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September 27, 2024

VIA EMAIL (crystal.henwood@novascotia.ca)

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Nova Scotia Utility and Review Board
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RE: Halifax Water 2024 Annual September Report

In accordance with direction from the Nova Scotia Utility and Review Board (Board), Halifax Water submits the attached 2024 Annual September Report.

The attached filing contains the Executive Summary of the 2023 WWMP Annual report, the full report will be made available by October 18, 2024.

Please contact me if you have any questions.

Respectfully submitted,

Signed by:
Kenda MacKenzie
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Kenda MacKenzie, P.Eng.
Acting General Manager/CEO

HALIFAX WATER SEPTEMBER REPORTING

to the Nova Scotia Utility and Review Board

September 27, 2024

Contents

1. Introduction

The Nova Scotia Utility and Review Board (NSUARB or Board) has directed Halifax Water to submit reports to the NSUARB on an annual basis in relation to various programs and assets at various times.

In late spring 2021, Halifax Water requested direction from the Board regarding these reports, given they overlapped in both timing and subject matter. In July 2021 in matter M10139, the NSUARB approved a revised annual reporting schedule consolidating various Halifax Water annual reporting requirements.

1.1. Origin of Reporting Requirements

This report stems from requests and directions from the Board in various matters. This report addresses these various reporting requirements as follows:

- Part 2 – Asset Management Program, including stormwater management
- Part 3 – Wet Weather Management Program, including private I/I reduction efforts and wastewater system hydraulic modeling
- Part 4 – Regulatory compliance update, including impact of potential future regulations

2. Asset Management and Capital Planning

The Asset Management & Capital Planning Business Unit underwent a collective growth process during the 2023/24 reporting period. This occurrence can be directly attributed to the completion of the organizational realignment within the Engineering & Technology Services Department which became effective in April 2023. The realignment resulted in six (6) Business Units organized to support implementation of the Integrated Resource Plan (IRP) including:

- Asset Management & Capital Planning
- Infrastructure Planning
- Capital Project Delivery
- Energy Efficiency & Business Development
- Strategic Projects
- Information & Technology (I&T) Services

Subsequent to the Engineering Department realignment, the I&T Services team has moved to the Corporate Services Department.

Figure 1 outlines the organizational realignment outcomes specific to the three (3) functional areas within the Asset Management & Capital Planning Business Unit including, Asset Management, Data Engineering, and Regional Infrastructure Planning.

Figure 1: Asset Management & Capital Planning Business Unit - Functional Areas

One aspect of the annual September Filing to the Nova Scotia Utility and Review Board (NSUARB) focuses on Halifax Water's Asset Management program, and some activities carried out by the Data Engineering, and Regional Infrastructure Planning groups that are connected to the NSUARB order for M09494.

Within this context, relevant initiatives from all three (3) functional areas have been highlighted within this submission to demonstrate their complementary interconnectivity in association with recent realignment efforts.

Halifax Water appreciates the ongoing feedback and support offered by the Board Counsel Consultants (BCC) and looks forward to continued collaborations regarding the ongoing development of Asset Management & Capital Planning initiatives.

3. Asset Management Program

Related to the 2023 September Report submission, in the 21 February 2024 decision for M11355, the NSUARB (the Board) identified several key findings for consideration by Halifax Water as the Asset Management program matures. These considerations include:

- Asset management readiness and roadmap implementation progress (Section 3.1).
    - Annual update on condition assessment program (Section 3.1.2.1.).
    - Closed circuit television (CCTV) program update (Section 3.1.2.2.).
    - Discussion on deterioration curves (Section 3.1.3.2.1.).

The annual report also provides updates related to the bi-annual Policy updates (Section 3.1.1.), annual AM (Asset Management) statistics (Section 3.1.3.2.) as well as a summary of program successes and upcoming priorities (Section 3.1.4.). This submission has been drafted in alignment with current asset management readiness and roadmap implementation progress to further clarify the direction of program planning.

3.1. Asset Management Readiness and Roadmap Implementation

Halifax Water's 2021 Asset Management Roadmap was provided as part of the review of the 2022/23 annual filing. The Asset Management Roadmap evaluated Halifax Water's progress across five major Asset Management Readiness Scale (AMRS) elements or competencies (shown below). The AMRS outcome areas for each element are assessed and graded based on the level of achievement of Halifax Water's current Asset Management Program on a 1 to 5 scale, where level 1 indicates a low level of achievement and 5 a high level of achievement.

This year's update demonstrates a positive evolution in the utility's asset management maturation, exceeding expectations set in the 2022/23 annual filing, as outlined in Table 1.

Table 1: Halifax Water's Asset Management Readiness (2023/24)

AMRS Element	AM Strategy			Updated State (2023/24)
	Current State (2020)	Target State (2024/25)	Target State (2026/27)	
Policy and Governance	1	3	3	**3**
People and Leadership	1	2	4	**4**
Data and Information	1	3	3	**3**
Planning and Decision Making	2	3	3	**3**
Contributions to AM Practice	1	2	3	**4**

Areas of strong continuous improvement have occurred in all categories, most notably in association with *People and Leadership* as well as *Contributions to AM Practice* elements. These improvements can be directly attributed to the realignment efforts described in the Asset Management and Capital Planning (Section 2).

In addition, the three (3) resources identified for the Asset Management team in the initial hiring cohort of 2023/24 were acquired (i.e., Manager of Asset Management, Asset Management Engineer, and Engineering Technologist) and Asset Management Implementation Team (AMIT) initiatives were refreshed (i.e., including focused stakeholder re-engagement efforts as well as subsequent Terms of Reference updates etc.). The Asset Management team also actively participates with various asset management communities of practices including, but not limited to, the PEMAC Asset Management Association of Canada (PEMAC) as well as the Canadian Network of Asset Managers (CNAM).

Based on an in-depth review of the AM Roadmap, implementation activities (designated for 2023/24) have been updated based on the evolving asset management maturation within the utility, as outlined in Table 2.

Table 2: Progress on Key Asset Management Roadmap Initiatives Designated for 2023/24 (shown in italics)

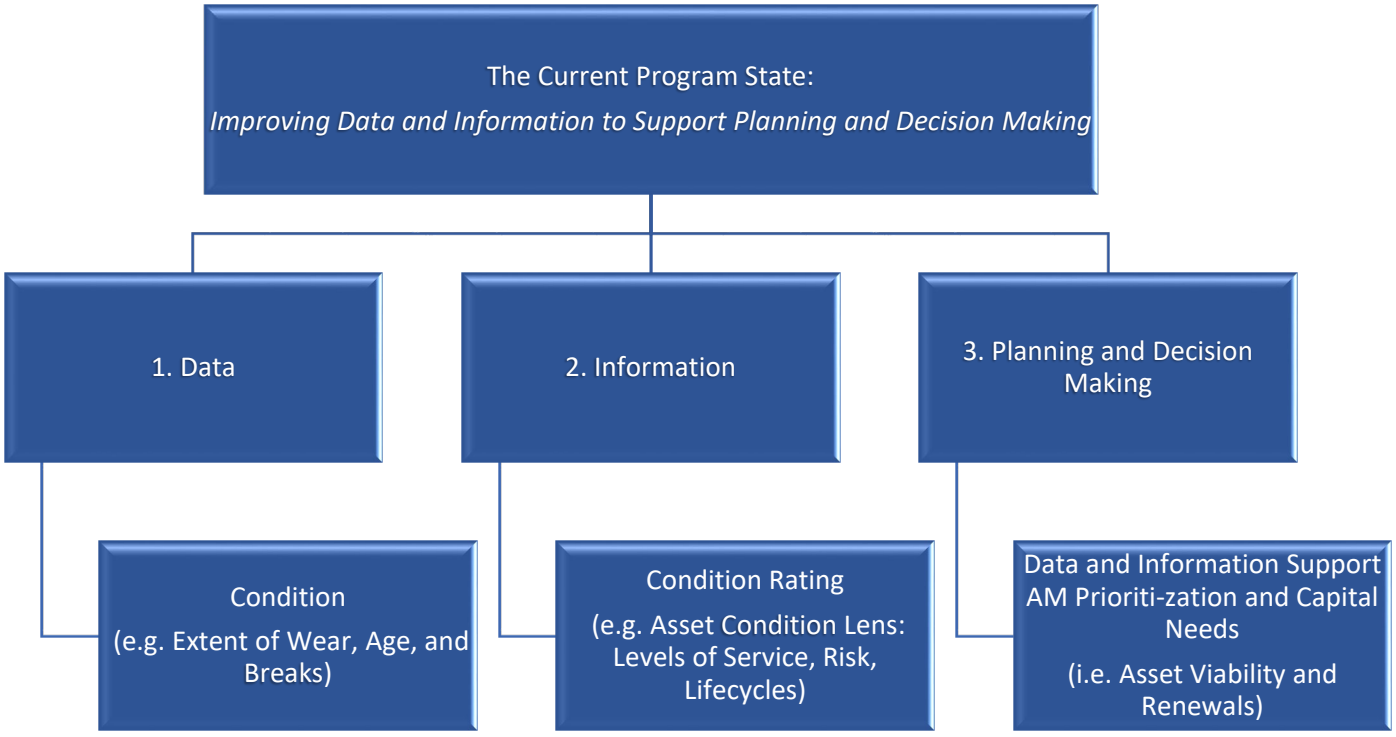
Element	AM Activity	Progress Summary
Policy and Governance	AM Policy Update (1a,b,c)	Approved by Halifax Water Board – September 2022. *Updated for Halifax Water Board – September 2024.*
	SAMP (9a,b)	Asset Management Strategy November 2023.
	AM Program Review Process (5a)	Completed with creation of Infrastructure Planning Committee – December 2021. *Ongoing, currently under review.*
People and Leadership	AM Program Resource Plan (0b)	Ongoing – to be informed by the 2024 Institutional Capacity Assessment recommendations.
	AM Advisory Committee (3a)	Formed in December 2021 as the Infrastructure Planning Committee. .
	AM Leadership Support (3b)	Completed with creation of Infrastructure Planning Committee – December 2021.
	Halifax Water Board Communications (2a)	*Annual updates as elements of the AM Roadmap are completed.*
	AM Enterprise Change Management Program (6a)	*Ongoing program, no anticipated end date.*
	AM Cultural Change Management Program (7a)	*Ongoing program, no anticipated end date.*
	AM Workforce Management Program Planning (11 a,b)	Ongoing program. *Manager of Asset Management, Asset Management Engineer, and Asset Management Engineering Technologist acquired in 2023/24.*
	AMIT R&Rs (11c)	*AMIT review and refresh initiated in 2023/24.*
Data and Information	Data Improvement Program (n/a)	*Ongoing program, no anticipated end date.*
	Critical Assets ID (8a)	*Currently in progress.*
	LOS (levels of service) Framework (10a,b)	*Initiated (Condition lens).*
	Condition Assessment Program (8b)	*Currently in progress.*
	Critical Assets Lifecycle Reqs (12a)	*Initiated (Condition lens).*
	LOS Monitoring and Reporting Program (13a)	*Initiated (Condition lens).*
	Lifecycle Costing (14a)	*Initiated (Condition lens).*
Planning and Decision-Making	Initial Project Prioritization (4a,b)	Initially completed and published as the Enhanced Prioritization Methodology (EPM) in May 2021. *Subsequent prioritization in association with Masterworks Capital Planning module implementation.*
	Annual AMP Update (n/a)	*Updated annually for AM statistics (e.g., inventory, valuation, condition information, long-term reinvestment projection).*
	Halifax Water Board AM Training (2b)	*Available at the discretion of the Board.*

Element	AM Activity	Progress Summary
Contribution to AM Practice	HW AM Staff Training Program (7b)	Initial training provided. *On-demand training available.*

As the current state of the Asset Management Program is centered on improving condition data and information to support planning and decision making across the utility (as shown in Figure 2), in addition to providing a *Policy and Governance* update (i.e. bi-annual policy update), *Data and Information* as well as *Planning and Decision Making* are key roadmap elements of focus for this submission.

Subsequent program phases are planned to transition, in alignment with the AM Roadmap, towards a focus on continuous improvement related to capital and operational expenditure integration, enhanced project prioritization, refined decision support scenarios, as well as the development of enhanced staff training and onboarding opportunities.

Figure 2: The AM Program – Current State



3.1.1. Policy and Governance

This report submission coincides with formal (2-Year) review requirement for the Asset Management Policy, last reviewed/approved by the Halifax Regional Water Commission (HRWC) Board on September 22, 2022.

The intent of the Asset Management Policy is to demonstrate Halifax Water's commitment "to asset management as an integrated management system aimed at service delivery. As a result, the policy defines the scope of the asset management system in association with Halifax Water's mission, vision, and values as well as aligns with the following corporate polices, strategies, and plans:

- Five-Year Business Plan and the corporate vision, mission, and values;
- Annual Business Plan;
- Integrated Resource Plan (IRP);
- Enterprise Risk Management (ERM); and
- Asset management related HRWC Board guidance.

Pending subsequent guidance provided by the Halifax Water Board, there are currently no recommended updates for the Asset Management Policy. A copy of the Asset Management Policy can be referenced in Appendix A.

3.1.2. Data and Information

The current focus of the AM program to continuously improve/progress within this element is directly associated with supporting more effective asset management planning and decision-making across the utility.

3.1.2.1. Condition Assessment Program

Halifax Water completed its Asset Management Strategy in 2023 which provided an outline focused on long-term planning, risk management and continuous improvement. The report identified the development of a Condition Assessment Program as a high priority.

A Condition Assessment Framework was initiated in 2023/24, as a key requirement of the Condition Assessment Program. The associated project objectives include:

1. Reviewing the current state of the utility's condition assessment projects and available data (including current methods and processes for maintaining this information);

2. Identifying, evaluating, and recommending optimal condition assessment methods for the utility's core 14 asset classes (supporting ongoing progress related to both water and sewer pipe condition assessments);

3. Identifying opportunities and business process changes to embed the framework of the Condition Assessment Program into ongoing condition assessment, maintenance management activities and routine inspection work;

4. Identifying opportunities for growing the program and which priority areas to focus on (i.e. in alignment with critical asset identification outlined in Section 3.1.2.3); and

5. Identifying pilot project opportunities for prioritized areas.

The primary goals of this project are to support the establishment of a refined, sustainable framework for completing more detailed and consistent condition assessment work across the utility as well as to continuously improve the planning of asset renewals.

The Condition Assessment Framework will also integrate the updated wastewater treatment facility (WWTF) and water supply plant (WSP) system structure hierarchies (asset segmentations) used to define physical condition and preliminary performance criteria during the 2023/24 AM Statistics reporting period (provided in Appendix B). Currently, the maximum sub-system condition/performance rating recorded is applied at the facility level to support a conservative planning approach (i.e., to flag consideration of near-term renewal needs of each facility). This information is used to prioritize candidate capital reinvestment needs.

Halifax Water is also completing a condition assessment of 3.75 km of the Dunbrack transmission main. This is one of the key transmission mains that supply water for the Halifax Peninsula and has limited redundancy. This 900 mm (about 2.95 ft) diameter pre-stressed concrete cylinder pipe (PCCP) was installed in 1976-77 and experienced a recent failure in 2023. The condition assessment will be completed using vibroacoustic technology that does not require shutting down the transmission main or using equipment inside the pipe. This project represents a collaboration between the Water Operations and Asset Management teams that will help refine water pipe condition assessments. Associated outcomes will be incorporated into the overarching Condition Assessment Program.

As noted, associated roadmap items have either been initiated or are in progress to reflect the current condition assessment program focus (e.g., including asset levels of service and lifecycle factors etc.). This approach was incorporated to support ongoing, incremental roadmap progression based on current programming and to set a path for continued integration with associated Data Engineering and Regional Infrastructure Planning initiatives, moving forward (e.g., asset operational functionality as well as resiliency data and information etc.).

3.1.2.2. CCTV Program

Halifax Water has a corporate sewer inspection program involving CCTV inspection of mainline and lateral pipes and scanning inspections of manholes. The program follows the National Association of Sewer System Companies (NASSCO) pipeline assessment certification program (PACP). Similar assessment certification programs exist for manholes (MACP) and laterals (LACP).

Halifax Water's sewer inspection program is delivered partly with contracted resources and partly with in-house resources. Historically, the program has targeted a production rate of 60,000 metres annually. With the current contract, the service provider was encouraged to move Halifax Water to 100,000 metres annually in year two of the contract. The mid-year contract timing has historically affected production numbers relative to the fiscal year.

As of August 30, 2024, staff have created 309 projects in the 2024/25 master inspection log. In comparison, 311 projects were set up in 2023/24. To date, 55,069 metres of inspected sewers have been completed; there are 27,751 metres of planned CCTV lengths either in progress or awaiting sewer cleaning prior to inspection. These amounts are tracking to more than 82,820 metres of inspection for 2024/25. The quantity of completed projects has expanded when compared to 2022/23 filing (i.e., 55,069 metres verses 26,744 metres) and current projections are within 20% of meeting the 100,000-metre aspirational goal for 2024/25.

Several factors continue to influence production including availability of skilled resources (both contracted and internal staff), equipment availability, traffic control services constraints, need and availability of sewer cleaning resources, competing demands (resources reallocated to weather and environmental events and cleanup), and increased number of proactive inspection areas (typically in areas expected to have more defects and therefore influencing the time to collect, code, and quality control check the inspection information).

A scope of work for a Sewer Inspection Program Review project was developed in 2023/24 to work towards mitigating these factors by identifying opportunities for continuous improvement. The primary objectives of this project, initiated in Q1 of 2024/25, are focused on:

- Documenting the current state sewer inspection program business processes;
- Further identifying challenges as well as opportunities for program improvement; and
- Developing a go-forward plan to implement program improvements.

3.1.2.3. Critical Asset Identification

In alignment with the utility's AM Strategy (provided as part of the review of the 2022/23 annual filing), Halifax Water recognizes ongoing work to assess the criticality of assets is essential to understanding the potential consequences of asset failure. The development of a critical asset inventory is currently in progress that includes an emphasis on incorporating available background information and internal knowledge sharing (across the organization) to identify system vulnerabilities, critical points of failure, and data gaps for each asset class. This work is being conducted in alignment with the overarching Condition Assessment and Corporate Enterprise Risk Management (ERM) Programs.

3.1.3. Planning and Decision Making

The current focus of the AM program to continuously progress within this element is directly associated with supporting the standardization of how the utility sets asset management priorities and conducts capital planning. Additional opportunities for continuous improvement are expected to include ongoing alignment with AM Roadmap initiative progression.

3.1.3.1. Update of CCTV Prioritization Model

The CCTV prioritization model calculates and assigns a risk score to each collection pipe in the Halifax Water geographic information system (GIS) database. To support the planning of the proactive CCTV program, the risk scoring is summarized and grouped into geographic areas that are ranked so that they can be bundled as projects for the CCTV contractor. In the original CCTV Prioritization model the grouping was based on the flow monitoring zones used in the corporate flow monitoring program. Using the flow monitoring zones as groupings for grouping pipes for proactive CCTV investigations had some drawbacks:

- Some of the flow monitoring zones are quite large spatially.
- Some of the zones overlap with each other if there is overlap in the source of flow for the corresponding monitor.
- The flow monitoring zones do not provide 100% coverage of pipes in the collection system. Particularly close to the harbour where no suitable locations could be found (hydraulically poor, safety for entry, etc.)

In Q1 2024, Halifax Water began developing a new GIS feature dataset of 'Small Geographic Units' (SGU) for use in several initiatives. The concept is similar to traffic survey zones used for HALIFAX traffic planning but with boundaries reflecting Halifax Water's infrastructure. One of the objectives of the SGU's is to be used for grouping CCTV risk rankings to replace the current practice of using flow monitoring zones. Halifax Water is currently reviewing a final draft of the SGU's and making modifications to the CCTV prioritization tool to use the new SGU features.

The CCTV prioritization tool was originally programmed using the T-SQL programming language so that it can be run directly within a SQL database. With experience using the tool in this configuration, Halifax Water has experienced some challenges conducting the loading required to stage the base data due to some cyber security restrictions on how we can access the GIS databases. Additionally, Halifax Water does not have full time staff with sufficient experience in T-SQL to effectively maintain the code. For these reasons, Halifax Water is porting the codebase to work in Python. Our current ESRI GIS tools have extensive support for the Python programming language. Therefore, there are already tools to support the data pre-processing requirements to calculate the prioritization ratings. There are also staff in both the Halifax Water GIS department and Asset Management with experience in Python programming making it easier for Halifax Water to maintain and update the tool. Python will also be more flexible to adjustments for the input data making it easier for Halifax Water to evaluate the impact of different assumptions on the base data.

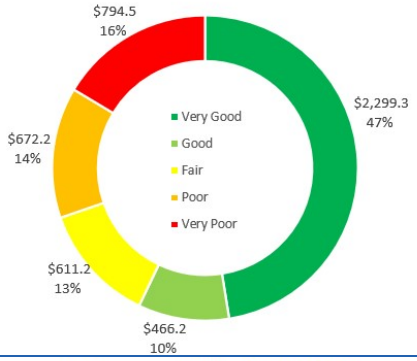
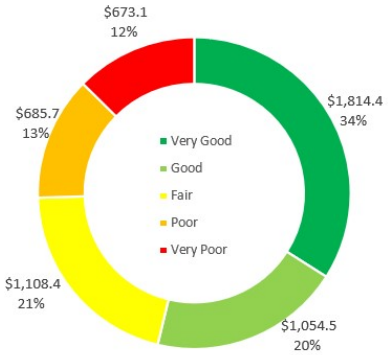
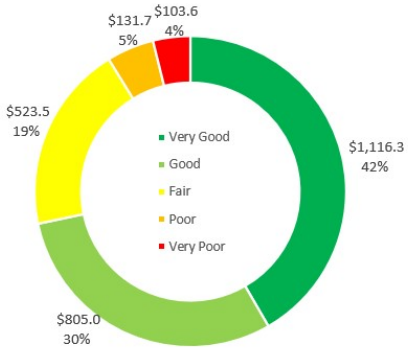
Halifax Water is currently working on the conversion of the prioritization tool from T-SQL to Python with anticipated completion in Q3 2024.

3.1.3.2. Asset Management Statistics and Capital Planning

Halifax Water's assets enable the utility to deliver water, wastewater, and stormwater services to the customers of HALIFAX. Halifax Water compiles statistics annually about its assets to present a state of good repair report on the inventory, replacement value, condition profile, and the anticipated asset renewal needs over thirty years. Historically, the statistical summary has formed part of the annual Asset Management Plan (AMP). Similar to the previous filing in 2023, staff continues to provide the annual statistics summary, however, a more detailed AMP is expected to be updated on a 5-year cycle consistent with Halifax Water's long-term infrastructure program. Specifically, the next AMP will be part of the upcoming IRP.

The AM statistics cover fourteen (14) asset classes: Water – supply plants, supply dams, structures, transmission mains, distribution mains, and reservoirs; Wastewater – treatment facilities, structures, gravity sewers, and forcemains; and Stormwater – management structures, gravity sewers, cross culverts, and driveway culverts and ditches. Table 3 shows the summary of the 2023/24 statistics.

Table 3: 2023/24 Asset Management Statistics Summary

System	Inventory	Condition & Valuation
	• 1,593 KM of water mains (transmission and distribution) • 8 supply plants • 6 water supply dams • 20 booster stations • 145 chambers • 17 reservoirs	Replacement Value $4,843.4 M 
	• 1,447 KM of wastewater sewers (gravity and forcemain) • 14 treatment facilities • 1 biosolids processing facility • 166 pumping stations • 5 wastewater holding tanks	Replacement Value $5,336.1 M 
	• 896 KM of stormwater sewers • 2,802 cross culverts • 17,661 driveway culverts (estimated) • 505 KM of ditches (estimated) • 43 stormwater management structures	Replacement Value $2,680.1 M 

Key updates reflected in the 2023/24 annual AM statistics include:

1. Updated deterioration curve formulas (further explored in Asset Deterioration Models, Section 3.1.3.2.1)

2. Updated WWTF/WSP system structure hierarchies (asset segmentations) used to define physical condition and preliminary performance criteria (outlined within Condition Assessment Program, Section 3.1.2.1).

3. Continued incorporation of asset condition data from CCTV inspections.

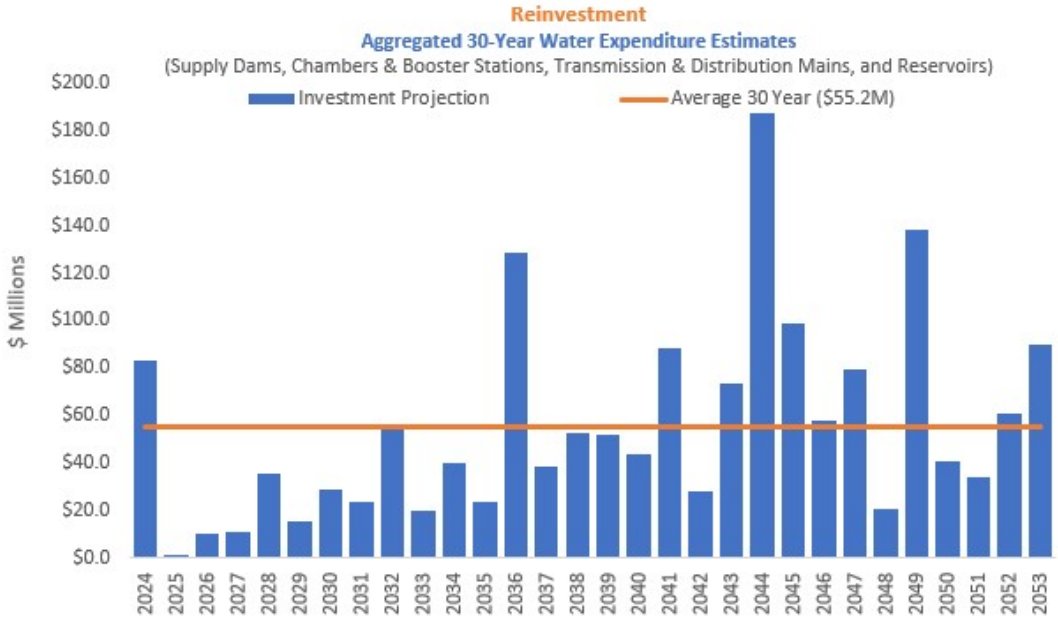
4. Updated cost estimates for projects nearing construction phase.

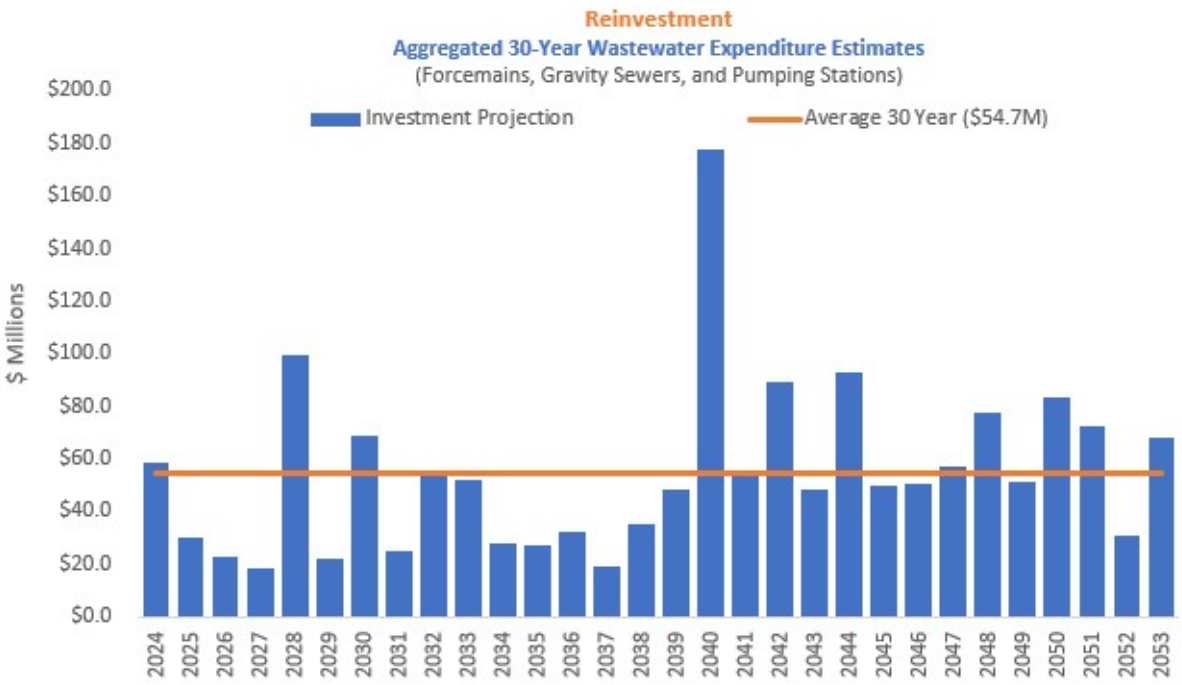
5. Application of the current Halifax Statistics Canada Building Construction Price Index for non-residential buildings (4.48%).

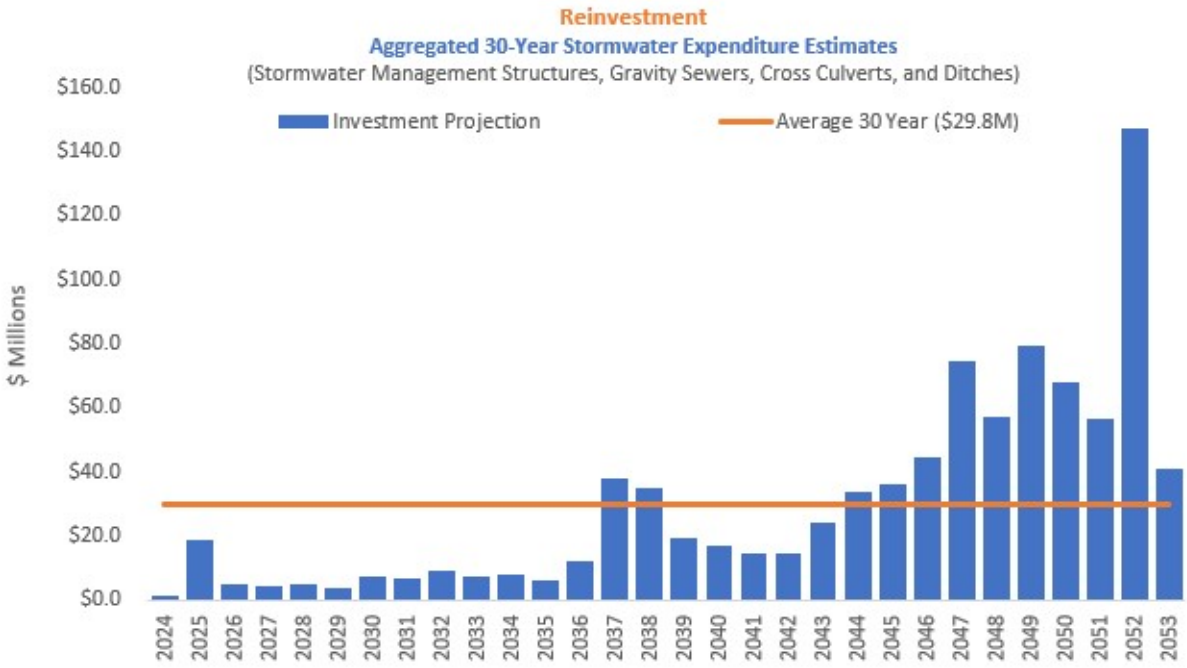
6. Application of the 30% contingency allowance (designed for planning purposes) as identified in Class 4 of the current Cost Estimation Framework.

Reinvestment (replacement) profiles have also been updated in association with the 2023/24 reporting period – refer to Figure 3. It is important to note that WSP and WWTF reinvestment information has been excluded in these profiles due to the maximum sub-system condition/performance rating application at the facility level (i.e. as outlined in Section 3.1.2.1). Although this approach provides value with flagging the potential near-term renewal needs of each facility, it does not capture the overall condition of each facility accurately. As a result, future stages of work are expected to move towards the incorporation of a Facility Condition Index approach that accounts for renewal needs in association with total replacement costs (i.e., continuous improvement of capital and expenditure integrations and enhanced project prioritization).

Figure 3: Aggregated 30-Year Replacement Expenditure Estimates







Additional refinements are expected along with recommendations from the upcoming IRP.

3.1.3.2.1. Asset Deterioration Models

Asset deterioration models are a critical component of a water utility's asset management system. The primary purpose of a deterioration model is to help decision-makers estimate the

remaining useful life of infrastructure and identify the anticipated timing for capital renewal activities (Thomson, 2012). Additionally, deterioration models can support a utility's risk management program by estimating the likelihood of asset failure and determining which assets should be prioritized for further inspection (Ellison, 2019).

The development and use of deterioration models is recognized as an industry best practice in the International Organization for Standardization (ISO) 55000 international standard on asset management, as well as the Institute of Public Works Engineering Australasia's (IPWEA) International Infrastructure Management Manual (IIMM) (IPWEA, 2015; ISO, 2014).

Effective deterioration models must be both easy to understand and develop while being grounded in evidence-based modeling techniques. While it may be appealing to develop highly complex deterioration models using advanced statistical modeling techniques, they are often not easily used in practice and, ultimately, have limited value to the organization (DCA Consultants, 2024).

Condition scoring for the utility has been developed using a 1 to 5 range - refer to Table 4.

Table 1: Condition Grade and Definitions

Grade	Short Title	Canadian Core Public Infrastructure Survey (CCPIS) 2017 Definition Adopted in 2019 Canadian Infrastructure Report Card (CIRC)	2016 CIRC Asset Management Primer	% of Remaining Estimated Service Life (ESL)
1	**Very Good**	The asset is fit for the future. It is well maintained, in good condition, new or recently rehabilitated.	*Fit for the future* – Well maintained, good condition, new or recently rehabilitated.	80-100%
2	**Good**	The asset is adequate. It is acceptable and generally within the mid-stage of its expected service life.	*Adequate for now* – Acceptable, generally approaching mid stage of expected service life.	60-79%
3	**Fair**	The asset requires attention. The asset shows signs of deterioration, and some elements exhibit deficiencies.	*Requires attention* – Signs of deterioration, some elements exhibit deficiencies.	40-59%
4	**Poor**	There is an increasing potential for its condition to affect the service it provides. The asset is approaching the end of its service life, the condition is below the standard and a large portion of the system exhibits significant deterioration.	*At risk of affecting service* – Approaching end of service life, condition below standard, large portion of system exhibits significant deterioration.	20-39%

5	**Very Poor**	The asset is unfit for sustained service. It is near or beyond its expected service life and shows widespread signs of advanced deterioration. Some assets may be unusable.	*Unfit for sustained service* – Near or beyond expected service life, widespread signs of advanced deterioration, some assets may be unusable.	<20%
	Unknown	Not enough data exists to respond.		

The PSD (Public Sector Digest) Citywide software (Citywide), currently adopted by Halifax Water to support compiling the annual AM statistics, has been configured to show the condition grade intervals and is correlated to the word description and % of remaining estimated service life (ESL) – refer to Table 5.

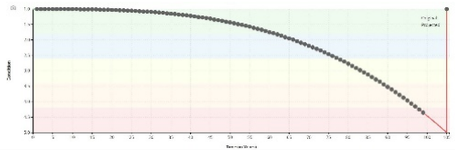
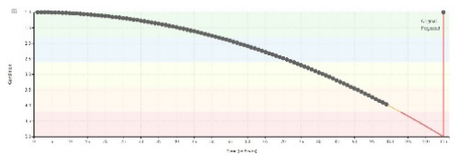
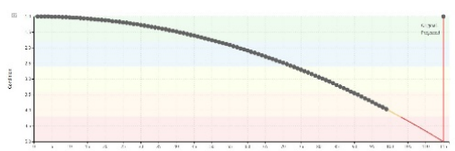
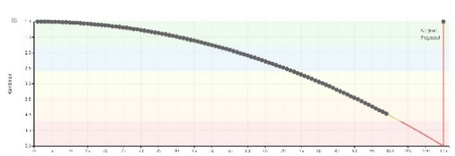
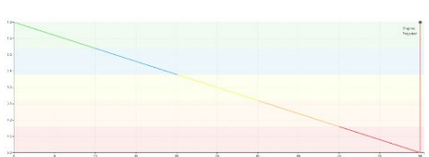
Table 2: Citywide Condition Grade Intervals

Grade	Short Title	% Remaining ESL	Transition Range
1	**Very Good**	80-100%	**1.00 – 1.80**
2	**Good**	60-79%	**1.81 – 2.60**
3	**Fair**	40-59%	**2.61 – 3.40**
4	**Poor**	20-39%	**3.41 – 4.20**
5	**Very Poor**	<20%	**4.21 – 5.00**

Historically for the AM statistics, Halifax Water has used straight line deterioration to determine how an asset's condition will degrade over its estimated service life.

Although straight line (linear) deterioration offers ease of application, it does not reflect a realistic model of degradation for all asset classes over time. In these applications, deterioration is shown as a uniform (conservative) drop in condition; however, it may prematurely indicate a need for intervention early in the asset's life. In comparison, the Citywide "out of the box" (default) deterioration curve option provided an asset deterioration relationship that more closely aligned with expected changes in the early years but showed a rapid deterioration in the latter years. As neither option was determined to be suitable for all asset classes, staff took the opportunity to further investigate other options. As a result, Halifax Water has updated deterioration curve formulas, to align with the utility's current Citywide (age-based deterioration) system, via a verification process that has included an industry scan (e.g. American Waterworks Association (AWWA), United States Environmental Protection Agency (US EPA), Federation of Canadian Municipalities (FCM), National Association of Sewer System Companies (NASSCO), Institute of Public Works Engineering Australasia (IPWEA), and National Co-Operative Highway Research Program NCHRP)), literature review (17 publicly accessible Canadian municipal AMPs), as well as municipal consultations (e.g. Region of Peel, City of Ottawa, and Region of York). A summary of associated updates are outlined in Table 6.

Table 3 : Updated Deterioration Curve Summary Table.

Asset Type	2023/24 Deterioration Curve Update Summary		
Water Distribution Mains and Forcemains	Cubic formula: $Condition\ Ratio$=1.0− $(Age/ESL)^3$		The cubic deterioration curve shape demonstrates a progressively increasing likelihood of failure (LOF).
Water Transmission Mains	Quadratic formula: $Condition\ Ratio$=1.0− $(Age/ESL)^2$		The quadratic deterioration curve shape demonstrates a more conservative, progressively increasing LOF.
Gravity Sewers	Quadratic formula: $Condition\ Ratio$=1.0− $(Age/ESL)^2$		The quadratic deterioration curve shape demonstrates a more conservative, progressively increasing LOF.
Culverts	Quadratic formula: $Condition\ Ratio$=1.0− $(Age/ESL)^2$		The quadratic deterioration curve shape demonstrates a more conservative, progressively increasing LOF.
Complex Assets (e.g., WSPs, WWTFs, dams, reservoirs, booster stations, WW pump stations, CSOs, stormwater management structures etc..)	Straight-line (linear) formula: $Condition\ Ratio$=1.0− (Age/ESL)		The linear deterioration curve shape demonstrates a highly conservative option that accounts for the complexities of modeling these asset types and is intended for use in cases without field verified condition assessments.

It is important to recognize that age-based deterioration curves used to estimate the condition of high consequence of failure assets (i.e., critical assets) should be used with caution. Given the potential threat to public health and service disruption, asset inspections and assessments are recommended to minimize the uncertainty and risk of failure (DCA Consultants, 2024). As a result, ongoing phases of work are currently expected to focus on supplementary exploratory data analysis including regular reviews of asset condition data in association with the overarching Condition Assessment Program (Section 3.1.2.1.) as well as critical asset identification efforts (Section 3.1.2.3).

3.1.3.3. Masterworks

In early 2023 Halifax Water commenced the implementation of the Masterworks initiative with a Capital Project Management and Information System (CPM&IS) project to support the continuous improvement of pre-existing (primarily manual) capital planning processes. The CPM&IS project team implemented the Capital Planning module of the Masterworks solution in the Spring of 2024. This module allows for the intake of candidate projects for the annual capital budget cycle which are then analyzed and prioritized for the 5-year capital plan and approval of the 1-year capital budget by the HRWC Board. The prioritization process (following project intake) currently includes criteria defined in alignment with departmental goals that are focused on the following 4 pillars: People; Health, Safety & Environment; Financial & Regulatory Accountability; and Operational Excellence.

3.1.4 Summary of Program Successes and Upcoming Priorities

Key accomplishments from the AM program over the past year include:

- The acquisition of AM resources (AM Manager, AM Engineer, Engineering Technologist).
- The incorporation of updated deterioration curves for the utilities 14 core asset classes in alignment with PSD Citywide.
- Implementation of the Capital Planning module of the Masterworks solution.
- Initiation of the Condition Assessment Program Framework (including the Dunbrack condition assessment).
- Initiation of the Sewer Inspection Program Review.

With the addition of resources to the team in Q3 of 2023/24, AM Program (RoadMap) activities have been reassessed and updated. Immediate priorities are expected to continue to focus on the ongoing progression/refinement of the following items through the current condition program lens:

- Asset criticality identification and condition assessment program (all asset classes).
- AM culture, communications, and change management.
- Aligning asset levels of service and Halifax Water business plan objectives in association with the IRP.

- Processes used to identify and evaluate capital renewal priorities and support investment decisions.

Subsequent phases of work are planned to transition, in alignment with the AM Roadmap, towards a focus on continuous improvement related to capital and operational expenditure integrations, enhanced project prioritization, refined decision support scenarios, as well as the development of enhanced staff training and onboarding opportunities.

4. Data Engineering Program

The Data Engineering functional area of the Asset Management and Capital Planning Business Unit includes a portfolio focused on:

- Managing multi-year data collection exercises (rain and flow monitors, Environment and Climate Change Canada (ECCC) hydrometric stream gauging partnership);
- Conducting hydraulic modelling;
- Analysis and reporting on collected data (rain gauges, flow monitors, stream gauges);
- Evolution of the current modelling practices into a digital twin tool;
- Identifying data analysis and integration needs within the broader Asset Management portfolio; as well as
- Developing an overflow monitoring, reporting, and abatement program.

The data engineering program offers support for the ongoing continuous improvement of the AM Program in association with operational functionality considerations (i.e., such as, supplementary system performance data and information). The data engineering program also offers support for the Regional Infrastructure Planning program through hydraulic modelling and coordination and evaluation of study inputs such as flow monitoring for RDII, base populations, and population growth distribution.

This section of the report will highlight outcomes of key Data Engineering initiatives undertaken during the 2023/24 reporting period that directly impacts the September Filing from the M09494 order.

4.1. Flow Monitoring

Halifax Water's Corporate Flow Monitoring program deploys rain gauge equipment and flow monitoring equipment within the wastewater collection system to better characterize system flows and manage areas subject to overflows. The program was developed to conduct flow monitoring and data analysis to support the following program objectives:

- Calibrate and verify Halifax Water's wastewater system hydraulic model (continuous data collection will be used to validate the wastewater model annually and calibrate where necessary);
- Evaluate wastewater, combined, and stormwater systems' performance and capacity;
- Identify and prioritize areas for wet weather management under the corporate Wet Weather Management Program (WWMP);
- Measure the effectiveness of wet weather management efforts including disconnection of private sources of inflow and infiltration (I/I), separation of systems, and lining rehabilitation work on Halifax Water owned infrastructure;
- Provide background and support for development of long-term capital reinvestment programs for wastewater and stormwater infrastructure;
- Support environmental compliance reporting.

In July 2024, Halifax Water awarded two contracts under the umbrella of the Corporate Flow Monitoring Program – one for Data Collection and one for Data Analysis. These July 2024 contracts are the third generation of the program. Each contract is for three years with an option to renew for an additional two-year period.

The data collection contract includes the operation and maintenance of flow monitoring and rain gauge equipment, traffic control requirements, data quality assurance/quality control (QA/QC) checks and delivery for our current flow monitoring network, along with installation, maintenance and reporting for any future requested sites. The data analysis contract will include analysis for all sites where data is collected under the data collection contract and historical data analysis for data collected under the previous generation of the flow monitoring contract (July 2021 contract). Details on requirement for historical data analysis under the July 2024 contract were provided through the funding application and information requests (IRs) responses under Matter M11742. A decision on M11742 was provided to Halifax Water on August 26, 2024.

The data collection contract was awarded to AMG Environmental (AMG) and kicked off in early July. AMG has deployed all rain gauge equipment in the field and has been working through flow monitoring equipment installations for all previously monitored locations throughout August and September. AMG is on track to complete installation of equipment at all previously monitored locations in our flow monitoring network by September 30th, 2024.

The data analysis contract was awarded to GEI Consultants (GEI) and kicked off mid-July. GEI is currently completing data analysis on the historical data collected under the July 2021 contract. GEI will complete monthly analysis on a go-forward basis for data being collected under the current AMG Data Collection contract once all flow monitoring equipment has been deployed.

4.2. SSO and CSO Management Program

The sanitary sewer overflow (SSO) and combined sewer overflow (CSO) Management Program was initiated in early 2024 and is a multi-year, multi-discipline initiative to understand the magnitude of overflow in Halifax Water's wastewater system, confirm regulatory reporting and operating requirements for SSO and CSO discharges and develop and implement a plan for Halifax Water to meet those regulatory requirements. The business practices established by this program will become part of normal operating procedures, however it is anticipated that there will be a number of projects required to achieve this future operational state.

In this first year of the program, Halifax Water has engaged Colliers Project Leaders to provide Project Management Services and assist with building out the program objectives. It was anticipated that the first year of the program would include the following:

- Phase 1 – Initiation
    - Identify key internal stakeholders.
    - Develop and finalize a Program Charter.
    - Establish internal multi-disciplinary working groups including team members from Asset Management, Regulatory Compliance Services, Technical Services and Operations.
    - Establish project management practices and services to be carried out through the duration of the Program.
- Phase 2 – Discovery Phase
    - Build an understanding of regulatory requirements.
    - Gather, validate, and compile all available data pertaining to CSOs and SSOs.
- Phase 3 – Gap Analysis Phase
    - Identify missing information from the Discovery Phase.
    - Identify the approach and method to close information gaps.
- Phase 4 - Capital Planning
    - Develop a list of projects to address the information gaps.

Halifax Water is currently working through the initiation and discovery phase. Internal stakeholders have been identified and the working groups established. The project charter has been finalized and signed-off. Several data sources have been identified for compilation and validation and are currently being reconciled.

A new position for an SSO/CSO Program Manager was approved for Q3 (September – December) 2024. This position is anticipated to be an Eng 3 classification reporting to the Manager, Data Engineering. The job description for this position is currently under development based on the findings of Phase 1 and Phase 2 from year one of the program as noted above. It is anticipated that the manager hired into the new position will take over the role currently being filled by

Colliers Project Leaders. One of the first assignments for the new manager will be in place to plan and execute filling the data and information gaps.

4.3. Hydraulic Modelling and Calibration

The regional wastewater system model, corporate flow monitoring program as well as the regional potable water system model are managed and maintained by Halifax Water's Data Engineering team within the Asset Management and Capital Planning Business Unit.

4.3.1 Wastewater System Hydraulic Modelling and Calibration

As part of the 2019 IMP, Halifax Water developed an all-pipe hydraulic model using Innovyze InfoWorks ICM software. The model represents the "core" system. This is the network servicing the following WWTFs:

- Halifax
- Dartmouth
- Herring Cove
- Lakeside/Timberlea
- Springfield Lake
- Mill Cove
- Eastern Passage

Halifax Water continues to work on improving the information within the model and the links to source information for the model as routine practice. Halifax Water continues to strengthen the data integration link to facilitate and automate the process of exporting sensor and infrastructure information from one system to the model. Automation of these processes decrease the opportunity for human error and decrease the time required to stage and run model scenarios. This is an important and continuous improvement process to improve the utility of the model to support decision-making beyond long term infrastructure planning.

4.3.2 2023/24 Wastewater Model Activities

During the 2019 Integrated Resource Plan, several areas in the local system were identified as 'under capacity' that were not anecdotally known problem areas. Experience has shown that these are often the result of erroneous GIS information or other model inputs as opposed to actual capacity constraints. Where the model identifies local flooding, further investigation is warranted to confirm if the model is reflecting a potential surcharge/flooding problem or if it is a result of erroneous inputs.

Through a project called 'Wastewater System Constraints Analysis' Halifax Water has been working to resolve the remaining local constraints identified in the 2019 Integrated Resource Plan by confirming input data prior to the upcoming Integrated Resource Plan update. This has

involved a substantial effort in reviewing record information and CCTV investigations to confirm the base GIS information. Where differences are found that information is fed back to the enterprise GIS systems and propagated back to the model software to maintain the integration between these corporate systems.

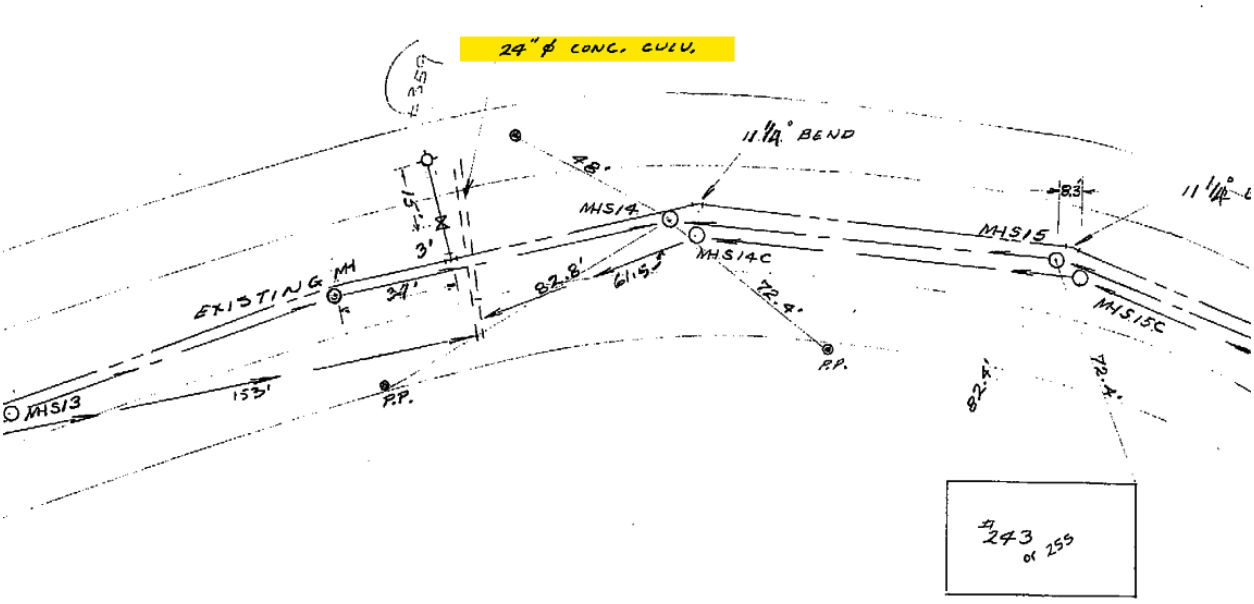
One interesting example of missing GIS information that caused a 'local flooding' flag in the model relates to a missing culvert under Highway 101, as shown in Figure 4.

Figure 4: Missing GIS Information & "Local Flooding" Flag (based on GIS as of April 21, 2021)

Normally this sort of missing culvert information would result in the model failing to run due to a 'missing outfall error' during initialization, triggering an investigation immediately. This case was somewhat unique as the local flat topology of the floodplain allows the flows within the pipes on Old Sackville Road to reverse (flow against grade) to the northwest and back to the system at Crystal Court. During dry weather simulations, this does not even cause a surcharge.

The source of the missing data in GIS is not uncommon. The pipe stubs shown in the 2021 GIS snapshot reflect what is shown on the record drawing from 1975 where the existence of a crossing pipe is inferred but not explicitly shown on the drawing – refer to Figure 5.

Figure 5: 1975 Record Drawing: Inferred Crossing Pipe



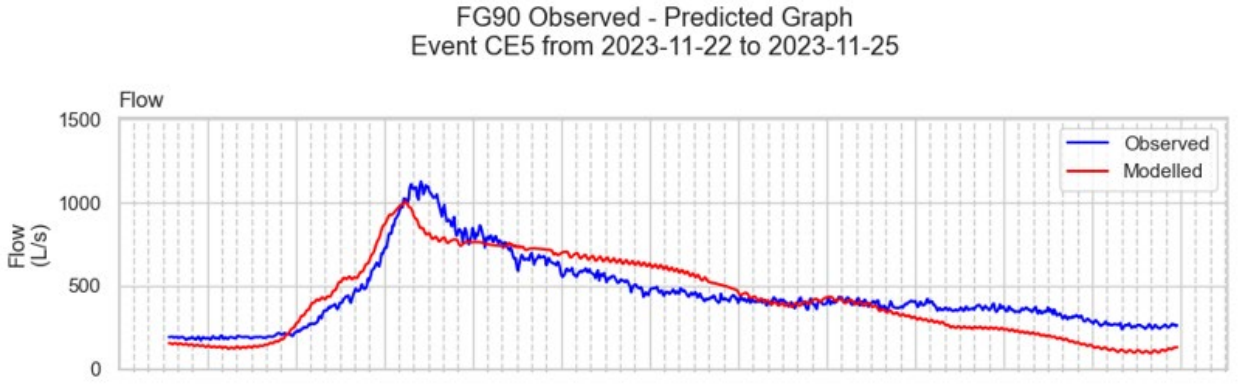
The GIS information was updated and reflected in the model, resolving the apparent local flooding issue – refer to Figure 6.

Figure 6: Updated GIS Information: "Local Flooding" Issue Resolved (based on GIS as of August 2024)

The wastewater system models use the corporate GIS database as the preferred source of infrastructure information. This information is supplemented and filled with record drawings and inferences where the GIS is incomplete. The data source is tracked in the modelling software using data flags. Therefore, the preferred workflow when gaps such as the one shown above are identified is to update the GIS and allow that GIS update to filter back to the models.

The wastewater system models combine system infrastructure information with information from the corporate flow monitoring program to calibrate flows simulated in the models. Calibration of Halifax Water's wastewater system models are evaluated annually by simulating a full year model run and comparing with data from the corporate flow monitoring program. Adjustments are made to the calibration where the modelling team deems a deviation from the monitored values is not the result of noise in the monitoring data or due to a temporary condition (e.g., construction within the sewershed resulting in flow diversions).

Figure 7: Example Monitoring (Observed) verses Model Run (Predicted) Flow Data Event Graph



Approximately every 5 years, the model calibration is completely refreshed during the Integrated Resource Plan update. Since the model calibration will be refreshed this year by the Integrated Resource Plan consultant, Halifax Water staff is not undertaking an annual update to the model calibration based on the findings of the validation runs. Halifax Water staff have instead been focused on making sure that the models are the best possible reflection of the current GIS information so that the Integrated Resource Plan consultant can focus on model calibration and not have to spend effort on reviewing completeness of the models.

Halifax Water also notes the comments made in the decision of M11742 – "2024/25 Corporate Flow Monitoring Program" about providing a summary of the hydraulic model calibration changes resulting from latest collected flow data and the impact to the Integrated Resource Plan servicing strategy. We will be working this year to create a system to facilitate that reporting requirement. Although, as the upcoming year's activities include a comprehensive refresh of the model calibration in support of the Integrated Resource Plan, the report will not likely contain

information of interest prior to the 2026/27 Corporate Flow Monitoring Program funding application.

4.3.3 Annual CSO Wastewater System Effluent Regulations (WSER) Reporting

Halifax Water continued the use of the Halifax and Dartmouth hydraulic models to generate annual combined sewer overflow (CSO) volumes and frequencies for the annual Wastewater System Effluent Regulations (WSER) report in February. This simulation is based on precipitation measured by the network of tipping bucket rain gauges maintained through the flow monitoring program.

It is anticipated that this practice will be reviewed as part of the data gap analysis being conducted by the SSO and CSO Management Program. The SSO and CSO Management Program will be making recommendations on how best to track and report volume and frequency of CSO occurrences. Halifax Water currently runs the models to support the annual WSER filing. However, it has been identified that volume and frequency reporting is required on an event-by-event basis as soon as possible following a CSO. Halifax Water will be working to develop a system of monitoring and/or modelling to be able to provide the required information for regulators closer to the event occurrence.

4.3.4 Wet Weather Management Program Support

The wastewater hydraulic models have been used in the past to support the wet weather management program (WWMP) through their use in the IRP strategy development. The models are used to identify opportunities where wet weather flow reduction is impactful within the context of:

- location of growth,
- quantity of inflow and infiltration (opportunity for flow reduction),
- and the impact from/or to infrastructure planned to support the compliance and renewal drivers of the integrated strategy.

Through the upcoming IRP, the hydraulic models will be used as part of the evaluation of the impact of the I/I reduction efforts completed since the previous Integrated Resource Plan within a regional capacity context.

Hydraulic modelling can also be a tool used as part of the Sewer System Evaluation Study (SSES) process within the tactical WWMP. Halifax Water has not used the model at this tactical level over the past several years as the wet weather program was not yet mature enough to take advantage of the model as part of their process. Following the recommendations of the Stantec Wet Weather Management Program Review – Technical Memorandum, the Halifax Water modelling team will be working with the WWMP team to find opportunities where use of the

model can be employed within the program. This would be incorporated into the Decision Matrix Report (DMR) to guide when it would be beneficial to employ the models.

5. Regional Infrastructure Planning

The Regional Infrastructure Planning functional area of the Asset Management and Capital Planning business unit includes a portfolio focused on:

- Conducting master infrastructure planning including the IRP and Growth Servicing Strategy;
- Tracking progress on master planning recommendations;
- Conducting vulnerability to climate change risk assessments; as well as
- Providing project management services for Business Unit assigned projects.

Halifax Water completed its first IRP in 2012. In 2019, the IRP was updated to reflect planning maturity and to ensure Halifax Water could continue to meet the servicing needs of HALIFAX. The goal of the 2019 IRP was to create one holistic program that would inform Halifax Water's activities for the next five years and provide a guide for the next 30 years. Asset renewal was one of the 3 key drivers of this report, along with Compliance and Growth, as shown in Figure 8.

Figure 8: IRP Key Drivers

The upcoming Integrated Resource Plan update, managed through the Regional Infrastructure Planning team, aims to build on the previous 2019 IRP by reviewing and incorporating updated data and information to further mature the utility's long-term infrastructure planning. In the next update to the IRP, identifying the needs of the three drivers will be fully integrated in one planning process leading to one guiding plan for the utility.

A significant amount of reinvestment was identified in the 2019 IRP for the Wastewater Treatment Facility (WWTF) asset class. As a result, the Wastewater Treatment Facility Planning Study was undertaken to better define the future investment needs for the existing Halifax and Dartmouth Wastewater Treatment Facilities. Completion of the study aimed to inform plans to provide wastewater treatment services for the current population and planned growth (based on 2019 IRP) while meeting current and future Wastewater System Effluent Regulations (WSER). Outcomes of the study will be reviewed as part of the long-term planning process in the update to the IRP.

The regulatory environment in Canada is also continually evolving. Consequently, the Future Regulatory Scenarios Study looked at emerging concerns and potential future regulations that could impact Halifax Water's water, wastewater (combined), and stormwater infrastructure. Feedback from M11648 and the paper hearing is being incorporated into the study and will be used to inform planning for the compliance driver during the IRP update. (Please note, previous versions of this report contained a section on Compliance, the intention is for that content to be incorporated into the Future Regulatory Compliance study and ultimately the IRP and not be a stand-alone section.)

The initiatives of the Data Engineering and Regional Infrastructure Planning teams were discussed with the Board Counsel Consultants at workshops in August 2024. Outcomes of those discussions will be considered as the update to the IRP moves forward.

Collectively, outcomes from both the Asset Management Program (asset renewal) and Data Engineering Programs (system performance and master planning) support Regional Infrastructure Planning initiatives.

6. Wet Weather Management Program

The requirement for Halifax Water to report on the advancement of the Wet Weather Management Program (WWMP) originates within NSUARB decisions (M09201, M09592, M09494, M10188). The 2023 WWMP Executive Summary is located in Appendix C (*Halifax Water will submit the full report to the NSUARB by October 18, 2024*).

The following summarizes Halifax Water's efforts to reduce inflow and infiltration (I/I) originating on the private side (customer's connections).

6.1. Private Side Pilot Project

In 2019, the Hornes Road area in Eastern Passage was chosen by the WWMP for a private side pilot project with the intent to identify non-compliant service connections to the Halifax Water systems. The financial burden to remediate the service connection lies with the customer.

Beginning in 2021, Halifax Water staff commenced private property inspections. 96 private properties were inspected, of which 20 were found to have stormwater sources connected to the wastewater system. The 20 properties included a total of 24 violations. To date, staff have reported they have achieved compliance in 15 out of the 24 violations, with 9 properties still with outstanding violations.

From 2021, 2022 and 2023 analyses, the post-rehabilitation peak RDII in the sewershed on average was higher by 19.3 L/sec (50%) than the pre-rehabilitation conditions for a 5-year design storm. The average dry weather flow also increased by 1.6 L/sec (118%).

The increase in RDII may be a result of higher average Q4 rainfall post-rehab than pre-rehab. The lack of flow data available for other sewersheds limits the ability to confirm this. The pre and post flow monitors were contracted from different manufacturers, which may also result in variances in flow data.

Due to the unexpected increase in RDII following the private-side pilot project, lateral inspections were completed in 2023 to determine if there are any additional I/I sources within lateral services beyond private inflow sources; the summary of those inspections are shown in the table below:

Street	Total no. laterals inspected	No. of laterals with defects	% of laterals with defects
Hornes Rd	94	47	50%
Janice Ann Dr	13	5	38%
Scott Dr	5	2	40%
TOTAL	**112**	**54**	**48%**

From this analysis, 48% of the laterals in WWMP24 had defects on either the public or private portion of the laterals that have the potential to contribute significant RDII and should be considered for future rehabilitation.

In conclusion, both dry weather and wet weather flows increased for WWMP24 post-rehabilitation. It is unclear why this is the case, whether it is a result of wet vs dry seasons or a change in flow monitor manufacturers. Further investigation and rehabilitation activities are recommended for this sewershed.

When planning future pilot programs, property inspections will need to be conducted in priority areas, prior to project initiation, to establish the contribution of I/I from private sources. This will inform project planning and whether it is appropriate to include private property disconnection in the scope of a given project.

It is essential to continue with the development of costs associated with various remediation and disconnection strategies, and the benefits of these strategies, to ensure that cost-effectiveness is a guiding factor in decisions around project selection and scoping.

The extent to which private property disconnection is achievable is directly related to the level of stormwater service provided. Where there is insufficient pervious area, existing flooding issues, or limited opportunity for green infrastructure, disconnection may not be possible unless a stormwater service connection is provided. Factors that may impact the potential for providing a stormwater service connection include existing basement elevations, cost effectiveness, technical feasibility and the scope of a given project.

6.1.1 Downspout Disconnection Program

The Downspout Disconnection Program is integrated with the Sewer Separation Program as a method to remove private downspout stormwater flows from newly separated wastewater systems. Regulatory Compliance Services and Engineering & Capital Infrastructure (formerly Engineering and Technology Services) staff meet regularly to discuss the joint coordination of the two programs. Joint meetings are held at project initiation, design, and construction phases. The program has been modified to include communication, education and outside field assessments in advance of project construction.

From 2021 to present, the areas with active Downspout Disconnection Programs include:

- Federal Avenue, Romans Avenue, Bayers Road, Chisholm Avenue and Micmac Street (this is a continuation of previous sewer separation project areas)
- South Park Street and University Avenue
- Wyse Road and Jamieson Avenue
- Maynard Lake and Clement Street Wetland Separation

Details of the status of these downspout disconnection areas are discussed below.

6.1.1.1. Federal/Romans, Bayers, Chisholm/Micmac Project Area

Halifax Water completed the construction of the Federal/Romans Avenue and the Bayers Road Sewer Separation (Phase 2) projects. The Downspout Disconnection Program for these projects commenced in 2020 and is now completed and thus will not be included in future reports.

Last year's report stated that within the two project areas, after customer outreach efforts, 16 downspouts remain connected. It should have stated that 27 downspouts remain (within 16 properties). This represents 8% of the 347 downspouts contained in the project areas and 30% of the 91 downspouts originally connected.

6.1.1.2. South Park Street and University Avenue Area

The South Park Street and Cathedral Drive Sewer Separation project (M09808) was divided into two phases of work. Phase 1, which is now complete, consisted of a portion of South Park Street and the intersection of University Avenue.

Phase 2 (M11717 & M11513) will continue from the intersection of University Avenue and extend along Cathedral Lane. new internal plumbing is already separated and as part of the project can connect to private storm laterals outside the buildings. The two multi-residential properties involved in this phase have existing separated stormwater and wastewater systems. Therefore, the stormwater from these properties, including downspouts, will be readily disconnected as part of the project. This phase is now under construction and is scheduled to be completed in 2025.

As mentioned in the 2023 report (M11355), this project identified the need for Regulatory Compliance Services and Engineering & Capital Infrastructure staff to better coordinate and identify properties that require stormwater service connections earlier in the capital project planning process to make the downspout disconnection program more effective. This coordination is now taking place for all new separation projects.

6.1.1.3. Wyse Road and Jamieson Street Area

The Albro Lakes and Wyse Road Sewer Separation project consists of two phases of work. Phase 1 (M10271), which is now complete, included a harbour outfall and dedicated stormwater main within Jamieson Street through intersections of Windmill and Wyse Roads up to Cairn and Graham Streets. Two of the properties with outstanding violations could not proceed with downspout disconnection given that it would worsen an existing property flooding condition. Installation Halifax Water scoped the possible installation of a public catch basin within an adjacent service easement to facilitate downspout disconnection but this was not in the scope of the project.

Phase 2 of the Wyse Road Area Sewer Separation project is with the Infrastructure Planning group and will be moving forward to design in 2025. As the design proceeds, Regulatory Compliance Services will work closely with Engineering & Capital Infrastructure to establish the scope of the downspout disconnection program for this area.

6.1.1.4. Maynard Lake and Clement Street Wetland Separation

The Maynard Lake and Clement Street Wetland Separation is a future capital project in the planning stages and Regulatory Compliance Services continues to work with Engineering and Capital Infrastructure to include a downspout disconnection program. This project is subject to a future NSUARB funding application.

6.1.2 Campus Property Program

As mentioned in last year's report, Halifax Water had proposed to engage stakeholders (such as Building Owners and Managers Association and Investment Property Owners Association of Nova Scotia) on advancing this program to gain feedback on addressing the implementation of future

investigations and compliance initiatives. However, upon further consideration and in consultation with Halifax Water's Communications group, the decision was made to engage directly with each campus, via an initial letter containing information on the Campus Program and a Q&A. The rationale for this approach is that most members of the above-mentioned associations would not be owners of Campus Properties but would own individual buildings scattered throughout the city. The initial letter will be mailed out directly to all Campuses.

Flow assessment has begun for several of the high priority Campus Properties located in the IMP priority areas. For each Campus, Halifax Water will proceed through the steps outlined in the previously provided (M11355 IR-14 Response) Campus Program Method.

6.1.3 New Service Account Compliance Program

Responsibility for this program has been assigned to the Regulatory Customer Programs group. A new coordinator position is being created to administer this program. The coordinator is expected to collaborate with various community stakeholders and Halifax Water program managers to ensure appropriate scope of the program and to identify opportunities to achieve program goals and success of the initiative. The program will look at both compliance regulations and any incentives to help attain the programs objectives. Revised program timelines will be established once the coordinator position is filled.

6.1.4 Overall Private Side I/I Program Review

Halifax Water held a workshop with the NSUARB's consultants in August 2024 which included a session dedicated to private side I/I. A number of private side challenges and possible next steps were discussed and are outlined below. The overall objective is to overcome these challenges to improve reduction of private side I/I sources to support overall success of the WWMP. To accomplish this, a scan of best practices and lessons learned from other utilities who have overcome these challenges will be conducted to then inform development of an enhanced private side I/I program moving forward. Currently, aspects of the WWMP exist within multiple departments within Halifax Water. The overall structure and placement of the WWMP program within the utility structure is being evaluated so that the future program can be better connected to achieve program goals.

Regulation Changes - The current Halifax Water Regulations are not clear on whether the utility has authority to require the repair of defects on the private portion of a wastewater service connection unless infiltration is observed entering through the defect area. Halifax Water will review the Regulations to determine what revisions may be required to more clearly provide the authority to require these defect repairs.

Inspection Success Rate - It is difficult to achieve a high inspection success rate by limiting available inspection times to within regular business hours. Halifax Water will adopt the scheduling of inspections outside of regular business hours, which has been demonstrated to achieve a high percentage inspection rate on the Hornes Road pilot project.

Long-term Compliance - It is difficult to achieve long-term private property disconnection compliance without permanent solutions for managing stormwater on the property or discharging to a stormwater system. Property inspections completed by Halifax Water include an assessment of whether there is sufficient pervious area to absorb water from downspouts and/or sump pumps. Those properties without sufficient area may be good candidates for Green Infrastructure (discussed further in Section 6.2) or may qualify for an exemption from disconnection. For separation projects, Regulatory Compliance Services has been working closely with Engineering & Capital Infrastructure to identify, early in the project planning stages, properties that may require stormwater service connections.

Regulatory Approach - Halifax Water has the authority to discontinue service, issue summary offense tickets, or prosecute for noncompliance with its regulations. However, the utility would prefer not to implement these severe measures if there are effective alternatives. Halifax Water will explore alternatives to these formal enforcement measures including a review of the approaches that other jurisdictions in Canada and the United States have taken to achieve compliance without strict enforcement, such as incentivizing private side repairs and green infrastructure education. It is understood that Halifax Water currently has no authority to fund private infrastructure installation, repairs, or disconnections. Therefore, this review will include possible funding options for private side incentives.

Resource Requirements – Current resourcing is inadequate to enhance private side I/I programs and increase the number of annual inspections. As the program develops and an implementation plan is determined, resourcing will be determined to meet program goals.

6.2. Jurisdictional Considerations

Halifax Water owns and maintains stormwater and wastewater systems and regulates connections and discharges to these systems including prohibiting stormwater discharges to the wastewater system. Some of HALIFAX's potentially impactful areas of responsibility are land development oversight, creation of major system overland flows, lot grading and icing on sidewalks and streets. The purpose of the Memorandum Of Understanding (MOU) discussed in last year's submission is to identify the roles and responsibilities of each party as they relate to the implementation of stormwater infrastructure projects within the Halifax Water stormwater service boundary. This MOU represents a fair and reasonable basis on which to allocate costs for joint capital works program relating to stormwater systems, subject to approval by Halifax Regional Council, the Halifax Water Board, and the Nova Scotia Utility and Review Board.

Icing on Sidewalks & Streets - Halifax Water has developed private property I/I disconnection exemption criteria for use in its I/I reduction program as well as in capital project planning. For

example, an exemption would be granted where disconnecting may worsen existing property flooding (including that caused by overland flow) or cause icing on sidewalks or streets.

Green Infrastructure - HALIFAX also provides educational material for property owners on how to manage stormwater on their property including information on various types of green infrastructure (GI).

Halifax Water will explore collaborating with HALIFAX on GI initiatives to enhance its private side I/I programs. For example, GI such as rain gardens may provide a more cost-effective disconnection alternative for properties with insufficient pervious area and where the GI installation is less costly than, and preferable to, connecting to a stormwater service connection.

Glossary of Terms

AC	asbestos cement
ADS	ADS Environmental Technologies
AI	artificial intelligence
AM	asset management
AMBC	Asset Management British Columbia
AMIT	asset management implementation team
AMOntario	Asset Management Ontario
AMP	asset management plan
AMRS	Asset Management Readiness Scale
AM-SK	Asset Management Saskatchewan
AO	Aesthetic objective
API	application programming interface
AWWA	American Water Works Association
CA	condition assessment
CCPIS	Canadian Core Public Infrastructure Survey
CCTV	closed circuit television
CIRC	Canadian Infrastructure Report Card
CNAM	Canadian Network of Asset Managers
CPIT	Capital Planning and Inventory Tool
CPM&IS	capital project management and information system
COF	consequence of failure
CSP	corrugated steel pipe
CSO	combined sewer overflow
csv	comma separated value
DSR	dam safety review
DSS	decision support system
ECCC	Environment and Climate Change Canada
EDO	environmental discharge objective
EMS	Environmental Management System
EPM	enhanced prioritization methodology
ERA	environmental risk assessment
ERM	enterprise risk management
ESL	estimated service life
ETL	extract, transform, and load
EUL	estimated useful life (also referenced as effective useful life)
FCODE	feature code
FCM	Federation of Canadian Municipalities
FMZ	flow monitoring zone
GIS	geographic information system
GFMAM	The Global Forum on Maintenance & Asset Management
HALIFAX	Halifax Regional Municipality
HCB	High Class Bituminous
HRWC	Halifax Regional Water Commission
HW	Halifax Water
IAM	the Institute of Asset Management
IAMA	Infrastructure Asset Management Alberta

ICB	Intermediate Class Bituminous
ICI	industrial, commercial, institutional
I/I	inflow and infiltration
IMP	Infrastructure Master Plan
IPWEA	The Institute of Public Works Engineering Australasia
IRP	Integrated Resource Plan
IS	information system
ISO	the International Organization for Standardization
KM	kilometre
LACP	lateral assessment certification program
LCB	Low Class Bituminous
LOF	likelihood of failure
LOS	levels of service
MAC	maximum acceptable concentration
MACP	manhole assessment certification program
NASSCO	National Association of Sewer System Companies
NCHRP	National Co-operative Highway Research Program
NSAC	new service account compliance
NSECC	Nova Scotia Environment and Climate Change
NSUARB	Nova Scotia Utility and Review Board
PACP	pipeline assessment certification program
PCCP	pre-stressed concrete cylinder pipe
PEMAC	PEMAC Asset Management Association of Canada
PSD	Public Sector Digest
QA	quality assurance
QC	quality control
QDMR	quality data management reporting
RDC	Regional Development Charge
RFP	request for proposals
SAMP	Strategic Asset Management Plan (also known as Asset Management Strategy)
SCADA	supervisory control and data acquisition
SGU	Small Geographic Unit
SQL	structured query language
SSES	sanitary sewer evaluation study
SSO	sanitary sewer overflow
SW	stormwater
UDG	Urban Drainage Group
US EPA	United States Environmental Protection Agency
VFD	variable frequency drive
WSER	wastewater system effluent regulations
WSP	water supply plant
WW	wastewater
WWMP	wet weather management program
WWTF	wastewater treatment facility

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Appendix A: Halifax Water Asset Management Policy

Intent:
To commit to asset management as an integrated management system aimed at service delivery. This policy defines the scope of the asset management system and connects to Halifax Water's mission, vision, and values.

Definitions:
Common asset management related terms, definitions, and references are available on the International Standards Organization (ISO) site at ISO 55000:2014(en), Asset management — Overview, principles and terminology.

Scope:
This policy applies to:

i. Board commissioners and employees that manage or influence service delivery.
ii. All services provided by the utility.
iii. All core infrastructure assets owned or operated by the utility.

Halifax Water will strive for the expansion of the scope to include all assets that have actual or potential value to the organization including natural assets, data and information, knowledge, and people.

This policy will guide the development of Halifax Water's Asset Management Strategy.

Guiding Documents and Integration:
This policy compliments and aligns with the following corporate policies, strategies, and plans:

- Five-Year Business Plan and the corporate vision, mission, and values
- Annual Business Plan
- Integrated Resource Plan (IRP)
- Enterprise Risk Management (ERM)
- Asset management-related Board guidance

Principles:

1) Strategic and Forward Looking
Halifax Water will make decisions and provisions that enable its assets to meet future challenges, including changing demographics and population, customer expectations, legislative requirements, and technological and environmental factors including climate change.

2) Evidence-Based Decision Making
Halifax Water will continuously review and improve data, data structures, and data accessibility to make evidence-based decisions that consider the balance of service levels, whole life cost, and risk. Halifax Water will take a holistic approach to decision making to consider all assets in a service context and the interrelationships between different assets to optimize service continuity.

3) **Quality and Service Focused**
Halifax Water will strive to deliver reliable, high-quality service that is efficient, cost-effective, and based on defined levels of service that balance community expectations and regulatory requirements with risk, affordability, and available resources.

4) **Communication and Stakeholder Engagement**
Halifax Water will encourage the sharing of data, information, and knowledge between departments to support the improvement of asset management practices and culture across service areas. Halifax Water will establish a stakeholder engagement strategy to enable transparent communications on the state of assets, levels of service, and the cost of service delivery.

5) **Fiscal Responsibility**
Halifax Water will approach service delivery and asset management in a way that is financially responsible, choosing practices, interventions, and operations that aim to reduce the cost of asset ownership, while satisfying defined levels of service, and risk thresholds.

6) **Continuous Improvement**
Halifax Water will continually improve its service delivery approach by systematically reviewing the asset management program processes, procedures, and tools. Halifax Water will stay informed on leading asset management and service delivery industry practices and will seek to be recognized as an industry thought leader.

7) **Environment and Sustainability**
Halifax Water will strive to be environmentally, and economically sustainable into the long term by incorporating triple bottom line considerations into long term planning, climate change, and infrastructure resiliency actions.

Procedure:

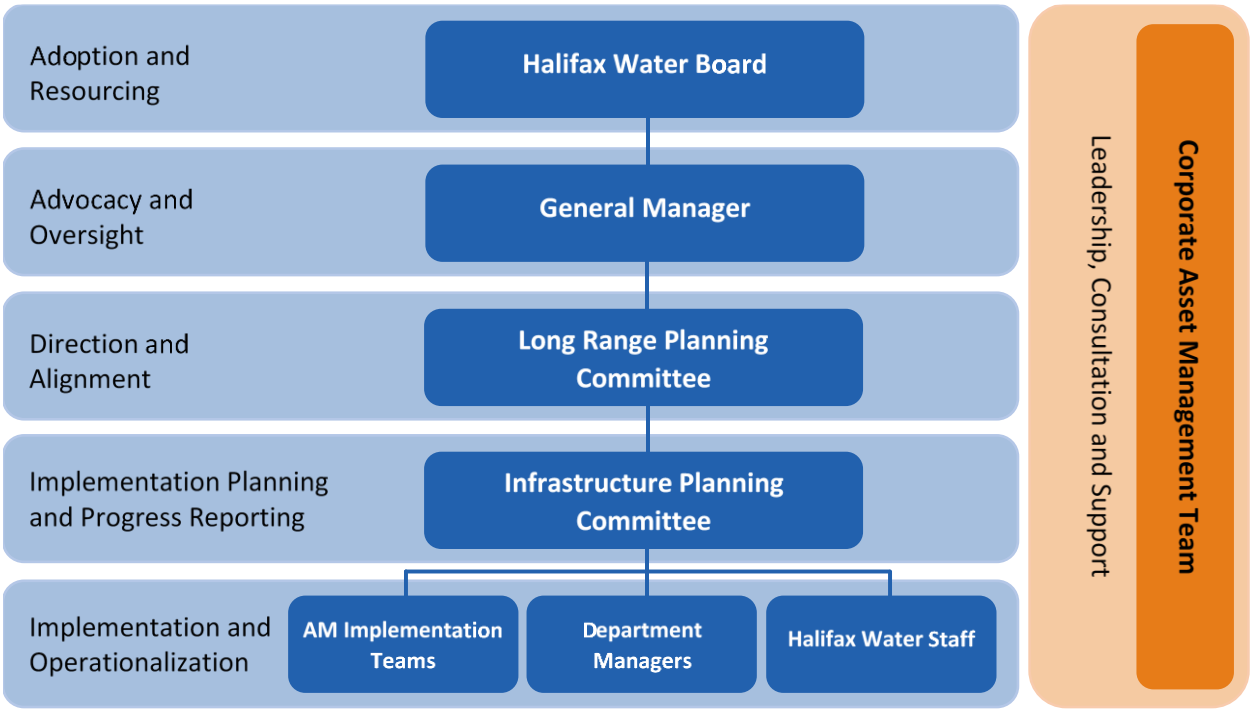
AM Strategy – Halifax Water commits to developing and maintaining an asset management strategy that will identify the practices and processes needed to implement the asset management policy principles and reciprocally integrate with the organization's other policies, strategies, management systems, business plans, and processes.

Culture – Halifax Water is committed to creating a service delivery culture where employees and commissioners consider asset management as part of delivery decisions.

Policy Review – Halifax Water will formally review the policy every 2 years.

Training – Halifax Water is committed to providing training, developing knowledge, and building capacity in asset management throughout the organization and for the Board commissioners.

Accountability:



Halifax Water Board of Commissioners is responsible for adopting this policy and supporting the allocation of resources for the implementation of the asset management program.

General Manager is responsible for advocacy and oversight of the asset management program and communicating the value of asset management to the rest of the organization.

Long Range Planning Committee is responsible for aligning the asset management program with the overall strategic direction of the organization.

Infrastructure Planning Committee is responsible for implementation planning for the asset management and infrastructure planning programs in alignment with other relevant corporate programs and projects to achieve the organizational service objectives identified by the Long Range Planning Committee. This includes reporting on program progress.

Corporate Asset Management Team provides utility-wide leadership in and consultation on asset management practices and concepts and consolidates asset management data from across the organization for enhanced decision making. The Corporate Asset Management Team supports the Asset Management Implementation Teams.

Asset Management Implementation Teams (AMITs) are the links between Operations and Engineering and support day to day operational functions that meet customer service delivery expectations. AMITs

are established to work towards coordinated and integrated decisions about assets, the value and services they provide, and the expenditures needed to meet agreed levels of service.

Department Managers are responsible for advocating asset management within their respective departments. This includes participating in or supporting the AMITs wherever possible and communicating to departmental staff about AMITs' role in asset management.

Halifax Water Staff will consider how their decisions impact service delivery and whether their actions are aligned with the principles identified in this policy. This may include embracing new business processes, technology, and tools necessary to be effective at asset management.

Revision: 20220609

Appendix B: Example System Structure Hierarchy & Physical Condition/Performance Criteria Updates

Performance Condition Definitions

Updated Criteria Example

Rating	Condition	Safety & Security	Performance/ Efficiency/ Demand	Technology	Maintenance History
1	Very Good	Minimal safety or security concerns	Performing **as new** and operates at peak efficiency	Using **new/modern** technology	Requires no reactive Maintenance
2	Good	Minimal safety concerns but some minor security concerns	Operating at **near-peak** efficiency (e.g. 50-75% Capacity)	Using **modern** technology	Requires minimal reactive maintenance
3	Fair	Minor safety and/or security concerns	Operating at slightly **reduced efficiency** (e.g. 75-85% Capacity)	Using **acceptable**/ adequate technology	Requires irregular reactive maintenance
4	Poor	Significant Safety and/or security concern(s) that can be mitigated	Reduced efficiency with moderate risk of breakdown/ failure (>85% Capacity)	Technology is old and no longer adequate. Limited parts availability	Requires **constant attention** and/or maintenance
5	Very Poor	Serious safety and/or security concerns	**High risk of breakdown**/ failure. Unreliable (Running at Max Capacity)	Technology is **obsolete** and needs upgrade. Parts not available	Requires **excessive maintenance** to remain in operation

Physical Condition Definitions

Rating	Condition	Civil/Structural	Mechanical	Electrical	Instrumentation
1	Very Good	**Physically sound** and performing as intended. Good access and secure safe site	Physically sound and performing **as new**	No abnormalities and resembles **as new**	Operating **without defect**
2	Good	Showing **Minor deterioration** (initial stages of decay)	Showing **Minor signs of deterioration** (increased vibration, noise, heat, etc.). Still operating efficiently.	Showing **Minor signs of deterioration**. Still operating efficiently.	No deterioration. **Not current generation**, but all components/ parts are still available.
3	Fair	Showing **deterioration.** Early stages of decay (minor cracking, staining, peeling paintwork, minor leakage)	Showing signs of **deterioration** (corrosion, vibration, noise, heat, etc.) becoming more evident.	Showing signs of **deterioration** (wear and tear). Reduced efficiently	Showing signs of **deterioration**. May not be current standard but parts are still available.
4	Poor	Portion of asset is **physically deficient** (leakage, cracking, spalling, loss of stability or deformation, corrosion)	Significant leaks, vibration, looseness, misalignment or out of balance. Requiring significant maintenance.	**Serious deterioration/defects** is impacting performance, serviceability and affecting the process.	**Frequent problems** due to significant defects. Difficult to obtain parts.
5	Very Poor	Physically unsound with **High probability of failure.** Serious structural problems causing significant safety concerns	**Unreliable** with frequent breakdowns. Requires excessive maintenance.	**High risk of breakdown** with a serious impact on the systems safety, efficiency and operation.	Total **replacement is required**. Parts are no longer available.

Example WWTF System Hierarchy (Asset Segmentations)

FACSYSID	FACSYSNAME	*MAX(SubSystem)*
SYSTEM ID	**SYSTEM NAME**	**CONDITION**
100	Control Building	
200	Headworks	
300	Primary Clarification	
400	Sludge Aeration	
500	Secondary Clarification	
600	Electrical Building	
700	UV Building	
800	Waste Sludge Handling	
900	Polymer NaOCl Systems	
990	Site	

Hierarchy (Asset Segmentations) are specific to each facility.

Example WWTF Sub-System Hierarchy (Asset Segmentations)

FACSYSID	FACSUBSYSID	FACSUBSYSNAME	*Performance*				*Physical*				*Age*			*MAX*
SYSTEM ID	**SUB-SYSTEM ID**	**SUB-SYSTEM NAME**	**Safety**	**Efficiency**	**Technology**	**Maint.**	**C**	**M**	**E**	**I**	**EUL**	**AGE**	**REMLife**	**CONDITION**
100	100	Control Building - Civil												
100	120	Control Building - HVAC												
200	200	Headworks Building - Civil												
200	201	Headworks - Screening												
200	202	Headworks - Grit Removal												
200	210	Headworks - HVAC												
200	270	Headworks - Biofilters												
200	280	Headworks - Odour Control												
300	300	Primary Clarification Building - Civil												
300	301	Primary Clarification - Tank 001												
300	302	Primary Clarification - Tank 002												
300	303	Primary Clarification - Tank 003												
300	320	Primary Clarification - Distribution Chamber												
300	330	Primary Clarification - Scum Pumping												
300	350	Primary Clarification - Sludge Pumping												
400	401	Sludge Aeration - Tank 001												
400	402	Sludge Aeration - Tank 002												
400	403	Sludge Aeration - Tank 003												
400	410	Sludge Aeration - Inlet												
400	450	Sludge Aeration - Blowers												
400	460	Sludge Aeration - RAS Splitter Box												
500	500	Blower Building - Civil												
500	501	Secondary Clarification - Tank 001												
500	502	Secondary Clarification - Tank 002												
500	503	Secondary Clarification - Tank 003												
500	510	Secondary Clarification - Inlet												
500	530	Secondary Clarification - Scum Pumping												
500	550	Secondary Clarification - Sump & RAS Pumping												
500	570	Secondary Clarification - WAS Pumping												
600	600	Electrical Building - Civil												
600	601	Electrical Building - HVAC												
600	610	Electrical Building - Backup Power												
700	700	UV Building - Civil												
700	701	UV Disinfection												
700	702	UV Building - HVAC												
700	750	UV Disinfection - Finger weirs												
800	801	Sludge Thickening												
800	802	Sludge Holding												
800	803	Sludge Pumping												
800	804	Sludge Dewatering												
900	901	Polymer Feed												
900	903	NaOCl Feed												
900	910	Outfall Chamber												
990	991	Site - Civil												

Condition Scoring Comments

Appendix C: 2023 WWMP Executive Summary

Halifax Water

Wet Weather Management Program: Executive Summary

2023/24

Prepared by: WWMP
Date: Sept 2024

1. Introduction

The purpose of the annual report is to provide a summary of WWMP activities and short-term and long-term objectives within the program. While the intent of the WWMP is to manage wet weather flows throughout the entire collection system, the current activities of the WWMP are focused within the priority sewershed areas identified within the Infrastructure Master Plan (IMP), Halifax Water's 30-year long-term infrastructure plan. The reporting period for this report is April 1, 2023 to March 31, 2024

2. Program Overview

The WWMP continues to work extensively to improve program integration with other Halifax Water departments. The Wet Weather Steering Committee (WWSC), which includes Halifax Water senior staff in Wastewater & Stormwater Operations, Regulatory Compliance Services and Engineering & Capital Infrastructure, continues to meet regularly to guide and coordinate WWMP direction and activities, ensuring alignment with the Integrated Resource Plan and the Infrastructure Master Plan.

Near the end of 2023, Stantec was engaged to complete an independent review of the Wet Weather Management Program. The goal of this engagement was to assess the current state of WWMP and compare to industry best practices. This identified where we align with industry best practices and where we have areas for improvement. The results of this review will be discussed in more detail in next year's report.

This report will include updated forecast for the following program activities in 2023:

- Priority Sewershed Ranking of flow monitoring zones
- Initial sewershed flow evaluation for new WWMP flow monitoring zones
- Evaluation of new WWMP flow monitoring sites for suitability of location and data quality

This report will include final results for the following projects:

- Hornes Road Private-side Pilot – second year (final) post reporting
- Clayton Park Lateral Grouting Pilot- third year (final) post reporting (additional year due to data unavailability)
- Crescent Ave east Capital Project – second year (final) post reporting

3. Program Activities

The WWMP continued to investigate Priority Sewersheds through Sanitary System Evaluations Surveys (SSES) to support projects and activities in all regions in 2023. A summary of SSES investigations and activities and future projects is provided in Figure 1 and Table 1. Project areas shown in blue are projects in IMP identified Priority Sewersheds and show SSES activities in areas where future projects will be or have been completed. Those shown in orange are pilot projects for the WWMP to evaluate new rehabilitation techniques and the effectiveness of private side activities on peak flow reduction.

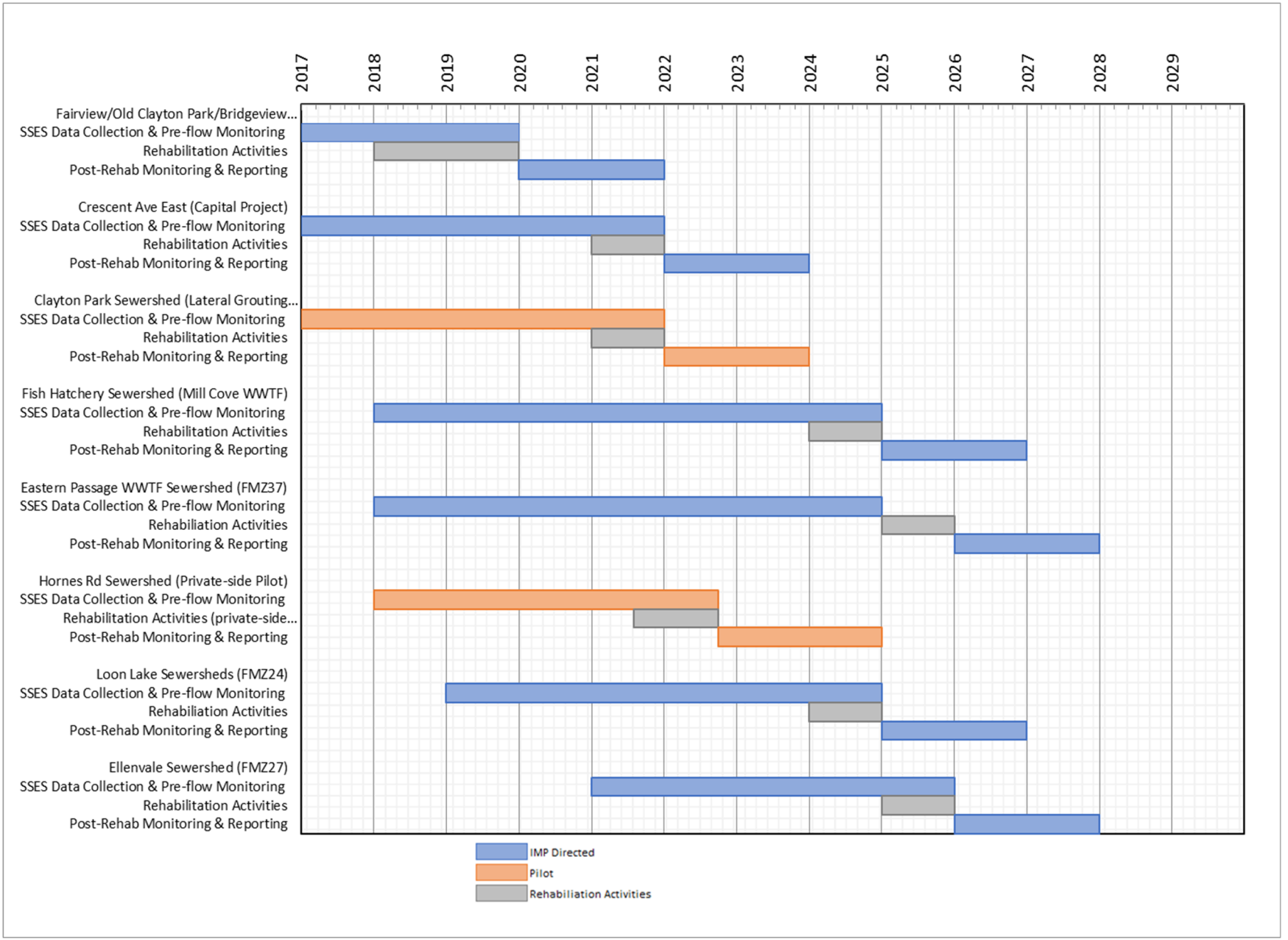


Figure 1: WWMP Projects Timeline

Table 1: 2023/24 WWMP Activity

SEWERSHED / PROJECT	2023/24 ACTIVITY	ASSET/DEFECT QUANTITY	REPORTING
Pilot Projects			
Hornes Rd Sewershed, Private-side Pilot (WWMP24)	Flow monitoring, SSES (CCTV lateral inspections) and private-side education & inspections	*112 property inspections* *93 lateral inspections*	*0 L/sec*[1]
Clayton Park Sewershed, Lateral Connection Grouting Pilot (WWMP16)	Flow monitoring	*138 lateral connections grouted*[2]	*0 L/sec*[3]
Capital Rehabilitation Projects			
Crescent Ave East, Mainline Lining Project (WWMP63)	Flow monitoring	*~1,500 m wastewater CIPP mainline lining (2021 project)*	*3.2 L/sec (16%)*[4]
Internal Rehabilitation Projects			
Loon Lake Sewershed (FMZ24)	CIPP lining of the Codroy Ave easement parallel to Montague Rd.	*~600 m of CIPP lining of wastewater pipe*	*Reporting deferred to 2024 Annual Report due to delays in receiving data*
IMP Priority Sewershed Investigations			
Fish Hatchery PS Sewersheds (FMZ07, FMZ10, &FMZ40)	Flow monitoring (18 monitors) and SSES (smoke testing, lateral and manhole inspections, mainline and manhole repairs)	*31 defects repaired* *~4,000 m of mainline inspections* *48 CleverScan manhole inspections* *~700 lateral inspections* *~18,000 m smoke testing*	*23% of identified mainline and manhole defects repaired in 2023-24.*
Eastern Passage Sewershed (FMZ37)	Flow monitoring (7 monitors) and SSES (Manhole, lateral inspections)	*22 manhole inspections, 112 lateral inspections and 10 mainline, manhole defects repaired in 2023*	*22% of public-side repairs completed, reporting deferred to 2024 Annual Report due to delays in receiving data*
Ellenvale Sewershed (FMZ27)	Flow monitoring (8 monitors) and SSES (CCTV mainline inspections)	*~7,200 m, mainline inspections*	*DMRs in progress*
Loon Lake Sewershed (FMZ24)	Flow monitoring (4 monitors), manhole, mainline repairs	*13 public-side defects repaired*	*57% of public-side repairs complete, reporting deferred to 2024 Annual Report due to delays in receiving data*
FOCP/Bridgeview Sewersheds	Flow monitoring and SSES (lateral inspections, manhole repairs)	*20 defects repaired* *~4,000 m mainline inspection (post-lining)*	*Additional lateral inspections and smoke testing to be completed in 2024*
Other Sewershed Investigations			
Frame WWTF Sewershed (WWMP56)	Flow monitoring and SSES (lateral inspections), CIPP mainline lining	*none*	*Lateral inspections to be reviewed, 2024 CIPP lining project* ***on hold***

SEWERSHED / PROJECT	2023/24 ACTIVITY	ASSET/DEFECT QUANTITY	REPORTING
Uplands WWTF Sewershed (WWMP10)	Flow monitoring and SSES (lateral inspections), CIPP mainline lining	*103 lateral inspections*	*Lateral inspections completed, 2024 mainline lining project **on hold***
Dingle PS Sewershed	Flow monitoring (2 monitors), manhole repairs.	*2 defects repaired* *36 CleverScan manhole inspections (to be reviewed)*	*Manhole repairs completed (CleverScan inspections may identify additional defects)*
Whimsical PS Sewershed	Flow monitoring (2 monitors), manhole repairs.	*2 defects repaired*	*Manhole repairs completed*
Jaybe PS Sewershed (WWMP64 & WWMP65)	Flow monitoring (2 monitors), CCTV mainline inspections	*~3000 m, mainline inspections, 20 major structural defects* *~1,700 m CIPP structural lining proposed for 2024*	*Results to be reported in 2024 Annual Report*

Results are based on 24- hour return period during 1 in 5-year rainfall event.

[1] project scope was originally 48 laterals, more at-risk laterals identified during project.

[2] pipe lengths lined updated after project completion, additional length added during project.

[3] no flow data for Q4 2021 available due to technical issue with flow meter, analysis deferred to 2022 report.

[4] number of repairs are estimated based on observed CCTV defects, TBD.

4. Pilot Projects

4.1. Hornes Road - Private-Side Pilot

In 2019, Hornes Road was chosen for a private-side pilot based on its location within a Priority Sewershed (Eastern Passage, FMZ37). Collection of baseline data began in Q3 2019 to monitor the entire Hornes Road sewershed and three temporary internal flow meters to isolate flows in problem areas. In Q4 2020, an online public education webinar was presented to homeowners within the Hornes Rd sewershed and property inspections were put on hold due to the COVID-19 pandemic. Private property inspections for Hornes Road were completed in three rounds between October 2021 and June 2022. In total, 96 properties were inspected (86%) and of the total properties in the project area, violations were identified at twenty (20) inspected properties (18%). Some properties had multiple violations. Some of those violations were corrected prior to the inspections based on the educational materials provided by Regulatory Compliance Services. There were also two (2) properties with suspected violations that required further investigation. Any violation corrections were completed prior to Q4 2021 therefore post analysis began in 2021.

To date, Regulatory Compliance Services have reported to the WWMP there are still nine (9) properties with outstanding violations, and they have achieved compliance in 15 of the 24 total violations (62.5%), as shown in Figure 2.

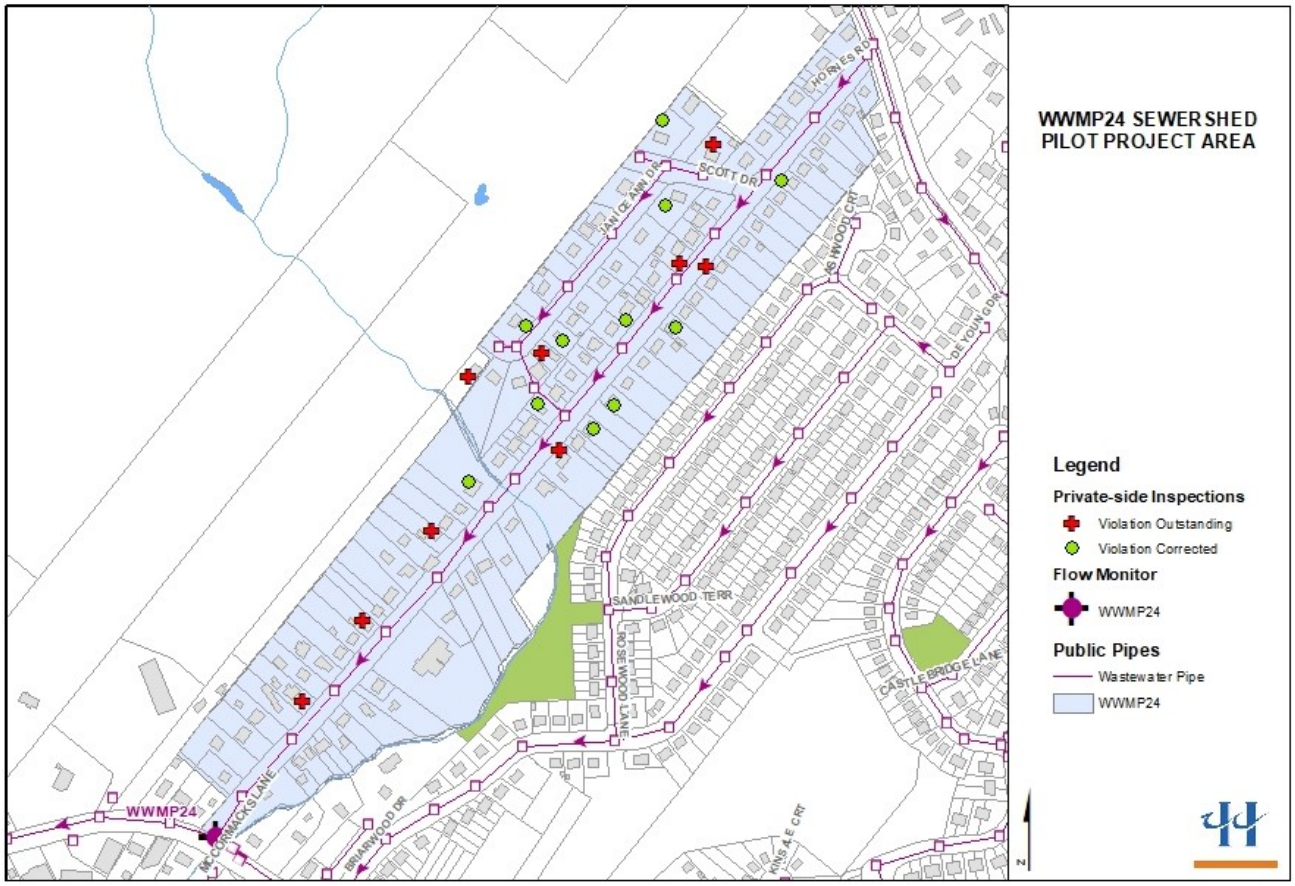


Figure 2: Hornes Rd Private-side Pilot Area (WWMP24 Sewershed)

From 2021, 2022 and 2023 analyses, the post-rehabilitation peak RDII in the sewershed on average was higher by 19.3 L/sec (50%) than the pre-rehabilitation conditions for a 5-year design storm, as shown in Figure 5. The Average Dry Weather Flow also increased by 1.6 L/sec (118%).

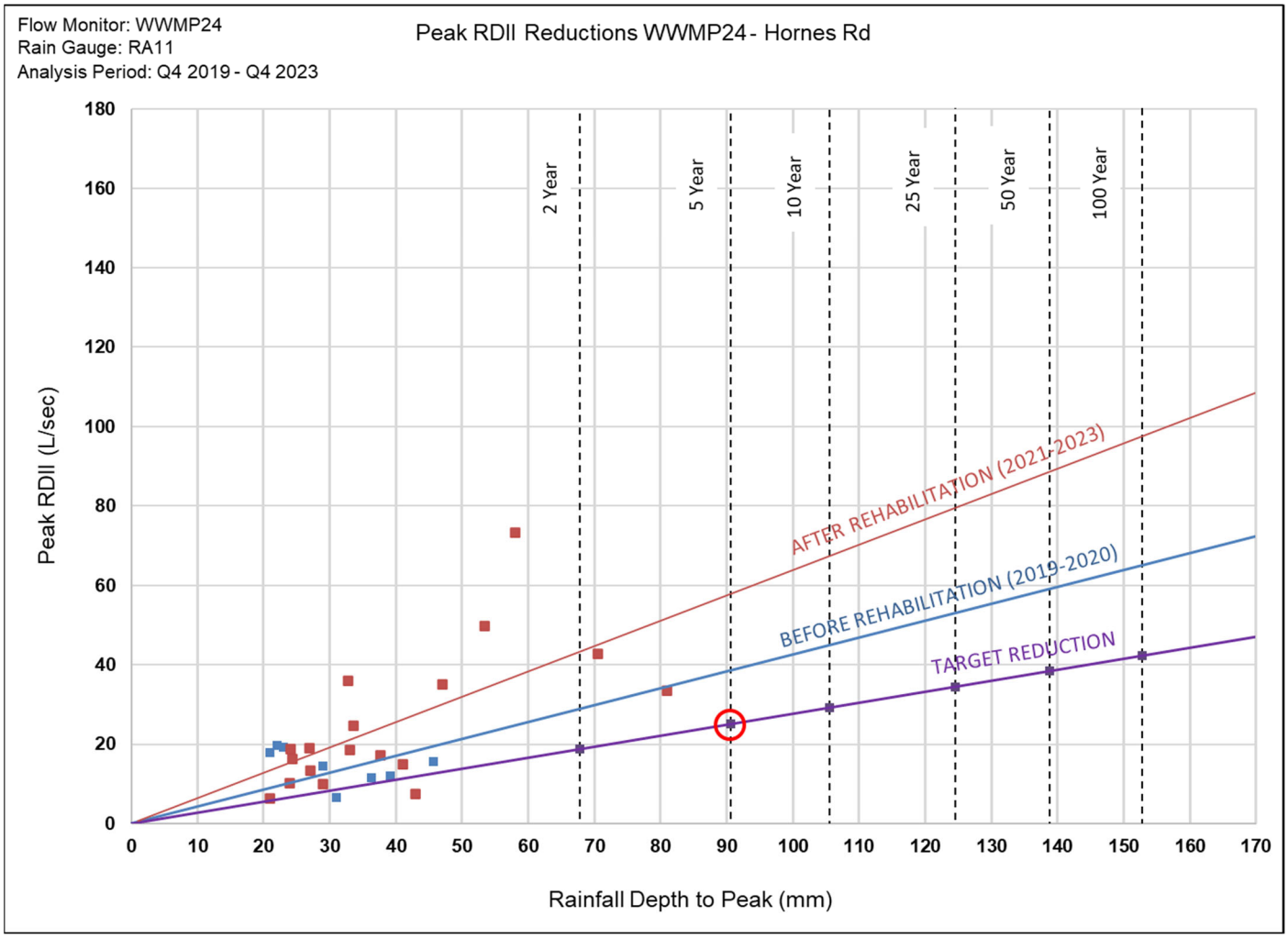


Figure 3: WWMP24 Private-side Reductions

The increase in RDII may be a result of higher average Q4 rainfall post-rehab than pre-rehab. Lack of flow data available for other sewersheds limits the ability to confirm this. The pre and post flow monitors were contracted from different manufacturers, which may also result in variances in flow data.

Due to the unexpected increase in RDII following the private-side pilot project, lateral inspections were completed in 2023 to determine if there are any additional I/I sources within lateral services beyond private inflow sources. From this analysis, 48% of the laterals in WWMP24 had defects on either the public or private portion of the laterals that have the potential to contribute significant RDII and should be considered for future rehabilitation in some form.

In conclusion, both dry weather and wet weather flows increased for WWMP24 post-rehabilitation. It is unclear why this is

the case, whether it is a result of wet vs dry seasons or a change in flow monitor manufacturers. Further investigation and rehabilitation activities are recommended for this sewershed.

4.2. Clayton Park – Lateral Connection Grouting Pilot

Following the full-scale capital mainline CIPP lining project in the WWMP16 Sewershed (Old Clayton Park), a lateral connection grouting pilot project was completed in 2021 to address defective lateral connections that were identified during SSES activities. In total, 138 laterals (48% of total laterals within the sewershed) were grouted and sealed during the project due to pressure test failures. Refer to project area map in Figure 4.

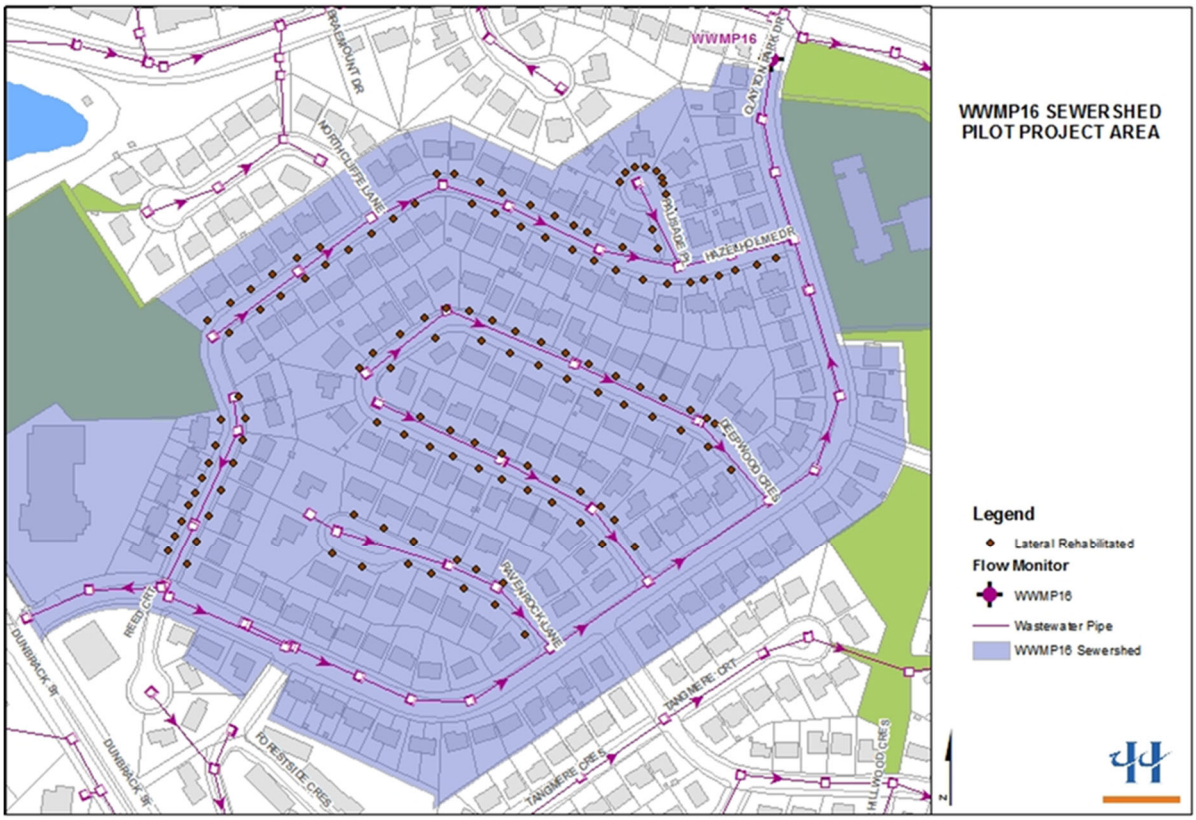


Figure 4: Lateral Connection Grouting Pilot Project Area (WWMP16 Sewershed)

Since only the connections to the wastewater main was rehabilitated, this left the remaining lateral defects untreated. Additionally, the lateral connections on the lower laying Clayton Park Dr were not included in the project scope due to budgetary reasons.

As shown the analysis in Figure 5, there was no measured reduction ("After Lateral Rehabilitation (2021-23)", data shown in purple) at the WWMP16 flowmeter for three consecutive Q4 seasons and peak flows appear to have increased following the grouting project. Due to this, the results from this rehabilitation pilot were not considered a success.

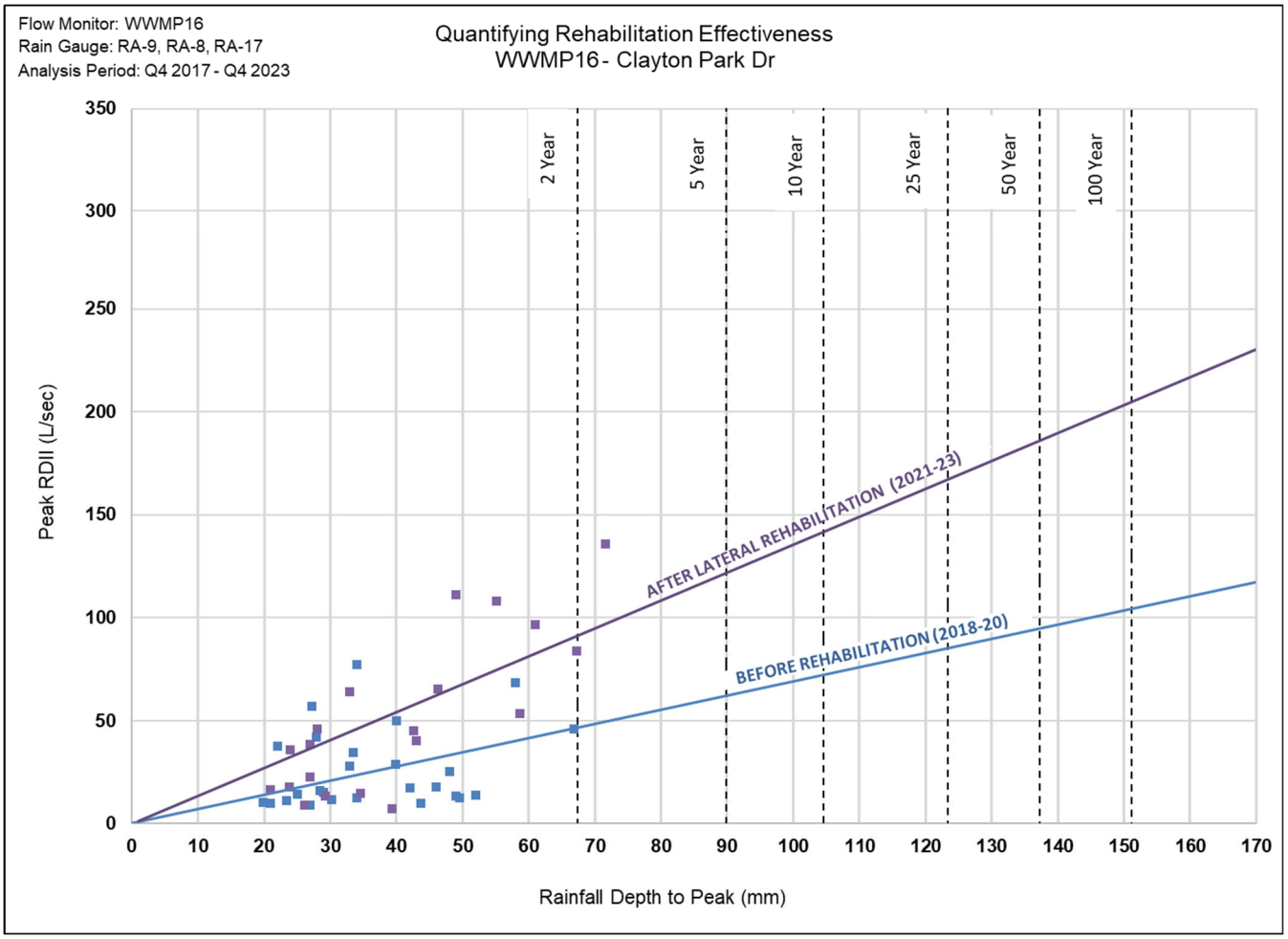


Figure 5: WWMP16 Pre & Post Rehabilitation Analysis

Based on the preliminary results of the pilot project in 2022, the WWMP decided to complete CCTV lateral inspections to identify any additional defects in lateral pipe assets that would convey inflow into the wastewater system within the sewershed. The results of these inspections are shown in Table 2. Note that many inspections could not be completed due to deformed no-corrode lateral pipe. These are at risk of collapse and should be replaced.

Table 2: Lateral Inspection Defects Summary

Street	Total no. lateral inspected	No. of lateral with defects	% Defective inspected laterals	No. of deformed no-corrode laterals
Deepwood Cres	54	27	50%	31
Clayton Park Dr	64	41	64%	21
TOTAL	118	68	58%	52

From this analysis, more than 50% of laterals in each street have defects beyond the connection point to the main; defects that would not have been addressed during the connection grouting pilot.

Mainline CCTV inspection was also completed to assess the condition of lateral connections after the pilot project. A number of defective lateral connections with high inflow on Clayton Park Dr (not included in project scope) and lower portions of Hazelholme Dr, Deepwood Dr and Ravenrock Ln were observed during the inspections; see results in Table 3.

Table 3: Lateral Connection Defects Summary (post lateral grouting pilot inspections)

Street	Total no. of lateral connections	No. of laterals with connection defects*	% Defective lateral connections
Deepwood Cres	54	16	30%
Clayton Park Dr	64	52	81%
Hazelholme Dr	62	38	61%
Ravenrack Ln**	16	13	81%
Palisade Pl	12	10	83%
TOTAL	208	129	62%

**post lateral grouting pilot project data*
***two laterals connected in MH8752, unknown condition*

Although wet weather flows increased following the grouting pilot, overall reductions trending following the mainline CIPP project in 2018 remained consistently lower than pre-rehabilitation peak flows, shown by the data in Figure 6.

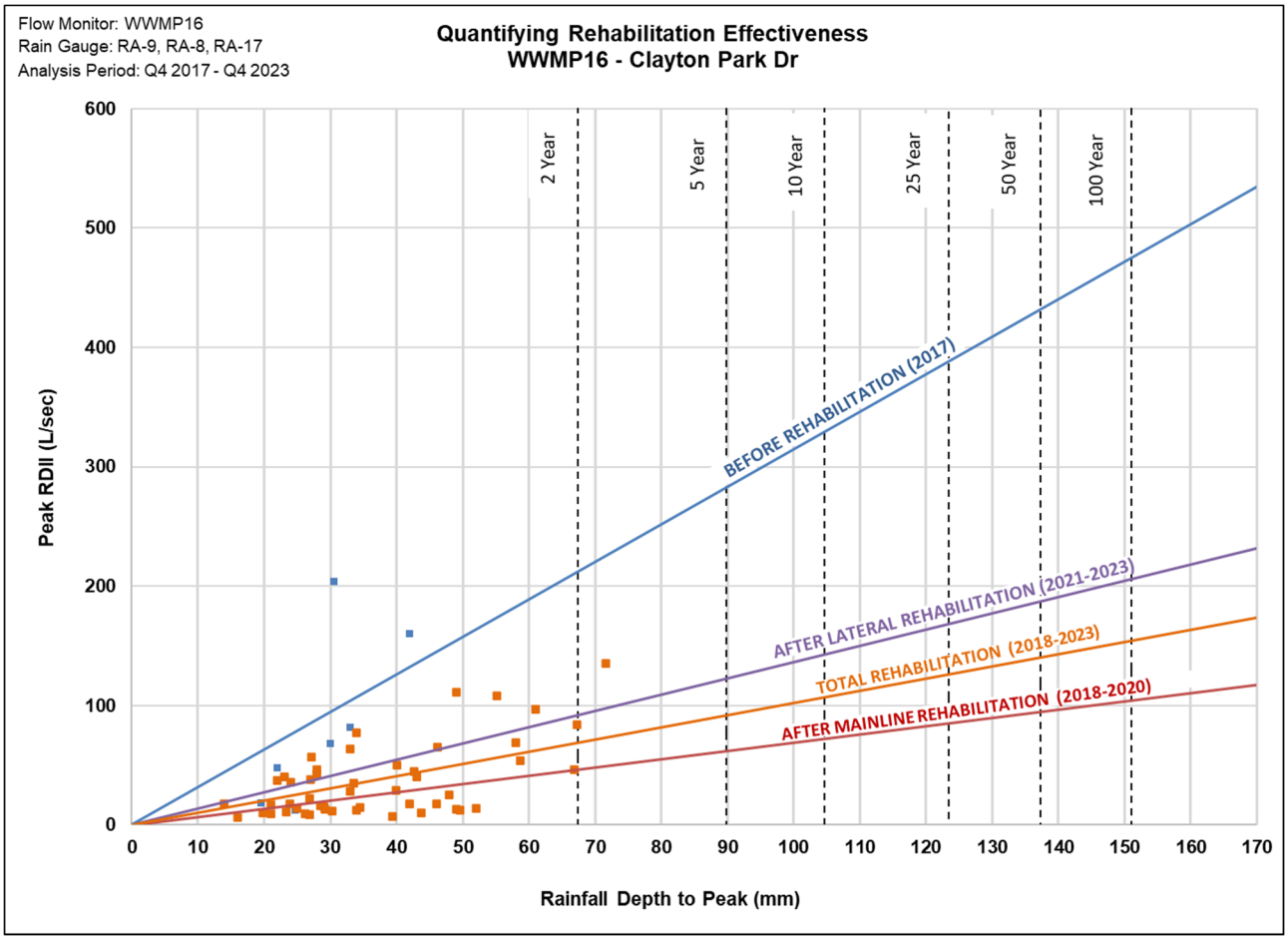


Figure 6: WWMP16 Pre & Post Rehabilitation Analysis

In conclusion, while lateral grouting is an acutely effective solution to mitigate lateral connection defects from a structural perspective it is not an effective approach to address inflow and infiltration due to the migration of wet weather flows and groundwater to weaker points in the system. Results of this pilot have shown that a more comprehensive approach in including complete full or "top-hat" lateral lining or replacement to be more effective where lateral defects exist beyond the connection point to the wastewater main. Further investigation and rehabilitation activities are recommended for this sewershed.

5. Capital Rehabilitation Projects

5.1. Crescent Ave East – Mainline CIPP Project

Beginning in 2016, CIPP lining rehabilitation was piloted within the west side of the Crescent Ave PS Sewershed. Approximately 25% of the sewershed was rehabilitated using mainline, manhole and lateral CIPP lining. The pilot proved effective in reducing peak flows to the pumping station. In 2021, the remaining 75% of the sewershed, approximately 1,500 m including a section of concrete pipe within an easement along Chocolate Lake was CIPP lined to further reduce wet weather flows as the pumping station still required operational intervention during heavy rain events. Refer to project area map in Figure 7.

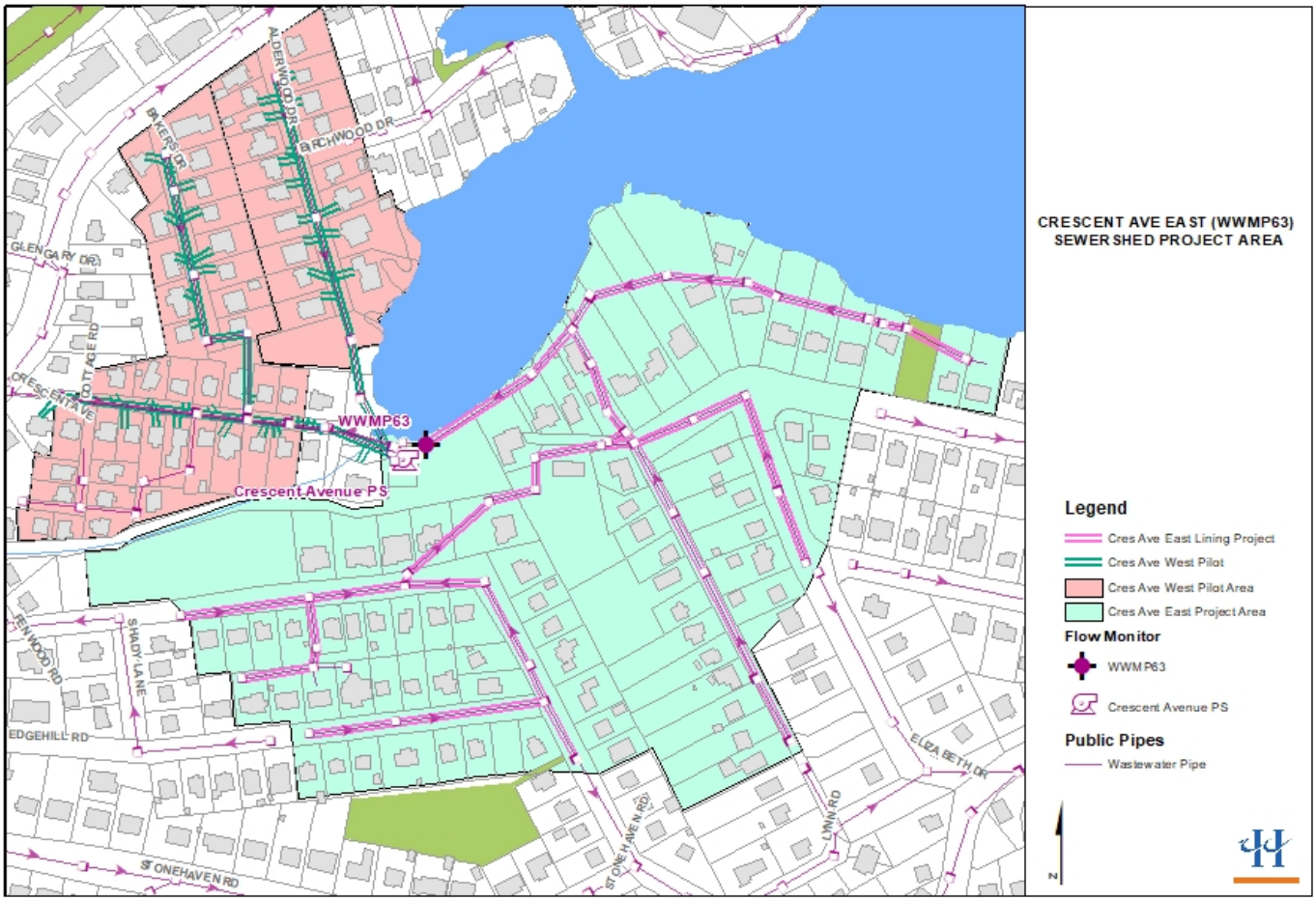


Figure 7: Crescent Ave East Pilot & Project Areas

As noted in the 2022 WWMP Annual Report, flow monitoring in the project sewershed has been difficult due to a failure in data collection for the flowmeter at MH177 and subsequent installation of new metering equipment in November 2022 (WWMP63). As shown in the analysis in Figure 8, there was a reduction of 3.2 L/sec for a 1 in 5 year design storm (16%) at the WWMP63 flowmeter. Although a reduction was observed, the use of two different flow monitors (MH177 FM & WWMP63), one with little maintenance, could impact the pre and post comparisons in the data due to differing instrumentation and calibration.

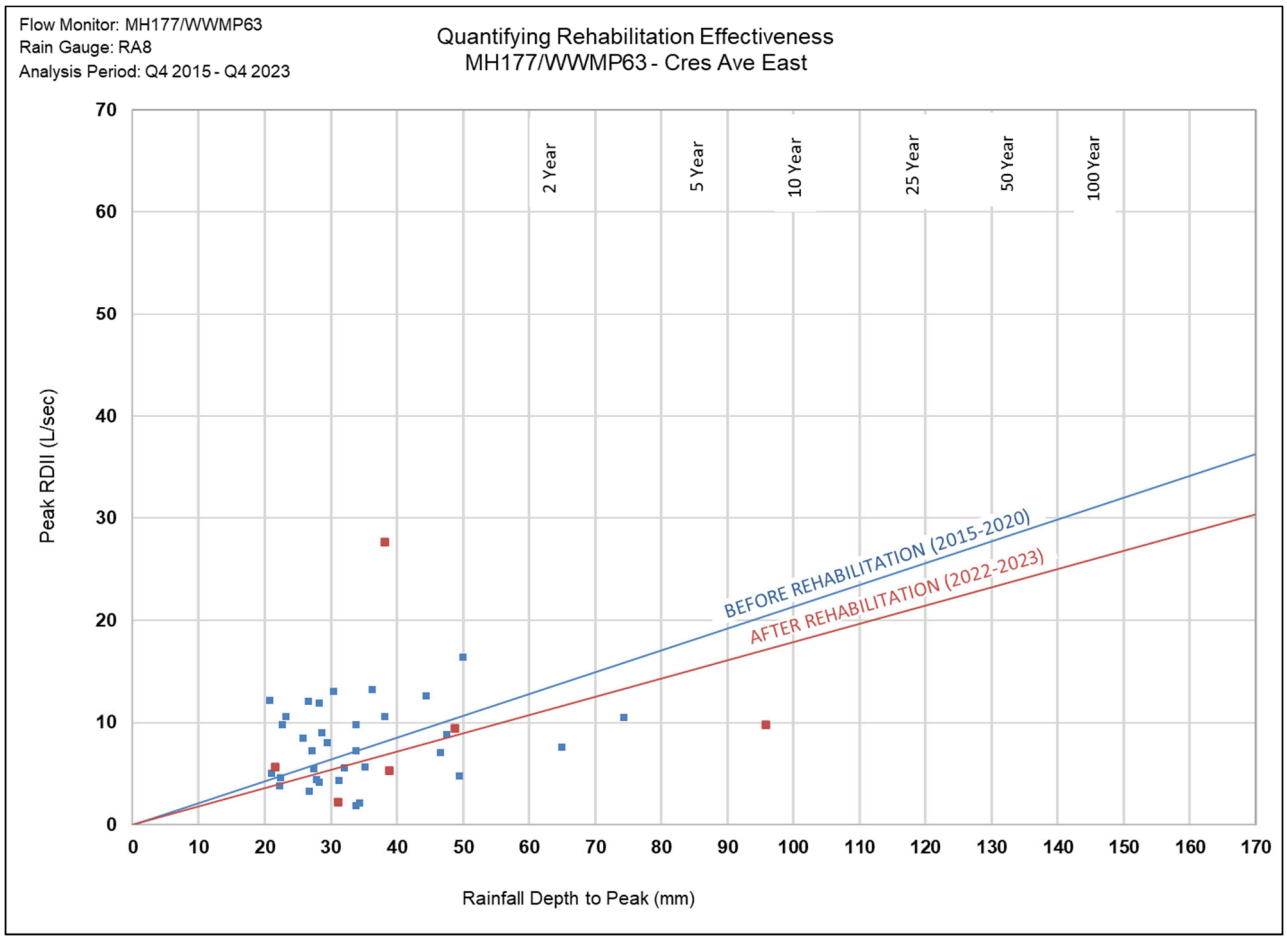


Figure 8: MH177/WWMP63 Pre & Post Rehabilitation Analysis

In addition to the reduction in peak flows as a result of this rehabilitation project, Cres Ave PS continues to manage flows during wet weather. In 2023, Crescent Ave PS experienced no recorded overflows for a second year following the project and have been consistently reduced as shown in Figure 9.

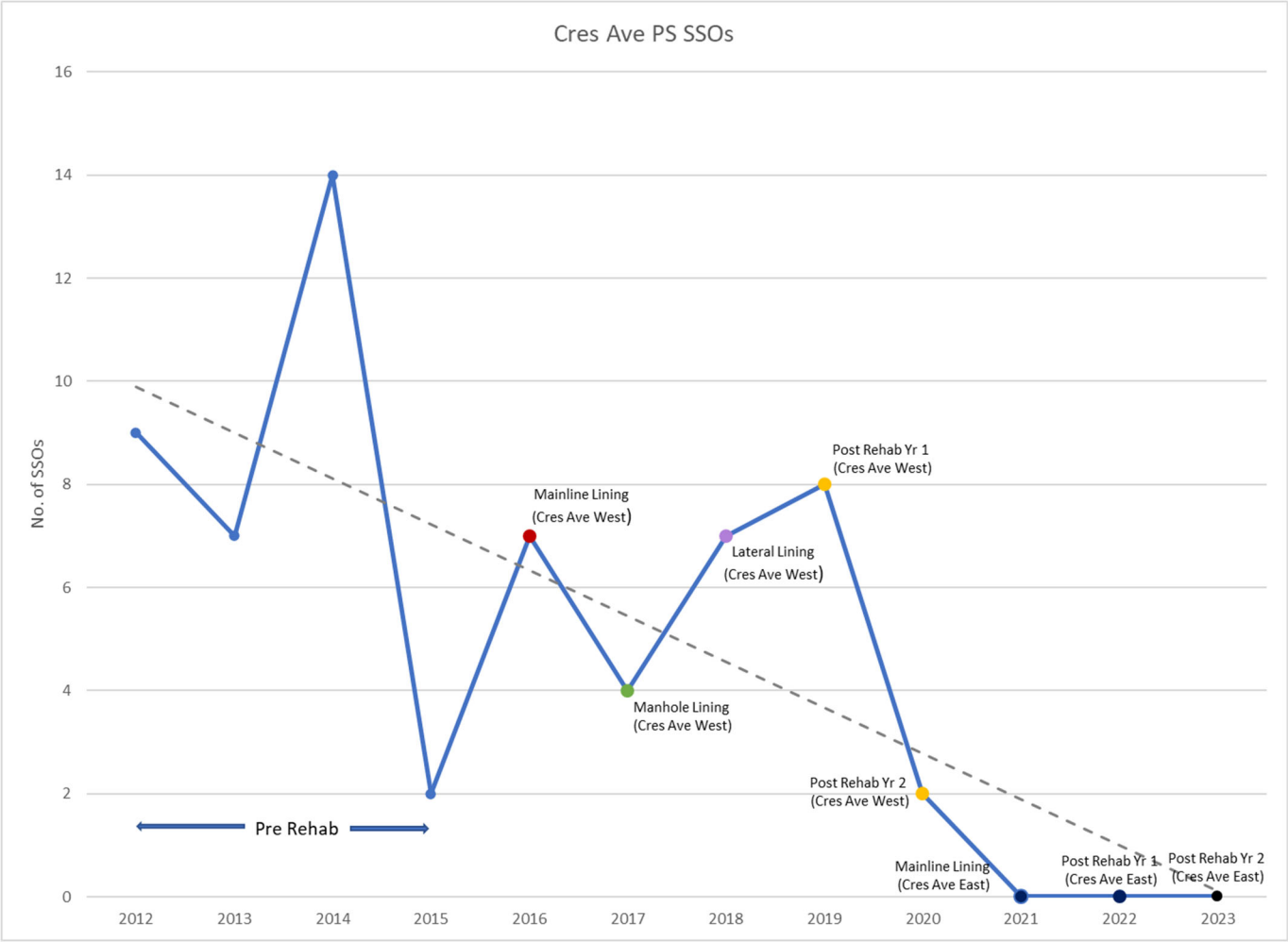


Figure 9: Crescent Ave PS Overflow Trending (2012-23)

In conclusion, CIPP lining still remains to be an effective rehabilitation technique in areas where mainline defects exist by sealing any existing infiltration and increasing the longevity of the pipe, however, peak flow reductions are limited by the ability to effectively address additional I/I sources on the private-side that continue to impact wet weather flows. Additional I/I reductions may be possible with more in depth investigation through lateral inspections to identify any lateral defects and private side defects identified during smoke testing.

6. Halifax Water Operations' Rehabilitation Projects

These small-scale rehabilitation projects are completed internally by Halifax Water Wastewater & Stormwater Operations to reduce I/I from public sources as identified by the WWMP review of CCTV inspection and I/I team investigation activities. Repairs are often carried out quickly, at a low cost, and with significant results. Coupled with the larger scale capital CIPP rehabilitation projects, these small yet effective rehabilitation activities are a key component to the WWMP Decision Matrix.

6.1. Fish Hatchery Sewersheds (FMZ07, FMZ10, FMZ40)

In the Fish Hatchery Priority Sewershed, defect repairs were completed in several WWMP sub-sewersheds in the form of manhole grout injection and mainline spot repairs. The location of these repairs in their respective WWMP sewersheds are shown in Figure 10.

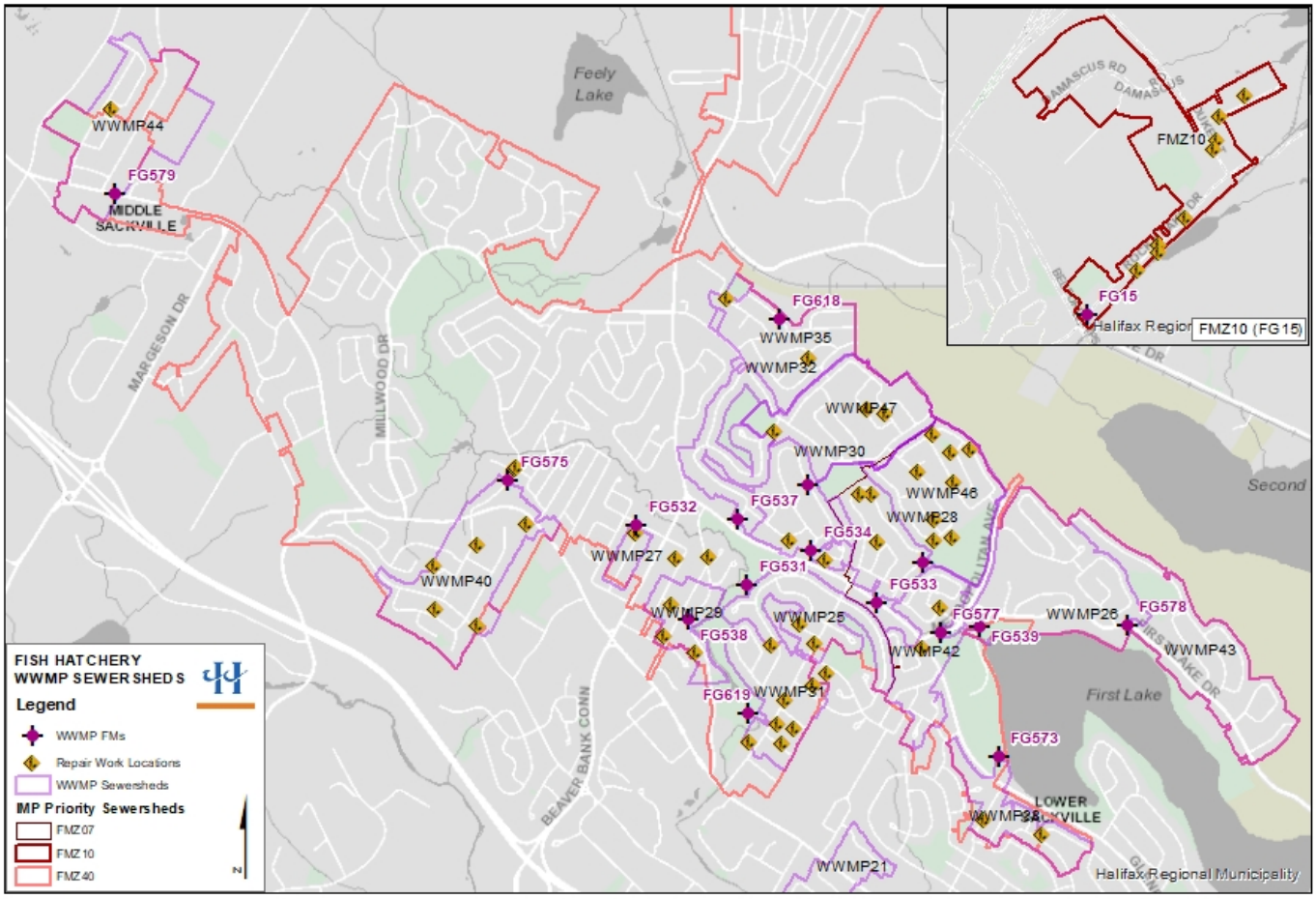


Figure 10: Fish Hatchery WWMP Sewersheds Public-side Repair Work Locations

A total of 36 public side repairs were completed of 155 defects identified in 2023.Halifax Water Operations will continue to repair identified defects on a priority basis. Properties where private-side defects have been identified were also compiled. A total of 249 private side defects on 234 properties were identified which account for approximately 10% of the sewershed. These defects will be advanced to the Regulatory Compliance Services group to make efforts for addressing the deficiencies. Reporting on the RDII reduction will be deferred to the 2024 annual report due to delays in receiving flow monitoring analysis.

6.2. Loon Lake Sewershed

In the Loon Lake Priority Sewershed, defect repairs were completed in several WWMP sub-sewersheds in the form of manhole grout injection and mainline spot repairs. The location of these repairs in their respective WWMP sewersheds are shown in Figure 11.

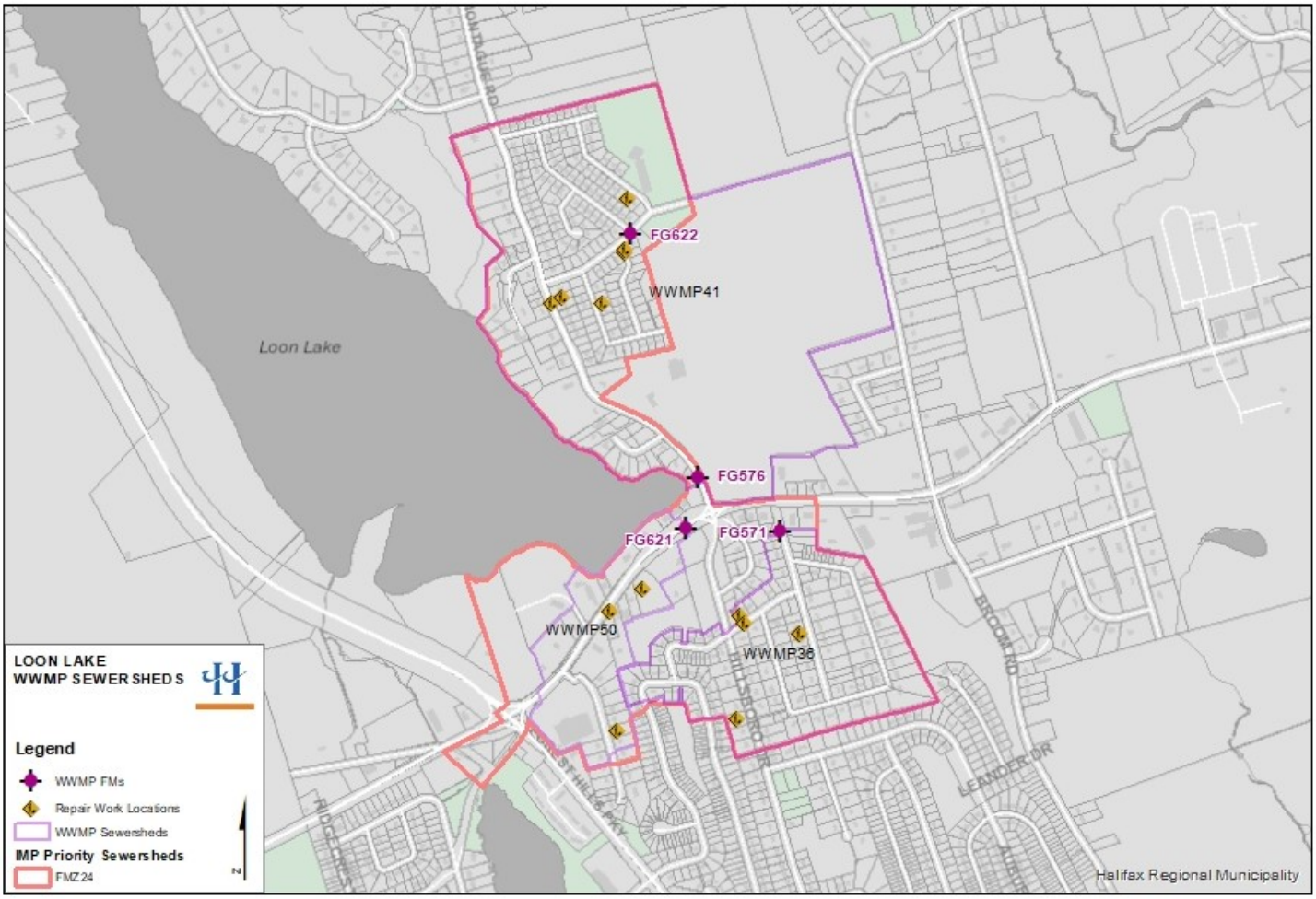


Figure 11: Loon Lake WWMP Sewersheds Public-side Repair Work Locations

A total of 13 public side repairs were completed of 23 defects identified in 2023. Halifax Water Operations will continue to repair identified defects on a priority basis. Properties where private-side defects have been identified were also compiled. A total of 54 private side defects on 52 properties were identified which account for approximately 12% of the sewershed. These defects will be advanced to the Regulatory Compliance Services group to make efforts for addressing the deficiencies. Reporting on the RDII reduction will be deferred to the 2024 annual report due to delays in receiving flow monitoring analysis.

6.3. Eastern Passage Sewershed

In the Eastern Passage Priority Sewershed, defect repairs were completed in several WWMP sub-sewershed in the form of manhole grout injection and mainline spot repairs. The location of these repairs in their respective WWMP sewersheds are shown in Figure 12.

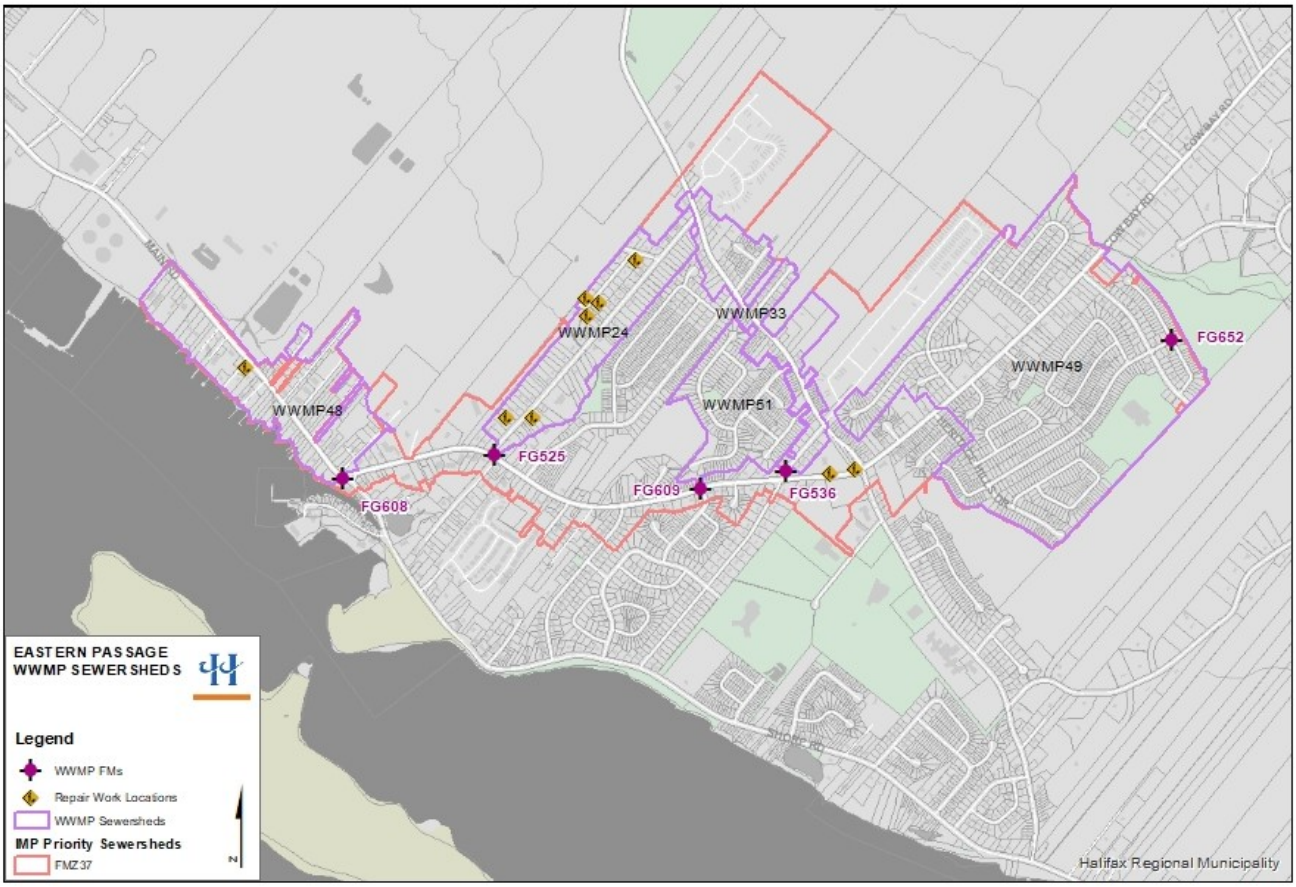


Figure 12: Eastern Passage WWMP Sewersheds Public-side Repair Work Locations

A total of 10 public side repairs were completed of 46 defects identified in 2023. Halifax Water Operations will continue to repair identified defects on a priority basis. Properties where private-side defects have been identified were also compiled. A total of 77 private side defects on 75 properties were identified which account for approximately 5% of the sewershed. These defects will be advanced to the Regulatory Compliance Services group to make efforts for addressing the deficiencies. Reporting on the RDII reduction will be deferred to the 2024 annual report due to delays in receiving flow monitoring analysis.

6.4. Fairview/Old Clayton Park/Bridgeview Sewersheds (FMZ03 & FMZ04)

In 2018/19, mainline CIPP lining was completed in several sewersheds withing the Fairview/Old Clayton Park/Bridgeview Sewersheds. As a follow-up to this project, any public-side repairs that were remaining in these sewersheds were identified and repaired. The location of these repairs in their respective WWMP sewersheds are shown in Figure 13.

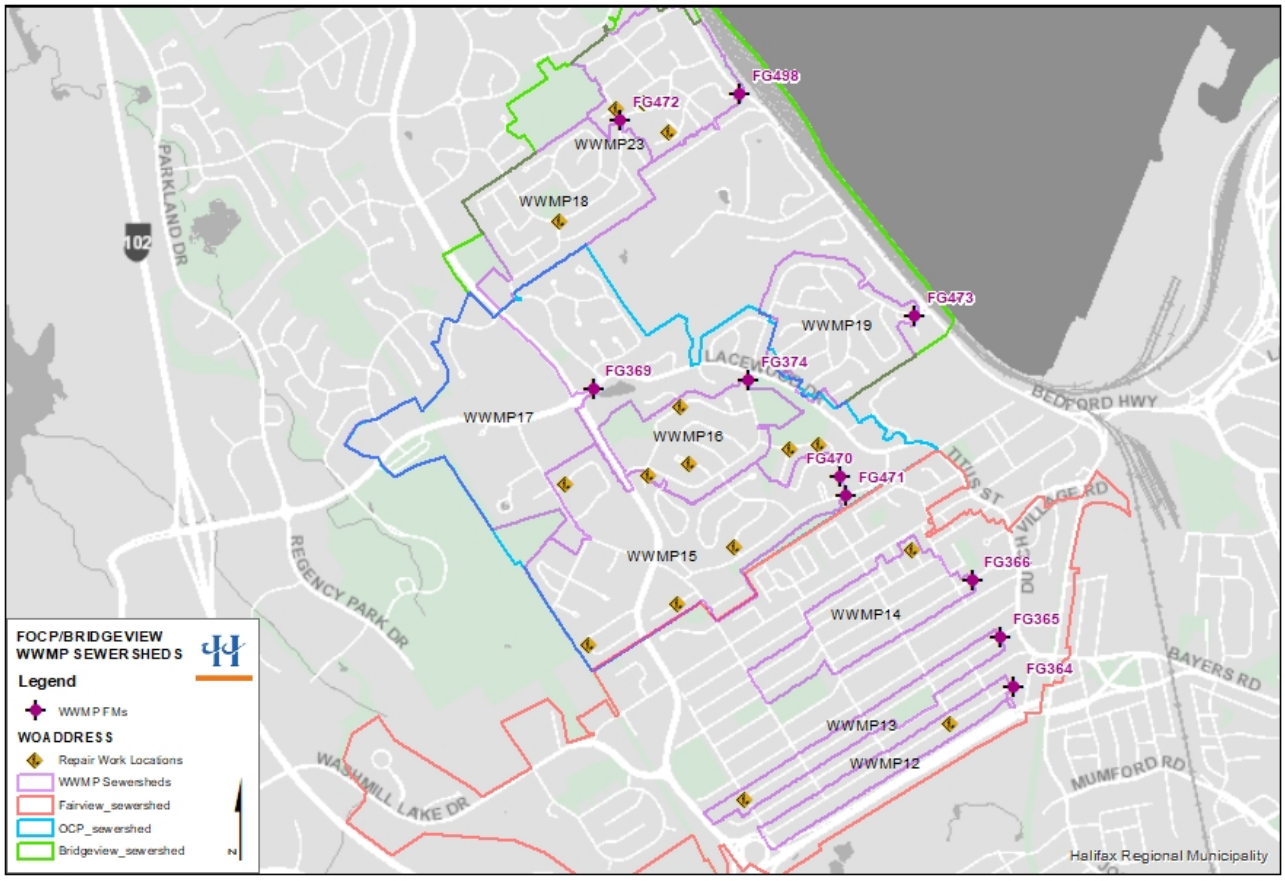


Figure 13: Fairview/Old Clayton Park (FOCP)/ Bridgeview WWMP Sewersheds Public-side Repair Work Locations

A total of 20 public side repairs were completed of 28 defects identified in 2023. Halifax Water Operations will continue to repair identified defects on a priority basis. In 2024, smoke testing investigations are planned for the Fairview, Old Clayton Park, and Bridgeview sewersheds. Reporting on the RDII reduction will be deferred to the 2024 annual report due to delays in receiving flow monitoring analysis.

7. 2024-25 Future Program Activities

The WWMP will continue to complete routine program activities such as flow monitoring, CCTV inspections, smoke testing and data analysis within the Priority Sewersheds identified in the Infrastructure Master Plan. There will be a focus on preparing Decision Matrix Reports for all of the WWMP flow monitoring zones to summarize data and support future decision making and rehabilitation projects.

The following identifies the WWMP's activities for 2024-25 to support the program's objectives:

- Program Development
    - Complete a review of the WWMP and rollout recommended improvements.
    - Enhance Decision Matrix Reports (DMRs):
        - Identify specific sources of RDII with the assistance of RTK analysis.
        - Add the cost benefit analysis to the DMRs to ensure the most cost-effective strategies are implemented.
        - Implement micro-monitoring to identify RDII influenced areas within sewersheds to help direct SSES activities more efficiently.
    - SSES Activities:
        - Continue to collect flow monitoring, CCTV, and smoke testing data as well as private side investigations.
- Defect Repair Program:
    - Continue to increase internal rehabilitation efforts through identification and repairs of defects in assets.
    - Continue to build data set of defects repaired for tracking of work completed.
- Private-side Program:
    - Continue to collaborate with Regulatory Services on level of enforcement and resource requirements.
    - Leverage existing internal resources to expand program.
- Pilot Project Activity
    - Continued to look for pilot project opportunities and continue monitoring and reporting of project outcomes.
- Capital Budget Planning
    - Develop costing estimates for each individual WWMP area to align with the capital budget for the IMP Priority Areas.
    - Identify all future capital budget expenditures for investigation and rehabilitation activities.
- Monitoring Sites
    - The WWMP will continue to monitor flow trends and report outcomes at various sites not identified in the Infrastructure Master Plan.