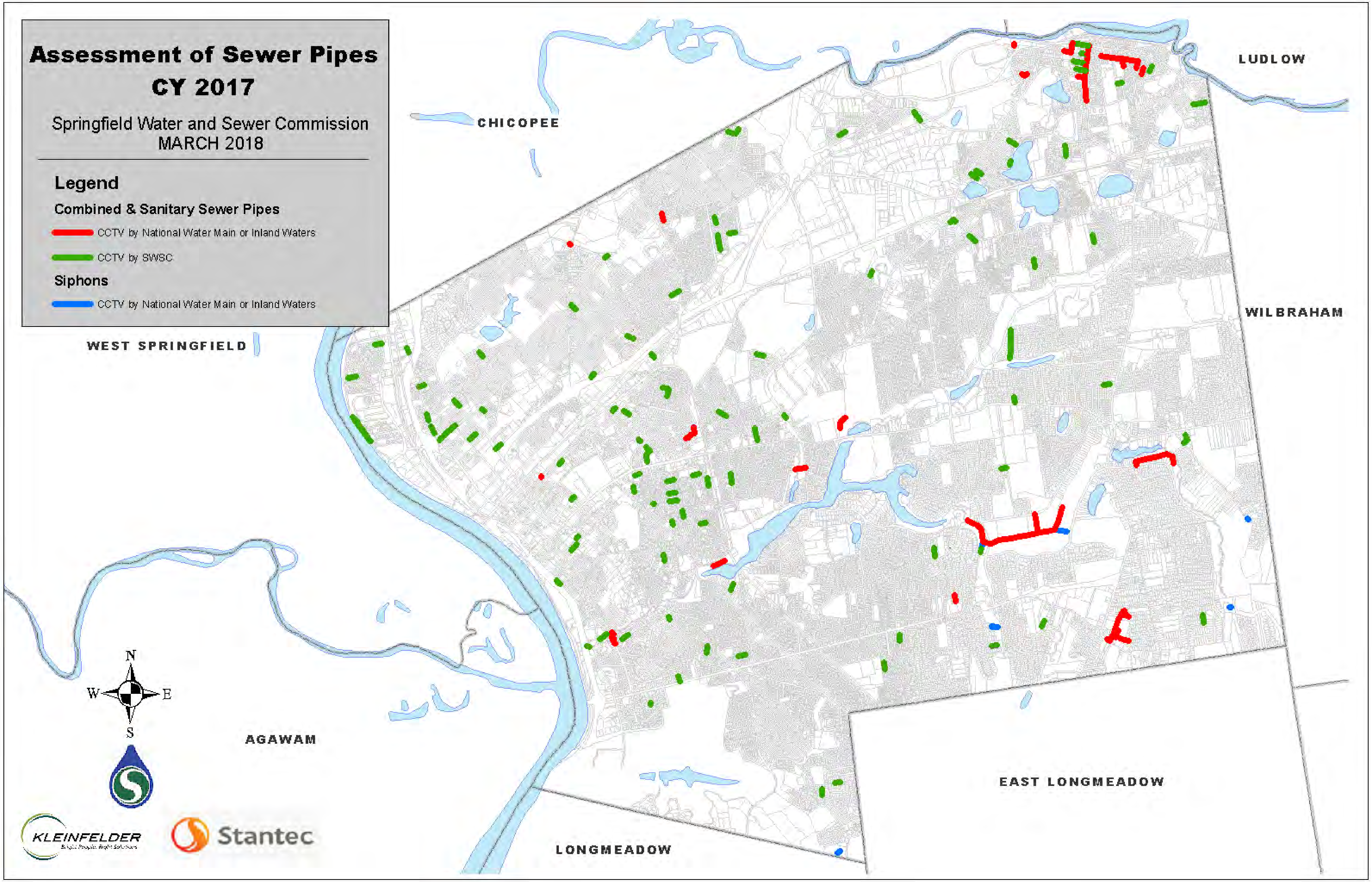
The pipelines inspected and assessed in 2017 overall were in good structural condition. The pipes that did exhibit significant structural defects were analyzed and taken into consideration for the annual update to the SWSC's Pipeline Infrastructure Improvements Rankings (PIIR). An example of a severe structural defect identified in 2017 is provided in Figure 3-9 below.

*Figure 3-9 Broken Crown of Pipeline in Easement 146*




Sewer mainlines are assessed for general preventative maintenance, in support of chemical and mechanical root and grease management programs, in response to sewer problems, and in support of the continued development of the SWSC's PIIR. The SWSC's PIIR is used to support the continued development and maintenance of the SWSC's Capital Improvements Program. Appendix A includes the updated PIIR.

The SWSC's staff, consultants, and sub-contractors are trained and licensed in NASSCo's Pipeline Assessment Certification Program (PACP) and Manhole Assessment Certification Program (MACP). PACP and MACP standards are used to evaluate the structural and operational condition of the pipelines and manholes in the sewer collection system. This information, in turn, is used to develop metrics to inform two of the SWSC's Risk Model failure modes, Structural Utility Condition Index (SUCI) and Maintenance Utility Condition Index (MUCI).



Assessment of Sewer Pipes
CY 2017
Springfield Water and Sewer Commission
MARCH 2018
Legend
Combined & Sanitary Sewer Pipes
CCTV by National Water Main or Inland Waters
CCTV by SWSC
Siphons
CCTV by National Water Main or Inland Waters
CHICOPEE
LUDLOW
WILBRAHAM
WEST SPRINGFIELD
AGAWAM
EAST LONGMEADOW
LONGMEADOW
N
S
E
W
KLEINFELDER
Stantec

The SWSC utilized its own crews as well as specialty contractors to maintain the sewer system. Specialty contractors are primarily used to clean siphons and hard to reach and hard to access easements. The sewer cleaning program includes preventative maintenance through grit removal, chemical and mechanical root removal, and accelerated cleaning in grease management areas.

In CY 2017, the sewer cleaning program, often done in conjunction with the pipeline assessment program, cleaned 690,542 linear feet of pipe. This total is comprehensive of all unique and repeated cleaning of pipeline assets as required to maintain the level of service in the collection system throughout the year. Of the 690,542 linear feet, a total of 310,828 unique linear feet of pipeline cleaning was conducted in CY 2017, which corresponds to approximately 12.1% percent of the mainline system. Over 1,973 tons of grit were estimated to be removed by the SWSC's crews and Sub-Contractors in CY 2017. The removal of grit is critical to maximize the unobstructed cross section area of the pipelines in the collection system which results in a benefit of increased hydraulic capacity and reduces the risk of SSOs.

*Table 3-1 Pipeline Cleaning Completed by the SWSC and Sub-Contractor CY 2017*

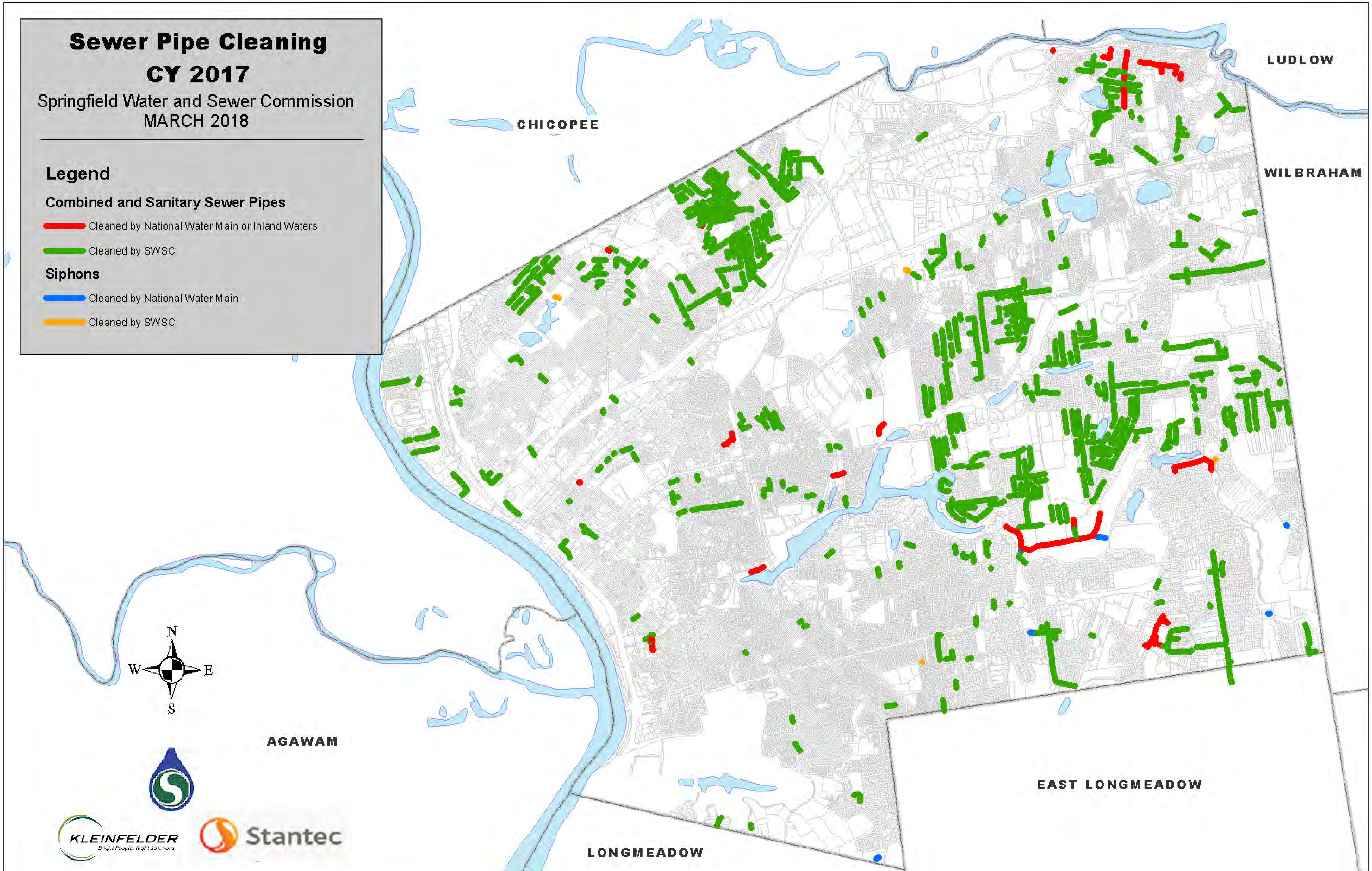
| CLEANING OVERVIEW | |
|---|---|
| ***SWSC LF Cleaned*** | ***Sub-Contractor LF Cleaned*** |
| 668,326* | 22,216 |
| **TOTAL FOOTAGE: 690,542** | |

*288,612 of the 668,326 linear feet cleaned by the SWSC was unique pipeline

Since the SWSC's Pipeline Cleaning and Assessment Program began in 2009, and including CY 2017, 1,844,779 linear feet of unique mainline sewer pipe, corresponding to approximately 75.7 percent of the mainline sewer system, has been cleaned by the SWSC's sub-contractors alone. The cleaning performed by the SWSC is not included in this total since they repeatedly clean pipes and have not accurately tracked this information until recent years. The CY 2017 SWSC's Pipeline Cleaning and Assessment Program continued to focus on many of the most difficult assets in the SWSC's inventory, which are sewer siphons and easement pipes. See Table 3-1 for a breakdown of the SWSC's sub-contractor's CY 2017 cleaning metrics. A table for the breakdown of the SWSC's CY 2017 cleaning metrics is not provided because they do not track this information in the same manner.

*Table 3-2 Pipeline Cleaning Completed Under Subcontract to Commission*

| SUBCONTRACT CLEANING | | |
|---|---|---|
| ***Size of Pipe*** | ***Type of Cleaning*** | ***Linear Footage*** |
| 6" - 12" | Light Cleaning | 3,164 |
| 13"-20" | Light Cleaning | 1,319 |
| 21"-29" | Light Cleaning | 2,219 |
| 30"-39" | Light Cleaning | 0 |
| 40"-49" | Light Cleaning | 0 |
| >49" | Light Cleaning | 0 |
| 6" - 12" | Medium Cleaning | 609 |
| 13"-20" | Medium Cleaning | 529 |
| 21"-29" | Medium Cleaning | 117 |
| 30"-39" | Medium Cleaning | 0 |
| 40"-49" | Medium Cleaning | 0 |
| >49" | Medium Cleaning | 0 |
| 6" - 12" | Heavy Cleaning | 795 |
| 13"-20" | Heavy Cleaning | 0 |
| 21"-29" | Heavy Cleaning | 807 |
| 30"-39" | Heavy Cleaning | 2,422 |
| 40"-49" | Heavy Cleaning | 0 |
| >49" | Heavy Cleaning | 728 |
| Pipes more than 1/4 Full | Heavy Cleaning | 13,019 |
| Sewer Siphons | Heavy Cleaning | 2,382 |
| **TOTAL FOOTAGE** | | **22,216** |


Sewer Pipe Cleaning
CY 2017
Springfield Water and Sewer Commission
MARCH 2018
Legend
Combined and Sanitary Sewer Pipes
Cleaned by National Water Main or Inland Waters
Cleaned by SWSC
Siphons
Cleaned by National Water Main
Cleaned by SWSC
CHICOPEE
LUDLOW
WILBRAHAM
AGAWAM
EAST LONGMEADOW
LONGMEADOW
N
W
E
S
KLEINFELDER
Stantec

The SWSC has an in-line grit removal system on the Connecticut River Interceptor (CRI) maintained by contract operator Suez.  In CY 2017 Suez removed over 87 tons of grit from the Clinton Street Grit Pit, a 53.0 percent increase over CY 2016’s 57 ton total.  The removal of this material increased the capacity and level of service in the CRI by capturing the material before it was deposited into the interceptor pipeline.

Manholes are inspected and cleaned during the SWSC’s and it’s sub-contractor’s cleaning and assessment activities. 2,049 manholes were cleaned and 1,427 manholes were assessed in CY 2017. The manholes inspected in 2017 overall were in good structural condition. Only 45 out of the 1,427 manholes inspected exhibited structural defects that were recorded on the digital inspection forms. The defects observed in 2017 included missing brick/mortar, fractures/cracks, corrosion and infiltration. In instances where a manhole is inaccessible (paved over, buried, ect.) it is recorded on the inspection form, added to a database and exposed by SWSC field crews to allow access for inspection and maintenance. An example of a manhole structural defect identified in 2017 is provided in Figure 3-10 below.

*Figure 3-10 Manhole Inspected with Displaced Brick Structural Defect*

# 3.1.3 Sewer Assessment and Repairs

Maintaining the wastewater collection system in good repair is a core service the SWSC provides to its rate payers. The SWSC has a well-established sewer pipe and manhole repair program. Each year as data is collected from the pipeline assessment program, structural condition and maintenance condition data is added to the Risk Model which is then in turn used to develop the Prioritized Infrastructure Improvements Ranking (PIIR). From this list, the SWSC and its consultants assemble highly ranked project(s) which are designed, bid and constructed. The project(s) include elements of pipeline replacement, renewal, and rehabilitation depending on the suitability of the technology, benefits, impacts and cost. Also, the SWSC's own crews proactively address many of the spot repair and pipeline replacement needs identified in the PIIR.

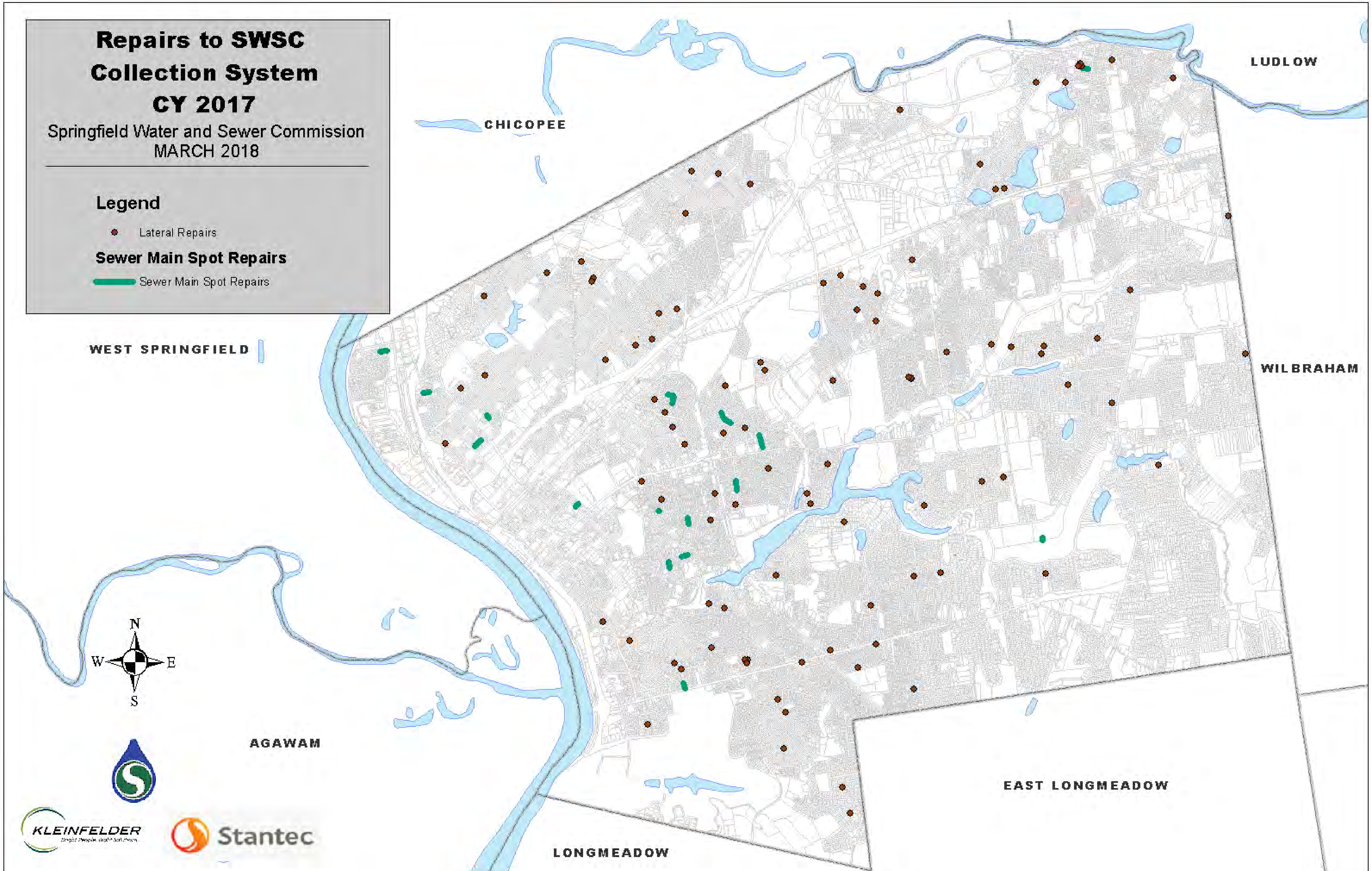
The SWSC continued its commitment to extend the useful life of the existing infrastructure where feasible by utilizing the latest pipeline rehabilitation technologies. Over 3,235 linear feet of pipeline was replaced, 6,104 linear feet of pipeline was rehabilitated or renewed, and 64 sewer manholes were replaced or rehabilitated/renewed utilizing contracted design and construction services.

*Table 3-3 General Quantities – Wastewater Collection System Infrastructure Replaced and Rehabilitated CY 2017*

| | | 2017 CIP Contract | MIS Project | Sub-Total | Total | General Description |
|---|---|---|---|---|---|---|
| **Item** | **Units** | **Quantities** | | | | |
| MH Rehab | Each | 29 | 11 | 40 | 64 | Manholes Replaced or Rehabbed |
| New MH | Each | 23 | 1 | 24 | | |
| 6-in | LF | 0 | 10 | 10 | 3,235 | Sewer Pipe Replaced (LF) |
| 8-in | LF | 691 | 0 | 691 | | |
| 10-in | LF | 247 | 0 | 247 | | |
| 12-in | LF | 1,475 | 0 | 1,475 | | |
| 15-in | LF | 498 | 0 | 498 | | |
| 18-in | LF | 314 | 0 | 314 | | |
| 12-in CIPP | LF | 276 | 0 | 276 | 6,104 | Cured-in-Place Pipelining (LF) |
| 15-in CIPP | LF | 2,021 | 0 | 2021 | | |
| 18-in CIPP | LF | 390 | 0 | 390 | | |
| 24-in CIPP | LF | 195 | 191 | 386 | | |
| 36-in CIPP | LF | 0 | 155 | 155 | | |
| 66-in CIPP | LF | 0 | 2,646 | 2,646 | | |
| 67''x 84'' CIPP | LF | 0 | 230 | 230 | | |

In addition, SWSC crews completed 18 mainline sewer repairs totaling nearly 167 linear feet. All of the repairs were unplanned. Sewer defects requiring immediate repair can be hard to predict, and for that reason, the repairs do not always follow the planned prioritized list that is updated annually. Repairs are considered unplanned if the work is in response to a collection system problem such as a sewer release, sinkhole, or the severity of the problem is significant enough to warrant the deployment of repairs within a week. Repairs on mainline sewers include sewer replacements and localized spot repairs where pipe sections are excavated and replaced or renewed using a trenchless rehabilitation technique.

The SWSC's crews also completed repairs to 104 service laterals, totaling approximately 1,693 linear feet. Ninety-nine of the repairs were unplanned. Unplanned sewer service lateral repairs are always in response to a sewer system problem. Planned service lateral repairs typically occur in conjunction with adjacent repairs on mainline sewers.


Repairs to SWSC
Collection System
CY 2017
Springfield Water and Sewer Commission
MARCH 2018
Legend
Lateral Repairs
Sewer Main Spot Repairs
Sewer Main Spot Repairs
CHICOPEE
LUDLOW
WEST SPRINGFIELD
WILBRAHAM
N
W
E
S
AGAWAM
EAST LONGMEADOW
LONGMEADOW
KLEINFELDER
Stantec

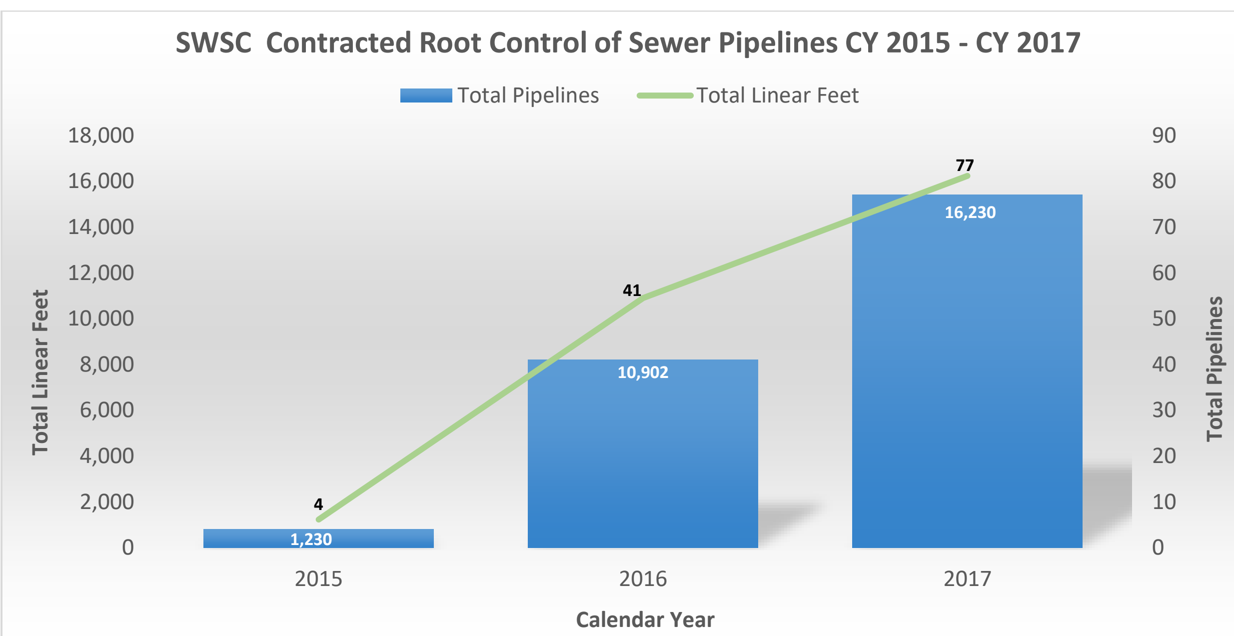
# 3.1.4 Root Management and Control Actions

The SWSC understands the need to balance urban tree plantings with proper maintenance of its collection system infrastructure. Over the past three years the SWSC has made it an initiative to annually increase the scope of their root management program. Over the past three years, the SWSC has steadily increased the number of pipelines annually receiving chemical and mechanical treatment for roots. As shown in Figure 3-11, the SWSC treated 4 pipes totaling 1,230 linear feet in CY 2015, 41 pipes totaling 10,902 linear feet in CY 2016 and 77 pipes totaling 16,230 linear feet in CY 2017.

During CY 2017, the SWSC managed the chemical and mechanical root control program using a third-party service provider. The contractor used a dense herbicidal foam that kills roots on contact without harming the surface vegetation. The SWSC's Root Control Program uses a priority ranking system to target and address the sewer mainline pipes within the collection system with the greatest need for chemical or mechanical root treatment. The top 100 prioritized root rankings, overview map and example map are provided in Appendix I. During CY 2017, 77 individual segments of mainline sewer totaling over 16,230 linear feet were chemically or mechanically treated for roots. The SWSC increased annual expenditures on their root control program by 31% from $28,344 in CY2016 to $37,139 in CY 2017.

At times, the SWSC's crews and subcontractors utilized mechanical root saws to locally remove roots in support of sewer inspection and cleaning activities as well as in response to sewer system problems.

*Figure 3-11 SWSC Contracted Root Control of Sewer Pipelines CY 2015 – CY 2017*



# 3.1.5 Grease Management and Control Actions

In response to the number of blockages caused by grease and in order to maintain compliance with U.S. EPA regulations, the SWSC implements a Fats, Oils and Grease (FOG) Program to educate residential customers on the hazards of grease clogs in the sewer system. The educational program called *"Cease the Grease Springfield"* is comprised of informational fliers (Figure 3-12), posters and on-site presentations at civic association meetings; condominium, rental and housing associations; and other public forums throughout the city. The goal of the program is to educate residents to understand that the proper disposal of grease and other FOG forming foods is in the garbage, rather than in the sink or toilet. The SWSC also has a flyer for Best Management Practices for Food Establishments.

*Figure 3-12 Residential Cease the Grease*

CEASE THE GREASE SPRINGFIELD

**Fats, Oils and Grease (FOG) and Sewer Backups**

WHAT IS FOG?

- FOG is fats, oils and grease that can build up in sewer lines. When grease is washed down the sink or toilet it coats and sticks to the inside of sewer pipes.

WHY IS FOG A PROBLEM?

- Sewer pipes can become clogged by FOG and cause backups into basements, roadways, and water bodies. Sewer backups create health hazards, can result in expensive property damage, and threaten the environment.

*Grease clog in a sewer pipe*

WHERE DOES FOG COME FROM?

- Meat Fats (bacon, sausage)
- Lard
- Cooking Oil
- Butter or margarine
- Food scraps
- Baking products
- Milk, ice cream, yogurt, sour cream
- Cream based sauces
- Salad dressings, cheeses, mayonnaise

**Keep these foods out of all drains!**

WHAT CAN I DO TO PREVENT SEWER BACKUPS?

- NEVER pour grease down sink drains or toilets.

YES!

- Dispose of cooled cooking fats, oils and grease into a waxed food container such as a milk carton or container with a lid and dispose of it in the garbage.
- Minimize the use of your garbage disposal. Foods containing FOG can get caught in the plumbing and cause sewer backups.
- Use baskets or strainers in sinks to catch food scraps. Empty scraps into the trash can.
- Scrape food scraps from dishes and pans into the trash can for disposal, before washing.
- DO NOT use the toilet for disposal of food scraps, sanitary items, rags, cloths, or towels.

DID YOU KNOW?

- Liquid dish detergents that claim to dissolve grease may actually pass grease down the sewer line, which could cause a sewer backup. It is important to scrape grease off all dishes.

PREVENTING SEWER BACKUPS PROTECTS PUBLIC HEALTH, THE ENVIRONMENT AND SAVES EVERYONE MONEY.

- The EPA has mandated that the Springfield Water and Sewer Commission reduce the number of sewer overflows caused by FOG.
- Grease related blockages can:
  - Cause the sewer to backup into your home through sinks, drains and toilets.
  - Cause backup of sewer into streets, parks, yards and waterways causing a public health risk and environmental concern.

*Avoid Sewer Backups in Your Home!*

- Raw sewage contains disease causing organisms that can be harmful to children, adults, and pets.
- Clean up and repairs for damage caused by sewer backups are expensive, unhealthy, and unpleasant.
- FOG related grease blockages increase the Commission's operation and maintenance costs resulting in higher sewer bills for all.

**HELP US CEASE THE GREASE, SPRINGFIELD!**

**Contact Information:**

Lori Belanger 413-787-6207 x202
Lori.Belanger@waterandsewer.org
or
Gail Colburn 413-787-6207 x244
Gail.Colburn@waterandsewer.org

The SWSC's Rules and Regulations prohibit the disposal of FOG to the collection system in amounts greater than 100 mg/L or in amounts which may result in restricted flow. The efforts made by the SWSC in controlling FOG have resulted in a program of proactive inspection of pipes known to have reoccurring FOG issues. Food service establishments are also required, per the SWSC's Rules and Regulations, to perform their own routine inspections, maintenance and record keeping. The SWSC reserves the right to inspect all facilities. Further, enforcement actions on FOG reoccurring violations, particularly with food service establishments and commercial/industrial generators have proved to be effective at improving FOG issues throughout the collection system.

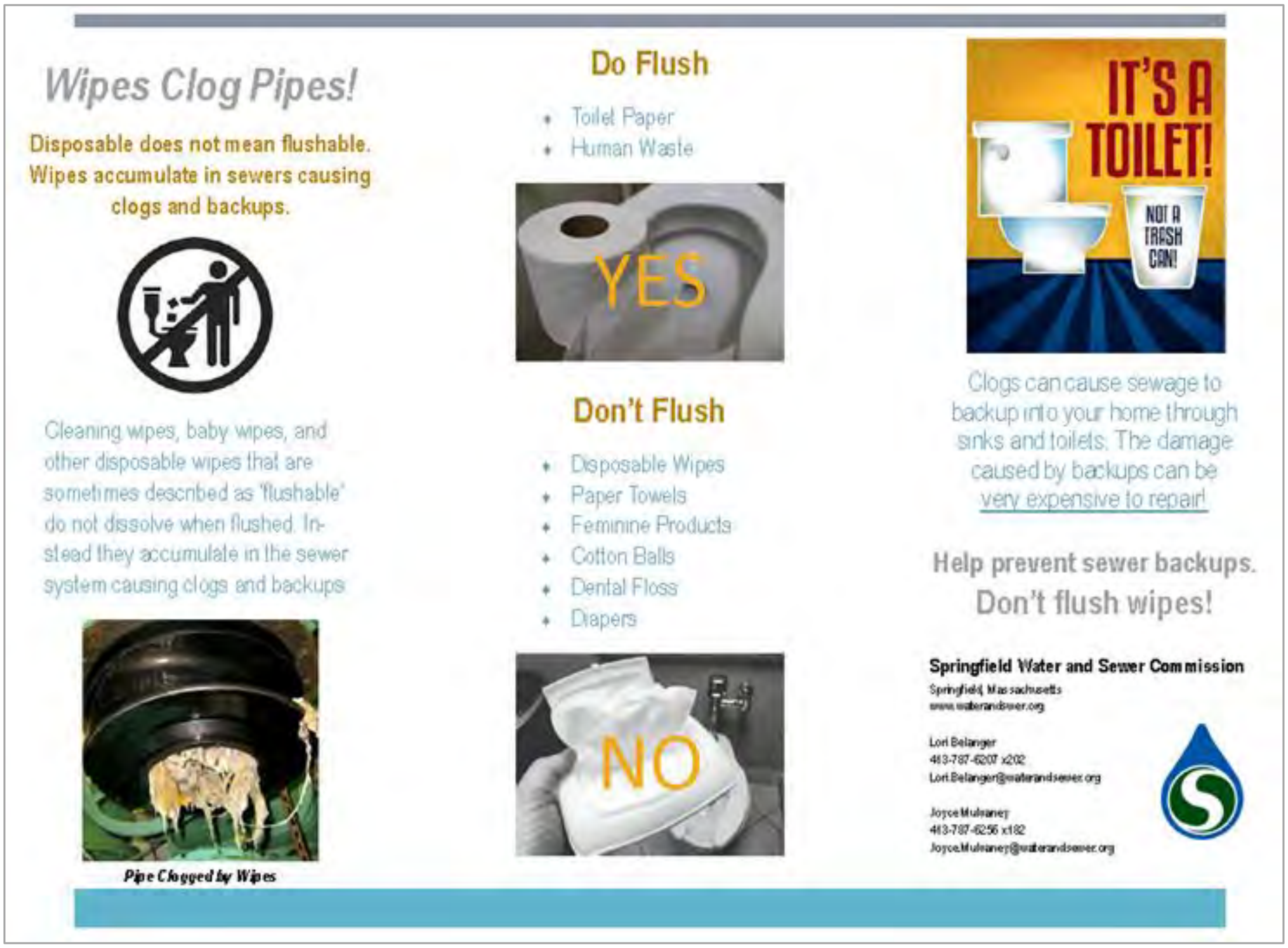
Accelerated Grease Cleaning Areas (AGCAs) are established based on grease problems identified through maintenance activities, preventative maintenance cleaning and CCTV assessment, and sewer release/back-up response activities.

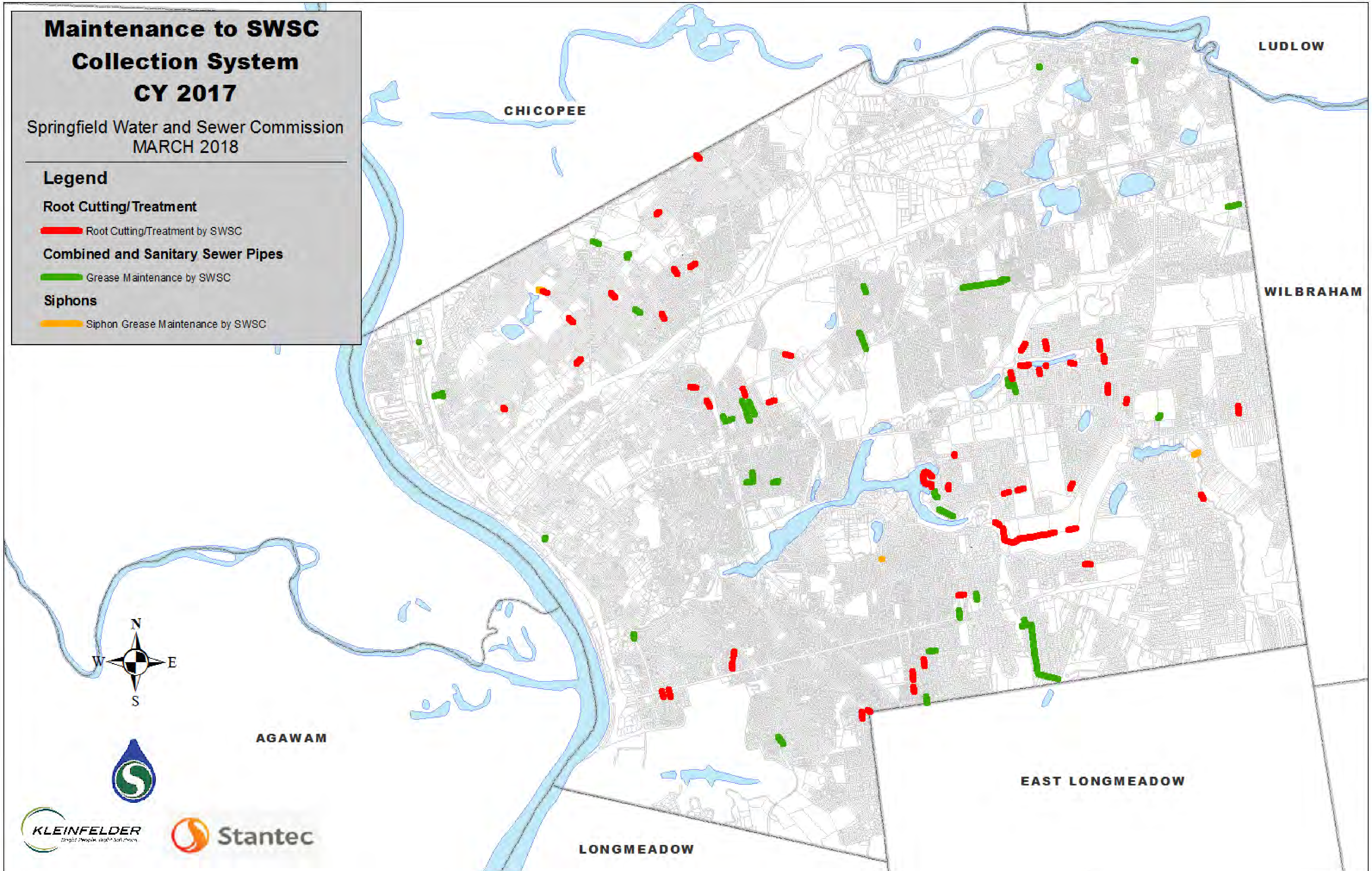
Routine investigations in areas of known FOG issues, performed by SWSC crews provides evidence needed for FOG enforcement actions. When a FOG discharge is identified, the SWSC may issue a Notice of Violation and will require the food service establishment to eliminate all FOG discharges, which is generally achieved by retrofitting the facility with a grease interceptor and plumb fixtures to the interceptor. The SWSC's inspection and enforcement, along with proactive retrofitting requirement for new and redevelopment food service establishments, significantly minimizes the potential for future FOG build-up and blockages in the collection system from these facilities.

The SWSC's Grease Control Program uses a priority ranking system to target and address sewer mainlines in the collection system with the greatest need for chemical and/or traditional cleaning. The top 100 prioritized grease rankings, overview map and example map are provided in Appendix J. During the CY 2017, approximately 79 individual segments of mainline sewers, totaling 15,996 linear feet in length, were cleaned or chemically treated specifically for FOG by SWSC crews as part of their collection system cleaning program. In 2017, the SWSC used 14,400 pounds of hot shot powder and 1,000 gallons of liquid degreaser to treat sewer pipelines with grease issues. Historically problematic areas in the SWSC collection system are treated repeatedly to proactively reduce the accumulation of FOG.

In addition to FOG, "disposable" wipes, are a collection system concern. Cleaning wipes, baby wipes, and other wipes that are sometimes described as "disposable" or "flushable" generally do not dissolve when flushed. Instead, they accumulate in sewer systems causing clogs and backups. The SWSC distributes a brochure to their customers that outlines the concerns of flushing items other than human waste and toilet paper (Figure 3-13). The brochure identifies disposable wipes, paper towels, diapers, feminine products, dental floss and cotton balls as products that are unsuitable to be flushed down toilets and explains that flushing these products can result in costly sewer backups and maintenance to pump stations.

*Figure 3-13 Wipes Clog Pipes Brochure*




Maintenance to SWSC Collection System CY 2017
Springfield Water and Sewer Commission
MARCH 2018
Legend
Root Cutting/Treatment
Root Cutting/Treatment by SWSC
Combined and Sanitary Sewer Pipes
Grease Maintenance by SWSC
Siphons
Siphon Grease Maintenance by SWSC
CHICOPEE
LUDLOW
WILBRAHAM
AGAWAM
EAST LONGMEADOW
LONGMEADOW
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# 3.1.6 Rainfall Derived Inflow and Infiltration Assessment and Removal

The SWSC has now assessed over 80% of the wastewater collection system since 2009 and maintains an extensive inventory of CCTV videos and PACP coded defect databases which have been leveraged to identify specific locations in the collection system where infiltration and inflow (I/I) is prevalent. In addition, the SWSC has over 25 permanent flow meters located throughout the collection system that have been collecting data on a continuous basis since 2004 as part of their CSO monitoring program and the data is reviewed monthly.

The SWSC has periodically conducted more robust metering programs, targeting not only its CSO regulators but areas throughout the combined and separated systems confirming collection system performance. In 2009/2010, over 40 meters were installed and monitored during various wet weather periods and again in 2013, 2014, 2015, 2016, 2017 for a total of 55 flow meters and 25 rain gauges installed during numerous seasonal programs. Data from these metering efforts was used to develop the LTCP for CSO control, whose improvements have been carried forward in the Integrated Wastewater Plan (IWP).

Focus on the removal of I/I from the SWSC wastewater collection system will continue to increase following the completion of rehabilitation projects of critical pipes with structural defects. In addition, the full database of pipeline PACP coded defects allows the SWSC to prioritize rehabilitation and repairs based also on I/I potential.

Many of the repairs and replacements performed by SWSC crews and the larger replacement, renewal and rehabilitation projects performed by SWSC contractors on an ongoing basis have addressed areas with structural failure, which by their nature were sources of infiltration into the collection system. The projects include new pipe and manholes as well as the rehabilitation and renewal of existing pipe and manholes.

Suez, in their role of contract operator of the SRWTF, the Combined Sewer Overflows, and the Flood Control System, has conducted annual inspections of the flood control/inflow structures on the combined sewer system as required by NPDES Permit No. MA0103331. Suez also routinely monitors flow data recorded at the SRWTF and contributing communities and any irregular or increased flows are investigated.

Appendix B attached to this Section includes letters from the communities which are serviced by the SRWTF (East Longmeadow, Longmeadow, Ludlow, Agawam, Wilbraham, and West Springfield), confirming their continued compliance with 314 CMR 12.07 (6) which requires wastewater collection system operators to report annually on new sewer system connections and I/I work conducted during the reporting period.

During CY 2017, the SWSC developed an I/I focused flow metering program focused on documenting the majority of the separated portion of the collection system. This program included 11 flow meters for a period of 12 weeks, from April 15 to June 28, 2017. The flow metering effort also included the installation of three rain gauges, in addition to the four permanent rain gauges that the SWSC maintains. The SWSC used the flow meter and rain gauge data collected in conjunction with past CCTV assessment data, to examine the I/I in the separated portion of the collection system as part of the I/I analysis report submitted to MADEP on December 27, 2017.

Utilizing this flow data and the knowledge gained through the collection system assessment program and other system analysis, the I/I analysis report outlined I/I sources within the SWSC collection system and summarized past I/I investigations, analysis and removal work completed during various system-wide programs.

The I/I analysis found that the majority of the separated system exhibits low infiltration rates, as defined by MassDEP (<2,000 gpd/in-dia-mi). Three of the eleven metered subareas were found to have moderate infiltration rates (2,000-4,000 gpd/in-dia-mi). These results were further supported by a rainfall-derived infiltration and inflow analysis (RDII) using the EPA Sanitary Sewer Overflow Analysis and Planning Toolbox. Only one of the eleven subareas was found to have a slightly elevated contribution from rainfall, however the contribution is estimated to be less than 2% of total rainfall. Based on these results, the incidence of I/I in the study area was found to be moderately low, and would not be cost effective to investigate further or remove the sources of extraneous flow.

The I/I analysis report also examined the overall risk of SSOs under a 5-year design storm. The SWSC reviewed wet weather SSO data from 2015-2017 and determined that the majority of the events occurred as a result of short duration, high intensity storms during which the collection system was temporally inundated. In addition, FOG and debris are often documented in addition to wet weather as a primary or secondary reason for the SSO event. Therefore, the analysis determined that the overall risk of SSOs under a 5-year design storm is low.

Through a separate study, the SWSC identified an inflow source from the Massachusetts Department of Transportation (MassDOT) highway stormwater system which discharges into the SWSC collection system. This illicit connection contributes nearly 22 million gallons of extraneous flow on an annual basis (typical year). The SWSC has and will continue to pursue the redirection of the known inflow from the MassDOT infrastructure from their collection system.

The SWSC continues to execute its collection system management programs as identified through the FLTCP, NMC and the IWP. The success of these ongoing programs has contributed to successful management of extraneous flows within the collection system.

# 3.1.7 Collection System Mapping

Since 2009, the SWSC continues to advance its efforts to develop and refine its collection system mapping. Typical annual activities include updating the sewer book, completing sewer service cards for new/replacement services, and improving the wastewater collection system ArcGIS geodatabase.

In CY 2017, 1251 manholes in the collection system were located by GPS. As a result, 855 manholes and 810 pipe segments were geospatially updated and asset attributes were also updated. In addition, the pump station and force main layers received spatial and attribute based updates.

The SWSC maintains a detailed sewer book (i.e. its wastewater collection system atlas) that covers the entire collection system. This document continued to be updated in CY 2017 as changes were made to the collection system or as record discrepancies were discovered.

In 2017 the digital data management responsibilities of the cleaning and assessment program began to be transferred to the SWSC Information Technology staff from their consultants. These responsibilities mainly include geospatial updates of sewer and drainage assets and maintenance of the geometric network for the sewer collection system. The complete transfer of these responsibilities to the SWSC from their consultant is scheduled to occur in 2018.

# 3.1.8 Records/Digital Archive

In 2012, the SWSC and its consulting engineers scanned over 26,000 archived plans and geospatially linked 20,000 of them to the assets in the GIS system. The SWSC continues to expand this program with the goal of digitally archiving and geospatially linking all record documents. In 2014, the SWSC began integrating these documents into the new asset management software. In 2015, 42,290 sewer service tie cards were also attached to service/address points in the GIS for easy access and reference. In CY 2016, digital archiving efforts were focused primarily on digital archiving of paper documents for the SWSC’s Water Distribution system, with a small quantity of documents for recently completed “as-built” construction plans being linked to the wastewater collection system GIS. In 2016, all linked documents were made available to the SWSC’s operations and maintenance crews through its asset management and maintenance software system. In CY 2017, the SWSC linked 137 pipeline assessment videos to their corresponding pipeline assets and 10,822 documents to manhole assets in their asset management software.

# 3.1.9 Work Order Management and Computerized Maintenance Management System

In CY 2017 the SWSC continued to customize and refine its asset management and maintenance software, VUEWorks. Among many powerful aspects of this software, this system serves as the basis for tracking SSOs and other important operational parameters. Through various reporting functions, trends can be tracked real-time which serves to inform SWSC leadership on the success of the various programs and their organization. The system continues to be further refined as more users throughout the SWSC are added and trained. In CY 2017, the SWSC began to modify details within VueWorks work orders to collect data in accordance to metrics within AWWA Benchmarking Performance Indicators.

In 2016, the SWSC worked with VUEWorks in the development of a user interface tool which can be used to facilitate the interaction of the VUEWorks work management system with the SWSC's customer billing system. In CY 2017 the development of the user interface tool was completed and integration with the application program interface was initiated. The SWSC anticipates the user interface tool will be incorporated into the application program interface by the summer of 2018.

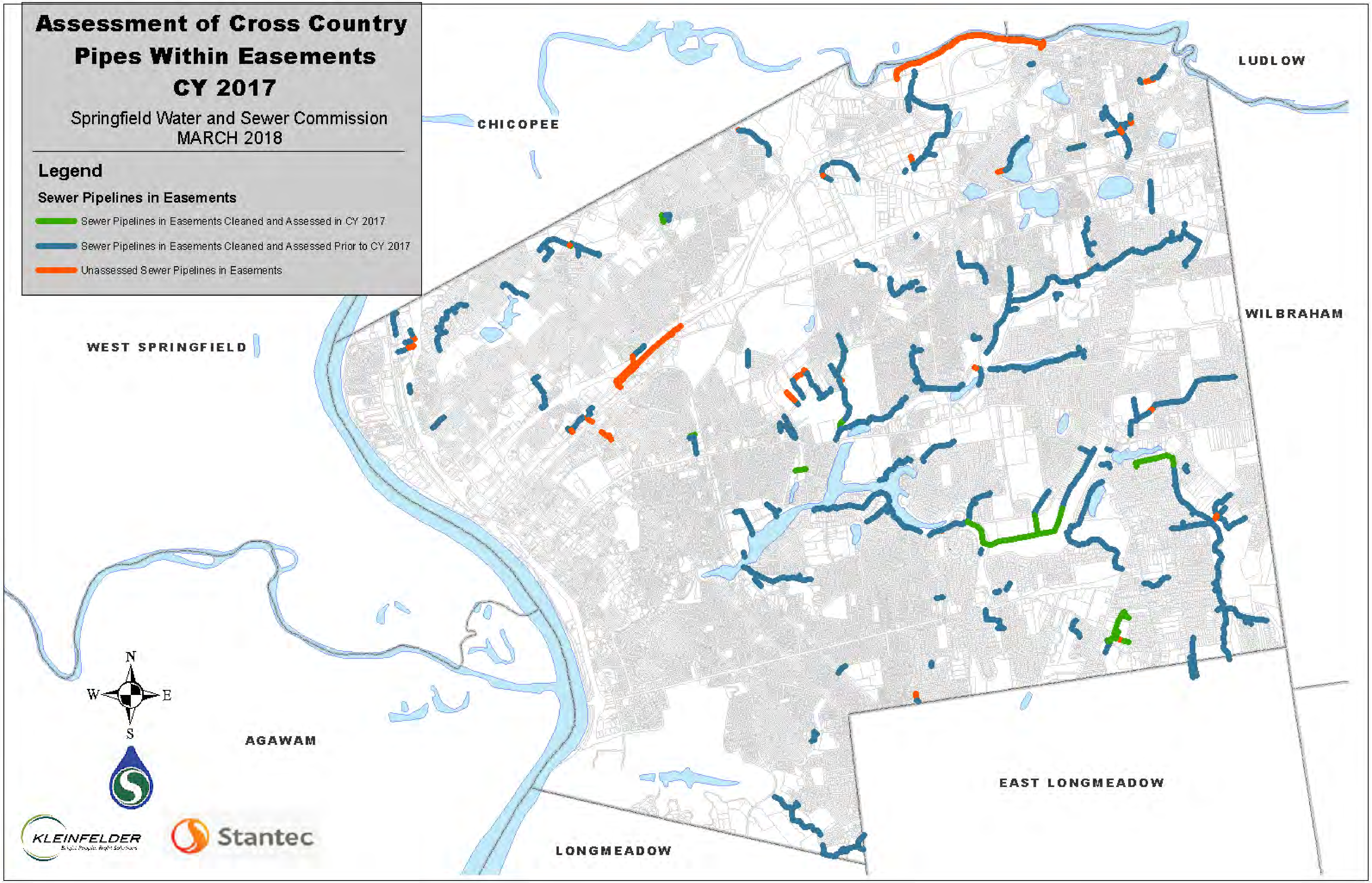
# 3.1.10 Easement Maintenance Programs

In 2014 the SWSC began identifying all cross-country easement collection system assets. There are 950 pipe segments in the SWSC collection system outside of the street right of way, totaling 193,500 linear feet (7.8 percent of the total system). The CY 2014 - CY 2017 Pipeline Cleaning and CCTV Assessment Program have almost exclusively focused on cleaning and assessing these cross country and easement assets. During CY 2017, 52 sewer mainlines and 7 siphons within cross country easements were cleaned and assessed totaling 14,642 linear feet. Overall, since the start of the SWSC's Pipeline Cleaning and Assessment Program, 88 percent of the pipelines within cross country easements have been assessed. The one remaining unassessed siphon in the collection system, located within a cross country easement, is scheduled to be assessed in CY 2018.

During this program the need to further maintain access through these historically hard to reach assets was further identified. A register of easement assets requiring clearing, access improvements, and easement maintenance was developed. This register is being used to develop short and long term maintenance plans for these easements.

A capital project for clearing, access improvements and easement maintenance was implemented in FY2016 (July 2015 through July 2016) and an equivalent project was completed during FY2017 (July 2016 through July 2017). During CY 2016 approximately 570,000 square feet within 6 of the SWSC's collection system cross country easements were cleared of vegetation and other illicit features specifically to enable access for the SWSC's Pipeline Cleaning and Assessment Program. Clearing of SWSC collection system easements is critical to the efficiency of SWSC's Pipeline Cleaning and Assessment Program and future access within the easements for planned and emergency maintenance/repairs. Budgeting for easement clearing will end for the time being after FY 2018 since the clearing of the inaccessible sewer easements is complete.

The SWSC also continues to track existing and install new visible sewer markers on cross country sewers and at hard-to-find manhole locations. The SWSC installed 74 of the visible sewer markers during CY 2017. The locations of these markers are maintained in the VUEWorks database.


Assessment of Cross Country
Pipes Within Easements
CY 2017
Springfield Water and Sewer Commission
MARCH 2018
Legend
Sewer Pipelines in Easements
Sewer Pipelines in Easements Cleaned and Assessed in CY 2017
Sewer Pipelines in Easements Cleaned and Assessed Prior to CY 2017
Unassessed Sewer Pipelines in Easements
CHICOPEE
LUDLOW
WILBRAHAM
WEST SPRINGFIELD
AGAWAM
EAST LONGMEADOW
LONGMEADOW
N
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KLEINFELDER
Stantec

# Section 4 Sewer Release Analysis and Performance

The SWSC's Corrective Action Plan (CAP) continues to be implemented as it advances the major components of the CMOM Program. In addition to the information provided in the prior section regarding the CY 2017 CMOM implementation efforts, this section outlines the elements of system reinvestment and risk reduction through the Wastewater Operations budget for 2017. The SWSC's CAP and CMOM establishes the process for responding to sewer releases from the combined and sanitary sewer system. Reporting to MADEP is in conformance with the SWSC's NPDES Permit.

The SWSC continues to improve its implementation of best management practices for collection system operation and maintenance to reduce the number and severity of sewer releases. Under the CMOM Program, additional emphasis is placed on understanding why releases have occurred and how to prevent future releases.

## 4.1 Sewer Release Tracking and Reporting

Based on conformance with the CMOM Self-Assessment Checklist and improvements to reporting trends, the SWSC continues to see a steady decrease in the annual number of Sanitary Sewer Overflows (SSOs). With the SWSC's Computerized Maintenance Management System (CMMS), VUEWorks, a connection between the work history and the assets is being made. Data controls continue to be improved and added to help manage work orders. Problem codes and standardization of planned and unplanned maintenance work types continue to be added to work orders and help develop histories, trends and valuable reports. Well-defined work codes help ensure that work related to sewer releases receives top priorities.

The SWSC tracks the causes of failures to facilitate the analysis of sewer releases as shown in Table 4-1.

*Table 4-1 Sewer Release Cause Descriptions*

| Sewer Release Cause | Description |
|---|---|
| Structural Defect | Release caused by a physical failure of the pipeline |
| Equipment Failure | Release directly resulting from equipment failure typically either at a pump station or during a flow bypass |
| Maintenance | Release caused by SWSC-related maintenance activity |
| Weather Event | Release caused by a hydraulic capacity issue (not including CSOs which are permitted) associated with weather |
| Grease | Release caused by blockage primarily due to grease |
| Debris | Release caused by a soft blockage due to sediment or other material |
| Roots | Release caused by a blockage primarily due to roots |
| Cause Unknown | Release where the investigation does not identify a specific cause |

The SWSC has included information for all SSOs that occur within the wastewater collections system in this report except for Combined Sewer Overflows from permitted CSOs. Appendix A to this report includes a summary of all SSOs for CY 2017. Pursuant to the requirements of Administrative Order Docket No. 08-037 (AO), the following information is presented in tabular form:

- Date and Time of SSO
- Date and time SSO was resolved
- Location of SSO
- Source Notification
- Cause of SSO (see above)
- Measures taken to resolve SSO
- Date of the last SSO that occurred at the same location
- Estimated volume of overflow
- Discharge location

# 4.2 Sewer Release Key Performance Indicators

Striving for continuous improvement is a cyclical process of evaluating current practices, identifying needed improvements, and measuring performance. The SWSC uses a set of key performance indicators to gauge the effectiveness of the CMOM PROGRAM.

# 4.2.1 SSO Trends and SSOs per Hundred Miles of Pipe

SSOs provide a good measure of the overall effectiveness of maintenance programs for controlling roots, fats, oils, grease, structural failures and pump station performance.

In 2006 the SWSC recorded 141 SSOs. There has been a decrease in each of the past 10 years with 25 SSOs reported in 2015, 22 SSOs reported in 2016 and 14 SSOs reported in 2017. This represents an 84% decrease in SSOs since 2006 and a 36% decrease from CY 2016 to CY 2017.

In addition to the overall trend of SSO reduction every year, the SWSC looks at the sewer overflow rate (SSOs per 100 miles of sewer) of their collection system as a metric for gauging overall success toward minimizing SSOs. The SWSC owns and operates 469 miles of mainline sanitary and combined sewers. At the start of the maintenance program in 2006, the sewer overflow rate was 30.1 SSOs/100 miles. During CY 2017 the SWSC experienced 14 SSOs over the 469 miles of collection system. The SWSC reduced their sewer overflow rate to 3.0 SSOs/100 miles in CY2017. Figure 4-1 below demonstrates the trend of continuously decreasing sewer overflow rates from 21.5 SSOs/100 miles in CY 2009 to 3.0 SSOs/100 miles in CY 2017.

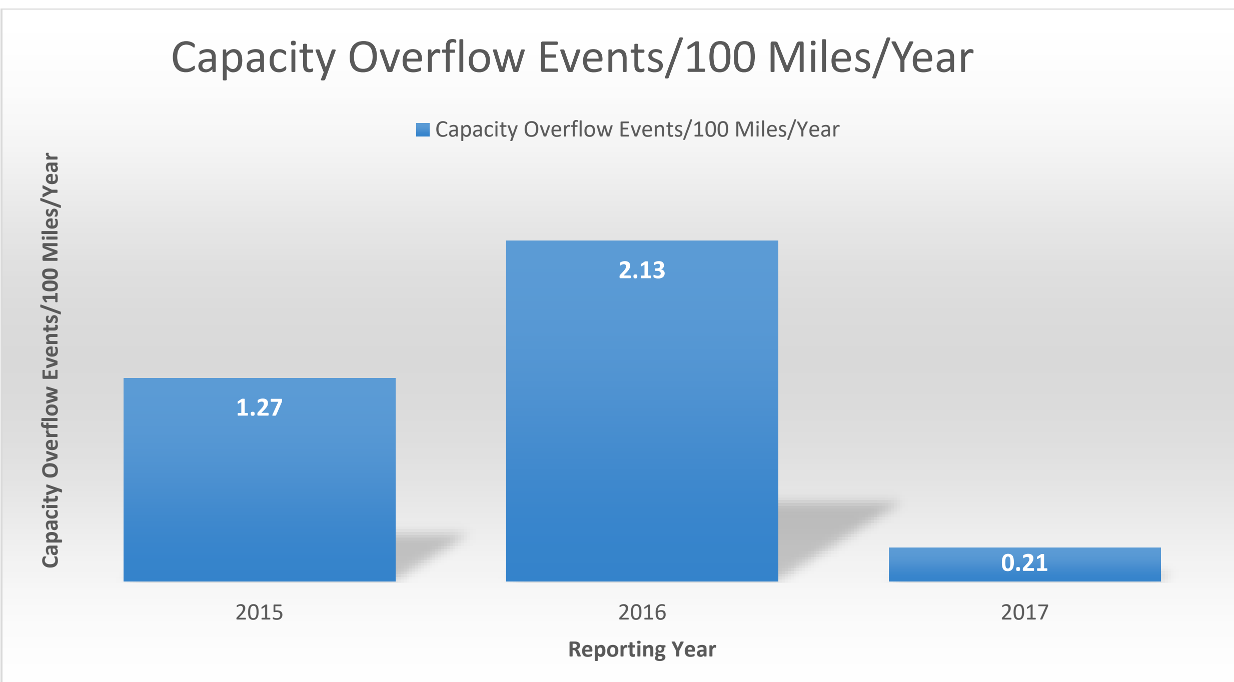
The SWSC also further analyzes the sewer overflow rate as it pertains to capacity vs. non-capacity SSOs. The AWWA defines a capacity overflow as a discharge that generally occurs as a result of inflow and infiltration and a direct result of rain events and a non-capacity overflow as a discharge related to maintenance issues. The capacity sewer overflow rate (capacity overflow events/100 miles of pipe) was 0.21 for CY 2017, an 83% reduction from the rate of 2.13 in CY 2016. The 0.21 capacity overflow rate is slightly above the FY 2015 reported top performing quartile AWWA Benchmarking Performance Indicator rate for combined operations of 0.2 and significantly below the median rate of 0.7. The AWWA Benchmarking Performance Indicators data for FY 2015 was used in lieu of the FY 2016, since the SWSC did not possess the FY 2016 survey data at the time of this report's development.

<u>These two metrics are leveraged by the SWSC for the following purposes</u>:

- observe trends related to the causes of SSOs in their collection system on an annual basis.
- determine if additional focus is warranted to reduce O&M related SSOs or upgrades/improvements to the collection system to alleviate capacity related SSOs. evaluate how these two benchmarking performance indicators compare nationally with other combined water and wastewater operation organizations using AWWA annual survey data.

*Figure 4-1 SWSC SSO/100 Miles/Year*


*Figure 4-2 SWSC Capacity Overflow Events/100 Miles/Year*



### 4.2.2 Response to Urgent Health and Safety-Related Service Request

The SWSC's goal is for a sewer emergency crew to be on site rapidly upon receiving the initial call reporting an urgent sewer release and subsequently addressing the release and its root cause within the same day of the report. The SWSC is responsible for maintaining electronic records of sewer releases. These records are used to assess the response time of the on-site emergency crew as well as the time taken to address each issue. During CY 2017 the average time to resolve reported SSO's was approximately 1 hour and 50 minutes, a 27% decrease from the CY 2016 average response time of 2 hours and 30 minutes. Under some circumstances, such as when a caller is reporting a release that happened in the past or is requesting to meet a SWSC crew at a pre-arranged time, a sewer release is considered non-urgent and the responsiveness goals do not necessarily apply.

## 4.3 Analysis of Causes and Locations of Sewer Releases

During CY 2017, the SWSC experienced 14 releases from the sanitary sewer system. There was 1 weather related SSOs during a rain event in CY 2017 where the flows exceeded the design capacity of the collection system (referred to as force majeure). All other wet weather releases during the year occurred at permitted CSOs. Output from the VUEWorks CMMS summarizing the SSOs as well as a Sewer Collection Work Summary are included in Appendix B. The release data shown is for releases due to problems in the SWSC-maintained portion of the collection system (excluding releases due to causes resulting from problems in privately-owned sewers or laterals). The locations of the MADEP reported SSOs are shown in the Figure at the end of this section and summarized on Table 4-2 on the following page. Several factors likely contributed to the releases that were reported in CY 2017.

*Table 4-2 MADEP Reported SSOs CY 2017*

| Location | Date SSO Discovered | Root Cause |
|---|---|---|
| 268 Newhouse Street | 1/1/2017 | Grease |
| 264 Newhouse Street | 1/23/2017 | Grease |
| 66 Wilshire Road | 3/2/2017 | Grease |
| 73 Squire Lane | 3/15/2017 | Ragging/Paper |
| 259 & 260 Ramblewood Dr* | 5/21/2017 | Basement Backup |
| Indian Orchard Pump Station | 8/12/2017 | Pump Station Failure |
| 42 Undine Circle* | 8/25/2017 | Root Intrusion |
| 42 Geneva Street* | 9/30/2017 | Grease |
| 11 Baywood Street* | 10/4/2017 | Blockage in Sewer Main |
| 83 Meadowlark Lane* | 10/4/2017 | Grease |
| Indian Orchard Pump Station | 10/25/2017 | Insufficient Capacity at Pump Station |
| 92 Juniper Drive* | 11/3/2017 | Root Intrusion |
| 53, 61, 65 Hudson Street* | 12/10/2017 | Grease |
| 1-3 Decatur Street* | 12/10/2017 | Grease |

*Event was a basement backup into property and did not release to grounds surface

There are several reasons for the downward trend in sewer releases. As the Pipeline Cleaning and CCTV Assessment Program enters its ninth year, more areas for potential releases driven by main line sewer structural and maintenance conditions are being pre-identified through inspections performed by the SWSC's crews as well as its sub-contractors. As areas of historic grit, grease, and root problems are identified and addressed, high intensity storms and wet weather events which may have caused problems in the past by inundating the capacity of the collection system no longer present the same problems, as the blockages or issues causing the capacity reduction have been addressed. Also, as the SWSC continues to address existing structural pipe failures, the threat of catastrophic pipe collapses has decreased. In addition to structural issues, I/I is also being reduced, increasing the available capacity in the pipelines.

# 4.3.1 Sewer Release Causes for CY 2017

In addition to the research conducted by the SWSC to determine the cause of sewer releases, improvements continue to be made including the use of the VUEWorks CMMS to track initial and actual codes on work orders. This enhanced capability provides a clearer understanding of the underlying reasons why a problem occurred or why work on (or near) an asset was required. For example, a work order may be initially coded as a release or a back-up when the call is received. When the crew responds to the issue and performs its investigation and determines the actual problem is grease or roots, this is subsequently recorded on the work order.

**Structural Defects.** There were no sewer releases as the result of a structural defect in CY 2017. The risk of release associated with structural defects will continue to decrease as sewer repair, rehabilitation, replacement and renewal projects are completed. Furthermore, risk will continue to be reduced as a comprehensive database of structural defects throughout the collection system nears 100% completion. At the end of CY 2017 the SWSC's Pipeline Cleaning and Assessment Program has assessed over 80% of the collection system. The continually expanding database of structural defects will enable the SWSC to continue to enhance prioritization of rehabilitation and replacement of pipes in their collection system.

**Maintenance Defects.** In CY 2017 there were no releases associated with maintenance activities. Maintenances activities can typically cause "blow back" where pressure from the SWSC sewer cleaning operations result in releases from plumbing on private property. SWSC crews and sub-contractors take precautions to prevent these occurrences especially where most private plumbing systems lack adequate venting and configuration. Other sources of maintenance flows can include CIPP lining bypass or service interruptions (services connected to pipelines were inadvertently not reinstated). Though handling flows during the SWSC's capital projects can be difficult, the SWSC and its engineers and contractors thoroughly plan the rehabilitation activities such that bypasses are appropriately sized and all services are located and scheduled for reinstatement. This attention to detail has helped eliminate maintenance sewer releases during CY 2017.

**Extreme Weather.** Although the SWSC has a successful system of integrating its treatment plant and collection system operation to minimize the effects of wet weather events and although the SWSC does have permitted CSOs, a high-intensity rainfall event of 3.75 inches nonetheless resulted in one release in CY 2017. The rain event occurred on October 25, 2017 and the SSO occurred when the overflow tanks at the Indian Orchard Pump Station (IOPS) became inundated and released a discharge which overflowed an estimated 84,500 gallons of stormwater and sewage to the Chicopee River over a period of 43 minutes. The SSO was a result of the combined sewer flows at the pump station exceeding the combined pump output.

**Roots, Grease and Debris.** There were 11 releases caused by root, grease or debris related blockages or flow restrictions. SWSC crews responded by jetting the mainline or cutting the roots to free the blockage. At times, when the property affected has basement level plumbing fixtures and finished basements/apartments, the SWSC strongly recommends the use of backflow preventers to help prevent future basement damage from backups.

**Pump Station Failures.** On August 12, 2017 the main programmable logic controller (PLC) at the IOPS malfunctioned resulting in operator controllable input settings to default to this highest or lowest settings of the ranking and caused the pump sequence controller to reset and call for pump No. 1, which was locked out for maintenance, to the lead position. Two Mechanics visited the site to reset the general dialer alarm, reset alarms on No. 1 pump and change the pump sequence to an available pump. Following the completion of the three tasks, one of the mechanics identified the PLC malfunction caused the influent gates to the pump station to close and the overflow storage to subsequently fill and release a discharge to the Chicopee River. The overflow tank filling alarms did not trigger due to the PLC malfunction. The mechanics immediately switched the influent gates from automatic to manual control mode and then opened the pump station influent gates to terminate the discharge. The release lasted for a duration of one hour and discharged an estimated 225,000 gallons of sewerage into the Chicopee River. On August 15, 2017 the facilities SCADA integrator added an influent gate command position status to the "Hydraulic" page graph to add additional information for troubleshooting. On August 16, 2017 an additional trouble shooting SOP for the IOPS was issued to the O&M staff to assist with troubleshooting unusual situations.

# 4.3.2 Sewer Releases to Surface Water in CY 2017

Sewer releases directly to surface water occurred on four occasions at three locations.

**Wilshire Road.** (release to Schneelock Brook): An overflow due to a grease blockage exited a sanitary sewer manhole behind 76 Wilshire Road on March 2, 2017 at 1:40 PM. The overflow entered the storm drain system through a nearby catch basin and released through a downstream outfall pipe into the Schneelock Brook. The sewer release was estimated to be < 3,000 gallons and there was also a backup into the home at 76 Wilshire Road. When the SWSC became aware of the release, emergency crews immediately responded and cleared the grease blockage and stopped the release at 3:30 PM. Follow up cleaning of the sewer pipelines in the area has occurred and this location will be monitored on a regular basis.

**Newhouse Street.** (release to Schneelock Brook): On January 1, 2017 at 3:40 PM, an overflow due to a grease blockage exited a sanitary sewer manhole adjacent to 268 Newhouse Street. The overflow entered the storm drain system through a nearby catch basin and released through a downstream outfall pipe into the Schneelock Brook. The sewer release was estimated to be < 1,000 gallons and there was also a backup into the home at 268 Newhouse Street. When the SWSC became aware of the release, emergency crews immediately responded and cleared the grease blockage and stopped the release at 6:00 PM. The sewer collection system was cleaned and chemically treated with degreaser to minimize the risk of future blockages due to grease.

**Indian Orchard Pump Station.** (release to Chicopee River): A sewer release into the Chicopee River from the IOPS occurred on two occasions in 2017. Reference the extreme weather and pump station failures portions of the previous section, 4.3.1, for details of these two events.

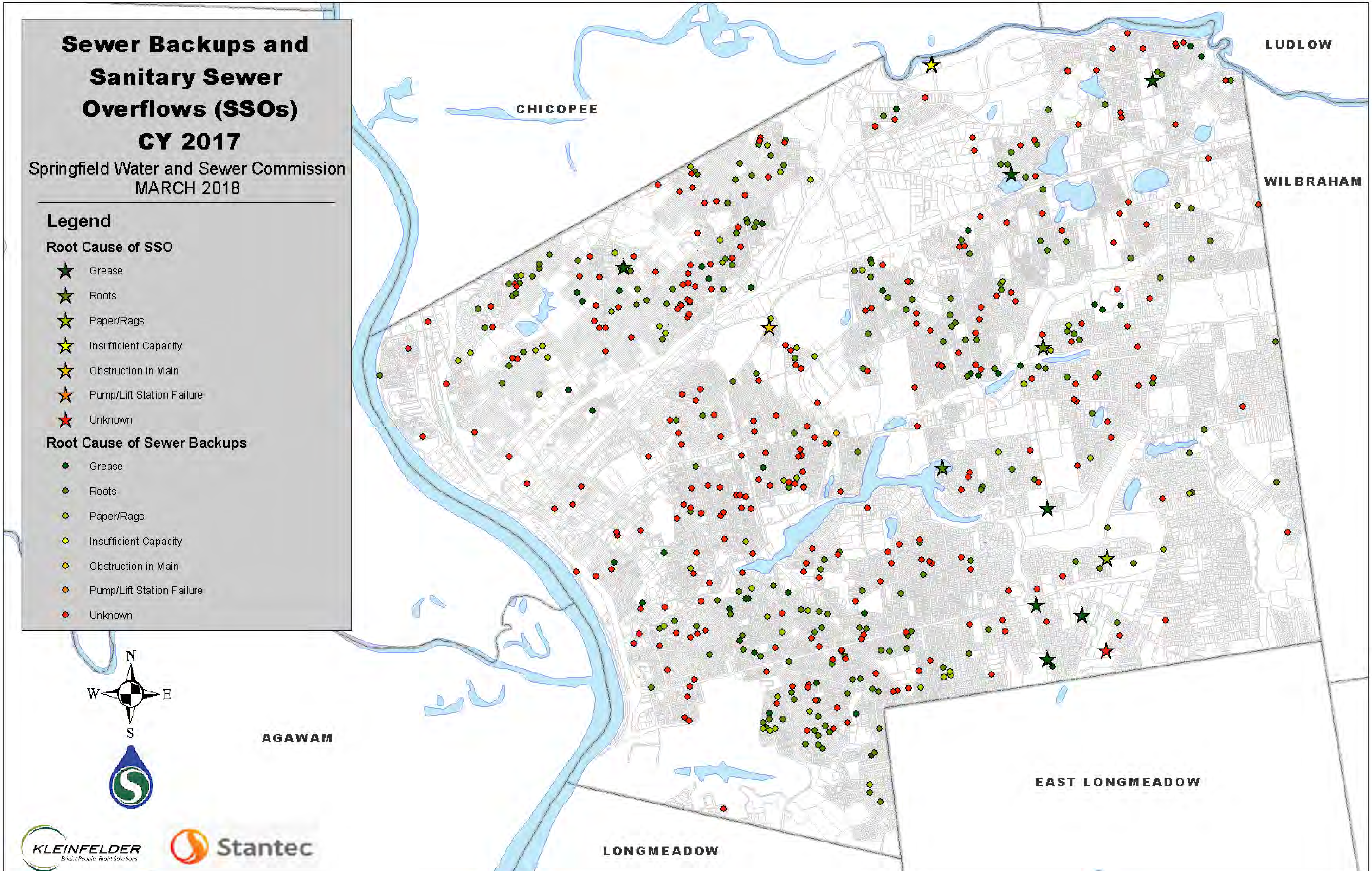
# 4.3.3 Conclusions and Follow-Up Actions for Sewer Release Reduction

The SWSC's continues to work toward the full implementation of its CMOM program. Shifting towards risk-reduction operations and maintenance of the collection system continues to result in a positive trend toward planned, proactive maintenance and fewer releases. The SWSC continues to develop and improve the VUEWorks CMMS to facilitate work prioritization and asset management in the gravity collection system. Although the SWSC's CMOM program effectively incorporates the essential elements and best management practices for proper operations and maintenance of the collection system, analysis of sewer releases in CY 2017 has highlighted some opportunities of continued improvements.

Root, sediment, and grease induced blockages continues to be a source of sewer releases. The SWSC will continue to identify historically problematic areas and will proactively address the grit, root, or grease issue. These areas are also included on the SWSC's list of routine and continued inspection and diagnostics so the potential for blockage can be identified before a release occurs.

The SWSC anticipates the number of releases attributable to structural defects will remain low or non-existent as capital projects under design and construction are completed. These projects to replace, renew, rehabilitate and repair collection system assets that pose the highest risk and consequence of failure will position the SWSC to be better able to provide proactive rather than reactive maintenance.

Overall, through the continued implementation of its LTCP for the control of CSOs and holistic IWP, the SWSC will address all wastewater condition and capacity needs in a system-wide approach, prioritizing investment and business risk reduction through progressive maintenance and prioritized capital projects which are of maximum benefit to the SWSC and its ratepayers.


Sewer Backups and Sanitary Sewer Overflows (SSOs) CY 2017
Springfield Water and Sewer Commission
MARCH 2018
Legend
Root Cause of SSO
Grease
Roots
Paper/Rags
Insufficient Capacity
Obstruction in Main
Pump/Lift Station Failure
Unknown
Root Cause of Sewer Backups
Grease
Roots
Paper/Rags
Insufficient Capacity
Obstruction in Main
Pump/Lift Station Failure
Unknown
CHICOPEE
LUDLOW
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# Section 5 Maximize Storage in the Collection System

The purpose of this control is to ensure that combined sewerage is stored in the sewer system as long as possible using available in-system storage without adding new storage facilities. The available storage in the collection system is used for minimizing CSO discharges and secondary bypasses at the SRWTF. Part of the SWSC's focus has been on keeping combined and sanitary sewers clean and free of capacity restrictions as well as removing clean stormwater and groundwater from the collection system through I/I reduction components of capital projects.

## 5.1 Collection System

### 5.1.1 Trunkline and Interceptor Storage

One of the SWSC's strategies for controlling CSOs is through the use of elevated weirs and passive mechanical hydraulic flow devices such as bending weirs, vortex throttles and hydroslides. This allows the capacity of the larger trunklines and interceptors to be maximized. Though this helps reduce overflows to receiving water bodies, it can also result in an increased risk of basement back-ups and street flooding when these large trunklines and interceptors are surcharged during large storms. During the design of CSO reduction projects in Springfield, level of service and minimum freeboard is analyzed to minimize the risk of increased SSOs and basement backups following completion of construction. For each project that seeks to optimize the collection system, CSO performance gains must be balanced against level of service risk. Level of service across a study area is assessed for vulnerability using a core set of large design storms, and where potential vulnerability is identified in localized areas, additional analysis in the form of enhanced hydraulic modeling (InfoWorks) is performed, through the simulation of a wider set of large design storm with a variety of rainfall intensities and volumes to understand the system's response to differing types of events. Furthermore, if the complexity of the hydraulics warrants, three-dimensional Computational Fluid Dynamics modeling is applied to validate the understanding of the system hydraulics. Modeling exercises are informed with supplemental field investigations (such as confined space entry, building inspections, and/or additional topographic survey) as applicable to confirm the configuration of the collection system and risk exposure to elevated levels in the sewer system.

The SWSC's contract operator, Suez, routinely maintains pump station wet wells to such levels as storage in the trunklines and interceptors is maximized without causing unwanted reductions in the level of service.

Through the SWSC's on-going Pipeline Cleaning and CCTV Assessment Program, additional capacity is developed as grit, root blockages, and grease restrictions are removed from the system. Also, every year, Suez performs a deep clean of the pump station wet wells to help ensure capacity is maximized not only in the wet well but also as a result, in the collection system.

Targeted flow metering is performed in the Connecticut River Interceptor sewer shed to support on-going CSO projects. This information is valuable in assessing the balance between CSO control objectives and level of service reduction risk mitigation.

As more CSO projects are completed by the SWSC, the frequency of CSO discharges continues to decrease but the impact of a reduced level of service on SSO frequency continues to be a focus of the SWSC. As new projects are developed, both CSO control projects and pipeline renewal, rehabilitation and replacement projects, the SWSC and its engineering consultants continuously balance CSO control goals with level of service protection. By understanding the effect of proposed flow controls in the CSO system on level of service the SWSC provides the best projects for CSO control with the least risk for future SSO problems associated with a reduced level of service. Ongoing and completed projects include:

- 2000-2004 System Optimization Measures Project
- Mill River CSO Relief Project (2003-2006): Key elements included the installation of one bending weir and five vortex throttles to maximize storage in the collection system.
- Chicopee River CSO Control Project (2007-2010): Key elements included the installation of a parallel relief sewer for the Ludlow Interceptor
- Phase I Connecticut River CSO Control Project (2009-2012): Key elements included construction of sewer and drain improvements upstream of CSO Regulators 007 and 049.
- Washburn CSO Control Project Phase II (2012-2015): Key elements included the relocation of an existing regulator structure to better facilitate CSO controls, modifications to the heights of existing static weirs, and the installation of two hydroslides to maximize in-system storage, particularly in the SWSC's existing Garden Brook Sewer (GBS) which was being greatly underutilized before the project was completed
- Main Interceptor and CSO Improvements (2014 – Present): Key elements include the improvements to CSO outfalls 012, 013, 018 to re-establish the operational capacity of each outfall. The project is currently in the process of being closed out.

In addition to the ongoing and completed projects above, Collection System Optimization Improvements (CSOI) were identified under Phase 2 of the SWSC's Integrated Wastewater Plan

(IWP). The improvements include several new passive hydraulic control structures to help optimize collection system storage, as well as adjustments to four CSO regulators on the Connecticut River Interceptor (CRI) system. The CSO control elements designated in Phase 2 of the IWP serve to decrease CSO activity and overflow volume while simultaneously preserving level of service protection throughout the system. The identified collection system optimization improvements were subjected to a re-assessment against short duration high intensity rainfall conditions to reconfirm level of service. The design of the CSOI project is being finalized as of the Spring of 2018 and will be bid in a package with other sewer system improvements by the summer of 2018.

# 5.1.2 CSO System Storage and Pumping Capacity Increases

In addition to the measures described above the SWSC has made advancements to its CSO storage elements. The 2007-2010 Chicopee River CSO Control Project created 100,000 gallons of CSO storage at the Indian Orchard Pump Station that captures potential CSOs at the site for storms larger than the 5-year return period and eliminated 700,000 gallons of surface flooding for a typical year at the pump station.

In 2017 Suez completed upgrades to the Washburn Street pump station to increase flow capacity to the SRWTF. The project consisted of the following elements:

- Installation of new hardened steel impellers and wear rings to bring all four pumps up to original specification.
- Installation of mag-flow meters on all four pumps.
- Installation of new knife gate valves, associated piping and electrical.
- Upgrade the pump station SCADA to accommodate the four new mag-flow meters.
- Program of the SCADA historian to collect and report the station flow data.

The next phase of the Connecticut River CSO Control Program is the Connecticut River Crossing and York Street Pump Station Improvements Project. This project will provide additional pumping capacity to the SRWTF which reduces CSO spill frequency and discharge volume while preserving sewer level of service. The project will also provide redundancy of critical infrastructure under the river and operational flexibility to isolate key infrastructure to enable future maintenance and rehabilitation. The design of the river crossing and new York Street Pump Station is currently underway. Phasing of the proposed river crossing work will be implemented ahead of the pump station work.

**Connecticut River Crossing and York Street Pump Station Improvements**

Connecticut River Crossing

A new pipeline crossing of the Connecticut River will be constructed to accommodate additional conveyance capacity from the York Street area to the Influent Structure at the SRWTF. The project scope consists of two 36-inch force mains and one 72-inch siphon. The requirement to accommodate additional connectivity from the proposed river crossing to the SRWTF Influent Structure is also included as part of the new pipeline crossing.

York Street Pump Station Improvements

Presently the York Street area, which serves the CRI portion of the collection system, is served by the existing York Street Pump Station, which operates at a capacity of approximately 34 MGD when using the flood control pumps to augment output. At the planning level in the IWP, the requisite future capacity is estimated to be 62 MGD.

The sewage pumping function of the existing pump station will be decommissioned and the proposed 62 MGD pump station will instead perform this function. The existing YSPS will continue to serve as a flood pumping station in the future.

The proposed YSPS work includes the following features:

- Intake Screening Structure, Pumping Station Building and Electrical and motor control center (MCC) building
- Standby Generator
- Odor control system

The schedule for the design and construction of the proposed Connecticut River Crossing including SRWTF Influent Structure Improvements and the York Street Pump Station Improvements includes[1]:

- Complete final design as Construction Manager at Risk Project – September 2017 to May 2019
- Construction of proposed project – May 2019 to December 2021

[1] The phasing of the construction of the proposed project is to be determined by the Construction Manager at-Risk to be selected by the SWSC in Q4 of 2018.

# 5.2 Stormwater Management Accomplishments

## 5.2.1 Downspout Disconnections

Though not typically a significant component of the SWSC's capital projects, the 2009-2012 Phase I Connecticut River CSO Control Project included a component of downspout disconnections that helped to reduce private property inflow into the collection system. Ninety-eight downspouts at 34 separate properties were disconnected from the collection system to support in the reduction of private property inflow.

## 5.2.2 Private Development and Redevelopment

The SWSC has standards for a stormwater infiltration and discharge hierarchy in areas where the stormwater runoff needs are serviced by only the combined sewer system. Permit applicants must first consider feasibility of onsite infiltration or off-site discharge to storm-only systems prior to off-site discharge to the combined sewer system.

# Section 6 Review and Modification to Pretreatment Requirements

To control the source of pollutants from industrial dischargers, the SWSC administers and Industrial Pretreatment Program (IPP) as outlined in the 1997 NMC Report. This program sets regulations for sewer use and pretreatment permits, and conducts inspections of IPP permitted institutions, and issues a separate IPP Annual Report.

The IPP conducts audits, compliance monitoring inspections, and demand monitoring inspections. The purpose of the audit and inspections is to collect and confirm information concerning an industrial user and its regulated processes and to evaluate the industry's compliance with applicable pretreatment standards and regulations. The IPP is primarily concerned with identifying the wastewater pollutant pathways through the industrial user, evaluating the effectiveness of the pretreatment and/or monitoring systems and verifying that residue associated with the removal of wastewater pollutants is disposed of properly.

The EPA granted approval of local limits in an April 26, 2001 letter. The SWSC approved these local limits on June 13, 2001 and they were subsequently incorporated into the SWSC's Rules and Regulations.

The IPP actively and aggressively enforced the pretreatment regulations in 2017. The program inspected all 50 SIUs at least twice during the program year. Of the 273 inspections conducted by the IPP, 99% were conducted at the 50 SIUs. Only 13% of the permitted outfalls of the SIUs received a Notice of Violation or greater in 2017.

The SWSC invested in new IPP management software in 2017 and implementation is schedule for mid-2018. Additionally, upon issuance of the new NPDES permit in 2018, local limits will be re-evaluated.

The SWSC is committed to continuing its present level of support to the IPP through adequate funding and continued training of IPP staff. All Program Inspectors have also been certified and trained in cross connection control and water distribution operation. At a minimum the Program Inspectors are also required to pass a Grade 2 Wastewater Operators exam.

# Section 7 Maximize Flow to the POTW

Maximizing flow to the SRWTF, as well as maximizing the use of storage, are both part of the overall integrated system operations strategy. The method by which these elements of the NMCs are implemented must be viewed in the context of the overall CSO system operating strategy that achieves multiple prioritized objectives.

## 7.1 CSO Operating Objectives

The SWSC operates the SRWTF based on certain objectives based on risk to human health and the environment. Objectives for the collection system, CSO control, and wastewater treatment can often conflict. Operations staff have clear direction to determine what is most important when conflicts do arise.

Protection of the treatment process is the highest priority, followed by protecting the public from sewer exposure and then protecting the environment from CSOs. Protection of the treatment process is the first priority because the highest risk across the integrated system is the risk of damaging the treatment process. The CSO operating objectives are as follows:

1. Protect and maintain biological system and meet effluent discharge limits
    a. Maintain and/or limit flow through secondary treatment in wet weather
    b. Meet secondary effluent limits
2. Capture and convey all dry weather flow
    a. Treat all dry weather flow through primary and secondary system
3. Prevent releases to streets and basements (SSOs)
4. Capture and convey maximum volume of wet weather flow to treatment
    a. Optimize capacity and conveyance and storage systems
    b. Treat all CSO via primary treatment at a minimum
5. Treat as much CSO through secondary as possible
6. Minimize sedimentation / settling in inlet channels, dry wells, and the collection system (particularly the interceptors)
    a. Keep flows to the plant at a high rate to prevent sedimentation
7. Minimize odor problems via proper operations
    a. Direct dry weather sewerage away from neighborhoods and odor generating facilities
    b. Activate odor control facilities when pumping through neighborhoods

8. Minimize energy usage and pump costs
    a. Keep flows moving through the collection system at the highest elevation possible
    b. Pump at rates and times that reduce electric cost

# 7.1.1 Integrating Permit and Regulations via CSO Operating Strategy

The CSO operating strategy is the SWSC's most reliable method to achieve the SWSC's NPDES permit requirements, the Nine Minimum Controls, and operational elements of the CMOM Program. These regulatory requirements are addressed as follows:

**SRWTF NPDES Permit Requirements.**

1. Protect and maintain treatment systems performance – *Meet Permit Effluent Limits*
2. Capture and convey all dry weather flow to secondary treatment – *Meet Permit Technology Requirements*
3. Prevent sewage releases to streets or basements – *Prevent SSOs*

**EPA CSO Policy and Nine Minimum Controls.**

1. Capture and convey maximum wet weather flows (CSO) to treatment – *NMC#4*
2. Protect sensitive areas from overflows – *EPA CSO Policy*
3. Provide high quality treatment of wet weather flows – *EPA CSO Policy*

**CMOM Requirements and Asset Management.**

1. Minimize sedimentation / maintenance in assets – *CMOM*
2. Minimize odor problems – *CMOM*
3. Minimize energy usage and chemical costs – *Asset Management*

These objectives are implemented through decision making hierarchy that SRWTF Operators follow:

1. "What Flow Rate can the SRWTF Treat?"
    a. Determine the maximum flow the facility can accept without causing problems to the primary and secondary systems
2. "What flow rate can the downstream system convey?"
    a. Determine the maximum flow rate the CRI and MIS can receive without activating a CSO and worse, overflowing to streets or basements

# 7.2 High Flow Management Plan

The SWSC's contract plant operator, Suez, follows procedures outlined in the SWSC's High Flow Management Plan to maximize flows to the SRWTF during wet weather events. The facility has treated maximum flows of 180 MGD through the secondary treatment process. Strategies utilized include routine flushing of the 66-in diameter inlet channels during dry weather to control accumulation of sediments which can restrict hydraulic capacity. Procedures developed in 2006 for improved high flow management continue to be used in 2017. These procedures included strategies such as State Point Analysis to optimize operations of the secondary clarifiers, automatic blanket monitoring instruments and implementation of step feed process control to allow for the parking of solids in the aeration basins during high flow events to reduce solids loss during periods of peak hydraulic loading in the secondary clarifiers. In 2015 the facility lowered the operating Sludge Retention Time (SRT) from approximately 30 days to 19 days. This process change increased the hydraulic loading capacity of the secondary system. This change then resulted in reducing secondary bypasses from 19 in 2015 to 1 in 2016 and 1 in 2017.

High flow events that result in influent bypass are verbally reported within 24 hours and a written report is filed within 5 days pursuant to NPDES requirements.

# 7.3 Recent System Upgrades

Recent system upgrades that contribute to maximizing flows to the SRWTF include:

**Remotely Operated Gate Actuators.** Remotely operated gate actuators were installed on inlet gates for both the primary and secondary processes in 2008. Remote operation of these gates allows operators to maximize flows the SRWTF.

**Ludlow Interceptor and Indian Orchard Pump Station Improvements.** Parallel relief for the Ludlow Interceptor and pumping system upgrades at the Indian Orchard Pump Station were completed in May 2009 increasing the capacity from 34 MGD to 52.5 MGD. This increase in pumping capacity affects the total volume of wastewater conveyed to the SRWTF without impacting downstream CSOs.

**Electric Pumps at the York Street Pump Station.** One electric pump at the York Street Pump Station (YSPS) was completely reconditioned in 2008, increasing the capacity for this pump station. Measured improvement showed a 25% increase in pumping capacity for that pump when compared to output prior to the reconditioning. A second YSPS pump was completely reconditioned in 2011.

**York Street Pump Station Automated Bar Racks.** Automated bar racks were installed in the YSPS in December 2009. The upgrade allows for the removal of more material from the wastewater stream that could become obstructions to flow. A similar project was completed at the SRWTF bar screens to optimize flow at the headworks entering the SRWTF.

**Washburn Street Pump Station Inlet Increase.** The transition to the Washburn Street Pump Station was modified with a larger inlet that connected to a new 30-inch diameter influent pipe to the pump station. This influent was upsized from the previous 18-inch diameter pipe. The larger pipe has reduced problematic blockages and maintenance issues from the regulator structure to the wet well. Construction of these improvements were completed in 2008. The sanitary pumps were also rebuilt in 2017 and flow meters were added to monitor performance. Pump flow data was incorporated into the facilities SCADA system.

**CSO 007 and CSO 049 Flow Control Devices and Sewer Separation.** Construction of new CSO regulator structures with flow control devices and 15,000 linear feet of new sanitary sewers was completed in 2009. The project separated combined flows, in the CSO 007 and CSO 049 Sewershed and contributed to minimizing CSOs and maximizing flows to the SRWTF.

**CSO 008 In-system Storage Improvements.** In-system storage has been constructed and is on line in the CSO 008 Sewershed. This project included additional flow control devices to maximize in-system storage and flow to the SRWTF.

# Section 8 Elimination of Dry Weather Overflows; Control of Solids and Floatables; and Pollution Prevention Programs

## 8.1 Elimination of Dry Weather Overflows

In accordance with Part I.A.2.c of the NPDES Permit, the SWSC reports any dry weather CSO discharges within 24 hours and provides written follow up identifying locations, durations, estimated volumes and the results of investigations. Recent efforts to eliminate dry weather overflows include:

**Regulator Inspections.** Twice weekly inspections of the CSO regulators as required by the NPDES Permit and outlined in the 1997 NMC Report.

**Remote CSO Monitoring.** Using level sensors and telemetry to communicate with a central SCADA system at the SRWTF to reduce impacts from CSOs by decreasing response times by maintenance staff.

**Mill River Relief Project.** Completion of the Mill River Relief Project that increased in-system capacity upstream of the seven CSO that discharge to the Mill River. Installation of vortex valve throttling devices and a bending weir maximize in-system storage and protect against dry weather overflows.

**Washburn Street CSO 008 Project.** Completion of the Washburn Street CSO 008 Project replaced the existing regulator and helped facilitate the maintenance of dry weather flow to the existing sanitary sewer pumping station has assisted in eliminating dry weather overflows.

**Indian Orchard Pump Station and Chicopee River CSO Improvements Project.** Completion of this Project in May 2009 eliminated CSO Regulators 043 and 044, increased pumping capacity to the SRWTF by approximately 18.5 MGD and created approximately

100,000 gallons of emergency storage at the pump station for extreme wet weather events or during a potential pump station shutdown.

**Phase I Connecticut River CSO Control Project.** Completion of the construction of sewer and drain improvements upstream of CSO Regulators 007 and 049. These improvements will reduce CSO discharges at both regulators through targeted CSO separation, increased drain and sewer conveyance, and optimization of in-system storage

**Heavy Grit Removal from the CRI.** Heavy Grit Removal through a cleaning program of the CRI is completed annually. Since 2011 a total of 755 tons of grit have been removed from the CRI, including 87 tons in 2017.

**Pipeline Cleaning and CCTV Assessment.** Since 2009, over 76% of the SWSC's collection system pipeline assets have been cleaned of grit, roots, and grease.

Based on data available from remote monitoring systems and inspection of the CSO overflows, in CY 2017, there were no dry weather overflows.

# 8.2 Control of Solids and Floatables

The SWSC has completed a system-wide program for the installation of floatable control baffles. Additional cleaning that has been mentioned in other sections of this Report has also eliminated solids from the collection system.

# 8.3 Pollution Prevention Programs

City of Springfield and SWSC ordinances pertaining to pollution prevention programs remain as detailed in the 1997 NMC Report.

The City of Springfield conducts various programs which contribute to minimization of materials entering the CSOs including the following:

- Erosion control measures
- Street cleaning
- Catch basin cleaning
- Household hazardous waste programs
- Recycling programs

# Section 9 Update of the Public Notification Program

The goals of the CSO notification program are to:

- Make the public aware that the SWSC has a combined sewer system that can overflow
- Explain what a CSO is and how it impacts water quality and can threaten public health
- Inform the public when a CSO has occurred and warn against contact with the receiving waters
- Raise public awareness of the benefits to the community of the SWSC's investment in CSO control.

**Signage.** In accordance with the NPDES Permit, the SWSC maintains identification signs at CSO locations identifying each location as "*Springfield Water and Sewer Commission Wet Weather Sewage Discharge Outfall (No.)*". Replacement signs were designed in 2012 and installed in 2014. Pursuant to the SWSC's NPDES Permit, the SWSC annually reviews and places additional signage when beneficial for public notification.

**Website.** The SWSC's website at http://www.waterandsewer.org/ includes a section titled "*What are Combined Sewer Overflows (CSOs)?*" This page defines CSOs, identifies CSO locations and corresponding impacted waters, and describes activities that have been completed as well as proposed activities to reduce or eliminate CSOs. The website also provides updates to locations of projects and maintenance activities.

**Citizen Council Meetings.** The SWSC routinely attends various monthly citizen council meetings to ensure the public is informed of the status of CSOs in Springfield and on the Connecticut River and to provide updates on CSO related projects. In addition, the SWSC holds specific project related community meetings as required to solicit input from ratepayers and the public in active project areas.

**Annual Report.** The SWSC publishes an Annual Report for each fiscal year. The Annual Report contains sections that detail sewer collection systems including CSOs. Maintenance and capital improvements projects on the CSO systems are discussed, and the SWSC's annual budget is detailed to include capital expenditures and maintenance activities.

**Scholastic Outreach.** The SRWTF conducts a scholastic outreach program by hosting classes at the facility to explain various aspects of water and wastewater collection and treatment including the importance of pollution prevention. *The World is Our Classroom* is a teaching program dedicated to raising achievement levels of the City's 5th grade students to meet the science and technology goals of the Massachusetts Curriculum Framework and the Comprehensive Assessment System (MCAS) tests.  A decision was made to create a “classroom within a company” at the Bondi’s Island water treatment facility.  This shapes a realistic environment where it is possible to teach about the science of water and technology of the wastewater treatment process.  In turn, it inspires student interest and equips teachers to teach in an authentic environment.  This goal sharpens the skills of analysis, creative thinking, identification of components and relationships, and interpretation of data.  The program blends inquiry, problem solving, real-world learning experiences, project-based learning and group decision making.  In 2017, 1,587 students and 168 teachers attended the program.  Since this program began in 2003, approximately 30,200 students have participated.

# Section 10 Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls

## 10.1 Connecticut River Water Quality Sampling and Model

In 2001 and 2002 the SWSC, in conjunction with the City of Holyoke, the City of Chicopee, and the Pioneer Valley Planning Commission developed and performed a Connecticut River Water Quality Sampling Program that gathered water quality sampling data at 12 select locations in receiving waters tributary to the Connecticut River or in the River itself. The program included both dry and wet weather sampling to determine fecal coliform and E. coli bacteria counts in the Connecticut River, Chicopee River, Mill River and the Westfield River. The intent of this program was to generate data that would be used initially to model and analyze baseline conditions in the receiving waters. These baseline conditions would then be used to measure the efficacy of potential control strategies for the SWSC's CSOs.

Water quality modeling was performed after the sampling program and subsequent discussions with the EPA and MADEP. Modeling included 3-month and 1-year baseline condition simulations and subsequent evaluation of the impact of Phase I CSO improvements. The analysis and report were completed in 2005. The SWSC initiated a program to update the model in 2011 as part of the development of the CSO LTCP. That work was completed in 2012 and helped inform the findings and recommended plan presented in the SWSC's CSO LTCP and the IWP. The SWSC maintains the Water Quality Model to support sound decision making for future CSO projects.

# 10.2 Permanent CSO Monitoring Program

Section 2 of this Report further details the review undertaken and summarizes the findings of the comparison of the CY 2017 annual rainfall and CSO flow meter data review against the 1976 typical year series currently being applied to the hydraulic model for CSO predictive analysis.

Section 2 incorporates the findings from an initial rainfall analysis of the four local rain gauges sited in the Springfield catchment and the recordings from the Bradley Airport Weather Station, during the entire CY 2017. The rainfall focused sections consider a breakdown of the annual rainfall recordings at all five gauges and how when applying some standard categorization they compare to the Springfield 1976 typical year.

Included in Section 2 are comparisons between the readings from the Springfield CSO overflow meters with the predicted results from when the sewer system hydraulic and hydrologic model is simulated using CY 2017 rainfall.

# Section 11 System Reinvestment and Risk Reduction

## 11.1 Expenditures for CSO, Collection System, and Treatment Systems

The SWSC implements a significant portfolio of maintenance projects for both the collection system (pipes and pump stations) and the treatment systems. Even now, at the peak of the CSO program's capital expenditures, when the Connecticut River Crossing and YSPS Project dominates most of the upcoming capital budget, the SWSC still invests in maintenance of non-CSO systems to ensure that public health and the environment are protected and regulatory requirements are met.

The SWSC's *Three Year Capital Improvement Program For Fiscal Years 2018-2020 Including One Year Capital Program Budget For Fiscal Year 2018* can both be found in Appendix C.

Generally, FY 2017 expenditures can be broken down as follows:

*Table 11-1 Breakdown of FY 2017 Capital Expenditures*

| Capital Expenditure Category | Amount |
|---|---|
| Wastewater Treatment Facility | $ 1,426,400 |
| Pump Stations | $ 0 |
| Wastewater Collection Improvements | $ 15,390,000 |
| CSOs | $ 1,456,480 |
| Total | $ 18,272,880 |

*Suez is responsible for funding and executing the maintenance of the pump station infrastructure within the SWSC wastewater collection system until the completion of their 20 year contract with the SWSC in 2020.

A majority of capital funding for FY 2017 was expended on wastewater collection system improvements which predominantly focused on the MIS project. $1,456,480 was spent during FY 2017 on CSO Reduction with the start of the final design of the Connecticut River Crossing and York Street Pump Station Improvements. Additional money will be spent on CSO Reduction during the continuation of final design and subsequent construction phases.

The SWSC's *Wastewater Operating Budget for the Year Ending 6/30/2018* can be found in Appendix D.

Generally, expenditures can be broken down as follows:

*Table 11-2 Breakdown of Wastewater Operating Budget for Year Ending 6/30/2018*

| Operations Expenditure Category | Amount |
|---|---|
| FOG and WW Administration | $56,800 |
| IOPS | $1,312,769 |
| Flood Control | $33,301 |
| Other Pump Stations | $638,197 |
| Operations Management WW | $127,570 |
| Sewer Collection Services | $14,982,461 |
| Treatment Plant Administration | $15,399,739 |
| IPP Administration | $281,760 |
| Total | $32,550,837 |

# 11.2 Risk Reduction Through Capital Improvement Projects

The SWSC uses an asset management framework to prioritize investments in projects that reduce the risk of failing to deliver wastewater collection and conveyance services. In the collection system, there are two dominant modes of failure: operations failure and structural failure. Both types of failures can result in sewage releases to basements, streets, or to surface waters. In addition, the structural failure mode can cause sinkholes, thereby increasing the potential consequences to public health and safety.

The SWSC's risk-based decision process focuses on cost-effective risk reduction projects. It is not sufficient to merely invest in improving high-risk assets; rather, it is necessary to invest in projects that reduce the risk of exposure of those assets to the degree that the risk reduction is greater than the project costs.

Most of the operational risk reduction is performed through proactive root identification and treatment projects; proactive FOG identification, enforcement, and aggressive cleaning; and grit removal through the SWSC's yearly Pipeline Cleaning and CCTV Assessment Program. The operational failure risk reduction program elements help eliminate risk associated with reduced capacity.

For the past several years, the SWSC has executed, through its design consultants and contractors, yearly, non-CSO related capital projects to address structural defects found during the SWSC's yearly Pipeline Cleaning and CCTV Assessment Project. In 2017 a total of $3,400,000 was expended on these projects. In addition to these larger-scale Projects, the SWSC's crews routinely and proactively address pipelines in need of isolated cleaning and emergency repairs.

*Figure 11-1 Sewer Pipe Replacement on Quincy Street for CIP Project*

# 11.3 Pipeline Infrastructure Improvements Recommendations Methodology

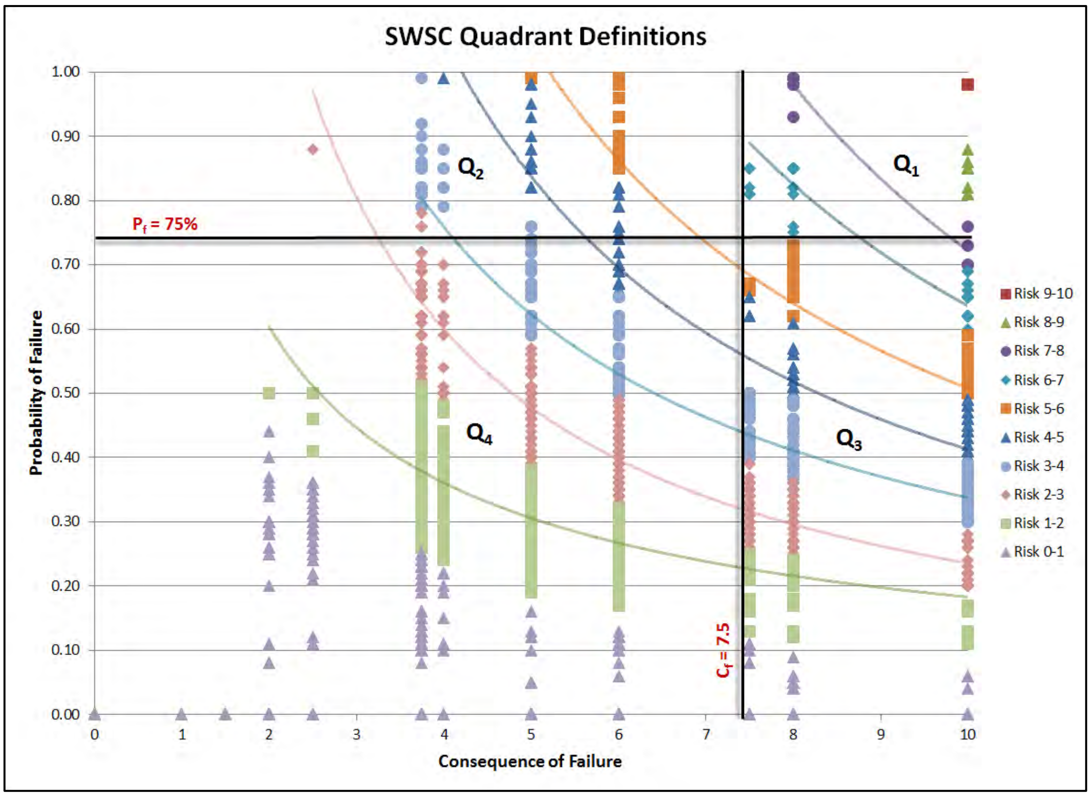
The following is a summary of the methods used to create the Prioritized Infrastructure Improvements Recommendations (PIIR) list that is provided in Appendix A. The purpose of the program is to provide recommendations for prioritization of areas with high probabilities of failure, regardless of the level of consequence associated with that failure that can be undertaken under the current FY budget.

**Prioritization Methodology**
*Risk Quadrants* – An assets risk is defined as the product of its probability of failure and the consequences of such failure.

$$R = P_f \times C_f$$

Each asset within the SWSC system has its own individual Risk Factor (RF) that falls within the range of 0 - 10. By plotting the Probability of Failure (Pf) versus the Consequence of Failure (Cf) that define each assets risk score, it becomes evident that there may be qualitative differences between two assets that have the same risk score.

*Figure 11-2 SWSC Quadrant Definitions*




As can be seen in Figure 11-2, an assets risk score can be grouped into quadrants on the Pf vs. Cf graph:

- Quadrant 1 – The Risky Quadrant – Assets with both a high probability of failure as well as a high consequence of failure. This quadrant contains the most critical assets in the worst condition.

- Quadrant 2 – The Failing Assets Quadrant – Assets with a high probability of failure, but a lower consequence of failure. These assets are typically less critical to day-to-day operations, but are either in major disrepair or are already failing to meet their design intent.
- Quadrant 3 – The Monitoring Quadrant – Assets with higher consequences of failure, but lower probabilities of failure. It is typical to conduct further monitoring and assessment of assets in this quadrant to prevent them from moving up into the “Risky” quadrant.
- Quadrant 4 – The Base Quadrant – Assets with low probability of failure and low consequence of failure. These assets are less critical to the overall system performance, and as such can be put on a more longer-term assessment program to monitor their movement toward the “Failing Assets” quadrant.

To focus the recommendations for improvements, all pipe assets within the SWSC system have been categorized using these quadrant definitions. Once categorized, pipes that fell within either the Risky Quadrant or the Failing Asset quadrant were further analyzed and grouped into the following categories:

1. Candidates for consideration for FY 2017 Infrastructure Improvements. This group includes the following sub-groups:
    a. Pipes that can be grouped with other similar pipes into a defined project
    b. Pipes that may require a form of point repair, including potential candidates for short sectional liners or small dig and replace segments.
    c. Pipes that require maintenance to repair either severe root issues or intruding taps that caused abandonment of CCTV operations. The passage of the CCTV camera was selected as the basis for the selection to this list since defects that prevent the passage of the camera could cause a capacity issue that may lead to an SSO.
2. Candidates for consideration for larger, more complex improvements.
3. Candidates for further ongoing diagnostics and assessment.
4. Assets that will no longer be considered for FY 2017 improvements.

*Initial Project Development* – Using the SWSC Geographical Information Systems (GIS) data as well as the geometric network, projects were defined based on geographical, attribute and systematic similarities. In general, the initial project definitions consisted of a grouping of 1,000 to 2,000 linear feet of pipeline that have similar attribute (pipe size, material, age), systematic (local collector, trunk, overflow) and geographical characteristics. In addition, where available, projects were also grouped to consider pipeline assets of similar conditions based on the data obtained during the ongoing system assessment program that SWSC consultants are managing on behalf of the SWSC.

*Project Analysis/Prioritization* –
To prioritize the list of projects, a weighted average project risk factor (PRF) and a weighted average project criticality factor (PCF) were created based on asset length and calculated to summarize the risk and criticality associated with each project as follows:

$$\mathrm{PRF_p} = \frac{\Sigma\{(RiskFactor_1 * \mathrm{Length_1}), \ldots (\mathrm{RF_n} * \mathrm{L_n})\}}{\Sigma(\mathrm{L_1}, \ldots \mathrm{L_n})}$$

$$\mathrm{PCF_p} = \frac{\Sigma\{(CriticalityFactor_1 * \mathrm{Length_1}), \ldots (\mathrm{CF_n} * \mathrm{L_n})\}}{\Sigma(\mathrm{L_1}, \ldots \mathrm{L_n})}$$

The projects were primary sorted from highest to lowest PRF and then secondary sorted from highest to lowest PCF.

A project analysis was then conducted to determine the final ranking each project would receive on the final PIIR list. This analysis was used to calibrate the recommendations by determining a prioritization score, which allowed for a better understanding of why each project had risen to the top of the list. The analysis took into consideration the weighted categories of PRF, PCF, the predominant defect type, potential customer impact of failure, maximum project depth, traffic impacts and utility conflicts. Table 11-3 below demonstrates the criteria that was used to determine a rank from 1 to 5 for each of the 7 categories. A prioritization score was then developed for each project by multiplying the criteria factor for each category by its associated weight and summing all of the resulting values. The project list was primary sorted by largest to smallest prioritization score, secondary sorted by largest to smallest PRF and tertiary sorted by largest to smallest PCF to develop the final rankings.

To determine which projects were on roadways that were eligible to be excavated under the moratorium regulations of the City of Springfield, historical roadway resurfacing databases were analyzed and incorporated into the project list. This was reflected in the project list by including the year the roadways in each project were last paved, the number of years since it was paved, and the year it is eligible for excavation. A list of scheduled CY 2018 roadway resurfacing projects in Springfield was also examined to identify overlapping PIIR projects to be completed before the resurfacing project got underway.

The final steps to finalize the project list was verification of the recommendations for each of the projects and then utilizing them to create preliminary project cost estimates. The videos and reports from the inspections of the pipes associated with each project were reviewed and final recommendations were developed. These recommendations were then translated into preliminary cost estimates utilizing pricing from the completed projects associated with the FY2013 – FY2017 PIIR.

The table in appendix A is the cumulative list of recommended projects for the FY2017 PIIR. Projects in rows that are colored grey and have text with red strikethroughs have been completed in previous fiscal years. Projects in rows that are colored orange are the FY2017 projects that are new to the cumulative list. The projects in rows that are colored grey, white, green and blue are the existing projects added in FY2013, FY2014, FY2015, FY2016 respectively. The order the active projects on the list are ranked, represent the initial recommendations of how they should be prioritized. However, moratorium restrictions, completion of a PIIR project before the start of a road resurfacing project, utilizing the resources within the SWSC opposed to a subcontractor and other factors can potentially change the order in which they are addressed

*Table 11-3 Prioritization Criteria Rankings for Prioritization Score*

| Prioritization Criteria Rankings | | | | | | |
|---|---|---|---|---|---|---|
| **Criteria** | **Category Weight** | **5** | **4** | **3** | **2** | **1** |
| **Project Risk Factor (PRF)** | 4 | PRF ≥ 8 | 8 > PRF ≥ 6 | 6 > PRF ≥ 4 | 4 > PRF ≥ 2 | PRF < 2 |
| **Project Criticality Factor (PCF)** | 4 | PQF ≥ 8 | 8 > PQF ≥ 6 | 6 > PQF ≥ 4 | 4 > PQF ≥ 2 | PQF < 2 |
| **Predominant Defect Type** | 3 | Collapse or Missing Wall/Hole causing Abandoned Survey | Hinge Fractures/Holes /Missing Wall Defects | Surface Aggregate Missing/Visible or Significant Infiltration | Longitudinal or Circumferential Fractures | Longitudinal or Circumferential Cracks |
| **Potential Customer Impact of Failure** | 3 | 100+ | 75 - 99 | 74 - 50 | 49 - 25 | 0 - 25, N/A |
| **Maximum Project Depth** | 1 | > 15 feet | 10 - 15 feet | 6 -10 feet | < 6 feet | |
| **Traffic Impact** | 1 | High | | Medium | | Low |
| **Utility Conflict** | 1 | Other Utility in same street is > 24" | Other Utility in same street is 18"- 24" | Other Utility in same street is 15"- 18" | Other Utility in same street is 12"- 15" | Other Utility in same street is < 12" |
| **Sink Hole** | 2 | Two or more sink holes reported in project area | | One sink hole reported in project area | | Zero sink holes reported in project area |