Halifax Water

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October 24, 2019

Craig MacMullin, MBA, CPA, CGA, Chair
Halifax Water
Halifax, Nova Scotia

A special meeting of the Halifax Water Board will be held on October 31, 2019. The In-Camera meeting will be held at 9:00 a.m., followed by the Regular Meeting at 10:00 am in the Boardroom at 455 Cowie Hill Road, Halifax.

AGENDA

In Camera Reports

1C Governance Matter

> **Motion:** That the Halifax Water Board convene to In Camera (in private) to discuss the matter.

2C Security Matter – Brought forward

> **Motion:** That the Halifax Water Board approve the recommendation as outlined in the private and confidential report dated September 17, 2019.

Regular Reports

1a. Ratification of In-Camera Motions

1b. Nomination of Committee Representative – Verbal

> **Motion:** That the Halifax Water Board appoint a representative (to be determined) to the Environmental, Health & Safety Committee.

2. Regional Development Charge Update

> **Motion:** That the Halifax Water Board approve an application to the NSUARB for the approval of the 5-year update of the Regional Development Charge and associated amendments to the Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services.

Information Reports

1-I Integrated Resource Plan Update

Original signed by:

Heidi Schedler
Secretary

ITEM # 2

HRWC Board

October 31, 2019

TO:	Craig MacMullin, MBA, CPA, CGA, Chair, and Members of the Halifax Regional Water Commission Board
SUBMITTED BY:	*Original Signed By;* Kenda MacKenzie, P. Eng., Director Regulatory Services
APPROVED:	*Original Signed By:* Cathie O'Toole, MBA, CPA, CGA, ICD.D, General Manager
DATE:	October 23, 2019
SUBJECT:	**Regional Development Charge**

ORIGIN

November 2009 HRWC Cost of Service Study

Dec. 17, 2010 Nova Scotia Utility and Review Board Decision, 2010 NSUARB 244 requesting Halifax Water to undertake a greater level of review and consultation in the preparation of the revised development charge; and complete a study which examines an efficient capital structure, policies of other utilities, its longer term capital needs, and options that would result in an efficient funding mechanism which is fair to present and future ratepayers.

April 17, 2014 NSUARB Decision, 2014 NSUARB 69, Halifax Water establishment of Regional Development Charge.

RECOMMENDATION

It is recommended that the Halifax Water Board approve:

1. Application to the NSUARB for the approval of the 5-year update of the Regional Development Charge and associated amendments to the Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services.

BACKGROUND

Prior to 2014, Halifax Water used historical charges transferred from the Halifax Regional Municipality (Municipality) to recoup some costs caused by development (Regional Wastewater Capital Cost Contribution, Sewer Redevelopment, and Trunk Sewer Charges). On April 17, 2014 the NSUARB approved a Regional Development Charge (RDC or Charge) for wastewater, replacing the three historic charges, and approving a new Regional Development Charge for water. The NSUARB required that Charge be updated every five years in conjunction with updates to Halifax Water's Integrated Resource Plan (IRP), or sooner if changes occurred impacting the Charge +/- 15%.

In developing the initial RDC, Halifax Water relied on the Regional Wastewater Functional Plan (RWWFP) and the IRP for the water components. Since 2014, Halifax Water adjusted the strategy for updating the RDC utilizing outputs from the Infrastructure Master Plan (Attachment A); more detailed servicing plans for wastewater and water completed for Halifax Water's West, East and Central Regions. The outputs from the Infrastructure Master Plan were also used to update the IRP.

Halifax Water reviewed the Charge in January 2018 (Attachment B) and determined that an update was not necessary at that time.

The IRP identifies three drivers for long-term infrastructure investment by Halifax Water: asset renewal, compliance and growth. Growth-related infrastructure facilitates continued growth within the region consistent with the Municipality's Regional Plan. Growth-related infrastructure includes local, area-master and regional infrastructure. Local and area-master infrastructure is either directly installed by a developer or captured within Halifax Water's Capital Cost Contribution policy, which the developer is directly responsible to finance at the time of development. Halifax Water is responsible for financing regional growth-related infrastructure, such as treatment facilities, trunk wastewater collection and water transmission mains.

In financing regional growth-related infrastructure, Halifax Water's role is to develop a long-term infrastructure plan and financial plan for the regional growth-related infrastructure needed to support on-going development.

The Infrastructure Master Plan and the IRP form the foundation for Halifax Water's plan for long-term growth-related infrastructure. The growth-related objectives of the IRP which are dependent upon RDC funding are to:

- Provide regional water, wastewater and stormwater infrastructure needed to support planned growth.
- Manage flow and demand to maximize capacity for growth and minimize the need for new hard infrastructure.

Following the cost causation principle, Halifax Water proposes to update the existing RDC to ensure a fully-funded financial plan is in place for a 20-year planning horizon. An updated RDC is required to provide sufficient funding for Halifax Water's regional growth-related capital investments to ensure that the appropriate infrastructure is in place to meet the needs of new development and growth.

Subject to Halifax Water Board approval of this report, an application to amend the RDC will be filed with the NSUARB to commence a public hearing process. A hearing has been scheduled the week of March 23 – 27, 2020. Approval of this report initiates the process; but quality control review, dialogue with stakeholders, and adjustments will continue throughout the process and the final charges approved by the NSUARB may be different than the charges requested in the application.

DISCUSSION

Halifax Water staff, with the support of technical consultants, completed a review of current practice, industry standards and utility infrastructure requirements to update the existing RDC.

Stakeholder Engagement

Halifax Water engaged with stakeholders through a process that included three formal stakeholder consultations (Attachment C). The full description of the stakeholder consultation process is contained within the *Regional Development Charge Update 2019 – Technical Memo, October 2019* (Attachment D).

For the benefit of the stakeholder engagement process, Halifax Water developed its adjusted RDC. The adjusted Charge was used during stakeholder engagement to identify current financial requirements and provide a consistent approach across the development industry. In determining the updated Charge, Halifax Water considered the Charges collected to date and financing costs over the 20-year period to facilitate the growth-related capital investment. The updated Charge for wastewater and water, as summarized below, includes an allocation across variations in building unit type: Single Unit or Townhouse/Row House Dwelling (SUD/TH/RH), Multi Unit Dwelling (MUD), Industrial/Commercial/Institutional (ICI).

It is proposed the wastewater RDC and the water RDC will be indexed each year on April 1, in accordance with the indexing set out in the consumer price index for Halifax, as published by Statistics Canada for the immediately preceding month, when compared to the same month for the immediately preceding year. This is consistent with annual indexing for Halifax Water Capital Cost Charges. The RDC financial model incorporates collections, infrastructure escalation, projected inflation and balance financing. The output of the financial model is a Charge in 2019 dollars and requires annual indexing. Annual indexing prevents over collection of Charges and developers in early years subsidizing those in later years. The annual indexing helps smooth the impact of future RDC adjustments and provide some predictability to the development community.

Table 1 Proposed Rate Structure - Wastewater*

Type of Development	Existing Charge	May 1, 2020
Adjusted for SUD/TH/RH	$ 4,080.80	$ 4,941.04
Adjusted for MUD	$ 2,740.84	$ 3,318.61
Adjusted for ICI m^2	$ 24.11 ($ 2.24 ft^2)	$ 25.83 ($ 2.40 ft^2)

Table 2 Proposed Rate Structure – Water*

Type of Development	Existing Charge	May 1, 2020
Adjusted for SUD/TH/RH	$ 182.88	$ 1,810.10
Adjusted for MUD	$ 122.83	$ 1,215.74
Adjusted for ICI m^2	$ 0.97 ($ 0.09 ft^2)	$ 9.47 ($ 0.88 ft^2)

*During the period from Board approval until the NSUARB application is submitted, staff will be conducting additional quality control as the Charge application is assembled and dialogue with the industry stakeholders continues. Minor changes in the Charge may occur. The Board will be notified of substantive changes that cause an impact greater than +/- 5% to the proposed Charge. Once the hearing process commences the Board will be updated at each board meeting.

Note the Infrastructure Program, Table 5 of the Tech memo, Attachment D, reflects total RDC program costs and does not contain any costs associated with financing or escalation.

The proposed water RDC has increased from the initial Charge as a result of more robust, comprehensive water modelling, improved data, and a review of infrastructure requirements.

During stakeholder engagement the following issues were discussed:

1) **Water conservation measures:** whether Halifax Water undertook any additional water conservation measures to reduce the overall infrastructure requirements.

Response/Discussion:

- *Halifax Water's approach to conservation measures has been to focus on Inflow and Infiltration (I&I) reduction programs and wet weather* *management; in recognition that these initiatives are most effective from a cost/benefit perspective*[1].

- *Halifax Water has introduced the use of I&I projects to gain capacity for growth. Halifax Water believes that I&I reduction efforts are, in the long term, the most cost-effective means by which to control wastewater system costs. Halifax Water will continue to vigorously pursue this program based upon its successful model in regard to water leakage reduction. A June 24, 2013 NSUARB Decision regarding Matter M05463 commented on conservation and demand side management initiatives. The Decision stated that:*

  > [69] The Board is aware of Halifax Regional Water Commission's (HRWC's) significant effort to complete the IRP for its water, wastewater and stormwater service, and is encouraged with the result. The IRP process has confirmed the initial assumption that there are significant data gaps and that they need to be filled. An overall conclusion is that HRWC has sufficient water supply but is restricted in wastewater treatment. While the Board, in general, supports water conservation efforts, in the case of HRWC, it is more financially effective at this time to reduce wastewater flows. The wastewater treatment system has sufficient capacity to deal with flows from water use but it can be overwhelmed with stormwater and I&I flows. While a cost/benefit analysis of Demand Side Management (DSM) programs will provide useful information, the primary focus at this time should be on I/I reduction. For now the Board will not order a structured analysis of DSM for water.

- *Halifax Water explored toilet rebate programs to replace older, high-flow toilets with low-flow toilets. Other municipalities have ceased their programs where provision of low-flow toilets have caught up with newer installations and renovations. These municipalities were not able to quantify the capacity gained or provide details on the cost benefits.*

- *In developing the model to analyze future infrastructure requirements, Halifax Water modelled the system to reflect measured flows for existing development and added anticipated growth. Since 2014, the per capita flow was lowered to better reflect measured flows within the wastewater system.*

- *Halifax Water is a participating member in the Alliance for Water Efficiency and is exploring best practice in conservation programs and models to evaluate costs and benefits of investments in conservation.*

- *Halifax Water has invested $25 million dollars in Advanced Meter Infrastructure (AMI) which will enable customers to monitor their*

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[1] 2013 Decision, Matter M05463 comments on conservation and demand side management initiatives at paragraph [69]

consumption through a future customer portal. The customer portal will also enable customers to receive alerts regarding high consumption, and customized water conservation tips. Meter installations are over 90% completed, and the Customer Portal Project is underway.

Over the previous 17 years, metered sales at Halifax Water have reduced by 21%, on average 1.6% per year, despite the ongoing growth. This trend is common across North America and is happening without incentives, as customers replace older fixtures and appliances with modern ones which use a fraction of the water. Given this natural conservation, Halifax Water has yet to identify a business case whereby additional utility investment would result in significant further gains in conservation.

2) Housing Affordability: whether exemptions or rebates could be provided for developers promoting affordable housing units. A request was made by the Municipality to allow interest-free deferral of the whole RDC for up to 10 years. The request contemplates the Municipality facilitating the deferral program by placing a lien on the property to ensure payment-in-full of the RDC.

Response/Discussion:

- *Halifax Water has an existing deferral program for RDCs. This program collects 75% of the RDC (for amounts above $100,000) to finance the infrastructure, as it is required, and allows deferral of 25% of the RDC (for amounts above $100,000). The 25% deferred RDC is due in full within two years and is not subject to interest during the two-year period.*[2] *This deferral program was established to recognize that the construction time for a typical MICI building is 18 to 24 months, therefore, they are not being serviced immediately, and are not immediately occupied and generating revenue.*
- *Halifax Water is mindful of the financial impacts that an affordable housing deferral program would have on the RDC and will explore this further through the application process. The Municipality's request will be included within the application, as a means of sharing it with stakeholders and including the issue within the public hearing process.*
- *Halifax Water is mindful of rate affordability as well as housing affordability, and notes that. if support for affordable housing developments transfers costs to utility rates, it will have a disproportionate impact on low income customers that have less capacity to absorb increases and less disposable income to invest in water conservation initiatives to reduce their bills.*

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[2] April 23, 2015 Halifax Water Board Report Collection of Deferred Regional Development Charges

3) Multiple rates based on number of bedrooms: setting specific and separate rates for bachelor, 1, 2 and 3 bedroom units within a multiple unit dwelling.

Response/Discussion:

- *Halifax Water sets the RDC structure on a "postage stamp" concept, where water and wastewater rates are the same throughout the Municipality regardless of where they are located in relation to the treatment facilities. The number of bedrooms or fixtures in a unit may not consistently reflect the number of people living in a unit. To address some differences in unit type, we have established charges for three building types (Single Unit or Townhouse/Row House Dwelling, Multiple Unit Dwelling, and Industrial/Commercial/Institutional).*
- *Having the RDCs associated with established building-types, not based on the number of bedrooms per unit, provides flexibility to the developer. It allows the developer to adjust the unit type (number of bedrooms per unit) throughout the building process and not have to reconcile the RDC.*

4) Tracking of money collected and growth projections: stakeholders requested Halifax Water provide information on the RDCs collected to-date and the projections for growth.

Response/Discussion:

2014-2019	***Wastewater***	***Water***
RDC Collected to date	*$ 41,325,608*	*$ 3,219,465*

2014-2019	***Units***	***People***
Projected	*8,830*	*21,192*
Actual	*13,057*	*31,337*

5) Review of flows for 5 and 10 year old growth areas: this was raised during the 2014 application and the follow-up flow monitoring was completed in consultation with stakeholders.

Response/Discussion:

- *The report, Detailed Flow Analyses for the RDC Flow Monitors (Attachment C) was provided after the first stakeholder session.*

6) Benefit to Existing (BTE) appropriate splits: stakeholders raised questions regarding eligible BTE splits for the RDC.

Response/Discussion:

- *Aerotech: The RDC eligible split for Aerotech were defined during the RWWFP as 90% RDC and 10% BTE. The total cost has been defined ($23,997,475) and used in the calculation, federal funding was granted*

($14M) and removed from the total project cost, leaving $9,997,475 to be funded by the RDC (90%) and BTE (10%). From the resulting RDC eligible amount, plus escalation and construction interest, the post period benefit of 18.01% was subtracted. The net amount to be funded by the RDC is $7,541,274.

This is the only project in the list that has been carried over in this way. The existing split was maintained for consistency with the current RDC.

- *I&I Reduction Projects: Some I&I reduction projects have a 95% eligible and 5% not eligible split. At the masterplan level, the approach to achieve the I&I flow reduction is not defined. It could be any range of combination of sewer rehabilitation and direct inflow removal. Achieving the same flow reductions through direct connection removal would not benefit existing infrastructure or customers. A new pipe to provide the required capacity could more readily be attributed to RDC eligibility. Halifax Water is committed to making the best decisions for our infrastructure and rate-payers.*

Proposed Changes in Rates, Rules and Regulations

Amending the RDC requires amendments to Halifax Water's Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services (Attachment E). The proposed amendments to section 29 and 30 will update the RDC for water and wastewater.

Further amendments are proposed to allow for I&I projects to be considered in creating capacity for growth within the wastewater systems. The NSUARB has already approved the concept in matters M08554 (April 2018) and M09213 (July 2019), with the approval of the Clayton Park/Mainland/Fairview Lining project. As well, amendments are proposed respecting the water eligible infrastructure projects to allow for demand reduction measures to provide capacity for growth.

Depending on further discussions with HRM on housing affordability options, adjustments or amendments to the deferral option may need to be considered. Halifax Water will have an opportunity to add this to the application prior to submission, through a revision, or as part of rebuttal evidence depending upon timing of the conclusion of the discussion with the Municipality.

Any and all amendments to the Schedule of Rates, Rules and Regulations must be vetted and approved by the NSUARB through an application process that allows for stakeholders to make submissions if desired.

BUDGET IMPLICATIONS

Halifax Water is collecting an RDC for wastewater and water infrastructure and is budgeting to expend $121,814,000 (water) and $352,040,000 (wastewater) in development related charges.

The Infrastructure Master Plan is based on a 30-year infrastructure schedule. The financial model used to calculate the RDC has a 20-year cost recovery, which creates a post-period benefit that is funded by future RDC collections; $26,761,000 (water) and $75,307,000 (wastewater).

In addition to project costs funded by the RDC, there is a benefit to existing Halifax Water customers that will be funded by rate-based funds such as depreciation and debt; $191,971,000 (water) and $184,044,000, (wastewater).

The RDC will be adjusted periodically to reflect projected growth requirements, actual cash inflows and outflows, and inflation and interest rates.

ALTERNATIVES

The NSUARB has directed Halifax Water to update the RDC every five years. The Halifax Water Board can direct that the application be deferred or adjusted, however, this would not provide sufficient time to accommodate the process and the filing deadlines in advance of the hearing scheduled for the week of March 23 – 27, 2020.

ATTACHMENT

Attachment A – Executive Summary - Infrastructure Master Plan *(Please Note: This attachment is a supporting document to the Technical Memo [Attachment D]; therefore, you will see the same report twice within the Board package.)*
Attachment B – RDC Memo to NSUARB, January 2018
Attachment C – Stakeholder Engagement
Attachment D – Halifax Water RDC Update 2019 Tech Memo – GM BluePlan
Attachment E – Proposed Changes to Halifax Water Schedule of Rates, Rules & Regulations For Water, Wastewater, and Stormwater

Original Signed By:

Report Prepared by: Kenda MacKenzie, P.Eng.,
Director, Regulatory Services, 902-237-7116

Original Signed By:

Financial Reviewed by: Louis de Montbrun, CPA, CA
Director, Corporate Services/CFO, 902-490-3685

Attachment A

Halifax Water

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

GM BluePlan Engineering

GUELPH | OWEN SOUND | LISTOWEL | KITCHENER | LONDON | HAMILTON | GTA
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EXECUTIVE SUMMARY

The Infrastructure Master Plan is a long-term infrastructure planning and engineering study to identify the optimal regional water and wastewater infrastructure implementation plan for Halifax Water to service growth until 2046.

The Infrastructure Master Plan expands on work completed by GM BluePlan under the West Region Wastewater Infrastructure Plan (WRWIP, 2017), which formalized the foundational policies of regional infrastructure planning in wastewater infrastructure needs and formed the servicing strategy for the West Region (Halifax, Beechville-Lakeside-Timberlea (BLT) and Herring Cove). The Infrastructure Master Plan incorporates the WRWIP and provides servicing strategies for the rest of the wastewater network, covering the Central and East Regions. The Infrastructure Master Plan then follows a similar approach for the water system, by formalizing the foundational policies of regional water infrastructure planning and forming a preferred servicing strategy that covers the regional water network for Halifax Water.

Aims and Objectives

The Infrastructure Master Plan has three distinct primary aims:

- To develop, evaluate, identify and detail the water and wastewater infrastructure servicing plans for Halifax Water to service growth to 2046.
- To integrate the WRWIP servicing strategy and its supporting studies into the Infrastructure Master Plan, forming a complete infrastructure master plan for Halifax Water.
- Provide value added through conceptual design and study scoping that support the Infrastructure Master Plan and enhance the preferred strategies.

To achieve the aims of the Infrastructure Master Plan the following objectives have been satisfied:

- Undertake a baseline review of the water and wastewater systems and update assumptions made in the WRWIP.
- In coordination with Halifax Regional Municipality (HRM) Planning Department and Halifax Water, determine baseline and growth planning projections for HRM.
- Review existing criteria, level of service, policy, legislation and best practices related to long term infrastructure planning for water and wastewater networks.
- Review and study potential wet weather management techniques that may be beneficial for overall system management (Wet Weather Flow Management Study).
- Create a Climate Change Management Framework and assess the impact of climate change on water and wastewater design standards.
- Host a series of workshops with Halifax Water Planning, Asset Management, Engineering and Operation staff to understand and document known opportunities and constraints in the water and wastewater networks.
- Build and enhance the modelling tools for Halifax Water through transitioning wastewater models to InfoWorks ICM and updating the existing WaterCAD models.
- Develop strategy solutions, cost estimates, and evaluate alternatives to identify preferred servicing strategies.
- Develop Capital Programs for the water and wastewater projects, studies and costs and identify an implementation phasing plan for the preferred servicing strategies.

- Undertake conceptual designs and study scoping for imminent projects were value can be added to the design.

Document Layout

The Infrastructure Master Plan is comprised of five Volumes as outlined in Executive Summary Figure 1.

VOLUMES:

- **Volume 1** – General Information and supporting studies
- **Volume 2** – Water Infrastructure for all Regions
- **Volume 3** – West Region Wastewater Infrastructure (Extracted from the WRWIP)
- **Volume 4** – Central Region Wastewater Infrastructure
- **Volume 5 –** East Region Wastewater Infrastructure

Executive Summary Figure 1: Infrastructure Master Plan Volume Layout

Volume 1 includes baseline information supporting the water and wastewater systems, the planning and growth projections, a summary of the standalone studies that were completed under the WRWIP and Infrastructure Master Plan, the general approach and methodologies used to develop the hydraulic model, strategy development processes used to form the final Capital Program, the conceptual designs completed and recommendations moving forward.

Volumes 2 to 5 cover the details within the water and wastewater networks, the unique features, opportunities and constraints in the networks, the assessment of alternatives and projects that lead to forming the preferred strategies, costing and phasing to form the Capital Programs.

As illustrated in Figure 1, the WRWIP has been incorporated into the Infrastructure Master Plan to form a complete master plan of the wastewater and water networks across Halifax Water.

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

VOLUME 1
GENERAL INFORMATION

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

GUELPH | OWEN SOUND | LISTOWEL | KITCHENER | LONDON | HAMILTON | GTA
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VOLUME 1 – GENERAL INFORMATION

Volume 1 covers the general information of the Infrastructure Master Plan. It starts out with outlining how the WRWIP has been integrated into the Infrastructure Master Plan, the aim and objectives, document layout, as described above. The subsequent sections of Volume 1 are summarized below.

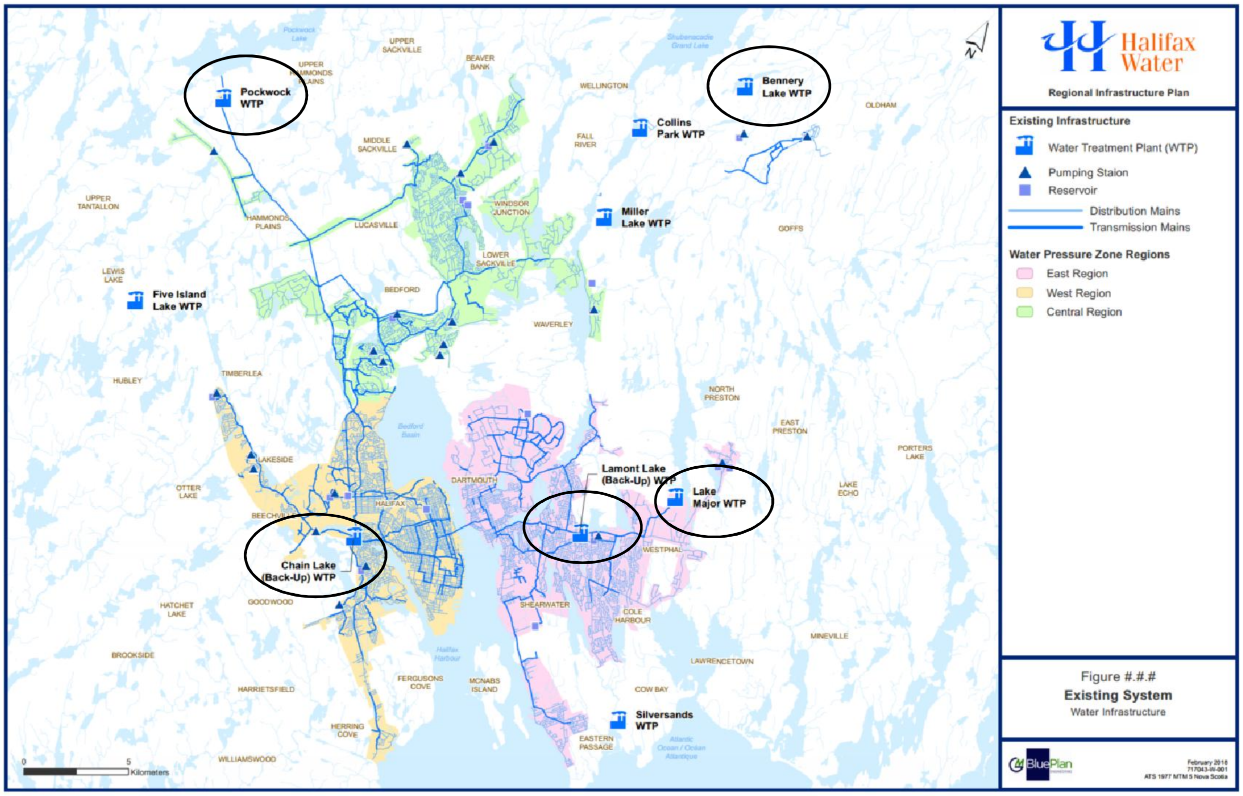
Baseline Review and Consultation

The baseline review and consultation process were completed to develop the team's project knowledge on the water and wastewater study areas, and form technically feasible and acceptable solutions. The background review included existing data available and past reports on infrastructure needs and requirements. The background review provided detailed understanding on the existing and potential future requirements on the water and wastewater study areas.

The Figures below provide a general overview of the systems and the location of the main water and wastewater facilities included in the Infrastructure Master Plan study.

WATER

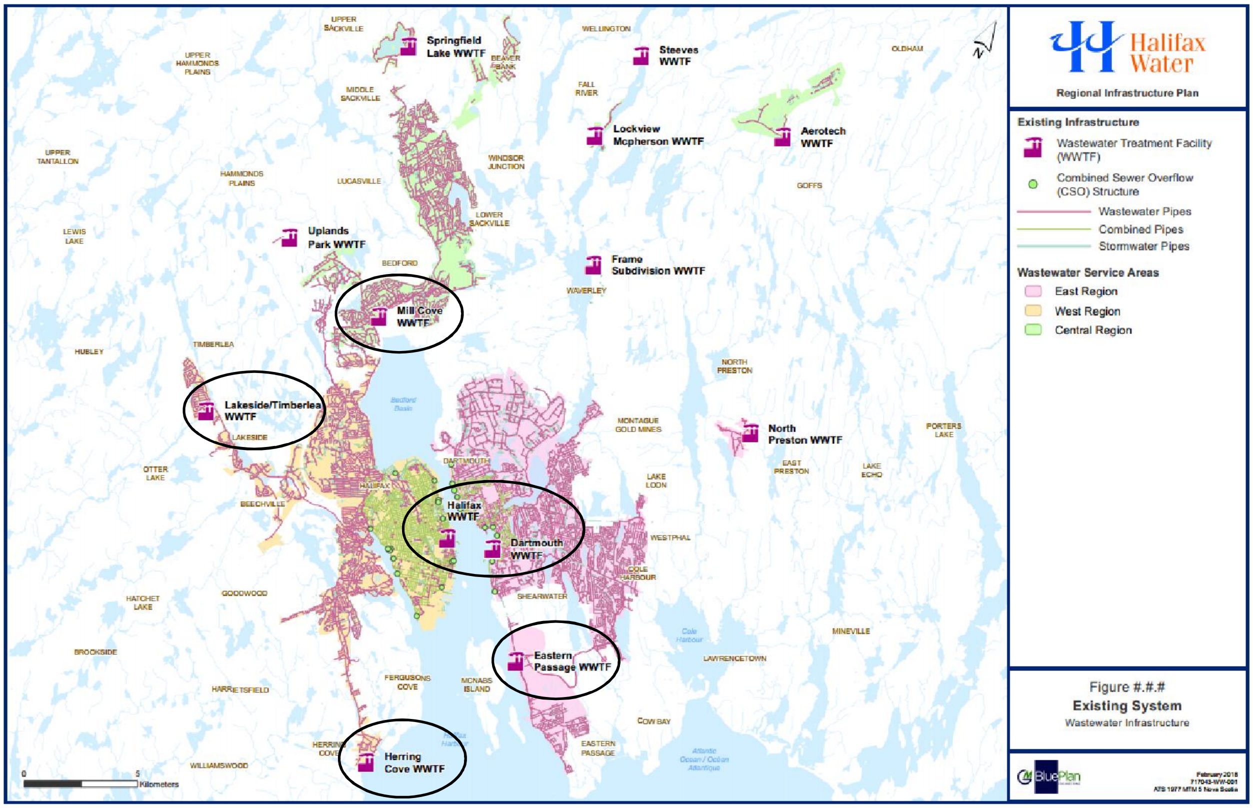
Executive Summary Figure 2 illustrates the delineation of the three main water distribution systems that are owned and operated by Halifax Water, and circles the main water supply plants (WSP) included in the Infrastructure Master Plan. The three main WSP are Pockwock, Lake Major and Bennery Lake WSPs, and the emergency back-ups supplies are Chain Lake and Lake Lamont.



Executive Summary Figure 2: Overview of the Water Distribution System, highlighting the WSPs

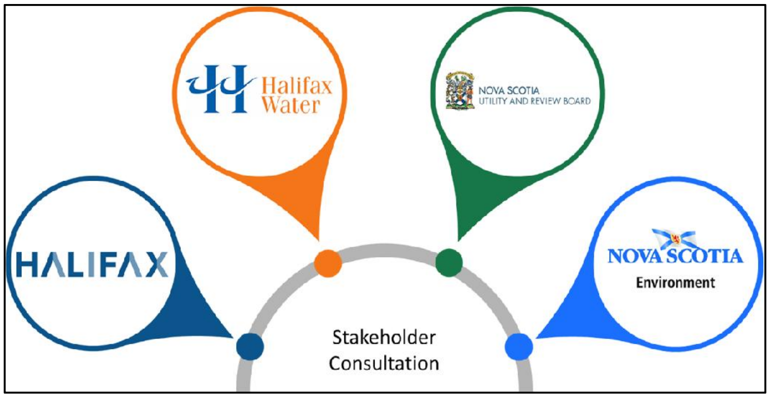
WASTEWATER

Executive Summary Figure 3 illustrated the wastewater treatment facilities systems that are owned and operated by Halifax Water and circles the main wastewater treatment facilities (WWTF) included in the Infrastructure Master Plan. The six main WWTF are Halifax, Herring Cove, Beechville Lakeside Timberlea (BLT), Mill Cove, Dartmouth and Eastern Passage.



Executive Summary Figure 3: Overview of the Wastewater Distribution System, highlighting WWTFs

An important component of the Infrastructure Master Plan is stakeholders' involvement and input throughout the consultation process. The main consultation teams involved in the Infrastructure Master Plan are outlined in Executive Summary Figure 4. GM BluePlan has been liaising with the consultation teams to confirm regulatory requirements, determine population growth figures, understand issues and constraints in the networks, and to inform parties on progress and decisions made.



Executive Summary Figure 4: Baseline Review Consultation Teams

Planning Data and Population Numbers

Halifax Water, GM BluePlan Engineering, and HRM Planning staff collaborated to define the planning projections dataset required to complete the Infrastructure Master Plan. Planning data and growth projections formed the baseline and growth demands on the systems, spanning the period from 2016-2046 (a 30-year planning horizon).

To form the baseline population numbers Census Data was used and distributed using dissemination blocks to civic address points, allowing existing population to be accurately added to the hydraulic models. The baseline employment numbers were determined from Industrial, Commercial and Institutional (ICI) customer billing points, that were then converted to population equivalent (PE), following design standards.

The growth projections defined under the Infrastructure Master Plan, reflect growth trends and planning guidelines to develop the Regional Centre, as outlined in the Centre Plan and Integrated Mobility Plan. Population growth was set to a 1% rate, and employment growth equating to 58% of population growth. Growth was divided between the Regions based on meeting the Integrated Mobility Plan population and employment growth splits and aligning with the Growth Areas and Allocation table, which included data on developments occurring over the project horizon.

Executive Summary Table 1: Growth Population Equivalent (PE) 2016-2046

Location	Employment Growth PE	Population Growth PE	Total Growth PE
Mill Cove	5,623	11,102	16,725[1]
Halifax	28,839	66,365	95,204
Herring Cove	-	3,814	3,814
BLT	-	4,473	4,473
Dartmouth	32,436	42,074	74,510
Eastern Passage	3,591	3,385	6,976
Aerotech	8,597	-	8,597
Rural	6,877	17,000	23,877
Total	**85,963**	**148,213**	**234,176**

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[1] *Total growth varied for Mill Cove between the water and wastewater systems. As two growth areas in the Central Region were only serviced by water the growth PE for wastewater was lower at 15,191.*

Supporting Studies

Several supporting studies have been completed to formalize the foundational policies of regional infrastructure planning and guide the development of the preferred servicing strategies through a robust and defensible process. The supporting studies are a compilation of studies completed under the WRWIP and Infrastructure Master Plan. The studies are as follows:

1. Design Criteria, Level of Service and Policy Review

A comprehensive review of Halifax Water's existing design criteria, level of service (LOS) objectives, and relevant policies, for water supply and wastewater collection was completed as part of the Infrastructure Master Plan and supported by the investigations completed under the WRWIP.

WASTEWATER

The WRWIP assessed the design criteria, LOS and policy review for the wastewater collection system, to guide the West Region servicing strategy. This document was reviewed under the Infrastructure Master Plan to confirm and update the underlying assumptions for the East and Central Regions covered in the Infrastructure Master Plan.

WATER

A full review of the design criteria, LOS and policy review for the water distribution system was completed under the Infrastructure Master Plan, to support the water servicing strategies. The review for water followed the same approach as the WRWIP, including trend analyses and an industry best practice to validate the appropriateness of the criteria and level of service objectives, as they relate to the Infrastructure Master Plan.

2. WRWIP Supporting Studies

The Long-Term Planning Framework and Cost Estimation Framework were developed under the WRWIP to guide infrastructure planning needs and costing guidance and have been included in the Infrastructure Master Plan, as studies that assisted in guiding the final strategies.

- The Long-Term Planning Framework document provides direction for long-term water, wastewater and stormwater infrastructure planning needs, in a holistic approach that integrates and considers infrastructure types together. The framework considers all drivers of infrastructure management including growth, asset renewal, regulatory compliance, and operability.
- The Cost Estimation Framework was developed to form a standardized process for costing infrastructure projects. Infrastructure project cost estimates are used to create short, medium, and long-term budgets and impact funding requirements, and ultimately customer and developer charges.

3. Wet Weather Flow Management Study

The Wet Weather Flow Management Study was initiated under the WRWIP to better understand the feasibility of alternative wastewater servicing strategies, that focus on wet weather flow management options. The Wet Weather Flow Management Study was initially completed on just the West Region and therefore under the Infrastructure Master Plan the study was revisited and updated to include the Central and East Regions.

The study focuses on three feasibility studies:

- Combined Sewer Separation Feasibility Study
- Low Impact Development (LID) Feasibility Study
- Rainfall Derived Inflow and Infiltration (RDII) Reduction Feasibility Study

COMBINED SEWER SEPARATION FEASIBILITY STUDY

The intent of this study is to identify the potential for strategic sewer separation within the combined networks (Halifax Peninsula and Dartmouth). Requirements to meet the Infrastructure Master Plan objectives and minimum local level of service of the wastewater infrastructure were considered against high level cost and feasibility.

It was ultimately determined that *Young Street, Kempt Road, and Connaught Avenue* in Halifax Peninsula and *Jamieson Street, Wyse Road, Nantucket Avenue, Thistle Street and Canal Street* in Dartmouth, are feasible areas for sewer separation and provide the greatest opportunities for flow reduction.

LOW IMPACT DEVELOPMENT FEASIBILITY STUDY

The intent of this study was to highlight areas across the combined networks with the greatest opportunities to implement Low Impact Development (LID) solutions. This study assessed the feasibility of LID solutions in terms of constructability, cost/benefit, and implementation.

Based on the feasibility study and background review, it is unlikely that LID practices can provide sufficient reductions in flow with confidence in the performance over the short and long term to be an overall solution for the Regional servicing plan. However, these practices can be incorporated into the larger solution, where feasible, to reduce the extent of other capital projects and set the stage for a potential LID programs that targets the private level.

INFLOW AND INFILTRATION REDUCTION FEASIBILITY STUDY

The intent of this study is to identify the potential for rainfall derived inflow and infiltration (RDII) reduction as part of the regional servicing strategy. The study covers the flow monitored separated networks across West, Central and East Regions. The RDII feasibility study provided RDII guidance for the West region under the WRWIP and was then expanded on under the Infrastructure Master Plan, for the Central and East Regions. A more in-depth assessment under the Infrastructure Master Plan led to providing pre-defined target RDII reduction areas that were incorporated into the preferred strategies for East and Central Regions.

4. Climate Change Study

The 2012 Integrated Resource Plan (IRP) identified the need to bring climate change considerations into municipal planning and meet a new objective of "adapting to future climate change". Through the Infrastructure Master Plan two climate change tasks were completed:

- Developing a "Vulnerability to Climate Change Risk Assessment" framework to create a robust framework that can be applied consistently across assets and be used to complete vulnerability assessments of existing infrastructure
- Review existing Design Standards and the Long-Term Planning Framework with climate change factors, allowing for future projects to include climate change considerations

The outcomes of the study led to climate change being included in the Infrastructure Master Plan as follows:

- Rainfall simulation events include a climate change factor of 16%
- Sea level rise was considered for infrastructure requirements
- A drought study was recommended on drinking water sources

5. Opportunities and Constraints Workshop

An Opportunities and Constraints workshop covering the wastewater and water systems was held at Halifax Water on March 6th, 2018. The workshop included Halifax Water's Operation Teams, Project Managers and Directors and the Halifax Water and GM BluePlan project teams. The workshop was set up to enable the project team to understand issues, constraints and opportunities within the wastewater and water supply networks. The GM BluePlan team then used the outcomes from the workshop to inform the overall servicing strategies that accommodate the Long-Term strategy drivers of growth, compliance, asset renewal, and operational optimization.

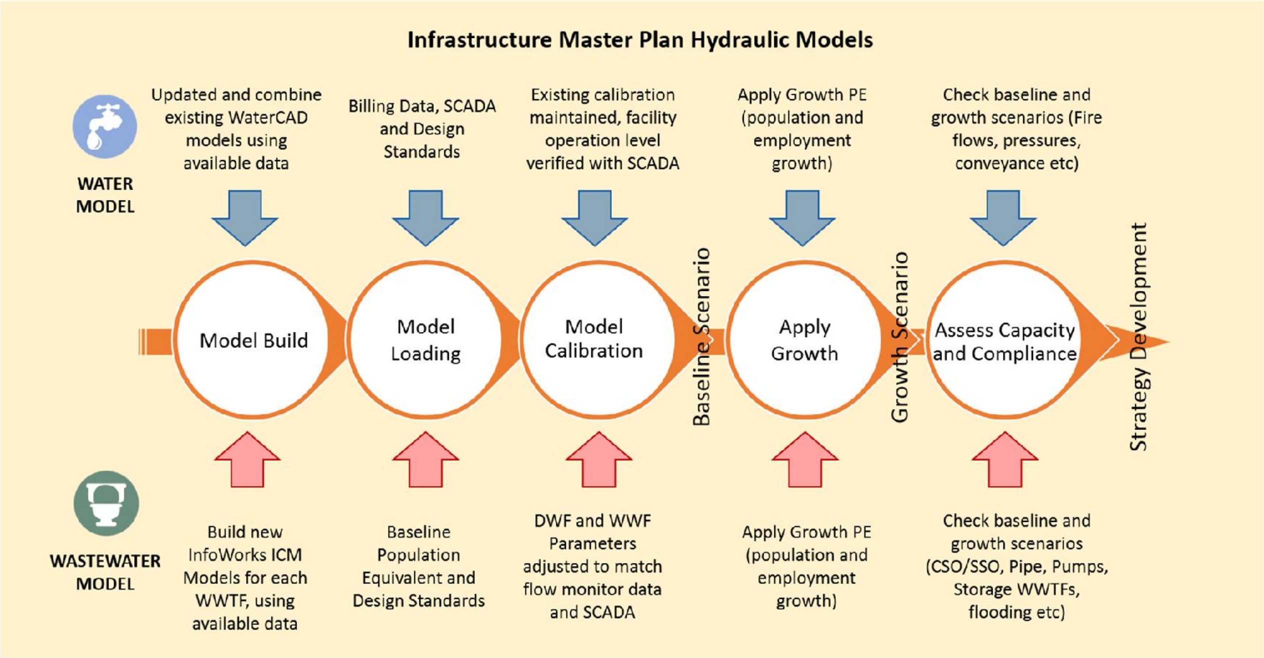
6. Unit Costing Workshop

Halifax Water's Unit Costing template is the main tool used for costing projects. The Unit Costing template has been refined over recent years, from costing capital projects under the IRP, being updated under the WRWIP to align with the Cost Estimation Framework, and further reviewed under the Infrastructure Master Plan at a Unit Costing Workshop. At the workshop the template was assessed to confirm current trends and updated to produce 2019 rates. The outcome of changes from a project cost perspective are relatively minor, and covered in the Project Evaluation and Costing section.

Hydraulic Modelling

A series of activities were completed to prepare and ultimately use the water and wastewater models to undertake the growth impact analysis on infrastructure requirements. The modelling process included model build, loading and calibration to form the baseline scenario, growth was then applied to the calibrated models to form the growth scenario, from there capacity and compliance was assessed, allowing the strategy development stage to occur. Executive Summary Figure 5 outlines the modelling stages with the processes and steps completed for both the water and wastewater models.

At the end of the modelling process the water systems were included in one model, while the wastewater models were divided by WWTFs. The combined water model was due to the interconnection and synergies between the water systems and strategies combining the regions serviced, while the wastewater models were distinctly separated by the existing WWTFs catchments.



Executive Summary Figure 5: Modelling Stages for the Water and Wastewater Models

To assist with future update to the models, guidelines on the modelling process are included in the appendices of Volume 1.

Capacity and Compliance

The newly calibrated models were used to assess system performance under both existing and growth scenarios. The results from these simulations were used to validate and identify the primary constraints within the system, and to evaluate opportunities to resolve these limitations.

Two other key sources of information were used for the capacity and compliance assessment, they were the opportunities and constrains workshop with Halifax Water staff and a facility desktop analyses. The desktop facility analysis included supply, storage and WSPs capacities for the water systems and WWTFs capacity for the wastewater systems.

The outcomes of the capacity and compliance assessment were used in the development of the servicing strategy for the water and wastewater systems.

Strategy Development

The strategy development process varied between the water and wastewater systems to align with service requirements and regulations. The processes are as follows.

WASTEWATER

The wastewater models followed the same strategy development process completed in the WRWIP. The opportunities and constraints identified for the Regions were used to inform the development of multiple servicing strategy alternatives, that were simulated using the model, costed and evaluated, to identify a preferred servicing strategy. Informed by the hydraulic model and various studies, the strategy development process began with the identification of projects common across all strategies, considered “Common Projects”. Once the Common Projects were defined different servicing strategies were tested in the models and compared, and the preferred servicing strategy was selected.

WATER

The water distribution strategy was developed using four key drivers; accommodate growth, provide security of supply and system resiliency, identify synergies with asset renewal, and where possible provide opportunities for system optimization. The strategy approach for growth followed a top-down approach starting with providing adequate supply to all systems, ensuring transmission networks can sufficiently convey the supply, and confirming local needs are met.

Project Evaluation and Costing Considerations

WASTEWATER

The selection of the preferred strategy was based on selecting the top three to five alternative strategies that would be evaluated against each other to determine the preferred strategy.

The first step was to remove less desirable strategies due to aspects of feasibility, cost and level of service. Then the top three to five alternative strategies were evaluated using the five-point evaluation factors (Technical, Financial, Legal/Jurisdictional, Environmental, and Socio/Cultural). Following stakeholder consultation, the final preferred strategy was presented with input from the project team.

PROJECT COSTING

A capital cost estimate (in 2019 dollars) was completed for all projects encompassed within the proposed strategies. Halifax Water’s Unit Costing template, a newly developed RDII Reduction Costing Template and existing knowledge on projects were used to build the final Capital Program costs.

The Unit Costing template is a detailed costing sheet that includes hard and soft cost components. Use of this template in the Infrastructure Master Plan resulted in Class 4 (Master Plan level) cost estimates (planning cost estimate with a 30% margin), in accordance to the Cost Estimation Framework. The costs are unit based and include an allowance for the following additional components:

- Engineering and Design
- Professional Fees/Geotechnical/Hydrogeological
- Construction Management/Contract Administration
- In-House Labour/Engineering/Wages/CAD
- Overheads
- Project Contingency

The Unit Cost template was reviewed and updated through the Infrastructure Master Plan, based on outcomes from the Unit Costing Workshop. The changes to the Unit Cost template included adjustments to unit rates for pipe construction, moving the location of the soft costs in the template and updating the overhead contingencies rate.

The impact of the above changes from a project cost perspective are relatively minor. The main change to costing projects was introducing a RDII Costing Template. The RDII Costing Template was developed to improve the accuracy of costing RDII reduction, through reviewing case studies and costing RDII based on catchment size, land use and volume of existing facilities in the catchment.

A cash flow analysis was completed to assess the annual lifecycle costs and net present value of each project. The individual project costs were added to determine the capital cost of each strategy.

PROJECT PHASING

A project phasing exercise was completed to identify the timing requirements for each project. Projects are either triggered immediately due to existing constraints, in the future when a specified capacity is reached because of growth, or dependent on the completion of other projects.

CAPITAL PROGRAMS

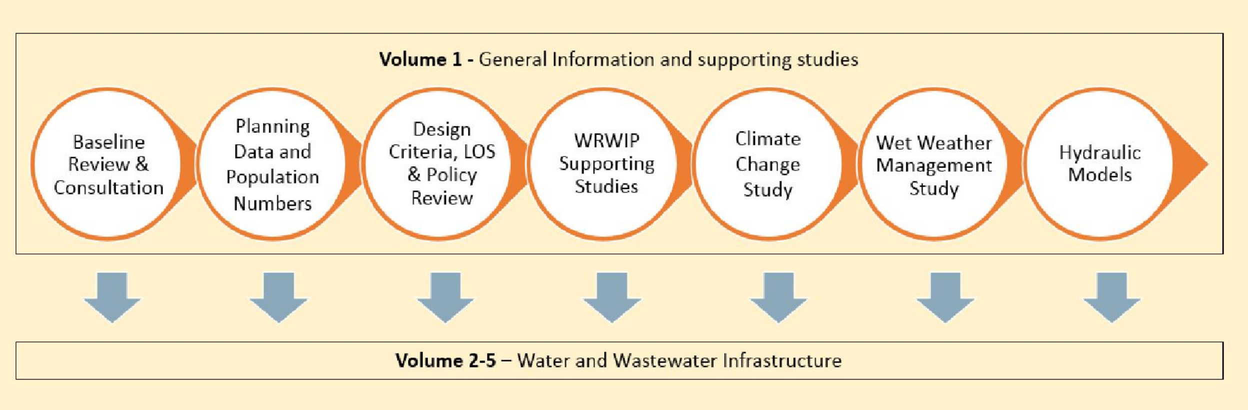
The final Capital Programs for wastewater are in Executive Summary Table 3 and for water are in Executive Summary Table 4, including project name, description, phasing, and capital cost. Executive Summary Table 2 summaries the capital cost per region for water and wastewater.

Executive Summary Table 2: Total Water and Wastewater Capital Costs Per Region

Location	Total Capital Cost (2019$)
West Region*	**$186,261,000**
Central – Mill Cove	**$163,483,000**
East – Eastern Passage	**$49,478,000**
East – Dartmouth	**$104,358,000**
Water all Regions	**$284,706,000**
Total	**$788,286,000**

*Cost updated from WRWIP to 2019 dollars using the updated Unit Costing and RDII Costing templates

As mentioned above, Volume 1 provides several supporting documents, methodologies and processes that feed into Volumes 2 to 5. Executive Summary Figure 6 summarizes the major components in Volume 1 that support the subsequent volumes.



Executive Summary Figure 6: Volume 1 Supporting Studies Summary

Executive Summary Table 3: Wastewater Capital Program Summary

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
West Region: Halifax	**Peninsula Halifax**	**WR1**	WRWIP: Spring Garden Area Sewer Separation	*Full separation of Spring Garden LoWSCA pocket - 5 individual projects*	2018-2023	2016-2021	$ 7,281,000
		WR2	WRWIP: Young Street Area Sewer Separation	*Full separation of Young Street LoWSCA pocket - 18 individual projects*	2018-2023	2016-2021	$ 21,879,000
		WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	*Full separation of a portion of the Kempt CSO sewershed - 17 individual projects*	2018-2025	2016-2021	$ 14,752,000
		WR4	WRWIP: Linear Upsize - Quinpool Road	*525mm ø combined sewer upsize along Quinpool Road (from Preston to Oxford)*	2020	2016-2021	$ 437,000
		WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	*750mm ø combined sewer upsize along Portland Place (from Saunders to Brunswick) + 900mm ø combined sewer upsize along Brunswick Street*	2020	2016-2021	$ 221,000
		WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	*Lower the invert of the combined sewer along Gottingen, on the south side of North Street*	2020	2016-2021	$ 500,000
		WR7	WRWIP: Young Pumping Station Upgrade	*New 300mm diameter alignment + Installation of new pumps to increase the station capacity from 114L/s to 250L/s*	2027	2026-2031	$ 2,169,000
		WR8	WRWIP: New Fairfield Holding Tank	*New 3,700 cubic metre holding tank at the existing Fairfield Holding Tank site*	2046	2041-2046	$ 12,403,000
		WR9	WRWIP: Replace Armdale Pumping Station Forcemains	*Upsize the existing 300mm ø Armdale Pumping Station forcemains with new twinned 400mm ø forcemains*	2020	2016-2021	$ 3,850,000
	Halifax Inflow and Infiltration	**WR13**	WRWIP: RDII Reduction Program	*Implement an Inflow and Infiltration Reduction Program within the Fairview, Clayton Park, and Bridgeview areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2020	2016-2021	$ 15,491,589
	Halifax Fairview Cove Tunnel	**WR19**	WRWIP: Fairview Cove Linear Upsize	*Upsize existing 1050mm ø tunnel to 1800mm ø*	2019	2016-2021	$ 19,781,000
	Wastewater Treatment Facility	**WR20**	WRWIP: Halifax Treatment Plant Capacity Upgrade	*Increase the rated capacity of Halifax WWTF from 134 MLD to 140 MLD*	2041	2036-2041	$ 25,142,000
	Halifax Greenfield	**WR21**	WRWIP: Linear Upgrades within the Kearney Lake Road Area	*Sanitary sewer upgrades downstream of the Kearney Lake Road Pumping Station*	2033	2031-2036	$ 2,997,000
	Halfax Flow Optimization	**WR22**	Infrastructure Master Plan: CSO Management Study	*Monitor and assess CSO facilities to mitigate discharges (16 facilities). Costed at $14,000/monitor and $15,000/CSO for assessment.*	2026	2016-2021	$ 965,000
		WR23	Infrastructure Master Plan: SSO Management Study	*Monitor and assess SSO facilities to mitigate discharges (6 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.*	2021	2016-2021	$ 415,000
	HALIFAX Total Wastewater Servicing Strategy Cost						**$ 128,283,589**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
West Region: BLT	**BLT WWTF Decommission**	**WR10**	WRWIP: BLT WWTF Decommission - New Timberlea PS	*New 247L/s Timberlea Pumping Station at existing BLT WWTF site*	2020	2016-2021	$ 5,928,000
		WR11	WRWIP: BLT WWTF Decommission - New Timberlea Forcemain	*New 450mm ø forcemain from new Timberlea Pumping Station to gravity sewer start near Bayers Lake*			$ 19,436,000
		WR12	WRWIP: BLT WWTF Decommission	*Decommissioning of BLT WWTF and site recovery*			$ 500,000
	BLT Diversion to Herring Cove	**WR14**	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Pumping Station	*Construct new 370L/s pumping station to divert all of BLT flow to Herring Cove*	2033	2031-2036	$ 8,063,000
		WR15	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain	*Construct new twinned 450mm ø forcemain along Northwest Arm Drive from new proposed Crown Drive Pumping Station to Cowie Hill*			$ 9,026,000
		WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	*Construct new 600mm ø gravity sewer along Northwest Arm Drive from Cowie Hill to Herring Cove Road south of Levis Street*			$ 4,319,000
		WR17	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	*Construct new 1050mm ø gravity sewer from COLTA sewer to new Crown Drive Pumping Station*			$ 3,266,000
	BLT Total Wastewater Servicing Strategy Cost						**$ 50,538,000**
Herring Cove	**Herring Cove Linear Upsizing**	**WR18**	WRWIP: Herring Cove Road - Gravity Sewer Upsize	*Upsize sanitary sewers (to 900mm ø) downstream of Roaches Pond Pumping Station*	2033	2031-2036	$ 7,439,000
	HERRING COVE Total Wastewater Servicing Strategy Cost						**$ 7,439,000**
	WEST REGION Total Wastewater Servicing Strategy Cost						**$ 186,260,589**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
Central Region: Mill Cove and Springfield Lake	**Trunk Upgrades**	**MC1**	Trunk Sewer Upgrades	*Sackville Trunk Upgrades to 1200mm diameter*	2036	2036-2041	$ 5,101,000
		MC2	Trunk Sewer Upgrades	*Sackville Trunk Upgrades to 1050mm diameter*	2036	2036-2041	$ 8,246,000
		MC3	Trunk Sewer Upgrades	*Sackville Trunk Upgrades to 1500mm diameter*	2036	2036-2041	$ 144,000
	Storage tank Upgrades	**MC4**	Storage Tank	*Offline storage tank near Sackville Goodlife Fitness Centre (5ML)*	2031	2031-2036	$ 17,469,000
	Upgrades to Pumping Stations	**MC5**	Fish Hatchery Park Pumping Station Upgrade	*Upsize existing 450mm forcemain from Fish Hatchery Park PS to 675mm diameter and increase pumping capacity to 1500 L/s with an addition of 100 L/s capacity*	2036	2031-2036	$ 10,529,000
		MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	*Increase pumping capacity at Beaver Bank #3 PS from 55 L/s to 100 L/s, and increase pumping capacity of Majestic Avenue PS from 82 L/s to 165 L/s to eliminate growth-impacted SSO discharge*	2036	2036-2041	$ 1,090,000
	Wastewater Treatment Facility	**MC7**	Mill Cove Wastewater Treatment Plant Capacity Upgrade	*WWTF Upgrade*	2021	2021-2026	$ 89,256,000
	Inflow and Infiltration	**MC8**	RDII Reduction Program FMZ07, FMZ10, & FMZ40	*Implement an Inflow and Infiltration Reduction Program within the Lower Sackville areas FMZ07, FMZ10, & FMZ40 (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2020	2016-2021	$ 9,288,248
		MC9	RDII Reduction Program FMZ02 & FMZ03	*Implement an Inflow and Infiltration Reduction Program within Bedford areas FMZ02 & FMZ03 (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2031	2031-2036	$ 8,023,065
	Local New Networks and Upgrades	**MC10**	Local network upgrades on Beaver Bank Rd. North of Glendale Dr.	*Upsize from 200mm to 450mm diameter gravity sewer along Beaver Bank Rd.*	2021	2021-2026	$ 2,086,000
		MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	*Upsize from 300mm to 450mm diameter gravity sewer along Beaver Bank Rd.*	2021	2021-2026	$ 1,490,000
		MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	*Upsize from 300mm to 375mm diameter gravity sewer along Beaver Bank Rd.*	2021	2021-2026	$ 1,667,000
		MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	*Upsize from 200mm to 375mm diameter gravity sewer along Old Sackville Road*	2036	2036-2041	$ 845,000
		MC14	Local network upgrades on on Hallmark Ave.	*Upsize from 200mm to 375mm diameter gravity sewer on Hallmark Ave.*	2036	2036-2041	$ 437,000
		MC15	Local Sewer Upgrades on Waterfront Drive	*375 mm Sewer Upgrade on Waterfront Drive*	2036	2036-2041	$ 500,000
	Springfield Lake	**MC16**	Springfield Lake Connection to Sackville	*Decommission Springfield Lake WWTF, divert all flow to Mill Cove WWTF via new pumping station and gravity sewer to connect at top of Sackville trunk sewer.*	2043	2041-2046	$ 6,226,000
	Flow Optimization	**MC17**	SSO Management Study	*Monitor and assess SSO facilities to mitigate discharges (18 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.*	2021	2021-2026	$ 1,086,000
	CENTRAL REGION Total Wastewater Servicing Strategy Cost						**$ 163,483,313**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
East Region Eastern Passage	**Gravity Pressure Sewer**	**EP1**	Install new Gravity Pressure Sewer	*Install new 450 and 825mm Ø gravity pressure sewer*	2021	2021-2026	$ 23,372,000
		EP2	Connect Beaver Crescent and Caldwell Forcemains to new 450mm gravity pressure sewer	*Connect Beaver Crescent and Caldwell Forcemains to new gravity pressure sewer*	2026	2026-2031	$ 78,000
		EP3	Install new pump out stations	*Install 4 new pump out stations in the low point of the gravity pressure sewer*	2026	2026-2031	$ 1,676,000
		EP4	Install gate valves at surge tank	*Optimize flows at the surge tank through gate valves*	2026	2026-2031	$ 420,000
		EP5	Decommission existing 450mm gravity pressure sewer	*Grout fill the 450mm Ø asbestos gravity pressure sewer*	2043	2041-2046	$ 559,000
	Upgrades to Pumping Stations	**EP6**	Upgrade Quigley Corner Pumping Station	*Increase pumping capacity at Quigley to 570l/s with an addition of 343l/s*	2021	2021-2026	$ 2,875,000
		EP7	Optimize Quigley's Corner PS	*Forcemain optimization and SLR assessment*	2021	2021-2026	$ 336,000
		EP8	Upgrade Memorial Drive Pumping Station	*Increase pumping capacity at Memorial Drive PS with an addition of 65l/s. Install new dual 300mm ø forcemain*	2031	2031-2036	$ 2,633,000
		EP9	Upgrade Beaver Crescent Pumping Station	*Increase pumping capacity at Beaver Crescent PS with an addition of 20l/s*	2036	2036-2041	$ 168,000
		EP10	Upgrade Bissett Lake Pumping Station	*Increase pumping capacity at Bissett Lake PS with an addition of 350l/s*	2041	2036-2041	$ 2,934,000
		EP11	Upgrade Caldwell Road Pumping Station	*Increase pumping capacity at Caldwell Road PS with an addition of 70l/s. Install new dual 200mm ø forcemains*	2039	2036-2041	$ 631,000
	Inflow and Infiltration	**EP12**	RDII Reduction Program FMZ23	*Implement an Inflow and Infiltration Reduction Program within the Cole Harbour areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining) - FMZ23*	2031	2031-2036	$ 3,204,580
		EP13	RDII Reduction Program FMZ24	*Implement an Inflow and Infiltration Reduction Program within the Loon Lake areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)- FMZ24*	2020	2016-2021	$ 1,570,040
		EP14	RDII Reduction Program FMZ37	*Implement an Inflow and Infiltration Reduction Program within the Eastern Passage areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)- FMZ37*	2020	2016-2021	$ 2,479,704
	Local New Networks and Upgrades	**EP15**	Local network upgrades on Caldwell Road	*Upsize from 200 to 300mm ø gravity sewer along Caldwell Road*	2036	2036-2041	$ 607,000
		EP16	Local network upgrades on Colby Drive	*Upsize from 200 to 300mm ø gravity sewer along Colby Drive*	2031	2031-2036	$ 1,176,000
		EP17	Local network upgrades on Forest Hill Parkway	*Construct new 450mm ø gravity sewer along Forest Hill Parkway connect to pipeline on Nestor Crescent*	2041	2041-2046	$ 4,275,000
	Flow Optimization	**EP18**	SSO Management Study	*Monitor and assess SSO facilities to mitigate discharges (8 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.*	2021	2021-2026	$ 484,000
	EASTERN PASSAGE Total Wastewater Servicing Strategy Cost						**$ 49,478,324**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
East Region : Dartmouth	Lakes and Sewer Separation	D1	LoWSCA: Canal Street Separation	*Full separation of Canal Street LoWSCA pocket - 1 individual project. Install new stormwater pipelines, separate 35 properties and reconnect 8 catchbasins.*	2020	2016-2021	$ 1,842,000
		D2	LoWSCA: Wyse Road Separation	*Full separation of Wyse Road LoWSCA pocket - 3 individual project, two phases.* *Phase 1 - Install new stormwater pipelines along Albro Lake Road and Windmill Road, separate 43 properties and reconnect 18 catchbasins (Area A).* *Phase 2 - Install new stormwater pipelines along Wyse Road, connecting to Albro Lake stormwater pipe, separate 111 properties and reconnect 4 catchbasins (Area B).* *Install new sewer diversion from Lyle St Catchment to Jamieson(Area C).*	2020	2016-2021	$ 3,860,000
					2021	2021-2026	$ 2,802,000
		D3	Additional Stormwater Separation on Wyse Street	*450mm ø stormwater pipe connecting to Park Ave CSO, separate 6 properties and reconnect 1 catchbasin.*	2031	2026-2031	$ 1,912,000
		D5	Albro Lakes Watershed Separation	*Full separation of Albro Lakes Watershed, install new stormwater trunk line, connecting to Jamieson Street CSO outfall.*	2021	2021-2026	$ 8,111,000
		D6	Maynard Lake and Clement Street Wetland Separation	*Full separation of Maynard Lake and the Clement Street Wetland - 4 phases* *Phase 1 - Install 1050mm pipeline in Old Ferry Rd, connection to CSO outfall, connect stormwater pipeline from Hazlehurst Street and catchbasins en route* *Phase 2 - Install 750mm pipeline working upstream to the Wetland, continue to connect to catchbasin en route* *Phase 3 - Install 600mm pipeline connecting Maynard Lake to the pipeline* *Phase 4 - Connect to stormwater network for DSM and Fenwick Drive properties and separate North Woodside - Southdale Elementary and surrounding businesses*	2031	2026-2031	$ 642,000
					2031	2031-2036	$ 4,540,000
					2033	2031-2036	$ 1,155,000
					2036	2031-2036	$ 453,000
	Upgrades to Pumping Stations	D7	New Valleyford Pumping Station	*Install new pumping station by the Valleyford Holding Tank to a capacity of 300l/s. Install new forcemain down Raymond Street and Maple Drive, to connect to the trunk sewer*	2041	2036-2041	$ 10,446,000
		D8	390 Waverley Road Upgrades	*Install new dual 500mm ø forcemain following existing path with a diversion to the North Dartmouth Trunk Sewer, by Highway 118*	2021	2021-2026	$ 11,361,000
		D9	Anderson Pumping Station Upgrades	*Install new 300mm ø forcemain following existing path. Alter flow path from holding tank to PS by adjusting pipe grades between infrastructure*	2031	2031-2036	$ 340,000
	Dartmouth WWTF Upgrades	D10	Upgrades to Dartmouth WWTF	*Upgrade Dartmouth WWTF to meet demand at end of Project Horizon*	2043	2036-2041	$ 12,572,000
	Inflow and Infiltration	D11	RDII Reduction Program	*Implement an Inflow and Infiltration Reduction Program within the Ellenvale areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2021	2021-2026	$ 5,941,076
		D12	RDII Reduction Program	*Implement an Inflow and Infiltration Reduction Program within the Woodside areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2031	2031-2036	$ 1,120,232
		D13	Additional flow monitoring	*Flow monitoring through the catchment to assess areas in model showing flooding*	2020	2016-2021	$ 252,000

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
East Region : Dartmouth	**Local New Networks and Upgrades**	**D15**	Green St Upsize	*Common project - Upsize from 375 to 750mm ø gravity sewer along Green Street*	2041	2041-2046	$ 513,000
		D16	Pinecrest Dr Upgrade	*Common project - Upsize from 200 to 375mm ø gravity sewer along Pinecrest Drive*	2031	2031-2036	$ 1,013,000
		D17	Peddars Way Upgrade	*Common project - Upsize from 300 to 375mm ø gravity sewer along Peddars Way*	2031	2031-2036	$ 555,000
		D18	Atlantic Street Upgrade	*Common project - Upsize from 250 to 450mm ø gravity sewer along Atlantic St*	2021	2021-2026	$ 3,831,000
		D19	Akerley Blvd and Railway Alignment Upgrade	*Strategy project - Upsize from 250 to 600mm ø gravity sewer along Akerley Blvd and Railway easement towards Ferguson Road CSO*	2041	2036-2041	$ 4,814,000
		D20	Pleasant Street Upgrade	*Strategy project - Upsize from 200 to 450mm ø gravity sewer along Pleasant St, and towards Cuisack Street CSO*	2021	2021-2026	$ 767,000
		D21	Princess Margaret Blvd. Upgrade	*Strategy project - Upsize from 450 to 600mm ø gravity sewer along Princess Margaret Blvd.*	2031	2031-2036	$ 3,106,000
		D22	Anderson Lake Development Connection	*Strategy project - Construct new 450mm ø gravity sewer to connect Anderson Lake development to Akerley Blvd*	2036	2036-2041	$ 7,609,000
		D23	Marvin Connection	*Strategy project - Construct new 450mm ø gravity sewer in Marvin Street and connect to connect Cuisack Street CSO*	2026	2026-2031	$ 1,380,000
	Flow Diversion	**D24**	King Street Diversion	*Common Project - 450mm ø sewer diversion to NDTS*	2026	2026-2031	$ 78,000
		D25	Diversion to Eastern Passage	*Install new pumping station at Melva St CSO. Install new dual 600mm ø forcemain following Pleasant Street and connecting to existing gravity pipe in Eastern Passage network. Upgrade existing gravity pipe from a 200 to 600mm ø.*	2036	2036-2041	$ 12,113,000
	Flow Optimization	**D14**	CSO Flow Management Study	Monitor and assess CSO facilities to mitigate discharges (11 facilities). Costed at $14,000/monitor and $15,000/CSO for assessment.	2036	2036-2041	$ 675,000
		D26	SSO Flow Management Study	Monitor and assess SSO facilities to mitigate discharges (9 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.	2021	2016-2021	$ 555,000
	DARTMOUTH Total Wastewater Servicing Strategy Cost						**$ 104,358,308**
	EAST REGION Total Wastewater Servicing Strategy Cost						**$ 153,836,631**
	ALL REGIONS Total Wastewater Servicing Strategy Cost						**$ 563,082,533**

Executive Summary Table 4: Water Capital Program Summary

Project Category	Project Name	Project ID	Project Task	Start Year	Planning Period	Total Capital Cost (2019$)
Pockwock - Peninsula	Peninsula Transmission Upgrades (Chain Control)	W06.1	Chain Control Transmission - Existing Peninsula Low Upsize	2021	2021-2026	$ 3,841,000
		W06.2	Chain Control Transmission - Existing Peninsula Intermediate Upsize	2021	2021-2026	$ 2,650,000
		W06.3	Pepperell Transmission	2036	2036-2041	$ 2,702,000
		W06.4	Chain Control Transmission - Existing Peninsula Low Lining	2036	2036-2041	$ 2,916,000
		W06.5	Chain Control Transmission - Valve Chambers	2036	2036-2041	$ 1,258,000
	Twinning of Peninsula Transmission (Robie)	W07	Replace High Risk Peninsula Transmission (Robie)	2026	2026-2031	$ 17,312,000
	Quinpool to Young Connection	W08	Peninsula Intermediate Looping - Quinpool Rd to Young St	2021	2021-2026	$ 4,319,000
	Young Street Pocket Upgrades	W10.1	Young St Upsize	2026	2026-2031	$ 1,315,000
		W10.2	Robie St Upsize	2026	2026-2031	$ 956,000
		W10.3	Almon St Upsize	2026	2026-2031	$ 1,168,000
		W10.4	Windsor St Upsize	2026	2026-2031	$ 1,004,000
Pockwock - Other	Lakeside Projects	W01.1	Geizer 158 to Lakeside High Looping	2021	2021-2026	$ 2,249,000
		W01.2	Gravity Supply to Brunello	2041	2041-2046	$ 2,328,000
		W01.3	Dominion Cres Upsize	2041	2041-2046	$ 447,000
		W01.4	Brunello Booster Pump Upgrades	2021	2021-2026	$ 236,000
	Lively, Geizer Hill, and Leiblin Booster Pump Upgrades	W03	Geizer Hill Booster Pump Upgrades	2021	2021-2026	$ 277,000
		W04	Leiblin Booster Fire Pump	2019	2016-2021	$ 395,000
		W15	Lively Booster Pump Upgrades	2036	2036-2041	$ 38,000
	Herring Cover Upgrades	W05.1	Herring Cove Rd Twinning	2020	2016-2021	$ 3,585,000
		W05.2	St Michaels Ave Upsize	2041	2041-2046	$ 502,000
		W05.3	Herring Cove Rd Looping - McIntosh St	2021	2021-2026	$ 2,272,000
	Lucasville Road Twinning	W12.1	Lucasville Rd Twinning (Phase 1)	2019	2016-2021	$ 8,117,000
		W12.2	Lucasville Rd Twinning (Phase 2)	2026	2026-2031	$ 8,956,000
	New Primary Sackville High and Beaver Bank Supply	W13.1	New Primary Feed to Sackville High	2026	2026-2031	$ 4,953,000
		W13.2	New Sackville Beaver Bank Valve Chamber	2026	2026-2031	$ 839,000
		W13.3	Reconfiguration of Beaver Bank Booster	2026	2026-2031	$ 100,000
		W13.4	New Sackville High PRV	2026	2026-2031	$ 420,000
	Second Supply to Windsor Junction	W14.1	Cobequid High Looping	2026	2026-2031	$ 2,233,000
		W14.2	Windgate Dr Upsize	2026	2026-2031	$ 882,000
	New Hemlock Tank	W16	New Hemlock Elevated Tank	2020	2016-2021	$ 6,209,000
	Pockwock Transmission Looping	W17	Pockwock Transmission Loop through Bedford	2021	2021-2026	$ 5,069,000
	Second Geizer 158 Feed and Lacewood Drive Loop	W02	Geizer 158 Looping - Lacewood Dr	2041	2041-2046	$ 2,002,000
		W20	Second Geizer 158 Feed	2041	2041-2046	$ 9,612,000

Executive Summary Table 4: Water Capital Program Summary (continued)

Project Category	Project Name	Project ID	Project Task	Start Year	Planning Period	Total Capital Cost (2019$)
Lake Major	New Transmission from Topsail to Burnside	W22.1	New Main Street to Caledonia Road Connection	2021	2021-2026	$ 3,072,000
		W22.2	Caledonia Rd Twinning	2021	2021-2026	$ 3,429,000
		W22.3	New Breeze Dr Watermain	2021	2021-2026	$ 5,801,000
		W28	Tacoma PRV Chamber	2021	2021-2026	$ 420,000
	Highway 118 Crossing	W23	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	2021	2021-2026	$ 6,063,000
	Windmill Road Upgrade	W24	Windmill Rd Upsize	2026	2026-2031	$ 6,104,000
	New Woodside Industrial Park Feed	W25	New Woodside Industrial Park Feed	2021	2021-2026	$ 1,649,000
	Willowdale-Eastern Passage Connection	W26	Willowdale to Eastern Passage Connection	2036	2036-2041	$ 6,290,000
System Interconnections Pockwock Transmission WTP Decommissioning	Pockwock Transmission Twinning	W19.1	Pockwock Transmission Twinning - 60in	2031	2031-2036	$ 65,516,000
		W19.2	Pockwock Transmission Twinning - 54in	2036	2036-2041	$ 16,228,000
	Extension to Springfield Lake	W21	Extension to Springfield Lake	2041	2041-2046	$ 3,043,000
	Bedford-Burnside Interconnection	W29.1	Bedford-Burnside System Interconnection (Phase 1)	2036	2036-2041	$ 24,499,000
		W29.2	Bedford-Burnside System Interconnection (Phase 2)	2036	2036-2041	$ 11,779,000
	Dartmouth-Peninsula Interconnection	W30.1	Lyle Emergency Booster	2026	2026-2031	$ 1,045,000
		W30.2	Valving for Central Intermediate Boundary Change	2026	2026-2031	$ 629,000
	Pockwock-Bennery Interconnection	W31.1	Extension of Fall River to Bennery Lake (Phase 1)	2026	2026-2031	$ 8,067,000
		W31.2	Extension of Fall River to Bennery Lake (Phase 2)	2026	2026-2031	$ 9,156,000
		W31.3	Extension of Fall River to Bennery Lake (PS)	2026	2026-2031	$ 1,310,000
	WSP Decommissioning	W32.1	Decommission Miller Lake WSP - Linear	2019	2016-2021	$ 628,000
		W32.2	Decommission Miller Lake WSP	2019	2016-2021	$ 61,000
		W33.1	Decommission Collins Park WSP - Linear	2041	2041-2046	$ 1,086,000
		W33.2	Decommission Collins Park WSP	2041	2041-2046	$ 168,000
		W34.1	Decommission Silversands WSP - Linear	2041	2041-2046	$ 1,931,000
		W34.2	Decommission Silversands WSP	2041	2041-2046	$ 168,000
	Aerotech Storage	W40	Aerotech Storage	2021	2021-2026	$ 4,752,000
Studies	Studies	W18	Chain Lake Backup Supply Study	2020	2016-2021	$ 50,000
		W27	Mt Edward Booster Fire Pump	2019	2016-2021	$ 50,000
		W29.3	New Orchard Control Chamber	2021	2021-2026	$ 50,000
		W30.3	Robie Emergency Booster	2021	2021-2026	$ 50,000
		W35	Safe Yield Study	2020	2016-2021	$ 100,000
		W36	New Hydraulic Water Model (InfoWater)	2020	2016-2021	$ 200,000
		W37	Comprehensive PRV Study	2019	2016-2021	$ 50,000
		W38	Transmission Main Risk Assessment and Prioritization Framework	2020	2016-2021	$ 50,000
		W39	Tomahawk Lake Supply Study	2036	2036-2041	$ 50,000
Total Water Servicing Strategy Cost						**$ 284,706,000**

Halifax Water

INFRASTRUCTURE MASTER PLAN

VOLUME 2
WATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

GM BluePlan ENGINEERING

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VOLUME 2 – WATER INFRASTRUCTURE

Catchment Overview

Halifax Water currently owns and operates three main water supply plants (WSP), two back-up WSPs, and six smaller community supply plants:

Main WSPs

- J.D. Kline WSP (West Region and Central Region) – the Pockwock System
- Lake Major WSP (East Region) – the Lake Major System
- Bennery Lake WSP (Airport and Aerotech Business Park) – the Bennery System

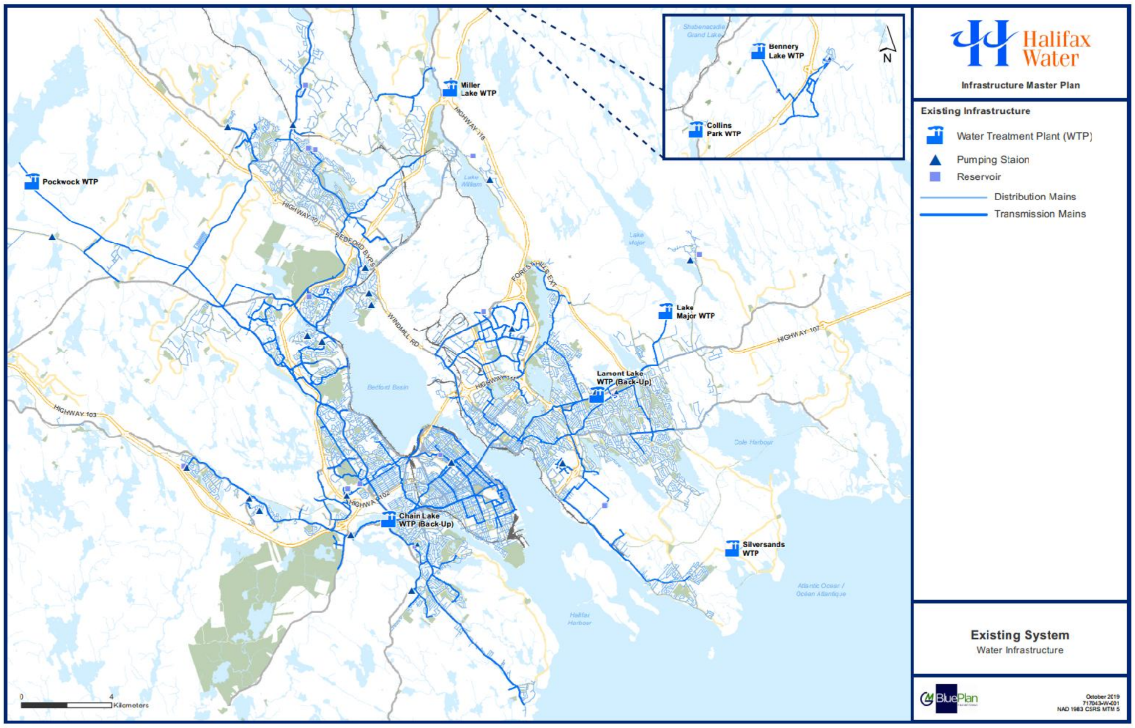
Back-up WSPs:

- Chain Lake
- Lake Lamont

Smaller Community WSPs

- Collins Park
- Silversands
- Miller Lake
- Five Island Lake
- Bomont
- Middle Musquodoboit

The water distribution systems are shown in Executive Summary Figure 7.



Executive Summary Figure 7: Existing Water Network Overview

Water Infrastructure Strategy Development

The water distribution servicing strategy has been developed with the primary aim of providing an adequate level of service to existing and future customers out to the 2046 planning horizon, and provides the following key drivers:

- Servicing strategy can accommodate the planned growth and 2046 future system demands;
- Water supply and overall system resiliency are secured, and risk of service interruption is minimized;
- The water distribution system is optimized to enhance operations and maintenance;
- Asset renewals and opportunities for synergy are considered.

The following inputs were used to complete the capacity and compliance analysis for the water distribution system under both existing and growth scenarios, and then assist in developing and testing multiple servicing strategies and selecting the preferred strategy:

<u>Opportunities and Constraints Workshop with Halifax Water Staff</u>

- Input from the Halifax Water staff knowledgebase through workshops and other correspondence was invaluable for the identification of system constraints, opportunities for optimization, operational concerns, growth pressures, and previously-recommended infrastructure solutions.

Supply, Pumping, and Storage Desktop Analysis

- The desktop analysis identified facilities and water supply sources with insufficient capacity to meet growth demands.

Hydraulic Modelling

- The updated WaterCAD hydraulic water model was used to highlight areas with limitations or constraints within the transmission network and validate the selected servicing strategy to ensure that overall servicing needs were met.

Water Infrastructure Preferred Strategy

The Capital Program for the Water Infrastructure Preferred Strategy is included in Volume 1 Executive Summary and supports the servicing of all regions. The Capital Costs for Water Infrastructure total approximately **$285M (in 2019 dollars).** The program costs are evenly distributed over the planning period as best as possible, by adjusting the implementation year of projects with flexible timing.

Projects to Accommodate Growth

System Supply

The servicing strategy aims to ensure sufficient system supply to meet 2046 growth demands for all three systems, with consideration given to post-2046 demands. Several concepts were reviewed to assess feasibility, social implications, and economic impacts.

i. Increase safe yield
ii. Water conservation
iii. New supply
iv. System interconnections

The following capital projects are proposed to accommodate system supply needs due to growth:

- Tomahawk Supply Study
- Lucasville Road Twinning
- New Primary Supply to Sackville High and Beaver Bank Boosted
- Orchard Control Chamber Study
- Bedford-Burnside Connection
- Second Supply to Windsor Junction
- Pockwock System Extension to Bennery Lake

Peninsula Supply

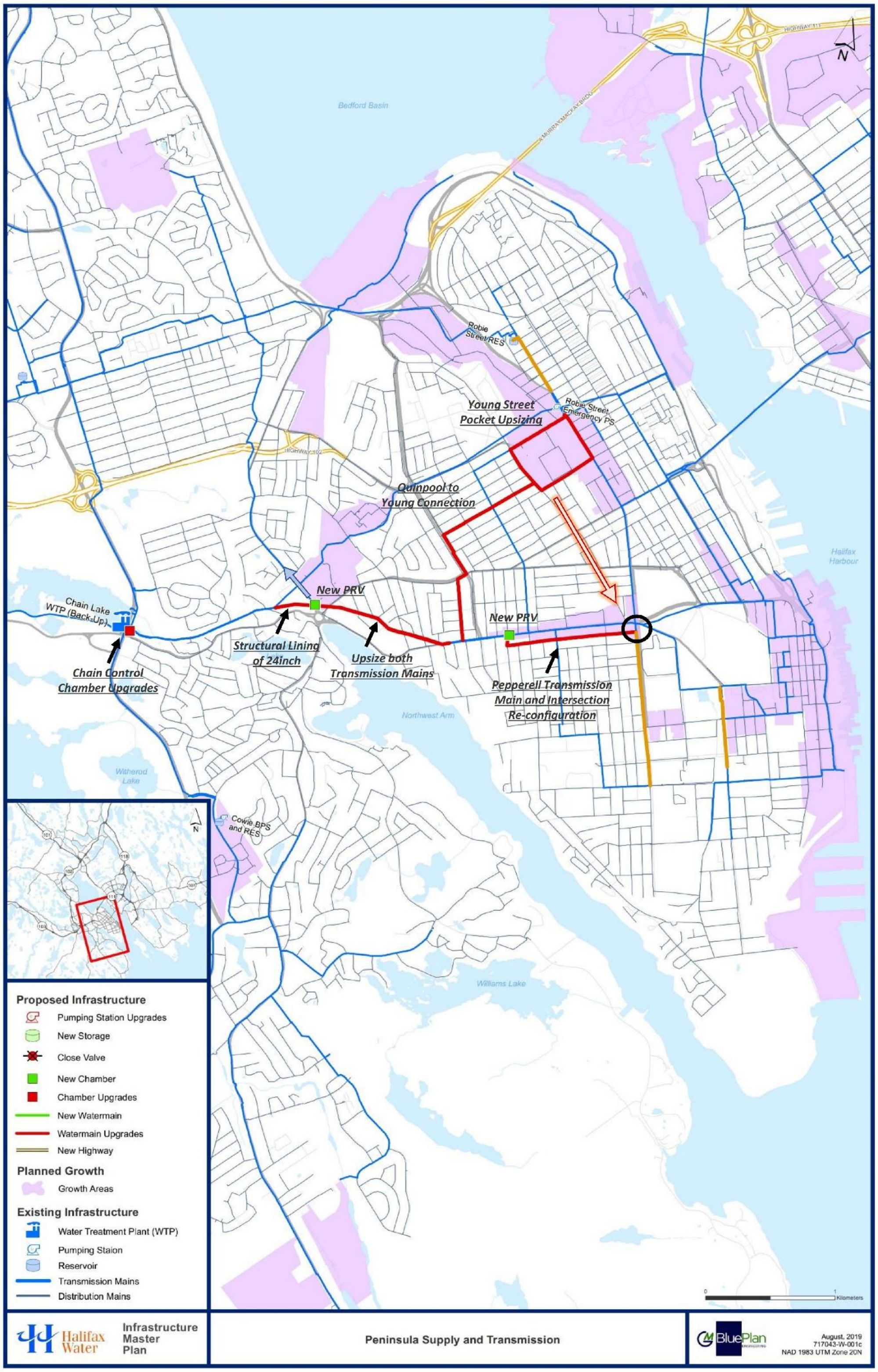
There is significant proposed growth on the Halifax Peninsula (approximately 51,000 population equivalent), and the existing transmission system is insufficient to meet 2046 demands. The preferred strategy for water supply to the Peninsula is through increased Chain Control transmission main capacity using a strategically-timed upsizing approach. The individual Peninsula supply strategy projects are shown in **Executive Summary** Figure 8.

Peninsula Transmission

Several opportunities have been identified to enhance the existing spine network to accommodate growth in the Peninsula, including:

- Young Street Pocket watermain upsizing
- Quinpool Road to Young Street transmission connection
- “Closing the Loop” strategy to enhance system resiliency from Young Street area to Quinpool/Robie intersection, as small old watermains are replaced
- Three (3) critical transmission mains in poor condition are to be strategically cleaned, lined, or replaced within the next 5 years as part of the Asset Management Program
- Local distribution watermains have not been focused on under the Infrastructure Master Plan; however, the replacement and/or upsizing of these local distribution mains will continue to improve localized pressure and fire flow capacity issues

These Peninsula transmission strategy opportunities are shown in **Executive Summary** Figure 8**.**



Executive Summary Figure 8: Peninsula Supply and Transmission Objectives and Projects

Hemlock Elevated Tank

A new storage facility is recommended within the Hemlock High pressure zone to support growth in the Bedford area, reduce peaking of water supply at Pockwock WSP, and improve overall system resiliency.

Aerotech Tank

The existing Aerotech Tank is currently operating at 90% of its design capacity. Proposed growth will require significantly more storage volume. A design study is recommended for storage tank replacement, as well as a review of tank location to identify opportunities for system optimization. The new storage facility should consider the proposed Fall River extension and new supply source.

Lakeside and Timberlea

The following projects are proposed to meet growth requirements in the Lakeside and Timberlea area:

- Brunello Booster Pump Upgrades
- Bayers Industrial Park Looping
- Gravity Supply to Brunello
- Dominion Crescent Watermain Upsize

Herring Cove

The previous water servicing strategy created in 2000 provided recommendations for the watermain extension along Herring Cove Road, a new reservoir, and local servicing throughout the Herring Cove area. The servicing strategy proposed in the Infrastructure Master Plan included a review of the previous water servicing strategy, and includes the following key projects:

- Twinning of Herring Cove Road watermain
- Upsize St. Michaels Avenue watermain and loop McIntosh Street watermain
- Extension of servicing along John Brackett Drive and Ketch Harbour Road (part of previous water servicing strategy) is likely to proceed

Lively (Berry Hills)

The Lively Booster was designed to meet peak domestic demands and provide fire flow capacity to the Lively subdivision. The existing capacity of the Lively Booster cannot meet the proposed 2046 growth demands, therefore future upgrades are needed. Demand monitoring is recommended as development comes online; when demands reach 80% of the existing capacity, the proposed upgrades should be implemented.

Geizer Hill

The Geizer Hill Booster was designed and constructed to meet domestic flows and provide fire flow capacity for current and future water demands. However, the existing capacity cannot meet the proposed growth demands to the 2046 planning horizon. Therefore, future upgrades are needed. Demand monitoring is recommended as development comes online; when demands reach 80% of the existing capacity, the proposed upgrades should be implemented.

Woodside Industrial Park

A gravity solution is recommended from the Woodlawn Intermediate transmission main to the Woodside Industrial Park, to accommodate the growth expansion. The existing Woodlawn Intermediate pressure zone HGL is adequate to service existing and future customers.

Shannon Park

Additional capacity is required within the Burnside Low pressure zone to accommodate significant growth in the Shannon Park and Wyse Road areas. It is recommended that the existing Windmill Road watermain is upsized to accommodate this growth.

Projects to Enhance System Resiliency

System resiliency is a key objective for the servicing strategy to minimize risk of loss of service, water quality issues, fire flow capacity, adaption to climate change, transmission main failure, etc. Numerous projects have been proposed in both the Pockwock and Lake Major systems that aim to enhance system resiliency.

Pockwock System

- Pockwock Lake has some redundancy available through Chain Lake emergency backup supply and will have additional redundancy through future Tomahawk Lake supply.
- Separate study for JD Kline WSP is recommended to review level of risk associated with the supply plant and the requirements to provide an adequate level of resiliency.
- Twinning of the single 60-inch transmission main servicing the Pockwock system from JD Kline WSP to provide capacity for post-2046 demands and allow the existing transmission main to be taken offline for rehabilitation.
- Twinning the single 54-inch transmission main from Lucasville Road to Hammonds Plains Road; however, this strategy should be reevaluated during the next Infrastructure Master Plan update.
- Loop watermain from Nine Mile Drive to Hammonds Plains Road to join the Pockwock transmission mains and provide redundancy to a large portion of the 48-inch transmission main, in addition to providing a second supply to Orchard Control, reducing risk for the existing single feed.
- The Peninsula transmission main from Geizer 123 to Robie does not require additional capacity to meet growth demands; however, as it is a critical piece of infrastructure and its current condition is not known, a detailed study is recommended to evaluate different strategies aimed at minimizing risk of failure.
- Twinning of the Geizer 158 transmission main is proposed, including looping of the Lacewood Drive watermain. This twinning would increase conveyance to the Geizer reservoirs, provide a second feed to Geizer 158 High zone, and enhance resiliency to Geizer-158 supported pressure zones.
- An investigation is proposed to determine the performance benefits of implementing an advanced operational system at the Robie 2 Emergency Booster (currently operated manually on an as-needed basis).
- The Chain Lake backup water supply does not provide major redundancy for the Pockwock transmission main. A comprehensive study is recommended to determine the requirements to activate Chain Lake WSP, the before and after conditions of the Pockwock system, and the overall additional resiliency that Chain Lake could provide.

Lake Major System

- A capacity increase is recommended from the Topsail Chamber to Burnside to improve system resiliency under the 2046 horizon. This will be achieved through a new 30-inch diameter watermain, and will allow increased conveyance to Akerley Reservoir, support the Bedford-Burnside connection, and allow for full Lake Major system resiliency.
- It is recommended that the flow capacity through Tacoma PRV is increased to eliminate the needs for significant linear upgrades. It is recommended that the PRV chamber is upgraded while the Topsail to Waverley projects are being constructed to strengthen and optimize system operations as demands increase with growth.
- The proposed Bedford-Burnside interconnection can provide over 60% of ADD supply to the Lake Major system; it is recommended that the Lyle Street Booster is designed to convey the other 40% of ADD supply, effectively providing complete redundancy to the Lake Major system in the event of catastrophic failure under 2046 demands. This redundancy would also negate the need for the Lake Lamont backup supply.

Projects to Provide System Optimization

Eastern Passage

The recommendation of the Infrastructure Master Plan is to construct a new feed to Eastern Passage from Willowdale (higher HGL) with a new PRV. This new 16-inch watermain would meet fire flow objectives, create a loop for improved resiliency, provide opportunities for improved water quality, and optimize system pressures.

Treatment Facilities

There are opportunities to connect three of the six smaller community WSP’s (Miller Lake, Collins Park, and Silversands) into the main networks and decommission the existing smaller facilities These projects are not growth-triggered, and their timing requirements are flexible.

Springfield Lake Connection

There is an opportunity to extend potable water distribution service to the Springfield Lake area via new watermain connection, through a synergy opportunity with the planned wastewater diversion along Sackville Drive. The Infrastructure Master Plan includes the service extension to Springfield Lake; a more detailed servicing study will be required to develop a specific plan for adequate customer servicing.

The extension of water service to Springfield Lake would require consultation with HRM on an extension of the water service boundary. The extension would depend on the desire of residents to receive water service as system extensions are typically paid for by the new customers who would be receiving service.

Mt. Edward Booster Fire Pump Upgrade

The capacity and compliance analysis desktop study concluded that the fire flow provided by Mt. Edward Booster is inadequate for some serviced buildings, including multiple schools. It was noted that this was a desktop review using master planning criteria and a review in greater detail should be completed using the Fire Underwriters Survey (FUS) calculation approach.

Leiblin Booster Fire Pump Upgrade

The capacity and compliance analysis desktop study concluded that the fire flow provided by Leiblin Booster is inadequate for some serviced buildings, including the school. It should be noted that a fire pump capacity upgrade at the booster station is already underway.

Halifax Water

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

VOLUME 3

WEST REGION WASTEWATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

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VOLUME 3 – WEST REGION WASTEWATER INFRASTRUCTURE

Catchment Overview

As the West Region's servicing strategy was completed under the WRWIP, this volume has taken components of the WRWIP relating directly to the West Region. The more generic components in the WRWIP have been included in Volume 1 of the Infrastructure Master Plan.

The West Regions includes the wastewater sewersheds of Halifax, Herring Cove and Beechville, Lakeside and Timberlea (BLT). Herring Cove and BLT are separated systems while Halifax, being an older system, is combined, particularly within Halifax Peninsula. The main unique features for the West Region are in the Halifax catchment surrounding the combined areas. Several major combined sewer overflow (CSO) facilities are located at pumping stations and other locations throughout the combined network of Halifax Peninsular, and discharge to the Halifax Harbour. Flow that bypass the CSO are either conveyed by the Northwest Arm Trunk Sewer along the southern side of Halifax Peninsula, or the Fairview Cove tunnel along the north side of Halifax Peninsula, to the Halifax WWTF. Real time control (RTC) set-up restricts flows entering Young Street Pumping Station and the amount of flows pumped from Duffus Street to the WWTF.

The primary constraints identified in the West Region were the Halifax and BLT WWTFs exceeding rated capacity, bottlenecks in the trunk sewer along Fairview Cove, limited capacity to accommodate significant growth in Young Street and Spring Garden Road areas, and limitations downstream of Roaches Pond forcemain discharge. The main opportunities in the West Region are surplus capacity at Herring Cove WWTF and an upgrade to Mill Cove WWTF, which would allow for Central Region to accommodate growth, removing the need for the major diversion towards the Peninsula as previously noted in the RWWFP.

Additionally, under the Infrastructure Master Plan, components of the WRWIP were updated to align with the overall Infrastructure Master Plan process. This included outlining the revised growth in the West Region in accordance to the *Planning Data and Population Numbers* study and the Capital Program costs updated to align with 2019 dollars and include the new RDII Costing Template.

Key Supporting Studies

WET WEATHER MANAGEMENT STUDY

The Wet Weather Management Study was developed under the WRWIP for the West Region. The combined areas in Halifax Peninsular were assessed under the sewer separation and LID feasibility studies, as outlined in Volume 1. For the RDII reduction feasibility study, it should be noted that the analysis was originally completed during the WRWIP for all areas within the West Region, including combined areas in the Peninsula. As part of the Infrastructure Master Plan, only the separated systems were carried forward for RDII reduction, as sewer separation is a more appropriate option for the combined sewer areas.

The outcome of the study for Halifax are as follows:

- The sewer separation study identified Young Street, Kempt Road, upstream of Bedford Hwy and Connaught Avenue as areas that were most feasible for sewer separation
- The RDII reduction study identified Bridgeview, Clayton Park and Fairview/Fairmount (flow monitor catchments FM-3, FM-4 and FM-6) as having significant issues of RDII and providing opportunities to remove wet weather from the separate sanitary system

- The study recommended that the RDII analysis was refined as a component of the overall strategy in the WRWIP, along with sewer separation

Adjustment to the RDII reduction areas made in the strategy, was to include only the Fairview area of FM-6 in the RDII reduction, this was done in recognition of Fairview being an old system and being located near other areas with high RDII.

ADDITIONAL STUDIES

In addition to the Supporting Studies in Volume 1, the other studies used to guide the preferred servicing strategies are as follows:

- Local Wastewater Servicing Capacity Analysis (LoWSCA)
- Northwest Arm Sewer Lining and Reconfiguration of Armdale Pumping Station
- Rehabilitation of Fairfield Holding Tank

West Region Strategy Development

The PCSWMM models and WRWIP growth numbers were used to complete the capacity and compliance analysis for the West Region under both existing and growth scenarios, and then assisted in developing and testing multiple servicing strategies and selecting the preferred strategy. Climate change was not considered in the West Region strategy as it is a new component under the Infrastructure Master Plan.

Common Projects in the strategies included: decommission BLT WWTF and divert flows, upgrades to Young Street and Armdale Pumping Stations, sewer separation in Young Street and Spring Garden LoWSCA areas and upstream of Kempt Road CSO, re-commission the Fairfield Holding Tank, North Street flow split configuration and RDII reduction.

Once the Common Projects were confirmed a range of serving strategies were assessed. In the West Region four (4) overarching servicing strategy alternatives were considered, including:

- One strategy that conveys all flows to Halifax WWTF (Strategy 1), including BLT flows.
- Two strategies with flow diversion to Herring Cove WWTF (Strategy 2a – 2b), to reduce upgrades to Halifax WWTF. Strategy 2a includes the BLT diversion to Herring Cove WWTF and reduced upgrades to Halifax WWTF. Strategy 2b include the BLT and Armdale diversion to Herring Cove WWTF to remove upgrades to Halifax WWTF but requires an expansion at Herring Cove WWTF.
- One strategy to protect the peninsula from upgrades (Strategy 3), through a major Highway 102 diversion and the BLT diversion to Herring Cove WWTF. With all flows diverted to Herring Cove WWTF, significant expansions at that facility are required.

West Region Preferred Strategy

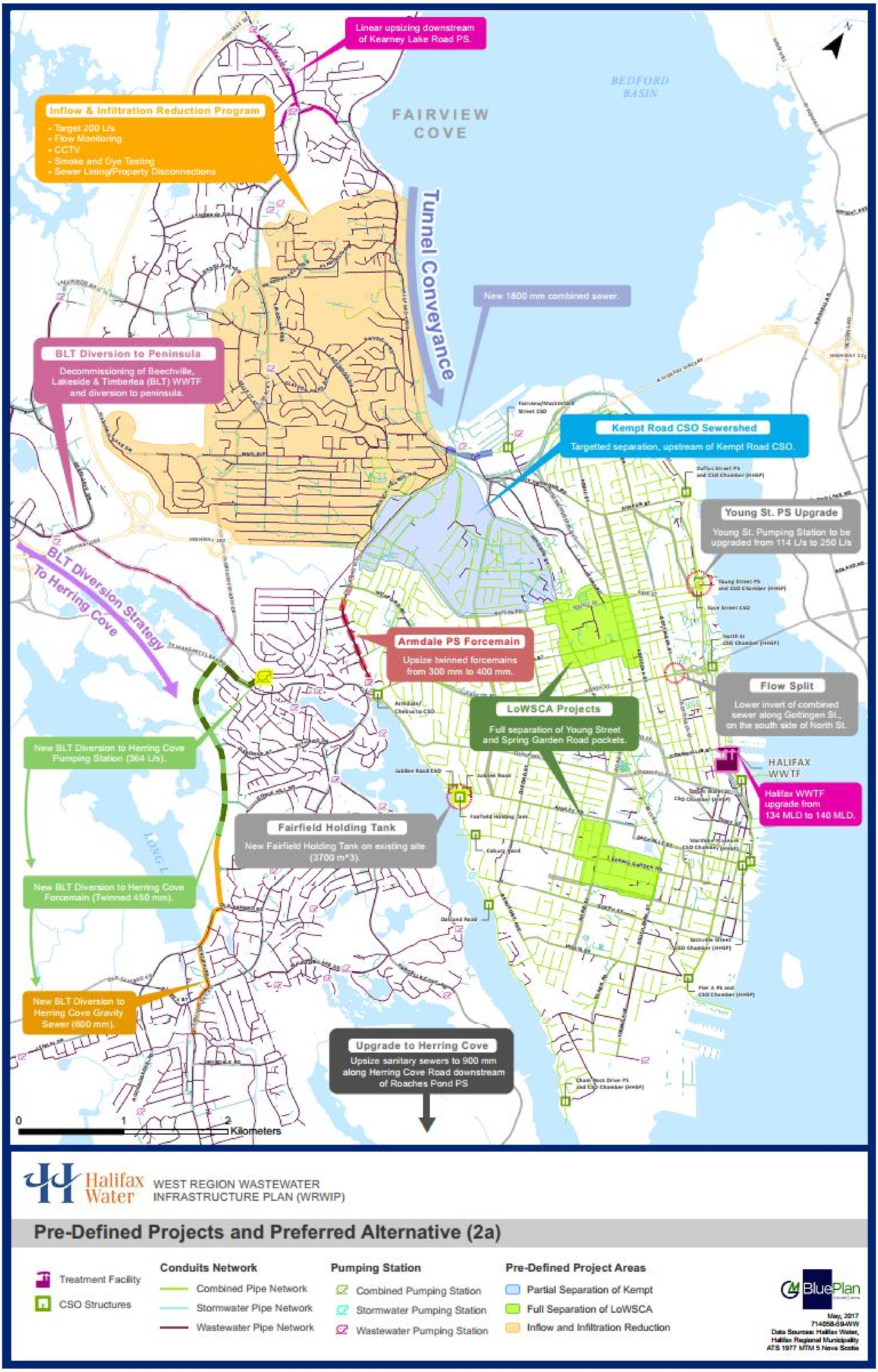
The preferred strategy for West region was Strategy 2a which is detailed in Executive Summary Figure 9: Preferred Servicing Strategy for the West Region. Strategy 2a was selected mainly due to providing greater flexibility, utilizes existing capacity at Herring Cove WWTF, ‘buys time’ on the Halifax WWTF upgrade, performing to an acceptable level of service, and being a cost-effective solution. In addition to selecting the preferred approach, two component evaluations were considered – Roaches Pond Pumping Station alternatives and determining the location of Crown Drive Pumping Station. The Roches Pond Pumping Station alternatives considered the pros and cons of removing the pumping station and replacing with a gravity pipe. Due to the expected difficulties, level of disruption and costs it was not recommended to proceed, instead more detailed investigation and data collection is recommended to properly identify the best operational strategy for this facility. The preferred strategy (2a) included a new pumping station within the Crown Drive and Northwest Arm Drive area. An exercise was completed to evaluate various locations and select a preferred location for the proposed Crown Drive Pumping Station.

The Capital Program for the West Region is included in Volume 1 Executive Summary. The capital cost for the WRWIP were updated under the Infrastructure Master Plan to be in 2019 dollars, including the updated RDII Costing Template and WRWIP Concept Design updates. This led to an increase in capital costs from **$165M (2018 dollars)** to **$186M (2019 dollars).**

The scope of work for the WRWIP project included conceptual design for all projects that are required within a 10-year horizon. The WRWIP preferred strategy Concept Design Projects were:

- New Fairview Cove Trunk Sewer
- New Crown Drive Pumping Station
- New BLT Pumping Station and Decommissioning of BLT WWTF
- Sewer Separation
- Young Street Pumping Station Upgrades

Refer to the WRWIP for the Conceptual Designs of the above projects.



Executive Summary Figure 9: Preferred Servicing Strategy for the West Region

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

VOLUME 4

CENTRAL REGION WASTEWATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

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VOLUME 4 – CENTRAL REGION WASTEWATER INFRASTRUCTURE

Catchment Overview

Central Region servicing strategy was completed under the Infrastructure Master Plan, following the same process as the West Region under the WRWIP. The Central Region included Mill Cove WWTF, Springfield Lake WWTF, and Aerotech WWTF sewersheds.

The Springfield Lake catchment was not originally included in study area, however in recognition of the potential future benefits of diverting flows from Springfield Lake to Mill Cove WWTF, it was added to the Central Region study area.

The Aerotech wastewater collection system has been considered in the Infrastructure Master Plan; however, the only regional infrastructure features in the area is the Aerotech wastewater treatment facility itself. A significant facility upgrade was completed in 2016 on the WWTF, which included a full assessment of existing flows and future growth to evaluate capacity expansion requirements. As these upgrades have already been completed, the Aerotech WWTF system is not a primary focus area within the Infrastructure Master Plan.

The Mill Cove wastewater collection system is a separated system that covers the Sackville and Bedford areas and contains several key features that affect flow conveyance to the treatment facility.

- Main conveyance feature in Sackville is the Sackville trunk sewer, which drains by gravity to Fish Hatchery Pumping Station
- Fish Hatchery PS is located at the northernmost tip of the Bedford Basin and pumps all flow from the Sackville trunk sewer to Mill Cove WWTF
- Wastewater flows from the Bedford area converge via multiple smaller trunk sewers at the Bedford Pumping Station, located directly southwest of the Mill Cove WWTF
- Local wastewater network along Shore Drive that conveys wastewater flows directly to Mill Cove WWTF via Bedford Yacht Club Pumping Station.
- The Mill Cove Wastewater Treatment Facility is located near the Bedford Basin, and planning for major expansion to this treatment facility is currently underway

The Springfield Lake wastewater collection system is a separated system that surrounds Springfield Lake. Flows are conveyed to the Springfield WWTF through a chain of pumping stations due to the hilly topography around the lake. There is a localized low pressure system in the low-lying Falcon Crest Court peninsula catchment, that conveys flows to higher elevation without pumping.

Key Supporting Studies

WET WEATHER MANAGEMENT STUDY

As Mill Cove sewershed is a separated system the only Wet Weather Flow Management study incorporated into the strategy was the RDII Reduction Analysis. The Mill Cove flow monitoring catchments FMZ02 (Glen Moir), FMZ03 (Millview), FMZ10 (Bedford Common), and FMZ07 and FMZ40 (Lower Sackville), were highlighted as having significant RDII issues and provide an opportunity to remove wet weather from the separated sewer system.

ADDITIONAL STUDIES

In addition to the Supporting Studies in Volume 1, the other studies used to guide the preferred servicing strategies are as follows:

- The National Disaster Mitigation Program (NDMP) - identify thirty (30) key areas in HRM that are prone to frequent flooding during heavy rainfall events
- Fish Hatchery Forcemain Inspection Report

Central Region Strategy Development

The InfoWorks ICM model for the Central Region was used to complete the capacity and compliance analysis under both existing and growth scenarios, and then assist in developing and testing multiple servicing strategies and selecting the preferred strategy. Climate change was considered in the strategies through applying a climate change factor to the rainfall simulations as outlined in the Climate Change Study.

Common Projects in Central Region included upgrades to Mill Cove WWTF, decommission of Springfield WWTF and connection to Mill Cove sewershed, upgrades to Majestic Avenue, Beaver Bank #3 Pumping Stations, local pipe upgrades and the RDII reduction.

Once the Common Projects were confirmed a range of serving strategies were assessed. In Central Region there were six (6) overarching servicing strategy alternatives were considered, including:

- Two conveyance strategies (Strategy 1a – 1b) based on upsizes to the Sackville trunk with/without enhanced RDII to reduce catchment flows.
- Three storage strategies (Strategy 2a – 2c) based on installing storage tanks along the Sackville trunk, with/without upgrade to the Sackville trunk. Variations between strategies included tanks sized and applying enhanced RDII to reduce catchment flows.
- Two tunnel strategies (Strategy 3a – 3b) aim to decommission Fish Hatchery Pumping Station via the construction of a new tunnel to Mill Cove WWTF. Strategy 3a has the tunnel starting from Fish Hatchery PS and includes trench upgrades to the Sackville trunk upstream of Fish Hatchery. Strategy 3b extends the tunnel up to the Bedford Bypass crossing to remove trench upgrades.

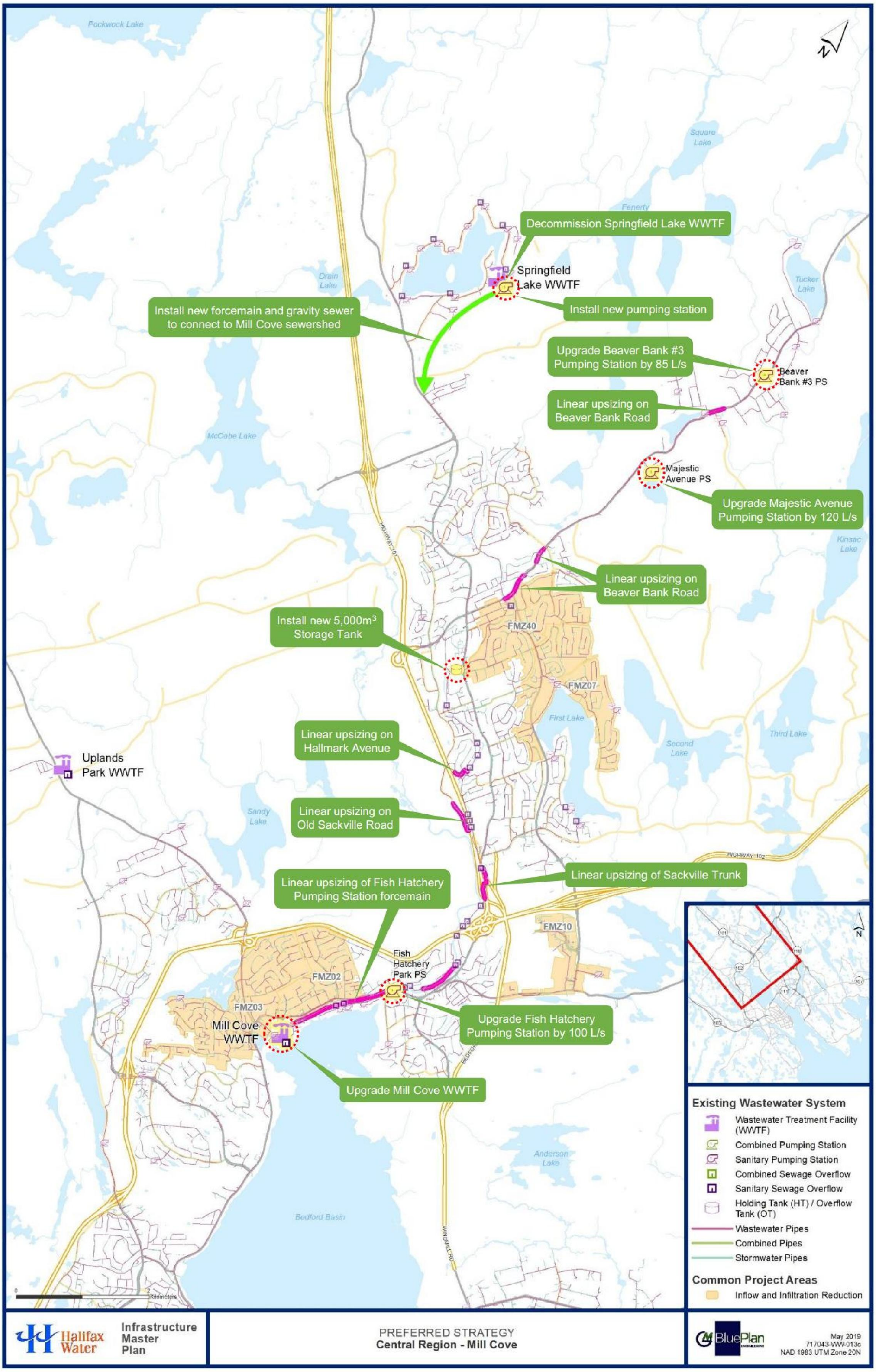
Central Region Preferred Strategy

The preferred strategy for Central was Strategy 2c which is detailed in Executive Summary Figure 10. Strategy 2c was selected mainly due to providing future flexibility, maximizes the use of existing assets, performing to an acceptable level of service, and being a cost-effective solution. In addition to selecting the preferred strategy for Central a component evaluation was done on RDII reduction rates and the impact on infrastructure requirements as RDII reduction directly affects tank sizing.

The Capital Program for the Central Region is included in Volume 1 Executive Summary. The Capital Costs for Central Region total **$163M (2019$).** The program is front heavy due to the cost associated with the upgrades to Mill Cove WWTF and the RDII reduction project required at the start of the project horizon.

The scope of work for the Infrastructure Master Plan included conceptual design for certain projects which are complex in feasibility and/or constructability. The projects selected for Conceptual Design were:

- Springfield Lake WWTF decommissioning and diversion to Mill Cove WWTF wastewater system
- Fish Hatchery PS forcemain upsizing (450mm to 675mm diameter)



Executive Summary Figure 10: Preferred Servicing Strategy for the Central Region

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

VOLUME 5

EAST REGION WASTEWATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

GUELPH | OWEN SOUND | LISTOWEL | KITCHENER | LONDON | HAMILTON | GTA
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VOLUME 5 – EAST REGION WASTEWATER INFRASTRUCTURE

Catchment Overview

East Region servicing strategy was completed under the Infrastructure Master Plan, following the same process as the West Region under the WRWIP. The East Region includes two wastewater sewersheds Eastern Passage and Dartmouth, and the sewersheds contain unique components and constraints with them.

The Eastern Passage is a separated system that covers the Cole Harbour and Eastern Passage areas. The main unique feature in the catchment is the gravity pressure sewer that connects the Cole Harbour area to the Eastern Passage treatment facility. Due to existing capacity constraints at the gravity pressure sewer there is a real time control (RTC) set-up that restricts flows from the main pumping station in Cole Harbour, Bisset Lake Pumping Station, to the surge tank at the start of the gravity pressure sewer. The main issues identified with the gravity pressure sewer include: flow restrictions causing spills at Bissett Lake, the condition of the asset affecting conveyance, odour control requirement and ongoing operational and maintenance concerns. Additional concerns in the catchment are Memorial Drive, Beaver Crescent and Quigley’s Corner Pumping Stations being under capacity, and Caldwell Crescent and Bissett Lake Pumping Stations being impacted by growth. The main opportunity in Eastern Passage is the newly upgraded WWTF. The treatment plant is located near Halifax Harbour and was expanded in 2014 to accommodate projected population growth in the serviceable boundary areas.

Dartmouth sewershed is an older system, largely comprised of combined systems within the Circumferential Highway, an area referred to as the Regional Centre. Outside the Regional Centre of the Dartmouth sewershed, it is considered a separated system. The combined system in Dartmouth includes flows from Albro Lake Watershed, Maynard Lake and the Clement Street Wetland located in the Southdale area, which leads to high peak flows and volumes being conveyed under storm events, causing capacity constraints on the system and combined sewer overflow (CSO) spills. Significant growth in the Dartmouth catchment will worsen conditions and lead to additional treatment capacity required at Dartmouth WWTF and increase flooding on Wyse Road and by Old Ferry Road CSO. In the separated areas upstream, there are existing constraints made worse by growth including SSO spills at Valleyford Holding Tank, Anderson Pumping Station and 111 Waverley Road Pumping Station.

Key Supporting Studies

WET WEATHER MANAGEMENT STUDY

It is evident from the background review and feasibility study outputs that there is significant potential for sewer separation within the combined system in Dartmouth and RDII reduction in the separated areas. The outcome of the wet weather management study for Dartmouth are as follows, and have been included in the strategy:

- The sewer separation study identified Jamieson Street, Wyse Road, Nantucket Avenue, Thistle Street, Rose Street and Canal Street as areas that were most feasible for sewer separation
- The Dartmouth flow monitoring catchments FMZ27 (Ellenvale) and FMZ45 (Woodside) were highlighted as having significant RDII issues and provide an opportunity to remove wet weather from the separated sewer system

As Eastern Passage sewershed is a separated system the only Wet Weather Flow Management strategy incorporated into the strategy was the RDII Reduction Analysis. The predefined flow monitor target areas were FMZ24 (Loon Lake), FLM23 and FMZ81 (Colby Village) and FMZ37 (Eastern Passage). All of the target areas were included with the exception of FMZ81, as the RDII reduction strategy did not alleviate flow restrictions observed along Colby Road making RDII reduction not the most cost-effective strategy.

ADDITIONAL STUDIES

In addition to the Supporting Studies in Volume 1, the other studies used to guide the preferred servicing strategies are as follows:

Dartmouth:

- Local Wastewater Servicing Capacity Analysis (LoWSCA)
- Gravity Stormwater Sewer from Little Albro Lake to Jamieson Street Pumping Station, Preliminary Design Report
- Port Wallace Master Plan Infrastructure Study
- National Disaster Mitigation Program (NDMP)

Eastern Passage:

- Eastern Passage WW Management Plan
- Quigley's Corner Preliminary Design Report
- Cow Bay Road Draining Investigation – Hydrologic and Hydraulic Analysis
- National Disaster Mitigation Program (NDMP)

Eastern Passage Strategy Development

The InfoWorks ICM models for the East Region were used to complete the capacity and compliance analysis under both existing and growth scenarios, and then assist in developing and testing multiple servicing strategies and the preferred strategy. Climate change was considered in the strategies through applying a climate change factor to the rainfall simulations and through looking at the impact of sea level rise on CSOs discharging to the Halifax Harbour in Dartmouth and SSOs in Eastern Passage.

Common Projects in Eastern Passage included upgrades to Memorial Drive, Beaver Crescent and Quigley's Corner Pumping Stations, local pipe upgrades and the RDII reduction.

Once the Common Projects were confirmed a range of servicing strategies were assessed. In Eastern Passage ten (10) overarching servicing strategy alternatives were considered, including:

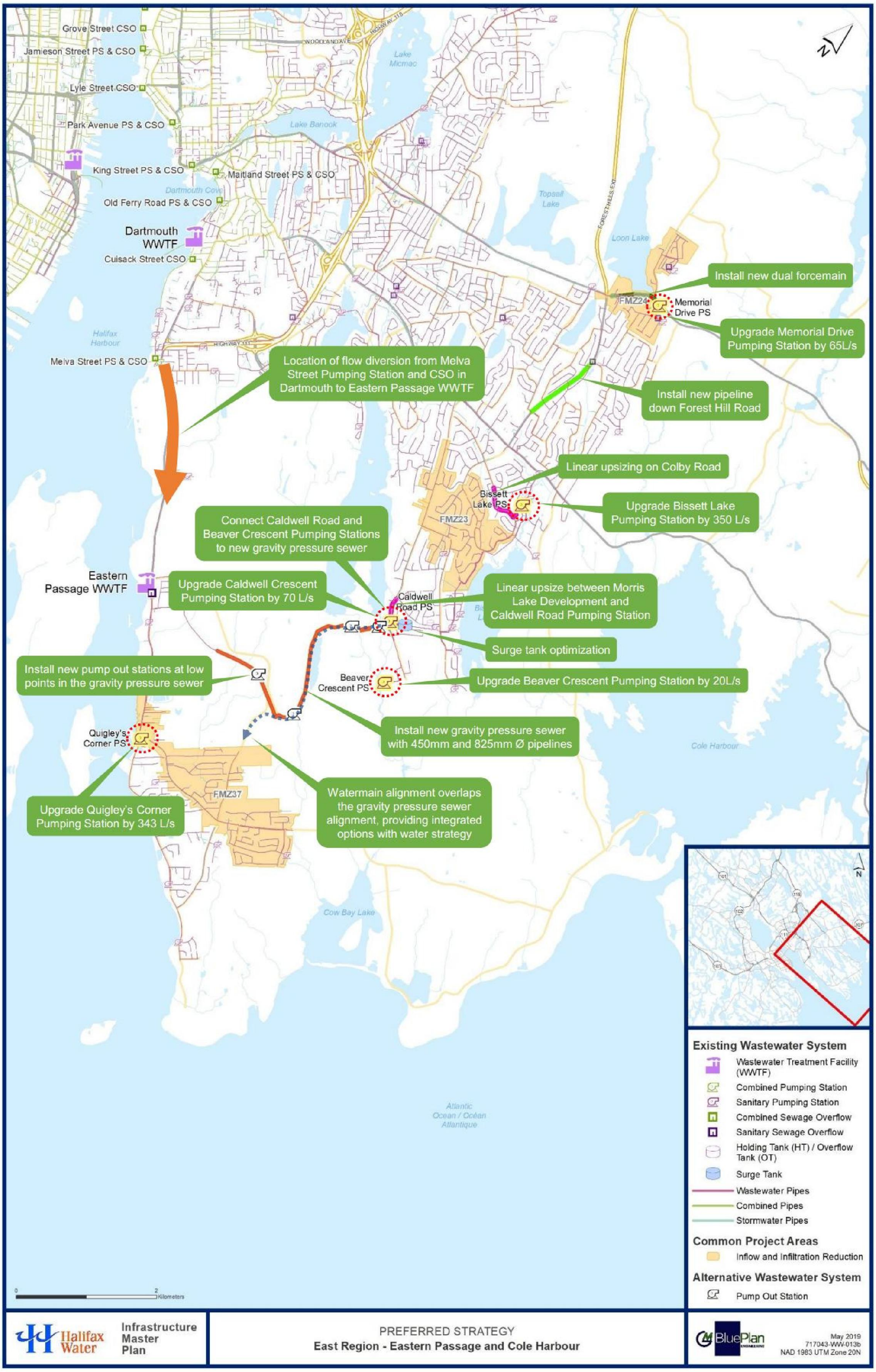
- Four conveyance strategies (Strategy 1a – 1d) based on installing a new gravity pressure sewer with pump out stations to improve conveyance and odour issues. Strategy 1d is a sub-option to all strategies where an alternate route for the gravity pressure sewer crossing under the Shearwater Airport is considered. Variation between Strategies 1a-1c included different pipe sizes and the use of enhanced RDII to reduce catchment flows.
- Four storage strategies (Strategy 2a – 2d) based on installing storage tanks, with/without upgrade to the gravity pressure sewer. Limited upgrades to the gravity pressure sewer meant the Strategies did not address odour issues. Variations between strategies included tanks sized to different level of services and applying enhanced RDII to reduce catchment flows.
- Two tunnel strategies (Strategy 3a – 3b) to remove the gravity pressure sewer. Strategy 3a installs a gravity tunnel from Bissett Lake Pumping Station to just upstream of Eastern Passage WWTF

and Strategy 3b is shortened alignment from the surge tank to the WWTF, including connections by Morris Lake to service growth in the area.

Eastern Passage Preferred Strategy

The preferred strategy for Eastern Passage was Strategy 1c which is detailed in Executive Summary Figure 11. Strategy 1c was selected mainly due to addressing the operations and maintenance issues surrounding the gravity pressure sewer, performing to an acceptable level of service, and being a cost-effective solution. The selected gravity pressure sewer alignment travels around the Shearwater Airport, forming an indirect path. It was recommended to revisit the cost saving of tunneling under the airport throughout the design stages. In recognition that additional assessment of the gravity pressure sewer could improve the design, it was included as one of the Conceptual Designs included under the Infrastructure Master Plan.

The Capital Program for Eastern Passage is included in Volume 1 Executive Summary. The program is front-heavy due to the cost associated with the gravity pressure sewer replacement which is required at the start of the project horizon.



Executive Summary Figure 11: Preferred Servicing Strategy for Eastern Passage

Dartmouth Strategy Development

Common Projects in Dartmouth included separation of Lake Albro, Maynard lake and the Clement Street Wetland, sewer separation in Wyse Road and Canal Street LoWSCA areas, Rose Street and Thistle Street, flow diversions in the Lyle Street and King Street CSO catchments, upgrades to Anderson Pumping Station, local pipe upgrades, RDII reduction, additional flow monitoring and a CSO Management Plan to improve CSO performance.

Once the Common Projects were confirmed a range of serving strategies were assessed. In Dartmouth seven (7) overarching servicing strategy alternatives were considered, including:

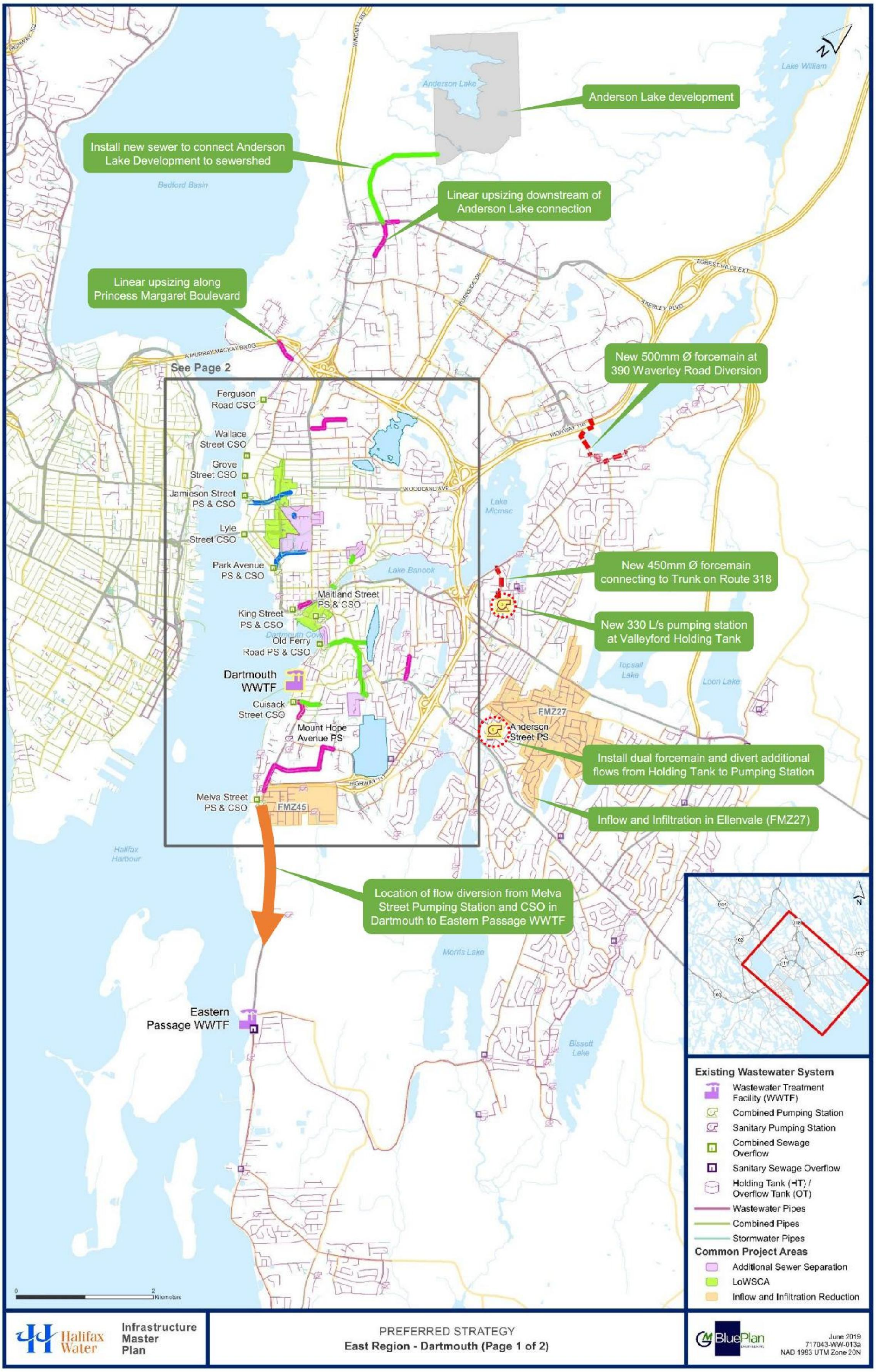
- Four conveyance strategies (Strategy 1a – 1d) include upgrades to existing alignment, reducing upgrades required through enhance RDII reduction and new conveyance alignments. Strategy 1d was a sub-option to all strategies with a diversion of Dartmouth flows to Eastern Passage WWTF to reduce the upgrades required at Dartmouth WWTF.
- Two storage strategies (Strategy 2a – 2b) consider installing storage tanks over conveyance upgrades to. Variations between strategies included tanks with/without applying enhanced RDII to reduce catchment flows.
- One tunnel strategies (Strategy 3) explores a tunnel option to eliminate CSO spills. The tunnel option is a cost on top of the other strategies, that address inner system constraints, making this strategy an expensive addition to the other strategies.

Dartmouth Preferred Strategy

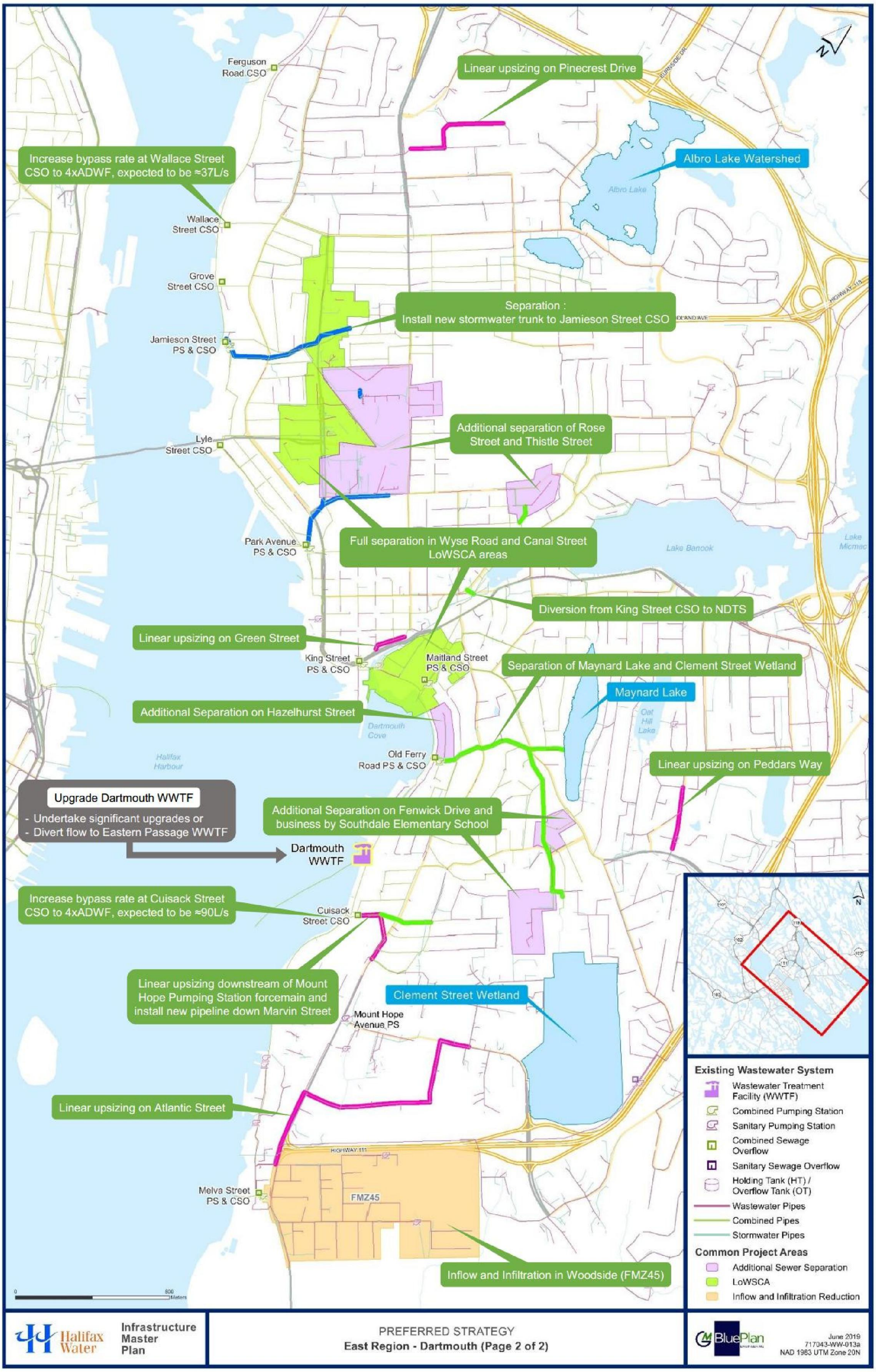
The preferred strategy for Dartmouth was Strategy 1c which is detailed in Executive Summary Figure 12. Strategy 1c was selected mainly due to providing future flexibility, balancing flows across system trunks, performing to an acceptable level of service, and being a cost-effective solution. In addition to selecting the preferred approach for inner system constraints two component evaluations were also considered - increasing the bypass rates at two CSOs and a flow diversion from Dartmouth to Eastern Passage WWTF (Strategy 1d). The CSO assessed were Cuisack and Wallace and based on the growth upstream the bypass rates were adjusted to match the CSO design rate of 4x average dry weather flow (ADWF). The rates were able to be increased due to the extent of sewer separation in the catchment and offsetting spill rates at other CSOs.

The flow diversions from Dartmouth to Eastern Passage WWTF was considered due to additional space for treatment being reserved at Eastern Passage WWTF, allowing for the rated capacity to be increased at a lower cost than upgrading Dartmouth WWTF. Upgrades to Dartmouth WWTF are expected to be high as the WWTF would likely require a system overhaul to accommodate growth while considering higher treatment standards and improved processes. The flow diversion therefore showed significant cost savings and ‘buys time’ on the upgrades to Dartmouth. As the diversion did not completely remove the need for increase capacity at Dartmouth WWTF a cost to upgrade Dartmouth WWTF by 3MLD was included in the strategy. The projects within Dartmouth that were brought forward to the Infrastructure Master Plan Concept Designs, were the separation of Lake Albro, Maynard lake and Clement Street Wetland, as sewer separation became a major component in the Dartmouth strategy and the projects showed potential for improvements to the designs.

The Capital Program for the East Region is included in Volume 1 Executive Summary. The Capital Costs for Eastern Passage total **$49M** and for Dartmouth are **$104M (2019$)** totaling **$153M** for the East Region.



Executive Summary Figure 12: Preferred Servicing Strategy for Dartmouth



Executive. Summary Figure 13: Preferred Servicing Strategy for Dartmouth

Halifax Water
Halifax Regional Water Commission
450 Cowie Hill Road, P.O. Box 8388 RPO CSC, Halifax, Nova Scotia B3K 5M1 phone 902 490-4820 fax 902 490-4808

January 31, 2018

Ms. Doreen Friis
Nova Scotia Utility and Review Board
1601 Lower Water Street, Suite 300
Halifax, NS B3J 3S3

Dear Ms. Friis:

Re: Halifax Water – Regional Development Charges

In 2014, the Nova Scotia Utility and Review Board (NSUARB) approved Halifax Water's application for approval of amendments to the *Schedule of Rates, Rules and Regulations for Water, Wastewater, and Stormwater* services to establish separate Regional Development Charge (RDCs) for water and wastewater and to eliminate the charges for trunk sewer and sewer redevelopment.

As part of this approval, the NSUARB and Halifax Water agreed that the RDC would be updated every 5 years. In addition, the finding of the RDC approval required that Halifax Water review the calculation of the RDC rate in advance of any 5-year update in the event that there are changes of circumstance which would result in a variance in the RDC by amounts greater than 15%. In late 2017, Halifax Water advised the NSUARB of the recent completion of the West Region Infrastructure Plan and anticipated that this plan would create changes in the West Region projects and cost estimates that may result in a variance of the original RDC of more than 15%. At that time, Halifax Water advised that we would be completing the details of this analysis and making a formal submission and requesting a hearing for an adjustment to the RDC based on this variance.

Our consultant has now completed the detailed review of the new servicing strategy and associated project costs required for the West Region (Attachment 1 – Regional Development Charge (RDC) Projects Update and Review – Technical Memorandum – GM BluePlan – January 29, 2018). Their detailed analysis indicates that this change to the project list causes a 5.1% increase to the Wastewater RDC project costs. Thus, it is our understanding that this does not trigger the need to review and change the existing RDC rate in advance of the upcoming 5-year evaluation.

.../2

The new project list, as provided in Table 6 of the attached technical document, should supersede that provided for the original RDC in the interim period until we can complete the 5-year review. Based on the above, Halifax Water will not be making a current, formal application for an adjustment to the RDC rate (based on the 15% variance clause) and thus would not need time held for a hearing in 2018.

We look forward to completing our analysis and making a formal submission for an RDC update based on the 5-Year interval requirement in 2019.

We thank you for your cooperation on this topic and are available at your convenience to discuss any comments or issues around the above noted subject.

Respectfully submitted,

Kenda MacKenzie
Director, Regulatory Compliance

Attachment 1: Regional Development Charge (RDC) Projects Update and Review – Technical Memorandum – GM BluePlan – January 29, 2018

c: Jamie Hannam, Director Engineering & IS Halifax Water
Carl Yates, General Manager - Halifax Water
Heidi MacIntosh - NSUARB

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Regional Development Charge (RDC) Projects Update and Review

Technical Memorandum

Regional Development Charge Review

Prepared by

GM BluePlan for:

Halifax
Water

The Halifax Regional Water Commission

Project No. 714058

January 30, 2018

Version Updates

The following is a record of the changes/updates that have occurred on this document:

Version	Changes / Updates	Author	Date
1	DRAFT: initial version for review	JJ	January 26th 2018
2	FINAL DRAFT: incorporated minor changes following HW review	JJ	January 30th 2018
3	FINAL: QA/QC review. Minor changes	CC	January 30th 2018

Table of Contents

1 Introduction

1.1 Background and Context

Having recently completed the West Region Wastewater Infrastructure Plan (WRWIP), Halifax Regional Water Commission (Halifax Water) further retained GM BluePlan to review the required changes and impact to the 2014 Regional Development Charge.

In 2014 the Nova Scotia Utility and Review Board (NSUARB) approved Halifax Water's application for approval of amendments to the *Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services*, to establish separate Regional Development Charges (RDCs) for water and wastewater, and to eliminate the charges for trunk sewer and sewer redevelopment and Regional Capital Cost Charges for Wastewater. The RDC is a regional charge based on the infrastructure needs of the entire region. The key premise of the RDC is to ensure that growth will pay for growth.

The RDC for water and wastewater infrastructure was based on the Integrated Resource Plan (IRP) project list. In turn, the IRP used the Regional Wastewater Functional Servicing Plan (RWWFP) project list to inform the requirements and costs for wastewater infrastructure. The process to generate the wastewater RDC rate involved identifying the projects in the RWWFP (and therefore the IRP) related to growth needs, regional infrastructure and be required within the agreed 20 year development charges horizon (2033) to create a wastewater RDC rate to apply to all new development.

In 2017 Halifax Water completed the West Region Wastewater Infrastructure Plan (WRWIP). This project looked specifically at wastewater needs for the Halifax, Beechville Lakeside Timberlea (BLT) and Herring Cove area (The West Region), considering the Central Region area as required, and recommended a new wastewater servicing strategy for the area. The WRWIP study resulted in new set of projects that supersedes the strategy for the West Region recommended in the RWWFP.

The NSUARB and Halifax Water agreed that the RDC would be updated every 5 years. In addition, a finding of the RDC approval requires that Halifax Water is to review the calculation of the RDC rate before any scheduled five year update in the event there are changes in circumstances which would result in a variance in the RDC by an amount greater than 15% (positive or negative).

1.2 Purpose, Aims and Objectives

The purpose of this Technical Memorandum is to compare the projects used to generate the initial RDC and those recommended in the WRWIP in order to estimate the potential cost impact. In particular, the purpose is to ascertain if the new WRWIP projects would result in a variance from the original RDC of +/- 15% in total RDC project costs.

This memo will review and document the changes to the west region projects and estimate the impact on the overall RDC.

The primary aim of the task is:

- To estimate the percentage change to the RDC costs based on the updated projects derived from the WRWIP.

To achieve the aim, the objectives of the task are:

- Compare the west region RDC projects with the WRWIP projects.
- Update the RDC project list using the new WRWIP projects.
- Calculate the cost and percentage change based on the updated project list.
- Document and justify assumptions used.

2 The RDC and WRWIP Projects

Figure 1 and Table 1 show the original RDC projects that were derived from the RWWFP. Projects that relate to the west region are highlighted. The original 2012 costs have been indexed to reflect 2018 costs using 2% per annum.

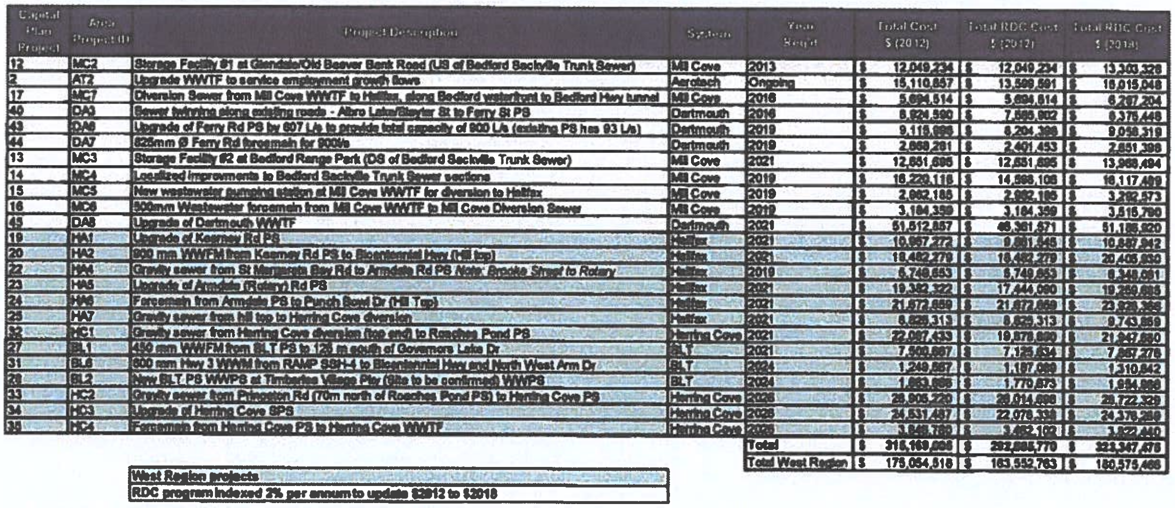
Figure 2 and Table 2 show the WRWIP projects, with those projects outside of the RDC horizon highlighted in the table.

Both tables show the total cost and the total RDC cost in $2018. The total RDC cost is the total cost minus the Benefit to Existing (BTE) and local servicing allocation. For the WRWIP projects the BTE and RDC costs are considered preliminary, noting that the WRWIP BTE costs were calculated using a further refined process which results in a higher BTE allocation than compared to the original RDC projects.

In isolation, a comparison of West Region only projects shows a reduction in cost. However, this comparison does not include the complete RDC, just the West Region, and does not account for important considerations and assumption changes that must be accounted for to enable an accurate comparison.

The next sections outline these considerations and provides the results of the analysis.

Table 1: RDC Project List with West Region Projects Highlighted

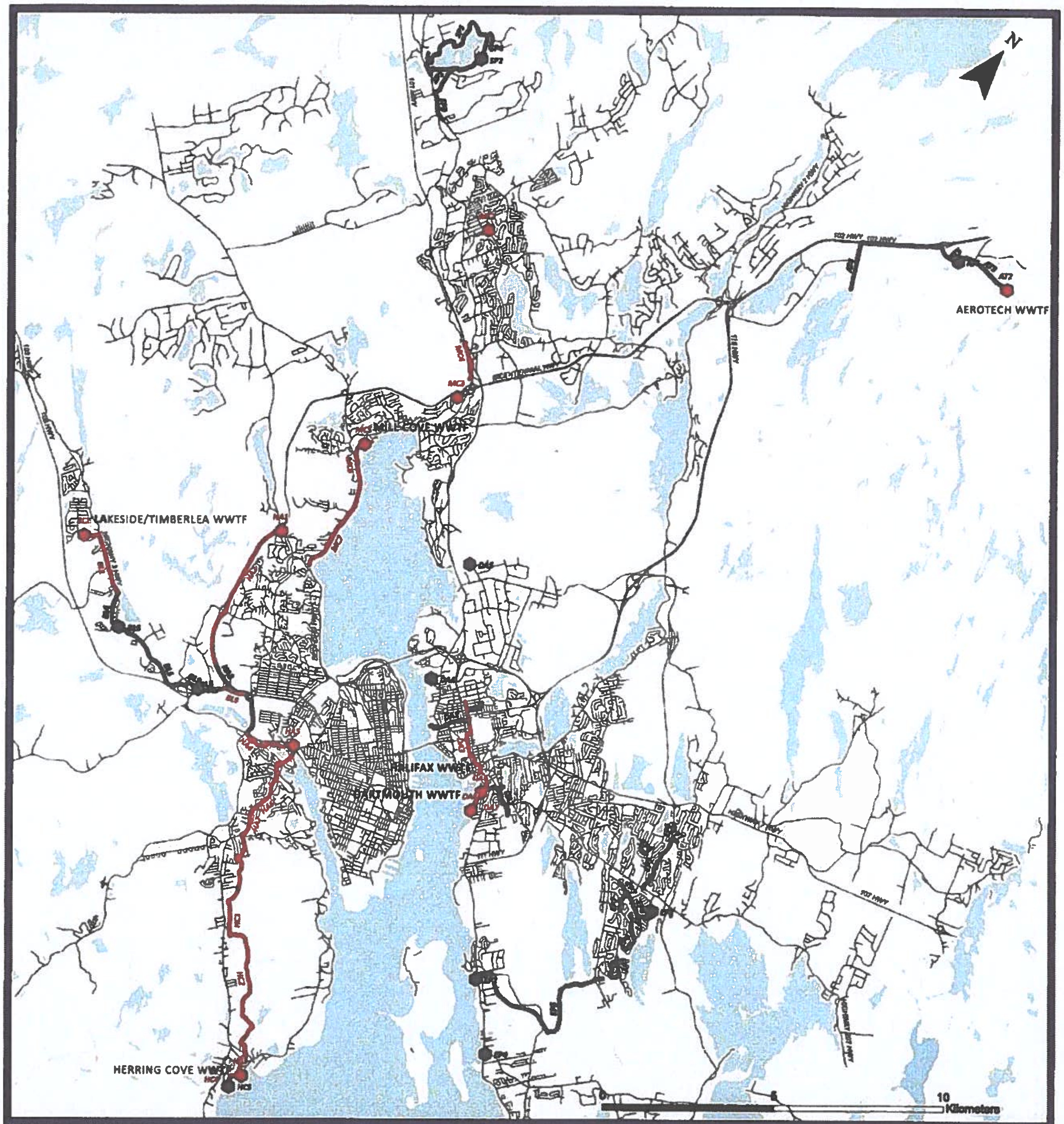


Capital Plan Project	Area Project ID	Project Description	System	Year Begin	Total Cost $ (2012)	Total RDC Cost $ (2012)	Total RDC Cost $ (2018)
12	MC2	Storage Facility #1 at Glendale/Old Beaver Bank Road (US of Bedford Sackville Trunk Sewer)	Mill Cove	2013	$ 12,049,234	$ 12,049,234	$ 13,303,328
2	AT2	Upgrade WWTF to service employment growth flows	Aerotech	Ongoing	$ 15,110,857	$ 13,599,691	$ 15,015,048
17	MC7	Diversion Sewer from Mill Cove WWTF to Halifax, along Bedford waterfront to Bedford Hwy tunnel	Mill Cove	2016	$ 5,694,514	$ 5,694,514	$ 6,287,204
40	DA3	Sewer twinning along existing roads - Albro Lake/Slayter St to Ferry St PS	Dartmouth	2016	$ 8,924,590	$ 7,585,902	$ 8,375,448
43	DA6	Upgrade of Ferry Rd PS by 807 L/s to provide total capacity of 900 L/s (existing PS has 93 L/s)	Dartmouth	2019	$ 9,115,995	$ 8,204,396	$ 9,058,319
44	DA7	825mm Ø Ferry Rd forcemain for 900l/s	Dartmouth	2019	$ 2,668,281	$ 2,401,453	$ 2,651,398
13	MC3	Storage Facility #2 at Bedford Range Park (DS of Bedford Sackville Trunk Sewer)	Mill Cove	2021	$ 12,651,695	$ 12,651,695	$ 13,968,494
14	MC4	Localized improvements to Bedford Sackville Trunk Sewer sections	Mill Cove	2019	$ 16,220,118	$ 14,598,106	$ 16,117,499
15	MC5	New wastewater pumping station at Mill Cove WWTF for diversion to Halifax	Mill Cove	2019	$ 2,962,185	$ 2,962,185	$ 3,282,573
16	MC6	500mm Wastewater forcemain from Mill Cove WWTF to Mill Cove Diversion Sewer	Mill Cove	2019	$ 3,184,359	$ 3,184,359	$ 3,515,790
45	DA8	Upgrade of Dartmouth WWTF	Dartmouth	2021	$ 51,512,857	$ 46,361,571	$ 51,186,920
19	HA1	Upgrade of Kearney Rd PS	Halifax	2021	$ 10,957,272	$ 9,861,545	$ 10,887,942
20	HA2	900 mm WWFM from Kearney Rd PS to Bicentennial Hwy (Hill top)	Halifax	2021	$ 18,482,279	$ 18,482,279	$ 20,405,930
22	HA4	Gravity sewer from St Margarets Bay Rd to Armdale Rd PS *Note: Brooke Street to Rotary*	Halifax	2019	$ 5,749,653	$ 5,749,653	$ 6,348,081
23	HA5	Upgrade of Armdale (Rotary) Rd PS	Halifax	2021	$ 19,382,322	$ 17,444,090	$ 19,259,895
24	HA6	Forcemain from Armdale PS to Punch Bowl Dr (Hill Top)	Halifax	2021	$ 21,672,869	$ 21,672,869	$ 23,928,366
25	HA7	Gravity sewer from hill top to Herring Cove diversion	Halifax	2021	$ 8,829,313	$ 8,829,313	$ 9,743,859
32	HC1	Gravity sewer from Herring Cove diversion (top end) to Roaches Pond PS	Herring Cove	2021	$ 22,087,433	$ 19,878,690	$ 21,947,850
27	BL1	450 mm WWFM from BLT PS to 125 m south of Governors Lake Dr	BLT	2021	$ 7,500,667	$ 7,125,634	$ 7,867,276
31	BL6	600 mm Hwy 3 WWFM from RAMP SSH-4 to Bicentennial Hwy and North West Arm Dr	BLT	2024	$ 1,249,567	$ 1,187,089	$ 1,310,642
29	BL2	New BLT PS WWPS at Timberlea Village Pky (Site to be confirmed) WWPS	BLT	2024	$ 1,863,865	$ 1,770,673	$ 1,954,998
33	HC2	Gravity sewer from Princeton Rd (70m north of Roaches Pond PS) to Herring Cove PS	Herring Cove	2026	$ 28,905,220	$ 26,014,698	$ 28,722,329
34	HC3	Upgrade of Herring Cove SPS	Herring Cove	2026	$ 24,531,487	$ 22,078,338	$ 24,376,289
35	HC4	Forcemain from Herring Cove PS to Herring Cove WWTF	Herring Cove	2026	$ 3,846,780	$ 3,462,102	$ 3,822,440
				Total	$ 316,169,996	$ 292,665,770	$ 323,347,678
				Total West Region	$ 175,054,518	$ 163,552,763	$ 180,575,466

West Region projects
RDC program indexed 2% per annum to update $2012 to $2018

Table 2: WRWIP Project List with Post 2033 projects Highlighted

Area Project ID	Project Description	Year Req'd	Total Cost $ (2018)	Total RDC Cost $ (2018)
WR1	WRWIP: Spring Garden Area Sewer Separation	2018-2023	$ 6,919,000	$ 3,489,000
WR2	WRWIP: Young Street Area Sewer Separation	2018-2023	$ 21,058,000	$ 14,548,000
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	2018-2025	$ 14,932,000	$ 14,185,400
WR4	WRWIP: Linear Upsize - Quinpool Road	2018	$ 404,000	$ -
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	2018	$ 206,000	$ -
WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	2018	$ 500,000	$ 475,000
WR7	WRWIP: Young Pumping Station Upgrade	2027	$ 2,279,000	$ 2,165,050
WR8	WRWIP: New Fairfield Holding Tank	2046	$ 12,813,000	$ 6,406,500
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	2018	$ 3,116,000	$ 1,558,000
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	2018	$ 10,000,000	$ 9,500,000
WR18	WRWIP: Fairview Cove Linear Upsize	2018	$ 19,083,000	$ 14,312,250
WR19	WRWIP: Halifax Treatment Plant Capacity Upgrade	2041	$ 15,000,000	$ 14,250,000
WR20	WRWIP: Linear Upgrades within the Kearney Lake Road Area	2033	$ 2,874,000	$ 2,730,300
WR10	WRWIP: BLT WWTF Decommission - New Timberlea PS	2020	$ 5,560,000	$ 5,282,000
WR11	WRWIP: BLT WWTF Decommission - New Timberlea Forcemain	2020	$ 17,543,000	$ 16,665,850
WR12	WRWIP: BLT WWTF Decommission	2020	$ 500,000	$ 475,000
WR14	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Pumping Station	2033	$ 8,193,000	$ 7,783,350
WR15	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain	2033	$ 12,608,000	$ 11,977,600
WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	2033	$ 4,108,000	$ 3,902,600
WR17	WRWIP: Herring Cove Road - Gravity Sewer Upsize	2033	$ 6,996,000	$ 6,646,200
		Total	$ 164,692,000	$ 138,352,100
	Post 2033 Projects	Total 2033	$ 136,879,000	$ 115,695,600



Halifax Water

RDC CAPITAL PROGRAM - WASTEWATER

RDC Projects

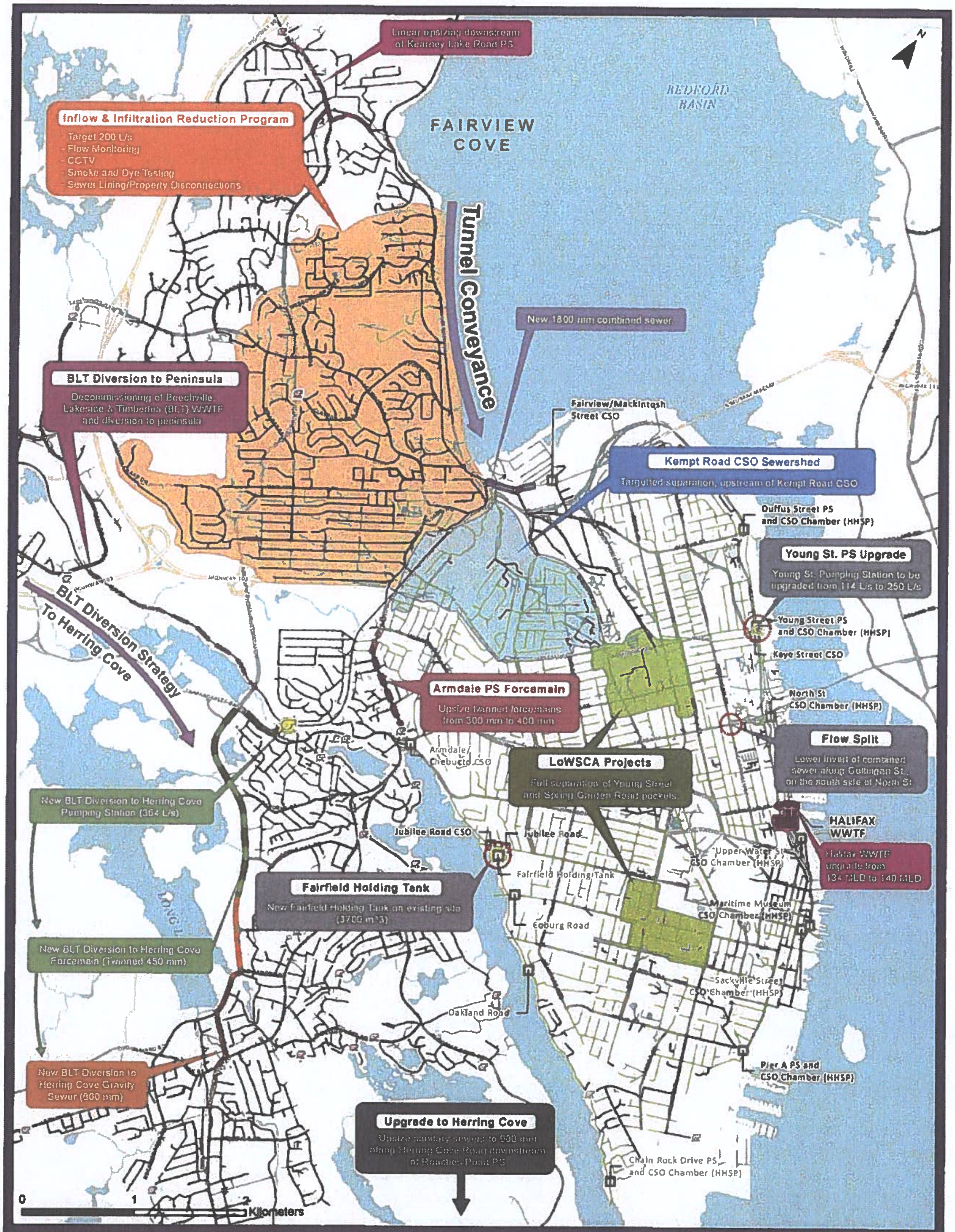
WW Capital Program
● Facilities
— Pipes

RDC Program
● Facilities
— Pipes

Figure 1: RDC Project Map

BluePlan ENGINEERING

October, 2017
714658-RDC-02
Data Sources: Halifax Water,
Halifax Regional Municipality
ATS 1977 MTM 5 Nova Scotia



Halifax Water

WEST REGION WASTEWATER
INFRASTRUCTURE PLAN (WRWIP)

Figure 2: WRWIP Project Map

Pre-Defined Projects and Preferred Alternative (2a)

Treatment Facility
CSO Structures

Conduits Network
Combined Pipe Network
Stormwater Pipe Network
Wastewater Pipe Network

Pumping Station
Combined Pumping Station
Stormwater Pumping Station
Wastewater Pumping Station

Pre-Defined Project Areas
Partial Separation of Kempt
🟩 Full Separation of LoWSCA
Inflow and Infiltration Reduction

CBCL/ [illegible] Plan

June 2017
714059-015-WW
Data Sources: Halifax Water, Halifax Regional Municipality
ATS 1977 MTM 5 Nova Scotia

3 Approach and Methodology

3.1 Key Assumption Differences between the RWWFP and the WRWIP

The most significant assumption change between the original RWWFP and the WRWIP strategy relates to the Central Region and Mill Cove Wastewater Treatment Facility Capacity.

The agreed assumption during the RWWFP was that Mill Cove WWTF in the Central Region could not feasibly be expanded due to site constraints and sensitive receiving waters. This led, in part, to the need for the diversion of flows from the Central Region towards the West Region, resulting in large scale pumping, pipe and treatment projects to convey and treat the flows. West Region projects (see Table 1) HA1, HA2, HA5, HA6, HA7, HC1, HC2, HC3, HC4 in the RDC are all impacted by the flows from the Central Region. Central Region projects MC5, MC6, MC7 are also related to the diversion of flows from the Central to West Region.

This assumption changed in the WRWIP. Halifax Water investigated alternative treatment technology that would allow for expansion of the WWTF capacity to deal with all existing and future Central Region flows. For the WRWIP it was assumed that all Central Region flows, existing and future growth, would be contained within the Central Region area. This negates the need for flow diversion projects contained in the RWWFP and reduces the amount of flow that need to be pumped, conveyed and treated in the West Region.

This change complicates the comparison of projects and costs between the original RDC and the WRWIP. The original RDC includes costs for all areas including the West and Central Regions so the interaction of flows between Central and West Regions are accounted for. The WRWIP only provides infrastructure and costs for the West Region. It is expected that projects required for the Central Region will be identified when the next master planning study covering the Central Region is completed.

Using simple terms, the original RDC for the West Region included infrastructure costs to service Central Region growth and the WRWIP did not. Therefore an allowance needs to be made in the comparison between the original RDC and the WRWIP.

Projects HA1 and HA2 in the original West Region RDC include an upsized Kearney Road pumping station and forcemain to convey flows that include Central Region flows. These projects are not required in the WRWIP. However, it is expected that pumping and conveyance projects will be required in Central Region when the assessment is completed. Therefore, when comparing the West Region projects these two projects should be excluded. However, the costs should be retained as an allowance to account for the projects that will be required in Central Region. Similarly, RDC projects MC5, MC6, MC7 (see Table 1) relate to the diversion of flows from the Central to West Region. It is expected these projects will change when the Central Master Plan is complete, but for comparison purposes the costs should remain part of the RDC project list.

There will also be a new treatment project and cost requirement for Mill Cove WWTF that is currently not accounted for in the RDC. In the RWWFP a significant expansion of Herring Cove WWTF (at a cost of $110m) was specified to accommodate growth flows, including those diverted from the Central Region. Because Herring Cove WWTF has existing headroom/capacity the treatment project was scheduled outside of the 20 year horizon and not accounted for in the RDC. Mill Cove WWTF does not have headroom/capacity and therefore a treatment project will be triggered within the RDC horizon. Halifax Water have made an allowance for this cost and have identified a $50m Mill Cove WWTF expansion project in their future years' budget. This cost should be included as an additional cost to the WRWIP projects to ensure that the infrastructure needs and cost comparison is consistent, regardless of where the projects are required.

These complexities are critical to allow for a reasonable and equitable assessment of the likely impact the WRWIP projects will have on the overall RDC calculation.

The following section summarizes the approach to the comparison analysis.

3.2 Summary of Approach to Analysis

The basic approach to complete the analysis is as follows:

1. Identify the total and West Region only original RDC costs for wastewater projects.
2. Compare and replace the West Region RDC projects and costs with the WRWIP projects and costs.
3. Add Central Region project estimates for expected conveyance and treatment.
4. Create a new updated RDC project list and assess the percentage cost change compared to the original program.

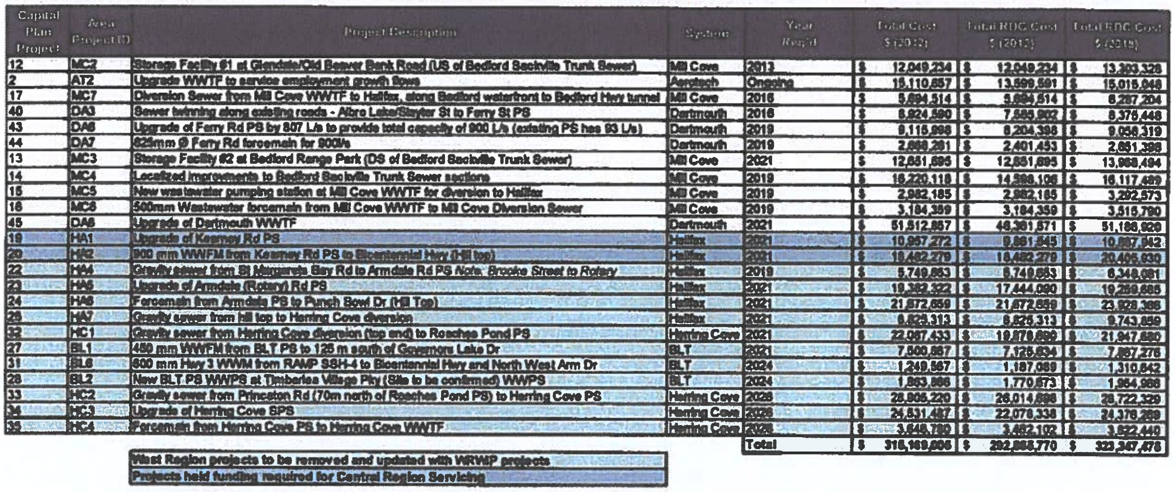
In order to account for the issues created by the Mill Cove WWTF assumption the following factors have been applied to the analysis:

- Projects HA1 and HA2, originally identified in the West Region to divert Central Region flows, are excluded from the RDC West Region costs, but included in overall analysis as an allowance for Central Region servicing.
- Projects MC5, MC6 and MC7 in the original RDC are expected to be updated/replaced by other projects within the Central Region upon completion of the Central Region master plan, but should be retained until that time.
- The currently budgeted Mill Cove WWTF expansion cost of $50m is included in the comparison to make allowance for the treatment upgrades that will be identified when the Central Region master plan is completed.
- The RDC was in $2012, the WRWIP was costed in $2018. The RDC costs are indexed to $2018 using a 2% per annum inflation rate.
- The RDC horizon was 2033, the WRWIP horizon was 2041. Only WRWIP projects required by 2033 or before are included.

4 Results

This section tabulates and presents the results of the comparison. Table 3 shows the full RDC project list with the West Region projects highlighted. It also highlights projects HA1 and HA2 which for the analysis are not included in the West Region but are retained project costs to allow for future Central Region servicing.

Table 3: Original RDC Project List



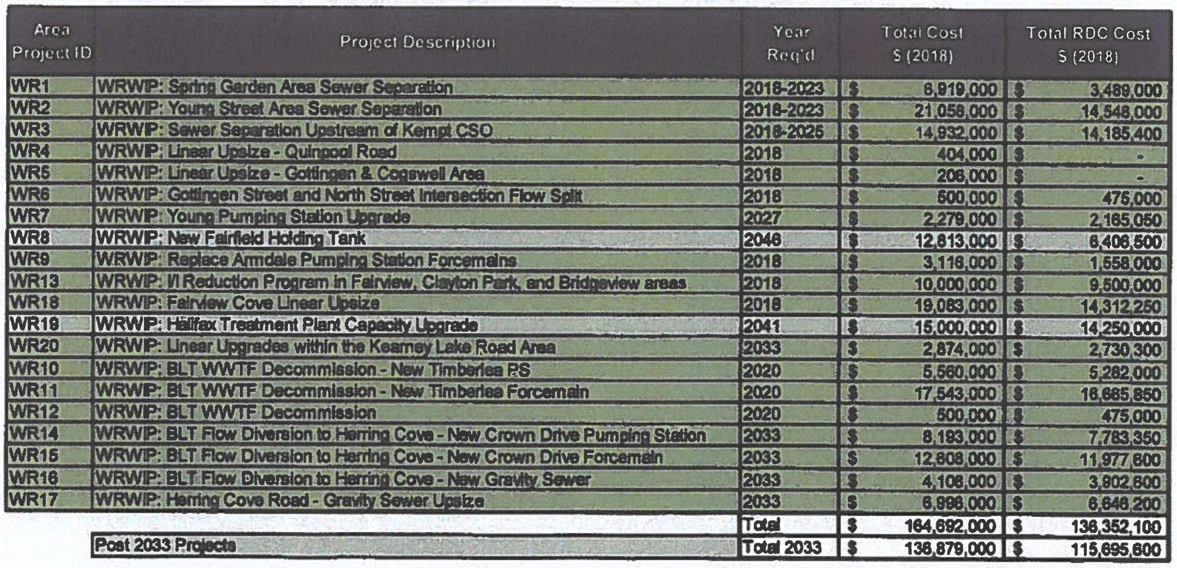
Capital Plan Project	Area Project ID	Project Description	System	Year Req'd	Total Cost $ (2012)	Total RDC Cost $ (2012)	Total RDC Cost $ (2018)
12	MC2	Storage Facility #1 at Glendale/Old Beaver Bank Road (US of Bedford Sackville Trunk Sewer)	Mill Cove	2013	$ 12,049,234	$ 12,049,234	$ 13,303,328
2	AT2	Upgrade WWTF to service employment growth flows	Aerotech	Ongoing	$ 15,110,657	$ 13,599,591	$ 15,015,048
17	MC7	Diversion Sewer from Mill Cove WWTF to Halifax, along Bedford waterfront to Bedford Hwy tunnel	Mill Cove	2016	$ 5,694,514	$ 5,694,514	$ 6,287,204
40	DA3	Sewer twinning along existing roads - Albro Lake/Slayter St to Ferry St PS	Dartmouth	2016	$ 8,824,580	$ 7,585,902	$ 8,376,448
43	DA6	Upgrade of Ferry Rd PS by 807 L/s to provide total capacity of 900 L/s (existing PS has 93 L/s)	Dartmouth	2019	$ 9,115,998	$ 8,204,398	$ 9,058,319
44	DA7	825mm @ Ferry Rd forcemain for 900l/s	Dartmouth	2019	$ 2,668,281	$ 2,401,453	$ 2,651,398
13	MC3	Storage Facility #2 at Bedford Range Park (DS of Bedford Sackville Trunk Sewer)	Mill Cove	2021	$ 12,651,695	$ 12,651,695	$ 13,968,494
14	MC4	Localized improvements to Bedford Sackville Trunk Sewer sections	Mill Cove	2019	$ 16,220,118	$ 14,598,106	$ 16,117,489
15	MC5	New wastewater pumping station at Mill Cove WWTF for diversion to Halifax	Mill Cove	2019	$ 2,982,185	$ 2,982,185	$ 3,292,573
16	MC6	500mm Wastewater forcemain from Mill Cove WWTF to Mill Cove Diversion Sewer	Mill Cove	2019	$ 3,184,359	$ 3,184,359	$ 3,515,790
45	DA8	Upgrade of Dartmouth WWTF	Dartmouth	2021	$ 51,512,657	$ 46,361,571	$ 51,186,929
19	HA1	Upgrade of Kearney Rd PS	Halifax	2021	$ 10,957,272	$ 9,861,545	$ 10,887,942
20	HA2	900 mm WWFM from Kearney Rd PS to Bicentennial Hwy (hill top)	Halifax	2021	$ 18,482,279	$ 18,482,279	$ 20,405,930
22	HA4	Gravity sewer from St Margarets Bay Rd to Armdale Rd PS *Note: Brooke Street to Rotary*	Halifax	2019	$ 5,749,663	$ 5,749,663	$ 6,348,081
23	HA5	Upgrade of Armdale (Rotary) Rd PS	Halifax	2021	$ 19,382,322	$ 17,444,090	$ 19,259,665
24	HA6	Forcemain from Armdale PS to Punch Bowl Dr (Hill Top)	Halifax	2021	$ 21,672,659	$ 21,672,659	$ 23,928,366
26	HA7	Gravity sewer from hill top to Herring Cove diversion	Halifax	2021	$ 8,826,313	$ 8,826,313	$ 9,743,859
32	HC1	Gravity sewer from Herring Cove diversion (top end) to Roaches Pond PS	Herring Cove	2021	$ 22,087,433	$ 19,878,690	$ 21,947,680
27	BL1	450 mm WWFM from BLT PS to 125 m south of Governors Lake Dr	BLT	2021	$ 7,500,867	$ 7,125,834	$ 7,867,276
31	BL6	600 mm Hwy 3 WWM from RAMP SSH-4 to Bicentennial Hwy and North West Arm Dr	BLT	2024	$ 1,249,567	$ 1,187,089	$ 1,310,642
28	BL2	New BLT PS WWPS at Timberlea Village Pky (Site to be confirmed) WWPS	BLT	2024	$ 1,863,866	$ 1,770,673	$ 1,954,968
33	HC2	Gravity sewer from Princeton Rd (70m north of Roaches Pond PS) to Herring Cove PS	Herring Cove	2026	$ 28,905,220	$ 26,014,698	$ 28,722,329
34	HC3	Upgrade of Herring Cove SPS	Herring Cove	2026	$ 24,531,487	$ 22,078,338	$ 24,376,289
35	HC4	Forcemain from Herring Cove PS to Herring Cove WWTF	Herring Cove	2026	$ 3,846,780	$ 3,462,102	$ 3,822,440
				Total	$ 316,169,906	$ 292,868,770	$ 323,347,678

West Region projects to be removed and updated with WRWIP projects

Projects held funding required for Central Region Servicing

Table 4, below shows the WRWIP projects with the two post period projects highlighted.

Table 4: WRWIP Projects with RDC eligible total



Area Project ID	Project Description	Year Req'd	Total Cost $ (2018)	Total RDC Cost $ (2018)
WR1	WRWIP: Spring Garden Area Sewer Separation	2018-2023	$ 8,919,000	$ 3,489,000
WR2	WRWIP: Young Street Area Sewer Separation	2018-2023	$ 21,056,000	$ 14,548,000
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	2018-2025	$ 14,932,000	$ 14,185,400
WR4	WRWIP: Linear Upsize - Quinpool Road	2018	$ 404,000	$ -
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	2018	$ 206,000	$ -
WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	2018	$ 500,000	$ 475,000
WR7	WRWIP: Young Pumping Station Upgrade	2027	$ 2,279,000	$ 2,165,050
WR8	WRWIP: New Fairfield Holding Tank	2046	$ 12,813,000	$ 6,406,500
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	2018	$ 3,116,000	$ 1,558,000
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	2018	$ 10,000,000	$ 9,500,000
WR18	WRWIP: Fairview Cove Linear Upsize	2018	$ 19,083,000	$ 14,312,250
WR19	WRWIP: Halifax Treatment Plant Capacity Upgrade	2041	$ 15,000,000	$ 14,250,000
WR20	WRWIP: Linear Upgrades within the Kearney Lake Road Area	2033	$ 2,874,000	$ 2,730,300
WR10	WRWIP: BLT WWTF Decommission - New Timberlea PS	2020	$ 5,560,000	$ 5,282,000
WR11	WRWIP: BLT WWTF Decommission - New Timberlea Forcemain	2020	$ 17,543,000	$ 16,665,850
WR12	WRWIP: BLT WWTF Decommission	2020	$ 500,000	$ 475,000
WR14	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Pumping Station	2033	$ 8,193,000	$ 7,783,350
WR15	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain	2033	$ 12,608,000	$ 11,977,600
WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	2033	$ 4,108,000	$ 3,902,600
WR17	WRWIP: Herring Cove Road - Gravity Sewer Upsize	2033	$ 6,996,000	$ 6,646,200
		Total	$ 164,692,000	$ 136,352,100
	Post 2033 Projects	Total 2033	$ 136,879,000	$ 115,695,600

Table 5, below shows the new complete RDC project list with the relevant and still valid original RDC projects, projects HC1 and HC2 which are retained for Central Region servicing, the budgeted allowance for Mill Cove WWTF (Central Region) treatment and the new WRWIP projects. The total costs in $2018 are shown identifying that the new RDC program is 5.1% higher than the original.

Table 5: Compete Updated RDC Project List

Capital Plan Project	Area Project ID	Project Description	System	Year Req'd	Total Cost $ (2018)	Total RDC Cost $ (2018)
12	MC2	Storage Facility #1 at Glendale/Old Beaver Bank Road (US of Bedford Sackville Trunk Sewer)	Mill Cove	2013	$ 13,303,328	$ 13,303,328
2	AT2	Upgrade WWTF to service employment growth flows	Aerotech	Ongoing	$ 16,883,387	$ 15,015,048
17	MC7	Diversion Sewer from Mill Cove WWTF to Halifax, along Bedford waterfront to Bedford Hwy tunnel	Mill Cove	2018	$ 6,287,204	$ 6,287,204
40	DA3	Sewer twinning along existing roads - Albro Lake/Slayter St to Ferry St PS	Dartmouth	2018	$ 9,853,468	$ 8,375,448
43	DA6	Upgrade of Ferry Rd PS by 807 L/s to provide total capacity of 900 L/s (existing PS has 93 L/s)	Dartmouth	2019	$ 10,084,789	$ 9,058,319
44	DA7	825mm Ø Ferry Rd forcemain for 900l/s	Dartmouth	2019	$ 2,945,997	$ 2,851,398
14	MC4	Localized improvments to Bedford Sackville Trunk Sewer sections	Mill Cove	2019	$ 17,908,321	$ 16,117,489
15	MC5	New wastewater pumping station at Mill Cove WWTF for diversion to Halifax	Mill Cove	2019	$ 3,292,573	$ 3,292,573
16	MC6	500mm Wastewater forcemain from Mill Cove WWTF to Mill Cove Diversion Sewer	Mill Cove	2019	$ 3,515,790	$ 3,515,790
45	DA8	Upgrade of Dartmouth WWTF	Dartmouth	2021	$ 58,874,356	$ 51,186,920
13	MC3	Storage Facility #2 at Bedford Range Park (DS of Bedford Sackville Trunk Sewer)	Mill Cove	2021	$ 13,968,494	$ 13,968,494
19	HA1	Upgrade of Kearney Rd PS	Halifax	2021	$ 12,097,713	$ 10,887,942
20	HA2	900 mm WWFM from Kearney Rd PS to Bicentennial Hwy (Hill top)	Halifax	2021	$ 20,405,930	$ 20,405,930
		Mill Cove WWTF Upgrade	Mill Cove	2021	$ 50,000,000	$ 50,000,000
	WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	2018-2023	$ 6,919,000	$ 3,489,000
	WR2	WRWIP: Young Street Area Sewer Separation	Halifax	2018-2023	$ 21,058,000	$ 14,548,000
	WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	2018-2025	$ 14,932,000	$ 14,185,400
	WR4	WRWIP: Linear Upsize - Quinpool Road	Halifax	2018	$ 404,000	$ -
	WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	2018	$ 206,000	$ -
	WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	Halifax	2018	$ 500,000	$ 475,000
	WR7	WRWIP: Young Pumping Station Upgrade	Halifax	2027	$ 2,279,000	$ 2,165,050
	WR9	WRWIP: Replace Armdale Pumping Station Forcemains	Halifax	2018	$ 3,116,000	$ 1,558,000
	WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	Halifax	2018	$ 10,000,000	$ 9,500,000
	WR18	WRWIP: Fairview Cove Linear Upsize	Halifax	2018	$ 19,083,000	$ 14,312,250
	WR20	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	2033	$ 2,874,000	$ 2,730,300
	WR10	WRWIP: BLT WWTF Decommission - New Timberlea PS	BLT	2020	$ 5,560,000	$ 5,282,000
	WR11	WRWIP: BLT WWTF Decommission - New Timberlea Forcemain	BLT	2020	$ 17,543,000	$ 16,665,850
	WR12	WRWIP: BLT WWTF Decommission	BLT	2020	$ 500,000	$ 475,000
	WR14	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Pumping Station	BLT	2033	$ 8,193,000	$ 7,783,350
	WR15	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain	BLT	2033	$ 12,608,000	$ 11,977,600
	WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	BLT	2033	$ 4,108,000	$ 3,902,600
	WR17	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	2033	$ 6,996,000	$ 6,646,200

RDC projects	$ 154,897,716	$ 142,772,009
Projects held funding required for Central Region Servicing	$ 32,503,643	$ 31,293,872
New Central Region Servicing project	$ 50,000,000	$ 50,000,000
New West Region WRWIP projects	$ 138,879,000	$ 115,895,600
TOTAL New RDC Program Total	**$ 374,080,359**	**$ 339,761,481**
Old RDC Program	**$ -**	**$ 323,347,475**
% Difference between New and Old		**5.1%**

5 Summary and Recommendations

Halifax Water are committed to regular five year reviews of the Regional Development Charge and are committed to identify interim changes and impacts based on new and best information.

The analysis shows that the new servicing strategy and the associated project costs required for the West Region are estimated to cause a 5.1% increase to the wastewater RDC project costs. This does not trigger the need to review and change the actual RDC rate.

The new project list should supersede that provided for the original RDC. The complete project list is provided in Table 6, below.

The analysis was completed using conservative assumptions, particularly around the anticipated increased costs required to service the Central Region area. Through the workings completed in this analysis no reasonable scenario that was considered would trigger the +/-15% RDC rate review requirement.

Table 6: Wastewater Regional Development Charge Project List. January 2018

Capital Plan Project	Area Project ID	Project Description	System	Year Req'd	Total Cost $ (2018)	Total RDC Cost $ (2018)
12	MC2	Storage Facility #1 at Glendale/Old Beaver Bank Road (US of Bedford Sackville Trunk Sewer)	Mill Cove	2013	$ 13,303,328	$ 13,303,328
2	AT2	Upgrade WWTF to service employment growth flows	Aerotech	Ongoing	$ 16,683,387	$ 15,015,048
17	MC7	Diversion Sewer from Mill Cove WWTF to Halifax, along Bedford waterfront to Bedford Hwy tunnel	Mill Cove	2016	$ 6,287,204	$ 6,287,204
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43	DA6	Upgrade of Ferry Rd PS by 807 L/s to provide total capacity of 900 L/s (existing PS has 93 L/s)	Dartmouth	2019	$ 10,064,799	$ 9,058,319
44	DA7	825mm Ø Ferry Rd forcemain for 900l/s	Dartmouth	2019	$ 2,945,997	$ 2,651,398
14	MC4	Localized improvments to Bedford Sackville Trunk Sewer sections	Mill Cove	2019	$ 17,908,321	$ 16,117,489
15	MC5	New wastewater pumping station at Mill Cove WWTF for diversion to Halifax	Mill Cove	2019	$ 3,292,573	$ 3,292,573
16	MC6	500mm Wastewater forcemain from Mill Cove WWTF to Mill Cove Diversion Sewer	Mill Cove	2019	$ 3,515,790	$ 3,515,790
45	DA8	Upgrade of Dartmouth WWTF	Dartmouth	2021	$ 56,874,356	$ 51,186,920
13	MC3	Storage Facility #2 at Bedford Range Park (DS of Bedford Sackville Trunk Sewer)	Mill Cove	2021	$ 13,988,494	$ 13,988,494
19	HA1	Upgrade of Kearney Rd PS	Halifax	2021	$ 12,097,713	$ 10,887,942
20	HA2	900 mm WWFM from Kearney Rd PS to Bicentennial Hwy (Hill top)	Halifax	2021	$ 20,405,930	$ 20,405,930
		Mill Cove WWTF Upgrade	Mill Cove	2021	$ 50,000,000	$ 50,000,000
	WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	2018-2023	$ 6,919,000	$ 3,459,000
	WR2	WRWIP: Young Street Area Sewer Separation	Halifax	2018-2023	$ 21,058,000	$ 14,548,000
	WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	2018-2025	$ 14,932,000	$ 14,185,400
	WR4	WRWIP: Linear Upsize - Quinpool Road	Halifax	2018	$ 404,000	$ -
	WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	2018	$ 206,000	$ -
	WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	Halifax	2018	$ 500,000	$ 475,000
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	WR18	WRWIP: Fairview Cove Linear Upsize	Halifax	2018	$ 19,083,000	$ 14,312,250
	WR20	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	2033	$ 2,874,000	$ 2,730,300
	WR10	WRWIP: BLT WWTF Decommission - New Timberlea PS	BLT	2020	$ 5,560,000	$ 5,282,000
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	WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	BLT	2033	$ 4,108,000	$ 3,902,600
	WR17	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	2033	$ 6,996,000	$ 6,646,200
				Total	$ 374,080,369	$ 339,761,481

Wet Weather Flow Management:

Sewer Separation, Rainfall Derived Inflow and Infiltration (RDII) Reduction, and Low Impact Development (LID) Feasibility Studies

Technical Memorandum

Infrastructure Master Plan

Prepared by
GM BluePlan for:

Halifax Water

Project No. 717043

GM BluePlan ENGINEERING

Version Updates

The following is a record of the changes/updates that have occurred on this document:

Version	Changes / Updates	Author	Reviewer	Date
1	DRAFT – Working version (Update from WRWIP final version)	Megan Blackburn	Bryan Bortolon	June 2019

GLOSSARY OF TERMS AND ACRONYMS

The following table provides a summary of terms and acronyms that are commonly used throughout the report.

Term or Acronym	Definition
BGWI	Base Groundwater Infiltration
CO	Combined Systems
CSO	Combined sewer overflows
CVCA	Credit Valley Conservation Authority
Cv	A volumetric coefficient of the percentage of precipitation
ERA	Environmental Risk Assessment
FMZ	Flow Monitor Zone
HRM	Halifax Regional Municipality
ICI	Institutional/Commercial/Industrial
IRP	Integrated Resource Plan
LID	Low Impact Development
LoWSCA	Local Wastewater Servicing Capacity Assessment Study
RDC	Regional Development Charge
RDII	Rainfall Derived Inflow and Infiltration
RWWFP	Regional Wastewater Functional Plan
SAN	Sanitary Systems
SUD	Sustainable Urban Drainage
WRWIP	West Region Wastewater Infrastructure Plan
WSER	Wastewater Systems Effluent Regulations
WWTF	Wastewater Treatment Facility

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TABLES

FIGURES

1 Introduction

The long-term wastewater strategy for Halifax Regional Municipality (HRM) was originally documented as part of the Regional Wastewater Functional Plan (RWWFP), which was used as a foundation for further work undertaken as part of the Integrated Resource Plan (IRP) and Regional Development Charges (RDC) Rate Study. Recommendations were made to enhance the development of the servicing strategy with a Wet Weather Flow Management study. This study was initiated during the West Region Wastewater Infrastructure Plan (WRWIP), which was recently completed as an update to the RWWFP to identify the preferred wastewater strategy/solution for the West Region system. The focus and primary goal of the WRWIP was to identify the most cost-effective long-term solution to accommodate the growth driver of the Integrated Resource Plan while being mindful of the compliance and asset renewal drivers, looking for opportunities for system optimization, and meeting the level of service objectives. In addition to evaluating the full suite of hard infrastructure servicing options, specific analyses were conducted to assess the feasibility of wet weather management alternatives and identify the potential for a combination of solutions to achieve an overall management strategy. Following a similar approach to the WRWIP, the Infrastructure Master Plan is being completed to include the East and Central Regions. The Wet Weather Flow Management Study focuses on three feasibility studies:

- Combined Sewer Separation; including partial and full separation
- Low Impact Development (LID) / Sustainable Urban Drainage (SUD)
- Inflow/infiltration reduction

The three feasibility studies are outlined in this memo and will provide insight on ways in which wet weather flow management can provide additional capacity for growth and/or improve existing levels of service. In addition to the above, the following should be considered:

- Wastewater flow management at the user level - as outlined in the 2019 Water and Wastewater Design Criteria, Level of Service Objective and Policy Reviews, completed as part of the Infrastructure Master Plan.
- Regulatory and compliance (e.g. existing and anticipated CSO regulations, WWTF regulations (WSER) and permits to operate).

A final study, critical to the completion of the Wet Weather Flow Management study, is the Centre Local Wastewater Servicing Capacity Analysis (LoWSCA). The GM BluePlan team were retained to complete the Regional Centre LoWSCA project for the Halifax Regional Municipality, which was sponsored by HRM and facilitated by Halifax Water. This project focused on local servicing solutions within Halifax's Regional Center (Halifax Peninsula and Dartmouth) to convey local flows from target intensification areas to the nearest regional infrastructure. The viability and cost effectiveness of various wet weather flow management alternatives were compared with traditional large pipe solutions. Considerations were made for integration with the West Region strategy as the study was completed concurrently with the WRWIP. The Dartmouth LoWSCA servicing was completed in advance of the Infrastructure Master Plan and therefore has been revisited under the Infrastructure Master Plan to ensure the final design aligns with the Regional Strategy and level of service requirements. The outputs from the LoWSCA study have been integrated into this Wet Weather Flow Management Study, primarily for the feasibility of sewer separation.

1.1 Aims, and Objectives

Aims: the overall aim of the Wet Weather Flow Management Study is to understand the feasibility of alternative servicing strategies that focus on wet weather flow management options. These strategies can help reduce the conveyance of stormwater to the WWTFs, and the frequency and volume of CSO discharges, subsequently minimizing the need for new infrastructure. The primary goal is to find the most cost-effective long-term solution to accommodate the drivers of growth, compliance, asset renewal, and operational optimization in the context of maintaining Halifax Water's levels of service.

Objectives:

- Identify and assess opportunities for sewer separation and assess the potential effectiveness and ability of combined sewer separation to meet the near and long-term overflow targets.
- Identify and prioritize areas with the greatest potential for low impact development implementation.
- Assess and prioritize catchment areas based on RDII reduction potential.
- Assess the cost/benefits of each strategy and the opportunities to combine wet weather flow management strategies.
- Compare the wet weather flow management alternatives to other infrastructure solutions.

The overall approach will utilize the three feasibility studies to address the wet weather management challenges, and will:

- Combined Sewer Separation Feasibility Study
- Low Impact Design (LID) / Sustainable Urban Drainage Systems (SUDS) Feasibility Study
- Inflow and Infiltration Reduction Feasibility Study

1.1.1 Combined Sewer Separation Feasibility Study

Aims: the aim of the Combined Sewer Separation Feasibility Study is to investigate the potential for sewer separation, including the requirements to meet the servicing needs and minimum level of service of Halifax wastewater infrastructure.

Objectives:

- Complete an industry background review of the Regional Centre.
- Complete a spatial analysis of Halifax's Regional Centre and summarize areas with the greatest opportunities and those with constraints, leveraging the servicing solutions defined in the LoWSCA project.
- Assess the effectiveness of partial and full sewer separation of each area, in terms of volume of stormwater removed:
    - Utilize the modelling outputs, specifically the CSO discharge frequencies and volumes.
- Assess the level of sewer separation required to service existing and future growth scenarios in the context of:
    - Sewer flows must be <80% pipe capacity.
    - No increase in CSO discharge frequency and volume.

1.1.2 Low Impact Design (LID) / Sustainable Urban Drainage Systems (SUDS) Feasibility Study

Aims: the aim of the LID / SUDS Feasibility Study is to investigate the potential to reduce peak wet weather flows and to define spatial areas where green infrastructure is and is not practical as a flow management strategy, within the development of a wider infrastructure servicing strategy.

Objectives:

- Complete an industry background review and a triple bottom line assessment of different green infrastructure techniques including their cost, benefits, and effectiveness.
- Use multiple criteria to complete a GIS and desktop assessment of the Regional Centre and identify and prioritize areas that are appropriate for Low Impact Development.
- Review ownership and maintenance issues including risks and sensitivity of deteriorating LID solutions where maintenance may not be within Halifax Water's mandate/ability to control (i.e. private versus public infrastructure).

1.1.3 Inflow and Infiltration Reduction Feasibility Study

Aims: the aim of the Rainfall Derived Inflow and Infiltration (RDII) Reduction Feasibility Study is to investigate the opportunities for RDII reduction and identify and prioritize the areas with the greatest potential for wet weather removal.

Objectives:

- Assess the wet weather response of flow monitor zone catchments within the Halifax Region, including the West, East and Central wastewater catchments.
- Prioritize flow monitor catchments and use to inform servicing strategies.
- This work will be primarily addressed using the assessment of flow monitor data to identify the amounts of RDII generated within different catchments. In addition, it will leverage the other components of this Wet Weather Flow Management Study and best practice review.

1.1.4 Additional Considerations

Additional considerations that could impact flows will be featured in each of the three feasibility studies and do not necessarily require independent work. These considerations include:

- *Demand Management Impact Assessment (i.e. population flows):* consider the impacts of demand reduction, e.g. lower per capita contributions.
- *Climate Change:* considered when evaluating and applying a design storm.
- *Coordination with other studies/programs:* will be included as appropriate. Particularly LoWSCA, which will be used to inform the sewer separation and LID assessments.
- *Long-Term Regulatory Scenario Assessment;* impacts on assumptions derived from known direction by environmental regulators.
- *Asset Assessment and Asset Renewal Needs;* incorporate specific asset renewal projects already identified by Halifax Water.
- *Analysis Extent:* the catchments boundary and extent that is included in the analysis.

It is important to note that the Wet Weather Flow Management study was completed over two stages. Stage one was conducted as part of the WRWIP and is focused on West Region (Halifax, Herring Cove and BLT WWTF catchments) strategies. Stage two was conducted as part of the Infrastructure Master Plan and assisted in guiding the East Region (Eastern Passage and Dartmouth WWTFs) and Central Region (Mill Cove WWTF) strategies. This document contains the results of stage one and stage two analysis. Therefore, the information in this technical memorandum supersedes that in the one included as part of the WRWIP.

Halifax Peninsula and Dartmouth within the Circumferential Highway (the Regional Centre) are the only areas with combined networks. Therefore, they are included in the Combined Sewer Separation and LID Feasibility Studies only. All remaining areas, including Mill Cove and Eastern Passage, are included in the Inflow and Infiltration Reduction Feasibility Study.

2 Combined Sewer Separation Feasibility Study

2.1 Overview

A background review (Appendix A) was completed to understand different approaches to sewer separation. The review also included a sewer separation feasibility study undertaken in the UK, by Thames Water (Appendix B). Thames Water completed a study to investigate the feasibility of a sewer separation alternatives, in place of constructing a new storage and transfer tunnel. The tunnel was initially proposed to relieve the system during precipitation events and limit the number of CSO spills.

The sewer separation analysis for this feasibility study will build on the methodology presented in the Thames Tunnel report and will incorporate outputs of the Regional Centre LoWSCA areas.

2.1.1 Sewer Separation Options Review

There are two primary ways to implement sewer separation:

- Convert the existing combined system to sanitary and construct a new separate stormwater system, with new outfalls and catchbasin connections as required.
- Convert the existing combined system to stormwater and construct a new separate sanitary system, with new lateral connections as required.

Table 2-1 summarizes the benefits of the two separation options.

Table 2-1: Sewer Separation Options Review

Factor	**Option A –** Convert Combined to Sanitary System and Construct New Separate Stormwater System	**Option B –** Convert Combined to Stormwater System and Construct New Separate Sanitary System
Intrusiveness at Property Level	*Moderate* – for partial separation, no new connections for stormwater at the lot level are required; for full separation, connections for stormwater at the lot level are needed and therefore more intrusive	*Greater* – disconnecting and reconnecting sanitary connections requires access to private lots and is much more intrusive
Environmental Risk	*Less risk* – do not have to worry about the cross connection of sanitary laterals into the stormwater system	*More risk* – when converting existing combined system to storm, it is essential to ensure every single sanitary connection is disconnected
Timeline	*Shorter* – assumes no reconnections needed for sanitary flows; depending on partial versus full separation, may need to allow for some stormwater connections from the lot level	*Longer* – converting the existing combined to storm is a much longer process to disconnect and reconnect every sanitary connection
Impact on Regional Infrastructure	*Untouched* – existing combined connections to interceptors remain intact and continue to convey sanitary flows	*Significant* – when converting local combined system to storm, they have to be disconnected from existing

Factor	**Option A –** Convert Combined to Sanitary System and Construct New Separate Stormwater System	**Option B –** Convert Combined to Stormwater System and Construct New Separate Sanitary System
		interceptors, which is where the new sanitary would connect
Partial/Gradual Separation Potential	*Moderate* – stormwater flows cannot be separated until the new storm sewer is in place; parking lots and rooftop connections can be disconnected gradually	*Higher* – installing a new sanitary system allows for the initial separation (partial) of roads and parking lots and rooftop connections can be disconnected gradually
System Design & LOS	*More robust LOS* – a new stormwater system can be designed appropriately for specified design storm. Combined sewer size often more than adequate for sanitary only service.	*Lower LOS* – if the existing system is converted to storm, it may not be sufficient to provide adequate level of service in the future.
Construction Feasibility	*Greater Impact* – construction of the new stormwater system will require larger diameter pipes and may be problematic within the right of way due to multiple services	*Moderate Impact* – a new sanitary system will be comprised of smaller size sewers. Construction along right of ways will be more feasible and less disruptive from social and environmental perspectives.

The two options were reviewed, and for the purposes of the Infrastructure Master Plan and WRWIP study, it is assumed that existing combined sewers would be converted to sanitary sewers and a new storm sewer system would be installed (Option A). This will have the following implications when completing this study:

- System designs and costs will only be relevant for new separate stormwater systems. This feasibility study cannot be used to justify future separation that consists of a new sanitary system.

2.1.2 *Existing Sewer Separation*

The combined catchments in Halifax are in the Regional Centre, including Halifax Peninsula and Dartmouth within the Circumferential Highway. GIS data was used to identify past sewer separation projects within the Regional Centre. There are many small pockets of separated sewer throughout the Regional Centre, however the majority are localized and connect to the existing combined sewer network. These sewer separation projects provide relief to the local system however the flows will still be conveyed to an existing CSO. As there are no combined networks in Mill Cove and Eastern Passage, the sewersheds were not included in the sewer separation feasibility study.

Although most of the existing sewer separation is local, there are a few major sewer separation projects of sufficient size to provide opportunities for additional separation at the local level and discharge directly to the harbour or waterbodies.

The major sewer separation areas identified in Halifax Peninsula are as follows:

A. Upstream of Kempt Road
   - Extent of separated network reaches the Young St. area
   - Comprised of sewers ranging from 350 – 900 mm
   - Provides opportunities for future sewer separation projects however would likely require upgrades
   - Discharges storm water via the Kempt outfall

B. Downstream of Spring Garden Road, from South Park Street to Pier ‘A’ CSO (Freshwater Brook)
   - The upstream 1,200 mm diameter sewer provides great opportunity for future sewer separation projects, which can connect into the existing trunk stormwater network
   - Discharges to the Pier A CSO outfall

C. Upstream of the Bedford Hwy
   - The upstream 1,050 mm diameter sewer provides great opportunity for future sewer separation projects, which can connect into the existing trunk stormwater network
   - Discharges to the Kempt outfall

The major sewer separation areas identified in Dartmouth are as follows:

A. Canal Road
   - Extent of separated network reaches the Canal St area
   - Sewers is 600 mm and services a small industrial area
   - Provides opportunities for future sewer separation projects however would likely require upgrades
   - Discharges stormwater via the Canal outfall

D. Downstream of Wyse Road on Windmill Street
   - Comprised of sewers ranging from 1050 – 1200 mm
   - Outfall dischargers at the corner of Sunnydale Ave and India St. and drains alongside the CN tracks to the harbour
   - The outlet supports a significant residential catchment already and therefore a detailed catchment assessment is recommended to confirm existing storm flows, predicted future flows and if upsizing is required

E. Rose Street connection to an overflow outfall to Sullivan’s Pond
   - GIS data showed an existing separated network on Rose St connecting to the combined network at MH57065, just upstream of an overflow to Sullivan’s Pond at MH57068
   - Provides great opportunity for sewer separation with minimal works required
   - During the hydraulic model build stage, a request was made to survey the sewer manhole which connected to the outfall on GIS. The manhole was not able to be located and therefore further investigation is recommended to locate and determine the arrangement of the overflow outfall pipeline discharging to Sullivan’s Pond
   - Comprised of sewers ranging from 525 – 600 mm, minor upgrade to improve conveyance between changing pipeline gradients
   - Discharges to Sullivan’s Pond

F. Thistle Street and Nantucket Avenue

- GIS data showed existing separation network in the areas around Thistle Street and Nantucket Avenue, connecting to the combined network on Wyse Road
- The surrounding areas is combined, however the separated areas are close to existing CSO outfall that discharge to the harbour
- The CN track run along the harbour and therefore upsizing the existing CSO oufall will be costly
- The existing CSO arrangements show potential options for assisting in sewer separation projects, however as the capacity, conditions and layout vary they will need to be reviewed on a case by case basis

G. Fenwick Drive, Rodney Road and Hazelhurst Street

- GIS data showed existing separation network connecting to the combined network on Fenwick Drive, Rodney Road and Hazelhurst Street
- There is currently no option for connecting to a storm sewer, however if the separation of Lake Maynard and/or the Southdale wetland are considered in the future it could provide a direct connection, in particular for Fenwick Drive and Hazelhurst Street
- Where flows from Lake Maynard and the wetland naturally convene there is an industrial and commercial area with separation potentials

2.1.3 LoWSCA Sewer Separation Solutions

The LoWSCA study focused on intensification growth within the Halifax Peninsula and Dartmouth areas and was used to support HRM's Centre Plan and other development studies. The LoWSCA study led to several recommendations that included upgrading of existing combined sewers and new sewer separation projects. The sewer separation projects that were recommended for Halifax Peninsula and Dartmouth were generally expansions of the existing separated sewer networks and potential separation options presented in Section 2.1.2.

It should be noted that the Combined Sewer Separation Feasibility Study, and prioritization of areas most suited for sewer separation, were completed in isolation of the LoWSCA study recommendations. However, the LoWSCA sewer separation projects will be considered and included as part of the overall Infrastructure Master Plan solutions.

The six LoWSCA intensification areas are listed below, with four pockets in Halifax Peninsula and two in Dartmouth.

- Spring Garden Road, Halifax Peninsula
- Young Street, Halifax Peninsula
- Gottingen & Agricola, Halifax Peninsula
- Quinpool Road, Halifax Peninsula
- Wyse Road, Dartmouth
- Canal Street, Dartmouth

Figure 2-1 presents the Centre Plan's Urban Structure Map showing the extent of the Regional Centre and the location of the LoWSCA intensification pockets. The areas labelled Centers generally align with the LoWSCA intensification pockets with slight adjustments made to the boundaries, with the Canal Street LoWSCA area becoming part of the Dartmouth Downtown area.

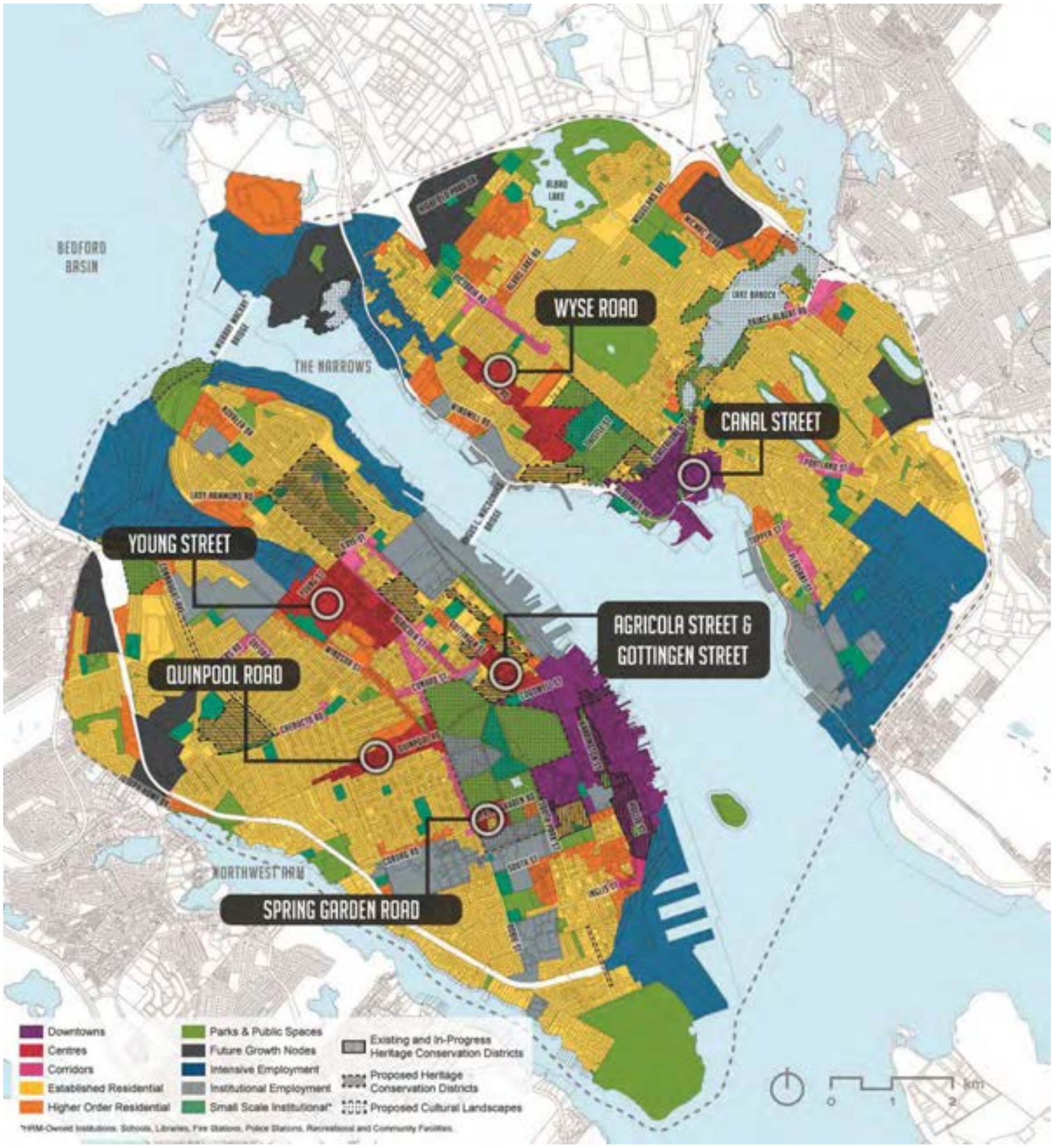


Figure 2-1: Centre Plan Map Labelled with LoWSCA Intensification Areas

The LoWSCA servicing solutions that included sewer separation were Spring Garden Road, Young Street, Canal Street and a section of Wyse Road. The LoWSCA designs are outlined in the following sections.

2.1.3.1 Spring Garden Rd. Area

The Spring Garden Road area is a currently developed area in Halifax Peninsula. Its location commands high land values. In Figure 2-2 below, sub-area 1 and 2 currently feature an 18 and 12 story building, respectively. It is not expected to achieve a significantly higher population density although there is density potential for an additional population of 2,600. Sub-areas 3, 4, 5 and 6 are currently low rise and primarily residential with some ground floor commercial. The area is near green space, adding to the desirability of the area. System knowledge in this area, prior to detailed hydraulic modelling capacity assessment, identified that this area may be nearing or at capacity and even modest increases in density would likely create issues.

The hydraulic analysis identified existing constraints within the area, which was made worse by the proposed growth. Many infrastructure solutions were considered including combined sewer upsizing, LID solutions, and sewer separation. The preferred solution was full sewer separation and the figure below presents the proposed alignment.

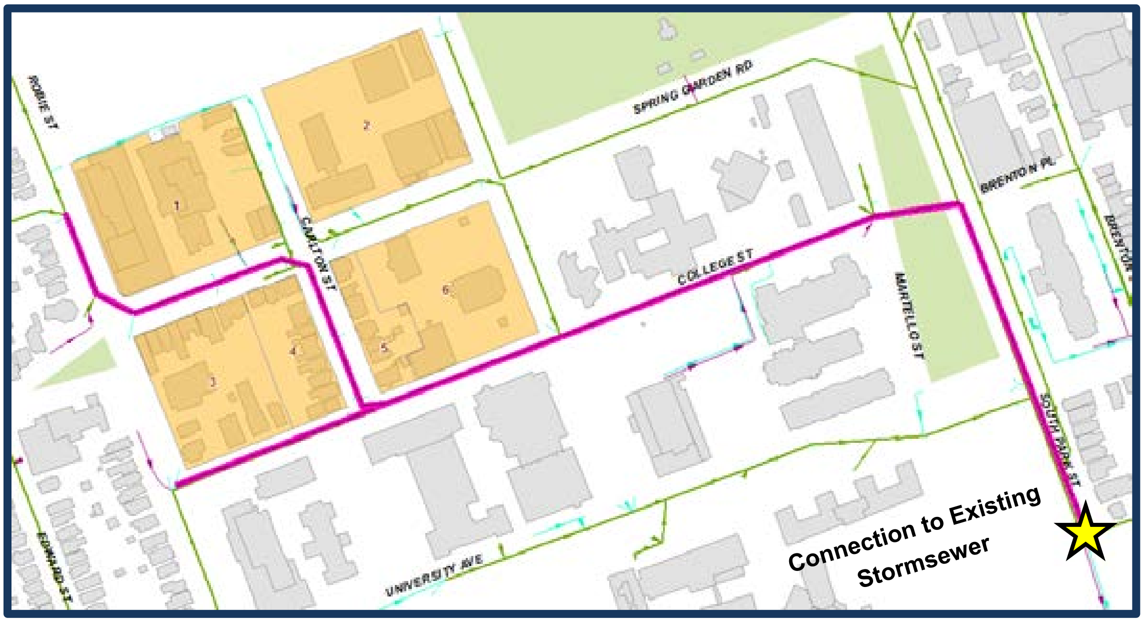


Figure 2-2: Sewer Separation Scenario for Spring Garden

This alignment would fully separate a portion of the Spring Garden Area and connect into the existing stormwater network that discharges downstream of the Pier A CSO, sharing the same outfall. By utilizing the existing storm network, no new outfalls are required. Although not required to accommodate the proposed growth, opportunities to further separate this area were highlighted, which would include the Public Gardens. Because of the opportunities for further sewer separation, the new stormwater sewers would be sized to accommodate future separation of upstream areas.

2.1.3.2 Young St. Area

The Young Street area represents the largest potential growth of all Peninsula growth pockets. The existing area is fully developed and features three large land owners that could create significant redevelopment potential. The Canada Post sorting facility, the Halifax Forum and Eastlink lands represent most of the defined spatial area. There are existing development applications for this area including an 18-story building and two 14-story buildings. Due to the large parcels, there is good opportunity for stormwater management solutions. Transportation links in the area have been subject to discussion and the widening of Bayers Road had been tabled.

The hydraulic analysis identified existing constraints within the Young Street area, which was made worse by the proposed growth. Many infrastructure solutions were considered including combined sewer upsizing, LID solutions, and sewer separation. The preferred solution was full sewer separation and Figure 2-3 below presents the proposed alignments.

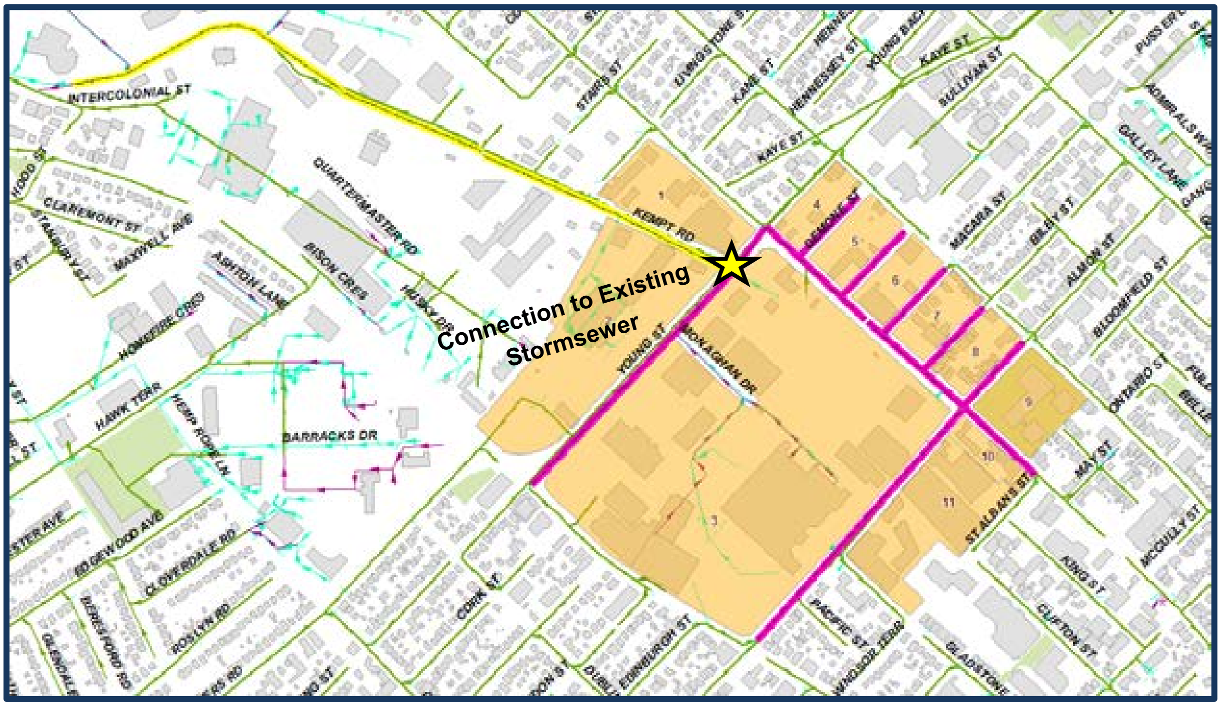


Figure 2-3: Sewer Separation Scenario for Young Street

This alignment would fully separate the Young Street Catchment and connect into the existing stormwater network along Kempt Road, which would require major upgrades. By utilizing the existing storm network, no new outfalls are required, which was identified as a likely constraint of constructing a new storm sewer along Young Street. It should be noted that the new stormwater sewers for the development area would be sized to accommodate future separation of upstream areas.

2.1.3.3 Canal St. Area

The Canal Street area is the subject of the Dartmouth Infrastructure Master Plan, which was completed after the LoWSCA study. The LoWSCA study identified redevelopment potential within the area and that the location poses some development obstacles including its low level in relation to sea level. Flows from this area are conveyed to both Maitland CSO and Pumping Station and Dartmouth Cove Pumping Station. The system has sufficient capacity to accommodate the growth and therefore infrastructure upgrades are not required. There is however opportunity for sewer separation with the existing 600mm storm sewer along Canal Street, which would assist in reducing spills at Maitland Street CSO. Key projects to note include: daylighting of the piped water channel to the west of the Canal Street area, formally known as Sawmill River, has been partly completed. Phase 1 from Sullivan's Pond up to Irishtown Road is complete, and Phase 2 will be completed soon connecting to the harbour by Alderney Drive.

The hydraulic analysis identified that CSO discharge at Maitland Street were made worse by the proposed growth and would also be affected by growth upstream of the Canal Street LoWSCA area. The evaluation of infrastructure upgrades was not required, however, opportunities for flow removed were still considered. The preferred LoWSCA solution was full sewer separation and Figure 2-4 below presents the proposed storm sewer alignment.

Figure 2-4: Sewer Separation Scenario for Canal Street

This alignment would fully separate the Canal Street Area and connect into the existing stormwater network on Canal Street, that discharges to the harbour. By utilizing the existing storm network, no new outfalls are required. It should be noted that the new stormwater sewers would be sized to accommodate future separation of upstream areas.

2.1.3.4 Wyse Rd. Area

Wyse Road is a large spatial area that has been identified as a high potential redevelopment area. Recently, land prices have seen increases, developer interest has heightened, and some redevelopment has occurred. There is currently a large public housing location east of the study area. The intent would be to add buildings that provide potential for medium density (multi-unit) buildings.

The hydraulic analysis identified existing constraints within the area, which was made worse by the proposed growth. Many infrastructure solutions were considered including combined sewer upsizing, LID solutions, and sewer separation. The preferred solution included full sewer separation for Area A sewer upsizing for Area B and Area C; Figure 2-5 presents the proposed alignments.

The recommended approach for Wyse Road was a combination of sewer separation and pipe upgrades.

- Area A included a new pipeline connecting to the existing storm sewer on Windmill Road and sewer separation (ref Figure 2-5, left image)
- Area B included upsizing the existing network along Wyse Road and up to Jamieson St CSO (Figure 2-5, right image)
- Area C Included upsizing the existing network along Wyse Road and up to Lyle St CSO (Figure 2-5, right image)

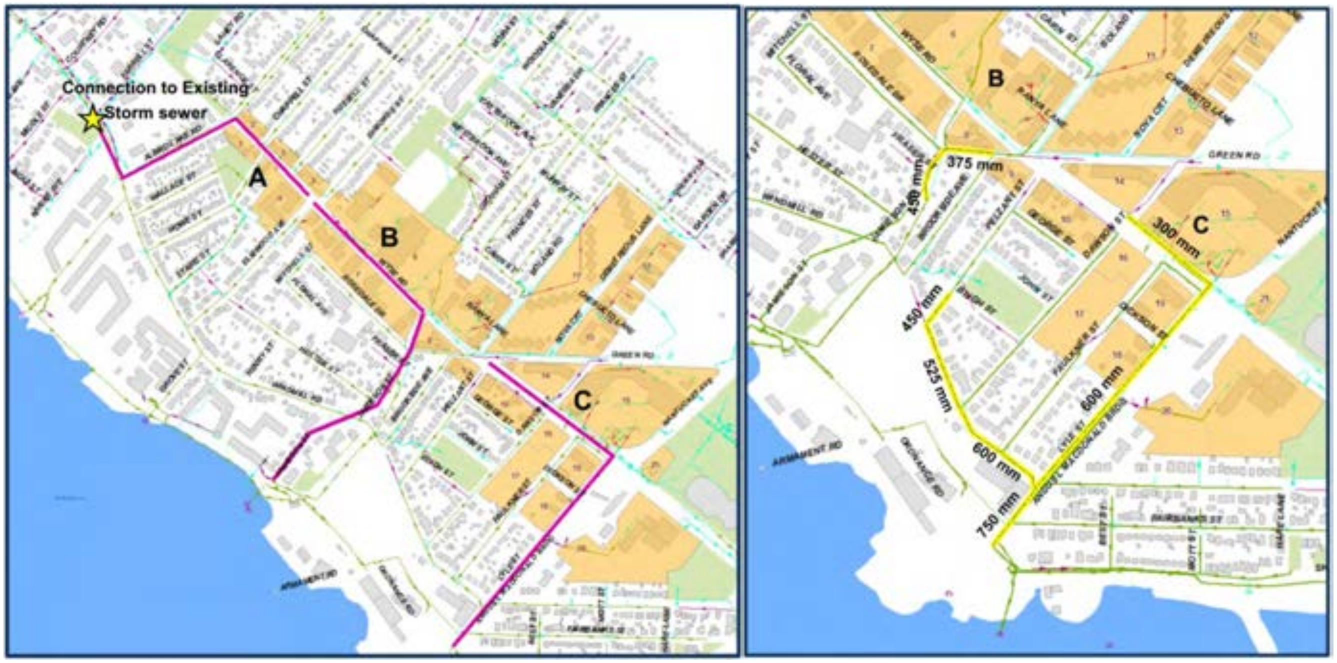


Figure 2-5: Sewer Upgrade and Separation for Wyse Road. Left image showing preferred option of sewer upgrade for Areas B and C, Right image showing preferred option of sewer separation for Area A.

Sewer separation in Area A utilized the existing storm network, with no new outfalls are required. It should be noted that the new stormwater sewers would be sized to accommodate future separation of upstream areas.

Although separation was not the preferred solution for Area B and Area C under the LoWSCA study, the study outlined that sewer separation would provide additional benefits to the system and should still be considered in the future, or as part of a regional strategy, primarily around the separation of Lake Albro.

2.2 Approach and Methodology

The tasks that were completed as part of the sewer separation feasibility review are presented in the process flow diagram outlined in Figure 2-6. This section of the report describes the approach and methodology for each task beginning with a combined system spatial analysis.

2.2.1 Regional Centre Spatial Analysis

GIS data was used to separate the Halifax Peninsula and Dartmouth combined areas into catchments, which were delineated for each existing CSO facility and any other local networks that connect into the regional infrastructure located at the Regional Centre. In Dartmouth the catchments draining to Ferguson Road and Melva Street CSO were not included in the analysis as the catchments are essentially separated and therefore are covered under the RDII reduction analysis. A series of spatial queries were then applied to collect and summarize key information that will be used to evaluate and score each catchment under the following four areas:

1. Existing and Future System Performance (regional infrastructure)
2. Reduction in Flows
3. Costing Analysis
4. Constructability Review

For each area, the catchments were ranked and a relative score (1-5) was assigned; 5 equating to the greatest/best, and 1 equating to the poorest/worst. The four scores were then weighted to produce an overall feasibility score. Maps were created to highlight the outputs and were used to identify areas with greater sewer separation potential, and those with barriers and limitations.

2.2.2 System Performance (Regional Infrastructure)

Model build and model calibration for the Peninsula and Dartmouth areas were initially completed as part of the LoWSCA and WRWIP projects using the previous PCSWMM hydraulic models. This encompassed the following activities:

a. The addition of local sewer networks for the LoWSCA pockets to the base trunk model, which is comprised of regional infrastructure.
b. The calibration of the model using flow monitoring data collected as part of the WRWIP (regional) and the LoWSCA (local) projects.

2.2.2.1 Halifax Peninsula

In 2016, the calibrated PCSWMM model was used to assess the feasibility of separation across the Halifax Peninsula and inform the development of the West Region wastewater servicing strategy.

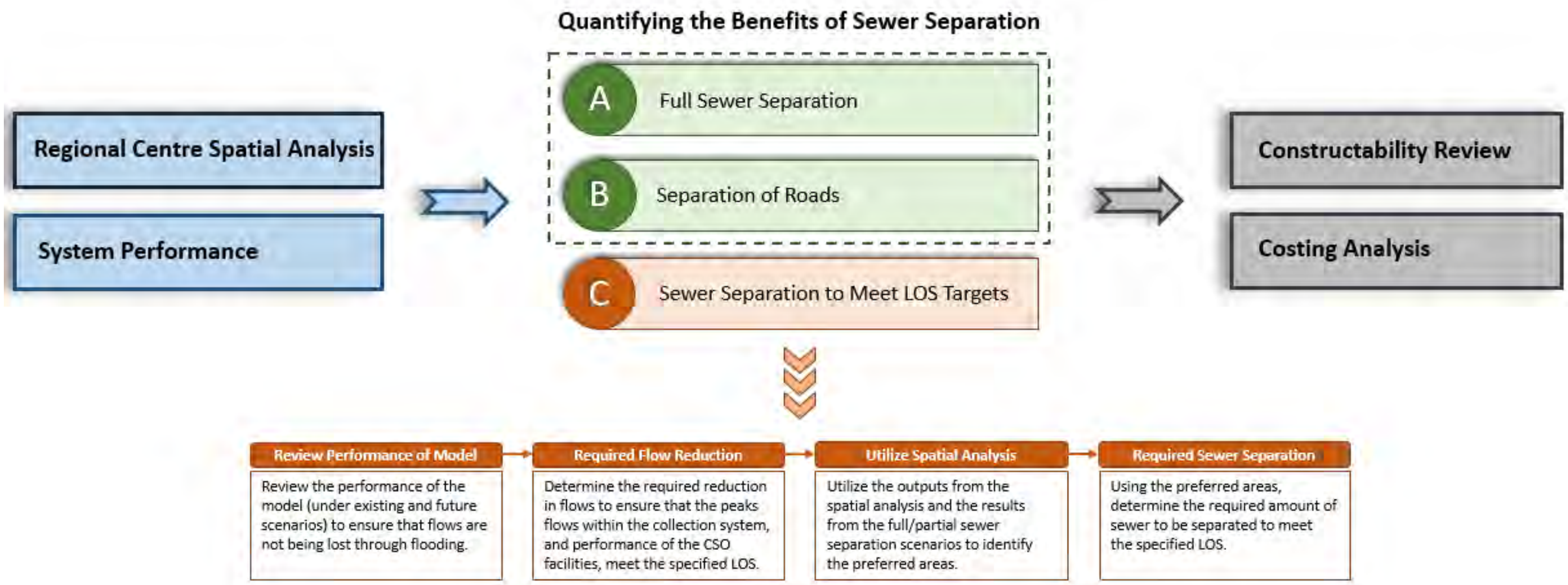
2.2.2.2 Dartmouth

In 2018, a new all-pipe model was built, using Innovyze InfoWorks software, as part of the Infrastructure Master Plan. This model was used to assess the feasibility of separation across Dartmouth and inform the development of the Dartmouth wastewater servicing strategy.

2.2.2.3 General Approach

The calibrated models were used to simulate a typical year of precipitation (2003) under existing demand conditions and a 2046 growth scenario. The system performance was evaluated in the context of regional infrastructure, including the spill volume and frequency of each CSO.

The scoring represents the effectiveness of sewer separation as part of the overall solution; i.e. the greater the CSO discharge (frequency and volume), the more opportunity there is to realize the benefits of sewer separation. A score of 5 will be assigned to the catchments with the greatest CSO discharge and most impacted by growth, and therefore the greatest opportunity for positive contribution to an overall wet weather flow management solution, a score of 1 representing the least opportunity for positive contribution.



Review the performance of the model (under existing and future scenarios) to ensure that flows are not being lost through flooding.

Determine the required reduction in flows to ensure that the peaks flows within the collection system, and performance of the CSO facilities, meet the specified LOS.

Utilize the outputs from the spatial analysis and the results from the full/partial sewer separation scenarios to identify the preferred areas.

Using the preferred areas, determine the required amount of sewer to be separated to meet the specified LOS.

Figure 2-6: Sewer Separation Feasibility Study – Process Flow Diagram

2.2.3 Reduction in Flows

The potential benefits of sewer separation were captured in terms of the volume of precipitation (m^3) that could be theoretically removed from the combined sewer system. This volume was estimated using and breakdown of surface area impermeability from the spatial analysis, and the 2003 precipitation data. The potential reduction in flows will be estimated for partial sewer separation and full sewer separation.

- *Partial Sewer Separation* – this scenario will review the minimum level of sewer separation by separating the road right of ways within the Regional Centre.
- *Full Sewer Separation* – this scenario will review the maximum level of sewer separation achievable by separating all impermeable surfaces within the Regional Centre.

The scoring represents the magnitude of flow reduction that can theoretically be attained; 5 representing the greatest reduction in volume, 1 the least. Taking a conservative approach, the reduction in flows weighting relies on the volume remove under partial separation conditions.

2.2.4 Costing Analysis

The costing analysis will be completed for both partial and full sewer separation.

Partial Sewer Separation

The breakdown of sewer lengths from the spatial analysis will be used to estimate a high level cost of construction for a new storm sewer network. Unit costs, in line with the Halifax Water costing framework, will be applied using the upper limits of each category; i.e. 450mm, 900mm, and 1500mm. A 100% uplift and contingency will be used in addition to the generic sewer unit costs; this represent additional uplifts such as construction within the Regional Centre, and project complexity.

Full Sewer Separation

In addition to the sewer construction costs, the full sewer separation scenario utilized the number of property connections, estimated in the spatial analysis, and a fixed cost to estimate the cost of property reconnections.

The costing exercise will be completed at the planning level, therefore costs will likely have a variance of +/-30%, in line with Halifax Water's Cost Estimation Framework. It should be noted that this costing analysis was completed to attain a relative cost comparison between the catchments, and is not a detailed costing analysis.

The scoring represents the magnitude of costs associated with separating each catchment; 5 representing the least costly catchments to separate, and 1 the most costly. As minimal difference in the scoring between partial separation and full separation was observed, for consistency partial separation was weighted with the final score used to ranking the cost analysis.

2.2.5 Constructability Review

This review will focus on the feasibility of sewer separation in the context of social impacts and constraints, such as local disruptions, in addition to constructability. Three criteria will be used and weighted to produce an overall constructability score. The following criteria will utilize the information from the spatial analysis:

- % Residential: will utilize the building footprints and land use to estimate the amount of residential area versus ICI; a score of 5 representing the least residential and therefore least local disruption.

- % Local Road: will utilize the road lengths to estimate the amount of local road as a percentage of all roads; a score of 5 representing the least amount of local road and therefore the most feasible from a construction point of view.
- Population per Length of Combined Sewer: will utilize the population count and combined sewer length to estimate a population density relative to the amount of separation that would be required; a score of 5 representing the least population dense catchments and therefore the least overall disruption.
- % Depth > 5m: will utilize the depth and length of sewers within each catchment to capture the relative constructability; a score of 5 representing the least percentage of sewer that is greater than 5m deep.

% Depth > 5m only applied to catchments in Halifax Peninsula as minimal number of pipe exceeded 5m in Dartmouth, making it a less applicable criteria in the weighting.

The overall weighted score represents the magnitude of disruption and ease of construction; 5 representing that catchments that are deemed the most feasible and least disruptive, from a construction point of view, and 1 representing the least feasible and most disruptive.

2.3 Priority Areas for Sewer Separation

2.3.1 Halifax Peninsula

Figure 2-7 presents an overview of the catchment delineation for the Halifax Peninsula; there are a total of 26 catchments. The spatial analysis was completed for each catchment and the outputs, in addition to the methodology used, are provided in Appendix C.

The outputs from the spatial analysis were used to rank and score each catchment for the four areas described in Section 2.2; the ranking and scoring tables are provided in Appendix D. Figure 2-8 presents the prioritization of the delineated catchments based on the overall feasibility of sewer separation. Additional figures are provided in Appendix D that present the scoring of each catchment for the four key areas that were used to determine the overall feasibility score. The outputs from this study highlight the areas that have the greatest potential for sewer separation, and those with barriers and limitations. It should be noted that both partial and full separation scenarios were assessed, however the prioritization was based on partial sewer separation, as it requires significantly less disruption and less uncertainty associated with the calculated outputs. Although the prioritization is based on partial separation, any proposed projects should include considerations for full sewer separation scenarios when sizing of sewers, so that it can happen over time as seen fit.

Generally, the Young Street, Kempt Road, and Connaught Avenue areas are the most feasible areas and provide the greatest opportunities for flow reduction due to existing trunk storm sewers. Dense residential areas are identified as less feasible due to constructability and less opportunities to reduce flow, as they have less connected impermeable areas. The outputs from this feasibility study were used, in conjunction with the other two flow management feasibility studies, to inform the overall WRWIP solution and determine what combinations of practices can provide adequate reductions in flows. This will include the assessment of the minimum sewer separation required to meet the LOS targets.

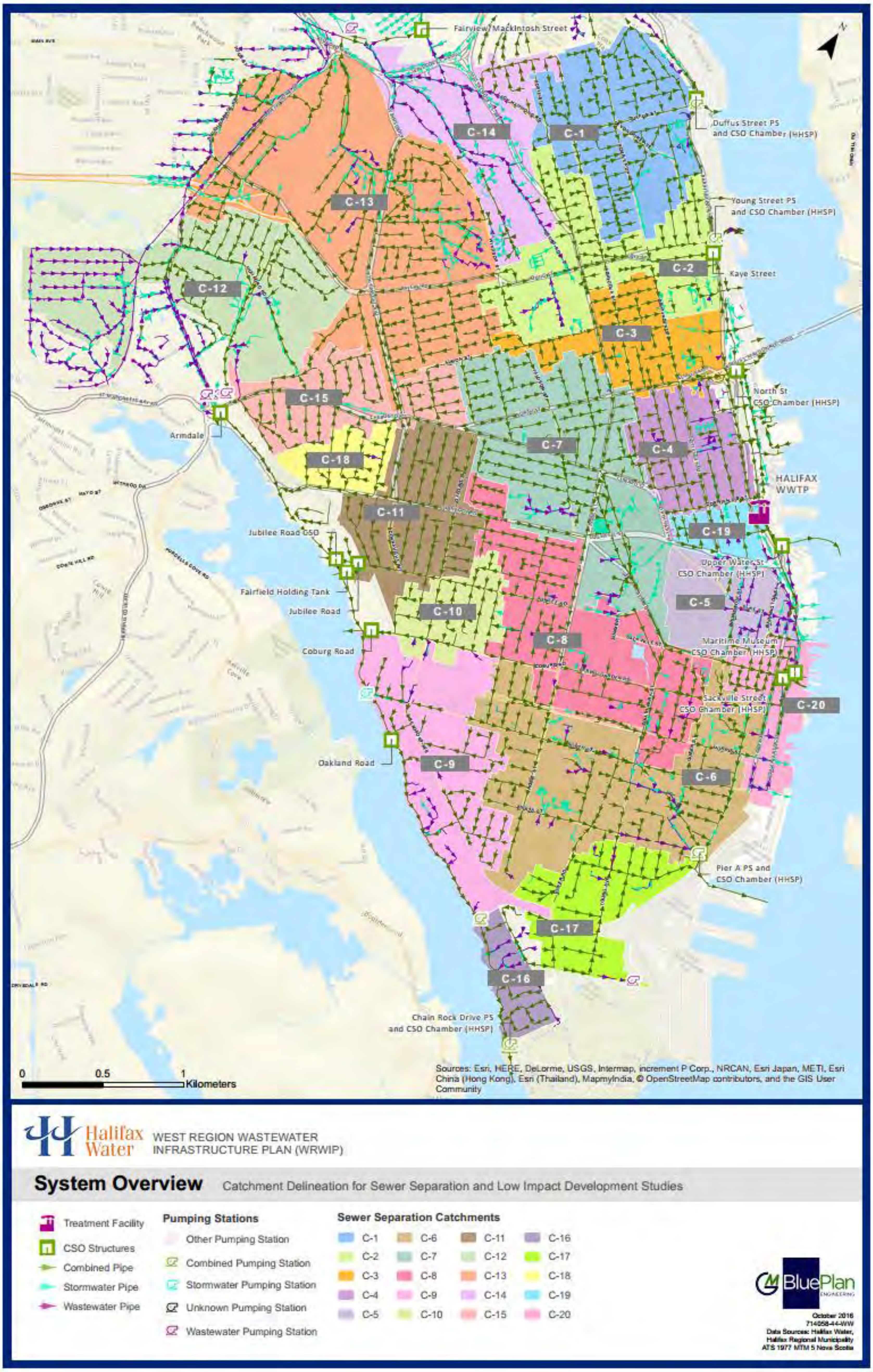


Figure 2-7: Catchment Delineation - Halifax

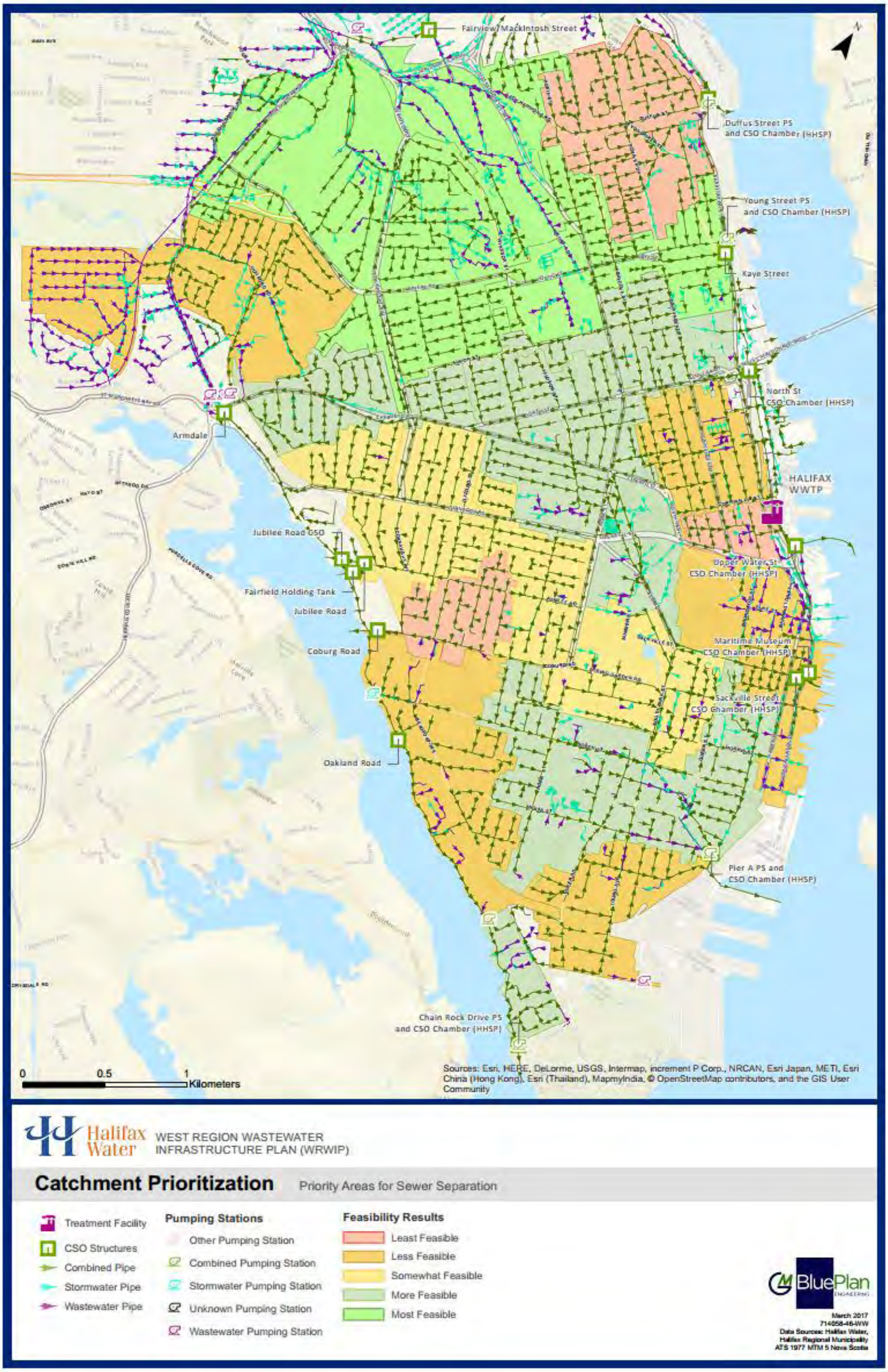


Figure 2-8: Catchment Prioritization for Sewer Separation - Halifax

2.3.2 Dartmouth

Figure 2-9 presents an overview of the CSO catchment delineation for Dartmouth, which includes a total of 11 catchments. The spatial analysis was completed for each catchment and the outputs, in addition to the methodology used, are provided in Appendix C.

The outputs from the spatial analysis were used to rank and score each catchment for the four areas described in Section 2.2. Figure 2-10 presents the prioritization of the delineated catchments based on the overall feasibility of sewer separation, and the ranking and scoring tables are provided in Appendix D. The outputs from this study highlight the areas that have the greatest potential for sewer separation, and those with barriers and limitations. As with the Halifax Peninsula analysis both partial and full separation scenarios were assessed, with prioritization on partial sewer separation.

Generally, the Jamieson Street, Wyse Road, Nantucket Avenue, Thistle Street, Rose Street and Canal Street areas are the most feasible areas and provide the greatest opportunities for flow reduction. Dense residential areas were identified as less feasible due to constructability and less opportunities to reduce flow. The outputs from this feasibility study will be used, in conjunction with the other two flow management feasibility studies, to inform the overall Infrastructure Master Plan solution and determine what combinations of practices can provide adequate reductions in flows. This will include the assessment of the minimum sewer separation required to meet the LOS targets.

Figure 2-9: Catchment Delineation - Dartmouth

Figure 2-10: Catchment Prioritization for Sewer Separation - Dartmouth

2.3.3 Sewer Separation to Meet LOS Targets

It is evident from the background review and feasibility study outputs that there is significant potential for sewer separation within the Regional Centre. The sewer separation feasibility study focused on identifying areas with the greatest potential, or best suited, for sewer separation, and those that would be less effective or may have barriers to implementation. This information will be used to inform the servicing strategy analysis, including the evaluation of different servicing alternatives. The sewer separation analysis will be refined to determine the minimum level of sewer separation that is required, as a component of the different overall strategies that are identified. The overall strategy must ensure that there is no increase in spill frequency or volume because of growth under a typical year of precipitation, 2003. A 1 in 5 year design storm will be used to size new stormwater infrastructure and to identify major constraints within the linear system.

The approach outlined in the process flow diagram is as follows:

1. Review the performance of the linear system (for existing and future scenarios) under a 1 in 5 year design storm
    a. Ensure that the linear system can convey flows to the regional infrastructure
2. Review the performance of the CSO facilities (for existing and future scenarios) under a typical year of precipitation, 2003.
    a. Ensure that there is no increase in CSO discharge frequency or volume due to growth
3. Determine the required reduction in flows to meet the specified LOS in parts 1) and 2).
4. Utilize the outputs from the spatial analysis and the results from the full/partial sewer separation scenarios to identify the preferred areas for separation.
5. Using the preferred areas, identify the amount of road to be separated, and any additional impermeable areas that may be required such as large parking lots or property reconnections.
6. Identify the amount of sewer length and property reconnections required to meet the servicing needs.

This analysis will be completed alongside confirming if the LoWSCA projects align with the regional strategy and sewer separation approach.

It should be noted that sewer separation cannot be implemented as a standalone solution for the Halifax Region as there are significant system constraints that are not solely downstream of combined sewers, such as the Fairview Cove tunnel in Halifax and the Port Wallace growth constraints in Dartmouth. In addition, a theoretical back-of-the-envelope estimate for impermeable area to be separated to meet the LOS targets cannot be completed as it will vary from catchment to catchment, and therefore CSO to CSO. The required amount of separation, to reduce CSO discharges, is not just a function of an amount of impermeable area and needs to be evaluated on an area by area basis to account for attenuation and peaking. For these reasons, determining the required amount of sewer separation to service the Region will be completed as part of the overall servicing analysis, which will allow for the integration of sewer separation with other concepts.

3 Low Impact Design Feasibility Study

3.1 Overview

Intensification of urban living and the urban sprawl, occurring in cities around the world, has led to a high level of impervious surfaces. This, in turn, changes the runoff patterns. Where in the past natural vegetation and soil type allowed gradual absorption of water through infiltration of rainfall or snow melt, now new impervious surface and adjusted slopes have led to increased speed and volume of runoff. There is also a direct relationship between the degree of development in an area and the concentration of contaminants found in urban runoff. The urban environment not only effects the stormwater flows but also facilitates the conveyance of contaminants to rivers, lakes, and marine waters. The changing mentality to managing stormwater has led to the rise of Low Impact Development (LID). LID has been included as an option in the Wet Weather Flow Management study as it has the potential to reduce the amount of stormwater entering the combined sewer network and in recognition of the water quality issues experienced, especially at the CSOs.

The purpose of this study is to highlight the benefits of implementing LID strategies alongside other infrastructure works projects, and how to assess the feasibility of LID solutions in terms of constructability, cost/benefit, and implementation. The intent of this study it to assist in bringing a holistic approach to separation of combined networks and stormwater management in the Halifax Region.

3.1.1 Background Investigation

Based on the LID background review and case studies, Appendix C and Appendix F respectively, it is apparent that implementing green infrastructure systems at the private, single family dwelling, level is complex and unique to the municipality and community, and will take a high level of effort and resources to ensure the end goals are met and maintained over time. For this reason, this study will focus on public green infrastructure with consideration for private level infrastructure on commercial and industrial private lots.

The Credit Valley Conservation Authority (CVCA) in Ontario has been investing a lot of time and resources to help move forward the practice of implementing LID facilities as part of stormwater management solutions. They have been developing design and construction guidelines, perform ongoing monitoring of over 20 pilot projects, and utilize field observations to determine maintenance requirements for different types of LID techniques. All this data and information, including general knowledge regarding LID practices, is made public through their website. Appendix F summarizes more information about the CVCA and their online portal.

The GM BluePlan Team completed site visits with employees from the CVCA to see LID facilities first hand. This allowed the team to gain a better understanding of the different aspects of LID practices including design, functionality, maintenance requirements, performance, and lessons learned. Additional information regarding the sites, including photos, is provided in Appendix F. The sites that were visited were primarily city owned except for one, which was a private commercial parking lot. It was evident from the site visit and discussions with the CVCA that there are great opportunities to realize the benefits of LID facilities including water quality, reduction in peak flow, reduction in volume, or a combination of all three. Although the performance reports demonstrate great abilities to remove TSS and metals and provide up to full precipitation capture of smaller precipitation events, LID techniques are not designed for major storm events with extreme intensities, and therefore require a diversion for flows exceeding the capacity of the LID device. Furthermore, the implementation of LID facilities is location dependent and their performance varies from site to site, even for the same LID technique. The performance may also vary from event to event as the infiltration will depend on the preceding conditions, such as soil saturation. Therefore, although a system of LID facilities can provide great benefits to an overall stormwater system, it is unclear if it would be a viable servicing solution on its own.

The "Sustainable Drainage Systems (SuDS) Retrofit Feasibility Tool" report, Appendix G, assessed the feasibility of a low impact development strategy and the implementation of green infrastructure and prioritized areas based on catchment characteristics. The approach outlined in this study will be used to assess the feasibility of LID techniques within the Peninsula and Dartmouth areas.

3.2 LID in Infrastructure Planning

LID is gaining traction in existing urban areas to reduce stress on ageing infrastructure, assist in prevention against climate change, optimize stormwater and wastewater treatment costs, improve ecosystem and protects public health, build resiliency, and improve local economy among other benefits.

Climate Change is predicted to exacerbate the concerns and risks around managing municipal assets, and the benefits of LID are being noticed globally. As LIDs mimic the natural hydrological cycle, they essentially work as an adaption technique through reducing the effects of urbanization on water quality and quantity, and the impacts on the receiving environment.

A "lead by example" approach is a good way to initiate private LIDs in a community where it is not common practice and there are currently no policies or initiatives to encourage public involvement. The recommended approach is to start by installing municipality owned LID devices, as this will bring awareness to LID and start to be able to quantify the benefits. The next stage is initiating policy changes or incentives to get privately owned LID devices implemented and properly maintained. For a municipality to reach the desired stormwater runoff reductions and water quality, public policies and initiatives are required, as most of the impervious surfaces are privately owned. Policy, incentives, and goals for the private and public sector are outlined in Appendix E.

To support the local LID initiatives and programs the following step are recommended.

1. Install LID devices in public land as part of the municipality planning strategies
2. Educate and outreach to the public with demonstrations
3. Initiate incentive for the use of LID
4. Review the municipal Stormwater Code
5. Undertake a feasibility study on LID
6. Monitor the LID program/s
7. Implement legislation requiring the use of LID for new impervious area

3.3 Approach and Methodology

This section summarizes the methodology that will be used to identify the areas with the greatest opportunity for low impact development. The assessment will utilize the information summarized as part of the spatial analysis to rank and score each catchment so that they can be prioritized as those that are and are not appropriate for the implementation of green infrastructure, at the public level. The methodology from the spatial analysis is provided in Appendix C.

Four criteria will be used and weighted to produce an overall score, which will represent how easily green infrastructure could be implemented as part of the overall solution; a score of 5 would represent the catchments with the greatest opportunity for LID.

- Ownership Status: the greater the amount of publicly owned land and properties, the more feasible it is to implement green infrastructure, including green roofs, onsite storage, and rain gardens.
- % Greenspace: the greater the amount of permeable area, the more opportunities for increased infiltration via green infrastructure.
- % Flat Roof: the greater the amount of flat roof, the more suitable the catchment is for green roofs.
- % Arterial Road: areas with wider roads will have greater opportunities for road right-of-way LID techniques such as Bioswales, Tree Boxes, and Storage.

3.4 Priority Areas for the Implementation of LID Techniques

This feasibility review is a high-level assessment of the potential opportunities for LID, identifying areas that are most feasible for implementing LID techniques, and those with limitations. This review focused on public LID practices, such as within road right-of-ways and public properties, as these provide more certainty with regards to proper maintenance and long-term performance. Furthermore, the implementation of private LID practices would require incentive-based programs or stormwater credits; these programs can be beneficial and should be considered. However, the uncertainty around maintenance and operations makes it unreasonable to consider these methods as part of the regional combined sewer management solution.

The outputs from the LID feasibility review in the combined areas of Halifax Peninsula and Dartmouth, including ranking and scoring of each catchment, are summarized in Appendix D. Figure 3-1 and Figure 3-2 presents the prioritization of the catchment areas, which identifies those that are most feasible for implementing LID techniques.

Based on the feasibility study and background review, it is unlikely that LID practices can provide sufficient reductions in flow on their own and there is risk of deteriorating performance over the long term. However, these practices can be incorporated into the larger solution, where feasible, to reduce the extent of other capital projects and set the stage for a potential low impact development program that targets the private level. Over time, as LID practices become more advanced and there is more knowledge around the maintenance schedules, costing, and proper measuring of performance, these solutions may become more viable.

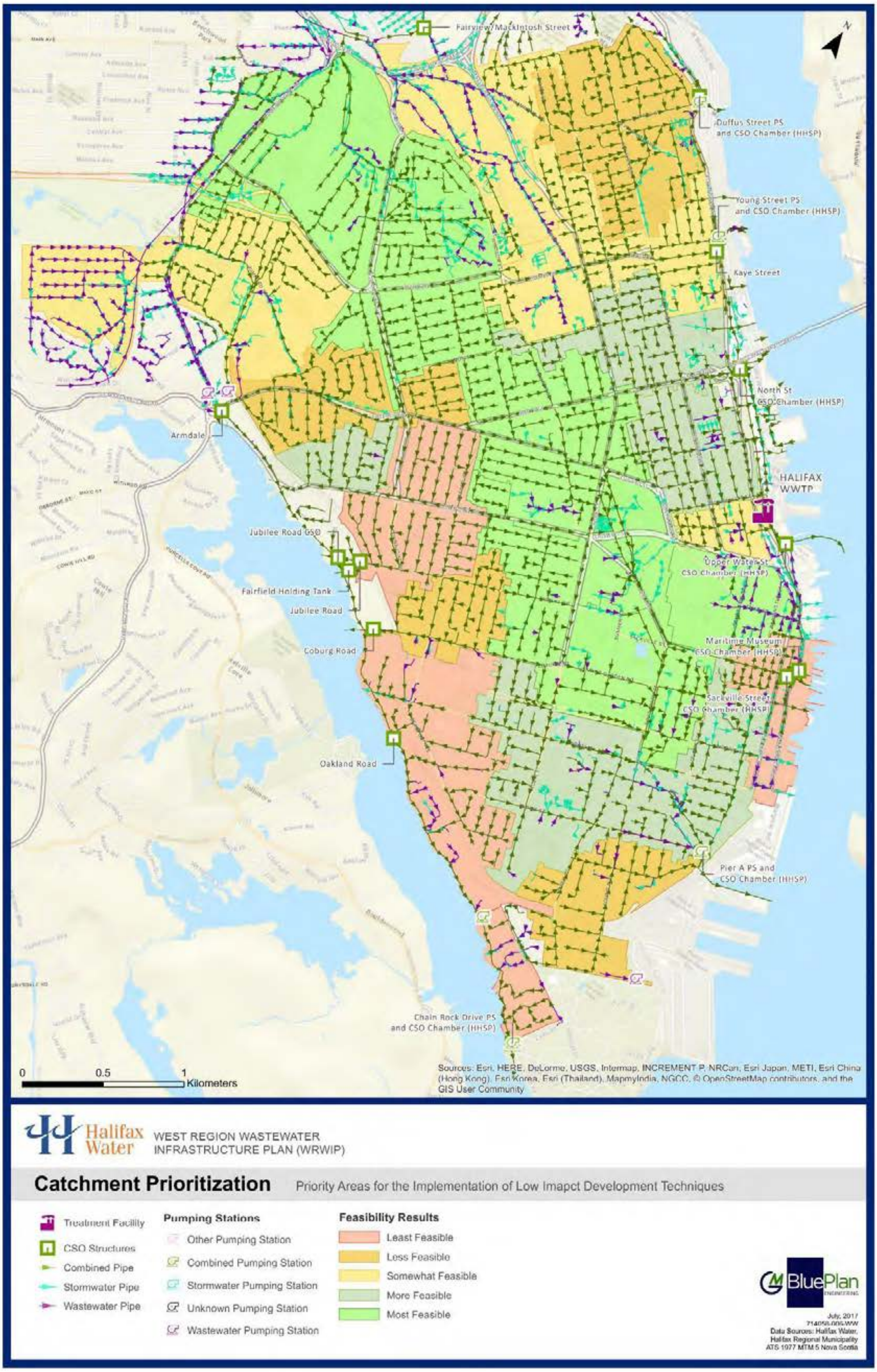


Figure 3-1: Halifax Peninsula Catchment Prioritization for Low Impact Development

Figure 3-2: Dartmouth Catchment Prioritization for Low Impact Development

4 Inflow and Infiltration Reduction Analysis

4.1 Overview

The rainfall derived inflow and infiltration (RDII) reduction analysis reviews the wet weather response of various flow monitored catchments to identify and prioritize areas with high inflow and infiltration within separated networks. The results from this study will inform the alternative servicing strategies.

The study extent covers the flow monitored separated networks across West, Central, and East regions. The RDII catchments were delineated by flow monitors and used flow monitoring analysis results from the Halifax Flow Monitoring Program to prioritize the areas.

4.1.1 Flow Monitoring Analysis

The monitoring period for flow and precipitation data varied between the West Region (WRWIP) and the East and Central Regions (Infrastructure Master Plan). West Region monitoring occurred between October and November 2015. The collection period for East and Central Region flow monitors was from September 2018 to June 2018.

For both collection periods, at least four (4) critical events occurred and were included in the RDII analysis. The number of flow monitors, by region and the combine/separated systems, are as follows:

- West Region – 26 Flow Monitors in Halifax (5 separated and 21 combined catchments)
- Central Region – 12 Flow Monitors in Mill Cove (all separated)
- East Region - 8 Flow Monitors in Eastern Passage (all separated) 21 in Dartmouth (13 separated and 8 combined catchments)

The location of the flow monitors and delineation catchment maps for each service area are outlined in the Flow Monitor Data Appendix H.

The data was used to complete a full suite of analyses, including:

- Identification of Critical Precipitation Events
- Review of Velocity-Depth Scatter Graph
- Dry Weather Flow Analysis
- Quantification of Rainfall Derived Inflow and Infiltration (RDII)
- Estimation of Design Flows

Criteria for critical rainfall event selection:

- minimum of 20 mm of total precipitation
- greater than a 5 mm/hour intensity.

The Halifax Flow Monitoring Program has progressed over time to provide more analysis detail and improve the interpretation of data collected. The improvements between the WRWIP and the Infrastructure Master Plan allowed for a more detailed and comprehensive assessment of RDII for the Mill Cove, Eastern Passage, and Dartmouth catchments. Although not as detailed, the West Region analysis as part of the WRWIP still provided sufficient results to prioritize the high RDII areas.

4.2 West Region Approach and Methodology

The quantification of Rainfall Derived Inflow and Infiltration (RDII) was used to evaluate and score flow monitoring catchments across the Halifax West Region in terms of the opportunity to remove flow from the wastewater system. Catchments with higher levels of RDII would be better candidates for implementing inflow and infiltration reduction programs. The following three variables were used to score each catchment:

- Cv (%): the volumetric coefficient measures the percentage of precipitation, which fell on the catchment, that entered the sewer system.
- Peak Unit RDII (L/s/ha): this value represents the peak flow, because of precipitation, normalized by the size of the catchment.
- Base Groundwater Infiltration (L/s/ha): this value represents the infiltration rate, normalized over the catchment size, during dry weather days.

The catchments were ranked against each other and a relative score was assigned. The ranking was completed on a 5-point scale from Least Feasible to Most Feasible. It should be noted that the analysis was originally completed during the WRWIP for all areas within the West Region, including the Peninsula. As part of the Infrastructure Master Plan, only the separated systems were carried forward as sewer separation is more appropriate for the combined sewer areas.

4.3 West Region Priority Areas for Inflow and Infiltration Reduction

The outputs from the RDII feasibility review including catchment delineation, ranking, and scoring of each catchment are summarized in Appendix D and Appendix H. The analysis suggests that FM-3, FM-4 and FM-6 provide great opportunity to remove wet weather from the sanitary system and these catchment areas should be included for RDII reduction works as part of the overall West Region wastewater servicing strategy. Figure 4-1 illustrates the delineated catchments and Figure 4-2 highlights the West Region priority areas.

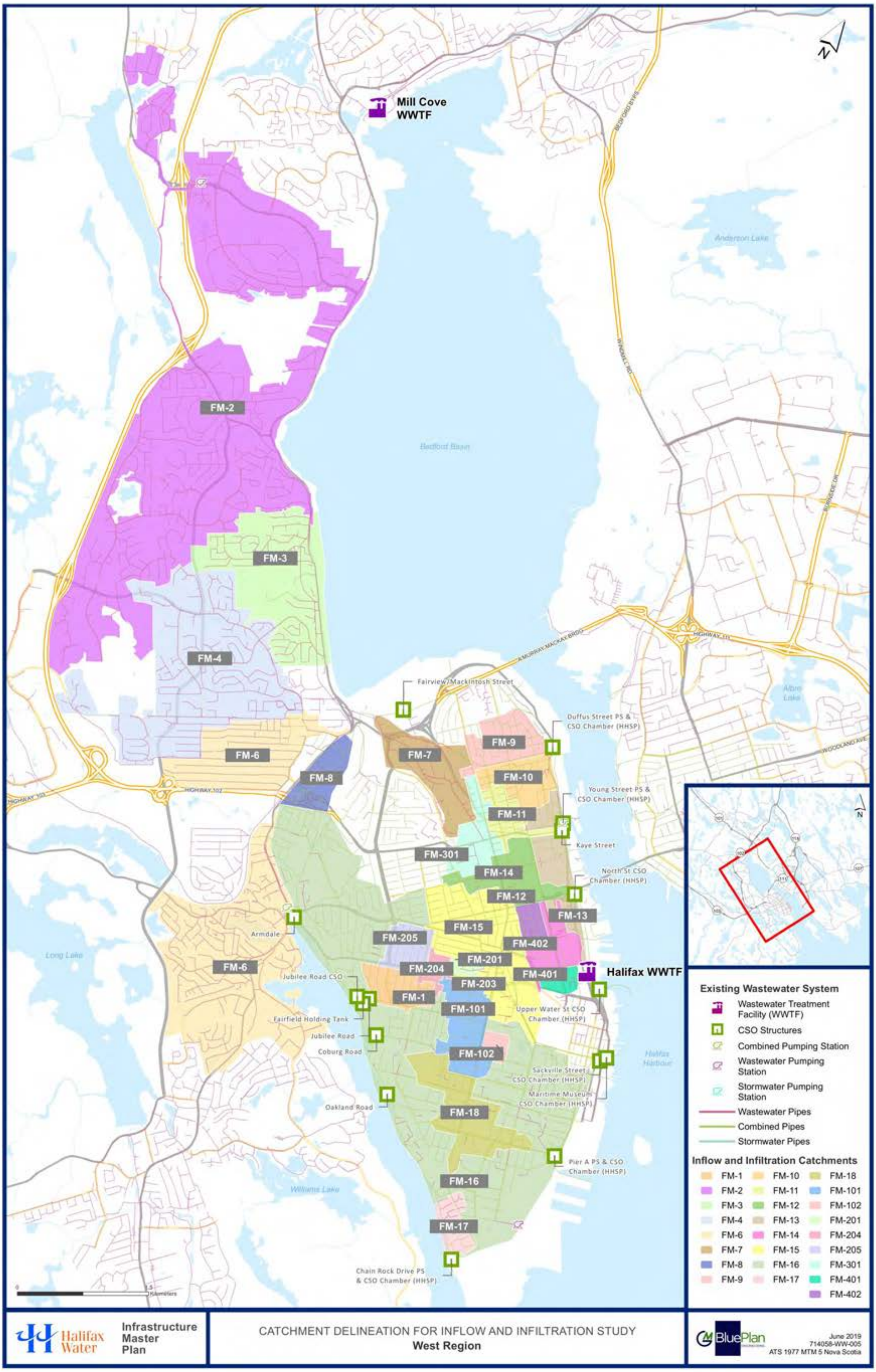


Figure 4-1: Catchment Delineation – West region

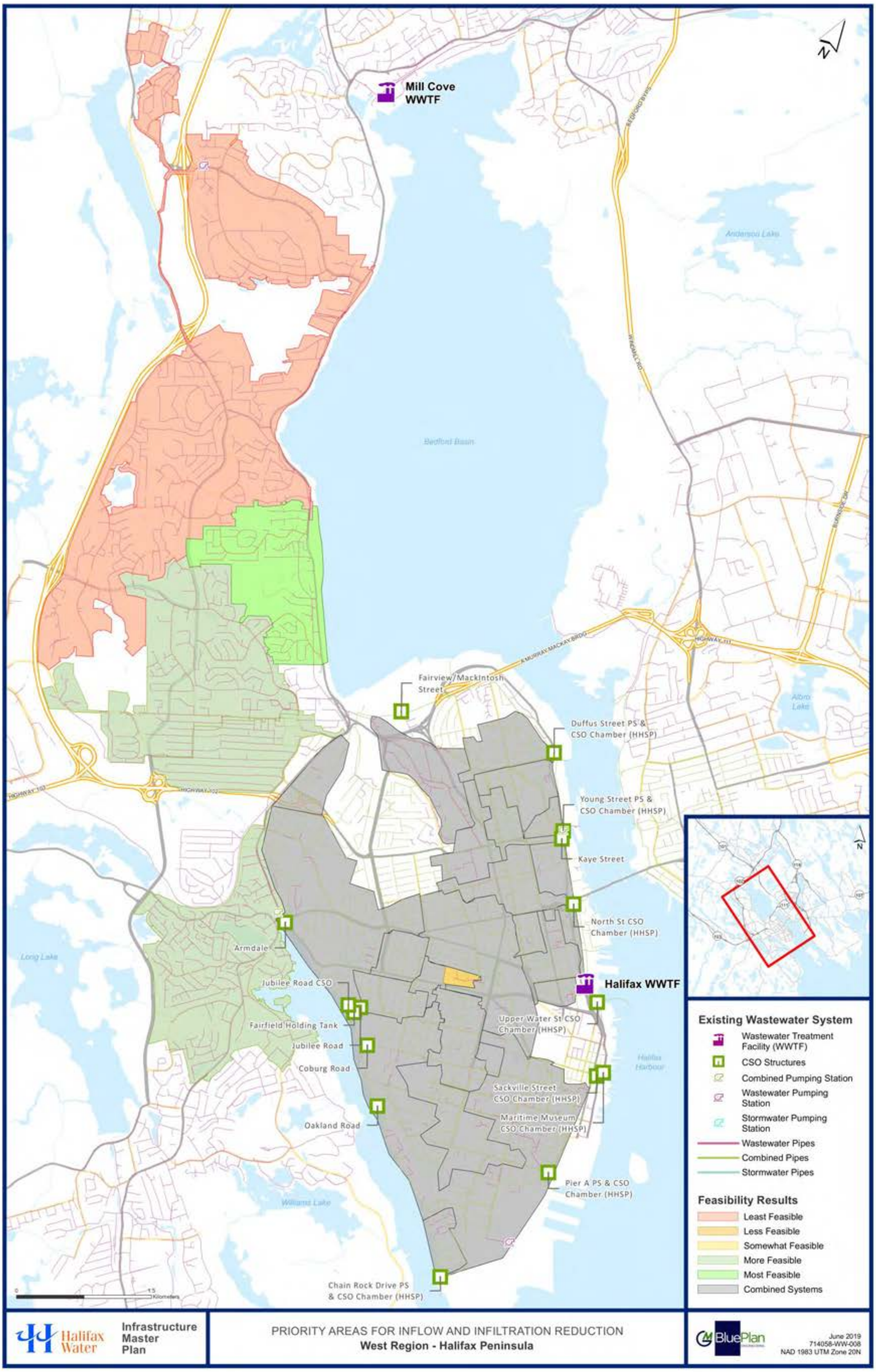


Figure 4-2: West Region Catchment Prioritization for Inflow and Infiltration Reduction

4.4 Central and East Region Approach and Methodology

The approach and methodology for prioritizing catchments for RDII reduction programs was revised as part of the Infrastructure Master Plan. Rather than “ranking” flow monitoring catchments solely based on metrics, which can sometimes be misleading for catchments downstream of other flow monitors, the RDII reduction potential of each area was concluded as high, medium, or low for each area based on various factors, including:

- Reviewing of wet weather flow metrics from various storm events:
    - Cv (%)
    - Unit Peak RDII (L/s/ha)
    - Peak RDII (L/s)
    - PWWF multiplier: this value represents the magnitude difference between peak wet weather flow and the average dry weather flow during the event.
- Review of flow monitoring network configuration (i.e. interpreting the analysis metrics based on understanding of upstream and downstream monitors).
- Review of wet weather response graphs to identify fast and slow response.

The delineated RDII catchments for Mill Cove, Dartmouth and Eastern Passage are in Figure 4-3 to Figure 4-5; it should be noted that the combined areas were excluded from the Dartmouth analysis.

After the high, medium, and low potential catchments were identified, schematic charts were created to present the results and show the links between catchments. The schematic charts are included in sections 4.5 to 4.7.

The areas identified as high priority (red) would be recommended for inclusion in the Infrastructure Master Plan strategy, and then engineering judgement was used to determine if any areas with medium priority (orange) should be included based on the interactions with connecting catchments.

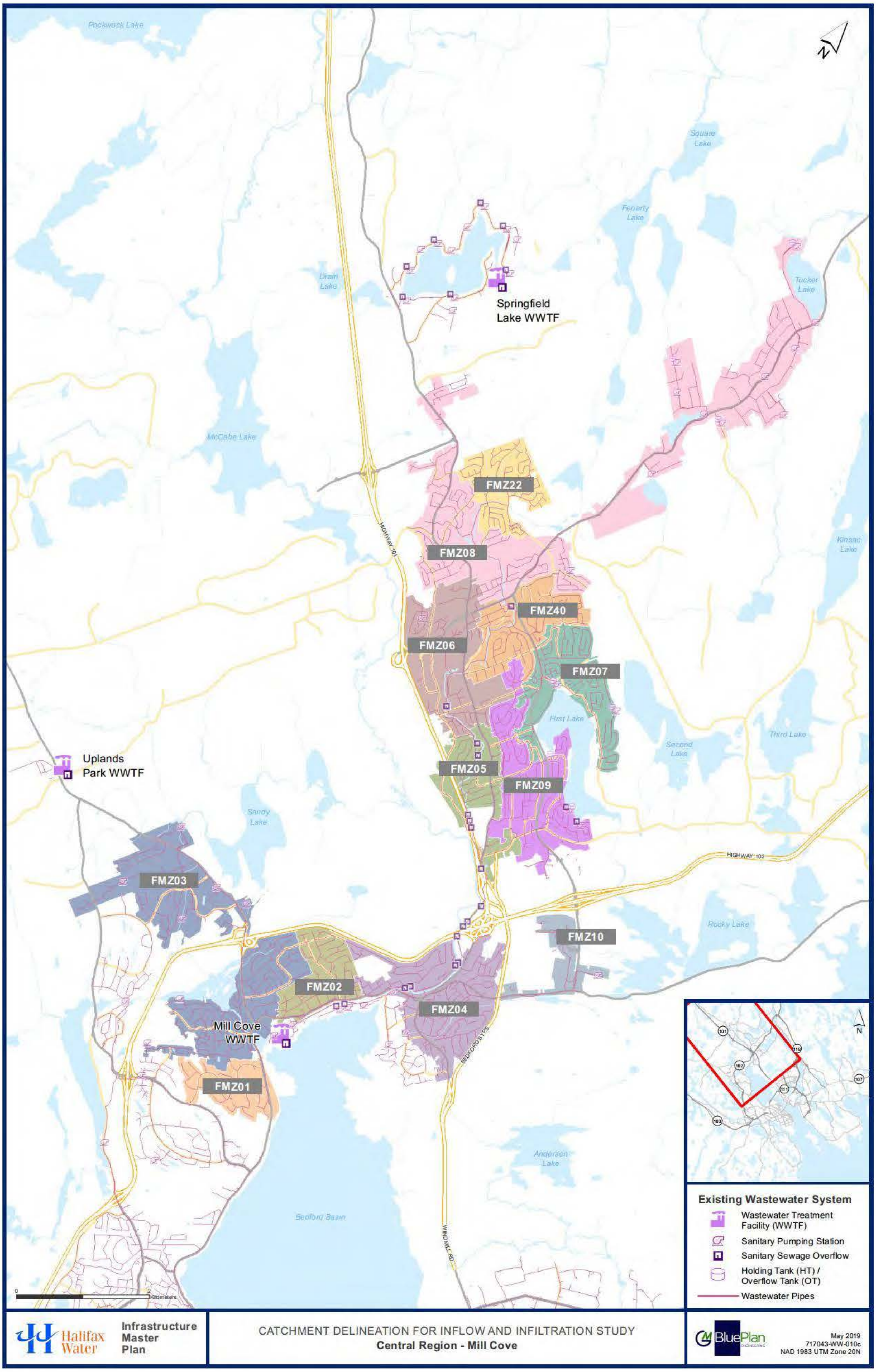


Figure 4-3: Catchment Delineation – Mill Cove

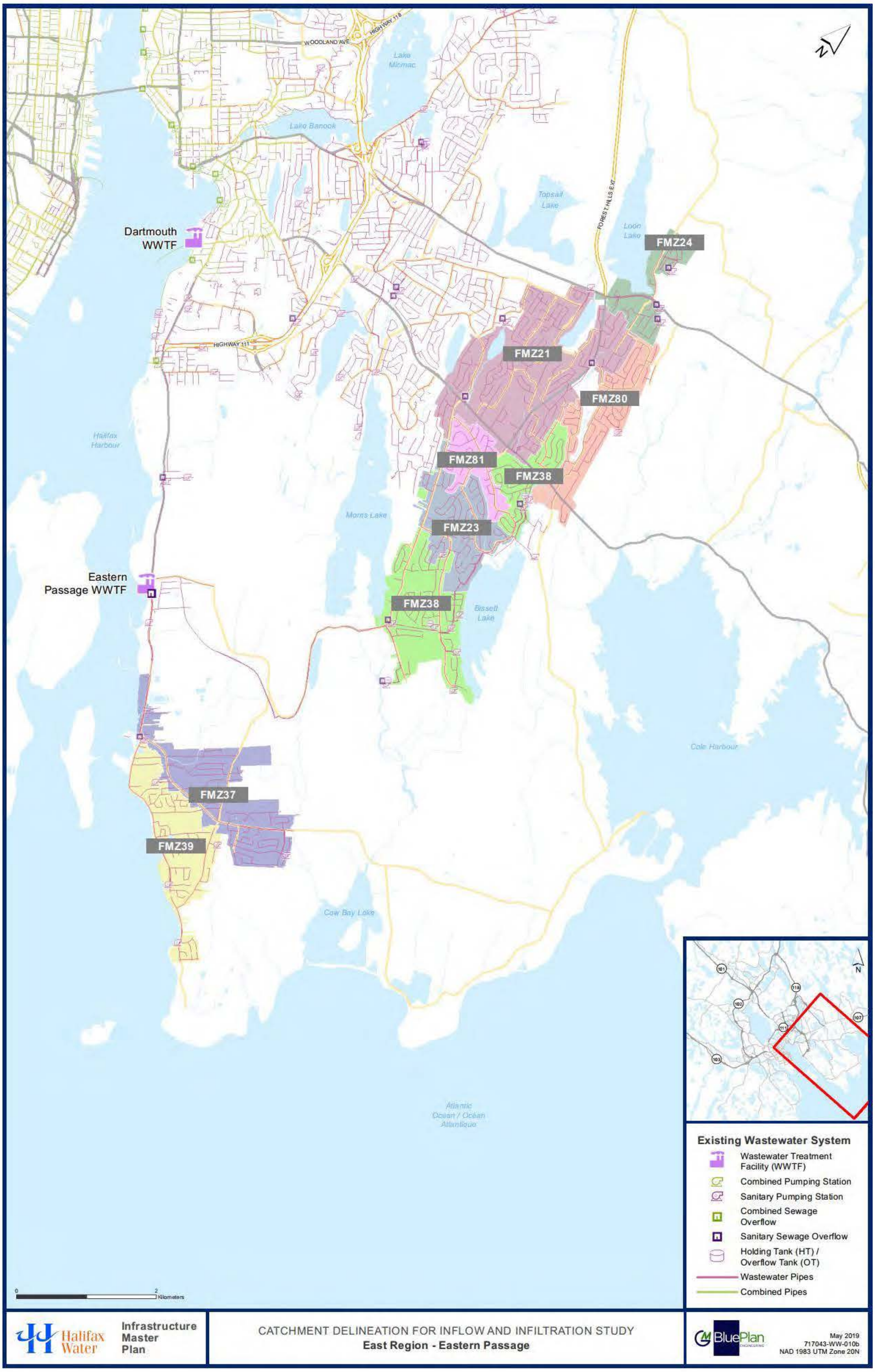


Figure 4-4: Catchment Delineation – Eastern Passage

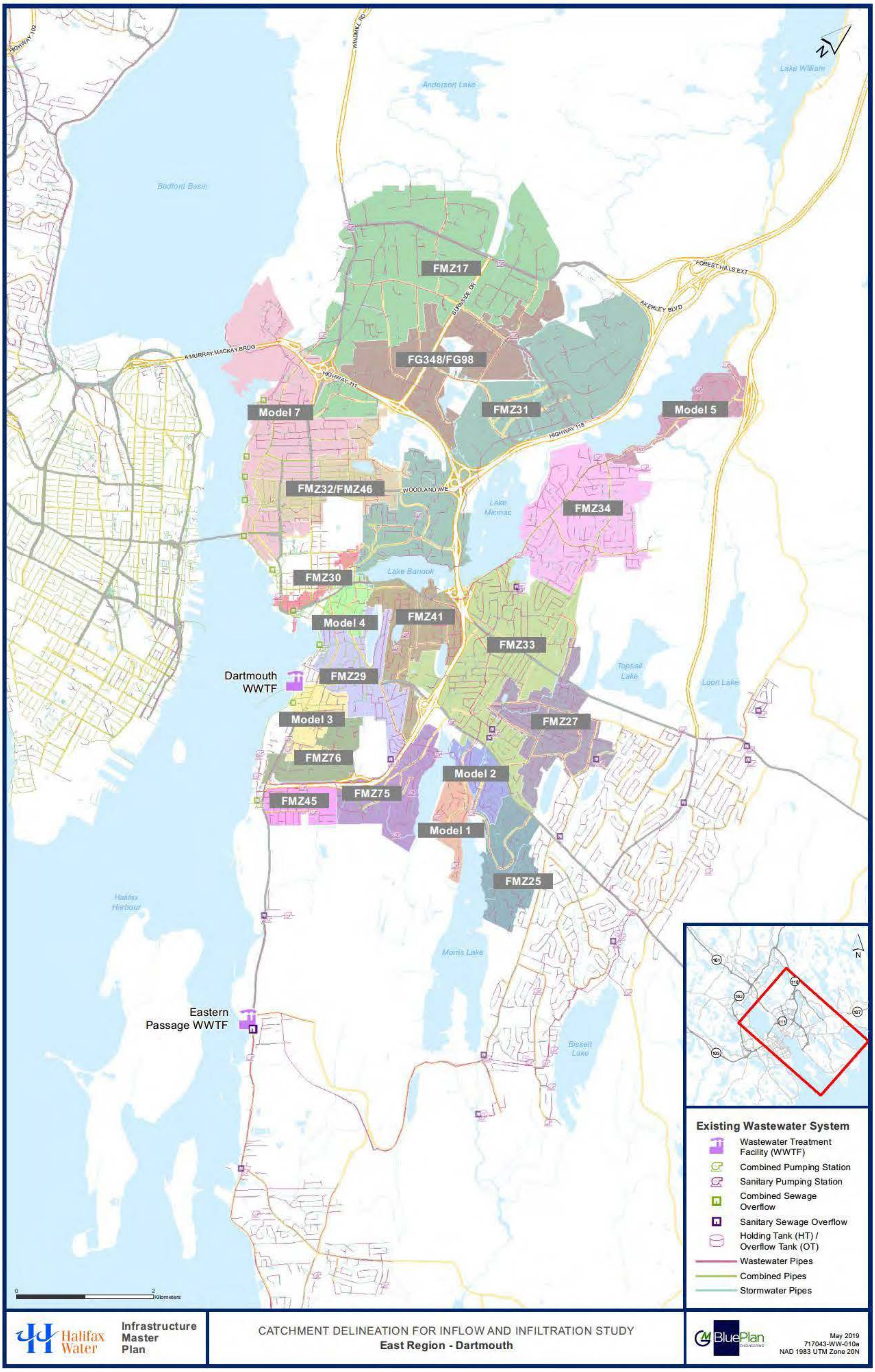


Figure 4-5: Catchment Delineation – Dartmouth

4.5 Mill Cove Priority Areas for Inflow and Infiltration Reduction

The output from the RDII feasibility analysis for the Mill Cove sewershed is summarized in a flow monitor schematic, Figure 4-6. The schematic presents the grading of the flow monitoring catchments and red boxes highlight those with the greatest opportunity for inflow and infiltration reduction. The following should be noted:

- All high potential areas are recommended for RDII reduction targeting and should be included as part of the Mill Cove servicing strategy in the Infrastructure Master Plan.
- FMZ03 and FMZ40 were assigned a medium rank based on the wet weather flow variables, however are comparatively high when observing the low metrics of the upstream catchments. Based on the interpretation of the wet weather flow metrics, these areas are also recommended as part of the Mill Cove servicing strategy in the Infrastructure Master Plan.
- FMZ03 should be refined using additional flow monitoring to better isolate the areas with high amounts of RDII.

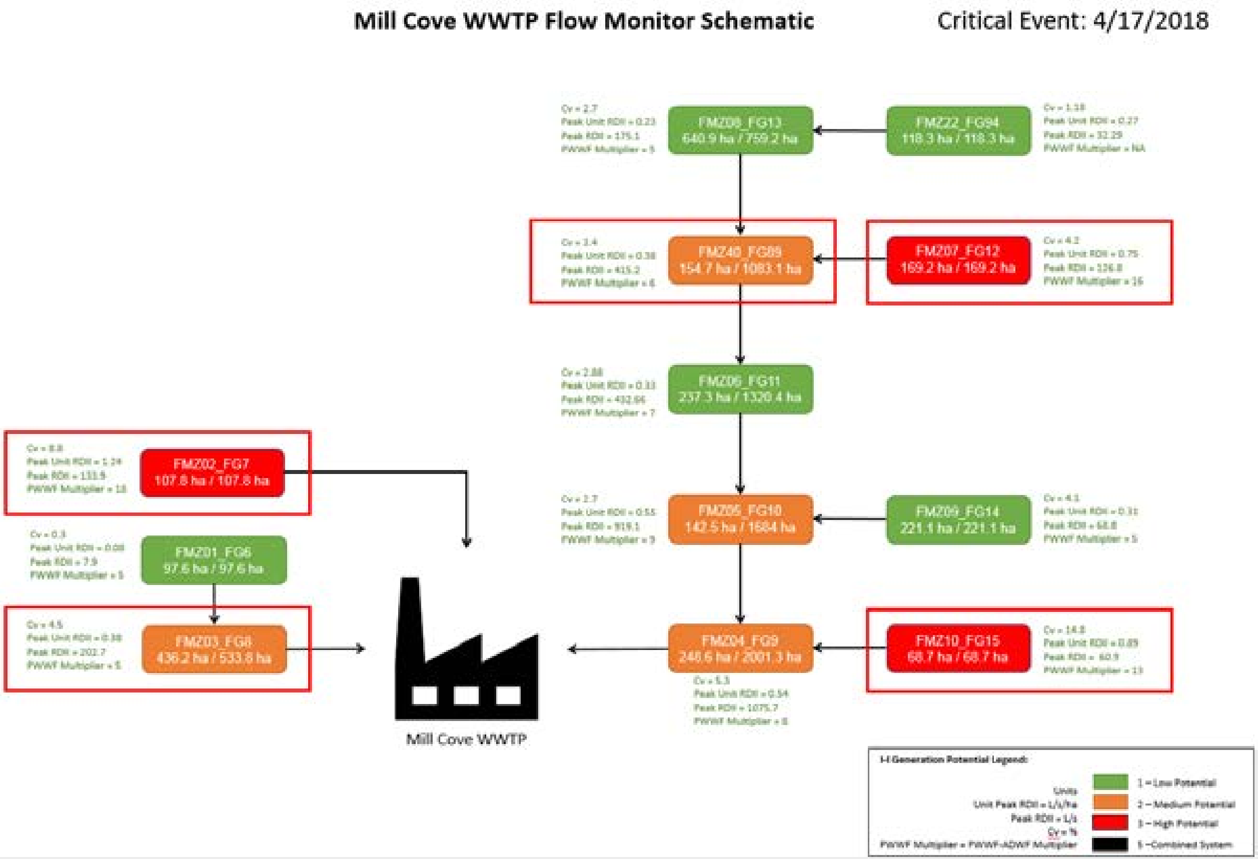


Figure 4-6: Flow Monitor Catchment Schematic for Mill Cove

4.6 Eastern Passage Priority Areas for Inflow and Infiltration Reduction

The output from the RDII feasibility analysis for the Eastern Passage sewershed is summarized in a flow monitor schematic, Figure 4-7. The schematic presents the grading of the flow monitoring catchments and red boxes highlight those with the greatest opportunity for inflow and infiltration reduction. The following should be noted:

- All high potential areas are recommended for RDII reduction targeting and should be included as part of the Eastern Passage servicing strategy in the Infrastructure Master Plan.

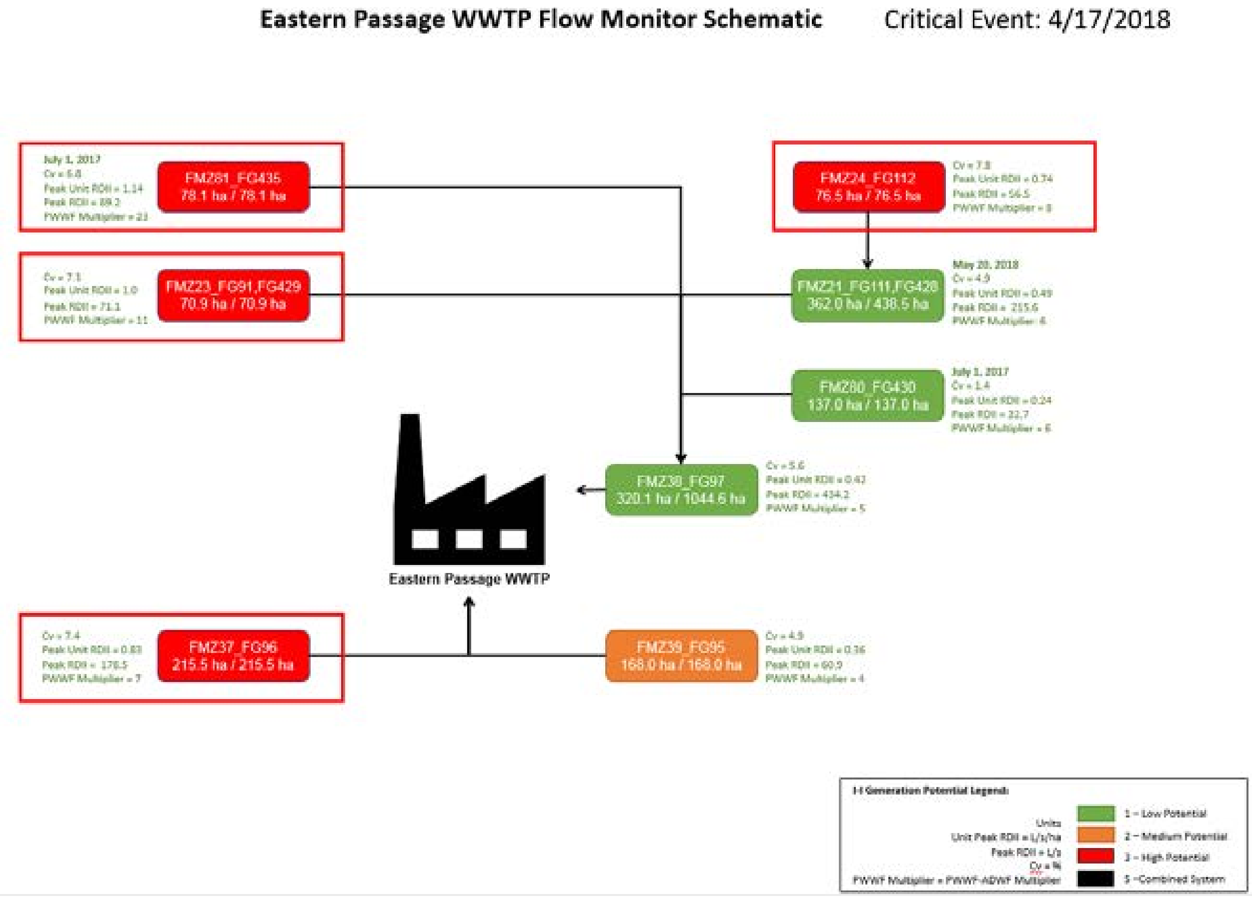


Figure 4-7: Flow Monitor Catchment Schematic for Eastern Passage

4.7 Dartmouth Priority Areas for Inflow and Infiltration Reduction

The output from the RDII feasibility analysis for the Dartmouth sewershed is summarized in a flow monitor schematic, Figure 4-8. The schematic presents the grading of the flow monitoring catchments and red boxes highlight those with the greatest opportunity for inflow and infiltration reduction. The following should be noted:

- All high potential areas are recommended for RDII reduction targeting and should be included as part of the Dartmouth servicing strategy in the Infrastructure Master Plan.

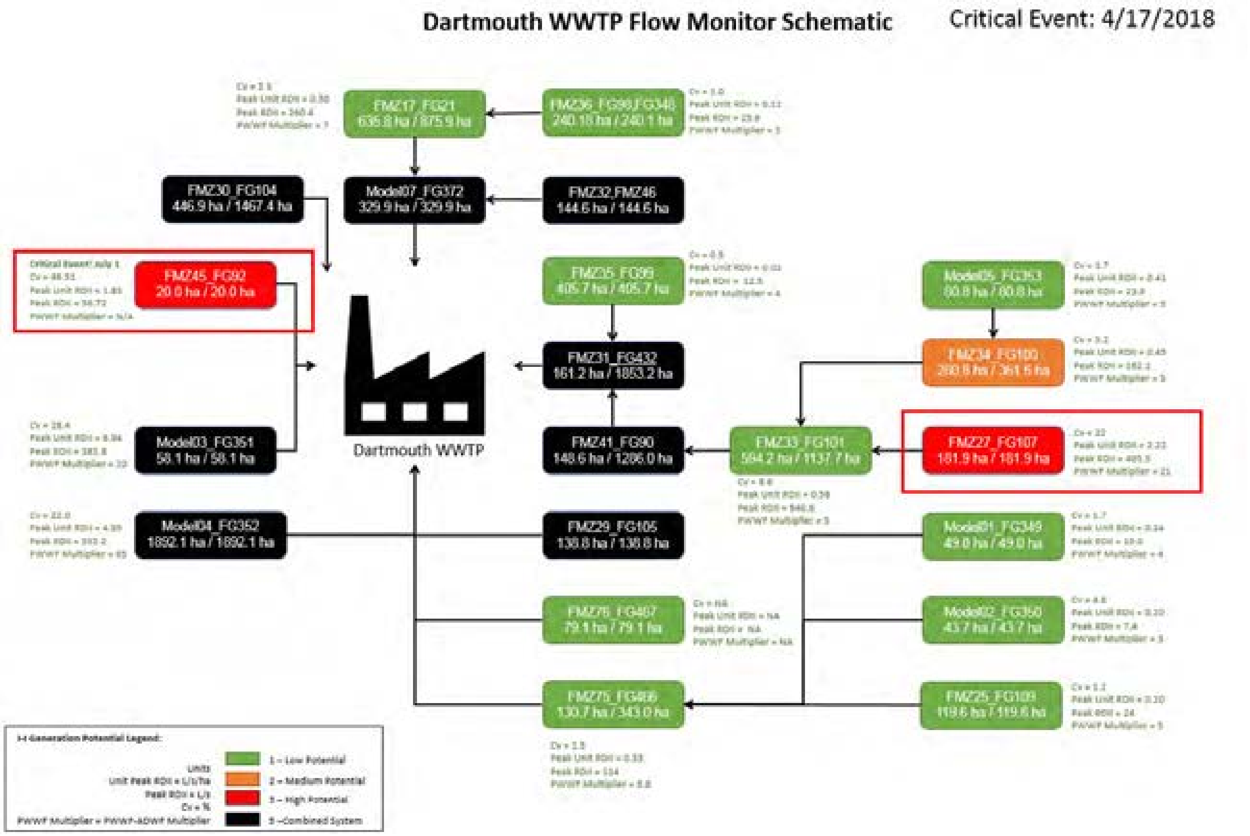


Figure 4-8: Flow Monitor Catchment Schematic for Dartmouth

5 Conclusions

Sewer Separation

It is evident from the background review and feasibility study outputs that there is significant potential for sewer separation within the combined sewer network, located within the Regional Centre. Dense residential areas are identified as less feasible due to constructability and less opportunities to reduce flows, as they have more lateral connections, can be complicated by plumbing within the home and have less connected impermeable area. The sewer separation feasibility study focused on identifying areas with the greatest potential for sewer separation based on the potential to remove the most stormwater at the most effective cost. The following areas are considered to be the most feasible, providing the greatest opportunities for reduction in peak flows and volume:

- Halifax Peninsula: Young Street, Kempt Road, upstream of Bedford Highway, and Connaught Avenue areas.
- Dartmouth: Jamieson Street, Wyse Road, Nantucket Ave, Thistle Street, Rose Street, and Canal Street areas.

It was noted that sewer separation cannot be implemented as a standalone solution as there are significant system constraints that are not solely downstream of combined sewers, such as the Fairview Cove tunnel in Halifax and the Port Wallace growth constraints in Dartmouth. Furthermore, a theoretical back-of-the-envelope estimate for impermeable area to be separated to meet the LOS targets cannot be completed as it will vary from catchment to catchment, and therefore CSO to CSO. The required amount of separation, to reduce CSO discharges is not just a function of an amount of impermeable area and needs to be evaluated on an area by area basis to account for attenuation and peaking. For these reasons, determining the required amount of sewer separation to service the Halifax Region will be completed as part of the overall servicing analysis, which will allow for the integration of sewer separation with other concepts. It is at this point that the sewer separation analysis will be refined to determine the minimum level of sewer separation that is required, as a component of the overall strategy. The overall strategy must ensure that there is no increase in spill frequency or volume because of growth under a typical year of precipitation, 2003. A 1 in 5 year design storm will be used to size new stormwater infrastructure and to identify major constraints within the linear system.

Low Impact Development

This feasibility review was a high-level assessment of the potential opportunities for LID, identifying areas that are most feasible for implementing LID techniques and those with limitations. This review focused on public LID practices, such as within road rights-of-way and public properties, as these provide more certainty with regards to proper maintenance and long-term performance. The uncertainty and risk that the maintenance and performance of private LIDs would not be maintained over the long-term is too great to rely on them as part of a regional solution.

Based on the feasibility study and background review, it is unlikely that LID practices can provide sufficient reductions in volume or rate of flow to be an overall regional solution for any servicing plan. However, these practices can be incorporated, where feasible, on a case by case basis to reduce the extent of other capital projects.

Individual LID techniques provide better water quality and some reductions in flow. Development of a public side LID program, founded in local scale capital projects, is the first step in promoting a future private side program. Over time, as LID practices become more advanced and there is more knowledge around the maintenance schedules, costing, and proper measuring of performance, these solutions may become more viable.

Inflow and Infiltration

The inflow and infiltration reduction analysis were completed to assess the wet weather response of various flow monitored catchments to identify and prioritize areas with high inflow and infiltration within separated networks. The analysis for the West Region was completed as part of the WRWIP study and a set of monitors installed specifically for the WRWIP project from October-November 2015. The analysis for the Central Region and East Region was completed as part of the Infrastructure Master Plan study using data from the Halifax Water corporate flow monitoring program, established in spring 2016.

It is recommended that the high potential RDII reduction areas be incorporated into the overall regional wastewater servicing strategies for the East, West, and Central regions. The Infrastructure Master Plan will work with the Halifax Water Wet Weather Management Program (WWMP) to determine target metrics for the high potential reduction areas. The WWMP team will determine the tactics to achieve the reduction in extraneous flows.

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APPENDIX A *Sewer Separation – Background Review*

Sewer Separation Overview

Sewer separation is a method by which the flows in a combined sewer system are split into two separate sewer systems, where there is a dedicated sewer for sanitary flows and a dedicated sewer for stormwater flows. Separation of flows can be full or partial. Partial separation retains the combined sewer status and install a new separate storm system for certain areas such as roads and parking lot drainage.

General disadvantages of sewer separation include the cost and widespread disruption as it conventionally involves an open-cut method to install a new sewers, which are required in every location where there is an existing combined sewer. The general advantages of sewer separation are the ability to accommodate more sewage flow while conveying less volume to treatment facilities as stormwater flows are discharged directly from stormwater outfalls. This allows for the treatment facilities to be sized to treat the sanitary flows and not be oversized or require peak wet weather discharges to the environment.

The feasibility of sewer separation can be unique to the municipality. As noted in the best practice preview, the City of Ottawa has identified sewer separation as a priority for their system whereas other cities, notably London U.K., have dismissed widespread separation as a feasible option due to cost, disruption and implementation periods, and instead opted for a large tunnel to capture wet weather flows.

Full Sewer Separation

Full combined sewer separation is more complex as it involves the separation of individual household runoff, including downspouts and foundation drains, in addition to the roadway reconnections. This would comprise of two completely separate systems, one for stormwater runoff and the other for population generated sewage. The existing combined sewer can be converted to a storm sewer and new sanitary sewers can be installed, however due to the possibility of missing sanitary reconnections and subsequent consequences of sewage entering the storm sewer, it is sometimes preferred to convert the existing combined sewer to a sanitary sewer and install new dedicated storm sewers, where feasible and cost effective. Ultimately, the decision should be based on many factors including the number of sanitary connections, the condition of the existing sewer, the capacity of the existing sewer, the required capacity and sewer size of the new sewer to name a few.

Partial Sewer Separation

A partially separated sewer system is typically comprised of disconnecting surface runoff from roadways and parking lots and allowing a percentage of the downspout connections to remain attached to the combined sewer. Similar to the explanation under full sewer separation, it would be more ideal to construct new storm sewers and the combined sewer would remain a combined sewer to convey sewage and downspout/foundation drain flows. By partially separating a combined sewer, the majority of the stormwater runoff that is captured from large impervious areas is removed without the need to deal with the many property connection. Obviously, partial separation separates less flow and may not always be sufficient to meet capacity needs.

The intention of the combined sewer separation feasibility study is to assess the amount of separation required to meet the servicing needs while also meeting policies and level of service targets both in the near and long term.

Sewer Separation Options

There are two primary sewer separation options to consider for complete sewer separation:

- Existing combined system is converted to sanitary and a new separate stormwater system is installed, with new outfalls and pumping stations, as required.
- Existing combined system is converted to stormwater and a new separate sanitary system is installed, with new pumping stations, as required. The new separate sewage system would have connections to existing interceptors, and the stormwater flows would discharge directly to a water body with the ability to overflow into the interceptors in the case of a major event, to maintain level of service.

A third option could be considered if implemented partial separation.

- A new partially separated stormwater system is installed to collect from certain areas based on land use, such as drainage from roads and large impermeable areas. Existing combined sewers are retained to convey the residual combined flows.

Combined Sewer Separation – Vancouver, British Columbia

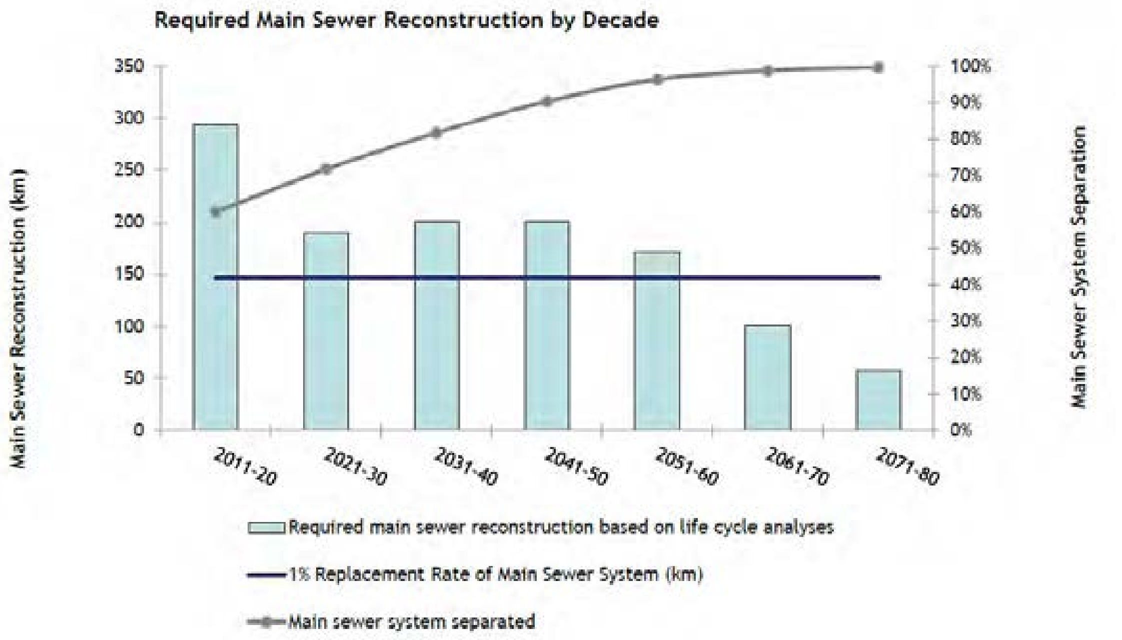
Situated between the Pacific Ocean and the Rocky Mountain range, Vancouver experiences frequent rainfall events, and subsequent overflow events. From the 16 overflows, Vancouver discharged a total of 23.17 million m^3 of untreated wastewater in 2011. The frequency of the overflow events varied, however some reached 279 occurrences.

British Columbia's provincial regulation, known as the Liquid Waste Management Plan (LWMP), requires Vancouver to phase out CSOs by 2050. Vancouver has adopted various methods to reach this target including Low Impact Development (green roofs, harvesting and on-site storage, rain gardens, permeable pavement), inflow and infiltration solutions (disconnecting roof leaders), and an infrastructure related solution.

The bulk of the plan to achieve the requirements of the LWMP will be through the infrastructure related solution, in the form of sewer separation (KWL, 2008). The current approach is to run two different separation programs simultaneously; one program will separate the sewer mains or general collection system sewers in the region's sewer network, while the other will separate the smaller sewer laterals that service each property and often include working with homeowners.

As part of the LWMP, sewers will be separated at an average annual rate of 1%. Based on the current plan, the year 2020 will see the completion of 60% of the necessary sewer separation, with complete separation expected to occur by 2075.

The program has reviewed the alignment of the sewer separation with the sewer reconstruction that is required based on theoretical lifecycle replacement projections. The following figure, created by the city of Vancouver, presents the city's projections for the timing of each.



There have been early signs of success such as herring spawning again in False Creek and salmon returning to span in East Vancouver creek.

APPENDIX B *Thames Tunnel Needs Report: Sewer Separation Feasibility Study*

The vast majority of London England is served by combined sewer systems and common to many other regions around the world, CSO discharges are occurring more frequently with the increase in population densities, impervious surfaces, and intensities of precipitation events. This is specifically an issue for catchments discharging into the Thames River. Recently, the government requested that Thames Water address this discharge by minimizing the number of spills at 10 CSOs, serving the Beckton and Crossness catchments, to four or less spills per annum. As a result, the construction of the Thames Tideway Tunnel was proposed.

The purpose of this second study was to investigate the feasibility of a sewer separation alternative, in place of the tunnel, that would also meet the Urban Waste Water Treatment Directive (UWWTD) requirements. Separating the combined sewers would allow for surface water discharge into the river rather than intercepting the combined sewer spills and conveying the entire flow for treatment via storage and transfer, as is the case with the proposed tunnel.

Data

The sewer separation study was completed with the assessment of five sub-drainage study areas. These sub-catchments provided a spectrum of land use and sewer types that make up the two larger Beckton and Crossness catchments. The flowing data was used throughout the study:

- Detailed mapping of roads, buildings, parks, and watercourses used to determine land use type, distribution, and prevalence.
- Model of catchment areas (only includes spine sewers).
- Address point data and population data to determine catchment densities. Important for representation of flats and multiple occupancy buildings.
- Asset data was used for local sewer information.

Sub-Catchment Classification

The following parameters were assessed for appropriateness with respect to sub-catchment classification:

- **Quantity of Impermeable Area**
- Land Use
- Property Density
- Sewer Size and Length
- Population Density
- Sewer Type
- Property Type

The percentage of impermeable area was considered the most consistent parameter to classify a sub-catchment and was therefore used to determine the appropriate sewer separation option; the classification was used later in the study to scale up the costs to the overall study area.

Sewer Separation Requirements

Three sewer separation options were considered:

- Existing combined system is converted to sanitary and a separate stormwater system is installed with new outfalls and pumping stations, as required.
- Existing combined system is converted to a stormwater system and a separate sanitary system is installed with new outfalls and pumping stations, as required. The new separate sewage system will have connections to existing interceptors. The existing combined sewers would be used as

stormwater conveyance and discharge into river, but have overflow into interceptor when required for large events, to maintain level or service.

- *A separate surface water system is to be installed to collect from certain areas based on land use, such as drainage from highways and large impermeable areas. The existing combined system carries the residual flows.*

Options 1 and 2 consider complete sewer separation whereas Option 3 considers partial separation. For Option 3, the amount of required sewer separation was determined using the existing model of spine sewers, and the percentage of impermeable area parameter.

1. Model the existing system, spine sewers only, to determine the existing conditions of the system using a 1 in 30-year precipitation event and 2021 population projections.
2. Simulate a range of hard surface area reductions to identify the required target for each sub-catchment.
3. Determine the distribution of hard surfaces, by area, within each catchment (roads, pavements, driveways, and building roofs).
4. Distribute the reduction calculated in Step 2 across the individual areas identified in Step 3 using the following preferred hierarchy:
   - Roads
   - Pavements
   - Driveways
   - Building Roofs
   - *Example: 75% total = 100% roads, 100% pavements, 70% driveways, 50% roofs.*
5. Choosing separation method:
   - If required separation is < 100% of the area of roads, pavements, and driveways, and < 50% area of roofs, a new surface water system is appropriate as it is less intrusive at the property level, would not require access to rear.
   - If required separation is 100% of the area of roads, pavements, and driveways, and > 50% of the roof area, new sewage system is the most appropriate.
   - Tried to limit roof area to 50% (front half), if more than 50% than a surface water system proposed.

Three maps were created to present the catchments by:

a. Required removal of hard surfaces.
b. Distribution of hard surface type.
c. Required removal of hard surfaces by type.

Local and property connection types were established based on system type selected for the spine system.

Review of Issues and Constraints

The initial investigation of sewer separation focused on changes to the existing system within the existing routes. Where appropriate, further investigation was completed to resolve system design issues by identifying more efficient routes and alternative discharge points to reduce large size or deep pipes, remove excess sewer lengths, avoid strategic roads and hot spots, and avoid tunneling if possible.

Things to consider:

- Local sewers: construction type, open cut, tunneling, and the impacts on disruption to local business, resident and traffic, depth less than six meters assumed open cut, other is tunneling
- Spine sewers: designed to follow existing sewer network will cause limited space with road

- Local pumping stations: available space and future maintenance
- Property connections: new connection from every roof area to surface water system and for foul system new connection from foul pipe from property. Requires access to private land, intrusive and considerable public relations and consultation

Aside from the costing analysis, completed later in the study, other issues and constraints that may arise as a result of construction and implementation were considered, including:

- Environmental and archaeological land use constraints
- A carbon assessment (ratio of carbon footprint in kg resulting from 1$ investment)
- Social impacts and impacts on large institutional bodies as a result of activities such as:
    - Utilities diversions
    - Property connections and disconnections
    - Construction of pump stations, overflows, and discharge points.

An impact analysis was completed for each issue/constraint by reviewing likelihood, severity, temporal scale, and spatial scale. The review of issues and constraints was an attempt to capture the negative social and environmental impacts of the different sewer separation options specific to each sub-catchment area.

Costing Analysis

A costing analysis was completed that took into consideration the construction issues and constraints specific to each catchment type. A generic costing table, costing database, and cost curves were created for different costing levels and separation methodologies to allow for scaling up of the entire Beckton and Crossness catchments, using the catchment classification. These curves were based on:

- Spine sewers: based on provided hydraulic model results, pipe sizes, depths, gradients, location, manholes, and existing system modifications.
- Local sewers: GIS data analysis to assess existing sewer length, typical depths, pipes sizes, manholes.
    - Developed representative sub-catchments using same process as spine and then put into costing database to get a total sub-catchment cost.
    - Then calculated a relationship between cost and sub-catchment area for both foul and storm water designs, which was then applied across all sub-catchments of similar classification.
- Property connections: GIS data analysis to assess pipe location, default size (property type), density, land use, typical depths, inspection chambers, typical lengths.
    - New foul sewer: property connection cost includes one downpipe and property connection to local sewer. Assumes at back or side of property.
    - New surface water sewer: cost based on number of connections, which correspond to property roof area. In addition, the cost includes manhole and gully connection costs.

Property Roof Area Range (m^2)	Description	Number of Connections
0-30	Non habitable buildings	0
30-100	Small residential and garages	1
100-400	Large residential	2
400+	Non-residential properties	3

Additional assumptions and other cost considerations:

- Foul connection at back of property would be more challenging to re-connect than front surface water connection.

- Additional pumping stations, outfall locations, diversions, and route of separation works accounted for in spine system analysis.
- Non-construction costs include: design, fees and insurances, contingency and risk, and management.

The cost curves were used to scale up based on best correlation between cost and parameters. The correlations were assessed by selecting separation technique, calculating local and spine lengths, total area and address points, approximate construction costs, uplifts factors and non-construction costs. The following cost relationships were identified:

- Spine sewer: total area for surface, existing total spine sewer length for foul
- Local sewer: sewer length per hectare for both foul and storm
- Property connections: cost per property for given size for both foul and storm.

Conclusions

- New surface water system would mean existing combined sewers would be significantly oversized and have the risk of not meeting self-cleansing velocity (odour problems and blockages)
    - Some level of pollutants would continue to discharge into the river as hydrocarbons and debris could still build up in separate stormsewers.
- New sanitary water system would have the risk of misconnections and sewage being discharged into river.
- 100% separation of all study areas resulted in 0 spills at combined overflows, however, in certain sub-catchments 100% separation of that catchment only did not eliminate overflows. This was due to the combination of surface runoff and incapacity of interceptor sewers to receive continuation flows.
    - If only selected areas are addressed, number of spills at CSOs does not significantly change since many of the systems are linked through interceptor systems. Other catchments use up the additional capacity and therefore discharge volume reduced but number of spills remain above the target.
- Installing new sewage systems and using combined for surface water only increases capacity marginally.
- In many cases, interconnected system leads to separation requirement being driven by interceptor capacity, which is sometimes outside of catchment.
    - There are many connections into interceptors and therefore many routes that flows can take in order to reach an overflow.
- A major factor for the choice of separation was extent of disruption at property level, foul system disruption significantly higher. However, in some instances, the cost analysis identified that the additional intrusion was outweighed by the high costs associated with a new stormwater system; due to sewer sizes and pumping requirements.
- In conclusion, after scaling up the costs for the entire catchments, sewer separation costs are significantly higher than the Thames Tunnel when trying to meet the 4 spill target. The timescale for implementation is also much longer and has many more social impacts.

APPENDIX C *Spatial Analysis Methodology*

Spatial analysis was completed on CSO delineated catchment in Halifax Peninsula and Dartmouth. Components included in the spatial analysis are detailed below.

Surface Area

The pervious area, building polygon, and road polygon data files were used to intersect with the sewer separation catchments layer to conduct spatial queries. The total area (in hectares) of each surface type was summed:

- Connected buildings (assumed those with footprint >40 m^2)
- Non-connected buildings (assumed those with footprint <40 m^2)
- Road right of ways
- Remaining impermeable surfaces
- Permeable area (greenspace)

Land Use and Ownership

The water meter dataset was spatially joined to the building polygon in which they were located. A summary of Residential and ICI land uses was created, including a null value for those that did not have a water peter.

To determine the proportion of ownership (public vs. private) within each sewer separation catchment area, the parcel polygons were intersected with the sewer separation catchments. The total area of land ownership was broken down for each area, with null values for those parcels identified as unknown.

Length of Gravity Sewers

The total length of gravity sewers within each catchment were broken down by combined, sanitary, and storm, and was summarized into three categories based on their diameter:

- <= 450 mm
- > 450 mm and <= 900 mm
- > 900 mm

Furthermore, a sum of the combined sewers greater than 5 m deep was identified.

Number of Stormwater Connections

The number of stormwater connections was dependent on the building roof area. The building polygon layer and a spatial query was used to classify the building roof areas, where < 40 m^2 generally represented sheds, or garages, not connected to the combined sewer network. A count of buildings in each category were summarized to determine the approximate number of connections within each catchment. The criteria for determining the number of connections is summarized in the table below.

Property Roof Area Range (m^2)	Description	# of Connections
40-150	Small residential and garages	1
150-400	Large residential	2
400+	Non-residential properties	3

Total Area of Flat Roof

Flat roofs were determined using the building footprints, overlaying the Digital Surface Model detailing the topography of the land and taking into account trees and buildings. The slope of the roof for each building was determined to identify those that are flat, and most ideal for a green roof.

Length of Road

The road centerline data file was used to determine the total length of road broken down by its classifications; local, arterial, and collector.

Population

The Census Population and Civic Address data files were used to assign a population multiplier to each civic address. All of the civic addresses within each sewer separation catchment were then summed to identify a total population. This population was divided by the total length of required separation (i.e. length of combined gravity sewers) to determine a population density of people per length of required separation.

APPENDIX D *Feasibility Scoring Outputs*

Priority Areas for Inflow and Infiltration

The Base Groundwater Infiltration Rate (BGWI), Unit Peak RDII, and Event Cv variables were summarized from the flow monitoring program analysis. The combined catchments were excluded from the analysis and are covered under the sewer separation analysis. Each of the separated catchments were ranked against one another (1-5 with 1 being the highest value, 5 the lowest) for each parameter, which were then weighted to produce a final ranking. The final rankings identified catchments with the least RDII issues (ranking 1), and those with the most (ranking 5).

This method was used for the West Region only as a different method was used on the East and Central Regions, refer to Section 4.4.

Ranking for Halifax under the Infrastructure Master Plan (excluding combined catchment)

		BGWI (L/s/ha)	**Unit Peak RDII (L/s/ha)**	**Event CV (%)**	**Rank**					
					BGWI	Unit Peak RDII	Event CV	Weighted	Final Rank	**Score**
FM-201	SAN	0.05	1	3	4	3	4	3.7	2	2
FM-2	SAN	0.03	0	2	5	5	5	5.0	1	1
FM-3	SAN	0.09	1	6	2	2	1	1.7	5	5
FM-4	SAN	0.17	1	6	1	4	2	2.3	4	4
FM-6	SAN	0.06	1	4	3	1	3	2.3	4	4

Rank		**Scoring**
1	1.5	1
1.51	2	2
2.01	3	3
3.01	4	4
4.05	5	5

Weighting	
BGWI	33%
Unit	33%
Cv	33%

Priority Areas for Low Impact Development

The amount of HRM owned land, permeable area, arterial road, and flat roof was summarized from the spatial analysis. Each catchment was ranked against one another (for Halifax 1-20 with 1 being the highest value, 20 the lowest) for each parameter, which were then weighted to produce a final ranking (1-20 with 1 being the catchment with the least opportunity for LID, 20 the most). The final rankings were converted to a score from 1-5, 1 being the catchments with the least opportunity for LID, 5 the most.

Ranking for Halifax under the WRWIP

	Catchment CSO	**HRM Land (ha)**	**% Greenspace (by area)**	**% Arterial Road (by length)**	**% Flat Roof (by area)**	**Rank**						
						HRM	Greenspace	Arterial	Flat Roof	Weighted	Final Rank	**Score**
C-1	Duffus St	6.0	30%	28%	19%	11	2	15	15	10.8	8	2
C-2	Young St	2.7	17%	43%	66%	13	10	8	3	8.5	12	3
C-3	North St	10.7	19%	46%	59%	8	7	7	6	7.0	16	4
C-4	Upper Water St	11.6	20%	38%	54%	6	4	11	7	7.0	16	4
C-5	Halifax WWTF	6.6	13%	70%	62%	9	11	1	5	6.5	18	5
C-6	Pier A 1	11.1	18%	49%	47%	7	9	5	9	7.5	14	4
C-7	Sackville St	32.5	19%	46%	43%	2	6	6	10	6.0	19	5
C-8	Pier A 1	22.7	28%	42%	33%	3	3	9	12	6.8	17	5
C-9	Chainrock (Ballmoral)	2.2	7%	17%	29%	14	19	18	13	16.0	4	1
C-10	Coburg St	6.2	12%	25%	14%	10	14	16	18	14.5	5	2
C-11	Fairfield HT	1.0	8%	35%	10%	17	18	12	19	16.5	3	1
C-12	Chebucto Rd	21.0	20%	20%	52%	5	5	17	8	8.8	10	3
C-13	Kempt_b	38.0	35%	41%	42%	1	1	10	11	5.8	20	5
C-14	Kempt_a	1.7	12%	52%	86%	16	13	4	1	8.5	12	3
C-15	Chebucto Rd	21.3	11%	30%	17%	4	15	14	17	12.5	7	2
C-16	Chainrock (Ballmoral)	0.0	11%	0%	18%	18	16	20	16	17.5	2	1
C-17	Pier A 1	0.0	19%	33%	25%	20	8	13	14	13.6	6	2
C-18	Upper Water St	2.1	12%	55%	70%	15	12	3	2	8.0	13	4
C-19	Maritime Museum	3.3	8%	59%	64%	12	17	2	4	8.8	10	3
C-20	Chainrock (Ballmoral)	0.0	5%	13%	1%	20	20	19	20	19.6	1	1

Rank		**Scoring**
1	4	1
4.01	8	2
8.01	12	3
12.01	16	4
16.01	20	5

Weighting	
HRM	25%
Greenspace	25%
Flat Roof	25%
Road Class	25%

Ranking for Dartmouth under the Infrastructure Master Plan

	Catchment CSO	HRM Land (ha)	% Greenspace (by area)	% Arterial Road (by length)	% Flat Roof (by area)	Rank						
						HRM	Greenspace	Arterial	Flat Roof	Weighted	Final Rank	Score
D-11	Wallace Street	15.1	49%	36%	34%	6	6	5	6	5.8	3	2
D-12	Grove Street	6.2	43%	22%	44%	8	7	9	3	6.8	1	1
D-13	Jamieson Street	31.6	52%	34%	35%	4	4	6	5	4.8	5	3
D-14	Lyle Street	35.5	41%	55%	29%	2	8	1	7	4.5	7	4
D-15	Park Avenue	22.9	53%	46%	43%	5	2	2	4	3.3	9	5
D-16	King Street	4.3	33%	39%	48%	9	9	4	2	6.0	2	1
D-17	Maitland Street	65.3	50%	44%	26%	1	5	3	8	4.3	8	5
D-18	Old Ferry Road	32.0	60%	23%	24%	3	1	8	9	5.3	4	2
D-19	Cuisack Street	8.6	53%	31%	51%	7	3	7	1	4.5	7	4

Rank		Scoring
1	2	1
2.01	4	2
4.01	6	3
6.01	7	4
7.01	9	5

Weighting	
HRM	25%
Greenspace	25%
Flat Roof	25%
Road Class	25%

Costing Analysis for Sewer Separation

The length of combined sewers were summarized by three diameter categories, and the number of property connections were tallied, for each catchment. The costs of partial and full separation were calculated using unit costs and an uplift + contingency factor; partial separation includes right-of-ways, whereas full separation includes additional impermeable areas such as parking lots and private properties. For each sewer separation scenario, the catchments were ranked against one another (for Halifax 1-20 with 1 being the highest value, 20 the lowest). The rankings were converted to a score from 1-5, 1 being the catchments with the highest cost, 5 being those with the lowest.

Ranking for Halifax under the WRWIP

	Length of Combined Sewer (m)			**Property Connections**	**Partial Separation**			**Full Separation**		
	<= 450mm	> 450mm & <= 900mm	> 900mm	#	cost (M)	Rank	Score	cost (M)	Rank	Score
C-1	10,022	2,132	958	1230	25	8	2	35	8	2
C-2	4,795	2,642	3,543	850	32	5	2	39	5	2
C-3	1,576	1,209	5,108	796	31	6	2	38	6	2
C-4	1,336	517	5,161	788	29	7	2	36	7	2
C-5	208	0	565	239	3	20	5	5	20	5
C-6	6,407	2,895	6,467	1918	50	3	1	65	3	1
C-7	3,936	1,625	11,537	1767	69	1	1	83	1	1
C-8	3,502	2,147	8,980	1586	56	2	1	69	2	1
C-9	4,600	976	2,019	933	20	10	3	27	10	3
C-10	2,228	757	1,676	622	14	14	4	19	15	4
C-11	5,908	1,760	1,134	1187	19	11	3	29	9	3
C-12	6,220	1,079	815	1206	16	12	3	26	12	3
C-13	19,012	3,759	1,948	2115	47	4	1	64	4	1
C-14	2,503	386	13	448	5	18	5	8	17	5
C-15	6,458	2,234	0	840	15	13	4	22	13	4
C-16	1,342	0	815	255	6	17	5	8	18	5
C-17	3,938	557	1,240	724	13	15	4	19	14	4
C-18	535	704	1,619	245	11	16	4	13	16	4
C-19	595	976	3,659	466	22	9	3	26	11	3
C-20	2,674	184	0	295	4	19	5	7	19	5

Unit Costs	
450mm Ø sewer	715
900mm Ø sewer	1,390
1500mm Ø sewer	2,529
property disconnection	4,000
uplift + contingency	*100%*

Rank		**Scoring**
1	4	1
4.01	8	2
8.01	12	3
12.01	16	4
16.01	20	5

Ranking for Dartmouth under the Infrastructure Master Plan

	Length of Combined Sewer (m)			Property Connections	Partial Separation			Partial Separation		
	<= 450mm	> 450mm & <= 900mm	> 900mm	#	cost (M)	Rank	Score	unit cost ($M/ML)	Rank	Score
D-11	2,864	694	0	328	6	6	3	0.019	6	3
D-12	1,801	157	0	207	3	9	5	0.022	5	3
D-13	8,304	1,513	1,084	789	22	2	1	0.014	8	5
D-14	4,842	908	118	300	10	4	2	0.056	1	1
D-15	4,506	632	176	291	9	5	3	0.018	7	4
D-16	2,324	743	93	284	6	8	5	0.012	9	5
D-17	9,104	1,762	2,453	777	30	1	1	0.040	3	2
D-18	6,740	687	1,539	672	19	3	2	0.031	4	2
D-19	3,610	295	0	198	6	7	4	0.051	2	1

Unit Costs	
450mm Ø sewer	715
900mm Ø sewer	1,390
1500mm Ø sewer	2,529
property disconnection	4,000
uplift + contingency	*100%*

Rank		Scoring
1	2	1
2.01	4	2
4.01	6	3
6.01	7	4
7.01	9	5

Flow Reduction Analysis for Sewer Separation

The impermeable surface area was summarized by right-of-ways (road and sidewalk), roof area of connected buildings, and other (parking lots and driveways). The volume of flows that could be theoretically removed through sewer separation was estimated for partial (right-of-ways) and full (all impermeable area) separation. The rational method was used with a coefficient of 0.7, representing a conservative value as not all of the precipitation that falls on impermeable surface enters the sewer system, and a typical year of rainfall (2003). For each sewer separation scenario, the catchments were ranked against one another (for Halifax 1-20 with 1 being the highest value, 20 the lowest). The rankings were converted to a score from 1-5, 1 being the catchments with the lowest potential reduction in flow, 5 being those with the highest.

Ranking for Halifax under the WRWIP

	Surface Area (ha)				Partial Separation			Full Separation		
	Right of Way	Building Roof	Other	Total Impermeable	Volume Removed (ML)	Rank	Score	Volume Removed (ML)	Rank	Score
C-1	20	13	7	40	176	5	4	357	8	4
C-2	18	18	17	53	158	6	4	467	6	4
C-3	13	14	8	35	115	9	3	307	9	3
C-4	11	12	6	29	96	11	3	259	12	3
C-5	7	11	3	20	60	16	2	179	15	2
C-6	24	36	23	83	207	4	5	732	2	5
C-7	25	26	18	70	224	2	5	614	3	5
C-8	24	25	14	63	210	3	5	555	4	5
C-9	9	14	8	30	76	13	2	266	11	3
C-10	7	7	3	17	57	17	1	147	18	1
C-11	14	12	6	32	119	8	4	280	10	3
C-12	18	21	18	56	157	7	4	498	5	4
C-13	39	29	30	98	344	1	5	869	1	5
C-14	10	14	21	45	92	12	3	395	7	4
C-15	12	9	5	26	110	10	3	233	13	2
C-16	2	3	1	6	16	20	1	53	20	1
C-17	8	9	5	22	68	14	2	192	14	2
C-18	4	5	2	11	37	19	1	97	19	1
C-19	5	10	3	18	41	18	1	161	17	1
C-20	7	3	9	19	63	15	2	170	16	2

Rational Method Coefficient
0.7
2003 Rainfall Depth (mm)
1260

Rank		Scoring
1	4	5
4.01	8	4
8.01	12	3
12.01	16	2
16.01	20	1

Ranking for Dartmouth under the Infrastructure Master Plan

	Surface Area (ha)				Partial Separation			Full Separation		
	Right of Way	Building Roof	Other	Total Impermeable	Volume Removed (ML)	Rank	Score	Volume Removed (ML)	Rank	Score
D-11	36	4	3	43	319	6	3	379	6	3
D-12	16	3	2	21	137	8	1	188	8	1
D-13	172	10	12	195	1,519	1	5	1,716	1	5
D-14	20	3	8	32	179	7	2	279	7	2
D-15	56	5	8	69	495	4	4	608	4	4
D-16	53	4	8	65	470	5	3	574	5	3
D-17	87	9	10	106	765	2	5	931	2	5
D-18	70	8	9	86	615	3	4	762	3	4
D-19	13	3	5	21	117	9	1	186	9	1

Rational Method Coefficient
0.7
2003 Rainfall Depth (mm)
1260

Rank		Scoring
1	2	5
2.01	4	4
4.01	6	3
6.01	7	2
7.01	9	1

Effectiveness Assessment for Sewer Separation

The downstream CSO was identified for each catchment and the corresponding discharge frequencies and volumes (under a typical year of precipitation, 2003) were summarized under existing and growth scenarios, in addition to their increase. Each catchment was ranked against one another in terms of their downstream issues, which include growth frequency and volume, and increase in frequency and volume (for Halifax 1-20 with 1 being the highest value, 20 the lowest). The different measures of downstream issues were weighted to produce a final ranking (1-20 with 1 being the catchment with the least downstream issues, 20 the most). It should be noted that some catchments share a similar downstream CSO and therefore are ranked equally. The final rankings were converted to a score from 1-5, 1 being the catchments that would have the least impact on reducing CSO discharge, 5 being catchments with the greatest impact.

Ranking for Halifax under the WRWIP

	Downstream CSO Discharge												
	Existing		Growth		Increase		Rank						
	Freq.	Vol. (m^3)	Freq.	Vol. (m^3)	Freq.	Vol. (m^3)	Growth Freq.	Growth Vol.	+ in Freq.	+ in Vol.	**Weighted**	**Final Rank**	**Score**
C-1	0	0	0	0	0	0	20	20	17	19	18.5	2	1
C-2	40	56,631	113	106,843	73	50,212	2	7	1	3	3.3	19	5
C-3	76	228,288	144	282,330	68	54,043	1	5	2	2	2.5	20	5
C-4	26	51,887	30	62,391	4	10,504	9	9	5	9	7.5	13	4
C-5	0	0	0	0	0	0	20	20	17	19	18.5	2	1
C-6	48	672,941	50	699,075	2	26,134	5	2	8	6	5.3	15	4
C-7	53	204,591	59	243,183	6	38,592	3	6	3	4	4.0	18	5
C-8	48	672,941	50	699,075	2	26,134	5	2	8	6	5.3	15	4
C-9	2	19,687	3	20,255	1	568	12	11	11	12	11.5	10	3
C-10	1	1,084	1	1,091	0	7	16	15	17	17	16.1	6	2
C-11	11	7,858	11	8,102	0	245	10	13	17	14	13.4	8	2
C-12	1	506	1	535	0	29	16	18	17	16	16.4	5	2
C-13	46	183,959	49	303,180	3	119,222	7	4	6	1	4.5	17	5
C-14	1	4,796	1	5,959	0	1,163	16	14	17	10	14.1	7	2
C-15	1	506	1	535	0	29	16	18	17	16	16.4	5	2
C-16	2	19,687	3	20,255	1	568	12	11	11	12	11.5	10	3
C-17	48	672,941	50	699,075	2	26,134	5	2	8	6	5.3	15	4
C-18	26	51,887	30	62,391	4	10,504	9	9	5	9	7.5	13	4
C-19	1	1,042	1	1,035	0	-7	16	16	17	20	17.1	3	1
C-20	2	19,687	3	20,255	1	568	12	11	11	12	11.5	10	3

Rank		**Scoring**
1	4	1
4.01	8	2
8.01	12	3
12.01	16	4
16.01	20	5

Weighting	
+ Freq.	25%
+ Vol.	25%
Growth Freq.	25%
Growth Vol.	25%

Ranking for Dartmouth under the Infrastructure Master Plan

	Downstream CSO Discharge												
	Existing		Growth		Increase		Rank						
	Freq.	Vol. (m^3)	Freq.	Vol. (m^3)	Freq.	Vol. (m^3)	Growth Freq.	Growth Vol.	+ in Freq.	+ in Vol.	**Weighted**	**Final Rank**	**Score**
D-11	47	27,756	85	37,725	38	9,969	2	8	2	4	4.0	6	3
D-12	44	18,802	44	19,200	0	398	9	9	8	9	8.8	1	1
D-13	72	231,730	77	247,317	5	15,587	3	1	5	3	2.9	8	5
D-14	30	11,927	365	46,075	335	34,147	1	6	1	2	2.5	9	5
D-15	43	112,805	45	117,434	2	4,629	8	4	6	7	6.3	3	2
D-16	39	31,408	46	37,799	7	6,392	7	7	3	6	5.8	4	2
D-17	66	115,518	66	167,107	0	51,589	4	2	8	1	3.8	7	4
D-18	52	145,957	57	155,449	5	9,492	5	3	5	5	4.4	5	3
D-19	56	46,321	56	49,321	0	3,000	6	5	8	8	6.8	2	1

Rank		**Scoring**
1	2	1
2.01	4	2
4.01	6	3
6.01	7	4
7.01	9	5

Weighting	
+ Freq.	25%
+ Vol.	25%
Growth Freq.	25%
Growth Vol.	25%

Constructability Review for Sewer Separation

The amount of residential land, local road, sewers with depth greater than 5m, and population density in terms of people per km of combined sewer, was summarized from the spatial analysis. Each catchment was ranked against one another (for Halifax 1-20 with 1 being the highest value, 20 the lowest) for each parameter, which were then weighted to produce a final ranking (1-20 with 1 being the catchment with the least disruption or easiest implementation of sewer separation, 20 the most disruption and hardest to implement). The final rankings were converted to a score from 1-5, 1 being the catchments with the least feasible from a construction point of view, 5 being the most.

Ranking for Halifax under the WRWIP

	% Residential (by area)	% Local Road (by length)	% Depth > 5m (by length)	Population/km of Combined Sewer	Rank						
					Residential	Local Road	Sewer Depth	Density	Weighted	Final Rank	Score
C-1	76%	72%	2%	0.306	7	6	5	13	7.8	18	1
C-2	38%	57%	2%	0.208	17	13	6	17	13.3	3	5
C-3	51%	54%	1%	0.374	14	14	14	7	12.3	5	4
C-4	51%	62%	1%	0.559	13	10	12	3	9.5	14	2
C-5	5%	30%	20%	0.787	20	20	1	1	10.5	9	3
C-6	44%	51%	1%	0.599	16	16	11	2	11.3	6	4
C-7	64%	54%	1%	0.409	9	15	9	5	9.5	14	2
C-8	55%	58%	1%	0.427	12	12	7	4	8.8	16	2
C-9	58%	83%	1%	0.186	11	3	8	19	10.3	12	3
C-10	82%	75%	2%	0.342	5	5	3	11	6.0	20	1
C-11	86%	65%	0%	0.318	3	9	17.5	12	10.4	10	3
C-12	66%	80%	0%	0.373	8	4	17.5	8	9.4	15	2
C-13	63%	59%	1%	0.269	10	11	13	15	12.3	5	4
C-14	21%	48%	0%	0.347	18	17	17.5	9	15.4	2	5
C-15	87%	70%	0%	0.257	2	7	17.5	16	10.6	8	4
C-16	83%	100%	0%	0.143	4	1	17.5	20	10.6	8	4
C-17	77%	67%	2%	0.346	6	8	4	10	7.0	19	1
C-18	45%	45%	4%	0.377	15	18	2	6	10.3	12	3
C-19	11%	41%	1%	0.203	19	19	10	18	16.5	1	5
C-20	96%	87%	0%	0.281	1	2	17.5	14	8.6	17	1

Rank		Scoring
1	4	5
4.01	8	4
8.01	12	3
12.01	16	2
16.01	20	1

Weighting	
Residential	25%
Local Road	25%
Depth	25%
Density	25%

Ranking for Dartmouth under the Infrastructure Master Plan

	% Residential (by area)	% Local Road (by length)	Population/m of Combined Sewer	Rank					
				Residential	Local Road	Density	Weighted	Final Rank	Score
D-11	87.5%	64%	0.278	4	5	3	4.0	7	2
D-12	97.6%	78%	0.513	1	1	1	1.0	9	1
D-13	82.8%	66%	0.189	5	4	6	5.0	6	3
D-14	81.4%	45%	0.128	6	9	9	8.0	1	5
D-15	58.0%	54%	0.253	9	8	5	7.3	2	5
D-16	77.0%	61%	0.426	7	6	2	5.0	5	3
D-17	90.0%	56%	0.163	2	7	7	5.3	4	4
D-18	88.9%	77%	0.258	3	2	4	3.0	8	1
D-19	63.9%	69%	0.148	8	3	8	6.3	3	4

Rank		Scoring
1	2	5
2.01	4	4
4.01	6	3
6.01	7	2
7.01	9	1

Weighting	
Residential	33%
Local Road	33%
Density	33%

Priority Areas for Sewer Separation

The scoring corresponding to each of the four sewer separation focus areas were summarized for each catchment. These scores were then weighted to produce a final ranking (for Halifax 1-20 with 1 being the catchment with the highest weighted score, 20 the lowest). It should be noted that some catchments share a similar weighted score and are therefore ranked equally. The final rankings were converted to a score from 1-5, 1 being the catchments that are the least suitable for sewer separation, and 5 being those that are the most suitable.

Ranking for Halifax under the WRWIP

	Catchment CSO	**Individual Scoring**						
		Cost	Flow Reduction	Effectiveness	Constructability	Weighted	Final Rank	**Score**
C-1	Duffus St	4	4	1	1	2.5	15	2
C-2	Young St	3	4	5	5	4.3	2	5
C-3	North St	2	3	5	4	3.5	5	4
C-4	Upper Water St	1	3	4	2	2.5	15	2
C-5	Halifax WWTF	5	2	1	3	2.8	12	3
C-6	Pier A 1	3	5	4	4	4.0	3	5
C-7	Sackville St	1	5	5	2	3.3	8	4
C-8	Pier A 1	2	5	4	2	3.3	8	4
C-9	Chainrock (Ballmoral)	2	2	3	3	2.5	15	2
C-10	Coburg St	3	1	2	1	1.8	20	1
C-11	Fairfield HT	4	4	2	3	3.3	8	4
C-12	Chebucto Rd	5	4	2	2	3.3	8	4
C-13	Kempt_b	4	5	5	4	4.5	1	5
C-14	Kempt_a	5	3	2	5	3.8	4	5
C-15	Chebucto Rd	4	3	2	4	3.3	8	4
C-16	Chainrock (Ballmoral)	1	1	3	4	2.3	18	1
C-17	Pier A 1	3	2	4	1	2.5	15	2
C-18	Upper Water St	2	1	4	3	2.5	15	2
C-19	Maritime Museum	1	1	1	5	2.0	19	1
C-20	Chainrock (Ballmoral)	5	2	3	1	2.8	12	3

Rank		**Scoring**
1	4	5
4.01	8	4
8.01	12	3
12.01	16	2
16.01	20	1

Weighting	
Cost	25%
Performance	25%
Effectiveness	25%
Constructability	25%

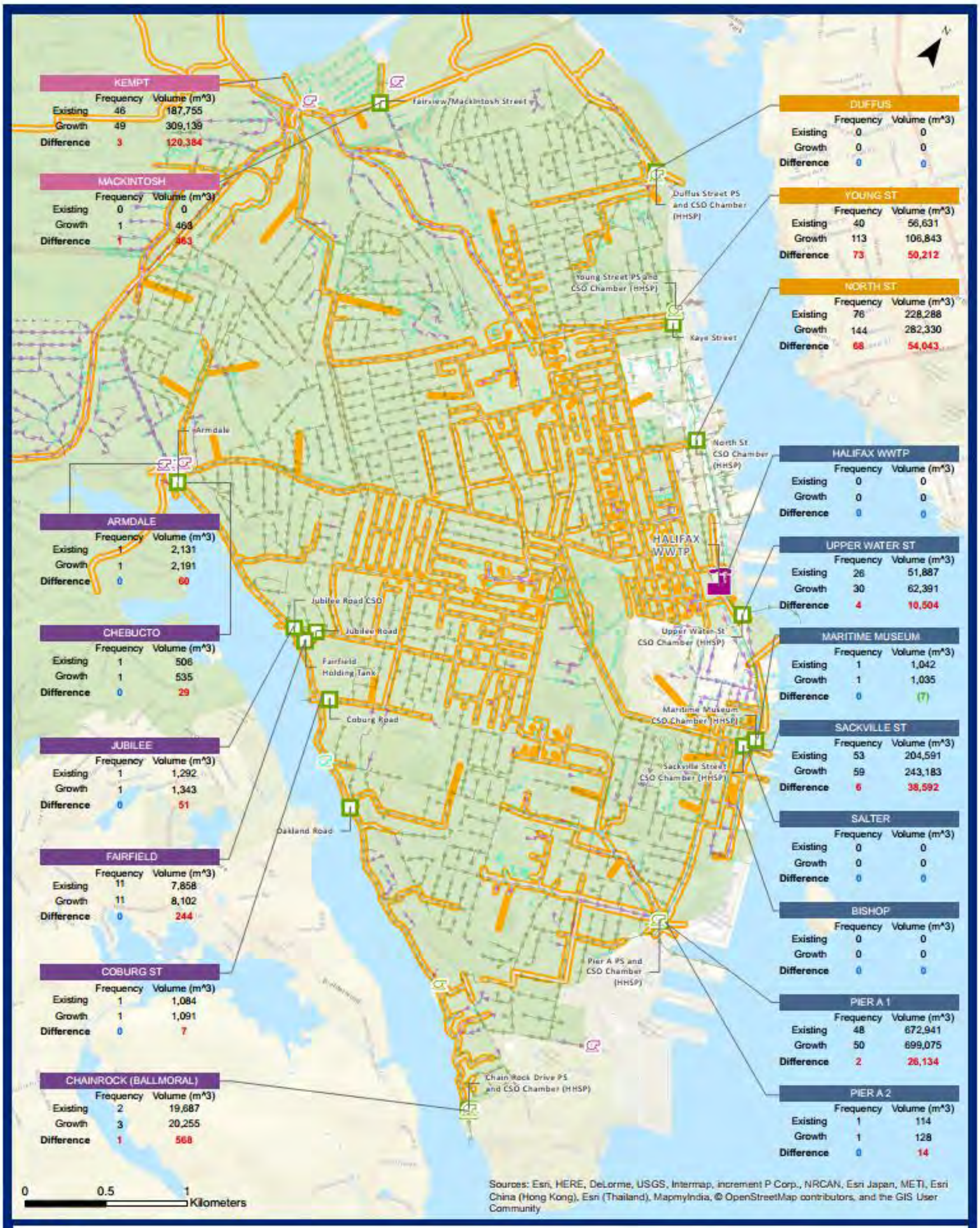
Ranking for Dartmouth under the Infrastructure Master Plan

	Catchment CSO	Individual Scoring						
		Cost	Flow Reduction	Effectiveness	Constructability	Weighted	Final Rank	**Score**
D-11	Wallace Street	3	3	3	2	2.8	6	3
D-12	Grove Street	3	1	1	1	1.5	9	1
D-13	Jamieson Street	5	5	5	3	4.5	1	5
D-14	Lyle Street	1	2	5	5	3.3	5	3
D-15	Park Avenue	4	4	2	5	3.8	3	4
D-16	King Street	5	3	2	3	3.3	5	3
D-17	Maitland Street	2	5	4	4	3.8	3	4
D-18	Old Ferry Road	2	4	3	1	2.5	7	2
D-19	Cuisack Street	1	1	1	4	1.8	8	1

Rank		**Scoring**
1	2	5
2.01	4	4
4.01	6	3
6.01	7	2
7.01	9	1

Weighting	
Cost	25%
Performance	25%
Effectiveness	25%
Constructability	25%

Halifax Model CSO Discharge – Frequency and Volume under Existing and Growth Scenarios (WRWIP)



KEMPT

	Frequency	Volume (m^3)
Existing	46	187,755
Growth	49	309,139
Difference	3	120,384

MACKINTOSH

	Frequency	Volume (m^3)
Existing	0	0
Growth	1	463
Difference	1	463

ARMDALE

	Frequency	Volume (m^3)
Existing	1	2,131
Growth	1	2,191
Difference	0	60

CHEBUCTO

	Frequency	Volume (m^3)
Existing	1	506
Growth	1	535
Difference	0	29

JUBILEE

	Frequency	Volume (m^3)
Existing	1	1,292
Growth	1	1,343
Difference	0	51

FAIRFIELD

	Frequency	Volume (m^3)
Existing	11	7,858
Growth	11	8,102
Difference	0	244

COBURG ST

	Frequency	Volume (m^3)
Existing	1	1,084
Growth	1	1,091
Difference	0	7

CHAINROCK (BALLMORAL)

	Frequency	Volume (m^3)
Existing	2	19,687
Growth	3	20,255
Difference	1	568

DUFFUS

	Frequency	Volume (m^3)
Existing	0	0
Growth	0	0
Difference	0	0

YOUNG ST

	Frequency	Volume (m^3)
Existing	40	56,631
Growth	113	106,843
Difference	73	50,212

NORTH ST

	Frequency	Volume (m^3)
Existing	76	228,288
Growth	144	282,330
Difference	68	54,043

HALIFAX WWTP

	Frequency	Volume (m^3)
Existing	0	0
Growth	0	0
Difference	0	0

UPPER WATER ST

	Frequency	Volume (m^3)
Existing	26	51,887
Growth	30	62,391
Difference	4	10,504

MARITIME MUSEUM

	Frequency	Volume (m^3)
Existing	1	1,042
Growth	1	1,035
Difference	0	(7)

SACKVILLE ST

	Frequency	Volume (m^3)
Existing	53	204,591
Growth	59	243,183
Difference	6	38,592

SALTER

	Frequency	Volume (m^3)
Existing	0	0
Growth	0	0
Difference	0	0

BISHOP

	Frequency	Volume (m^3)
Existing	0	0
Growth	0	0
Difference	0	0

PIER A 1

	Frequency	Volume (m^3)
Existing	48	672,941
Growth	50	699,075
Difference	2	26,134

PIER A 2

	Frequency	Volume (m^3)
Existing	1	114
Growth	1	128
Difference	0	14

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

WEST REGION WASTEWATER
INFRASTRUCTURE PLAN (WRWIP)

Combined Sewer Overflow Results

Average Year (Model Simulations)

🟪	Treatment Facility
🟩	CSO Structures
▨	Halifax Sewer Shed

Conduits Network

→	Combined Pipe
→	Stormwater Pipe
→	Wastewater Pipe
—	Conduits (Existing)
▬	Conduits (Growth)

Pumping Stations

○	Other Pumping Station
☑	Combined Pumping Station
☑	Stormwater Pumping Station
☑	Unknown Pumping Station
☑	Wastewater Pumping Station

OVERFLOW TRADING

FAIRVIEW COVE

Frequency	Volume (m^3)
3	120,847

EAST HARBOUR NORTH

Frequency	Volume (m^3)
72	104,255

NORTHWEST ARM

Frequency	Volume (m^3)
0	960

EAST HARBOUR SOUTH

Frequency	Volume (m^3)
6	75,236

April 2017
714058-36-WW
Data Sources: Halifax Water, Halifax Regional Municipality
ATS 1977 MTM 5 Nova Scotia

Dartmouth CSO Discharge – Frequency and Volume under Existing and Growth Scenarios (Infrastructure Master Plan)

CSO10 FERGUSON ROAD

	Frequency	Volume (m³)
Existing	18	34,880
Growth	24	63,672
Difference	6	28,792

CSO11 WALLACE STREET

	Frequency	Volume (m³)
Existing	47	27,757
Growth	85	37,724
Difference	38	9,967

CSO12 GROVE STREET

	Frequency	Volume (m³)
Existing	44	18,802
Growth	44	19,197
Difference	0	395

CSO13 JAMIESON STREET

	Frequency	Volume (m³)
Existing	72	231,596
Growth	77	247,356
Difference	5	15,760

CSO14 LYLE STREET

	Frequency	Volume (m³)
Existing	29	11,740
Growth	365	46,423
Difference	336	34,683

CSO15 PARK AVENUE

	Frequency	Volume (m³)
Existing	43	112,800
Growth	45	117,408
Difference	2	4,607

CSO16 KING STREET

	Frequency	Volume (m³)
Existing	39	31,290
Growth	46	37,678
Difference	7	6,388

CSO17 MAITLAND STREET

	Frequency	Volume (m³)
Existing	66	115,897
Growth	66	166,878
Difference	0	50.981

CSO18 OLD FERRY ROAD

	Frequency	Volume (m³)
Existing	53	146,061
Growth	58	155,185
Difference	5	9,124

CSO19 CUISACK STREET

	Frequency	Volume (m³)
Existing	56	46,270
Growth	56	49,113
Difference	0	2,842

CSO20 MELVA STREET

	Frequency	Volume (m³)
Existing	0	0
Growth	0	0
Difference	0	0

Existing Infrastructure

▇	Wastewater Treatment Facility (WWTF)
⚙	Combined Pumping Station
⚙	Sanitary Pumping Station
🟩	Combined Sewage Overflow
▣	Sanitary Sewage Overflow
▨	Dartmouth Sewershed
—•—	Wastewater Pipes
—•—	Combined Pipes
—•—	Stormwater Pipes

OVERFLOW TRADING

	Frequency	Volume (m³)
NORTH OF ANGUS L. MACDONALD BRIDGE	385	89,596
ALDERNEY LANDING & DARTMOUTH COVE	14	71,101
SOUTH OF DARTMOUTH WWTF	0	2,842

Halifax Water
Infrastructure Master Plan

Combined Sewer Overflow Results - Existing vs. Growth
Average Year
East Region - Dartmouth

BluePlan ENGINEERING
May 2019
717043-WW-005
NAD 1983 UTM Zone 20N

APPENDIX E *Low Impact Development – Background Review*

The Rise of Stormwater Management and LID

Pre-1970's stormwater drainage designs focused on public safety and infrastructure, using a utility-based approach. The traditional stormwater systems consisted of the onsite collection and direct conveyance of stormwater to either a basin, water body, or sewer system. Combined stormwater and sewer systems would convey the flow to a body of water with little treatment, resulting in higher concentrations of runoff pollutants and water quality degradation. The aims of traditional methods were to convey runoff as quickly as possible to the nearest drainage system and prevent flooding. The effects of increasing development on the stormwater system were generally ignored, leading to downstream flooding and degradation of the water quality.

Stormwater management arose after the 1970's with the inclusion of separate networks for stormwater and the prevention of erosion and flooding issues downstream, however stormwater quality issue were not considered part of drainage planning or design. It was not until the 1990's that the water resource management agencies recognized the importance of watershed planning on ecosystems and human health. A multidisciplinary approach to stormwater management at a watershed level was initiated, involving many disciplines including engineers, scientist, planners and government agencies. Stormwater management now included all process and influencing factors in the hydrological cycle and LID was based on mimicking these natural processes.

Urbanization on the Hydraulic Cycle

The hydrological cycle constantly cycles water, where rainfall falls on the ground or snow melts, water can either enter the ground, pond, run across the surface or evaporate. It depends on the geological location, metrological conditions and land cover, through typically the pre-development conditions are around 50% infiltration, 40% evapotranspiration and 10% runoff. Urbanization can dramatically alter these rates with increased impervious surfaces, so that the amount of infiltration and evapotranspiration is reduced, and the amount of runoff increases. Altering the ground cover leads to increased volume of runoff, peak flows, duration of discharge, temperature of runoff and pollutant loading.

LID is a stormwater management strategy that aims to mitigate the effect of increased stormwater runoff and stormwater pollutions, due to urbanization.

Stormwater Management and LID

The Halifax Region consists mainly of traditional stormwater management systems, with onsite collection and direct conveyance of stormwater to either a basin, water body, or sewer system. The separate sewer systems collect stormwater and convey the flow to a body of water with little treatment, resulting in higher concentrations of runoff pollutants. The combined sewer systems, such as the case for the majority of the Regional Centre, convey a mixture of stormwater runoff and wastewater from end users; the combined sewer systems are susceptible to overflows of raw sewage. In either case, this type of stormwater management could potentially lead to a variety of negative environmental, economic, and social consequences. The most common issues now associated with combined networks:

- Bank erosion and increased turbidity
- Destruction of wildlife and habitats
- Contaminated water bodies and beach closures
- Downstream flooding
- Infrastructure damage
- Unnecessary conveyance and treatment costs

- Disruption of groundwater table and natural cycle

There are many interpretations of the term *Low Impact Development* (LID), but in general it refers to a land development or re-development approach that utilizes site specific methods and techniques to manage both the quantity and quality of stormwater runoff, at the source. Different onsite wet weather flow management strategies can be implemented to reduce the conveyance of stormwater, which could help resolve existing capacity deficiencies while providing additional environmental and social benefits. It can be a cost-effective approach by minimizing the potential capital costs associated with new hard or grey infrastructure. It is a sustainable stormwater practice that can be applied to high density urban areas as well as low density neighbourhoods.

Common principles associated with the LID approach include:

- Decentralized controls to infiltrate, evaporate, or store onsite runoff
- Mimic and protect natural systems and process of the hydrological cycle
- Protect and enhance natural ecosystems
- Promote interdisciplinary planning and design
- Preserve open spaces and minimize land disturbance
- Pollution prevention
- Maintain runoff rate and duration from site

As previously mentioned, traditional stormwater management systems collect and convey runoff from the site into sewers, and then either to storage facilities, large retention ponds, or direct discharge into water bodies. These controls do not allow for the recharge of groundwater or pollution control. The need for conveyance and retention of stormwater can be minimized through the LID approach resulting in less stress on existing separate or combined sewer system infrastructure. Portland Oregon's active LID program was put in place to satisfy environmental commitments that include CSO discharges; Appendix F provides more details regarding some aspects of their program. Minimizing the conveyance of stormwater runoff can help reduce capacity issues within a combined sewer system, and reduce the discharge of stormwater runoff pollutants that are associated with separate storm sewer systems. Although sewer separation may help reduce CSO discharge, the tradeoff is an increase in the discharge of runoff pollutants. The LID approach focuses on reducing the quantity of stormwater runoff and therefore any associated pollutants. This +stormwater management approach focuses on the problem, being development patterns and imperviousness, rather than the symptoms, which are large stormwater volumes.

Capacity issues, which are resulting in flooding and/or discharge of runoff pollutants and CSOs, are not only a result of growth and increased imperviousness but also changes in precipitation patterns. Precipitation events are expected to increase in frequency and severity and for this reason, limiting the source may be more adaptable for the future than increasing the amount of grey infrastructure. Planning for and maintaining waste and stormwater infrastructure should be done with a changing climate in mind. The expected intensity, duration, and frequency of events should be considered over the lifetime of the infrastructure and therefore other best practices other than conveyance should be considered.

Many cities throughout the United States are employing green infrastructure solutions, as presented in the case studies in Appendix F. They consider green infrastructure to be a smart investment of public funds that provide the triple bottom line of benefits (social, economic, environmental) and extend the life of existing grey infrastructure. Other stormwater management principles similar to the LID approach have been established internationally. The United Kingdom has established an approach originally called the *Sustainable Urban Drainage System* (SuDS), now commonly referred to as the *Sustainable Drainage*

System (SDS) to accommodate rural sustainable water management practices. In Australia, the common approach to sustainable stormwater management is the *Water-Sensitive Urban Design* (WSUD). Similar to LID, SDS and WSUD integrate stormwater, groundwater, and wastewater management into the land planning and engineering design stage. This type of practice helps govern stormwater runoff thereby minimizing the impacts on the environment and existing infrastructure.

Green Infrastructure

Green Infrastructure can be used as a means of meeting LID targets and encompasses a variety of techniques that utilize nature as a driver for onsite management of stormwater. These techniques provide great flexibility with a variety of benefits in support of the LID principles. Green infrastructure utilizes vegetation, soils, and natural processes to improve infiltration rates and/or capture and reuse stormwater to reduce the quantity and improve the quality of stormwater runoff. These techniques aim at minimizing onsite production of stormwater flows thereby minimizing the required capacity of combined sewers. This reduction in stormwater conveyance has many advantages:

- Increased capacity within the existing sewers
- Decrease in CSO frequency, volume, and peak flow
- Less treatment required at facilities.

Many municipalities are finding that for their unique system, they can effectively manage stormwater runoff in a more cost-effective and overall beneficial way in comparison to the traditional collect and convey approach. Green infrastructure can be implemented at any scale from a single to lot to entire citywide plan. Green infrastructure can refer to a “system”, similar to wastewater, water, and stormwater systems. With respect to combined sewer systems, municipalities do not have to rely solely on conventional storage or sewer separation techniques. The individual techniques that make up the green infrastructure systems are dependent on many aspects of the area or community in which it is to be implemented. The appropriate type of green infrastructure will depend on the type of development, topography, weather, and other area specific characteristics.

The most common types of green infrastructure are presented below and each has its own advantages, disadvantages, costs, and benefits.

Rainwater Harvesting

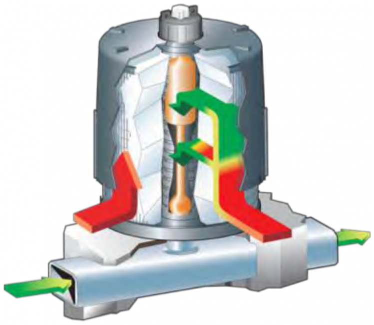
Green Roof

Vegetated Bioswale

Pervious Surface

Tree Box

Rain Garden



Filter - Stormwater 360

StormFilter™

Infiltration trench

Swale

These techniques aim at minimizing onsite production of stormwater flows thereby minimizing the required capacity of combined sewers. This reduction in stormwater conveyance has four primary advantages:

- Increased capacity within the existing sewers
- Decrease in CSO frequency, volume, and peak flow (combined sewer systems)
- Decrease in the discharge of stormwater runoff pollutants (separate sewer systems)
- Less treatment required at facilities

Public versus Private (ownership)

Green infrastructure can be implemented at the site level or community/neighborhood level. Green infrastructure is often thought of as development related, however it can be either publically or privately owned and the implementation, feasibility, costs, and benefits can differ. It is much more difficult to implement green infrastructure privately as it requires significant buy-in and commitment by the developers and community. It typically requires rebates or fee-based incentives to encourage its implementation. It is also very difficult to ensure that they are properly maintained so that it remains effective as part of a system wide stormwater management strategy. For this reason, privately owned green infrastructure is typically better served for localized benefits. Green infrastructure that is owned by the municipality or region may be easier to implement and the benefits can be realized at the system wide level.

Localized and System Wide Benefits

Green infrastructure systems can provide many environmental, social, and economic benefits to the localized are as well as the larger community. The benefits are summarized into three categories:

Environmental

- Sources of vegetation can improve air quality reducing greenhouse gases
- Groundwater recharge ensures the water table remains as was before development
- Provides protection and/or creation of wildlife and insect habitats
- Water conservation
- Minimizes pollution associated with stormwater discharge into water bodies or overflows (improved water quality)
- Minimize sewer overflow events
- Drinking water source protection

Social

- Minimizes heat island effect by providing shade and protection against sun
- Improved aesthetics and communal benefits such as recreational opportunities
- Efficient land use
- Establish urban greenways and attractive streetscapes
- Flood mitigation
- Enhanced livability with respect to green roofs
- Educate the public about stormwater management

Economic

- Reduced life-cycle costs
- Increased property values and communal marketability
- Minimize need for grey infrastructure (reduction in construction and maintenance costs)
- Minimizes treatment costs
- The implementation of green infrastructure techniques and subsequent reduction stormwater runoff can slow down the trend toward increased stormwater utility fees and taxes that are inevitable with traditional stormwater management systems
- Encourage economic development
- Reduce energy consumption

Although the social and environmental benefits are evident, many municipalities undervalue the contribution of green infrastructure simply because it is difficult to quantify the potential benefits i.e. reduction in flows entering the sewer systems. It is difficult to determine, with a high level of accuracy, the capacity of the green infrastructure system, in addition to the lack of confidence that it will remain at that level over time. More research including the monetization of benefits and detailed financial analyses would be required to gain more insight to better value these systems against traditional grey infrastructure.

Although the benefits of green infrastructure is difficult to quantify, there is evidence from many case studies, including those in Appendix F, that demonstrate the potential. If properly planned and there is sufficient commitment from all stakeholders, the implementation of an LID approach can provide reduced infrastructure costs as the need for large-scale storage and end-of-pipe systems are minimized. Land used for detention ponds can be put towards an alternative use that is beneficial to the public and environment such as recreational or reforestation. An LID approach also enhances the livability or property value by improving the aesthetics and hydrologic conditions of the site. Should be noted that all of this is dependent on many factors and opportunities with the area, such as soil conditions, land use, etc.

Implementation

The flexibility of green infrastructure techniques means that the systems can be implemented at all scales for any type of development depending on land limitations and surroundings, whether it be urban, high-density urban, or rural. However, the implementation of green infrastructure requires strategic planning, commitment from multiple stakeholders, and interaction with the public, primarily local residents. Since the majority of the impervious surfaces are privately owned, these stakeholders are essential to the magnitude of benefits resulting from the implementation of a green infrastructure system. Communal involvement is required for a municipality to reach desired stormwater runoff reductions and therefore public policies and initiatives are required.

Policies, Initiatives, and Goals

Policies and initiatives are required to initialize the implementation of green infrastructure and LID strategies and it will take time. Once the long-term benefits are realized, future implementation of green infrastructure will be encouraged and more easily justifiable. Policies can emphasize the reduction of impervious surfaces, preservation of vegetation, and/or water quality improvements.

It is essential to have short-term site specific and long-term system specific goals. Progress must be monitored and measured in the early stages of implementing policies and initiatives to continuously improve the program. This iterative process has helped Portland, Oregon, establish one of the most mature and functional hybrid stormwater systems in the United States; more details are provided in Appendix F. Feasible locations should be selected that will generate the greatest outcomes, such as those that are prone to flooding, good soil for infiltration, and large flat rooftops.

Case studies should be reviewed and pilots need to be implemented to provide public awareness and education. Many case studies have found that to implement successful stormwater management, municipalities must implement multiple policies and initiatives, including stormwater ordinance and new regulations to govern new development, funding systems for capital projects, and financial incentives to encourage redevelopment and retrofit. Policies can be categorized as either public or private sector policies, where public programs can be set up internally by government agencies and private sector programs apply to private development and property owners including both residential and commercial. Common policies and initiatives that are applicable to most municipalities, and can be implemented in combination, are as follows:

Public Sector

- Education and Outreach – any kind of awareness regarding existing green infrastructure projects or the general importance and impact of reducing stormwater runoff on the surrounding environment and levels of service.
- Demonstration projects – can serve for testing new programs or be evidence of the feasibility and functionality.
- Transportation and Capital Projects – e.g. street retrofits, public buildings, parks, etc.
    - A lot of potential as these projects can reduce runoff from large impervious areas. Only requires small percentage of total project funding to go towards green infrastructure portion.
- Local Code Review and Revision – to remove barriers on new stormwater regulations and standards

Private Sector

- Stormwater Regulations (not just minimizing peak flow rate)
    - The enforcement of on-site stormwater runoff management using a specified threshold. It is common to implement a requirement that addresses pre- and post-development runoff flows. It can be a volume-based, process-based, or menu based approach.
    - Impervious surface ratio requirements
    - A mandatory green roof policy
- Incentives for Implementing Green Infrastructure
    - Stormwater fees – generate a dedicated revenue stream that directs the costs for stormwater management towards the properties producing the runoff. Typical method is to calculate user fee based on total lot size and percentage of imperviousness. ****This was noted by the EPA as one of the most critical elements that will ensure the successful implementation of other green infrastructure policies and programs.*
    - Stormwater fee discounts – encourage retrofits of existing properties and implementation of green infrastructure
        - Philadelphia, Portland, and Seattle provide property owners the ability to reduce the amount they pay by decreasing impervious surfaces
        - Less burden on public infrastructure
        - Discount support fee-for-service system.
        - See the following table for an example of stormwater fee discount programs from the "Municipal Policies for Managing Stormwater with Green Infrastructure by US EPA"

Goal of Discount	Mechanism for Fee Reduction	Process for Implementation
Reduce Imperviousness	- % fee reduction - Per-square-foot credit	- % reduction in imperviousness - Square feet of pervious surfaces
On-site Management	- % fee reduction - Quantity/Quality credits	- List of practices with associated credits - Total area (square feet) managed
	- % fee reduction - Quantity credit	- % reduction in imperviousness - Performance-based - Total area managed (square feet) - Practices based on pre-assigned performance values
Use of Specific Practices	- % fee reduction - Onetime credit	- List of practice associated credits

To help deal with the many implementation barriers, the EPA report recommended the following 3-step policy implementation to support the local green infrastructure initiatives and programs.

8. Stormwater Regulation and Code Review – encourages and mandates green infrastructure.
9. Demonstrations/Pilot Studies, Education/Outreach, and Incentives – can set the stage for instituting a stormwater utility.
10. Capital and Transportation Projects, Stormwater Fees, and Fee Discounts – the most difficult as it requires more political and support and takes the most time to complete the process.

Implementation Barriers

There are many barriers to implementing green infrastructure that can add time and effort and in some cases prevent the advancement of its implementation.

- Quantifying the benefits or reduction of stormwater runoff before implementation i.e. justifying green infrastructure.
- Implementing the framework and policies.
  - Funding/cost concerns
  - Lack of political support/leadership
  - Resistance to change
  - Coordination of multiple stakeholders
- Land use and/or soil conditions
- Maintaining its effectiveness.

In areas where land is mostly developed, there may not be a significant amount of space to implement sufficient LID to meet criteria such as limiting CSO discharges or preventing basement flooding. Due to dense urbanism, widespread retrofitting with green infrastructure may be disruptive, costly, and take a long time to complete, in comparison to implementing LID with new development.

Traditionally, there is a lack of funding, political support/leadership, resistance to change, coordination of multiple stakeholders and partners, legislative action, conflicting regulations, need for technical information and training, misunderstanding about land use issues, and cost benefit analyses. Since the implementation of LID is a new concept for many municipalities, the learning curve tends to be slower in the beginning and therefore it is important to identify partners and begin with small projects that can then evolve into official policies and initiatives.

A single initiative or policy will most likely not be enough to gain momentum therefore multiple programs and policies are recommended. Where there is a lack of LID opportunities, given a unique system or circumstance, green infrastructure may not be productive on its own. If this is the case, a hybrid of green and grey infrastructure can be used to ensure that the criteria and level of service are met and the benefits of LID are still gained.

A document developed by North Carolina State University "Low Impact Development a Guidebook for North Carolina", contains almost every aspect of LID, for both on-site LIDs and municipal programs, including local government maintenance and enforcement after construction. One way of providing regulatory inspections (to meet legal, ordinance, and permit requirements) is to have a qualified professional do an assessment, usually paid for by the entity responsible for the maintenance or funded by the financial-performance guarantee. The executed and recorded operation and maintenance agreement obligates the owner to ensure the LID is inspected by a professional engineer every 5 years. The O&M agreement obligates the owner to maintain LIDs to city standards. If the municipality is responsible for the functionality of the green infrastructure, any performance bonds or guarantees can be called upon and used to recoup cost of maintenance, inspections, or repairs.

With respect to the maintenance and enforcement of LID practices, the document discusses the transition from construction (when the developer or contractor is responsible for its functionality) to post-construction (when another entity, such as Halifax Water, is responsible). The document recommends enforcing inspections and maintenance requirements to preserve the long-term functionality and benefits of the LID systems. Different options include:

- Site LID Operating Permits: the permit would specify maintenance requirements and provisions and would typically require renewal after a certain period (typically 5 years)
- Maintenance Plans: make maintenance plans legally enforceable by passing an ordinance that references them and specifies provisions for enforcement.

Financial Performance Guarantees: requires developer and landowner to provide various future costs related to LID functionality such as maintenance, repair, replacement, and inspections that another party would take care of. Can be in the form of performance bonds, liens, letter of credit, etc.

Costs of Green Infrastructure

The costs incurred with the implementation of green infrastructure, whether it be by a developer, consumer, or municipality, can be recovered however it is difficult to quantify. Due to the difficulty in quantifying the effectiveness of green infrastructure, it is difficult to estimate the return on investment. Municipalities may experience a direct correlation with the management of their systems, property owners may see in increase property or home value, commercial areas may experience better economic benefits, however it is difficult to quantify these financial benefits and estimate the cost recovery.

A LID strategy can be more cost effective than other solutions, however it is very dependent on the opportunities unique to the land and municipality's situation. An analysis conducted by the city of Vancouver indicated that retrofitting with green infrastructure will cost marginally more than rehabilitating the conventional system, however the additional benefits of aesthetic city space and reduction of water pollution justify this additional cost. The study also noted that green infrastructure being implemented with new development will cost less than traditional stormwater controls. The U.S. Environmental Protection Agency completed a report on 2007, which assessed 17 case studies of developments that include LID and found that the majority of cases had the capital cost of LID from 15 to 80 percent less than conventional methods.

A global literature review on the economics of LID was completed ECONorthwest in 2007. The review looks at the cost of LID project against more conventional method of stormwater networks and ponds, and how LID can address to costs of CSO spills and extend the useful life of stormwater infrastructure. The study summarized that LID devices can cost less to install, have lower operations and maintenance (O&M) costs, and therefore provide more cost-effective solutions to stormwater management and water quality than conventional stormwater controls. In some cases LID construction cost could be higher however the added benefits of LID could make LID more desirable overall and sustainable in the long term.

Although the focus is traditionally on retrofitting with LID devices, implementing these techniques in the early stages of community development can provide the most benefits at the least cost. In many cases, LID is less costly than conventional controls when it is part of large-scale projects rather than a number of individual small-scale projects.

APPENDIX F *Low Impact Development – Case Studies*

Credit Valley Conservation

The Credit Valley Conservation (CVC) is one of 36 Conservation Authorities in Ontario. These authorities ensure that Ontario's water, land, and natural habitats are conserved, restored, and managed responsibility through watershed-based programs. The CVC receives funding from municipalities, donors, and grants, and has developed a comprehensive website to share all of their knowledge, research, and other information regarding the protection and conservation of areas within the Credit Valley.

In addition to volunteering opportunities, general knowledge in watershed science, and relevant permits, regulations, and policies, the website has a wealth of information that focuses on Low Impact Development. The CVC has dedicated time and resources to advance the practice and implementation of LID solutions by targeting both the private and public sectors. The following summarizes key information that is provided on the CVC website.

Guidelines for the Planning, Design, and Construction of LID Retrofits.

The implementation of LID solutions can vary significantly depending on the land use; public owned versus private, small residential lots versus large commercial. Therefore, individual documents were developed for four (4) land uses, which include residential, business and multi-residential, road right-of-ways, and public lands. These documents generally provide a summary of LID options and their evaluation, the design and implementation process, public consultation, financing and marketing strategies.

Case Studies

Multiple case studies are provided that are organized by land use. These studies cover the entire implementation process from planning to design, construction, economics, maintenance, and long-term performance. An interactive map showcases sustainable projects throughout the Credit River Watershed.

LID Maintenance and Monitoring

The CVC currently monitors LID sites to determine specific maintenance needs and identify how LID techniques perform over time. The public has access to LID monitoring reports, monitoring plans, performance assessment guides and other documents.

CVC Services and LID Training

The City of Mississauga has instituted a stormwater utility charge in 2016, and the CVC offers their services to commercial and residential property owners so they can learn how to reduce their stormwater runoff through LID practices. The CVC also organizes events and courses by industry leaders in LID planning, construction, monitoring, and maintenance.

Site Visit

The GM BluePlan Team organized a day with employees from the CVC Authority, who provided a guided tour of five pilot LID facilities that are being monitored for performance and maintenance requirements to better understand the overall lifecycle of these assets.

Figure 1: GM BluePlan Team & Employees from the CVC Authority

LID Facilities

The following is a brief summary of the sites that the team visited, however design reports, monitoring data, and further information regarding the construction, performance, and maintenance of each facility can be found on the CVC website, in addition to many other sites.

The first site was the CVC head office parking lot, which was constructed in two sections with permeable pavers in both; one section met the LEED standard by utilizing recycled materials as the base, and the

Figure 2: CVC Parking Lot with Permeable Pavers

other followed standard practice. The sites were tested for performance before and after cleaning to better understand the overall infiltration rates.

The second is a city owned site located adjacent to a school and was original an empty storm ditch. The upstream contributing area would runoff on either side of this road into two ditches, however was regraded to flow to the one site and LID facilities were installed to capture, infiltrate, and treat the runoff. A camera was installed to visually monitor the rising and falling of the water level within the storage area to better understand the infiltration performance, in addition to the inflow and outflow for peak reduction, measures, reduction in quantity and increases in quality; it was found that precipitation events up to 10mm in depth were fully captured and infiltrated. During larger events, where downstream discharge from the facility may occur, up to 80% TSS are removed. This facility also provides a significant reduction in peak flows.

Figure 3: Rain Garden Boxes for Storage, Infiltration, and Water Quality

The city has many medians within their larger roads and decided to implement an LID facility for stormwater treatment. This green infrastructure utilizes large underground cells filled with different media. The runoff is collected upstream, passes through the media, providing source of water for the vegetation and trees, and

Figure 4: Road Median with Underground Cells for Improved Water Quality

discharges back into the minor system with a significant reduction TSS, metals, and phosphorus. This LID facility was designed specifically for water quality.

It was evident to the CVC Authority that there is a lot of opportunities for LID techniques within residential areas, along local roads. This site encompassed an entire local road where runoff discharged to either side through curb divots to Bioswales that were constructed on each front lawn. The Bioswales were constructed with a highlight permeable media to provide a significant amount of infiltration. In addition to the Bioswales, some home owners took this opportunity to install rain gardens, as presented in the top left corner of the photo below. At the bottom of each driveway, permeable pavers were used for additional infiltration. This site was monitored for peak, volume, and water quality at the discharge end of the road, and compared to the local street next to it that did not have any LID facilities.

Figure 5: Neighbourhoods LID – Along Local Street

The final site was a private parking lot where two LID facilities were installed; permeable pavers were installed at the back of the lot where the bedrock was deeper, and where permeable pavers were not

Figure 6: Private Parking Lot – Permeable Pavers and Bioswale

suitable, a Bioswale was installed to collect, treat, and infiltrate any remaining runoff. The private property owner, the CVC Authority, and the city worked together to achieve results that can be used to apply for stormwater credits.

Toronto's Green Roof Bylaw

Toronto's Wet Weather Plan includes four principles:

- Recognize rainwater and snowmelt as valuable resource
- Manage wet weather flows on watershed basis
- Implement hierarchy of wet weather practices
    - Source
    - Conveyance
    - End-of pipe
- Educating communities and involving the public

Toronto is recognized as having one of the most advanced green roof initiatives. An Environment Canada study estimated that greening 6% of Toronto's roofs would cost $36 million over 10 years, but would succeed in retaining 1 billion gallons of stormwater annually. In 2009, Toronto became the first city in North America to implement a bylaw that requires new development (residential, commercial, or institutional), with a gross floor area of at least 2,000 m^2, to include a green roof as part of the structure; residential building with less than 6 stories are exempt. The required percent coverage of green roof increases with gross floor area from 20% to 60%. The city has created guidelines and an official plan that is continuously updated and improved to help with the designing and planning of the green roof. Toronto's green Roof Strategy also helps meet the goals of the City's Climate Change Action Plan.

From February 1, 2010 – March 1, 2015, 260 green roofs have been constructed totaling 196,000 m^2 of additional green space. It is estimated that this green space has resulted in a reduction of 435,000 ft^3 of stormwater each year in addition to 1.5 million KWH of energy savings for building owners.

At Ryerson University, a study evaluated municipal level benefits of wide-scale implementation of green roofs throughout Toronto. The assumptions included all buildings with roof area greater than 3,750 square feet and were covered by at least 75%; this represents 8% of total city land area. The results were $100 million of stormwater capital cost savings, $40 million in CSO capital cost savings, and $650,000 in CSO annual cost savings.

*Recent green roof projects in Canada have averaged between $6 and $7 per square foot.

Toronto also has also implemented a mandatory downspout disconnection program. For new homes, municipal code prohibits connection of downspouts to sanitary, combined, or storm sewer systems. For existing homes, a citywide voluntary downspout disconnection program was put in place in 1998. Toronto offered to disconnect at no cost to property owners. In 2003, Toronto's Wet Weather Flow Management Master Plan identified downspout disconnection as one of the most effective and available source control options to reduce system demands. By 2006, an average of 2,300 disconnections were being completed per year with 1.5 million annual funding. Starting in 2011, it became mandatory to disconnect unless home owners secured an exemption.

Portland, Oregon's Green Stormwater Management

Portland, Oregon is recognized nationally for its green stormwater management strategy. The strategy encompasses many comprehensive programs that have been implemented and updated over many years. The success is a result of a city wide program that was viewed as necessary for the city of Portland due to its large combined sewer system. Instead of solely implementing new gray infrastructure, the city has invested in green infrastructure that has led to an estimated savings to ratepayers of $224 M in otherwise CSO costs. About half of Portland's land are is impervious, of which 25% streets and 40% rooftops.

Portland's policies target the on-site management of both private and public development. With respect to the private developments, incentives for homeowners and developers are used to encourage the implementation of LID.

- Portland's Downspout Disconnection Program targets homes and small businesses in combined sewer areas (the program includes public education about stormwater and CSOs).
  - Portland's downspout disconnections (about 56,000 properties) prevent an estimated 1 billion gallons of stormwater from entering the system each year.
- Portland's Clean River Rewards provides discounts on stormwater user fees; up to 100% of on-site stormwater management services and up to 35% of the total stormwater bill depending on the extent and effectiveness of practices to limit flow rate, pollution, and disposal.
  - 35,000 participants (residential and commercial) have received $5.5 M in retroactive credits for having properties that meet LID criteria. Participation is expected to reach 110,000 of 176,000 ratepayers.
- Portland has a Stormwater Management Code and Manual, which all new development or redevelopment, over 500 square feet of impervious surface, must follow.
- A Floor Area Bonus for Roof Gardens and Eco-roofs. This bonus increases a building's allowable area in exchange for adding a green Roof.
  - There are over 120 buildings throughout the city with a green Roof.
  - New city-owned buildings are required to have green roof covering 70%.
- A pilot stormwater trading program allows developers who are unable to satisfy on-site stormwater management requirement to privately finance or buy credits for stormwater mitigation elsewhere in the city.

The city has been accumulating significant data on the effectiveness of decentralized stormwater management technologies. A vegetated curve extension was proven to reduce the peak flow from a 25-year storm (two inches in six hours) by 88%, and prevented 85% of the initial 2,000 gallons from entering the combined sewer system; cost was approximately $15,000. Over two years of monitoring a 10-story building with over 5,000 square feet of green roof (4-5 inches thick), found that it retained 58% rainfall. Infiltration planters for a 36,000 square foot parking lot can retain entire volume of a 2-year storm; cost was approximately $75,500.

Philadelphia Water Department – Grant Funding for Green Infrastructure

Philadelphia's sewer collection system is 60% combined sewers and 40% separate sewers. To improve stormwater management, the Philadelphia Water Department (PWD) began to implement policies and initiatives to create a new stormwater standard. This standard is made up of the following four requirements:

- Channel protection (control one year storm)
  - Redevelopment may be exempt
- Flood protection (post-development conditions must be equal to pre-development)
  - Redevelopment may be exempt

- Water quality (infiltrate/manage first inch of rainfall on site from all connected impervious surfaces)
- Site design requirements to reduce imperviousness

Philadelphia has an impervious-based billing system where 80% of the city's new stormwater fee is based on impervious area and the remainder is on property's gross area. This ensures that vacant lots, parking lots, etc. are accounted for appropriately. They offer a fee discount up to 100% of the impervious area charge. The development community is now building green infrastructure projects which help achieve the city's goals.

A competitive grand program in July 2014 called the greened Acre Retrofit Program (GARP). This program was aimed at encouraging contractors, design firms, and consulting firms to implement green infrastructure projects by competing for public grant funding set aside for the green infrastructure market. Some benefits recognized by the PWD included the following:

- *"The local sewer or stormwater utility obtains installed (and privately maintained) stormwater infrastructure at a fraction of the cost of public right-of-way projects with similar environmental benefit;*
- *Local green infrastructure contractors benefit from a program that rewards project aggregation and provides long-term green infrastructure maintenance opportunities; and*
- *Property owners benefit from aggregators identifying cost-effective green infrastructure opportunities that can result in reduced stormwater fees and improved property value."*

Chicago, Illinois

The city of Chicago uses pilot projects to demonstrate the effectiveness and implementation of green infrastructure practices to the public and development community. As the public and development community become more familiar with the concepts, the adoption of financial incentives, new policies, and changes in stormwater regulations become more feasible. The pilot projects have also led to increased cost-competitiveness within the green infrastructure market.

The city's green roof program began with a 20,300 square foot roof on its own city hall. The green roof retains 75% of the volume from a one-inch storm, preventing it from reaching the combined sewer system. This pilot project led to a pilot program which included the implementation of 80 green roofs that totaled over 1 million square feet. The Chicago Department of Environment found that runoff from green roofs was generally 50% less than regular roof tops, and even greater for smaller storms. The city now sponsors installations and demonstration sites by providing incentives. A density bonus is offered to developers who cover at least 50% of their roof with a green roof, or 2,000 square feet, whichever is greater. By 2010, over 4 million square feet of green roofs have been installed on 300 buildings.

Public outreach programs have been implemented to engage homeowners to purchase rain barrels and install rain gardens. Over 440 residents have purchased 55-gallon rain barrels for 15$ and the program cost to the city has been $40,000, excluding labour. It is estimated that this pilot project will divert 760,000 gallons annually from combined sewer systems. This is a small number relative to the entire system however the program targeted localized areas with a high frequency of basement flooding. The city of Chicago has also began two studies to assess the effectiveness of green infrastructure technologies. They have monitored green roofs and completed a stormwater reduction practices feasibility study using hydraulic modelling. Two primary results were:

- In a 1,370 acre area, 80% residential, disconnecting all homes reduced the peak flow by 30% for a one-year storm. This corresponded to an estimated 20% reduction in CSO outfall and a drop in water levels in the sewer system by 8 inches.
- Six inch deep rain gardens at each home could further reduce total runoff by 7% for a one-year storm event.

Milwaukee, Wisconsin

Milwaukee Wisconsin has developed a strategy to limit CSO discharge by implementing green infrastructure within combined sewer areas. Their green roof program began with a pilot study that involved the installation of a 20,000 square foot green roof on a 114-unit midrise building at a cost of $380,000. This green roof retains 80% of a two-inch storm and the remaining 20% is directed to rain gardens. Further monitoring and modelling of other green infrastructure techniques showed that a downspout disconnection, rain barrel, and rain garden programs, in residential areas, could reduce contribution to annual CSO volumes by 14-38%, flows to treatment plants by 31-37%, and stormwater peak flow rates by 5-36% depending on the size of the event.

Kitchener and Waterloo, Region of Waterloo

The cities of Kitchener and Waterloo have implemented a stormwater funding system that requires property owners to retain increased volumes of stormwater and reduce water demands to be rewarded with tax credits. They replaced their tax-based funding with a user pay system so that users pay for stormwater management services that reflect their use of the service. The first step was to determine how much each property contributed to run-off; this was based on the impervious area of the property. The financial research led to the development of 13 funding tiers that range from 47$ to $23,000 annually. After switching to the user based system, the residential portion of funding decreased from 75% to 55%, whereas the industrial, commercial, and institutional properties saw an increase. These changes were viewed as appropriate since they were based on the footprint and base amount of runoff entering the sewer system.

After the implementation of the user based system, the cities implemented a stormwater credit program for properties who wish to install onsite stormwater controls. This program saw contributions from both the residential and non-residential property owners and less than a year later, Waterloo received 750 applications and Kitchener 4,500. The public is also now inquiring about different stormwater retention techniques that they can implement, which is providing the cities with an opportunity to educate the communities on the importance of good stormwater management principles.

Leadership in Energy and Environmental Design (LEED)

The LEED initiative was established by the U.S. green Building Council (USGBC) and is centered on sustainable planning and design as this is a growing focal point of many municipalities. The USGBC credits projects that meet a number of criteria, which demonstrates its contribution to improving the triple bottom line, the environment, society, and the economy.

Leadership in Energy and Environmental Design (LEED) is a recognized standard in North America that promotes sustainable development. A development, redevelopment, or restoration of an existing building can earn a LEED status by demonstrating its commitment to sustainability and improving social and environmental impacts. There are five (5) categories of which can earn points including:

- Water conservation
- Energy efficiency
- Material selection

- Sustainable site design
- Indoor environmental quality.

The LID principles in section 2.1 are recognized throughout the LEED standard in the water conservation and sustainable site design categories. There are credits for implementing a green roof, having a certain ratio of pervious land, minimizing parking, and stormwater reuse to name a few. Each of these categories contribute to the LID approach by using GI techniques. Grants for LEED credited development or substitutes for similar types of projects could encourage developers, consulting firms, and design firms to consider a LID approach for the long-term benefits of a sustainable, environmentally friendly, socially and financially beneficial development. Implementing a program to encourage a standard such as LEED could be beneficial to the developer, public, and municipality in both the short-term and more importantly the long-term.

Sustainable Site Design Stormwater design – quantity control: if existing imperviousness <50% post-development peak runoff rate and quantity not more than pre-development rate, if >50% than at least 25% less (can use any form of GI)

Sustainable Site Design Stormwater design – quality control: capture and treat runoff from 90% average annual rainfall

Green roof can be used to earn multiple credits including:

- Reduce Heat island effect (i.e. reduce imperviousness)
- Stormwater design quantity control (increase infiltration)
- Maximize open space (if roof used for occupants)
- Optimize energy performance (control internal temperatures).

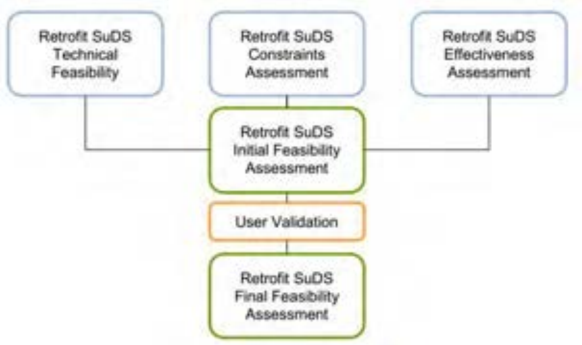
APPENDIX G *Sustainable Drainage Systems (SuDS) Retrofit Feasibility Tool*

HaskoningDHV UK completed a feasibility study to identify areas where SuDS retrofit is justifiable and identify which types are the most appropriate to the specific area. They provided guidance on the implementation of appropriate SuDS retrofit measures and developed illustrative maps to convey the results. This tool provides a high level assessment of where to pursue the implementation of retrofit SuDS. The tool uses spatial data analysis techniques that include spatial data (land-use and land-cover), topographic data, surface water flood risk mapping, known water pollution vulnerability issues, geology, and environmental data.

Discussions and consultation were undertaken with SuDS industry practitioners in addition to the academic community. Information gained from these consultations and other workshops were used to refine the tools that is applicable to a variety of users. The tool was designed to be compatible at any scale and for any area, however an example was only completed for a pilot area in the Royal Borough of Kensington and Chelsea. This pilot area confirmed the methodology was appropriate.

To allow for a more automated process, the tool was implemented into an ArcGIS software environment. Any data set can be assessed using this approach. Data was provided by Royal Borough of Kensington and Chelsea and Thames Water including digital surface model, which provides the elevation of structures to determine roof slopes.

The process behind the tool includes many components as outlined in the figure below:



A few innovative steps included:

- Analysis of road width to assess suitability for curb extension SuDS measures.
- Analysis of property type data to identify constraints of things just as property ownership.
- Analysis of roof slope for green roof suitability.
- Water body assessment to indicate areas for water quality improvements.

Key output maps include:

- Environmental constraints: higher values indicate greater number and importance of constraints making it more difficult to implement SuDS
- Infiltration constraints: higher values indicate SuDS requiring infiltration will be more difficult.
- Property ownership constraints: private more difficult than public.
- Effectiveness: higher scores indicate greater potential benefit (impacts on flooding and water quality)

SuDS opportunities – number and type of SuDS that can be implemented.

APPENDIX H *Flow Monitoring Analysis*

Supporting flow monitoring information for Halifax, Mill Cove, Eastern Passage and Dartmouth sewersheds are covered in this appendix. For additional data on Halifax sewershed refer to the WRWIP.

Halifax Sewershed Supporting RDII Reduction Analysis Data

The flow monitor locations and supporting data in the table below are sourced from the WRWIP and the RDII reduction maps have been updated to remove combined catchments from the RDII reduction analysis.

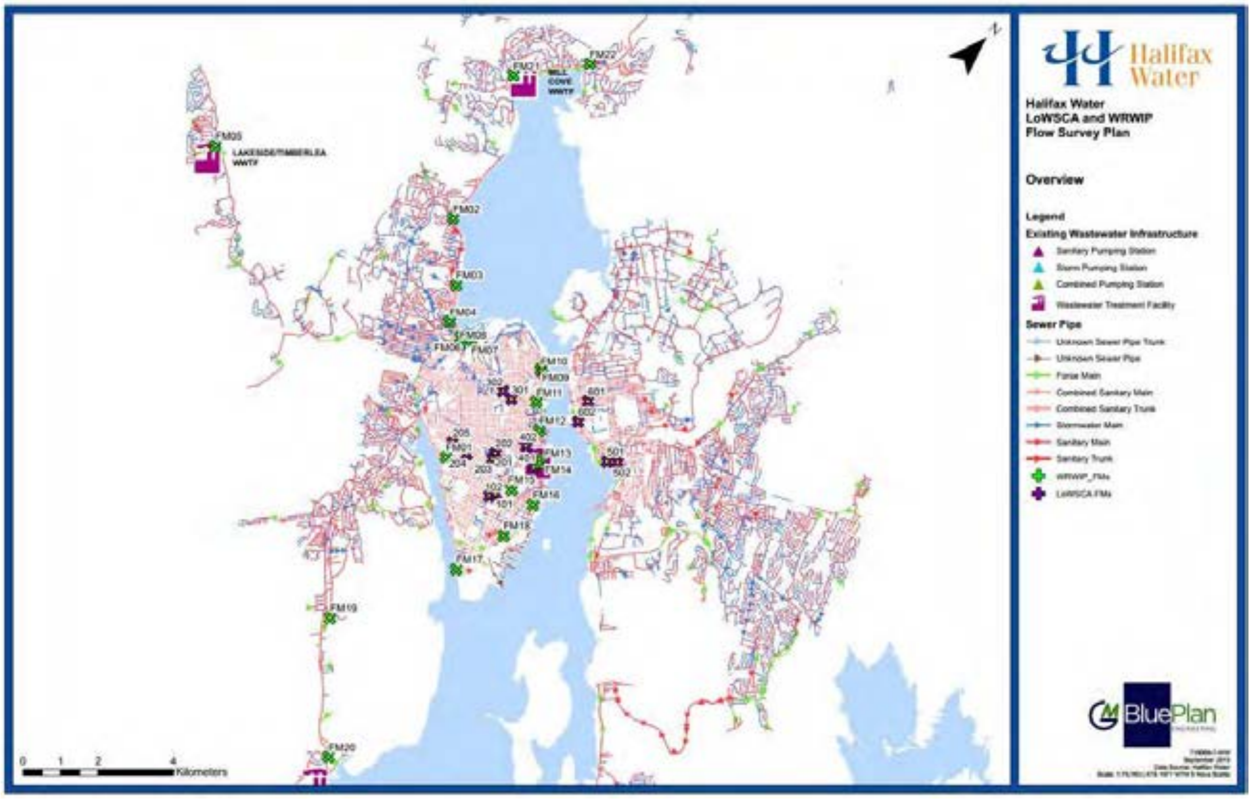


Figure 7 - Flow Monitor Locations

The table below outlines the WRWIP data on flow monitor ID, if the catchment is sanitary (SAN) or combined (CO), the location of the flow monitors and period of recording data, as stated in the WRWIP.

Flow Monitor ID	Sewer System	Location	Manhole Number	Flow Monitoring Period	Pipe Size (mm)
FM-1	CO	Jubilee/Fairfield	1170	Oct. 7 – Nov. 24	900
FM-2	SAN	Bedford	11042	Sep. 29 – Dec. 1	1500
FM-3	CO	Bedford/Seton	7109	Sep. 29 – Nov. 27	750
FM-4	SAN	Off Bedford	9035	Oct. 28 – Nov. 30	750
FM-5	SAN	Rosewood	52083	Sep. 29 – Dec. 1	600
FM-6	SAN	Ramp Rd	4352	Sep. 30 – Nov. 27	600
FM-7	CO	Bayne Street	4485	Sep. 30 – Nov. 26	900
FM-8	CO	DS of Lakeside PS Diversion	4374	Sep. 30 – Dec. 1	600
FM-9	CO	Duffus/Barrington	4953	Oct. 6 – Nov. 25	600

Flow Monitor ID	Sewer System	Location	Manhole Number	Flow Monitoring Period	Pipe Size (mm)
FM-10	CO	Barrington	4972	Oct. 4 – Nov. 25	1200
FM-11	CO	Kaye/Vincent	3952	Oct. 9 – Nov. 26	750 x 500
FM-12	CO	Valour	49592	Sep. 30 – Nov. 30	1050
FM-13	CO	Upper Water/Valour	49424	Oct. 9 – Nov. 30	1350
FM-14	CO	WWTF Halifax Plant	5330	Oct. 6 – Nov. 30	900 x 600
FM-15	CO	Sackville/Bell	2016	Oct. 8 – Nov. 30	1800
FM-16	CO	Hollis/Salter	49808	Oct. 8 – Nov. 30	900
FM-17	CO	Chain Rock	49898	Oct. 6 – Nov. 30	1800
FM-18	SAN	Inglis/Mitchell	49817	Oct. 4 – Nov. 25	750
FM-20	SAN	Lancaster/Tribune	14366	Oct. 6 – Nov. 30	750
FM-21	SAN	Incoming to Mill Cove WWTF	33726	Sep. 29 – Nov. 10	900
FM-22	SAN	Fish Hatchery PS	23016	Sep. 29 – Dec. 1	1200
FM-101	CO	Spring Garden/Summer	1676	Oct. 7 – Nov. 25	450
FM-102	CO	College/Carlton	1374	Oct. 7 – Nov. 25	900
FM-201	SAN	Windsor/Welsford	2314	Oct. 8 – Nov. 24	300
FM-202	ST	Windsor/Welsford	2313	Oct. 8 – Nov. 24	750
FM-203	CO	Quinpool	2348	Oct. 8 – Nov. 24	525 x 350
FM-204	CO	Quinpool/Oxford	1513	Oct. 8 – Nov. 24	600
FM-205	CO	Quinpool/Bloomingdale	1522	Oct. 7 – Nov. 24	900
FM-301	CO	Young/Agricola	3753	Oct. 4 – Nov. 2	900 x 600
FM-302	ST	Kempt/Livingstone	3827	Sep. 30 – Nov. 26	375
FM-401	CO	Brunswick/Portland	48737	Oct. 27 – Nov. 26	600
FM-402	CO	Buddy Day/Gottingen	2966	Oct. 8 – Nov. 26	600 x 400
FM-501	SAN	Canal	18736	Oct. 9 – Nov. 27	900
FM-502	CO	Maitland	50394	Oct. 5 – Nov. 27	600
FM-601	CO	Jamieson/Wyse	19279	Oct. 9 – Nov. 24	1500
FM-602	CO	Lyle/Williams	18824	Oct. 3 – Nov. 27	375

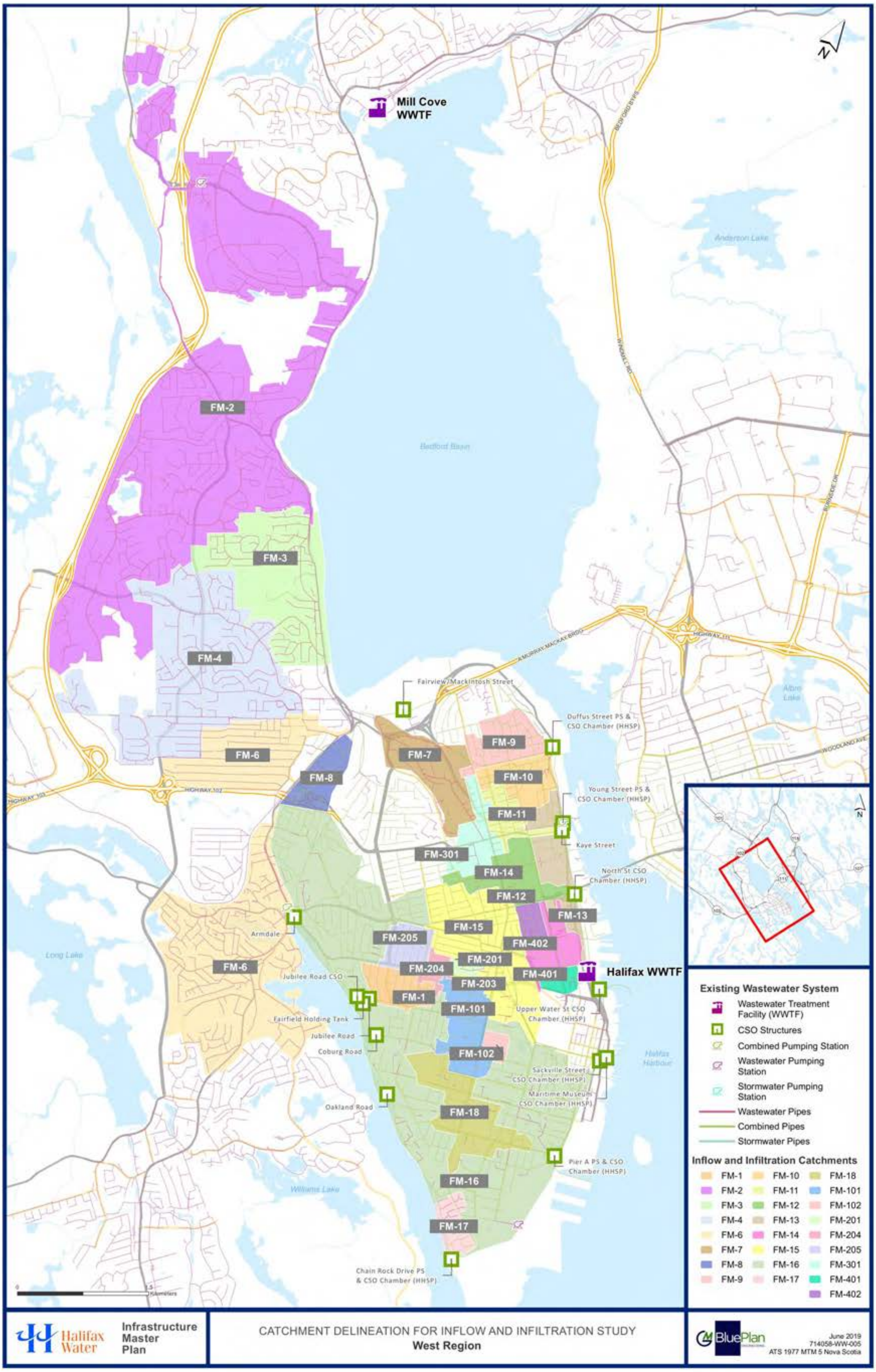


Figure 8 - Catchment Delineation – Halifax

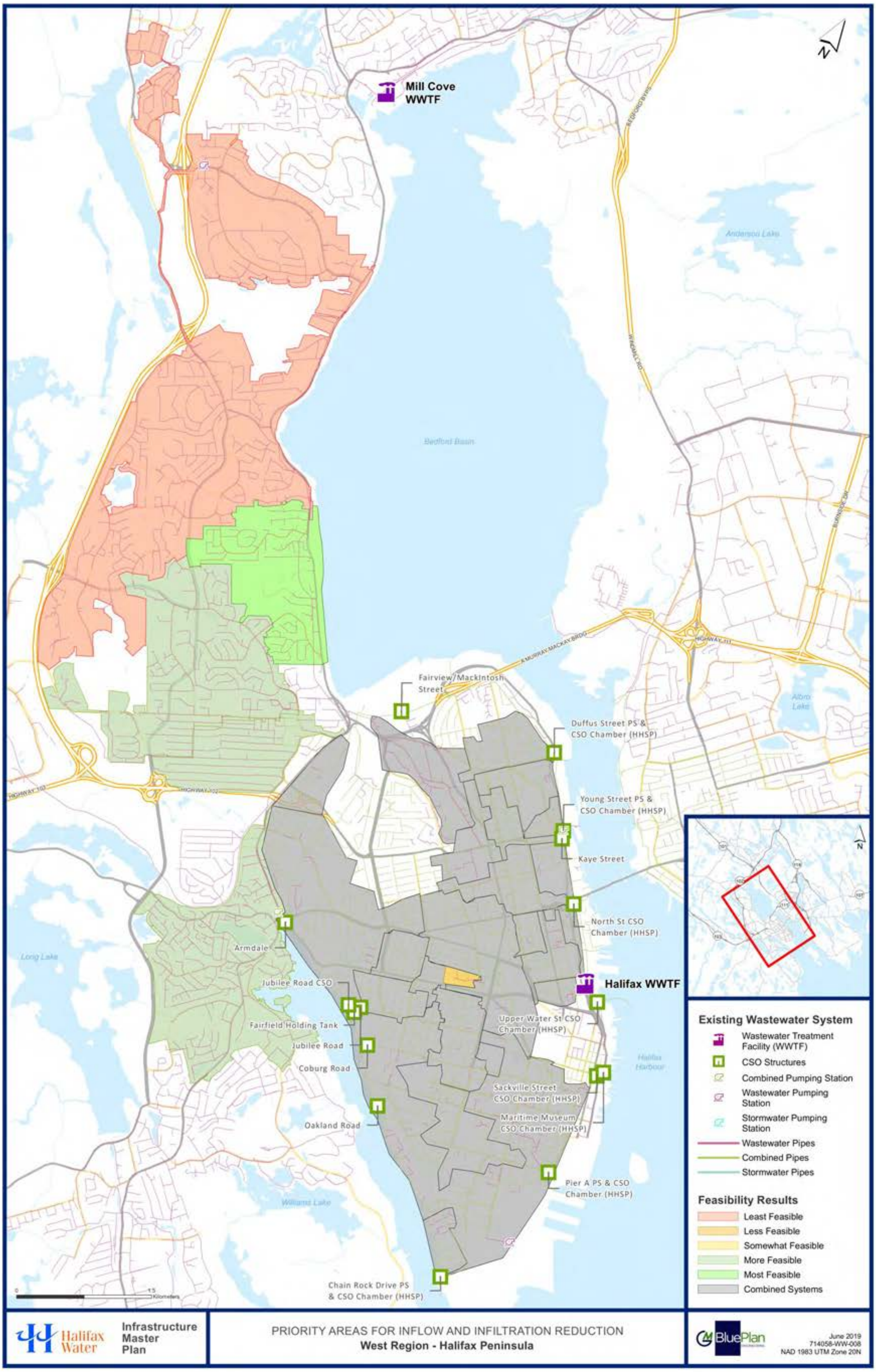


Figure 9 - Catchment Prioritization for Inflow and Infiltration Reduction - Halifax

Mill Cove Sewershed Supporting RDII Reduction Analysis Data – Infrastructure Master Plan

The table below outlines the flow monitor ID within Mill Cove sewershed, if the catchment is sanitary (SAN) or combined (CO), the location of the flow monitors and period of recording data.

Flow Monitor ID	FG ID	Sewer System	Location	Manhole Number	Install Date	Removal Date	Pipe Size (mm)
FMZ01	FG6	SAN	873 Bedford Hwy, Bedford	MH49233	3/10/2016	-	375
FMZ02	FG7	SAN	12 Shore Avenue, Bedford	MH33732	3/8/2016	-	600
FMZ03	FG8	SAN	961 Bedford Hwy, Bedford	MH33726	3/8/2016	-	900
FMZ04	FG9	SAN	1441 Bedford Hwy, Bedford	MH23016	3/8/2016	-	1200
FMZ05	FG10	SAN	1748 Bedford Hwy, Bedford	MH23013	3/11/2016	-	1050
FMZ06	FG11	SAN	74 Hallmark Avenue, Lower Sackville	MH23056	3/8/2016	-	750
FMZ07	FG12	SAN	1380 Riverside Drive, Lower Sackville	MH16765	3/9/2016	-	450
FMZ08	FG13	SAN	57 Beaver Bank Road, Lower Sackville	MH23097	3/9/2016	-	750
FMZ09	FG14	SAN	115 Sackville Drive, Lower Sackville	MH15385	4/14/2016	-	600
FMZ10	FG15	SAN	380 Rocky Lake Drive, Bedford	MH59014	3/9/2016	-	450
FMZ22	FG94	SAN	60 Sawyer Cres, Sackville	MH23123	9/19/2016	-	600
FMZ40	FG89	SAN	679 Sackville Drive, Sackville	MH23075	9/14/2016	-	750

The location of the Mill Cove flow monitors is in Figure 4 below, followed by the catchment delineation in Figure 5 and the recommended catchments for RDII reduction are illustrated in Figure 6.

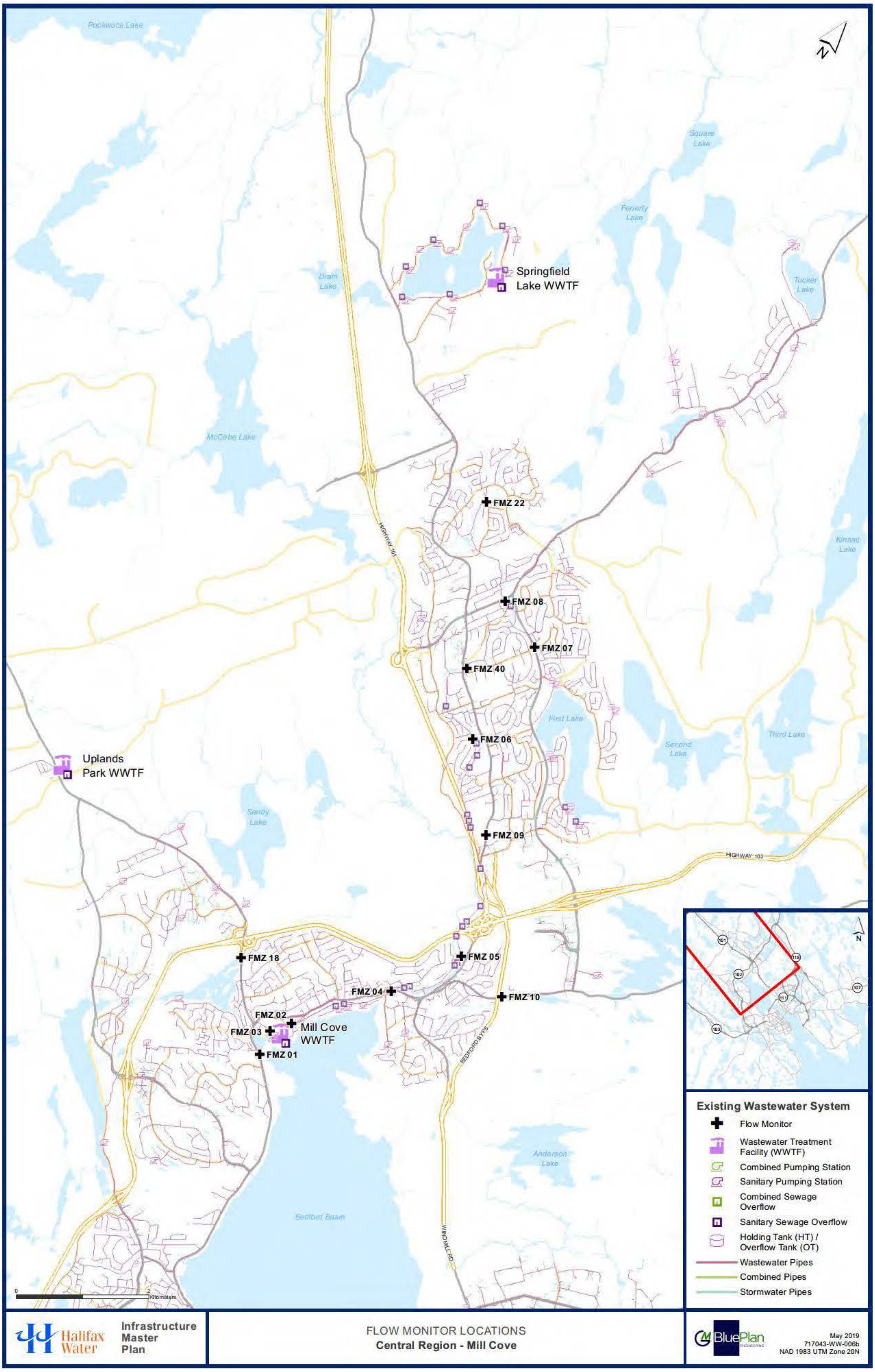


Figure 10 - Flow Monitor Location – Mill Cove

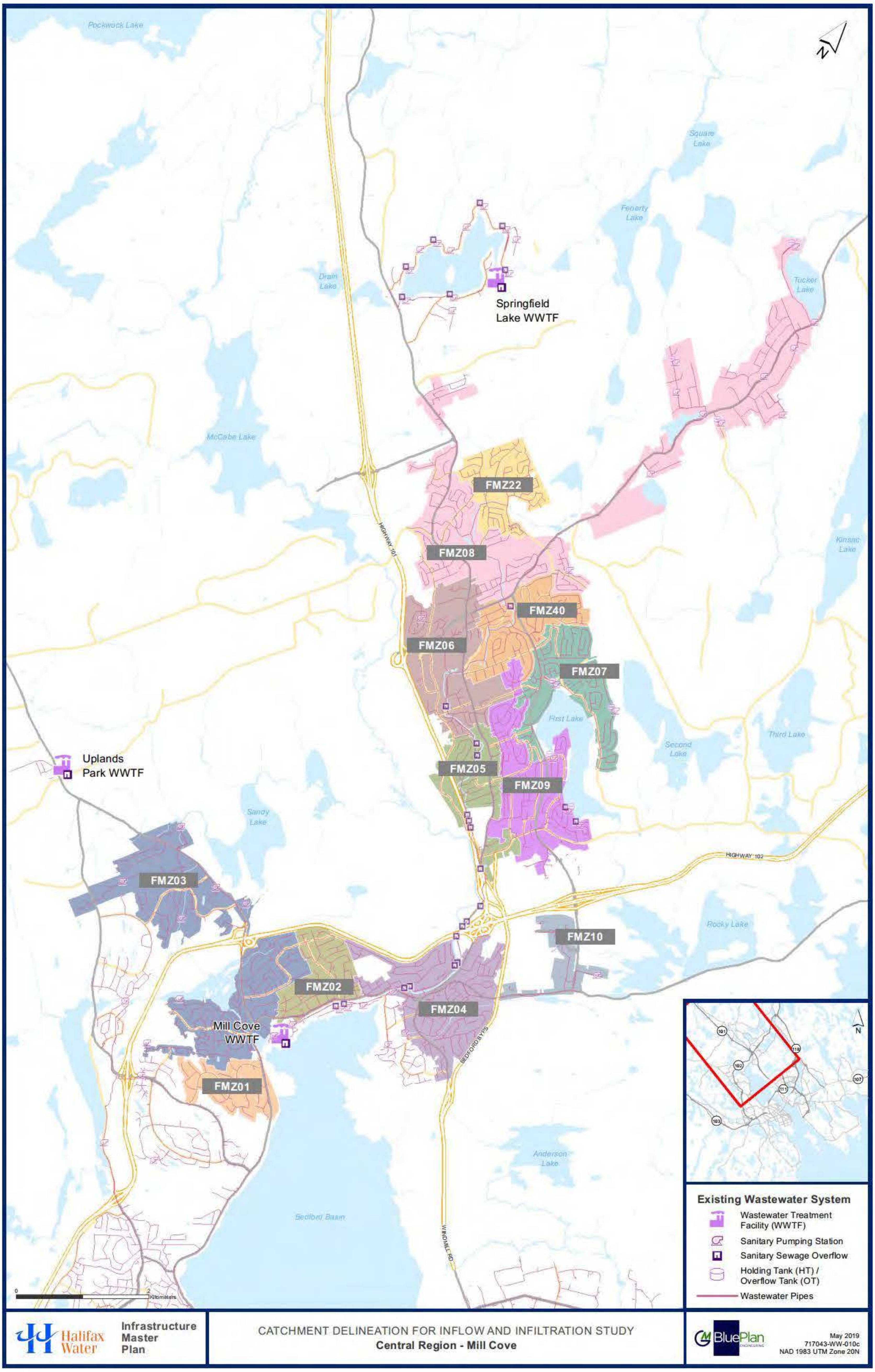


Figure 11 - Catchment Delineation - Mill Cove

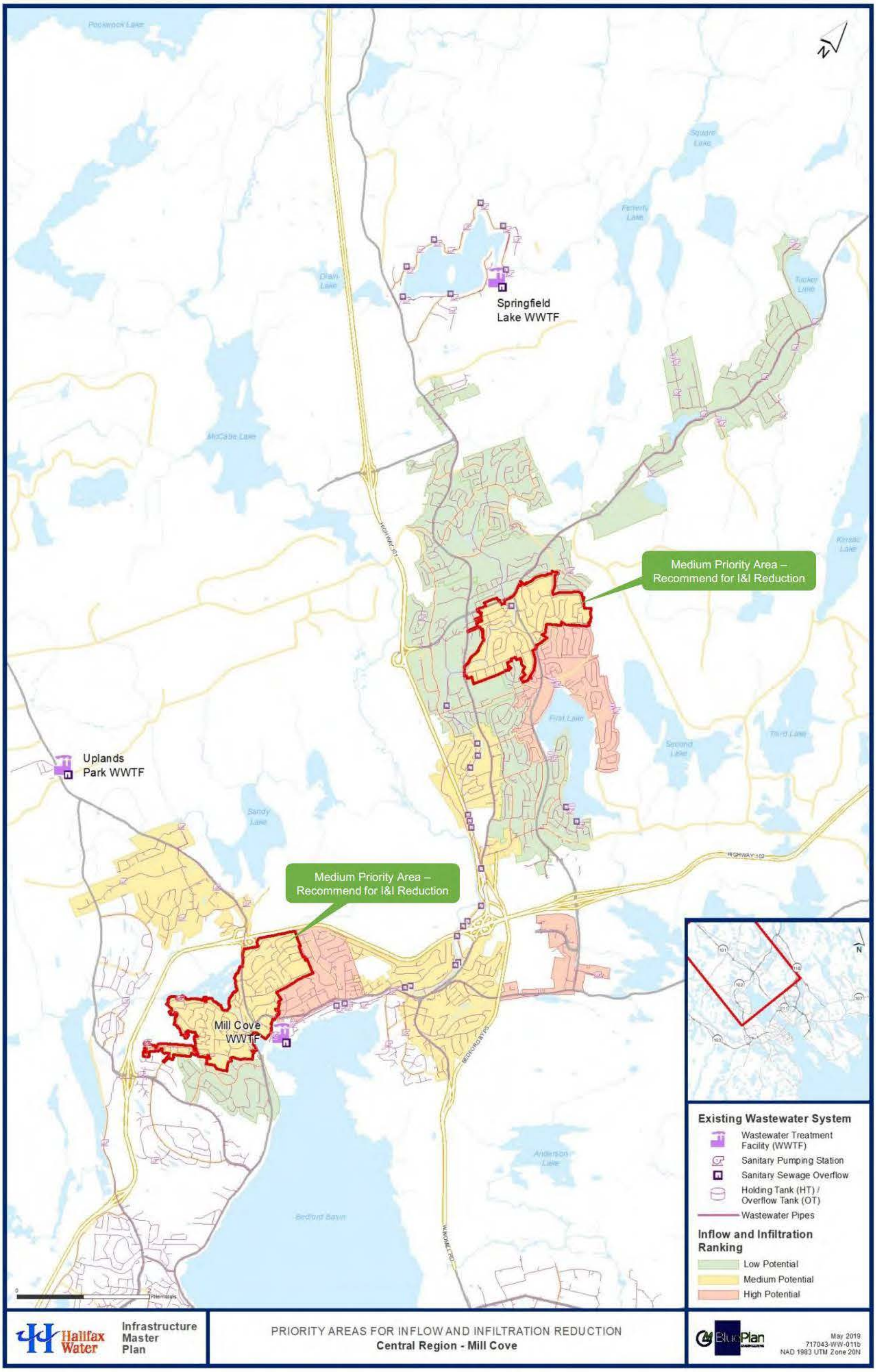


Figure 12 - Catchment Prioritization for Inflow and Infiltration Reduction – Mill Cove

<u>Eastern Passage Sewershed Supporting RDII Reduction Analysis Data – *Infrastructure Master Plan*</u>

The table below outlines the flow monitor ID, if the catchment is sanitary (SAN) or combined (CO), the location of the flow monitors and period of recording data.

Flow Monitor ID	FG ID	Sewer System	Location	Manhole Number	Install Date	Removal Date	Pipe Size (mm)
FMZ21	FG428	SAN	1112 Cole Harbour Rd, Cole Harbour	MH27832	3/28/2018	-	600
FMZ21	FG111	SAN	1172 Cole Harbor Rd, Cole Harbour	MH30820	9/8/2016	3/28/2018	600
FMZ23	FG429	SAN	257 Colby Drive, Cole Harbour	MH25468	4/5/2018	-	525
FMZ23	FG91	SAN	54A Attwood Crescent, Cole Harbour	MH25474	9/8/2016	3/31/2018	525
FMZ24	FG112	SAN	566 Main Street, Cole Harbour	MH28798	9/8/2016	-	300
FMZ26	FG108	SAN	1180 Cole Harbor Rd, Cole Harbor	MH30819	9/8/2016	3/28/2018	450
FMZ37	FG96	SAN	15717 Shore Road, Eastern Passage	MH24147	9/10/2016	-	750
FMZ38	FG97	SAN	On walking trail off of Howard Ave	MH25525	8/10/2016	-	800
FMZ39	FG95	SAN	1528 Shore Road, Eastern Passage	MH24146	9/10/2016	-	750
FMZ44	FG110	SAN	54A Attwood Crescent, Cole Harbour	MH25475	10/6/2016	4/2/2018	450
FMZ81	FG435	SAN	188 Colby Drive, Cole Harbour	MH25565	4/3/2018	-	300
FMZ80	FG430	SAN	1207 Cole Harbour Rd, Cole Harbour	MH25597	3/29/2018	-	450

The location of the Eastern Passage flow monitors is in Figure 7 below, followed by the catchment delineation in Figure 8 and the recommended catchments for RDII reduction are illustrated in Figure 9.

Figure 13 - Flow Monitor Location – Eastern Passage

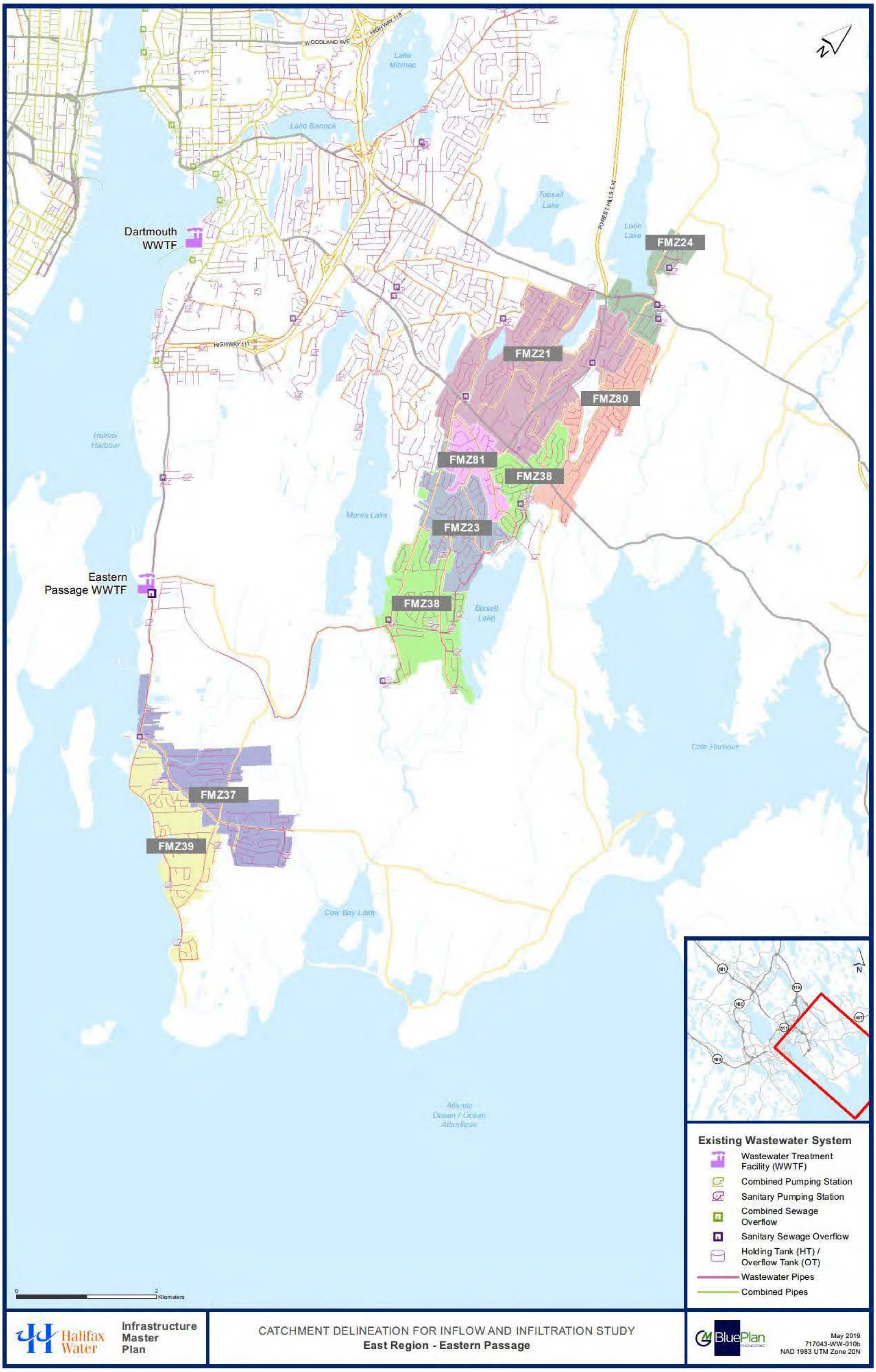


Figure 14 - Catchment Delineation – Eastern Passage

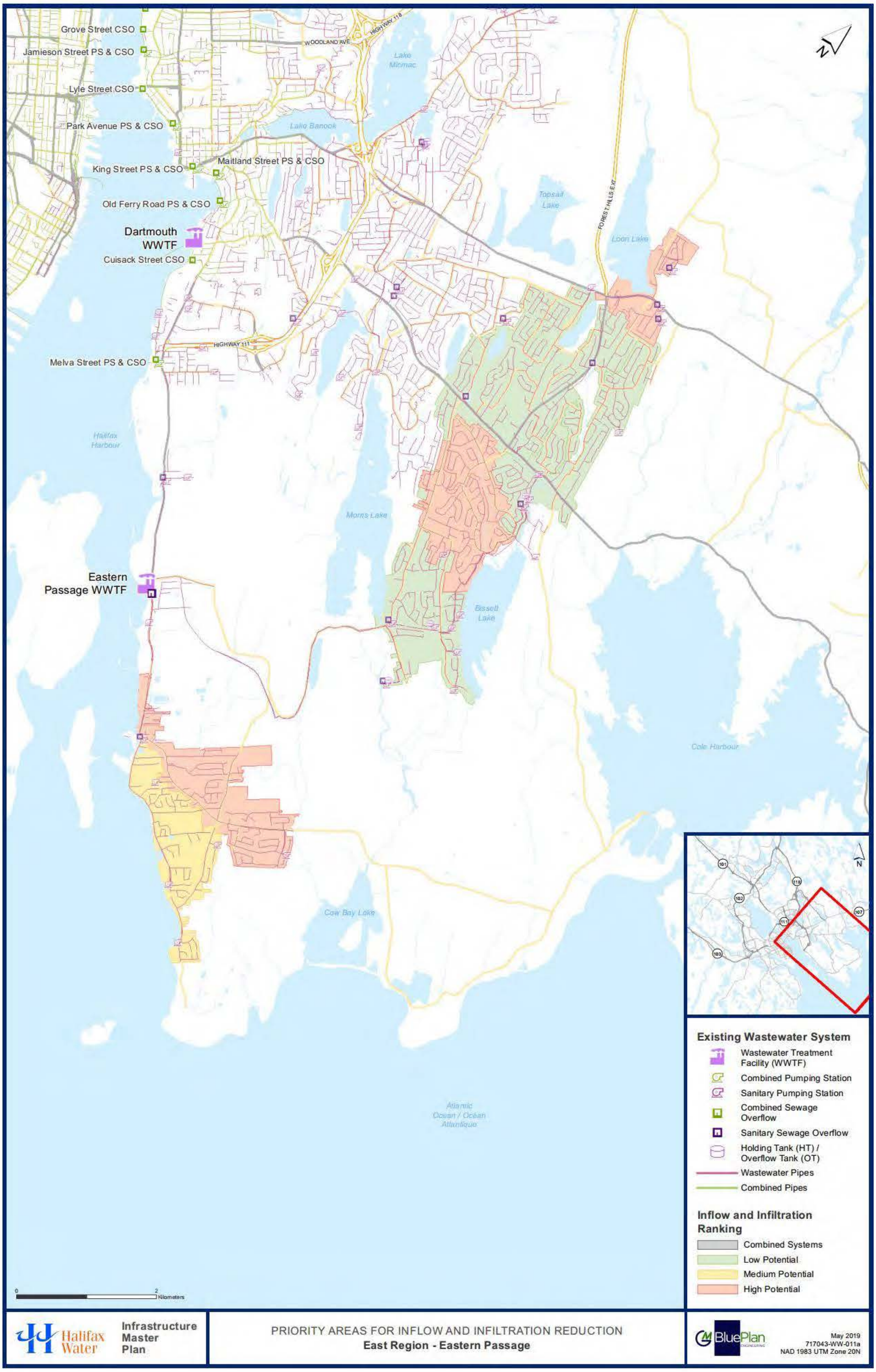


Figure 15 - Catchment Prioritization for Inflow and Infiltration Reduction - Eastern Passage

Dartmouth Sewershed Supporting RDII Reduction Analysis Data – *Infrastructure Master Plan*

The table below outlines the flow monitor ID, if the catchment is sanitary (SAN) or combined (CO), the location of the flow monitors and period of recording data.

Flow Monitor ID	FG ID	Sewer System	Location	Manhole Number	Install Date	Removal Date	Pipe Size (mm)
FMZ17	FG21	SAN	100m N of Princess Margaret Blvd - 10m W of tracks, Dartmouth	MH14652	3/17/2016	-	1200
FMZ25	FG109	SAN	38 Portland Hills Drive, Dartmouth	MH29689	9/9/2016	-	450
FMZ27	FG107	SAN	17 Ellenvale Ave, Dartmouth	MH19626	9/9/2016	-	750
FMZ29	FG105	CO	4 Old Ferry Rd, Dartmouth	MH18483	9/12/2016	-	1200
FMZ30	FG104	CO	130 Alderney Drive, Dartmouth	CSO16	9/13/2016	-	900
FMZ31	FG432	CO	123 Hawthorne Street, Dartmouth	MH18040	4/9/2018	-	1200
FMZ32	FG102	CO	3 Jamieson St, Dartmouth	MH50274	9/17/2016	4/2/2018	600
FMZ32/46	FG93	CO	1 Jamieson St, Dartmouth	MH50281	9/17/2016	4/2/2018	1500
FMZ32	FG433	CO	14 Jamieson Street, Dartmouth	MH14525	4/3/2018	-	375
FMZ32/46	FG437	CO	1606 Bell Road, Dartmouth	MH2027	4/12/2018	-	1800
FMZ33	FG101	SAN	9 Braemar Drive, Dartmouth	MH56334	9/13/2016	-	1200
FMZ34	FG100	SAN	200 Waveryly Rd, Dartmouth	MH40501	9/16/2016	-	525
FMZ35	FG99	SAN	158 Lakeshore Park Terr, Dartmouth	MH54156	9/13/2016	-	900
FMZ36	FG98	SAN	120 Thornhill Drive, Dartmouth	MH14682	9/16/2016	-	250
FMZ36	FG348	SAN	120 Thornhill Drive, Dartmouth	MH14682	9/16/2016	-	250
FMZ41	FG90	CO	7 Nowlan Street, Dartmouth	MH17846	9/12/2016	-	900
FMZ45	FG92	SAN	Corner of Station Rd. & Pleasant St, Dartmouth	MH30125	9/16/2016	3/14/2018	375
FMZ75	FG466	SAN	Highway of Heros (off road in grass behind Mcdonalds)	MH30305	4/11/2018	-	600
FMZ76	FG467	SAN	500 Pleasant Street, Dartmouth	MH19631	4/23/2018	-	250
Model 1	FG349	SAN	47 Portland Hills Drive, Dartmouth	MH29730	3/22/2017	3/15/2018	450
Model 2	FG350	SAN	2 Matthew Francis Ct, Dartmouth	MH29098	3/23/2017	3/15/2018	250
Model 3	FG351	CO	Oceanview Drive, Dartmouth	CSO19	3/21/2017	3/15/2018	750
Model 4	FG352	CO	28 Maitland Street, Dartmouth	MH17721	3/22/2017	3/15/2018	1200
Model 5	FG353	SAN	390 Waveryly Road, Dartmouth	PS100	3/22/2017	3/15/2018	750
Model 7	FG372	CO	58 Shore Rd, Dartmouth	MH50367	6/15/2017	3/15/2018	900
Model 8	FG373	CO	11 Ferguson Rd, Dartmouth	MH14418	7/19/2017	3/15/2018	525
Model 9	FG368	CO	11 Ferguson Rd, Dartmouth	MH14443	7/19/2017	3/15/2018	600

The location of the Dartmouth flow monitors is in Figure 10 below, followed by the catchment delineation in Figure 11 and the recommended catchments for RDII reduction are illustrated in Figure 12.

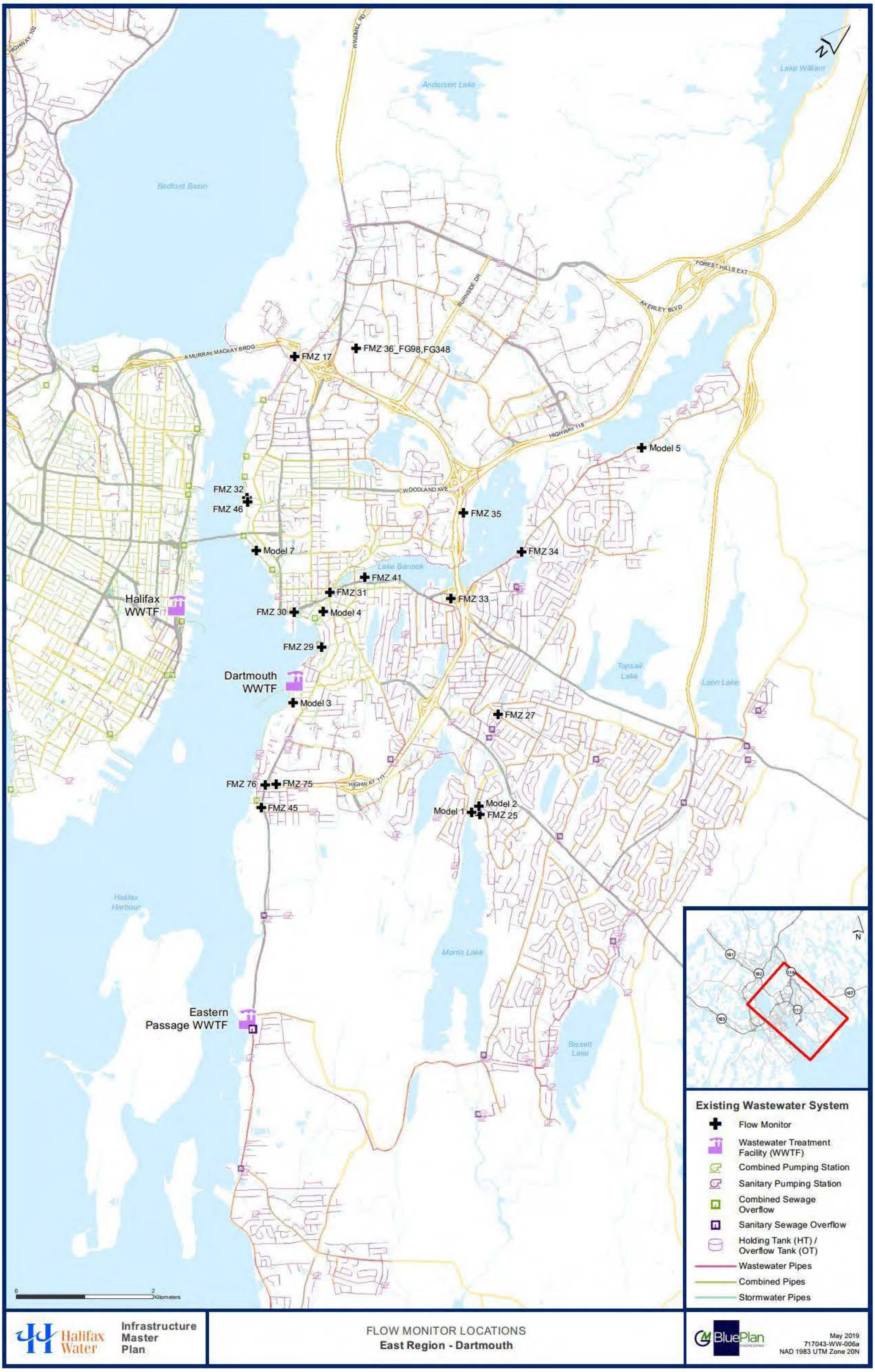


Figure 16 - Flow Monitor Location – Dartmouth

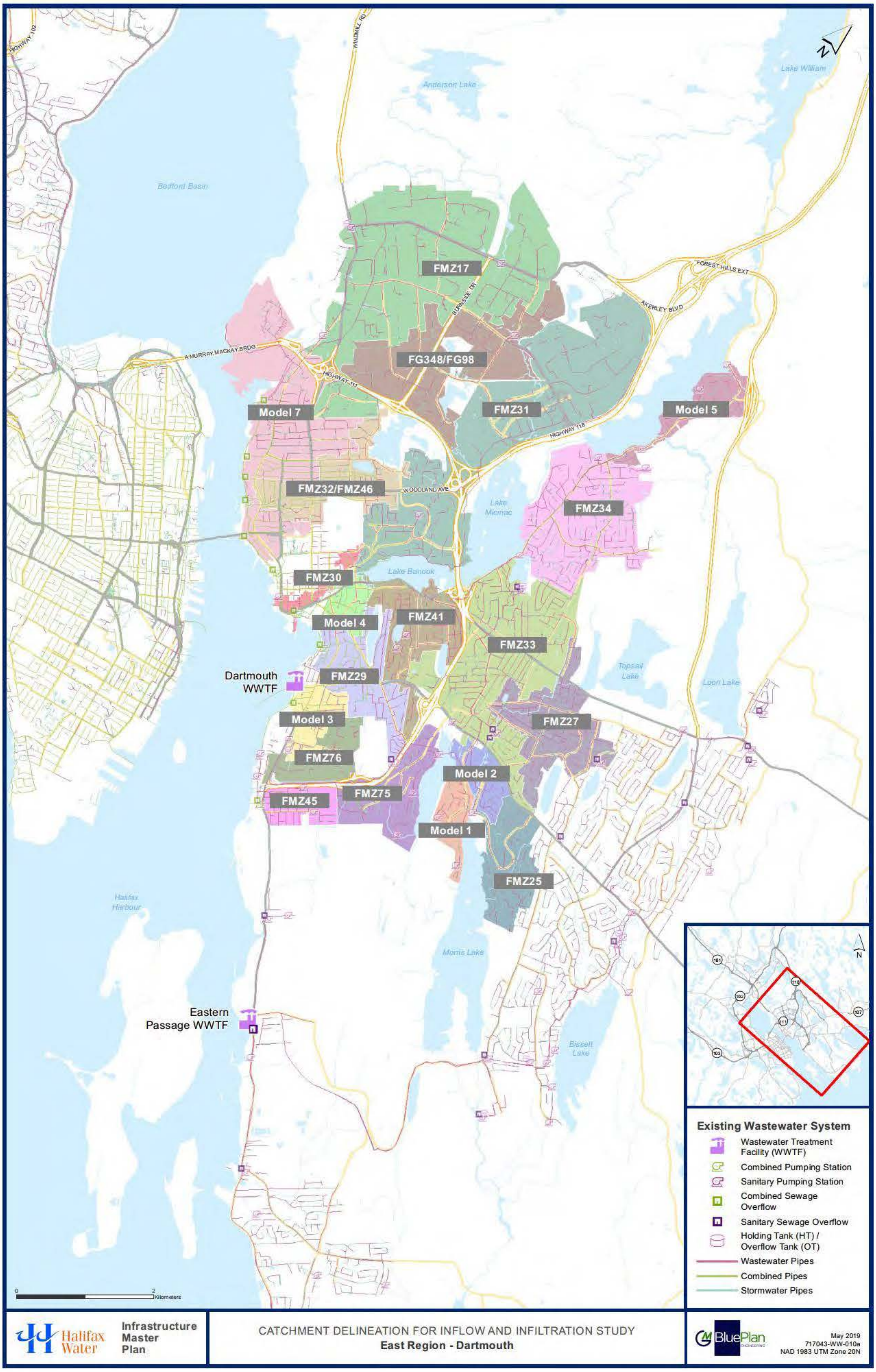


Figure 17 - Catchment Delineation – Dartmouth

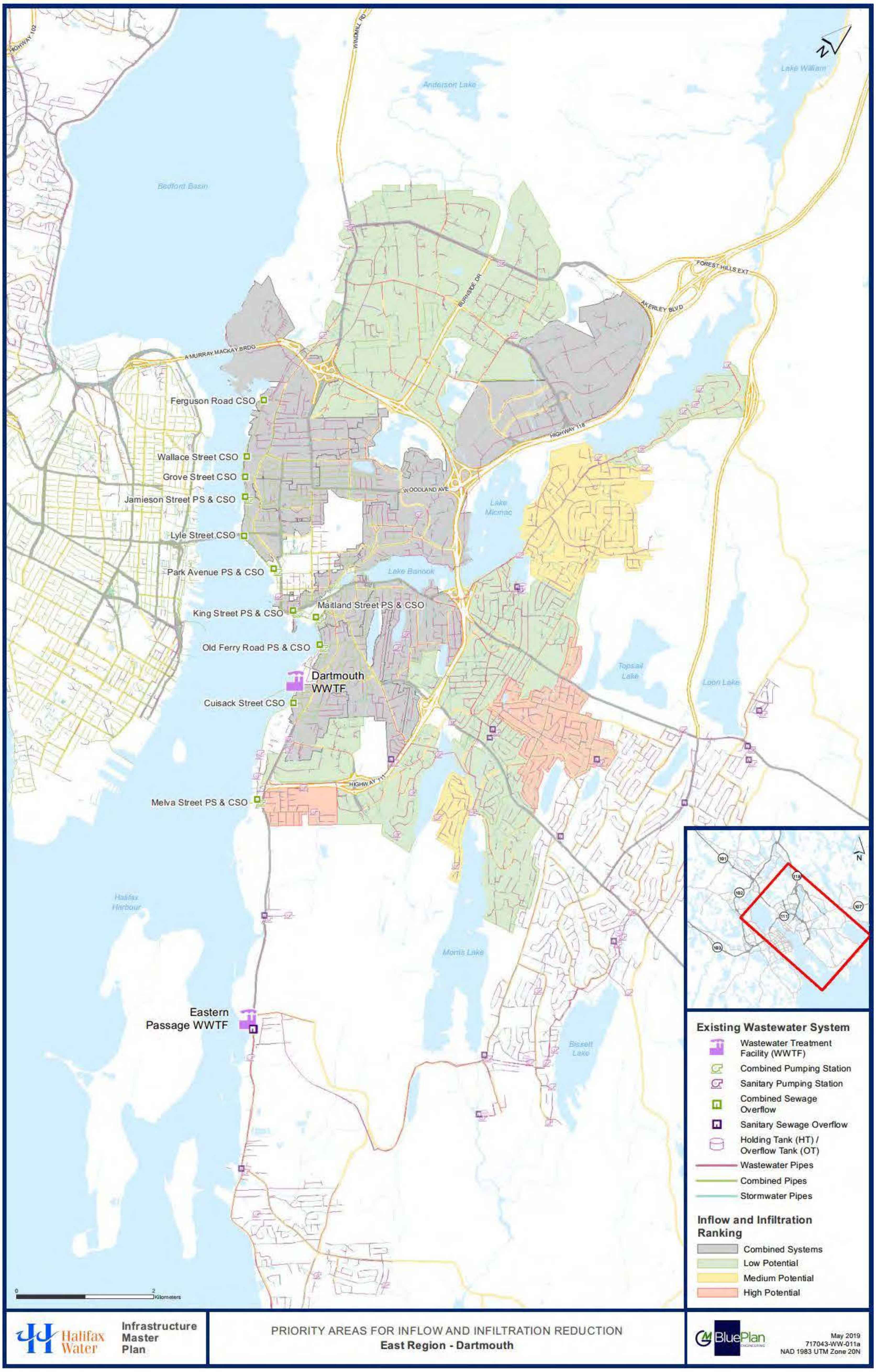


Figure 18 - Catchment Prioritization for Inflow and Infiltration Reduction – Dartmouth

Date:	July 3rd, 2019	File:	716006
To:	David Blades, Halifax Water		
From:	Bryan Bortolon, GM BluePlan Engineering		
Project:	Halifax Water Flow Monitoring Program		
Subject:	Detailed Flow Analysis for the RDC Flow Monitors		

1. INTRODUCTION

This technical memorandum provides an overview and summary of the RDC flow monitor surveys that were completed as part of the Halifax Water Flow Monitoring Program. The flow monitors were installed for approximately one year, from September 2016 to September 2017, with the intent of recording flows and assessing performance of newly developed areas. Different land uses were captured by the four RDC monitors including residential, multi-residential, and commercial areas; Section 3.1 describes the upstream catchment of each monitor.

FGID	Catchment Name	General Location	Manhole ID	Pipe ID
FG119	RDC 1	620 Nine Mile Drive	MH40630	P455832
FG118	RDC 2	671 Larry Uteck Blvd	MH40621	P455826
FG115	RDC 3	120 Southgate Drive, Bedford	MH49223	P504403
FG113	RDC 4	72 Gale Terrance, Dartmouth	MH45771	P500808

Flow analyses were completed for each dataset. A description of the analysis modules is provided in Section 2 and Section 3 summarizes the analysis outputs. The analysis was completed using quarterly splits to account for seasonality, which allows for a more accurate assessment of dry weather and wet weather conditions.

Quarter	Season	Months (1, 2, 3, 4)
1	Winter	January / February / March
2	Spring	April / May / June
3	Summer	July / August / September
4	Autumn	October / November / December

It should be noted that all flow monitor and rain gauge data is expressed in the Coordinated Universal Time (UTC) zone.

2. ANALYSIS METHODOLOGY

This section outlines the methodology of the Wastewater Inflow and Infiltration Flow Analysis Tool (WiiFAT).

The flow monitors were calibrated and maintained on a weekly to bi-weekly schedule by AMG Environmental. Flow monitor data was continuously collected and reviewed with a full data QA/QC by AMG. The flow monitor and precipitation data were provided to GM BluePlan, where it had further QA/QC scrutiny and was then imported into the WiiFAT and used to complete a full suite of analyses, including:

Identification of Critical Precipitation Events

The precipitation data, collected by the rain gauge nearest to the flow monitor location, was used to identify and summarize all precipitation events during the reporting period. The precipitation events were filtered to include only critical events, which have a minimum total precipitation depth of 25 mm. Considerations were made for events that were just under meeting the 25 mm total depth criteria but had a high peak 1-hour intensity, generally greater than 5 mm/hour. Intensity-Duration-Frequency (IDF) information from the Environment Canada Atmospheric Environment Service (AES) weather station at Shearwater Airport was used to quantify a return period for each critical event.

Review of Velocity-Depth Scatter Graph

The relationship between the flow monitor velocity and depth data was used to evaluate the performance of the flow monitors and assess the pipe flow conditions. The scatter graphs can be used to either identify issues with the flow monitor, such as malfunctioning sensors, or better understand flow characteristics, such as backwater and surcharging.

Dry Weather Flow Analysis

Precipitation data was used to identify and summarize dry weather days, from which 5 representative weekdays and 5 weekend days were selected. The selected dry weather days were used to assess and calculate dry weather flow variables, graph the 24-hour average dry weather flow diurnal curves, and determine the hourly dry weather flow factors. The base groundwater infiltration rate (BGWI) was calculated using the Stevens-Schutzbach method.

Quantification of Rainfall Derived Inflow and Infiltration (RDII)

The flow monitoring data, precipitation data, and results from the dry weather flow analysis were used to quantify the catchment's response (RDII) to each critical precipitation event. Key RDII variables were calculated, which include the Unit Peak RDII (L/s/ha) and the Volumetric Runoff Coefficient (Cv). The Cv is defined as the rainfall that entered the sewer system as a percentage of the total precipitation that fell on the catchment area. Wet weather flow graphs were developed to illustrate the different flow components.

Estimation of Design Flows

Results from the quantification of RDII were used to estimate the flows that might be expected in response to different design storms based on the Shearwater IDF curves. The design flow equivalents, based on observed data and catchment characteristics, are compared against current design criteria and theoretical pipe flow capacity.

3. FLOW MONITOR ANALYSIS

ACRONYMS

ADWF	average dry weather flow = average sanitary flow + BGWI
BGWI	base groundwater infiltration
MNF	minimum nighttime flow
CE	critical event
RDII	rainfall derived inflow and infiltration
Cv	volumetric runoff coefficient
IDF	intensity-duration-frequency

3.1. Flow Monitor Installation and Catchment Specifications

Table 1 and Table 2 summarize the flow monitor installation and catchment specifications that were used in the flow analysis exercise. Figures 1-4 highlight the general location of the four RDC flow monitors.

TABLE 1: FLOW MONITOR INSTALLATION

Catchment Name	Manhole ID	Pipe ID	Sewer System	Install Date	Removal Date
RDC 1	MH40630	P455832	Sanitary	7-Sept-2016[1]	5-Oct-2017
RDC 2	MH40621	P455826		7-Sept-2016[1]	6-Oct-2017
RDC 3	MH49223	P504403		7-Sept-2016	5-Oct-2017
RDC 4	MH45771	P500808		13-Sept-2016	5-Oct-2017

[1] Due to very low flows recorded at this site, an ultrasonic monitor and a flume were installed on December 6, 2016. Data for 2016-Q4 was disregarded and not included as part of the analysis.

TABLE 2: CATCHMENT SPECIFICATIONS

Catchment Name	Catchment Area (ha)	Population (cap)	Total Sewer Length (km)	Rain Gauge
RDC 1	11.8	647	1.2	Mill Cove WWTF – RA9
RDC 2	4.3	572	0.2	Mill Cove WWTF – RA9
RDC 3	46.3	1,710	4.4	Mill Cove WWTF – RA9
RDC 4	197.0	3,647	8.0	Mt. Edward RES – RA1

General Notes:

- The catchment for RDC 1 is primarily residential land with one multi-residential building. The RDC 1 flow monitor is located downstream, but near, to the private pumping station on Armenia Drive, which services the multi-residential building. Due to the proximity of the pumping station, flow spikes are observed throughout the monitoring period as the pumps turn on and off.
- The catchment for RDC 2 contains three multi-residential buildings.
- The catchment for RDC 3 is primarily residential land with townhouses and a large portion of wooded area. It is noted that there are multi-residential buildings that connect into the same manhole as the RDC 3 flow monitor, however this inflow is downstream of the monitor.
- The catchment for RDC 4 is primarily commercial land and contains a significant amount of impermeable area. There are two forcemains for the John Savage Avenue Pumping Station in the GIS that was provided, one travelling south on John Savage and the other east along Wright towards the RDC 4 flow monitor. After discussions with Halifax Water, it is thought that only one forcemain is active and flows are only conveyed south along John Savage and not to RDC 4; this was the assumption carried forward in the analysis.

The remainder of Section 3 highlights the key flow analysis outputs for the RDC flow monitors.

Figure 1: Overview of RDC Monitors and Catchments

FIGURE 2: RDC 1 AND RDC 2 CATCHMENT AREAS

FIGURE 3: RDC 3 CATCHMENT AREA

FIGURE 4: RDC 4 CATCHMENT AREA

3.2. Velocity-Depth Scattergraphs

Velocity-depth scattergraphs were created to assess the monitor performance and flow hydraulics. The following summarizes the flow hydraulics observed during the flow monitoring period:

RDC 1: a flume was installed at this site due to very low flows; therefore, velocity-depth scattergraphs could not be created.

RDC 2: a flume was installed at this site due to very low flows; therefore, velocity-depth scattergraphs could not be created.

RDC 3: generally good flow hydraulics. Curve suggests that the monitor is installed in a steep pipe, however confirmation of pipe slope is required as the flow hydraulics do not follow the theoretical manning equation curve.

RDC 4: good flow hydraulics; curve generally follows theoretical manning equation curve.

3.3. Population Estimates and Per Capita Sanitary Flow Rates

Population equivalents were estimated for each RDC catchment so that per capita consumption and per capita sanitary flow rates could be calculated. Population numbers were originally estimated using 2016 census data, however they are high-level estimates using dissemination blocks, only residential, and significant development has occurred within these catchments since the count. Population equivalents for each of the four catchments were calculated using water meter points and assumed population densities and these values were carried forward in the per capita analysis.

Per capita water consumption and per capita sanitary flow rates were calculated for each catchment using billing data and flow monitoring analyses respectively. The two methods of assessing the per capita rates were compared and summarized in a memo, which is provided in Appendix A.

<u>Results</u>

RDC 1: primarily residential with one high-rise building.

- Per capita sanitary flow rates are significantly low in comparison to billing and previous statistical analyses. The calculations are made using the 5-minute interval data, which may be impacted by an upstream pumping station at the high-rise building that frequently turns on and off. The flow data is potentially being underestimated and a more refined data capture would be required to improve the accuracy of flow data. However, the per capita consumption rate is generally in line with the 25% quartile.

RDC 2: three multi-residential buildings.

- The per capita sanitary flow rates are in line with the average per capita water use rates and the 25% quartile.

RDC 3: primarily residential with townhouses.

- The per capita sanitary flow rates are in line with the average per capita water use rates and the 25%-50% quartile range.

RDC 4: contains primarily commercial buildings; population numbers correspond to a population equivalent.

- The average per capita sanitary flow is in line with the average per capita water use.

3.4. Base Groundwater Infiltration Assessment

Base groundwater infiltration was assessed as part of the dry weather analysis to quantify the amount of groundwater entering the system.

Results

RDC 1: BGWI < 0.01 L/s/ha; only 1,200m of sewer in this catchment area.

RDC 2: BGWI < 0.01 L/s/ha; only 200m of sewer in this catchment area.

RDC 3: BGWI approximately 0.02 L/s/ha.

RDC 4: BGWI approximately 0.01 L/s/ha.

All flow monitoring catchment areas appear to have relatively low levels of BGWI[1], expected with new infrastructure.

3.5. Wet Weather Flow Analysis

A wet weather analysis was completed for each flow monitor to calculate key wet weather variables and assess how the catchment areas generally respond to precipitation.

The analysis was originally completed for all precipitation events that met the critical rainfall criteria (total depth greater than 15 mm) and using an approach in line with industry best practice; the final design flow results for this analysis are provided in Appendix B.

The observed Peak RDII values, and subsequently the design storm flows, were estimated at significantly high levels because of various analysis constraints. It was noted that there are difficulties with assessing observed Peak RDII response for catchments RDC 1 and RDC 2, due to the following:

- Noise caused by low flows suggests false Peak RDII when using traditional flow analysis approach (wet weather flow subtract average dry weather flow).
- Although the precipitation gauge was located close by, the recorded precipitation could potentially differ from that which fell on the small flow monitor area.
- Both RDC 1 and RDC 2 flows are also impacted by upstream pumping stations, which result in large flow spikes.

For these reasons, the traditional approach for calculating wet weather response was refined with further detail analysis.

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[1] Halifax Water's design criteria for inflow and infiltration is 0.28 L/s/ha. For wet weather flow management analysis and master planning 0.20 L/s/ha is allocated to Peak RDII and 0.08 L/s/ha is allocated to BGWI.

Wet Weather Analysis Results

The observed peak RDII (L/s/ha) varies by precipitation event and is typically correlated with the intensity of rain. For context, Halifax Water's current design criteria for I/I is 0.28 L/s/ha[2]. The following summarizes the general results:

RDC 1: observed peak RDII range 0.04 - 0.16

- Flow spikes caused by apartment building pumping impacted typical wet weather analysis, resulting in overestimated observed Peak RDII values (see Figure 6).
- An exercise was completed to remove spikes/apartment flows and assess observed Peak RDII of the remaining area (see Figure 5).
- Although the analysis was improved, it remained difficult to eliminate all noise.

RDC 2: observed peak RDII range 0.16 - 0.37

- RDC 2 monitor experienced flow spikes as well, however they could not be removed in the same manner as RDC 1 since the entire catchment flows are from three apartment buildings; removing the spikes would essentially leave no flow.
- Furthermore, there is very little infrastructure to assess, making it difficult to isolate such low flow conditions.
- The observed peak RDII are likely over-estimated due to the high pumping peaks.

RDC 3: observed peak RDII range 0.05 - 0.16

RDC 4: observed peak RDII range 0.01 - 0.11

- It should be noted that significant development occurred within the RDC 4 catchment area during the monitoring period. It does not appear as though the wet weather analysis was impacted by the ongoing construction.

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[2] Halifax Water's design criteria for inflow and infiltration is 0.28 L/s/ha. For wet weather flow management analysis and master planning 0.20 L/s/ha is allocated to Peak RDII and 0.08 L/s/ha is allocated to BGWI.

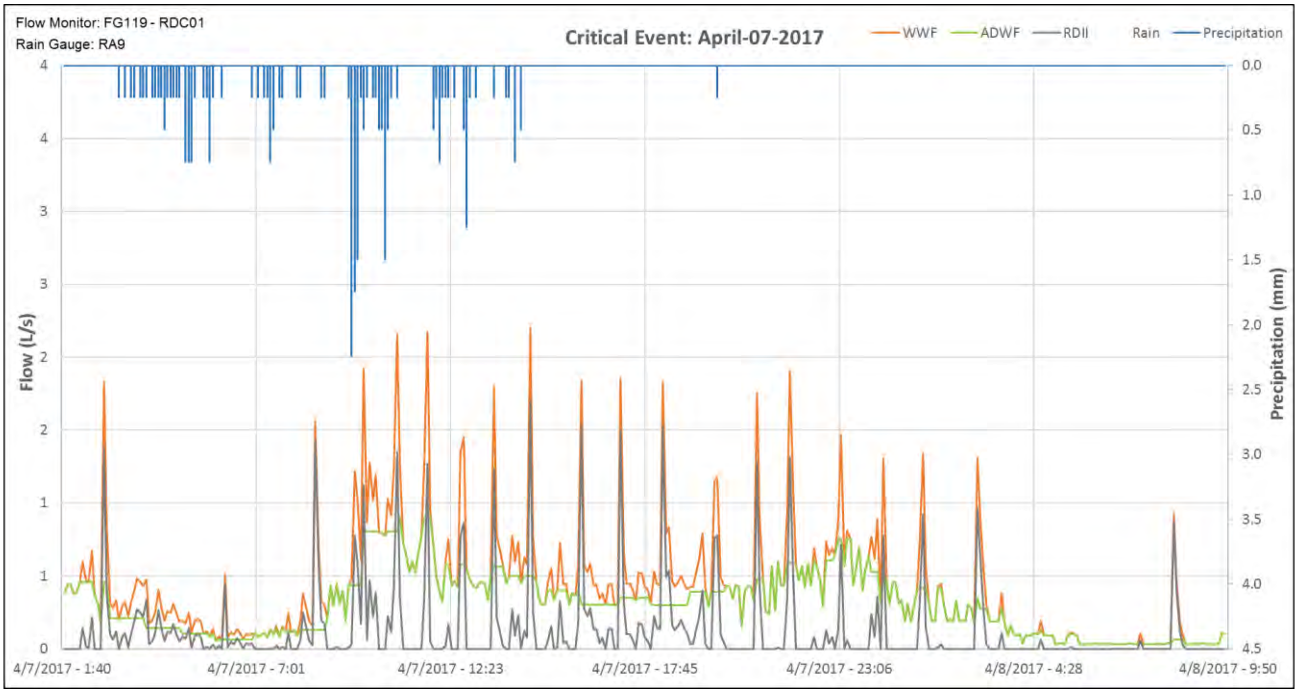


FIGURE 5: RDC 1 FLOWS WITH PUMPING STATION

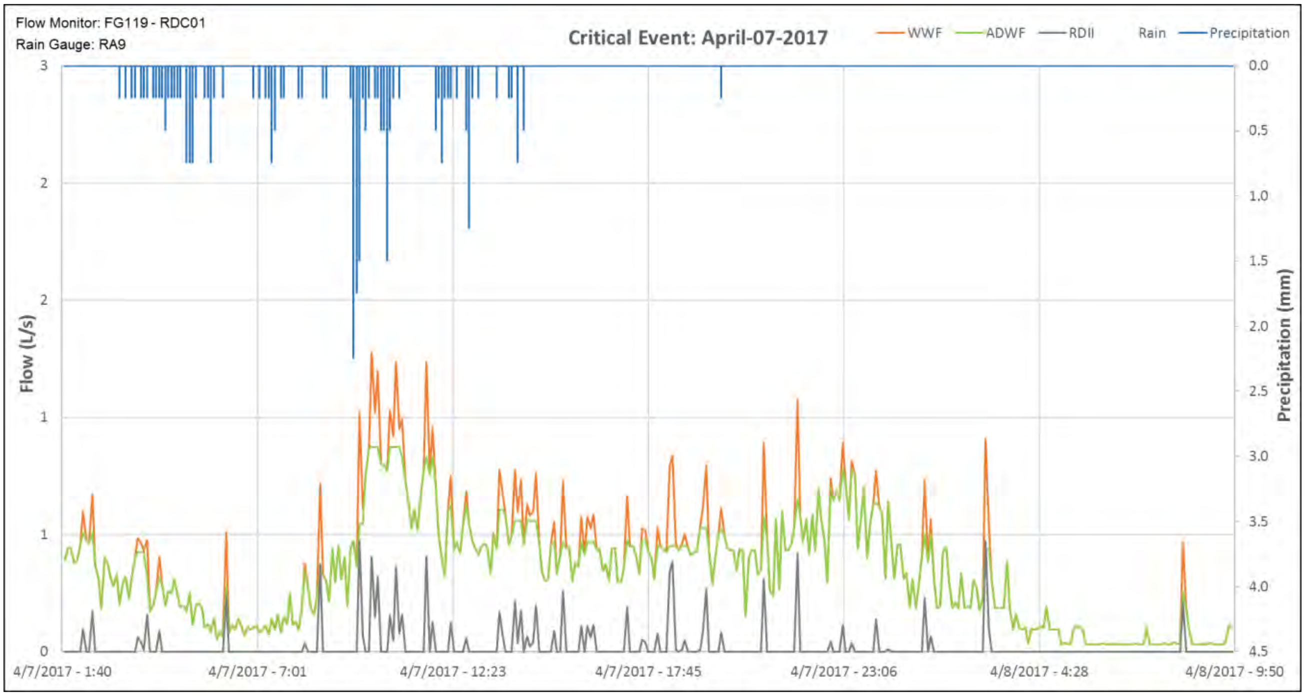


FIGURE 6: RDC 1 FLOWS WITHOUT PUMPING STATION

3.6. Design Flow Envelopes

A design flow envelopes exercise was completed to extrapolate the "observed" Peak RDII values, from the wet weather flow analysis, using the Shearwater IDF curve data. This process allows for the calculation of a best-fit line (with outliers removed) and estimation of wet weather response under various design storms. The estimated design flows for each flow monitor are presented in Table 3.

The Halifax Water Design and Construction Specification does not assign a corresponding return period to the inflow and infiltration allowance; however, common industry practice is that the RDII allowance should correspond to a 1 in 25-year design storm for separate sanitary systems.

TABLE 3: ESTIMATED DESIGN FLOWS

Return Period	RDC 1		RDC 2		RDC 3		RDC 4	
	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)
Design Criteria	**0.20**	**2.0**	**0.20**	**0.9**	**0.20**	**9.3**	**0.20**	**39.4**
2-Year	0.08	0.8	0.28	1.2	0.16	7.5	0.07	14.6
5-Year	0.10	1.0	0.35	1.5	0.20	9.4	0.09	18.1
10-Year	0.11	1.1	0.40	1.7	0.23	10.6	0.10	20.5
25-Year	**0.13**	**1.3**	**0.45**	**1.9**	**0.26**	**12.2**	**0.12**	**23.5**
50-Year	0.14	1.4	0.50	2.1	0.29	13.3	0.13	25.7
100-Year	0.15	1.5	0.54	2.3	0.31	14.5	0.14	27.9

Conclusion

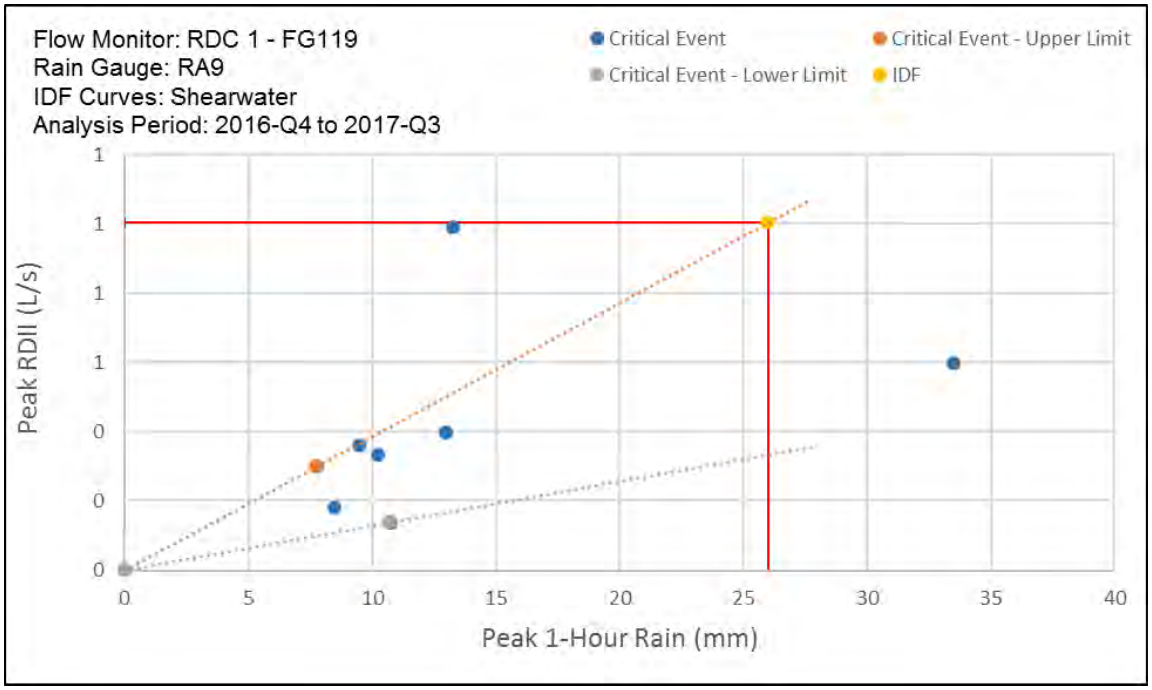
All flow monitors demonstrate some response to precipitation. Although not significant response in comparison to other older parts of the HRM collection system, it is anticipated that as this infrastructure ages, sources of RDII will increase. It is important to note that the design criteria value is intended to represent the I/I allowance over the life of the infrastructure.

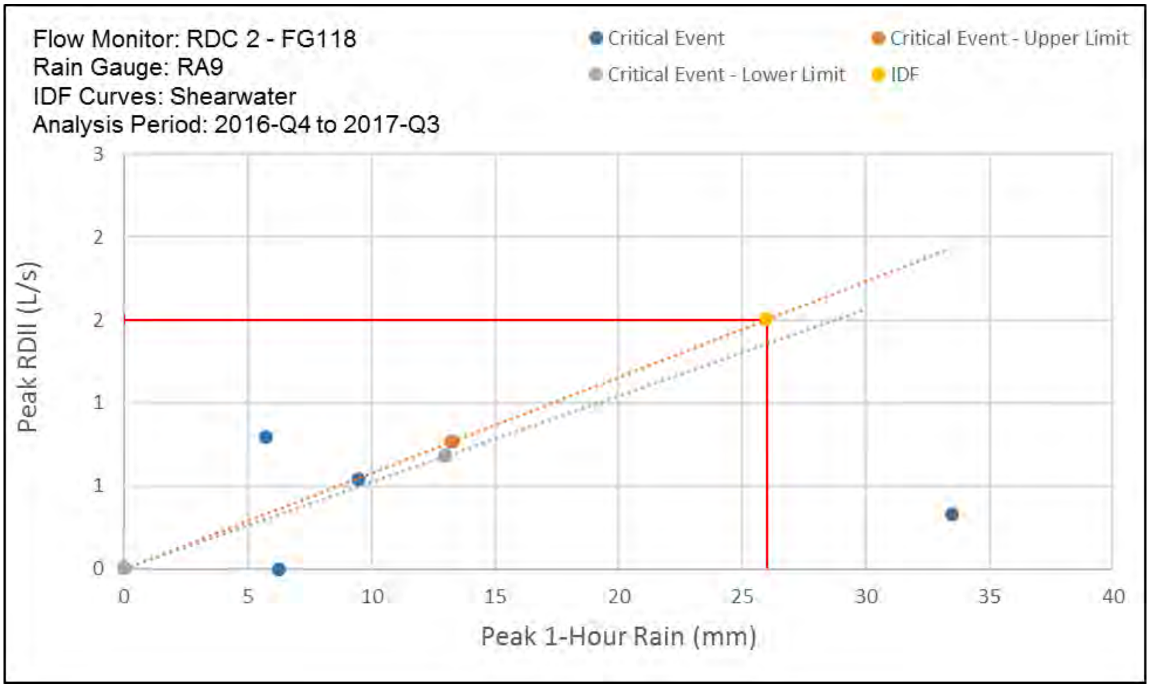
RDC 1: catchment currently performing better than design criteria (> 100-year)

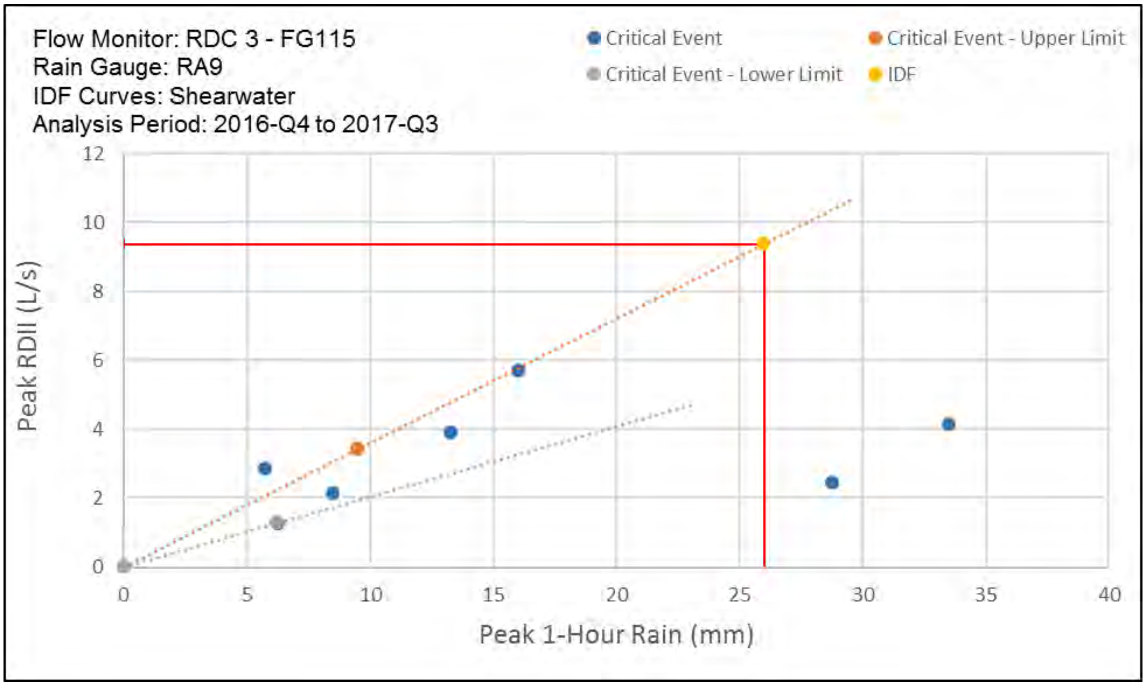
RDC 2: observed Peak RDII flows impacted by pumping spikes, conclusion cannot be made.

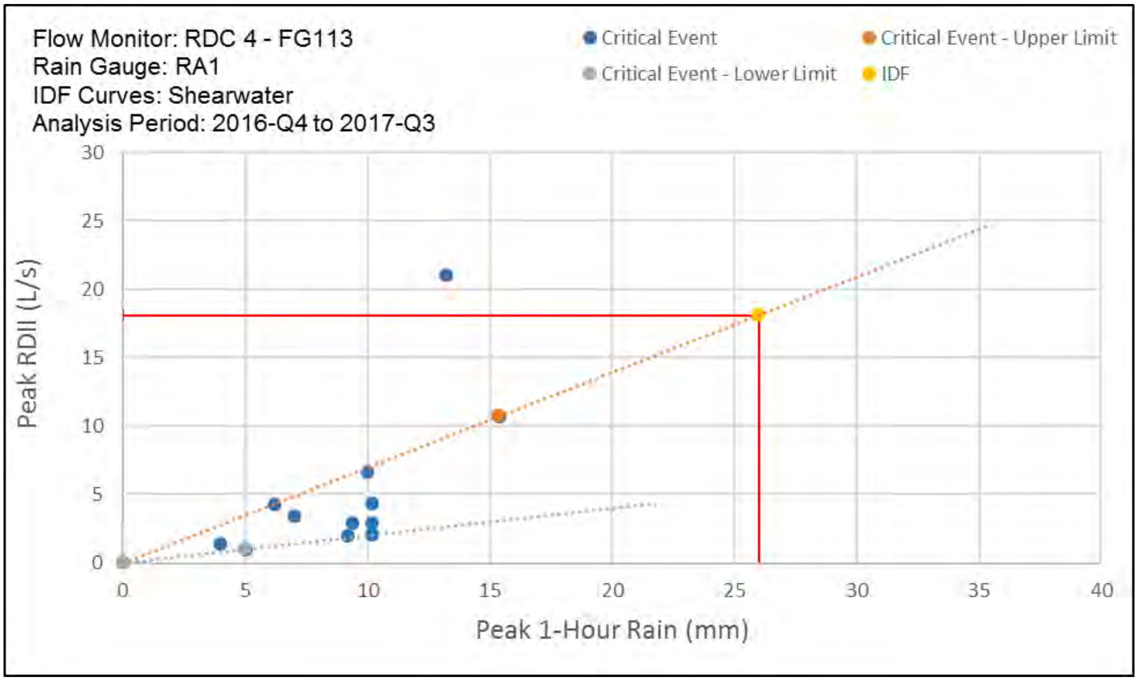
RDC 3: catchment currently performing less than design criteria (5-year).

RDC 4: catchment currently performing better than design criteria (> 100-year).


Flow Monitor: RDC 1 - FG119
Rain Gauge: RA9
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
● Critical Event
● Critical Event - Upper Limit
● Critical Event - Lower Limit
● IDF
Peak RDII (L/s)
1
1
1
1
0
0
0
0
5
10
15
20
25
30
35
40
Peak 1-Hour Rain (mm)


Flow Monitor: RDC 2 - FG118
Rain Gauge: RA9
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
● Critical Event
● Critical Event - Upper Limit
● Critical Event - Lower Limit
● IDF
Peak RDII (L/s)
3
2
2
1
1
0
0
5
10
15
20
25
30
35
40
Peak 1-Hour Rain (mm)


Flow Monitor: RDC 3 - FG115
Rain Gauge: RA9
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
● Critical Event
● Critical Event - Upper Limit
● Critical Event - Lower Limit
● IDF
Peak RDII (L/s)
0
2
4
6
8
10
12
Peak 1-Hour Rain (mm)
0
5
10
15
20
25
30
35
40


Flow Monitor: RDC 4 - FG113
Rain Gauge: RA1
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
● Critical Event
● Critical Event - Upper Limit
● Critical Event - Lower Limit
● IDF
Peak RDII (L/s)
0
5
10
15
20
25
30
Peak 1-Hour Rain (mm)
0
5
10
15
20
25
30
35
40

4. CONCLUSION AND RECOMMENDATIONS

After a detailed analysis and review of the RDC flow monitoring catchments, which is intended to support the wastewater collection system design criteria memo developed as part of the infrastructure master plan, the following is concluded and recommended:

- It is evident from flow monitoring analysis that Per Capita Sanitary rates vary across the system depending on land use and building type. The RDC monitor catchments fell between the 25-50% quartiles.
- The design criteria of 300 L/cap/day is appropriate and there is no evidence suggesting that it should be changed.
- It is evident from flow monitoring analysis that observed Peak RDII varies by event depending on the depth and intensity of precipitation. After normalizing the observed response to the Halifax IDF curve data, the RDC catchments generally appear to be performing above design criteria levels, however do show some sort of response, which is may worsen over time as the infrastructure ages.
    - Design criteria should be such that it can be used to plan for the lifespan of infrastructure under specific design conditions.
- The design criteria of 0.28 L/s/ha is appropriate and there is no evidence suggesting that it should be changed.

Appendix A – Population Estimate Memo

Date: June 28th, 2019 File: 716006
To: David Blades, Halifax Water
From: Bryan Bortolon
Project: Halifax Water Flow Monitoring Program
Subject: Population Estimates and Per Capita Sanitary Flow Rates for RDC Flow Monitor Catchments

TECHNICAL MEMO

Introduction

The purpose of this memo is to outline the approach used to estimate population numbers and per capita consumption rates for flow monitor catchments RDC 1, RDC 2, RDC 3, and RDC 4. Population numbers were originally estimated using 2016 census data, however they are high-level estimates using dissemination blocks, only residential, and significant development has occurred within these catchments since the count. Population equivalents for each of the four catchments were calculated using water meter points and assumed population densities and these values were carried forward in the per capita analysis.

Per capita water consumption and per capita sanitary flow rates were calculated for each catchment using billing data and flow monitoring analyses respectively. The two methods of assessing the per capita rates were compared and summarized in this memo.

Population Numbers (2016 Census Approach)

The 2016 Census data was used to estimate the residential population for each RDC catchment area; Table 1summarizes the results.

Table 1: 2016 Census Population Estimates

Catchment	Residential Population Estimate
RDC 1	602
RDC 2	886
RDC 3	1,376
RDC 4	10

Population Numbers (Water Meter and Densities Approach)

The following was completed to estimate population equivalents for each RDC catchment, using water meters and assumed densities:

1. A spatial analysis was used to total the number of premises (meter points) within each RDC catchment, filtered by residential and multi-residential premise type.
    a. It was assumed that a premise equates to one dwelling for residential properties.
    b. The number of units were provided for the RDC 1 and RDC 2 multi-residential premises:
        i. 671 Larry Uteck (89)
        ii. 635 Larry Uteck (88)
        iii. 630 Larry Uteck (77)
        iv. 76 Armenia Drive (70)
    c. The average quarterly billing data for the above multi-residential units was used to calculate an average per unit use, and this was applied to the RDC 3 multi-residential premises to estimate the number of units.
2. For commercial premises, the building footprint GIS layer was used to calculate the total square footage of units within each RDC catchment.

3. The following densities were used to estimate population numbers by premise type, and overall, for each RDC catchment (see Table 2):
    a. Residential: 3.35 ppl/dwelling
    b. Multi-Residential: 2.25 ppl/dwelling
    c. Commercial: 0.02 ppl/m^2

Table 2: RDC Catchment Population Estimates by Dwelling Type and Overall

	Residential		Multi-Residential		Commercial			
Catchment	# of Premises	Population	# of Units	Population	Footprint (m^2)	Population	Total Population Equivalents	2016 Census Approach
RDC 1	146	489	70	158			**647**	602
RDC 2			3	572			**572**	886
RDC 3	429	1,437	10	217	2,833	57	**1,710**	1,376
RDC 4					182,365	3,647	**3,647**	10

Per Capita Sanitary Flow

Raw flow data (October 1, 2016 – June 30, 2017) was imported into a flow analysis tool for each RDC flow monitor, which was used in addition to the estimate population numbers to estimate the per capita sanitary flow. The following approach was used to calculate the per capita sanitary flows, in line with typical industry standards:

1. Five (5) dry weather flow (DWF) days were selected to generate an average DWF diurnal curve.
2. An average dry weather flow (ADWF) value was calculated.
3. The average sanitary flow (ASF) was estimated by removing base groundwater infiltration (BGWI) from the ADWF; BGWI was calculated using the Stevens-Schutzbach method.
4. The per capita sanitary flow was estimated using the ASF and the estimated population.

Per Capita Water Use

Water billing data for (April 2015 – June 2017) was assessed to estimate the per capita water use within each RDC catchment:

1. Average quarterly water use was calculated for each premise.
2. Spatial analysis was used to sum the quarterly water usage within each RDC catchment.
3. The quarterly water use per catchment and the population estimates were used to estimate a per capita water use for each RDC catchment.

Per Capita Rate Summary

Table 3 summarizes the estimated average per capita sanitary flow from the flow monitor analysis and the average per capita water use from the billing data analysis.

Table 3: Analysis Outputs

Catchment	Estimate Population Equivalents	Average Sanitary Flow (L/day)	Average per Capita Sanitary Flow (L/cap/day)	Average Consumption (L/day)	Average per Capita Water Use (L/cap/day)
RDC 1	647	48,960	76	77,551	120
RDC 2	572	69,984	122	73,387	128
RDC 3	1,710	277,344	162	261,318	153
RDC 4	3,647	330,480	91	336,628	92

Per Capita Rate Summary

Halifax Water has a comprehensive flow monitoring program with over 100 active flow monitors. A summary of the variability in per capita sanitary flow rates is provided in Figure 1, which is a statistical analysis of all flow monitors using 2017 analysis results.

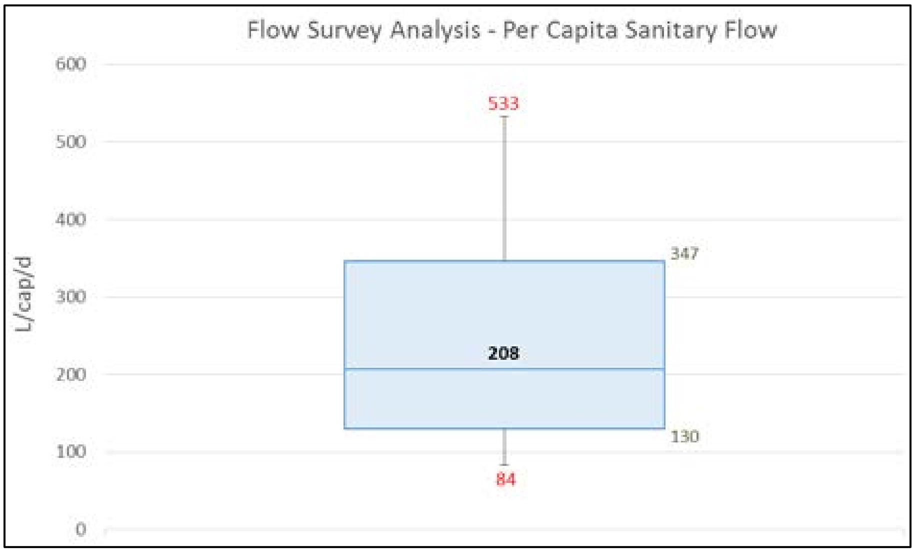


Figure 1: Per Capita Sanitary Flow Statistical Analysis

Conclusion

RDC 1: primarily residential with one high-rise building.

Per capita sanitary flow rates are significantly low in comparison to billing and previous statistical analyses. The calculations are made using the 5-minute interval data, which may be impacted by an upstream pumping station at the high-rise building that frequently turns on and off. The flow data is potentially being underestimated and a more refined data capture would be required to improve the accuracy of flow data. However, the per capita consumption rate is generally in line with the 25% quartile.

RDC 2: three multi-residential buildings.

The per capita sanitary flow rates are in line with the average per capita water use rates and the 25% quartile.

RDC 3: primarily residential with townhouses.

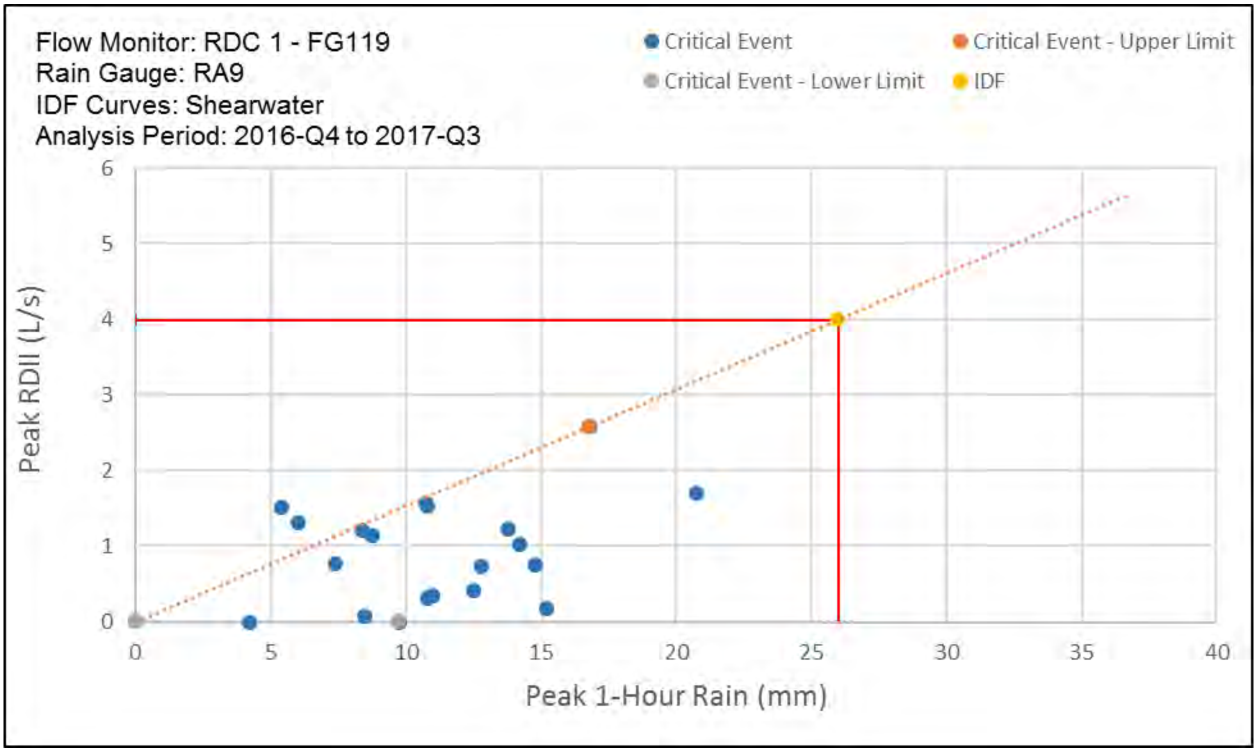
The per capita sanitary flow rates are in line with the average per capita water use rates and the 25%-50% quartile range.

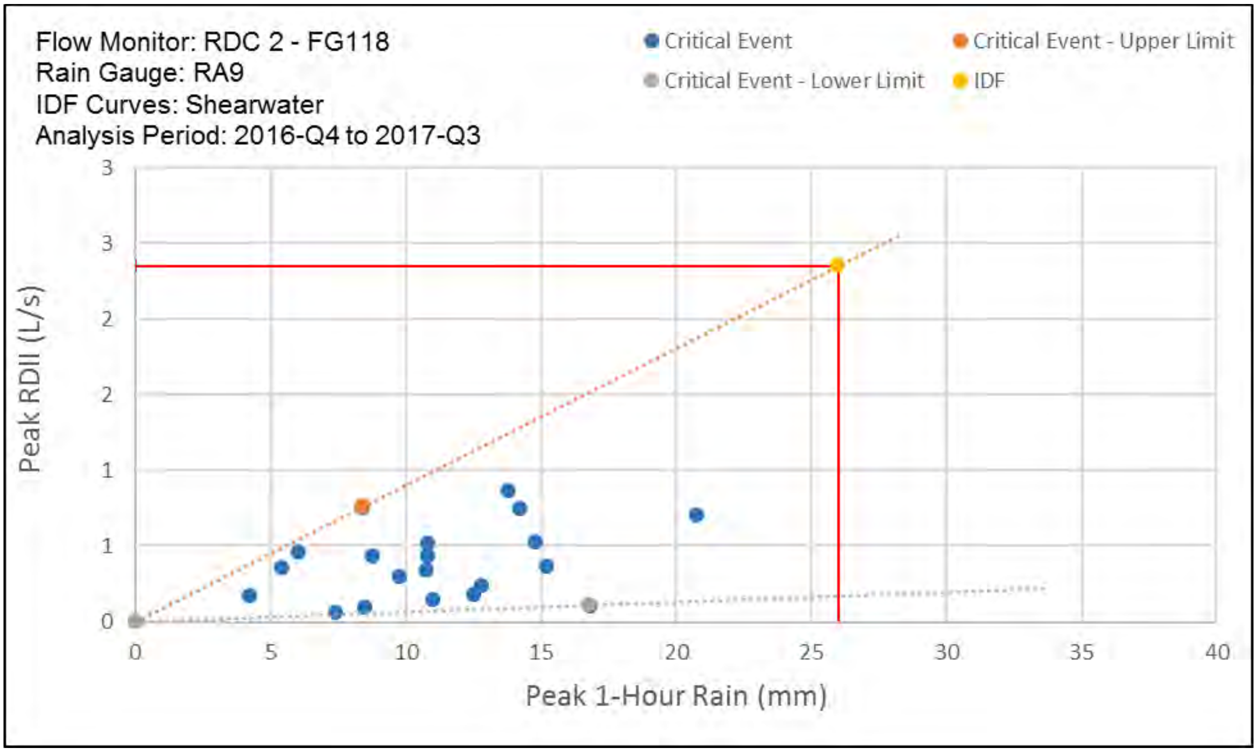
RDC 4: contains primarily commercial buildings; population numbers correspond to a population equivalent.

The average per capita sanitary flow is in line with the average per capita water use.

Appendix B – Original RDC Monitor Analysis Results

Return Period	RDC 1		RDC 2		RDC 3		RDC 4	
	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)	Unit Peak RDII (L/s/ha)	Peak RDII (L/s)
Design Criteria	**0.20**	**2.0**	**0.20**	**0.9**	**0.20**	**9.3**	**0.20**	**39.4**
2-Year	0.31	3.2	0.44	1.9	0.31	14.4	0.11	21.3
5-Year	0.39	4.0	0.55	2.4	0.39	17.9	0.13	26.5
10-Year	0.44	4.5	0.62	2.7	0.44	20.3	0.15	29.9
25-Year	0.51	5.2	0.71	3.0	0.50	23.2	0.17	34.3
50-Year	0.56	5.7	0.78	3.3	0.55	25.4	0.19	37.6
100-Year	0.60	6.2	0.84	3.6	0.60	27.6	0.21	40.8


Flow Monitor: RDC 1 - FG119
Rain Gauge: RA9
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
Critical Event
Critical Event - Upper Limit
Critical Event - Lower Limit
IDF
Peak RDII (L/s)
0
1
2
3
4
5
6
0
5
10
15
20
25
30
35
40
Peak 1-Hour Rain (mm)


Flow Monitor: RDC 2 - FG118
Rain Gauge: RA9
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
Critical Event
Critical Event - Upper Limit
Critical Event - Lower Limit
IDF
Peak RDII (L/s)
0
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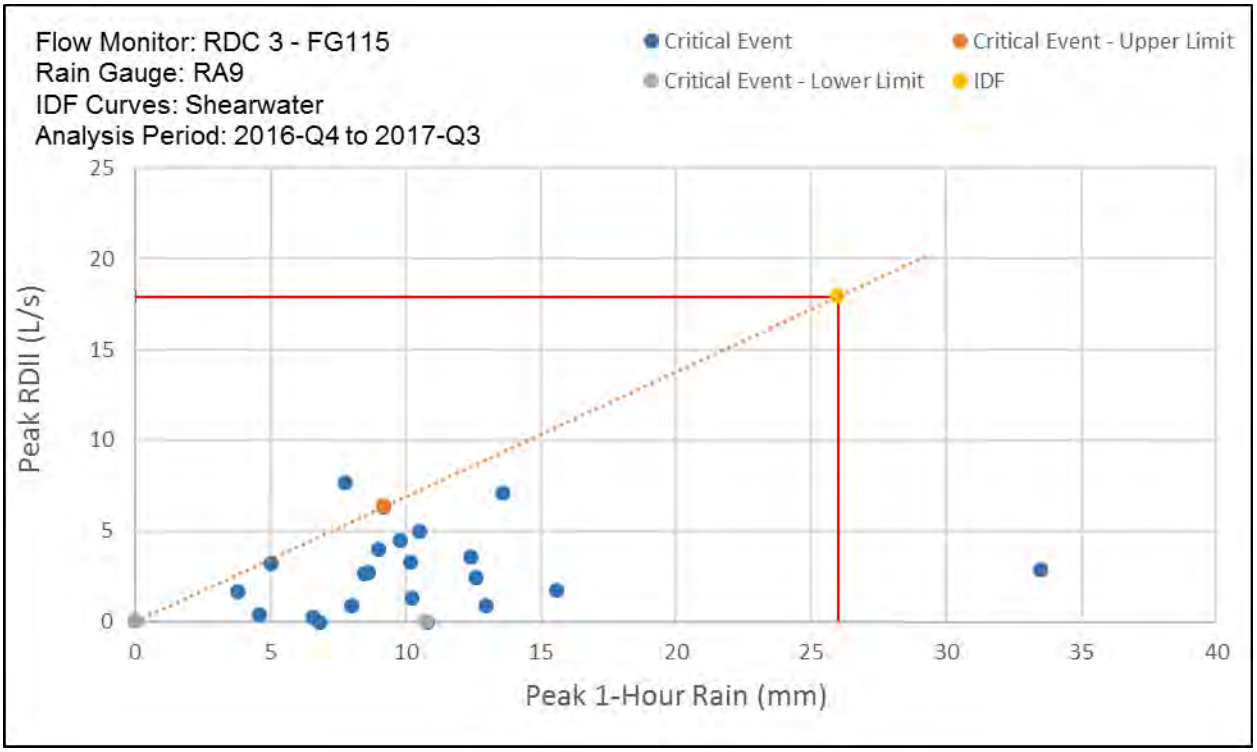
40
Peak 1-Hour Rain (mm)


Flow Monitor: RDC 3 - FG115
Rain Gauge: RA9
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
● Critical Event
● Critical Event - Upper Limit
● Critical Event - Lower Limit
● IDF
Peak RDII (L/s)
0
5
10
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20
25
Peak 1-Hour Rain (mm)
0
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10
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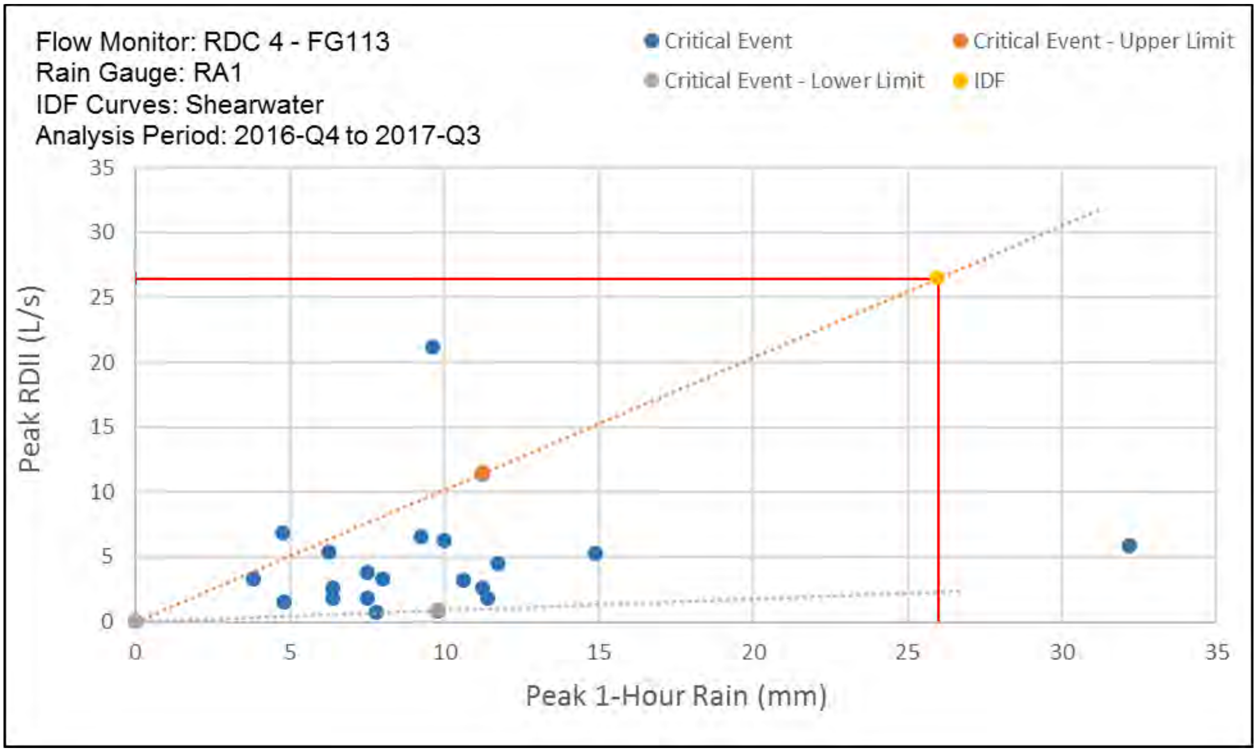
30
35
40


Flow Monitor: RDC 4 - FG113
Rain Gauge: RA1
IDF Curves: Shearwater
Analysis Period: 2016-Q4 to 2017-Q3
● Critical Event
● Critical Event - Upper Limit
● Critical Event - Lower Limit
● IDF
Peak RDII (L/s)
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25
30
35
Peak 1-Hour Rain (mm)
0
5
10
15
20
25
30
35

Regional Development Charge

Stakeholder Session #1

June 20, 2019

STRAIGHT from the SOURCE

Agenda

- Meeting Objectives
- Infrastructure Drivers
- Categories of Infrastructure
- RDC Objectives
- Current RDC Outline
- Update Process
- Schedule
- Opportunities for Input

Meeting Objectives

- High level introduction to the process
- Review the history of the RDC
- Map out the process for the update
- Schedule and next steps

Infrastructure Drivers

- Halifax Water has three corporate drivers:

Asset Renewal, Growth and Compliance

Asset Management Plans
ASSET RENEWAL

Infrastructure Master Plan
GROWTH

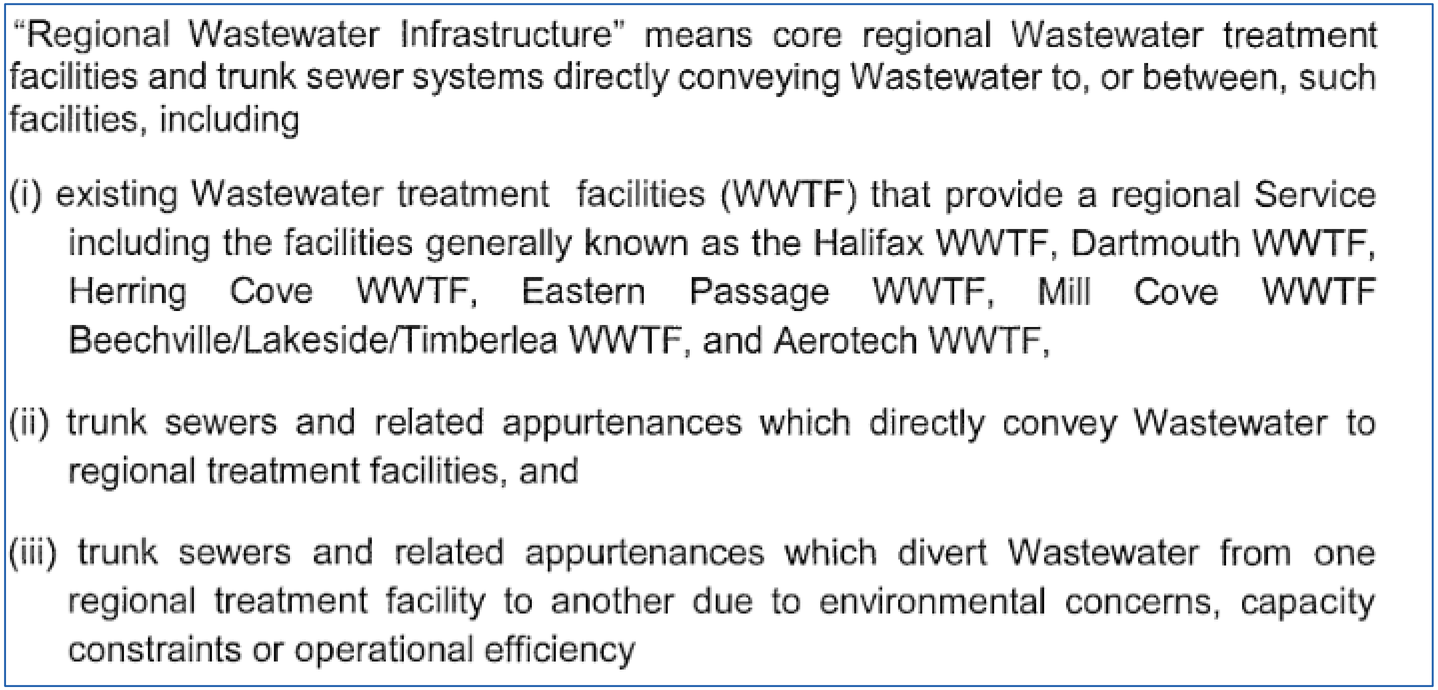
Compliance Plan
COMPLIANCE

Categories of Infrastructure

- Three Categories - Regional, Area Master and Local Infrastructure

Regional Infrastructure Wastewater and Water Infrastructure only

As defined in Halifax Water's Rules and Regulations Section 29 & 30

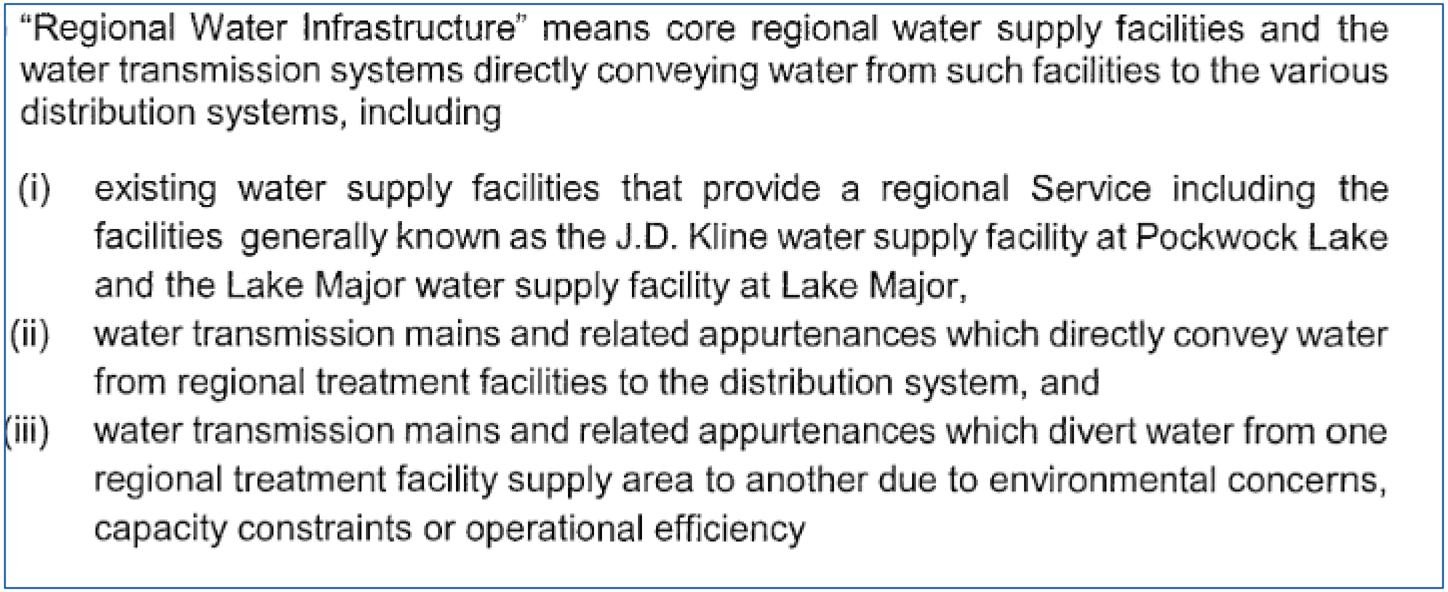


"Regional Wastewater Infrastructure" means core regional Wastewater treatment facilities and trunk sewer systems directly conveying Wastewater to, or between, such facilities, including

(i) existing Wastewater treatment facilities (WWTF) that provide a regional Service including the facilities generally known as the Halifax WWTF, Dartmouth WWTF, Herring Cove WWTF, Eastern Passage WWTF, Mill Cove WWTF Beechville/Lakeside/Timberlea WWTF, and Aerotech WWTF,

(ii) trunk sewers and related appurtenances which directly convey Wastewater to regional treatment facilities, and

(iii) trunk sewers and related appurtenances which divert Wastewater from one regional treatment facility to another due to environmental concerns, capacity constraints or operational efficiency



"Regional Water Infrastructure" means core regional water supply facilities and the water transmission systems directly conveying water from such facilities to the various distribution systems, including

(i) existing water supply facilities that provide a regional Service including the facilities generally known as the J.D. Kline water supply facility at Pockwock Lake and the Lake Major water supply facility at Lake Major,
(ii) water transmission mains and related appurtenances which directly convey water from regional treatment facilities to the distribution system, and
(iii) water transmission mains and related appurtenances which divert water from one regional treatment facility supply area to another due to environmental concerns, capacity constraints or operational efficiency

During the update process, we will be reviewing the definition for wastewater and for the potential addition of a fourth bullet to support infrastructure projects pertaining to flow reduction activities as an alternative to large, new, regional infrastructure

Categories for Infrastructure

Area Master	Oversized Infrastructure that benefits a Master Plan Community, with multiple land owners. A Capital Cost Contribution Charge is established to fund the oversized components that benefit servicing of multiple properties. Where planned infrastructure benefits existing customers, Halifax Water contributes to the cost. *Examples - Bedford South, Bedford West, Russell Lake Estates*
Local	Developer constructs the infrastructure required to service their subdivision.

RDC Objectives

- Funds oversizing, upgrading of existing or installation of new infrastructure to accommodate growth
- Plan required infrastructure to align with the timing of growth
- Coordinate infrastructure to be efficient and cost effective manner
- Proportion charges to ensure equity and “cost causer pay”
- Conduct 5-year updates to ensure currency in costs, strategy and technology
- Develop a financial model to smooth the costs of large infrastructure requirements

Current RDC Outline

- RDC was approved in July 2014, (phased in)
  - Projected growth (HRM)
  - Developed infrastructure plan and associated costs to service the growth
  - Created a charge – 20 year Horizon
- 3 different Charges:
  - Single unit & Townhouse units

    Wastewater $4,080.80/unit Water $182.88
  - Multi Unit

    Wastewater $2,740.80/unit Water $122.83
  - Industrial/Commercial/Institutional (ICI)

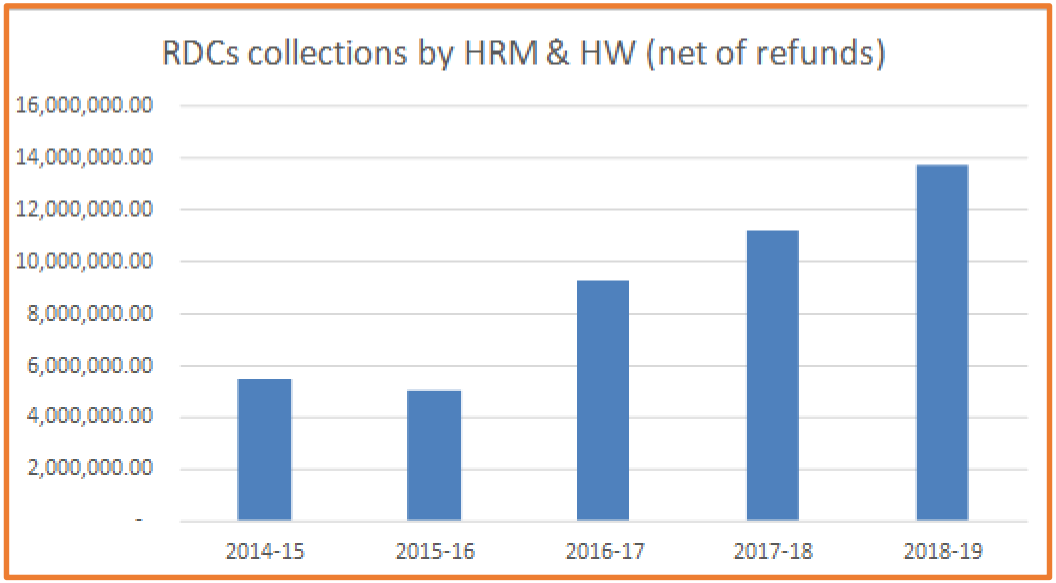
    Wastewater $2.24/sqft Water $0.09/sqft
- Net out demolitions from renovations
- Only charges applied for additional units or floor area for ICI

What has Happened since 2014?

- West Region Wastewater Infrastructure Plan (2016)
- Population Updates
  - HRM’s Active Mobility Plan,
  - Regional Centre review and
  - Assignment of growth nodes
- Review of Design Criteria (Presentation 2016)
- Cost Estimation review (2016)
- Evaluation of current charge based on WRWIP (15%) (Jan 2018)
- East and Central Region Infrastructure Plans (July 2019)
- Incorporate all 3 IMPs into one document in 2019 dollars (July 2019)
- Benefit to Existing (BTE) Policy (2019)

Collected to Date

$ 44.5 M has been collected since 2014


RDCs collections by HRM & HW (net of refunds)

	2014-15	2015-16	2016-17	2017-18	2018-19
Total $	5,452,019.44	5,012,522.98	9,230,594.04	11,160,737.10	13,689,198.88

Spent to Date & Near Term Projections

- Lakeside Diversion Project - $6.6 M
- Fairview & Clayton park Sewer Lining -$3 M
- Kearney Lake Road – Design work
- Sewer Separation – Design work

Five year capital budget has $113m in RDC funded project (2019-20 to 2023-24)

- Kearney Lake Road Upgrades - $5 M
- Bedford HWY tunnel – $14.4 M
- Timberlea PS and forcemain

Update Process

1. Identify amount, type and location of growth to a fixed horizon
2. Identify servicing needs to accommodate growth
3. Identify capital costs to provide services to meeting the needs
4. Deduct
   - Grants, subsidies and other contributions
   - Benefit to existing customers (BTE)
5. Net costs are then allocated between residential and non-residential (ICI)
6. Net costs divided by growth to provide the RDC Charge

Additional Considerations

- Review of benefit to existing, post period and oversizing scenarios
- Inflow and Infiltration (I/I) analysis with area focused flow monitoring
- Incorporating Inflow and Infiltration projects into the RDC project list
    - There will be I/I solutions in this RDC as an alternative to “big pipe solutions”. The I/I solutions are a more cost effective and better long term solution

Supporting Studies – Session 2

- Wastewater Design Criteria, Level of Service Objectives and Policy Review
    - Matter number M08221 https://uarb.novascotia.ca/fmi/webd/UARB15 Exhibit H-2(i)
- Water Design Criteria, Level of Service Objectives and Policy Review
- RDC Flow Monitoring of New Developments
- Benefit to Existing Position Paper
    - Matter number M09065 https://uarb.novascotia.ca/fmi/webd/UARB15 Exhibit H-4
- Wet Weather Flow Management Study (being updated)
    - Matter number M08221 https://uarb.novascotia.ca/fmi/webd/UARB15 Exhibit H-2(i) for West Region

Schedule

- Stakeholder Session #1 – June 20, 2019
- Share Stakeholder meeting materials - July 5, 2019
- Staff available to address questions arising from materials
- Stakeholder Session #2 – August 22, 2019
- One on One Stakeholder meetings- August 23- September 30, 2019
- Stakeholder Session #3 – September 27, 2019
- Report to HRWC Board – October, 2019
- Application to NSUARB – November, 2019
- NSUARB Hearing - February, 2020

Questions or Comments?

Memo

To: RDC Stakeholders

From: Kenda MacKenzie, P.Eng.

Date: June 7, 2019

Re: Regional Development Charge Review

In 2014, Halifax Water established the Regional Development Charge (RDC). There is a requirement to review and update the RDC on a five cycle; the first five-year review period is scheduled for 2019.

Halifax Water has developed a schedule for stakeholder engagement over the next few months:

- Stakeholder Session No. 1 – June 20, 2019
- Stakeholder Session No. 2 – Mid-August 2019
- Individual Stakeholder Sessions (by request) – Early September 2019
- Stakeholder Session No. 3 – Late September

The sessions will be an opportunity to discuss the charge and how it has been implemented, share the background information that supports the charge, receive feedback from the stakeholder group and discuss our path forward. The RDC will incorporate the infrastructure programs developed as part of the ongoing Infrastructure Master Plan project.

This memo is formally inviting you to the session on June 20, 2019 at 2 pm. An agenda will be shared closer to the meeting date. Many of you are receiving this invitation as your association is viewed as a Stakeholder in the upcoming update of the Regional Development Charge or you were copied on the information provided during the last Hearing M05811. If you do not wish to receive further emails on this topic, please advise and we will remove you from the email list.

Halifax Water appreciates your feedback as it relates to the update of the RDC. If you have any questions or comments, do not hesitate to contact me at mackenk@halifaxwater.ca or 902-237-7116.

Wastewater Design Criteria, Level of Service Objectives and Policy Review

Infrastructure Master Plan

Prepared by
GM BluePlan for:

Halifax Water

Project No. 714058
July 5, 2019

Glossary of Terms and Acronyms

The following table provides a summary of terms and acronyms that are commonly used throughout the report.

Term or Acronym	Definition
HRM	Halifax Regional Municipality
NSE	Nova Scotia Environment
WRWIP	West Region Wastewater Infrastructure Plan
LoWSCA	Local Wastewater Servicing Capacity Assessment Study
RDC	Regional Development Charge
RWWFP	Regional Wastewater Functional Plan
HWDS	Halifax Water Design Specifications
LOS	Level of Service
WWTF	Wastewater Treatment Facility
DWF	Dry Weather Flow
WWF	Wet Weather Flow
RDII	Rainfall Derived Inflow and Infiltration
WER	Wastewater Effluent Regulations
BGWI	Base Groundwater Infiltration Rate

Table of Contents

FIGURES

1 Introduction

This technical memorandum is an updated of the Design Criteria, Policy, and Level of Service Review for the wastewater network, that was completed under the 2017 West Region Wastewater Infrastructure Plan (WRWIP), as a supporting study. This revised version, includes the major components of the WRWIP Design Criteria, Policy, and Level of Service Review, with additional information used to inform the completion of the Infrastructure Master Plan and subsequent long-term planning projects. The main changes in this revision include additional material on key performance indicators and the outcomes of the Environmental Risk Assessment, in the policy review.

The report is sectioned into the three key areas of review; Design Criteria, Level of Service and Policy. The Design Criteria section presents the design criteria summary completed in the WRWIP and the current Design Criteria for proposed growth in the Infrastructure Master Plan.

The Level of Service (LOS) review aims to establish the performance indicators and targets that will be used to assess the overall performance of infrastructure and identify the triggers for new infrastructure or infrastructure upgrades.

The section covering Policy builds on the extensive review completed as part of the RWWFP and WRWIP and includes new material on environmental assessments.

A major outcome of the WRWIP Design Criteria, Policy, and Level of Service Review, was adjusting the Design Standards which is detailed in this technical memorandum, with supporting information from the WRWIP. For simplicity the Design Criteria, Policy, and Level of Service Review completed under the WRWIP, has been refer to as the WRWIP in this technical memorandum.

2 Design Criteria

A Design Criteria review on wastewater was completed under the WRWIP. The review included assessing the 2014 Halifax Water Design and Constriction Specifications, in addition to flow trends and an industry best practice review of other similar regions and municipalities. The WRWIP Design Criteria Analysis is summarized below, alongside how Halifax Water's Design Standards (HWDS) have been updated since the WRWIP.

2.1 Background

Design criteria is set by the Utility/Municipality/Region and used for infrastructure planning. It is used as a system wide approach and a design criteria equation is used to calculate design flows and to size future infrastructure. It is a 'one size must fit all' approach and therefore requires robust values to ensure adequate infrastructure sizing for the majority, not the average number of cases. Design criteria varies across utility providers and is generally based on a combination of local data and national/international industry guidance. It is important that design values consider variability and long-term trends in order to be relevant for the full asset lifecycle.

2.1.1 WRWIP Design Criteria Analyses

A review of the HWDS was completed as part of the WRWIP to assess the average per capita sanitary flow and components of Rainfall Derived Inflow and Infiltration (RDII). The WRWIP Design Criteria Analysis is summarized below, including a summary of the flow trend analysis, water billing analysis, flow survey analysis and industry best practice review.

2.1.1.1 WWTF Flow Trend Analysis

A flow trend analysis was completed to estimate the per capita DWFs across the Halifax West Region. The analysis reviewed 2013-2015 flow data recorded at Halifax, Herring Cove and BLT WWTF's. Precipitation data was used to identify dry weather days, which were used to isolate DWFs. The Halifax West Region average per capita DWF was 324 L/cap/d in 2013, 308 in 2014 and decreased to 297 L/cap/d in 2015.

Due to the large variation in observed DWF, most likely a result of varying amounts of base groundwater infiltration rate (BGWI), further analysis was completed in an attempt to isolate the sanitary flows from the BGWI. When focusing only on months May through October, when flows were at their lowest, the average per capita DWF for the Halifax West Region appears to range from ***237 - 300 L/cap/d*** with an average of ***273 L/cap/d***; the results are summarized in Table 1.

Table 1: Dry Weather Flow Analysis (May to October)

Area	Year	Ave. (MLD)	Ave. per Capita (L/cap/d)	Range
Halifax West Region	2013	76.8	274	250 – 292
	2014	73.3	261	237 – 281
	2015	79.3	283	247 – 300
		76.5	**273**	**237 – 300**

2.1.1.2 Water Billing Data Analysis

A billing data analysis was completed to determine the average consumption rate within the Halifax Region. Using 2011 population data, the overall per capita rate for the Halifax Region was estimated to be 190 L/cap/d.

In order to provide greater resolution, and a better understanding of the variability of per capita consumption rates, an analysis was completed for the Halifax West Region, by spatial area, using Billing Data and Water Meter service points. A statistical analysis was completed to capture an appropriate range of values and remove outliers; the following Table 2 summarizes the results:

Table 2: Per Capita Consumption by TAZ (L/cap/d)

Statistic	Employment	Residential	Combined
Lower Limit	12	107	65
Median	**130**	**206**	**189**
Upper Limit	546	319	330

This analysis provides a better understanding of the variability in per capita consumption rates: residential ranging from ***107 - 319 L/cap/d*** with an average of ***206 L/cap/d***.

2.1.1.3 Flow Survey Analysis

A flow monitoring survey was completed as part of the WRWIP and the Local Wastewater Servicing Capacity Analysis (LoWSCA) projects. The flow monitoring data was used to complete a suite of analyses, including a dry weather flow analysis and an extraneous wet weather flow analysis, for 34 locations. A statistical analysis was completed in order to better understanding the variability of these parameters. RDII was only analyzed for 10 flow monitors that were installed on sanitary (i.e. not combined) sewers. During the flow survey no events exceeded a 1 in 2 year return period. Table 3 summarizes the results of the flow survey analysis.

Table 3: Flow Survey Results

Statistic	Ave. per Capita Sanitary Flow (L/cap/d)	Peak Unit RDII (L/s/ha)
Lower Limit	84	0.19
Median	**208**	**0.52**
Upper Limit	533	1.18

With probable outliers removed, the average per capita sanitary flows range from ***84 - 533 L/cap/d*** with an median of ***208 L/cap/d***; the central 50% ranges from 130 - 347 L/cap/d. Similarly, the average peak unit RDII ranges from ***0.19 - 1.18 L/s/ha*** with an average of ***0.52 L/s/ha*****.** The results area shown on Figure 1, below.

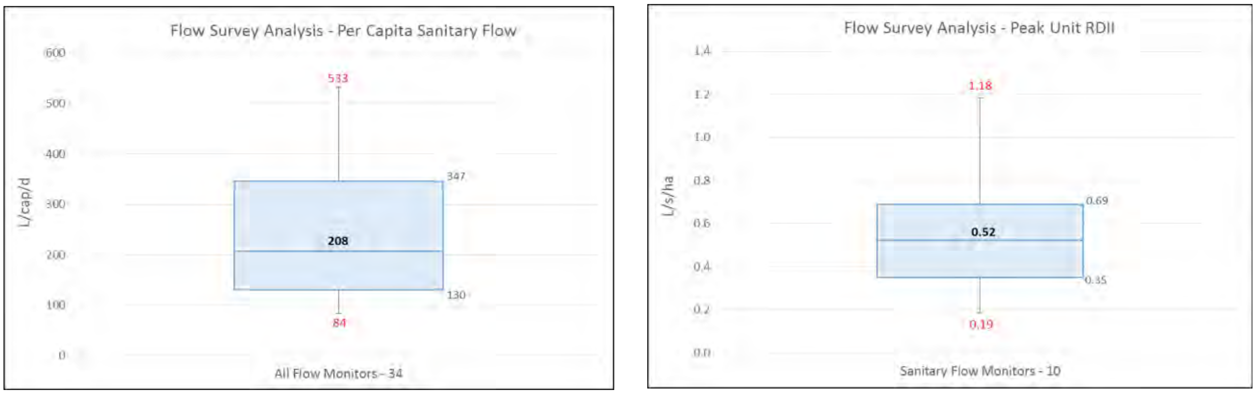


Figure 1: Flow Monitor Analysis Per Capita and Peak RDII Results Whisker Plots

2.1.1.4 Industry Best Practice Review

The industry best practice review was conducted for 10 municipalities and regions with similar population size and/or share parallels with Halifax Water's system, i.e. complex combined sewer systems with discharges to sensitive water bodies. The design criteria averages for these municipalities was:

- Per Capita Sanitary Flow: ***286 L/cap/d*** with a range of ***240 - 345 L/cap/d***
- RDII Allowance: ***0.22 L/s/ha*** with a range of ***0.10 - 0.40 L/s/ha***.

2.1.2 Design Criteria Recommendations

Table 4 summarizes the results from all the WRWIP design criteria analyses.

Table 4: Summary of Design Criteria Analyses and Review

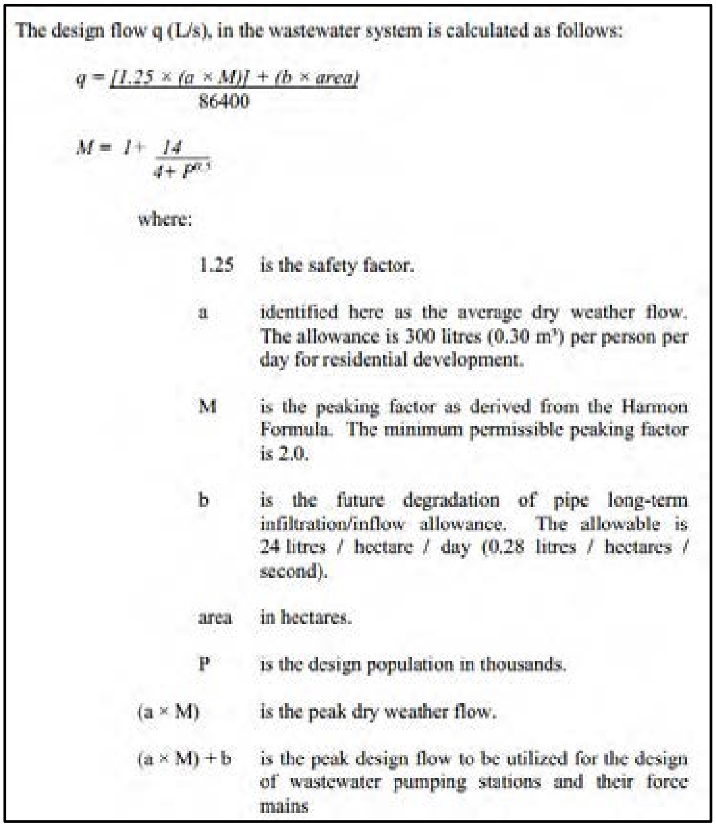
Analysis		Flow Type	Per Capita Sanitary Flow (L/cap/d)	Range	RDII (L/s/ha)	Range
WWTF Flow Trend (May- October)	2013	Dry Weather Flow	274	250 - 292	-	-
	2014		261	237 - 281	-	-
	2015		283	247 - 339	-	-
Billing Data (Residential)		Potable Water Consumption	206	107 - 319	-	-
Catchment Flow		Sanitary Flow	208	84 - 533	0.52	0.19 - 1.18
Industry Best Practice		Sanitary Flow Criteria	286	240 - 345	0.22	0.10 - 0.40
Recommendation			**300**		**0.28**	

The following recommendation were made in the WRWIP, based on the design criteria analyses and review:

- Existing design flow basis be maintained for estimating sanitary design flows, including the 1.25 factor of safety from the HWDS;
- The per capita sanitary flow criteria be reduced from 330 L/cap/d to 300 L/cap/d; and
- The RDII allowance rate remain at 0.28 L/s/ha, as it is found to be a conservative rate based on the industry best practice review.
    - Although the flow monitor analysis indicates that the system is performing worse than the criteria, existing programs will work towards ensuring new infrastructure performs at the 0.28 L/s/ha level.

2.2 **Halifax Water's** Design Criteria

Halifax Water's design specifications for the wastewater system were updated based on the WRWIP recommendations of adjusting the average DWF allowance from 330 to 300l/p/day. The DWF allowance was updated in the 2017 Design Specification for Water, Wastewater & Stormwater Systems, and has been carried forward in subsequent version. The design flow extracted from the 2018 Design Specification & Supplementary Standard Specification for Water, Wastewater & Stormwater, is shown in Figure 2.



The design flow q (L/s), in the wastewater system is calculated as follows:

$$q = \frac{[1.25 \times (a \times M)] + (b \times area)}{86400}$$

$$M = 1 + \frac{14}{4 + P^{0.5}}$$

where:

1.25	is the safety factor.
a	identified here as the average dry weather flow. The allowance is 300 litres (0.30 m³) per person per day for residential development.
M	is the peaking factor as derived from the Harmon Formula. The minimum permissible peaking factor is 2.0.
b	is the future degradation of pipe long-term infiltration/inflow allowance. The allowable is 24 litres / hectare / day (0.28 litres / hectares / second).
area	in hectares.
P	is the design population in thousands.
(a × M)	is the peak dry weather flow.
(a × M) + b	is the peak design flow to be utilized for the design of wastewater pumping stations and their force mains

Figure 2: Halifax Water Design Criteria (sourced from Design Specification & Supplementary Standard Specification for Water, Wastewater & Stormwater, 2018)

3 Level of Service

3.1 Background

A review on Halifax Water level of service (LOS) was completed under the WRWIP, including an industry best practice review of other similar regions and municipalities, from which recommendations were drawn. In general, it was recommended that the CCME national standard guidelines for CSOs and SSOs continue to be followed and infrastructure solutions be identified so that, in light growth, current LOS be maintained, particularly overflow frequency and volume performance. Refer to Section 4 Policy and Regulation Compliance for CCME and CSMMW national standard guidelines on CSO and SSO.

3.2 Existing & Future Level of Service

In the WRWIP the LOS targets were based on the RWWFP, which detailed that modelling analyses be undertaken for each CSO using “average year” rainfall data. This approach was undertaken to conduct the baseline and growth modelling comparisons, as well as to test and size the proposed infrastructure. Historical rainfall data analysis indicated that the year 2003 corresponded well with the Environment Canada Normal total annual precipitation (1254.3 mm). As such, overflow frequencies in the baseline (2003) scenario were used as a starting point to establish the existing LOS for the CSOs and SSOs.

The hydraulic models developed under the Infrastructure Master Plan will be used for defining existing and growth CSO spills frequency and volume, to understand the impact of growth on the existing network.

3.3 WRWIP Level of Service Analysis

Additional LOS reviews were completed under the WRWIP, including the options of defining LOS based on the receiving water quality objectives and beach closures, looking at design storm and the inclusion of climate change. A summary of the WRWIP additional LOS items covering the greater HRM area are below.

3.3.1 Receiving Water Quality Objectives

The Halifax Harbour Task Force (HHTF) established Halifax Harbour specific water quality objectives based on the section of Harbour. Figure 3 presents the HHTF classifications.

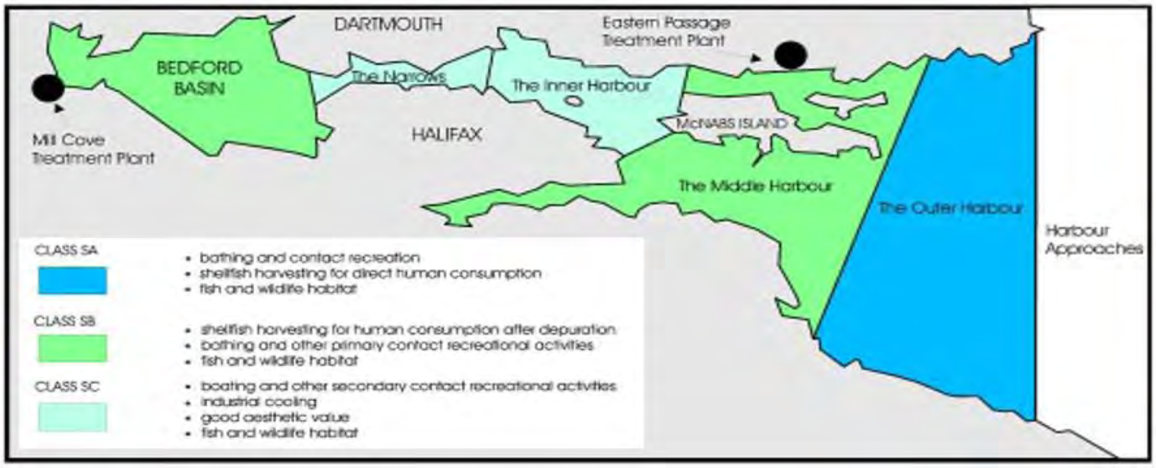


Figure 3: Halifax Harbour Water Quality Classifications

The purpose of HHTF's classification system was to represent the different standards of water quality corresponding to different water uses. It is based on the capacity of the receiving waters to assimilate the discharges and on the uses and importance of the Harbour section to its primary users.

Figure 4 then presents the generalized existing land use along the Bedford Basin and Halifax Harbour. The WRWIP recommended that higher levels of water quality protection should target water quality objectives and higher amenity land use activities, such as parks and residential land use areas.

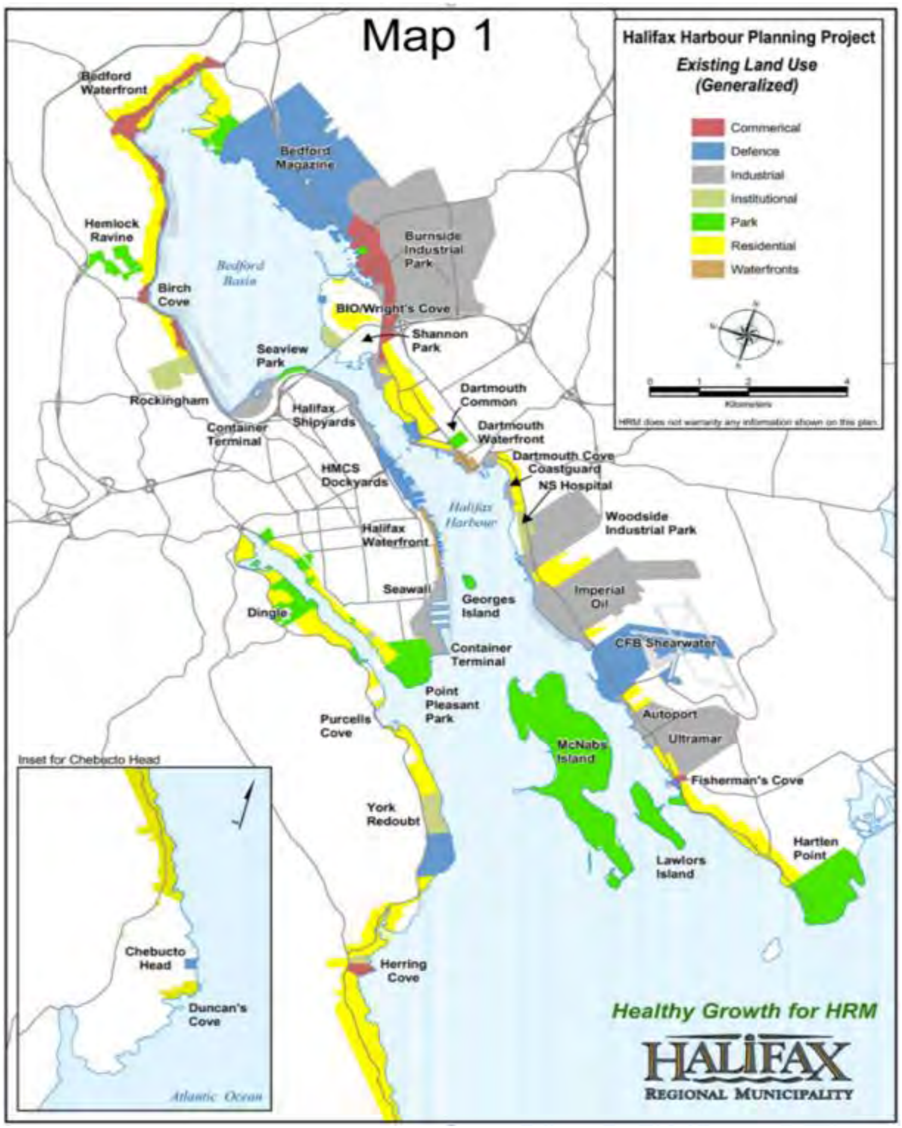


Figure 4: Halifax Harbour Land Use

Under the WRWIP additional investigation into the receiving environment was completed in particular on the Northwest Arm, refer to the WRWIP for recommended guidance on the LOS around tributary areas in the West Region.

Since the WRWIP, an Environmental Risk Assessment was completed for all Halifax Harbour WWTFs (Halifax, Dartmouth, Herring Cove, Mill Cove, and Eastern Passage). This study provided minimum National Performance Standards and recommendations on Effluent Discharge Objectives for the WWTFs. The outcomes of the Environmental Risk Assessment are covered in Section 4 Policy and Regulatory Compliance.

3.3.2 Beach Closures

Beaches provide an important public service and their closures, due to overflow-led contamination, negatively affect the LOS of the wastewater system. A review was carried out to investigate both historic and recent beach closures within the Halifax West Region in the WRWIP. In addition, an industry review was completed to better understand how other regions and municipalities handle beach closures as a result of precipitation related sewage discharges. For more details on the historic beach closures refer to the WRWIP.

3.3.3 Overflow Reduction and Cost of Mitigation

The WRWIP included an analysis to assess the cost effectiveness of potential CSO discharge reductions in comparison to other utility providers that have published information on the strategies and costs that they intend to implement or have implemented to reduce discharges. London, UK relates to a large tunnel solution. Indiana, USA has a consent decree to implement multiple reduction strategies. Portland, USA implemented multiple reduction measures. Table 5 and Figure 5 show the costs of the strategies and the estimated reduction in CSO discharges. Based on the estimated future discharges and the capital cost associated with the RWWFP, it shows that Halifax Water has the potential to greatly mitigate the effect of future growth on CSO discharge levels if it implements the investments outlined in the RWWFP. However, the analysis also shows that the current CSO performance is worse than the comparator examples on a per capita basis. In other words, based on CSO discharges, Halifax Water's current LOS, on a per capita basis, is lower than the comparator examples.

Table 5: Cost Effectiveness of CSO Reduction

Municipalities/Companies	Total Discharge Volume (m^3)	Amount Spent ($)	Population	Total Discharge Volume per Capita (m^3)	Amount Spent Per Capita ($)	Reduced Discharge Volume (m^3)	Reduced Discharge Volume per Capita (m^3)	Volume Reduction/ $ Spent (m^3)	discharge per captia
Halifax Water*	18,541,063	521,451,807	390,096	47.5	1336.726875	8,945,063	22.9	0.018	47.5
Indianapolis, Indiana, USA	29,500,000	2,165,510,194	852,866	34.6	2539.097811	27,000,000	31.7	0.001	34.6
London, UK	39,000,000	10,080,448,770	8,308,000	4.7	1213.342413	36,600,000	4.4	0.000	4.7
Portland, Oregon, USA	22,700,000	1,752,435,995	609,456	37.2	2875.410194	21,338,000	35.0	0.001	37.2

* Total discharge volume for Halifax Water is the predicted volume under 2046 growth conditions with no intervention. Amount spent is the recommended total capital program costs as submitted throght the RDC. Population includes unserviced population, consistant with other examples. Reduced Discharge Volume is the total predicted growth scenario volume minus the total predicted baseline volume (9,596,000m3) i.e. maintaing the baseline frequency and volume

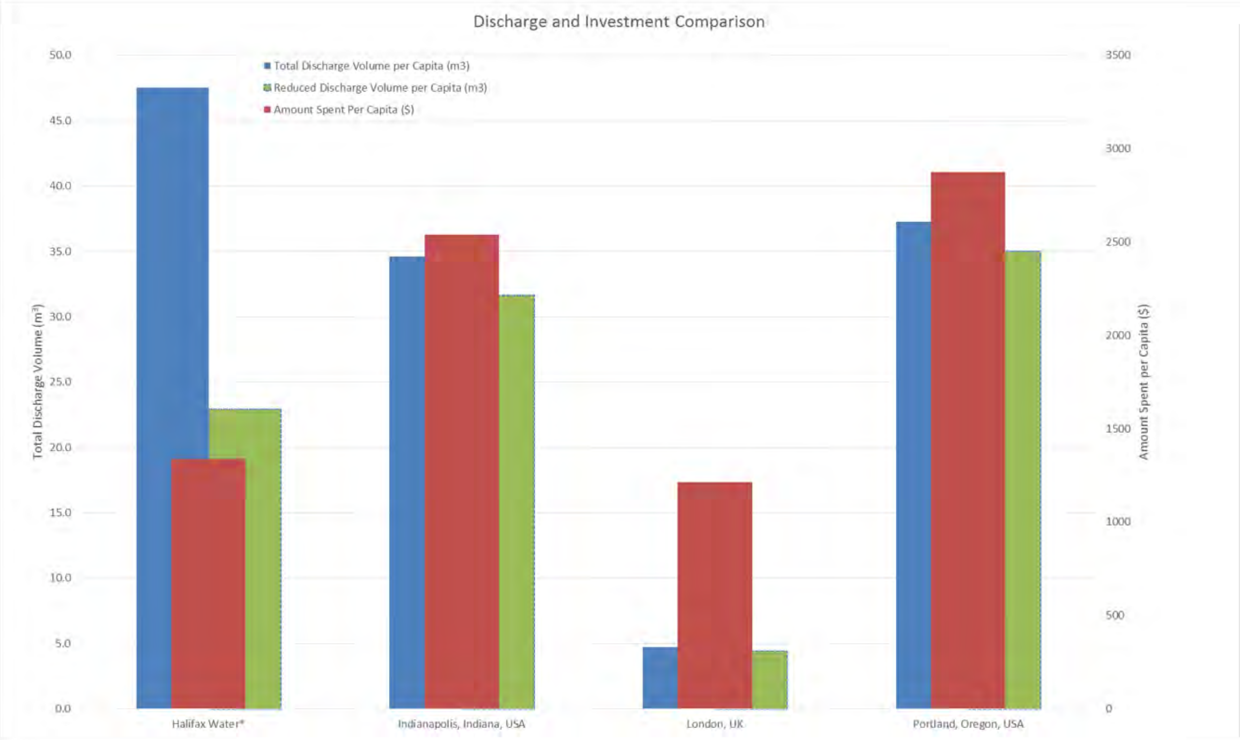


Figure 5: Graph of Cost Effectiveness of CSO Reduction

3.4 Design Storm

The design storms in the stormwater section of the current HWDS are the Intensity Duration Frequency (IDF) curves, synthetic design storms using hyetographs of the Chicago type distribution, and historical design storms using historical flood records or runoff simulations of historical storms.

Recognizing that wet weather events are different from region to region, and vary with respect to the return period and duration, design storms should reflect the rainfall events experienced in that particular area. The development of a storm unique to the Halifax area, and based on historical data, is the most suitable method to analyzing the existing sewer system and future growth scenarios.

To form a temporal pattern for an area, historic recorded rainfall events should be used as it accurately represents the local precipitation patterns. The historic data is normalized to form a standard temporal pattern for that particular site over a set duration, such as 24 hour, and then different storm events are added to the temporal pattern to create a hyetograph.

Assessing options for calculating precipitation and forming design storm events with Climate Change is covered in more details in the Climate Change portion of the Infrastructure Master Plan, in Volume 1.

3.5 Recommended LOS Objectives

Based on the WRWIP review of existing Levels of Service, analysis of CSO discharges and beach closures it outlined that Halifax Water's existing LOS is lower than many other regions, including Ontario, many USA cities and all of Europe. The reason is simple; there is no policy or legislation that requires more stringent standards. In fact, with the adoption of maintaining current discharges rates in light of growth Halifax Water is exceeding currently legislated Levels of Service.

Based on the WRWIP review of industry trends in Canada and across the world, it is certain that Halifax Water will be subject to more stringent standards in the future. It is therefore recommended that Halifax Water maintain the LOS of no increase in discharge as a result of growth and consider the receiving waters and surrounding land use.

As part of the WRWIP study, it was recommended that the CCME national standards for combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) continue to be followed so that the current LOS is maintained with future growth.

The LOS objectives adopted for of the Infrastructure Master Plan:

- A 1 in 5-year design event is to be used to assess peak flows and capacity of existing infrastructure
- Ensure that new development does not increase the frequency and/or volume of CSOs or SSOs, or impact on the water quality
- No CSO or CSO discharge during dry weather, except during spring thaw and emergencies

3.6 Key Performance Indicators

Additional key performance indicators are highlighted in Appendix A. The Infrastructure Master Plan will focus primarily on the performance of regional infrastructure, therefore the majority of these key performance indicators do not apply. However, they should be noted as they can be incorporated into local servicing studies and intensification analyses where assessing the local network is the primary focus.

4 Policy and Regulatory Compliance

Compliance with national and regional standards is a major driver for infrastructure planning. The wastewater and water supply networks must meet national and provincial legislation and policy, while also aligning with regional standards and goals, to achieve a high standard of service for the customers, employers and stakeholders.

The following key policy and legislation documents will be used to determine the level of compliance of the wastewater systems and guide the Infrastructure Master Plan's optimization strategies.

- Nova Scotia Environment (NSE)
- Regional Wastewater Functional Plan RWWFP (2012)
- Wastewater System Effluent Regulation (WSER) (2012)
- Canadian Council of Ministers of the Environment (CCME) (2009)
- Chartered Institute of Water and Environmental Management (CIWEM).

4.1 Nova Scotia Environment (NSE)

Nova Scotia Environment (NSE) is the provincial government department that oversees water supply sources, standard of drinking water and treatment and disposal of wastewater. NSE is responsible for setting the standards, issuing approvals, protecting water sources, drinking water quality, and auditing compliance with provincial standards.

As outlined in the WRWIP, NSE has indicated that it plans to adopt the aspects of the CCME, which fall within provincial jurisdiction. The CCME standards to be adopted are described below in Section 4.3 Wastewater Policy Review and Recommendations. Following the WRWIP process, continued engagement with NSE is important with defining targets and triggers used to identify infrastructure needs and size.

4.2 Environmental Management System

Halifax Water has adopted the Environmental Management System (EMS) which certifies both water treatment plant and wastewater treatment facilities, through the International Organization for Standardization (ISO) 14001-2004 Environmental Management System Standard. The EMS 14001-2004 is an internationally agreed standard that improves organizations environmental performance, through efficient use of resources and reducing waste in a holistic way.

In September 2015, ISO issued a new standard ISO 14001-2015, with a three year transition period until September 2018, for upgrades to be completed to maintain certification. To achieve this new level EMS is running awareness sessions on the new standard and internal audits will be required.

Bennery, Pockwock and Lake Major WSP are currently certified by the International Organization for Standardization (ISO) 14001-2004 Environmental Management System.

In 2016 Halifax Water expanded its ISO 14001 designation to include Herring Cove WWTF, becoming the first WWTF to obtain certification in Atlantic Canada. Halifax Water is aiming to get the remaining WWTFs certified by 2020, starting with Dartmouth in 2018.

4.3 Wastewater Policy Review and Recommendations

A wastewater policy review with recommendations was completed under the WRWIP. The results are outlined below alongside the current status of the network and the outcomes of a recent Environmental Risk Assessment.

4.3.1 RWWIP

The RWWIP was reviewed under the WRWIP and based on the policies proposed in the RWWFP, Halifax Water's existing wastewater policy statements are summarized as follows:

1. Optimize the use of the existing wastewater system/network.
2. Minimize the long-term life cycle costs of the wastewater system through revised design standards.
3. Monitor wastewater systems to identify water quality/waste loading issues and system capacity/quantity limitations.
4. Manage wastewater flows in the combined sewer system to minimize overflows to the environment and property.
5. Manage wastewater flows in the sanitary sewer system to minimize overflows to the environment and property.
6. Optimize available system capacity.
7. Regulate allowable flow into the wastewater system.
8. Meet effluent discharge limits as defined by NSE and consistent with the CCME for all wastewater treatment facilities.
9. Ensure new development does not impact the frequency, volume, and quality of combined sewer overflows (CSOs) or sanitary sewer overflows (SSOs).
10. Ensure HRM and Halifax Water policies for growth are consistent.

To maintain or improve the level of service the WRWIP built on the policies and regulations in the Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CSMMW), Canadian Council of Ministers of the Environment (CCME) and Canada Wastewater Systems Effluent Regulations (WSER), as detailed below.

4.3.2 The Wastewater Systems Effluent Regulations and the Canada-wide Strategy for the Management of Municipal Wastewater Effluent

The most significant policy/regulation related to Halifax Water's long-term wastewater planning objectives is the Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CSMMW), which is endorsed by the Canadian Council of Ministers of the Environment (CCME). The Canada Wastewater Systems Effluent Regulations (WSER) are the principal instruments that Environment Canada is using to implement the CSMMW.

The objective of CCME is to achieve regulatory clarity in managing municipal wastewater effluent under a harmonized framework that is protective of human health and the environment. The strategy could result in relatively strict limits on effluent discharges that will require significant upgrade of current infrastructure.

The CSMMW specifies expected national standards for CSOs and SSOs. In summary:

For CSOs:

- No increase in CSO frequency due to development or redevelopment, unless it occurs as part of an approved CSO management plan.

- No CSO discharge during dry weather, except during spring thaw and emergencies.
- Floatable materials will be removed, where feasible.

And for SSOs:

- All SSOs should be monitored and reported, at least on an occurrence basis. Since SSOs should not occur, the objective is elimination through corrective measures. As a minimum:
  - SSO frequencies should not increase due to development or redevelopment; and
  - SSOs should not occur during dry weather, except during spring thaw and emergencies.

At the time of the WRWIP, the CCME strategy stated that no additional overflow discharges (frequency and volume) could occur as a result of growth. For a wastewater system that has relatively frequent overflow discharge events, as a result of wet weather, any additional flows in the system create an increase in discharge occurrences for which additional infrastructure capacity or a reduction in other source flows is required in order to maintain the status quo of overflow operation.

Since the establishment of the CCME guidelines, the Wastewater System Effluent Regulations (WSER), 2012, have become law. However, the legislation only focusses on the need to better understand overflow frequency and operation; CSO reporting is a mechanism to facilitate this enhanced understanding. The legislation is silent on maintaining overflow operation at current levels and the lack of any tangible objective or target regarding overflow operation which would have profound implications on the Infrastructure Master Plan, as outlined in the WRWIP.

As an extreme example, if overflow operation is allowed to increase indefinitely as a result of growth, albeit documented, then virtually no additional infrastructure would be required to support growth; all additional flow would discharge to the environment.

4.3.3 Current Wastewater Standards Review

Since the WRWIP the updated WSER national standard for effluent discharge of deleterious substances to fish habitats are:

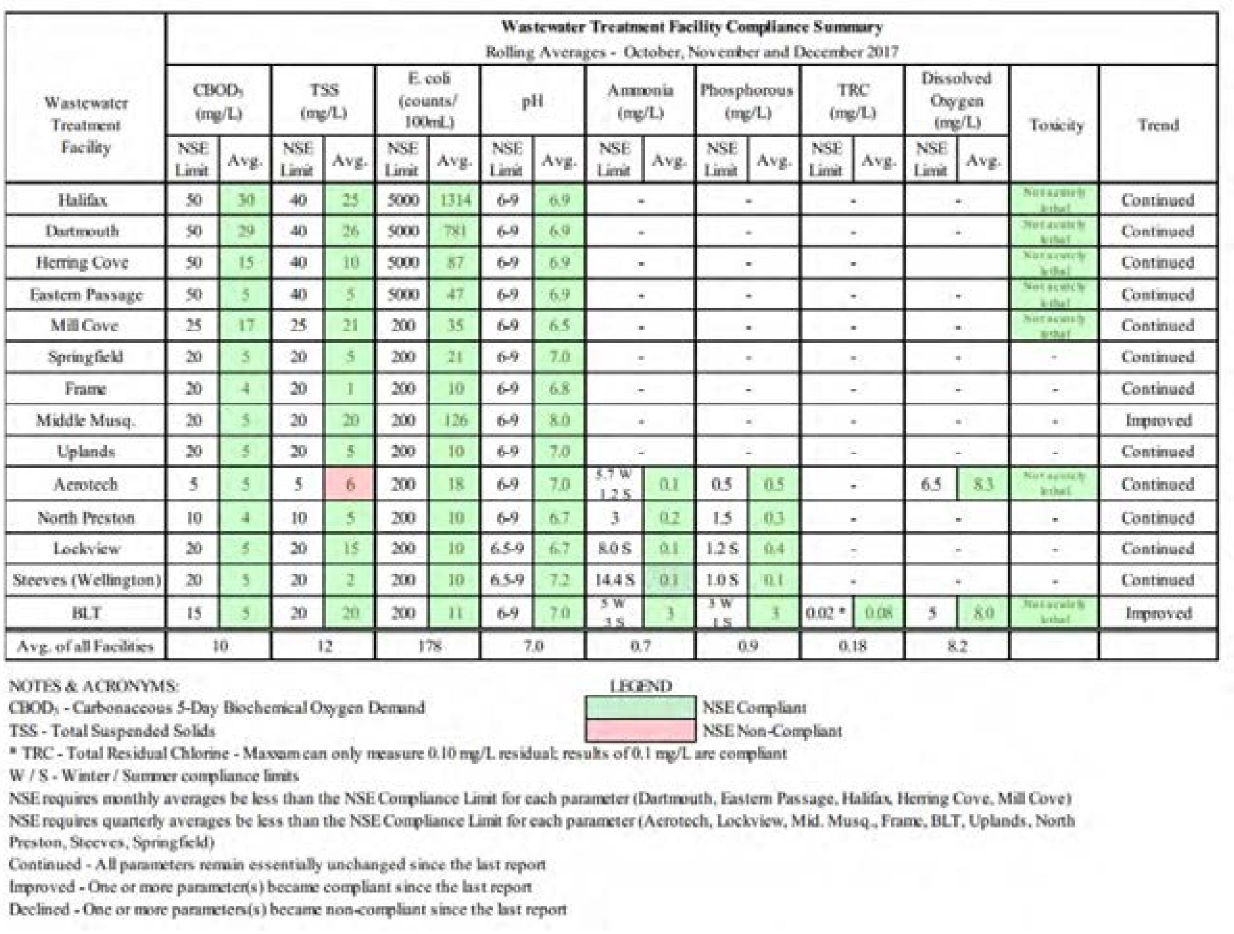
- Carbonaceous Biochemical Oxygen Demand [CBOD]; 25 mg/L
- Total Suspended Solids [TSS]; 25 mg/L
- Total Residual Chlorine [TRC – for facilities using chlorine disinfection]; 0.02 mg/L
- Un-ionized Ammonia; 1.25 mg/L as Nitrogen, at 15^0C ± 1^0C.

Halifax Water have provided a compliance summary sheet for the WWTFs from October to December 2017, as shown in Figure 6 below. This shows that Halifax and Dartmouth WWTFs currently exceed the WSER limits on CBOD and TSS. Facilities that are not compliant required a Transitional Authorization (TA) to exceed the limit. Halifax Water obtained TAs for Halifax and Dartmouth WWTFs, which gives Halifax Water until 31st December 2040, to reduce CSO discharges and upgrade the Halifax and Dartmouth WWTFs.

Halifax, Dartmouth and Herring Cove WWTFs are the three main WWTFs that discharge to salt water bodies and use a lower level of treatment - advanced-primary treatment. Herring Cove WWTF currently meets the WSER discharge limits, however it is not at full capacity and as more growth occurs in the area the WWTF will move closer to the discharge limit. Upgrades to all three WWTFs will be constructed as part of the Halifax Harbour Solution Project, to meet the WSER discharge limits and remain compliant beyond 2040.

Figure 6 also shows how NSE standards are being met for all WWTFs except Aerotech WWTF, which is currently being upgraded to comply with NSE and WSER standards.

Of the smaller community WWTFs, they are generally compliant with their NSE permits, with nutrient removal being the main reason for noncompliance. The sewersheds that have issues with wet weather flows leading to overloading the systems will be addressed in the Wet Weather Flow Management Study, of the Infrastructure Master Plan.



Wastewater Treatment Facility	Wastewater Treatment Facility Compliance Summary Rolling Averages - October, November and December 2017																	
	CBOD5 (mg/L)		TSS (mg/L)		E. coli (counts/100mL)		pH		Ammonia (mg/L)		Phosphorous (mg/L)		TRC (mg/L)		Dissolved Oxygen (mg/L)		Toxicity	Trend
	NSE Limit	Avg.	NSE Limit	Avg.	NSE Limit	Avg.	NSE Limit	Avg.	NSE Limit	Avg.	NSE Limit	Avg.	NSE Limit	Avg.	NSE Limit	Avg.		
Halifax	50	30	40	25	5000	1314	6-9	6.9	-		-		-		-		Not acutely lethal	Continued
Dartmouth	50	29	40	26	5000	781	6-9	6.9	-		-		-		-		Not acutely lethal	Continued
Herring Cove	50	15	40	10	5000	87	6-9	6.9	-		-		-				Not acutely lethal	Continued
Eastern Passage	50	5	40	5	5000	47	6-9	6.9	-		-		-		-		Not acutely lethal	Continued
Mill Cove	25	17	25	21	200	35	6-9	6.5	-		-		-		-		Not acutely lethal	Continued
Springfield	20	5	20	5	200	21	6-9	7.0	-		-		-		-		-	Continued
Frame	20	4	20	1	200	10	6-9	6.8	-		-		-		-		-	Continued
Middle Musq.	20	5	20	20	200	126	6-9	8.0	-		-		-		-		-	Improved
Uplands	20	5	20	5	200	10	6-9	7.0	-		-		-		-		-	Continued
Aerotech	5	5	5	6	200	18	6-9	7.0	5.7 W 1.2 S	0.1	0.5	0.5	-		6.5	8.3	Not acutely lethal	Continued
North Preston	10	4	10	5	200	10	6-9	6.7	3	0.2	1.5	0.3	-		-		-	Continued
Lockview	20	5	20	15	200	10	6.5-9	6.7	8.0 S	0.1	1.2 S	0.4	-		-		-	Continued
Steeves (Wellington)	20	5	20	2	200	10	6.5-9	7.2	14.4 S	0.1	1.0 S	0.1	-		-		-	Continued
BLT	15	5	20	20	200	11	6-9	7.0	5 W 3 S	3	3 W 1 S	3	0.02 *	0.08	5	8.0	Not acutely lethal	Improved
Avg. of all Facilities	10		12		178		7.0		0.7		0.9		0.18		8.2			

NOTES & ACRONYMS:
CBOD5 - Carbonaceous 5-Day Biochemical Oxygen Demand
TSS - Total Suspended Solids
* TRC - Total Residual Chlorine - Maxxam can only measure 0.10 mg/L residual; results of 0.1 mg/L are compliant
W / S - Winter / Summer compliance limits
NSE requires monthly averages be less than the NSE Compliance Limit for each parameter (Dartmouth, Eastern Passage, Halifax, Herring Cove, Mill Cove)
NSE requires quarterly averages be less than the NSE Compliance Limit for each parameter (Aerotech, Lockview, Mid. Musq., Frame, BLT, Uplands, North Preston, Steeves, Springfield)
Continued - All parameters remain essentially unchanged since the last report
Improved - One or more parameter(s) became compliant since the last report
Declined - One or more parameters(s) became non-compliant since the last report

LEGEND
🟩 NSE Compliant
🟥 NSE Non-Compliant

Figure 6: Wastewater Treatment Facility Compliance Summary October to December 2017 Results

4.3.4 Environmental Risk Assessment

A site specific Environmental Risk Assessment (ERA) was completed on the four WWTFs that discharge to Halifax Harbour, in 2015. The ERAs are based on the CCME Strategy, which requires that all facilities achieve minimum National Performance Standards (NPS) and develop and manage site-specific Effluent Discharge Objectives (EDO).

The report looks at the following four WWTFs:

- Mill Cove WWTF
- Halifax WWTF
- Dartmouth WWTF
- Herring Cove WWTF

The focus of the ERA is on defining WWTF allowable effluent concentrations which are protective of the receiving environment and human health.

Effluent levels were compared against the following standards:

- CCME Marine Aquatic Life (MAL)
- Canadian Environmental Quality Guidelines (CEQG)
- CCME National Performance Standards (NPS)
- Fisheries Act requirements

A year-long assessment from October 2012 to October 2013 was completed to determine effluent characteristics for the four facilities. It was found that effluent exceed CCME MAL requirements for pH, cadmium, mercury and naphthalene level. Fecal coliforms exceeded the CEQG recreational criteria. Effluent from all facilities occasionally exceeded TSS and CBOD limits of the CCME NPS. These substances were considered Substances of Potential Concern (SOPC).

A risk assessment of the WWTFs was completed in the ERA. Under the CCME risk criteria, Herring Cove WWTF was considered a low risk and Halifax, Dartmouth and Mill Cove WWTFs a medium risk, for implementing measures to meet NPS standards and objectives.

As outlined in the CCME - for existing facilities that do not meet the NPS:

- High-risk facilities will meet the NPS within 10 years
- Medium-risk facilities will meet the NPS within 20 years
- Low-risk facilities will meet the NPS within 30 years

EDOs were developed for each site based on the degree of mixing and available assimilative capacity. Some of the recommended EDOs are more stringent than current NSE Approval discharge limits. The ERA report outlines the EDOs for each facility.

4.3.5 Summary

Without national legislation to define specific targets, it is important to engage Nova Scotia Environment (NSE) and agree the targets and triggers used to identify infrastructure needs and sizes. Based on this review it is reasonable, almost certain to assume that future legislation will require the attainment of stringent overflow targets. Given the current legislative environment it is important the Halifax Water agree their own mandate; it is suggested that preventing additional overflows in light of growth is a solid foundation on which to build additional measures for areas considered high amenity.

APPENDIX A *Key Performance Indicators to Evaluate Level of Service Objectives*

Table 1: Key Performance Indicators for Wastewater Collection Systems

Customer Service Statement	Service Objectives	Technical Objectives	Key Performance Indicators - Technical	Key Performance Indicators - Customer
"To provide an efficient, sustainable, and reliable sanitary sewer collection system that minimizes environmental impacts and is capable of accommodating growth"	*Efficient*	- Full life-cycle costing - Renewal of aging infrastructure - Optimization of system operations - Reduction of inflow and infiltration	- Energy consumption - SOGR program - Pumping needs - RDII flows - Performance of treated sewage - Surcharging during wet weather event	- Number of complaints (water bills, cost, odour, etc.) - Basement flooding (due to extraneous flows) - Default rates - Service interruptions - Compliance with Standards
	Sustainable	- Full life-cycle costing - Renewal of aging infrastructure - Resiliency to climate change - Costs associated with sanitary servicing fees	- SOGR program - Age of infrastructure - Replacement/rehab costs - O&M costs	
	Environmental	- Compliance with Water Quality Objectives - CCME Wastewater Effluent Regulations - Sewer system meeting capacity targets	- RDII flows - Treatment needs - Percent of system meeting capacity needs (q/Q)	
	Reliable	- Conditions of sewer system (CCTV) - Capacity to meet wastewater production - Minimal service interruptions - Facilities have backup power available	- System capacity is compliant with PACP - Percent of system meeting capacity needs (q/Q) - Surcharging during wet weather event	
	Capacity	- Availability to service Urban Boundaries - Minimal service interruptions - Ability to convey growth wastewater production	- Treatment needs - Pumping needs - Percent of system meeting capacity needs (q/Q)	
	Regulatory	- Compliance with Water Quality Objectives - CCME Wastewater Effluent Regulations	- Dry and wet weather controls - Sewer and forcemain velocities - Treatment capacity - Pumping capacity - Level maintained below basement floor	
	Growth	- Rated capacity of facility can support growth (treatment, pumping) - Sewers system can support growth (gravity sewers) - Projected demands are applied to areas of planned growth	- Pumping needs - Treatment needs - RDII allowance - Per capita rate - Peaking factor - Surcharging during wet weather event	

Water Design Criteria, Level of Service Objectives, and Policy

Infrastructure Master Plan

Prepared by
GM BluePlan for:

Halifax Water

Project No. 717043
July 3, 2019

GLOSSARY OF TERMS AND ACRONYMS

The following table provides a summary of terms and acronyms that are commonly used throughout the report.

Term or Acronym	Definition
ADD	Average Day Demand
DMA	District Metered Area
DWF	Dry Weather Flow
FF	Fire Flow
FUS	Fire Underwriters Survey
HRM	Halifax Regional Municipality
HWDCS	Halifax Water Design and Construction Specifications
LOS	Level of Service
MDD	Maximum Day Demand
NRW	Non-Revenue Water
NSE	Nova Scotia Environment
PHD	Peak Hour Demand
RDC	Regional Development Charge
SCADA	Supervisory Control and Data Acquisition
WRWIP	West Region Wastewater Infrastructure Plan
WSP	Water Supply Plant
WWTF	Wastewater Treatment Facility

Table of Contents

FIGURES

1 Introduction

This technical memorandum contains a comprehensive review of Halifax Water's Design Criteria, Level of Service objectives, and influencing Policies that are used for infrastructure planning purposes. The review includes an assessment of the current criteria against available information and industry best practice. The objective is to validate or amend the criteria and assumptions that will be used to inform the Infrastructure Master Plan and subsequent long-term planning projects.

The Design Criteria review includes various trend analyses using customer water meter consumption data and SCADA data from treatment plant production and district meter areas (DMA). The trend analyses focus on treatment plant production and DMA consumption, as population estimates by customer meter is unknown. In addition to trend analyses, the Design Criteria review summarizes industry best practice and assesses Halifax Water's existing specifications. The recommendations from the criteria review will be incorporated into the Infrastructure Master Plan. They will also inform the 2019 update of the Halifax Water Design Specification.

The Level of Service (LOS) review aims to establish the performance indicators and targets that will be used to assess the overall performance of infrastructure and identify the triggers for new infrastructure or infrastructure upgrades within the Infrastructure Master Plan.

The section covering Policy addresses compliance with national and regional standards as a major driver for infrastructure planning.

2 Design Criteria

2.1 Existing Design Criteria

The approach to determining water flows for both existing and future growth varies by municipality. However, in general, it is common practice to utilize an average day domestic demand with the application of maximum day and peak hour demand factors. In some cases, average day domestic demand may be broken up into two components, billing and non-revenue water (NRW).

Halifax Water's Design Specification for Water, Wastewater, and Stormwater (2017 edition) states that water distribution systems are to be designed to accommodate an Average Day Demand of 410 L/cap/day, which accounts for non-revenue water, with peaking factors as outlined in Table 1.

Table 1: Water Distribution Peaking Factors in 2017 Design Specifications

Land Use	Minimum Hour	Peak Hour	Maximum Day
Low Density Residential	0.70	2.48	1.65
High Density Residential	0.84	2.50	1.30
Industrial	0.84	0.90	1.10
Commercial	0.84	1.20	1.10
Institutional	0.84	0.90	1.10

2.1.1 Assessment of Existing Design Criteria

In order to assess the suitability of the existing design criteria, a number of data sets were used to complete a number of analyses.

Key Design Criteria

1. Water Consumption Rates
2. Non-Revenue Water
3. Peaking Factors

Trend Analyses

1. Treatment Plant Production
2. Region-wide Consumption
3. DMA Flow Balance

Datasets

1. Statistics Canada Census Population Estimate (2006, 2011, 2016)
2. Water Supply Plant (WSP) Production – SCADA
3. District Metering Area (DMA) Consumption – SCADA
4. Customer Consumption Data – by Halifax Water from 2006-2018. Included:
   a. Premise ID
   b. Land Use (residential, multi-residential, institutional, industrial, commercial)
   c. Consumption

2.2 Water Consumption Rates

The aim of the water consumption rates analysis was to validate, or revise, the per capita consumption rate (L/cap/day) that is provided in the current Halifax Water Design Specification (2017). This analysis provides greater resolution on the current water demand and a good understanding of the variability of per capita consumptions rates throughout the system. The recommendations from this analysis will also be used in the completion of the Infrastructure Master Plan.

The consumption rates were assessed using the following trends:

- Region-wide Consumption Trend
- Variability across DMAs
- Supply Plant Production

2.2.1 Region-wide Consumption Trend

The per capita consumption rate was first evaluated against the overall Halifax Region trend, which provides a macro-level baseline.

The following process was used to assess the overall consumption trends:

1. Customer consumption data (2006-2017) was spatially allocated to the CustomerMeterPoint GIS data using the accounts premise ID.
2. The consumption of all serviced areas was summed and broken down by residential (single and multi) and ICI (industrial, commercial, institutional) premise types, for each annum.
    - This analysis was completed on Pockwock and Lake Major systems.
    - Consumption data did not include the North Preston pressure zone. The residents of North Preston are charged a flat rate and are not billed based on water usage.
3. Census data was used to calculate annual serviced population estimates.
    - Census Population Estimates for 2006, 2011, and 2016 were sourced from Statistics Canada. These estimates include the census undercount correction.
    - Population estimates were interpolated between the years 2006-2011 and 2011-2016.
    - The 2017 population estimate was extrapolated from the 2016 value using the average growth rate between 2011 and 2016.
4. Annual per capita consumption rates were calculated for:
    a. Residential consumption only
        – residential consumption / population
    b. Total consumption
        – total consumption / population
5. The per capita consumption rates do not account for non-revenue water as the data source is customer water meters.

The results from the region-wide trend analysis (Figure 1) suggest that:

- There is an overall decrease in residential and employment consumption year over year.
- The current (2017) residential consumption rate is 170 L/cap/day.
- The current (2017) total consumption rate is 264 L/cap/day.
    - with application of the system wide non-revenue water rate of 24% from section 0, the average per capita day demand is 347 L/c/d (Consumption 264 + NRW 83).

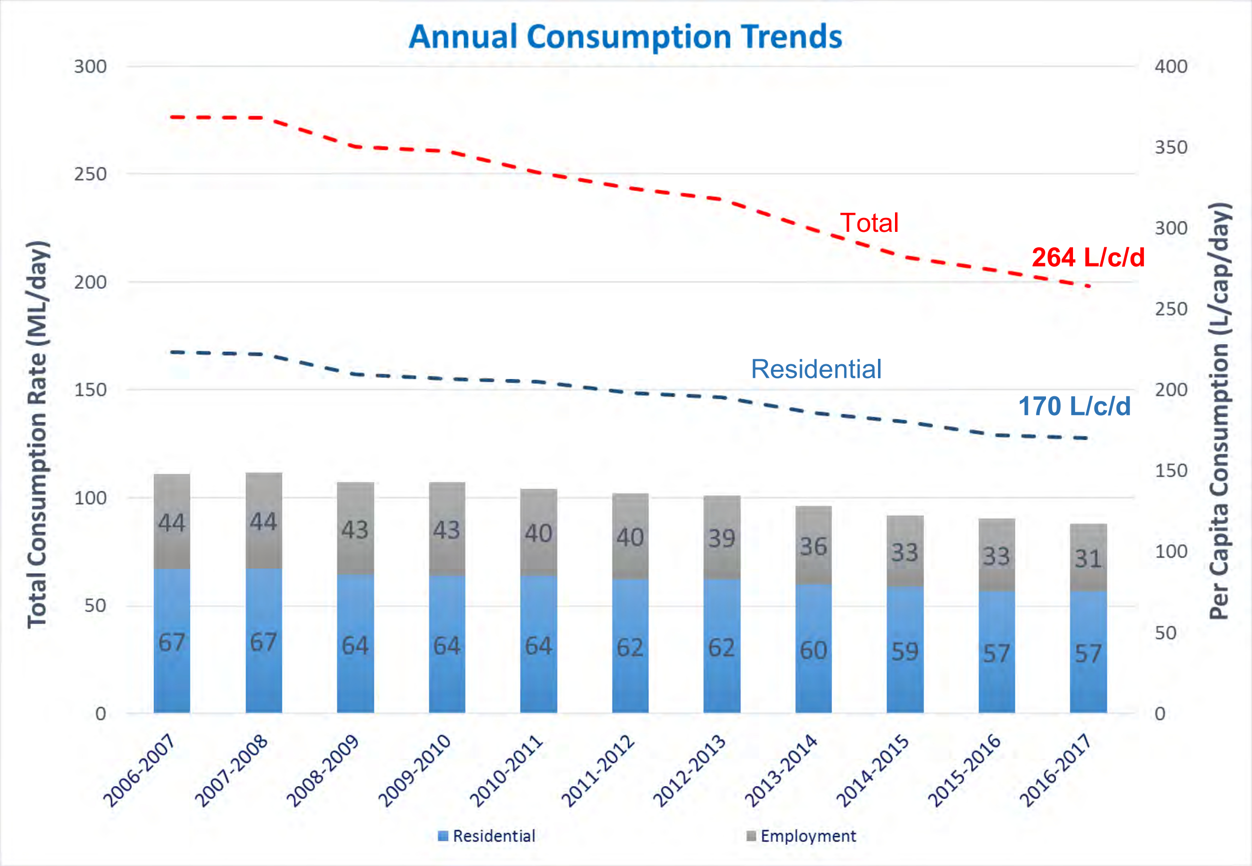


Figure 1: Region-wide Annual Consumption Trend (excluding Non-Revenue Water)

2.2.2 *Variability across DMAs*

To understand the variability of consumption rates throughout the system, a trend analysis was completed at smaller resolution using the district metering areas (DMAs). The DMA consumption analysis was completed using both the water consumption data and the SCADA data.

2.2.2.1 Population Data

The Statistics Canada census data was used to assign residential population estimates to each DMA. The following should be noted:

- The 2016 census data, including undercount, was inflated by 1.15% to attain a 2017 residential population estimate as the DMA consumption trend analyses were completed using 2017 consumption and SCADA data. The 1.15% is the average growth over the past five years.

2.2.2.2 Box-and-Whisker Plots

Box-and-whisker plots were used to present the degree of deviation and variability of per capita consumption rates. It is a statistical analysis that is centered on the dataset's quartiles (the box), and upper and lower limits that isolate outliers (the whisker).

The components of the box-and-whisker plot are as follows:

- The upper quartile (upper limit of the box) represents the 75th percentile
- The median value (interior band in the box) represents the 50th percentile.
- The lower quartile (lower limit of the box) represents the 25th percentile
- The whiskers represent the minimum and maximum of all data points, excluding the outliers. The outliers are considered values either greater than 1.5 times the upper quartile or less than 1.5 times the lower quartile.

2.2.2.3 Consumer Billing Data

The following process was used to assess the variability of per capita consumption by DMA using customer meter data:

1. Customer consumption data for 2017 was spatially allocated to the CustomerMeterPoint data layer using the account premise ID.
2. The consumption data was summed by DMA, following outlier removal and erroneous results approximately 60 DMA's were included in the analysis.
3. Consumer billing data is collected from billing meter reads which are done quarterly for residential consumers and monthly for larger consumers.
4. The population estimates from 2.2.2.1 were used to calculate per capita rates for Residential Consumption and Total Consumption.

The results from this analysis were plotted using the box-and-whisker plots; refer to Figure 2 and Figure 3. The results suggest that:

- The range of residential consumption rates vary from 91 L/cap/day to 235 L/cap/day.
- The range of total consumption rates vary from 91 L/cap/day to 362 L/cap/day.

It is important to note that these consumption trends do not account for any non-revenue water, which is primarily leakage but also consumption that was not billed.

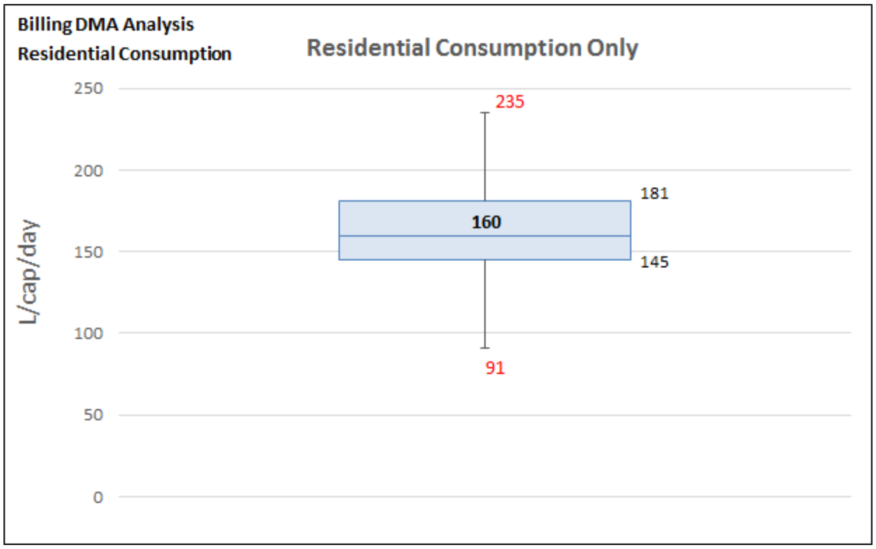


Figure 2: Billing DMA Box-and-Whisker Plot – Residential Consumption Only

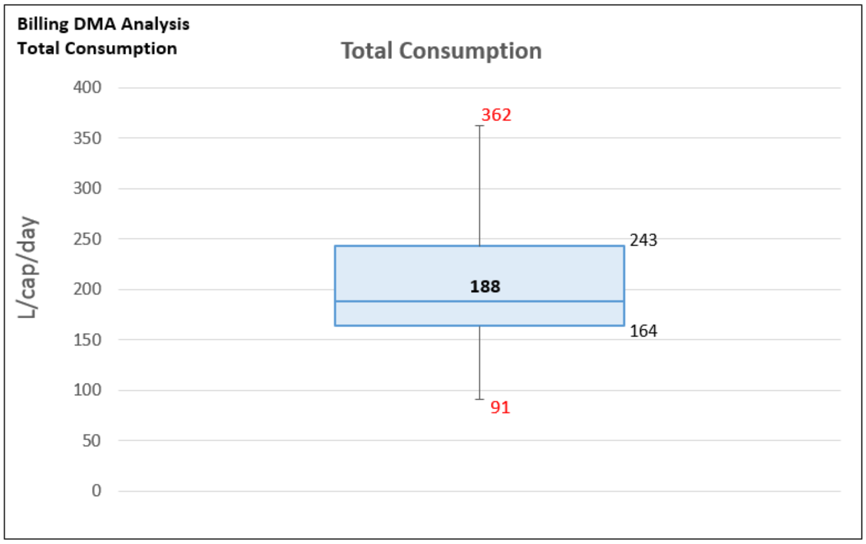


Figure 3: Consumption by DMA Box-and-Whisker Plot – Total Consumption

2.2.2.4 Flow Balance using SCADA Data

The following process was used to assess the variability of per capita ADD, by DMA, using SCADA:

1. SCADA data from 2017 was used to complete a flow balance for each DMA. Total ADD was calculated, which includes both billed consumption and non-revenue water. Following outlier removal and erroneous results, approximately 60 DMA's were included in the analysis.
2. The population estimates from 2.2.2.1 were used to calculate the per capita ADD by DMA.

The results from this analysis were plotted using the box-and-whisker plots; refer to Figure 4. This analysis includes non-revenue water in the DMA.

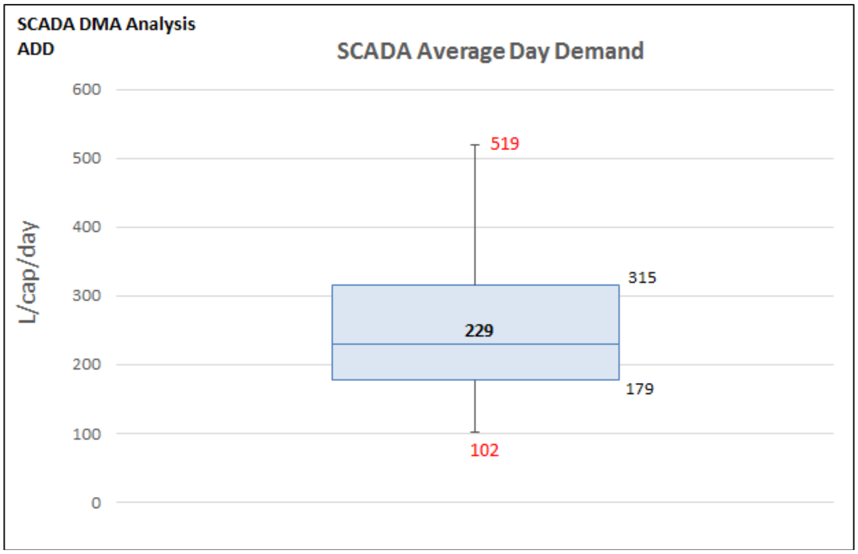


Figure 4: SCADA DMA Box-and-Whisker Plot – Average Daily Demand

The results suggest that:

- The range of per capita ADD varies from 102 L/cap/day to 519 L/cap/day.
- It should be noted that the mean or median values do not take into consideration a size weighting of each DMA. In addition, some DMAs were omitted due to erroneous results or inability to complete the flow balance. Therefore, the mean or median value cannot be compared with the production or region-wide trend analyses and is rather meant to demonstrate the variability across the system. This analysis does not include the same exact set of DMAs as the consumer analysis in the previous section.

2.2.2.5 Non-Revenue Water Analysis

Non-revenue water is the water that has been distributed to the network but has not been billed to the customer, the water lost is due to leakages in the network and non-billed water consumption.

The DMA non-revenue analysis looked at the difference between the recorded water being supplied to the DMAs (tracked through SCADA data) and the water received by the customers (tracked through consumption data), for each DMA. Understanding the amount of water lost in the network is an important consideration when reviewing the design criteria.

The following process was used to assess the variability in non-revenue water, by DMA, using SCADA and customer meter data:

1. Average day demand (SCADA) and average day consumption (customer meters) were collected from 2013 to 2017 for each DMA.
2. Non-revenue water was calculated as a percentage difference between the ADD and consumption and averaged over the 5-year analysis period. Following outlier removal and erroneous results, approximately 60 DMA’s, out of 77, were included in the analysis.

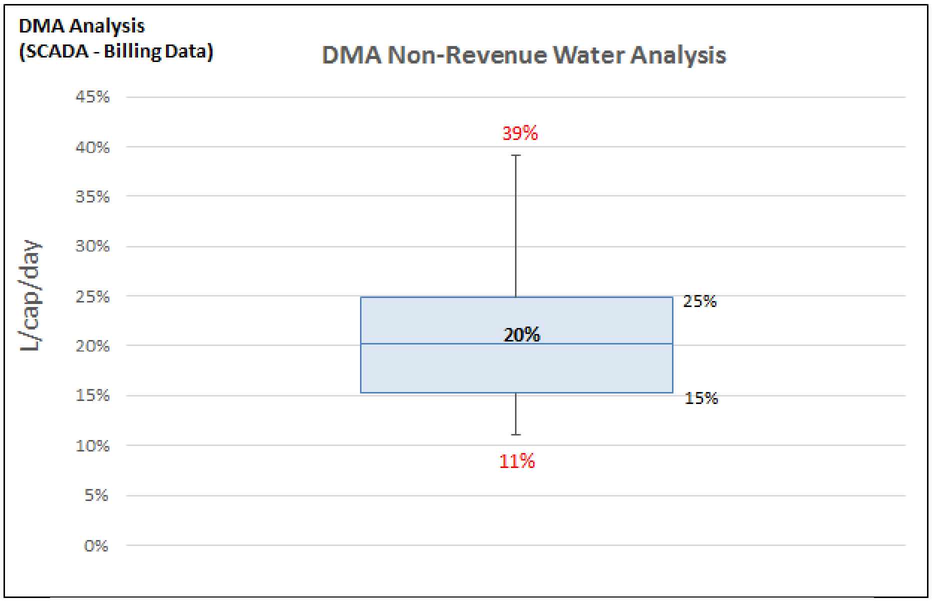


Figure 5: Percentage of Non-Revenue Water by DMA

The results from this analysis were plotted using box-and-whisker plots, refer to Figure 5. The results suggest that the range of non-revenue water losses across the DMAs varies from 11% to 39%. It should be noted that Halifax Water also does an analysis of non-revenue water following the ILI method however the approach outlined in this memo was undertaken as it is more applicable to the master planning consumption exercise.

2.2.3 Treatment Plant Production

SCADA data was collected for five years (2013-2017) for Pockwock and Lake Major water treatment facilities. The data was used to assess the production of the two facilities over time. Table 2 summarizes the average production (megaliters per day - MLD) and the per capita average production (L/cap/day), by year, for Pockwock and Lake Major treatment facilities. It should be noted that this is inclusive of all billed consumption and non-revenue water. The per capita average daily production rates were calculated using the allocated population numbers from 2.2.2.1.

Table 2: Annual Average Treatment Plant Production from 2013-2017

WSP	Year	Ave. (MLD)	Population	Ave. per Capita (L/cap/d)
Pockwock	2013	80.6	215,411	374
	2014	80.8	217,884	371
	2015	85.8	220,357	389
	2016	82.7	222,830	371
	2017	80.4	225,392	357
Lake Major	2013	39.2	106,585	367
	2014	36.8	107,809	341
	2015	35.7	109,032	328
	2016	34.4	110,256	312
	2017	31.9	111,524	286

In addition to an annual average summary of production, average daily per capita production was plotted for the past five years to assess consumption trends at a more refined level. A trend line from January 2013 to December 2017 was plotted representing the aggregate of both facilities, as shown in Figure 6, below.

This treatment plant trend analysis suggests the following:

Note: values presented below are derived from the 5-year monthly line of best fit shown in Figure 6, therefore, vary from the annual average values presented in Table 2:

- The average daily per capita production was approximately 372 L/cap/day in 2013.
- The average daily per capita production was 337 L/cap/day in 2017, a decrease of 35 L/cap/day from 2013-2017, an average decrease of approximately 9 L/cap/day per year.
- It should be noted that the systems have a limited connected across the Macdonald Bridge and supply can be transferred between the two networks, as observed by the spikes in Figure 6. However, this is not done frequently and is generally for a short period and therefore is not expected to influence the results of the annual analysis.

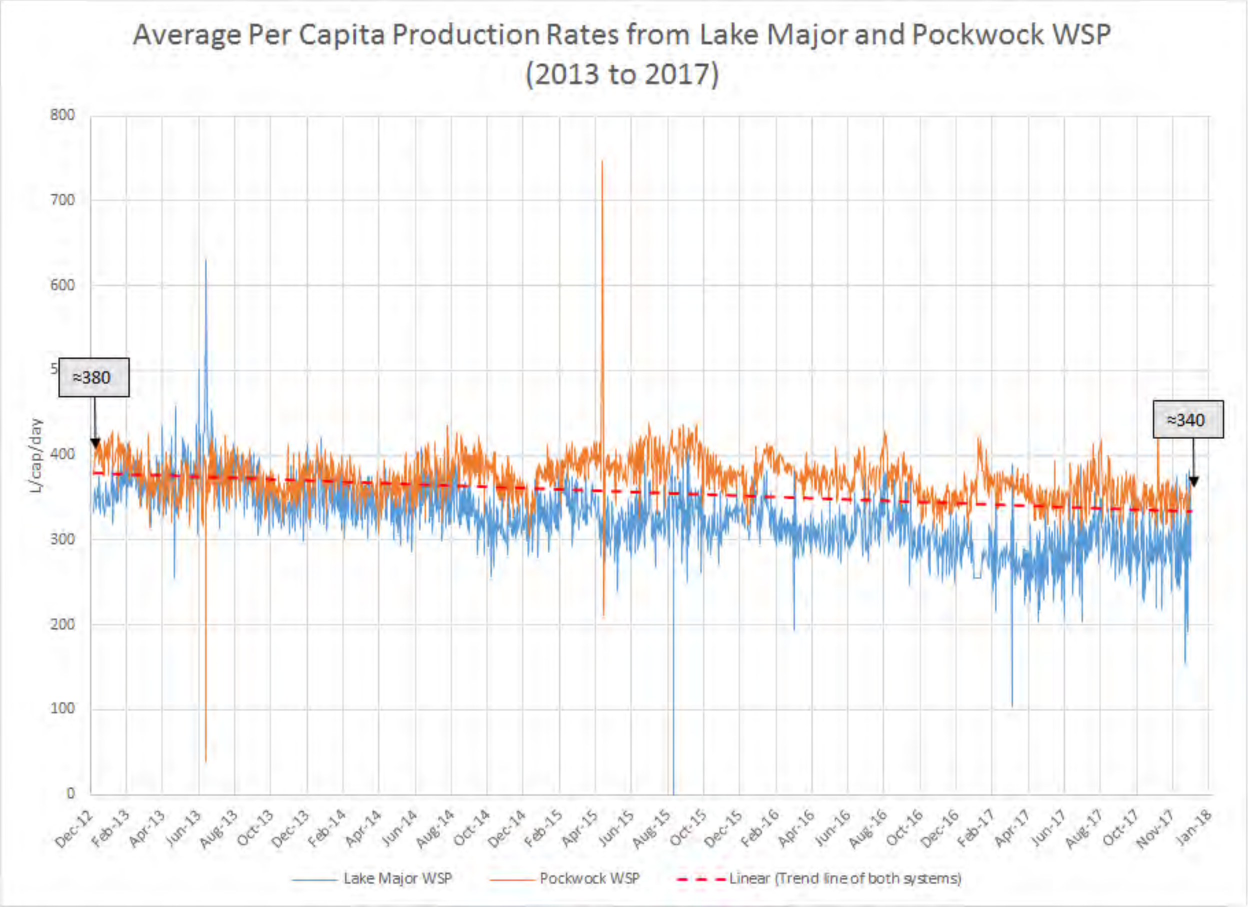


Figure 6: Treatment Plant SCADA – Average Per Capita Production Rates

2.2.3.1 Non-revenue Water Analysis

The treatment plant production data was compared against system wide consumption to assess the percentage of NRW for the Pockwock and Lake Major water distribution systems.

The results from the system wide NRW analysis are presented in Table 3. The results suggest that:

- The Pockwock system has a significantly larger amount of non-revenue water compared to the Lake Major system (30% compared to 18%)
- The overall percentage of NRW across the Halifax region was roughly 25% in 2017. This value is in line with the DMA analysis, which assessed NRW across each zone.

Table 3: Treatment Plant Production and Consumption Rates from 2013-2017

WSP	Year	Production Rate (MLD)	Consumption Rate (MLD)	NRW
Pockwock	2013	80.6	56.3	30%
	2014	80.8	55.4	31%
	2015	85.8	58.3	32%
	2016	82.7	60.2	27%
	2017	80.4	56.3	30%
Average		**82.1**	**57.3**	**30%**
Lake Major	2013	39.2	31.2	20%
	2014	36.8	29.8	19%
	2015	35.7	29.6	17%
	2016	34.4	27.8	19%
	2017	31.9	27.6	14%
Average		**35.6**	**29.2**	**18%**
Combined	2013	119.7	87.6	27%
	2014	117.6	85.2	28%
	2015	121.5	87.8	28%
	2016	117.1	88.1	25%
	2017	112.3	83.9	25%
Average		**117.7**	**86.5**	**26%**

2.2.4 Industry Review

An industry review was conducted on a number of municipalities and regions with similar population size, or which tended to share parallels with Halifax Water's water supply system, to understand typical domestic demand rates and peaking factors. A similar industry review was carried out in the West Regional Wastewater Infrastructure Plan (WRWIP) on the wastewater network and assisted in justifying a revision of the wastewater design standards for average dry weather flow (DWF).

A detailed industry review is summarized in 0. Figure 7 highlights the range of domestic demand rates by 28 municipalities/regions within select parts of Canada. The average per capita domestic demand was 334 L/cap/day with a typical range from 170 - 545 L/cap/day. Halifax Water's current rate of 410 L/cap/day is above the average, but within the trend ranges. It has been recognized that new growth areas are experiencing a trend in decreased water usage due to new construction, appliance standards and public awareness. Municipalities are tending to reduce the design criteria for average per capita domestic demand. This aligns with the results from the overall region wide consumption rate trend presented in Section 2.2.1.

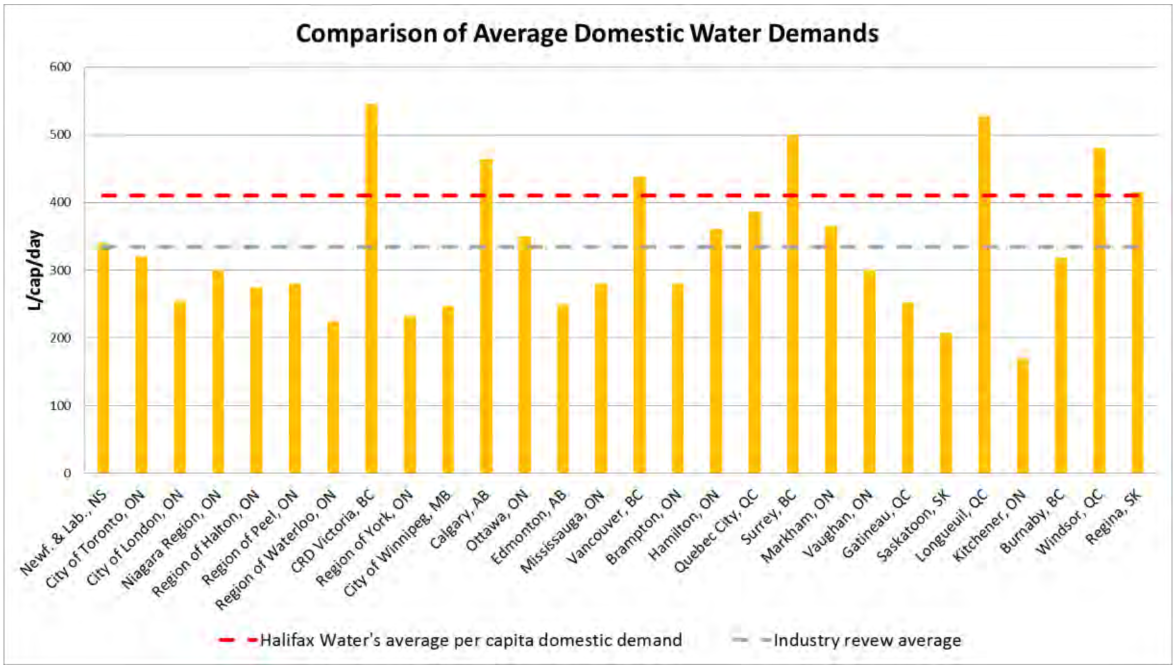


Figure 7: Comparison of Average Residential Water Demands between Municipalities

2.2.5 Recommendations

Prior to the revisions of the wastewater criteria (2017), the per capita sanitary flow (330 L/cap/day) was 80% of the per capita average day demand (410 L/cap/day). This was consistent with the industry standard of wastewater use being between 80% and 90% of water demand. Based on the trend analyses and industry review completed as part of the WRWIP study, the per capita sanitary flow rate was lowered to 300 L/cap/day, which is reflected in the 2017 Design Specifications.

A comparison of water production and wastewater treatment was completed to validate the 80% relationship. Table 4 summarizes the per capita production and treatment in 2017. The treatment plant production analysis excluded wet weather response and focused on months June-October when base infiltration was at its lowest. However, it should be noted that the dry weather flow treatment still includes some magnitude of infiltration that would not be included in production.

Table 4: Comparison of Per Capita Production against Treatment

Year	Dry Weather Wastewater Treatment Facility Flow (L/cap/d)	Water Supply Plant Production (L/cap/d)	Relationship (%)
2017	275	335	82%

With a well-established connection between water consumption and wastewater disposal rates, it would be desirable to maintain that 80% relationship by lowering the per capita average day demand to 375 L/cap/day. While a rate of 375 L/cap/day remains conservatively above the industry average rate of 334

L/cap/day, it is more in line with observed data in Halifax. The per capita average day demand is an all-encompassing design rate that accounts for non-revenue water.

The consumption trend analyses and industry review were completed to validate the appropriateness of a 375 L/cap/day averaged day demand.

The following summarizes the key results from the analyses:

- The region-wide trend analysis demonstrates a decreasing per capita consumption rate for both residential and employment.
- The region-wide trend suggests a 2017 Total Consumption rate of 264 L/cap/day. When applying the observed system-wide non-revenue water rate of 24%, the per capita average day demand for 2017 would be **347 L/cap/day**.
- The DMA demand analysis suggests that the per capita ADD ranges from 102 - 519 L/cap/day.
- The Supply Plant trend analysis suggests that the per capita average day production was approximately **337 L/cap/day** in 2017.
- The industry review highlights an average per capita domestic demand of **334 L/cap/day** across various similar regions and municipalities with a range from 170 - 545 L/cap/day.

The consumption trend analyses and industry review justify a reduction in per capita average day demand from 410 L/cap/day to 375 L/cap/day, which will be used for the completion of the Infrastructure Master Plan and future long-term planning studies. This per capita average day demand is also recommended to be included in the next iteration of the Design Specifications.

2.3 Peaking Factors

2.3.1 Treatment Plant Production

SCADA data was collected for the Pockwock and Lake Major treatment facilities to assess the peaking of production for the past five years. Table 5 summarizes the MDD and PHD factors. Figure 8 shows that Pockwock is observing an increasing ADD and MDD trend and Lake Major a reducing trend.

The following should be noted:

- The average maximum day demand factor for supply (Pockwock and Lake Major, combined) is 1.35.
- The peak hour demand factor for supply varies significantly. Large systems with various pressure zones and storage strategies, specifically for balancing, makes it difficult to assess a system-wide peak hour demand using treatment production data.

Table 5: Treatment Plant Peak Production

Pockwock WTP	ADD (MLD)	MDD (MLD)	PHD (MLH)	MDD Factor	PHD Factor
2013	80.58	92.24	4.39	1.14	1.31
2014	80.85	94.69	4.33	1.17	1.29
2015	85.78	164.71	11.37	1.92	3.18
2016	82.70	95.41	6.21	1.15	1.80
2017	80.37	104.12	11.37	1.30	3.39
5-Year Average	82.05	110.23	7.53	**1.34**	**2.19**

Lake Major WTP	ADD (MLD)	MDD (MLD)	PHD (MLH)	MDD Factor	PHD Factor
2013	39.16	67.32	3.22	1.72	1.97
2014	36.76	45.42	2.38	1.24	1.56
2015	35.74	45.58	2.49	1.28	1.67
2016	34.44	42.14	1.91	1.22	1.33
2017	31.94	43.40	1.90	1.36	1.43
5-Year Average	35.61	48.77	2.38	**1.36**	**1.59**

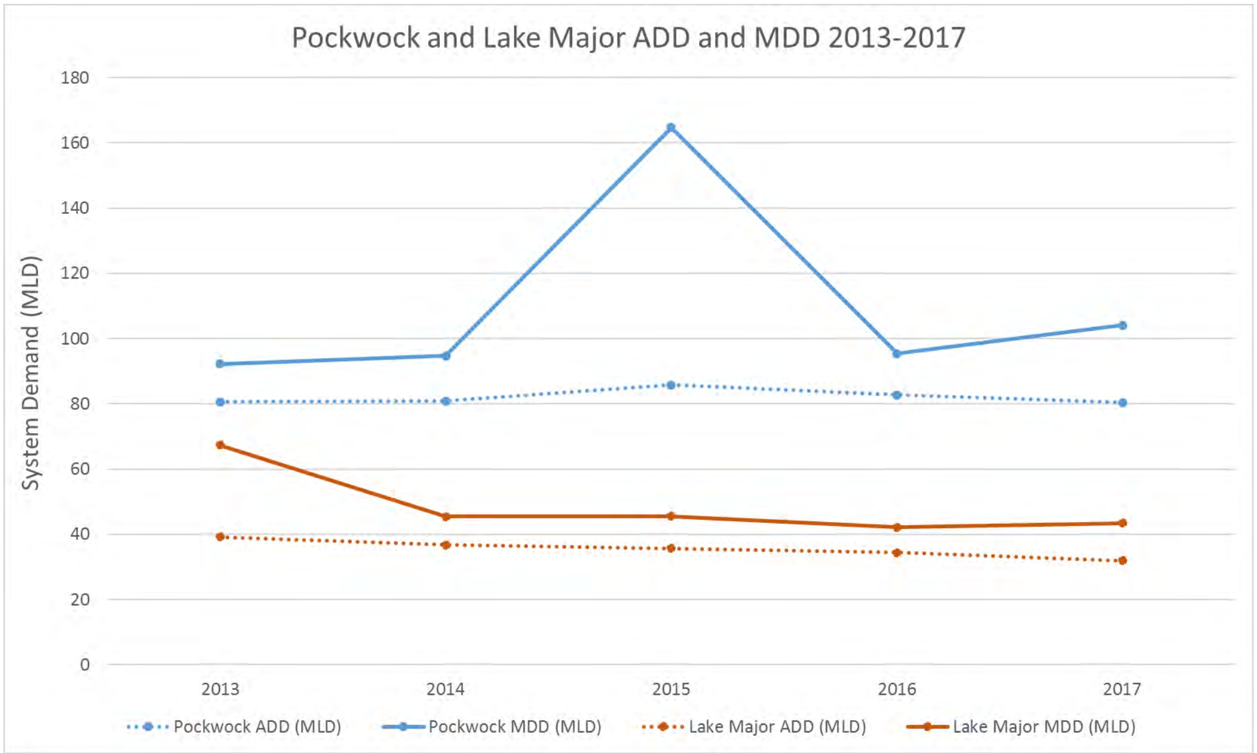


Figure 8: Graph to Show Pockwock and Lake Major ADD and MDD

2.3.2 Variability across DMAs

The following process was used to assess the peaking factors, using SCADA:

1. SCADA data from 2013 to 2017 was used to determine peaking factors across the DMA.
    - The Average Day Demand (ADD), Maximum Day Demand (MDD) and Peak Hour Demand (PHD) was determined for each year from 2013 to 2017, for each DMAs.
2. For each year, two peaking factors were calculated in the assessment, as follows:
    - 5-year Average MDD Peaking Factor
    - 5-year Average PHD Factor

2.3.2.1 Maximum Day Demand and Peak Hour Demand Peaking Factors

The results from this analysis were plotted using the box-and-whisker plots (Figure 9 and Figure 10). The results suggest that:

- The range of MDD peaking factors varies from 1.3 to 2.8, with a median value of 1.8 x ADD.
- The range of PHD factors varies from 2.0 to 4.9, with a median value of 3.6 x ADD.

The DMA peaking factor analysis is showing much larger peaking factors than those calculated using the treatment production data. This is due to the much smaller population size that results in larger peaks, and the buffering impact that in-system storage has on treatment production Also, the maximum day for the supply plants does not necessarily correspond to the maximum day for each DMA (i.e. a DMA can experience a maximum day demand when others do not). Following outlier removal and erroneous results, approximately 60 DMAs, out of 77, were included in the analysis.

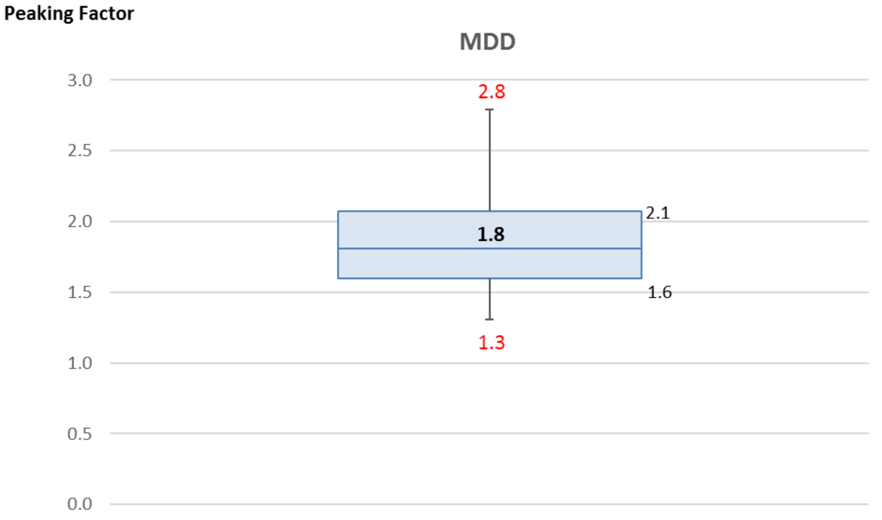


Figure 9: DMA Peaking – MDD Factor

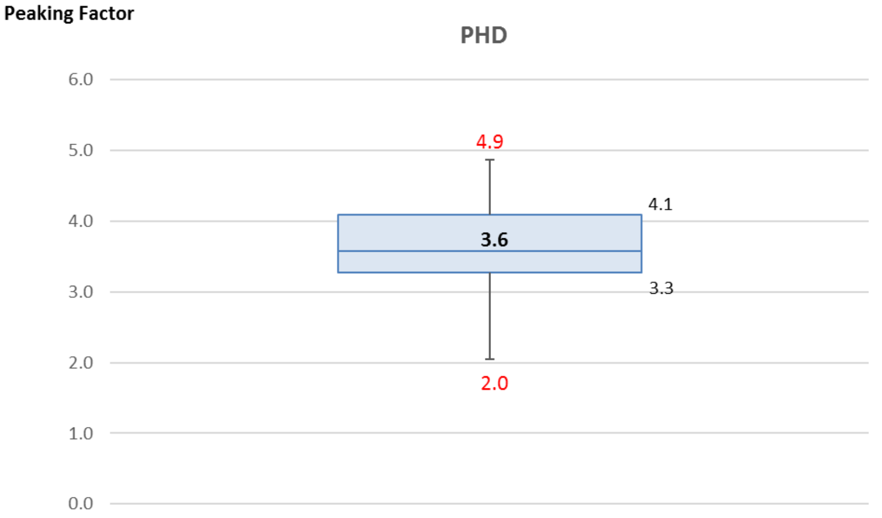


Figure 10: DMA Peaking – MDD Factor

2.3.2.2 Instantaneous flow factor (IFF)

The Design and Construction Specifications (Water, Wastewater & Stormwater Systems) 2016 Edition, contained guidance on how the instantaneous flow factor (IFF) should be calculated. The guidelines were as follows:

"For instantaneous peak flow demands (i.e. Flow when residential consumption including lawn watering is at its highest) a minimum of 5.45 L/min (1.44 US gallons per minute) per dwelling unit is to be used."

It is not typically industry best practice to have an IFF and it is recommended that this section be removed from Halifax Water's Design and Construction Specifications.

Provided lift stations are adequately sized to the greater value of peak hour demand or max day demand plus fire flow, adequate station capacity redundancy is provided through the firm capacity calculation mitigating most issues caused by instantaneous flow demands.

The firm capacity should be calculated to provide peak hour demand and max day plus fire flow within the stations full maximum capacity (see section 3.2.3.2). Using this approach means that the Instantaneous Peak Flow (IPF) can generally be accommodated within those capacity limits.

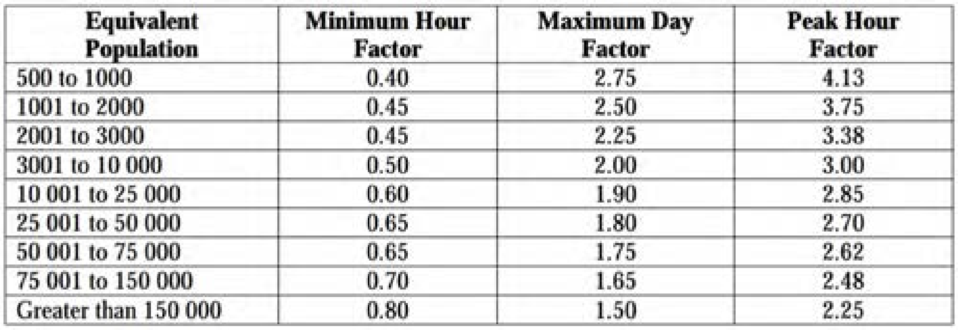
It should be noted that closed pressure zones are generally small and when the zone has alternative sources such as PRV's it is those sources that are able to provide the capacity required for peak instantaneous demand. Further, there are inherent limits in the system's ability to respond to the IPF demand and the system will self-modulate, dropping pressure and reducing flows during high demand periods.

2.3.3 Industry Review

The municipalities included in the industry review for water consumption rates, in Section 2.2.4, were also included in the industry review peaking factor, to understand the current design criteria's being used. During the industry review it was determined that it is not common practice to have IFF, therefore the industry review covers industry best practice for MDD and PHF only.

In reviewing the different municipalities design specification, it was found that several municipalities separate out peaking factors based on the services population size. The "*Atlantic Canada Guidelines for Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems* and the *Newfoundland and Labrador 2005 Guidelines for Design, Construction and Operation of Water and Sewerage Systems (2004)"* use the same guidelines as Ontario for minimum hour factor, maximum day factor, and peak hour factor, which considers servicing population, as outlined in Table 6.

Table 6: Ontario Guidelines for Minimum Hour Factor, Maximum Day Factor and Peak Hour Factor



Equivalent Population	Minimum Hour Factor	Maximum Day Factor	Peak Hour Factor
500 to 1000	0.40	2.75	4.13
1001 to 2000	0.45	2.50	3.75
2001 to 3000	0.45	2.25	3.38
3001 to 10 000	0.50	2.00	3.00
10 001 to 25 000	0.60	1.90	2.85
25 001 to 50 000	0.65	1.80	2.70
50 001 to 75 000	0.65	1.75	2.62
75 001 to 150 000	0.70	1.65	2.48
Greater than 150 000	0.80	1.50	2.25

Halifax Water's Design Specification for residential peaking factors did not provide a range of peaking factors based on the serviced population, and when compared against the peaking factors in Figure 9 above, were in-line with the larger equivalent population ranges of +75,000 people, but did not accommodate the smaller equivalent population ranges, that tend to have higher peaks.

Table 7 provides a range of municipalities who have a single peaking factor, irrespective of the serviced population. In general, the municipalities that do not separate out peaking factors by equivalent population tended to have an overall higher peaking factor, than what is currently in Halifax Water's Design Specification.

Table 7: Summary of Peaking Factor Comparison between Municipalities

Municipality / Guideline	Peaking Factor Res
Halifax Regional Municipality	Low density residential: Max Day = 1.65 Peak Hour = 2.48 High density residential: Max Day = 1.30 Peak Hour = 2.50
City of Toronto, ON	Max Day = 1.65 Peak Hour = 2.48
City of London, ON	Max Day = 3.5 Peak Hour = 7.8
Niagara Region, ON	Max Day = 1.43 Peak Hour = 4
Region of Halton, ON	Max Day = 2.25 Peak Hour = 4
Region of Peel, ON	Max Day = 2 Peak Hour = 3

2.3.4 Recommendations

The peaking factor analyses and industry review were completed to inform the selection of demand peaking factors for this Infrastructure Master Plan and for the next iteration of the Design Specifications.

2.3.4.1 Infrastructure Planning

Table 8 summarizes the demand peaking factors that are recommended for infrastructure planning studies.

Table 8: Peaking Factors for Infrastructure Planning

Category	MDD	PHD
System Supply	1.30	-
Storage	1.80	-
Pumping and PRVs	-	3.60

Key things to note regarding the selection of the peaking factors in Table 8:

- System supply (MDD) – generally in line with the observed MDD peaking at the Pockwock and Lake Major treatment facilities for the past five years.
- Storage (MDD) – in line with the median of the DMA peaking analysis and Atlantic Canada Guidelines for 25,001 - 50,000 serviced people, a reasonable average for a storage facility.
- Pumping and PRVs (PHD) – in line with the median of the DMA peaking analysis and Atlantic Canada Guidelines for 1,001 - 3,000 serviced people, typical range for Halifax Water pumping stations

2.3.4.2 Design Specifications

Due to the variability of demand peaking across the DMAs, and high-level analysis that took place, further discussion is required with Halifax Water team to decide on the criteria to be used in the next iteration of the Design Specifications. Existing criteria is summarized in Table 9.

Table 9: Existing Water Distribution Peaking Factors

Land Use	Minimum Hour	Peak Hour	Maximum Day
Low Density Residential	0.70	2.50	1.65
High Density Residential	0.84	2.50	1.30
Industrial	0.84	0.90	1.10
Commercial	0.84	1.20	1.10
Institutional	0.84	0.90	1.10

3 Level of Service

A range of level of service objectives can be used to identify when the water system is no longer performing as designed. These requirements typically include acceptable pressures or velocities within transmission and distribution mains, meeting available fire flow targets, providing sufficient system storage, and ensuring adequate water quality. This section will outline the key level of service objectives that will be used to assess the performance of Halifax Water's transmission/distribution systems within the Infrastructure Master Plan. These objectives need to be realistic, economically achievable, make sense technically, and satisfy Halifax Water's customers. The assessment of the water distribution system will be a high-level review that focuses on:

- System optimization,
- Operational strategies,
- Security of supply,
- Transmission Main conveyance.

The following list of criteria are to be considered when developing the level of service objectives:

- Efficiency
- Sustainability
- Safety
- Reliability
- Capacity
- Regulatory Compliance
- Growth

3.1 Current Design Standards

The following summarizes the specifications that are outlined in the existing 2017 Design and Specifications:

Allowable Pressure Range

- Average Day & Maximum Day Demand between 350 kPa (50 Psi) and 550 kPa (80 Psi).
- Minimum Hour & Peak Hour Demand between 275 kPa (40 Psi) and 620 kPa (90 Psi).

Fire Scenarios

- The minimum residual pressure during a Maximum Day Demand plus fire flow demand scenarios will not be less than 150 kPa (22 Psi) at any location in the water distribution system.

Fire Flow Requirements are presented in Table 10:

Table 10: Existing Fire Flow Requirements (2017 Design Specifications)

Land Use	Fire Flow (L/min)	Duration (hours)	Number of Fire Hydrants
Single unit dwellings	3300	1.5	1
Two family dwellings	3300	1.5	1
Townhouse	4542	1.75	1
Multi-unit high rise	13620	3	3
Commercial	13620	3	3
Industrial	13620	3	3
Institutional	13620	3	3

Other Targets:

- Maximum velocity not to exceed 1.5 m/s (peak hour demand) or 2.4 m/s during fire flow conditions
- Supply redundancy:
    - No group of 30 or more metered customers are supplied by a single source of supply.
    - To be designed to exclude any dead-ended pipe.

It should be noted that these specifications are for new construction and do not outline level of service objectives for existing customers. These criteria were reviewed to inform the development of the level of service objectives.

3.2 Recommended Level of Service Objectives for the Infrastructure Master Plan

The following sections outlines level of service objectives for water distribution systems that are recommended for infrastructure planning studies, including the Infrastructure Master Plan.

3.2.1 System Pressure

The existing pressure level of service objectives are in line with industry standards. It is recommended that they continue to be used and are summarized in Table 11. A flag identifies system constraints that are a concern whereas an action identifies inadequate performance that requires a strategy to resolve.

Table 11: System Pressure Level of Service

Scenario	Level of Service Pressures (psi)	Explanation
MDD and ADD	40-50 or 90-100	FLAG: if ADD and MDD pressures are between 40-50 psi or 90-100 psi
PHD and MDD	<40 or >100	ACTION: if PHD and MDD pressures are below 40 psi or above 100 psi
MDD + FF	>22 psi	FLAG: if available fire flow is between 80-100% of target ACTION: if available fire flow is < 80% of target

3.2.2 Fire Flow Requirements

There are many different methods of determining system fire flow requirements.

The Fire Underwriter's Survey (FUS)

This is a calculation-based method for determining fire flow requirements and is dependent on individual property use and building configuration. The approach is outlined in the "Water Supply for Fire Protection" section of the Fire Underwriter's Survey. The FUS method is a good approach when assessing site-specific fire flow requirements or unique customers, however, there is a large variability across land use types (e.g. commercial). Halifax Water's fire flow requirements (2017 Design Specification) are based on the FUS and designers are referred to this methodology if their application is not covered by the standardized table within the specification.

Ministry of the Environment and Climate Change (MOECC)

This is a population-based guideline that provides a recommended flow and duration depending on the serviced population within the pressure zone of interest. It is typically the most conservative approach for calculating fire flow storage and pumping requirements.

Design Specifications

Some municipalities establish their own fire flow level of service objectives, which are typically categorized by land use. The requirement may be informed by the FUS approach or MOECC guidelines and usually account for the large variation in fire flow requirements.

3.2.2.1 Recommendation

The Infrastructure Master Plan will focus on the assessment of trunk infrastructure. In terms of fire flow objectives, the primary task will be to ensure that the required fire flows within each DMA can be attained through the transmission infrastructure. The following outlines the general approach for assigning fire flow targets across the water distribution system:

Use the fire flow level of service objectives (

- Table 12) to assign a fire flow to each parcel based on land use, in line with the current Halifax Water Design Specifications (2017).
- Use the FUS approach to calculate a fire flow requirement for any unique or critical customers.
- Assign a single fire flow requirement to each DMA, which will correspond to the largest fire flow requirement allocated within.
- Assess the trunk infrastructure based on its ability to deliver the required flow to each DMA.

As noted, the level of service objectives for the Infrastructure Master Plan are to assess regional infrastructure. After Halifax Water develops their all pipe hydraulic model, a more refined fire flow level of service can be used to assess system capacity and constraints at the distribution piping level. Future infrastructure studies and the next iteration of the master plan can utilize the future all pipe model to assess fire flow objectives at each property or node in the system, not just satisfying the high-level DMA requirements. However, for the purposes of this master plan, the approach outlined in this memo is sufficient.

Table 12: Fire Flow LOS based on Land Use (Master Plan)

Land Use	Fire Flow (L/min)	Duration (hours)	Number of Fire Hydrants
Single unit dwellings	3300	1.5	1
Two family dwellings	3300	1.5	1
Townhouse	4542	1.75	1
Multi-unit high rise	13620	3	3
Commercial	13620	3	3
Industrial	13620	3	3
Institutional	13620	3	3

3.2.3 Facility Review

A comprehensive review of all facilities, storage, pumping, and PRVs, will be completed as part of the Infrastructure Master Plan. This section highlights the key level of service objectives associated with storage and pumping station facilities.

3.2.3.1 Storage

Storage needs can vary greatly depending on the methodology that is used to calculate the required volumes. It depends on the fire flow calculations, demand peaking factors, and emergency storage requirements. Storage capacity is also impacted by the pumping strategy or overall system and pressure zone needs, such as closed (pumped storage) and open zones (floating storage).

The following outlines some key considerations when defining the storage level of service objectives:

- More storage can reduce pumping needs but may lead to increased water quality issues.
- Risk of being over conservative:
  - High peaking factors
  - High emergency storage
  - Pump station firm capacity criteria
- Less storage would mean that the system is more reliant on pump capacity and has less operational flexibility.
- Storage sharing across pressure zones.
- Ability to fill tanks under MDD scenario (capacity of transmission network)
- Distance from storage to zones it is providing protection for (capacity of transmission network).

The following approach, based on the Atlantic Canada Guidelines for sizing of water storage facilities, is recommended when completing the storage review for the Infrastructure Master Plan:

Total Storage = Fire Storage (A) + Equalization Storage (B: 25% of MDD) +
Emergency Storage (C: 25% of A+B)

The upper most portion of a storage facility is designated as the equalization storage, the middle tier as fire storage, and bottom portion emergency storage.

Fire Storage Needs (A)

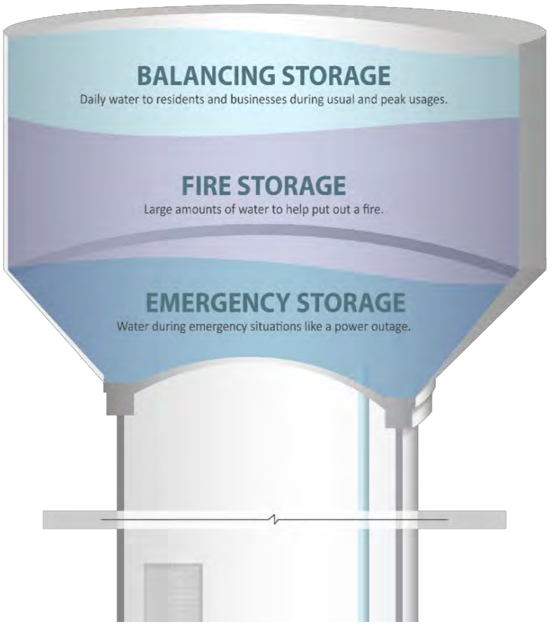
Fire storage is intended to provide the volume of water required to fight a fire within the zone that the storage tank is servicing. The required fire storage will be based on the zonal fire flow requirements outlined in Section 3.2.2.

Equalization Storage Needs (B)

Equalization storage, also known as peak balancing or operational storage, is intended to meet peak demands that surpass the available supply. It is a function of the diurnal demand fluctuation, which varies from zone to zone. It is calculated as 25% of the zone's max day demand (MDD).

Emergency Storage (C)

Emergency storage will be 25% of the sum of fire (A) and equalization (B) storage and is intended to accommodate demand during maintenance shut-downs or emergency situations.



In addition to an available storage level of service objective, water quality should also be considered. This is recommended in the Atlantic Canada Guidelines as a maximum turnover of 72 hours.

3.2.3.2 Pumping Requirements

The following outlines some key level of service objectives regarding pumping station facilities, which are in line with industry best practice and typical for assessing firm capacity and performance

- Pump Station Firm Capacity:
    - For PHD requirements: calculated with the fire pump (if present) and the largest non-fire pump out of service.
    - For MDD+FF requirements: calculated with the largest non-fire pump out of service.
- Capacity Criteria:
    - Meet MDD when there is sufficient zonal storage
    - Meet the maximum of PHD and MDD+FF when there is insufficient zonal storage

Other considerations when defining the pumping level of service may include:

- Risk of being over conservative with 100% redundancy within a pumping station through oversized pumps
- Higher pumping capacities may increase system operational flexibility
- Need to balance pumping and storage criteria.
- There are many small pumping stations throughout HRM that service small residential areas without designated storage.
    - The design specifications state that the capacity should be such that it can provide 80% of peak hour flow with one lag and one jockey, and one lag can provide 55% of peak instantaneous. If the recommendation to remove Instantaneous Flow Factor calculation from the Design Specifications then the above noted reference to peak instantaneous flow should also be removed from the specifications.
    - These facilities need to be assessed on a case-by-case basis with considerations for whether they are fundamentally providing fire protection. If fire protection is being provided by an alternate source, such as a check valve, then the capacity criteria can be to meet PHD with one pump out of service.

3.3 Key Performance Indicators

Additional key performance indicators are highlighted in **Error! Reference source not found.**. This master plan will focus primarily on the performance of regional infrastructure; therefore, most of these key performance indicators do not apply. However, they should be noted as they can be incorporated into local servicing studies and intensification analyses where assessing the local network is the primary focus. Many of these additional level of service objectives will require additional tools, such as an “all-pipe” hydraulic model to assess performance at the local pipe by pipe level, or an extended period simulation (EPS) model to assess tank performance and water quality over time.

4 Policy and Regulatory Compliance

Compliance with national and regional standards is a major driver for infrastructure planning. The wastewater and water supply networks must meet national and provincial legislation and policy, while also aligning with regional standards and goals, to achieve a high standard of service for the customers, employers and stakeholders.

The following key policy and legislation documents will be used to determine the level of compliance of the water supply systems and guide the Infrastructure Master Plan's optimization strategies.

- Nova Scotia Environment (NSE)
- Health Canada, Guidelines for Canadian Drinking Water Quality (CDWQ)
- Halifax Water - Water Quality Master Plan (WQMP)
- Canadian Council of Ministers of the Environment (CCME) (2009)
- Chartered Institute of Water and Environmental Management (CIWEM).

4.1 Nova Scotia Environment (NSE)

Nova Scotia Environment (NSE) is the provincial government department that oversees water supply sources, standard of drinking water and treatment and disposal of wastewater. NSE is responsible for setting the standards, issuing approvals, protecting water sources, drinking water quality, and auditing compliance with provincial standards.

NSE has developed a comprehensive drinking water strategy and standards for drinking water. The Drinking Water Strategy for Nova Scotia[1] aims to protect Nova Scotia's drinking water supplies for current and future generations, providing a consistent high quality of water to all communities - through defining key elements and forming an action plan. The Nova Scotia's Treatment Standards for Municipal Drinking Water Systems[2], outlines the minimum requirements that apply to municipal drinking water systems in Nova Scotia, including standards for municipal drinking water, source water protection requirements, adequate treatment and distribution, operation, monitoring, reporting and management guidelines. Continued engagement with NSE is important with defining targets and triggers used to identify infrastructure needs and size.

4.2 Environmental Management System

Halifax Water has adopted the Environmental Management System (EMS) which certifies both water supply plants and wastewater treatment facilities, through the International Organization for Standardization (ISO) 14001-2004 Environmental Management System Standard. EMS 14001-2004 is an internationally agreed standard that improves organizations environmental performance through efficient use of resources and reduction of waste in a holistic way.

In September 2015, ISO issued a new standard ISO 14001-2015, with a three-year transition period for upgrades to be completed to maintain certification after September 2018. To achieve this new standard, EMS awareness sessions and internal audits will be required.

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[1] https://novascotia.ca/nse/water/docs/NSWaterStrategy.pdf

[2] https://novascotia.ca/nse/water/docs/Treatment_Standards_for_Municipal_Drinking_Water_Systems.pdf

Bennery, Pockwock and Lake Major WSP are currently certified by the International Organization for Standardization (ISO) 14001-2004 Environmental Management System.

In 2016 Halifax Water expanded its ISO 14001 designation to include Herring Cove WWTF, becoming the first WWTF to obtain certification in Atlantic Canada. Halifax Water is aiming to get the remaining WWTFs certified by 2020, starting with Dartmouth in 2018.

4.3 Water Supply Policy Review and Recommendations

The water supply policy review included reviewing the Health Canada's Guidelines for Canadian Drinking Water Quality (CDWQ), the Halifax Water - Water Quality Master Plan (WQMP) and Halifax's Water Research Program with Dalhousie University.

4.3.1 Guidelines for Canadian Drinking Water Quality

Health Canada's Water Quality and Health Bureau plays a lead role in water quality and health standards for Canada and has developed guidelines to establish drinking water requirements for all Canadians.

The Guidelines for Canadian Drinking Water Quality (CDWQ), were prepared by the Federal-Provincial-Territorial Committee on Drinking Water and published by Health Canada. The guidelines state acceptable levels of microbiological, chemical and physical and radiological contaminants in drinking water, as well as acceptable aesthetics, such as taste and odour.

Operational considerations are also factored in, as the addition/removal of substances can interfere with a treatment process or technology. A table of the acceptable levels for contaminants and guidelines for water quality, are updated regularly and published on Health Canada's website (www.healthcanada.gc.ca/waterquality).

4.3.2 Halifax Regional Water Commission Water Quality Master Plan

The Water Quality Master Plan (WQMP) is a key tool developed by Halifax Water to continuously provide safe drinking water to HRM. The WQMP was initiated in 2006 to provide direction for drinking water compliance and to assess drinking water quality, in a way that keeps in line with rapidly changing regulations. In 2011, Version 2 of the WQMP was released with a focus on upgrades and investigation concerns for J.D Kline WSP. Version 3, now the current version, was released in 2016. Version 3 shifted the focus towards source water quality and the impacts on treatment processes and distribution systems. There were two main drivers for this change in focus. One of the drivers was that research had indicated lakes in Nova Scotia may be impacted by a reduction in acid rain resulting in changing PH and biological growth. Both Lake Major and J.D. Kline WSPs had been dealing with changing source water quality issues. The other driver was in acknowledgement of lead exposure from pipelines. Version 3 included development of a plan for removal of both public and private lead service lines by 2050.

The WQMP has kept Halifax Water ahead of expected regulatory changes, through placing emphasis on the reduction of disinfection by-products (Trihalomethanes and Haloacetic acids), adapting to changing trends around new water quality parameters and lower Maximum Acceptable Concentrations (MACs), and incorporating up to date research and development trends.

4.3.3 Water Research Programs

In 2007, Halifax Water established a water research program with Dalhousie University and the National Science and Engineering Research Council (NSERC) of Canada. In 2017 the program was renewed, with a focus on understanding the relationship between raw water quality and treatment operations, including understanding the extent of potential impacts from a changing water source on asset management.

This research program helps keep Halifax Water at the forefront in the development of best practices and able to be proactive in planning for upcoming regulatory changes by introducing efficient and effective practices that protect the public's health. Recent trends have shifted towards understanding corrosive inhibitors for lead and further research in lake recovery.

Research direction over the next five years will focus on the following themes:

- Understanding source water quality changes - including lake recovery
- Optimization of treatment processes to meet source water challenges
- Improved distribution system water quality
- Integration of data management processes

4.3.4 Current Water Supply Standards Review

The CDWQ provides the drinking water criteria set by the federal government. Recent changes to CDWQ drinking water regulations are as follows:

- In 2016 Health Canada proposed a new guideline for the magnesium aesthetic objective value to change from 0.05 to 0.02mg/L, and a maximum acceptable concentration (MAC) of 0.1mg/L. These guidelines are expected to be published in 2018.
- In January 2017, Health Canada issued a new guideline for lead with a MAC of 0.010 mg/L. Halifax Water was better prepared for this change than other utilities in Canada, through initiating programs that incentivized customers to remove private lead pipes.

It is expected that over the long term the following regulatory adjustments will occur:

- Reducing Disinfection By-Products - Trihalomethanes (THMs), Haloacetic acids (HAAs); and,
- New Parameters and Lower Maximum Acceptable Concentrations (MACs).

The WQMP has addressed the reduction of THMs and HAAs, and the WSP improvement projects required to meet expected disinfection by-product targets are included in the Five-Year Business Plan. As new parameters or lower MACs are expected to occur, they will be addressed on an on-going basis through the WQMP.

Halifax Water operates three large state-of-the-art water supply plants (WSPs), which all currently have water withdrawal permits, are certified by the International Organization for Standardization (ISO) 14001 Environmental Management System Registration and meet the Canadian Drinking Water Standards.

APPENDIX A *Key Performance Indicators to Evaluate Level of Service Objectives*

Table 13: Key Performance Indicators for Water Distribution Systems

Customer Service Statement	Service Objectives	Technical Objectives	Key Performance Indicators - Technical	Key Performance Indicators - Customer
"To provide an efficient, sustainable, and safe water distribution system that meets regulatory requirement, minimize service distribution and is capable of accommodating growth"	*Efficient*	- Full life-cycle costing - Renewal of aging infrastructure - Optimization of system operations - Increased water conservation - Non-revenue water is maintained at a reasonable rate	- Non-revenue water rate - Per capita rate (residential, employment) - Peaking factor - Energy consumption - SOGR program - Watermain headlosses and velocities - Pumping needs - Storage needs	- Number of complaints (water bills, cost, pressures, quality etc.) - Default rates - Service interruptions - Compliance with Standards
	Sustainable	- Full life-cycle costing - Renewal of aging infrastructure - Resiliency to climate change - Costs associated with water servicing fees	- SOGR program - Age of infrastructure - Number of watermain breaks - Replacement/rehab costs - O&M costs	
	Safe	- Reliability of the distribution system - Maintain chlorine residuals with distribution system - Provide adequate fire protection	- Water age - Chlorine residuals - Flushing rates - Watermain velocities - Turnover in storage facilities - Fire flow - Emergency storage	
	Reliable	- Ability to supply adequate pressures and flows, uninterrupted to the distribution system, - Ability to meet daily demands - Minimal service interruptions - Facilities have backup power available	- Pressure - Fire flow - Supply needs - Pumping needs - Storage needs - Backup power at facilities - System redundancies	
	Capacity	- Ability to supply adequate pressures and flows, uninterrupted to the distribution system, - Ability to meet daily demands - Minimal service interruptions - Ablilty to meet growth demands and adquately provide pressures and flows in the future	- Pressure - Fire flow - Supply needs - Pumping needs - Storage needs	
	Regulatory	- Standards, Acts, and Regulations	- Pressure - Emergency pressure (fire flow) - Chlorine residuals - Supply capacity	

Customer Service Statement	Service Objectives	Technical Objectives	Key Performance Indicators - Technical	Key Performance Indicators - Customer
	Growth	- Rated capacity of facility can support growth (supply, pumping, storage) - Pressures, fire flow, and water quality are maintained at or above current performance objectives - Projected demands are applied to areas of planned growth	- Pressure - Fire flow - Supply needs - Pumping needs - Storage needs - Per capita rate (residential, employment) - Peaking factor	

Benefit to Existing Position Paper

Technical Memorandum

2019 Regional Development Charge

Prepared by GM BluePlan for:

The Halifax Regional Water Commission

Project No. 719008

April 2019

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1 Introduction

1.1 Background and Context

Halifax Regional Water Commission (HRWC) retained GM BluePlan to undertake the West Region Wastewater Infrastructure Plan (WRWIP) project. The scope of the project included the development of a position paper regarding infrastructure costs resulting from development growth providing a Benefit to Existing (BTE) customers and 'Out of Period' oversizing of projects where the beneficiary of new infrastructure is beyond the 20 year time frame of the Regional Development Charge (RDC).

The regional infrastructure projects identified through Long Term Planning studies that are triggered by growth, should be paid for by growth. However, in some cases the projects and infrastructure that are recommended could provide tangible benefit to the existing population. For the initial RDC implementation this assessment was based on a review of the individual projects and an estimated reduction percentage BTE, generally 5%, 10% or 15%, was applied accordingly.

Further to understanding BTE and oversizing calculations in a regional infrastructure and greenfield development context, there is a lack of definition regarding intensification, brownfield developments and the appropriate split of costs, especially where existing capacity constraints are identified.

1.2 Development Charges

Many cities and towns face development pressure, which requires the expansion of existing or the installation of new infrastructure systems to support new development and its demand on utilities and services. However, the costs associated with these infrastructure requirements create significant public sector burden. Increasingly all governments are facing significant constraints in the use of general purpose taxation and have placed greater emphasis on the “user pay”, or “benefiter pay”, principle. In response to these pressures, Development Charges (DCs) have been utilized by municipal governments and utility providers as a cost recovery mechanism for apportioning infrastructure project costs amongst developers of land who will benefit from and require the servicing.

DCs allow monies to be pooled from many developers so that funds can be raised to construct the necessary services in an equitable manner. Simply, the municipality or utility owner can be considered to be the coordinator of the capital program and administrator of the funds collected. (Development Cost Charge Best Practices, British Columbia, Ministry of Community Services, 2000)

1.3 Purpose, Aims and Objectives

The purpose of this Memorandum is to provide a position paper to inform and provide decision support for Halifax Water to identify the approach to the cost splits of capital projects regarding growth, BTE and oversizing.

The paper will review and document industry best practices regarding the application of BTE and oversizing calculation, present options and recommend a preferred position.

The primary aim of the task is:

- To recommend preferred approaches to the identification of Benefit to Existing and ‘out of period’ oversizing infrastructure project cost allocation.

To achieve the aim, the objectives of the task are:

- To review and document industry best practice
- Document the key components of BTE and oversizing
- Consider the differences between greenfield and brownfield/intensification development.

2 Current Situation

2.1 Historic Overview

The following section summarizes the history of development charges in HRM.

In August 2000 Halifax Regional Municipality (HRM) undertook to develop a policy for implementing Infrastructure Charges in the Municipality. The result was the INFRASTRUCTURE CHARGES BEST PRACTICE GUIDE:

2.1.1 Capital Cost Contribution Policy (CCC)

This Guide addresses the legislation, policies and practices relevant to cost apportionment for new infrastructure in the Municipality on a site specific level. It proposes a policy for recovery of infrastructure charges in the Municipality. The charge recovered under the policy is intended to capture costs directly attributable to the subdivision of land - rather than all costs associated with new infrastructure required for the “core” area of the Municipality. The policy is designed to allow the Municipality to apportion the costs associated with new infrastructure without unduly impacting normal market forces and conditions.

The CCC Policy relates to specific areas or sites. The definition of the areas are confirmed through infrastructure planning studies. Once identified the cost of infrastructure required to service the site is calculated which is then apportioned amongst the developers of the site. The CCC does not include provision of costs related to regional infrastructure such as large trunk sewers, regional pumping stations or regional treatment facilitates.

2.1.2 Regional Development Charge

In 2014 the Nova Scotia Utility and Review Board (NSUARB) approved Halifax Water’s application for approval of amendments to the *Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services*, to establish separate Regional Development Charges (RDCs) for water and wastewater, and to eliminate the charges for trunk sewer and sewer redevelopment. The RDC is a regional charge and is separate to the site specific CCC. The key premise of the RDC is to ensure that growth will pay for growth and is focused on the recovery of costs of only those infrastructure needs which are defined as regional.

The RDC charge for water and wastewater infrastructure was based on the Integrated Resource Plan (IRP) project list. The BTE of those projects was estimated based on the hydraulic modelling results, engineering judgement and industry averages. This resulted in many of the projects being allocated a BTE as a percentage of total project cost, generally between 0% and 15%. The approach was acknowledged as high-level and traceable although simplistic and provided an initial consideration of BTE. The NSUARB RDC hearing decision included the following summary and direction regarding BTE:

> “*The Board has considered the evidence and it appears that no one is opposed to the concept of BTE, but it is the amount and accuracy of the BTE which is questioned.*

> *[204] HRWC has calculated the BTE based on how other municipalities (particularly in Ontario) have calculated the BTE and whether the existing population will benefit. In addition, HRWC also considered the level of service and flooding improvements as factors in determining the BTE.*
>
> *[205] HRWC reviewed each project considering these factors and assigned BTE values of 0% to 15% based on its judgement. HRWC also indicated that these values will be updated for each project when it prepares detailed engineering design and tender documents for each project. No contrary evidence was led about the BTE percentages or their application to specific projects.*
>
> *[206] Based on the above understanding, the Board approves the BTE as calculated by HRWC in the Application. The Board expects HRWC to update the BTE amounts during the engineering and tendering process when more accurate information becomes available. The updated BTEs will be incorporated into the calculation of the RDC in the five year reviews.*"

The approach to the calculation of BTE for the RWWFP was made more appropriate by the Regional context of the plan. The majority of the growth areas assessed consisted of greenfield areas, which generally have a limited impact on the existing system users. However, in an intensification context, such as Peninsula Halifax the impact of BTE could be more pronounced. Peninsula Halifax is fully developed, has older infrastructure and has existing capacity constraints. Any new, improved, upsized infrastructure or measures to recapture capacity will most likely create a benefit to existing users. A key aim of this paper is to provide feasible options to approach this situation resulting in an equitable and transparent approach to BTE apportionment.

3 Definitions

The following sections provide detailed descriptions of the various terms that are relevant to Development Charges policies. Some terms, such as oversizing and post period are similar in context but should be distinct in application. For the purposes of this position paper and future discussion it is recommended that these definitions remain and are understood by all involved stakeholders. It is imperative that the final agreed terminology adopted is used consistently by Halifax Water in all long term infrastructure planning and development charge discussions.

3.1.1 Local and Regional Service Policy

A Local and Regional Service Policy sets out the fundamental criteria for what infrastructure is eligible for Development Charges.

For Halifax Water two charges are applicable. The area master infrastructure development charge, administered through the Capital Cost Contribution (CCC) policy and the regional infrastructure development charges, administered through the Regional Development Charge (RDC). Both have definitions of what infrastructure is eligible. The following text relates to the definition of regional infrastructure and by virtue of this definition all other infrastructure is considered local infrastructure.

For Halifax Water Regional Infrastructure is defined in the SCHEDULE OF RATES, RULES & REGULATIONS FOR WATER, WASTEWATER, and STORMWATER SERVICES
Effective July 1, 2013, as amended.

Wastewater Infrastructure means core regional wastewater treatment facilities and trunk sewer systems directly conveying wastewater to, or between, such facilities, including:

i. existing wastewater treatment facilities (WWTF) that provide a regional service including the facilities generally known as the Halifax WWTF, Dartmouth WWTF, Herring Cove WWTF, Eastern Passage WWTF, Mill Cove WWTF and Beechville/ Lakeside/ Timberlea WWTF,

ii. trunk sewers and related appurtenances which directly convey wastewater to regional treatment facilities, and

iii. trunk sewers and related appurtenances which divert wastewater from one regional treatment facility to another due to environmental concerns, capacity constraints or operational efficiency but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

Regional **Water Infrastructure** means core regional water supply facilities and the water transmission systems directly conveying water from such facilities to the various distribution systems, including:

i. existing water supply facilities that provide a regional service including the facilities generally known as the J.D. Kline water supply facility at Pockwock Lake and the
Lake Major water supply facility at Lake Major,

ii. water transmission mains and related appurtenances which directly convey water from regional treatment facilities to the distribution system, and

iii. water transmission mains and related appurtenances which divert water from one regional treatment facility supply area to another due to environmental concerns, capacity constraints or operational efficiency but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

3.1.2 Benefit to Existing (Non Growth)

Benefit to Existing (BTE) represents the non-growth components identified for certain projects which benefit the existing service area. These components are typically associated with upgrade to the existing systems or facilities necessary to continue to meet Level of Service targets for existing residential and ICI users. These projects may also involve or be triggered by upgrades or expansions which provide additional capacity to meet growth in the service area.

The premise is that any costs associated with BTE should be removed from the Regional Development Charge rate calculation. There are several ways to calculate BTE, each with advantages and disadvantages, which in many cases are dependent on the situation within which they are applied.

3.1.3 Post period benefit

Development charge planning horizons typically matches infrastructure master planning study horizons and are generally not less than 20 years. For Halifax Water's RDC a rolling 20 year horizon is required, as directed by the NSUARB. The RDC is to be updated every five years and supported by updated infrastructure master plan studies. The infrastructure master planning horizon is currently 30 years. It is good engineering and infrastructure planning practice to provide sufficient capacity to meet infrastructure servicing requirements beyond the RDC horizon (20 years), particularly for large diameter trunk piping and major structural components of facilities, based on assumed asset life, future projected growth beyond the RDC horizon and to mitigate impact of construction.

Post-period benefit is taken into account with projects that provide an additional allowance to service growth beyond the 20 year RDC horizon. The difference in cost for the recommended size of infrastructure to meet the RDC horizon (e.g. 20 years) and the size of infrastructure selected that would serve post period growth (e.g. to the 30 year master plan horizon) would be front end funded by Halifax Water and collected through future RDC updates as the rolling RDC horizon captures and justifies the need. Master plan 30 year horizon growth projections can be used to indicate the extent of additional flows beyond the planning horizon and used to assess the need and relative risk of oversizing.

4 Industry Review

4.1 Overview

To provide insight into the approach adopted by other utility providers the following provides a review of industry best practice. In particular, examples are taken from providers that have long established approaches, often substantiated with legislation to support them.

4.2 Ontario Development Charge Act (DCA)

Subsection 5(1) of the DCA sets out the method that must be used to determine development charges with the first step stating that:

"*The anticipated amount, type and location of development, for which development charges can be imposed, must be estimated.*"

Further steps refer to "*the increase in need for service attributable to the anticipated development.*" Therefore, the estimate of anticipated residential and non-residential development is a critical starting point to the process. Such development will generate increased servicing needs through its occupancy and use.

In Ontario the DCA requires that the amount, type and location of development be estimated. "Timing" is not referenced, other than indirectly, in Section 8 para 3 of O. Reg. 82/98, where capital costs to be incurred during the term of the proposed development charge by-law, must be set out. Also, s.s.5(1)4 of the Act restricts the estimate of the need for services other than water supply, wastewater, highways, storm water drainage and control … to a maximum of 10 years following the preparation of the Development Charges Background Study.

It is common practice in Ontario that water, wastewater and road service requirements are based on projected growth beyond the 10 year horizon to better capture the extended benefit, life and construction costs associated with longer term servicing requirement in a more equitable manner. The DC horizon is often based on Best Planning Estimates associated with Regional and Local Municipal Official Plans that are in conformity with Provincial Growth Targets. These horizons have been historically tied to projected census data years thus at 5 year intervals and out to Provincial target horizons of 2021, 2031 and 2041.

4.2.1 Development Charge Background Study

The Ontario Development Charges Act (DCA) requires that a Development Charge Background Study must be completed by Municipalities prior to passing a development charges by-law in an open and transparent manner. The Background Study should include:

- Anticipated amount, type and location of development
- Calculations for each service to which the development charge would relate to
- An examination, for each service to which the development charge by-law would relate, of the long term capital and operating costs for capital infrastructure required for the service
- Allocation of the estimated capital costs relating to each service between costs that would benefit new development and costs that would benefit existing development

- Total estimated capital costs relating to the service
- Total of the estimated capital costs relating to the service that will be incurred during the term of the proposed development charge
- Allocation of the total estimated capital costs between costs that would benefit new development and costs that would benefit existing development
- Estimated and actual value of credits that are being carried forward relating to the service

4.3 Best Practices: British Columbia

4.3.1 Program Time Frame

The appropriate time frame for the Development Cost Charges (DCC) program should be considered when developing a DCC bylaw. A certain time period is needed for looking at the estimation of new development and the capital projects required to service that new development. To this end, DCC programs can be established on either a “build out” or a “revolving” basis.

4.3.2 A Build-out Program

A build-out program, by definition, includes all the DCC projects which will need to be constructed to allow development to occur to the full extent and level defined by the Official Community Plan (OCP). The OCP usually involves a long time horizon, and the plan may not be fully realized for 20 or 25 years.

4.3.3 A Revolving Program

A revolving program is also consistent with the OCP, but consists of only those projects which are necessary to support development that is expected to occur in some defined time period such as five or ten years. In effect, a number of sequential revolving time windows together make up a build out program.

4.3.4 Criteria for Decision Making

Considerations regarding the decision to establish a build out or revolving program include:

- The type of capital projects in the DCC program (e.g., a sewage treatment plant would probably be constructed to build out service population);
- Cash flow requirements for DCC project construction, as monies may be collected faster with a shorter term program;
- The availability of long range plans for municipal servicing and land use;
- Cost-sharing equity between developers over time;
- DCC rate stability over time, as a revolving program may result in sharp increases/decreases;
- Flexibility to use DCC funds for projects where the timing has been advanced;
- Time and location sensitivity of development projections; and,
- Co-coordinating the time frame of the DCC program with the interval of time between major reviews of the OCP or the time period for a major amendment of the DCC and Zoning Bylaws.

4.3.5 Recommended Best Practice

The time frame for a DCC program should be tied into the time frame of a Financial Plan.

Beyond these considerations, reference is made to two other DCC issues: DCC recoverable costs and future bylaw administration. With respect to the former, the capital cost component should be consistent with the DCC time period. For example, the full costs associated with and the ultimate standard of construction (e.g., a multi-phased arterial road project) to be achieved within the next 20 years should not be included in a five year revolving DCC program. In this case, only the interim standard envisioned to be constructed in the next five years should be included in the immediate revolving program. Regarding the future administration of the bylaw, the time frame of the DCC program may impact how the various projects are monitored and tracked.

The inability to estimate future project costs adequately often makes creation of a build out program difficult. For road DCCs, long range corridors have to be sufficiently defined in the Master Transportation Plan. The level of information available from background stormwater management plans and studies, from sanitary sewer modelling and master sewerage plans, from water modelling studies, and from the Parks Master Plan and park policies in the OCP will affect whether compiling a build out program is feasible. However, a build out approach offers the most flexibility in relation to development sequencing and project construction timing, since all the projects needed to support build out of the entire OCP are included in the DCC program.

4.3.6 Development Charge Apportionment

It is acknowledged that the allocation of benefit may be difficult to quantify, especially if projects are being proposed for construction in ten or twenty years. Although an element of subjectivity will always exist, the rationale for apportionment of capital costs in the DCC bylaw should include supporting documentation, technically-based where possible.

Two approaches to allocating benefit are suggested below: a general “rule of thumb” approach, and a method based on some technical means. Either approach could be applied on a project by project basis or on the total value of the DCC program, depending on the types and nature of the capital improvements.

One way is to use the following “rule of thumb.” if construction of the proposed works would not proceed at all if there was no new development, then it would be fair to say that none of the costs should be paid by existing users. In other words, 100% of the costs would be attributable to new development and eligible for DCC recovery. In some cases, the marginal costs associated with “oversizing” may be assessed in this manner.

If it is evident that the existing public gains at least some benefit from new capital works and infrastructure improvements and that some benefit will be received by a component of growth that will not be reflected in new development units (and thus will not be subject to DCCs), then equitable assessment of that benefit is dependent upon selection of a suitable means for apportionment. For example, in the case of an arterial road, the capital costs could be apportioned according to traffic capacity, while for trunk sewers, costs could be split according to flow. Service population could also be a way of allocating benefit. If only a planning level of engineering analysis is available at the time of bylaw development, general ranges of benefit could be assigned based on technical data accompanied by good engineering judgement.

Example 1 Allocating Benefit	
Given: Sanitary Sewer Project Assumptions: • 250mm diameter pipe presently 50% full, good condition, no service issues. • 300mm diameter pipe required for new development	Using "rule of thumb" rationale, project would not proceed if it was not for new development needs. Therefore, benefit to new development = 100% and full cost for 300mm diameter sewer project are Developer funded through DCC.

Example 2 Allocating Benefit	
Given: Sanitary Sewer Project Assumptions: • 250mm diameter pipe presently leaking • replace with 300mm diameter pipe required for new development • 250mm diameter pipe replacement to cost $50,000 • 300mm diameter pipe replacement to cost $60,000	Allocating benefit according to the following rationale. The argument is that the sewer needs to be replaced anyway. Only apportion marginal cost between installation of 250mm diameter and 300mm diameter pipe to new development. Therefore benefits to new development = $10,000/ $60,000 = 17%

4.4 Cost Recovery Mechanism

4.4.1 British Columbia

Section 933 (5) of the Local Government Act states that DCCs are payable at the time of approval of subdivision or at the issuance of a building permit, as the case may be. In practice, DCCs are commonly collected:

- At the subdivision approval stage, or at the building permit stage for single family DCCs;
- Upon issuance of a building permit for multi-family, commercial and institutional DCCs; and,
- At subdivision approval or building permit issuance for industrial DCCs.

4.4.2 Ontario Development Charges Act

A development charge is payable for a development upon a building permit being issued for the development unless the development charge by-law provides otherwise under subsection (2). 1997, c. 27, s. 26 (1).

As a special case, for the approval of plan of subdivision a municipality may, in a development charge by-law, provide that a development charge for services set out in paragraphs 1, 2, 3, 4 or 5 of subsection 5 (5) for development that requires approval of a plan of subdivision under section 51 of the *Planning Act* or a consent under section 53 of the *Planning Act* and for which a subdivision agreement or consent agreement is entered into, be payable immediately upon the parties entering into the agreement. 1997, c. 27, s. 26 (2).

4.5 Review of Other Municipal Practices

GM BluePlan completed a review of other municipality's publically available information regarding Development Charges policy. Generally, the Development Charge rates are available but the specific details of approach, such as how was BTE actually calculated, was not readily available.

The case studies below, for the most part, are based on working knowledge and not publically available information. The examples have been chosen to highlight specific features relevant to the municipalities, such as: area specific DCs, approach to intensification DCs, inclusion of capacity gain projects (I/I reduction) and pre-defined DC growth/non growth splits.

4.5.1 Halton Region

4.5.1.1 Halton's Area Specific DC

The Region serves as an example of a municipality that has used an area specific approach to DCs in the past. One of the drivers for this was the "big pipe" transfer of lake-based water supply to the Town of Milton. The premise of separating the DCs for Milton from those of its neighbouring municipalities to the south, was based on the question of "*why should development outside of Milton help front the costs of infrastructure purely needed to meet growth in Milton?"* As a result, the Region adopted an area-specific DC for Milton.

4.5.1.2 Halton's Approach to Intensification Projects

Halton Region provides a good example of a municipality that demonstrates evolving DC policies over time. In 2012, the Region of Halton's DC Background Study identified specific intensification projects included in the DC. A new DC Eligibility Policy also included pipes smaller than the standard minimum size as defined through the Local Servicing Policy.

In the latest 2017 DC Background Study, projects have changed and Benefit to Existing review has been undertaken to include intensification projects. The Region of Halton's current DC policy framework accounts for residential versus employment growth, benefit to existing users of water and wastewater services, and benefit to growth beyond the Region's planning period (e.g. 2031). The Region recently underwent a process to review the need for infrastructure projects, which ranged from security/redundancy requirements, growth related, and non-growth related needs.

A Benefit to Existing (BTE) ratio was calculated as the ratio of the existing capacity deficiency, relative to the total increase in capacity required for both existing and growth needs. BTE was calculated as:

BTE = Existing deficiency / (growth flow + existing deficiency)

When considering intensification, critical security/redundancy requirements and impacts on critical existing trunk infrastructure were also considered. For projects involving construction in intensification areas, additional cost escalation factors were applied to project costs, providing additional provisions for utility coordination/relocation, urban reinstatement, and urban construction impacts.

The Region has adopted a capital implementation plan containing projects being classified into the following three categories:

1. ***Capacity:*** Projects related to Region-wide needs of water supply/wastewater treatment or supporting the transfer/conveyance of capacity.
2. ***Distribution – Greenfield:*** Projects that support service to Greenfield growth outside the current urban built boundary
3. ***Distribution – Built Boundary:*** Projects that support service to growth within the current urban built boundary, including infill and intensification within urban growth centres and corridors

Figure 1 illustrates the application of the above concept to a water distribution network. This simplified schematic shows a booster pumping station transferring water supply via a transmission watermain to the next subsequent pressure zone filling a reservoir within a greenfield area. The transmission watermain and pumping stations are Category 1 projects as they provide Region-wide capacity to the system. The reservoir is a Category 2 project as it supports growth to a greenfield area outside the built boundary. The local distribution watermains are Category 3 as they provide local distribution within the built boundary.

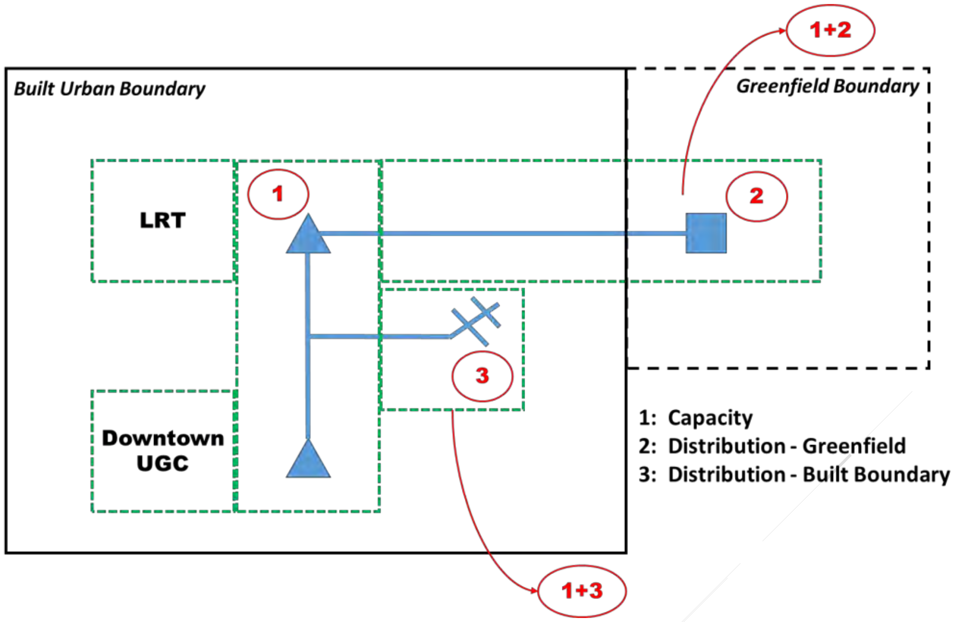

Figure 1. Project DC Classification Schematic

The cost of the distribution watermains will be split among Categories 1 and 3, as those projects benefit from the increased Region-wide capacity (Project 1) and from growth within the current urban built boundary (Project 3). Similarly, the cost of the reservoir will be split among Categories 1 and 2.

4.5.2 City of Hamilton: Pre-defined Growth/Non Growth Splits

The City of Hamilton identifies projects throughout the City and rolls the costs up into a uniform DC in order for the City to ensure securing DC funding for the budget year. The City now applies an intensification lump sum allowance, where the split is 50% development and 50% rate base.

The City of Hamilton has received full capital funding from the Province for a Light Rail Transit (LRT). Currently, the City is looking to initiate a study that will consider implications of the LRT on existing services, including relocation of existing infrastructure and sewer separation. This study will present an opportunity for the City to update the BTE approach specifically for intensification areas.

4.5.3 Region of Peel: Inclusion of I/I reduction costs in DCs

The Region of Peel's 2014 DC program resulted in additional programs that included $100 million for inflow and infiltration reduction mitigation measures and initiatives. The latest DC update includes a distribution and collection system review that will be used to identify further local water and wastewater projects. The Region, like the City of Hamilton, identifies all the projects and rolls them up into a uniform DC. However, with increased pressure for intensification growth and increased costs of infrastructure to extend services into greenfield areas, the Region is now undertaking area-specific cost reviews to assess value and cost of area-specific development (i.e. cost of infrastructure vs DC revenue).

4.5.4 City of Ottawa: Incentivizing Intensification Growth

DC rates sometimes reflect a municipality's desire to effect or promote more efficient land use. For instance, the City of Ottawa levies a lower DC ($16,447 / unit) for development within the inner boundary of the city's designated Greenbelt than areas beyond the outer boundary of the Greenbelt ($24,650 / unit).[1]

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[1] *Development Charge Consultation Document. Development Charges Act.*

5 Approaches to Calculation of BTE, Oversizing and Post Period Benefit

5.1 Benefit to Existing (BTE)

Benefit to Existing (BTE) represents the non-growth components identified for certain projects which benefit the existing service area. These components are typically associated with upgrades to the existing systems or facilities necessary to continue to provide or improve level of service to existing residential and business users. These projects may also involve upgrades or expansions which provide additional capacity to meet growth in the service area.

Described below are five approaches to the calculation of benefit to existing cost associated with infrastructure costs. Each has advantages and disadvantages in concept and application.

Method 1 – Age of Pipe

This approach is based on cost of pipe replacement, discounted for any residual life. The approach requires an assumption of pipe life expectancy, typically around 80 years. Where the existing pipe has exceeded the assumed life expectancy a default minimum percentage remaining (e.g. 10%) can be applied to acknowledge the fact that whilst the pipe has exceeded expected age it is still in serviceable condition and to acknowledge that infrastructure may exceed the estimated life in reality.

$$Unused\ life\ Credit = \frac{\text{Estimated Life} - \text{ Current } Age}{\text{Estimated Life}}\ X\ (Cost\ of\ replacement)$$

The following provides a simplified hypothetical example to highlight the potential impact on the cost split calculation:

- Assume existing pipe is 300mmØ
- Assume existing pipe is 60 years old
- Assume life expectancy of 80 years
- Like for Like replacement value of 300mmØ is $800 k
- Under growth conditions a 400mmØ is required at a cost of $1 million

Cost of pipe replacement approach calculation:

Total growth project cost = $1 million
$1m - $800k (growth component only cost) = $200k (DC Cost)
80-60 = 20/80 = 0.25 (age factor) * $800k (cost of replacement) = $200k (DC Cost)
$800k (replacement cost) - $200k (BTE) = $600k (Total Rate Base Cost)
$200k (growth component cost) + $200k (age remaining cost) = $400k Total DC Cost

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Unused life credit provides estimate of BTE and allocates costs to Development	In downtown core many pipes exceed assumed life ages; no unused life credit but sewer still serviceable; does not take account of condition
Relatively easy to apply	Assumed life age definition subject to challenge
Understandable concept easy to communicate to stakeholders	Reliable pipe age data required to identify age of pipe
No specialist tools (e.g. hydraulic modelling software) required	Does not address new technologies that extends life expectancy of pipe infrastructure (i.e. structural pipe lining)

Method 2 - Level of Service Range Approach

The calculation of benefit to existing can be complicated. The following approach seeks to apply simplified rules that align with a utility's recognized levels of service. The simplicity of the approach provides transparency and understanding to all stakeholders.

The following defines suggested categories and associated cost splits that could apply for the varying potential circumstances.

Category	B.T.E. %	Description
B.T.E.1	5% B.T.E.	These projects are driven by growth and would not otherwise be considered. They could address some very limited minor existing deficiencies potentially related to level of service, security of supply, age, operational flexibility, condition or performance. **EXAMPLE**: • A replacement and upsizing is required to support growth in a new greenfield area • Replacement provides new service to new users and a replacement of the existing watermain • *Minor condition/age deficiency is addressed by construction of new watermain, therefore, 5% B.T.E. is applied*
B.T.E.2	25% B.T.E.	These projects are driven by growth and would not otherwise be considered. They will address some known existing deficiencies potentially related to operational issues or significant level of service, security of supply, age, operational flexibility, condition or performance. **EXAMPLE:** • A new development within an intensification area is to be serviced by an existing sewer which has known capacity deficiencies and modelled surcharging • A larger sewer is required to address the existing capacity constraint as well as to service growth

		• *Level of service / capacity deficiency is addressed by construction of new watermain, therefore 25% B.T.E. is applied*
B.T.E.3	50% B.T.E.	These projects equally provide additional capacity for growth as well as enhanced level of service in existing service areas. These projects address known existing deficiencies but also improve servicing conditions including security of supply/service. **EXAMPLE**: • A new development within an intensification area is to be serviced by an existing sewer which has significant known condition issues and significant capacity constraints including *modelled* surcharging and occasional *observed* surcharging and capacity constraints • A larger, new sewer is required to address the existing deficiencies as well as to service growth • *Level of service, capacity and condition/age deficiencies are addressed by construction of new sewer, therefore 50% B.T.E. is applied*
B.T.E.4	75% B.T.E.	These projects primarily provide enhanced level of service in existing service areas as well as provide additional capacity for growth. These projects address known existing deficiencies and also improve servicing conditions including security of supply/service. **EXAMPLE**: • A new development within an intensification area is to be serviced by an existing sewer which has significant known condition issues and significant capacity constraints including *modelled* flooding and occasional *observed* flooding and capacity constraints • A larger, new sewer is required to address the existing deficiencies as well as to service growth • *Level of service, capacity and condition/age deficiencies are primarily addressed by construction of new sewer, therefore 75% B.T.E. is applied*
B.T.E.5	Other	These projects do not fall within B.T.E.1-B.T.E.4 categories and may require a unique split based on project specific factors. **EXAMPLE**: • An existing sewage pumping station is deficient in pumping capacity, wet well storage capacity and standby power. Additionally, pumps and other mechanical equipment require replacement due to condition • Modifications to the station are recommended to address all issues, including pump replacement • The new pumps will be re-sized to accommodate both the increase in required existing flow as well as an additional marginal increase in capacity to accommodate small potential intensification developments • *Major capacity and level of service and condition constraints trigger the need for S.P.S. upgrade; only marginal increase in capacity is required, therefore an estimated 90% B.T.E. is applied to the project cost*

This approach applies cost splits as a predefined range based on Level of Service. Advantages and disadvantages are summarized as follows:

Advantages	Disadvantages
Provides a defined range of BTE estimates	High level rule of thumb methodology not supported by unique calculations
BTE splits relate directly to Level of Service	Open to some subjectivity
Understandable concept easy to communicate to stakeholders	Because of ranges applied some specific scenarios may not be accurately calculated
Allows for BTE differentiation between projects and scenarios	Requires availability of hydraulic modelling tools

Method 3 - Deficiency Ratio Approach

This approach requires the use of a hydraulic model to assess existing flows and existing capacity deficits to provide a ratio with proposed growth flows. The approach has been used by other municipalities for DC rate allocation. The analysis of capacity, in terms of which pipe to assess, can create some subjectivity and challenge to the approach. In addition, the technical nature of the method means that non-technical stakeholders can find it difficult to fully understand.

BTE share is ratio of the existing capacity deficiency, relative to the total increase in capacity required for both existing and growth scenarios.

BTE calculated as existing deficiency / (growth flow + existing deficiency)

An Example: an existing sewer has a pipe full capacity of 100l/s. Peak flows in the existing sewer are 120l/s. This results in an existing deficiency of 20l/s (120l/s – 100l/s = 20l/s). New proposed growth flows equate to 40l/s. The resulting equation is 20l/s (existing deficiency) / 60l/s (growth flow + existing deficiency) = 0.33 BTE factor.

*Could be applied on a sewershed basis

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Provides specific project by project BTE estimates	Requires and relies on availability and quality of hydraulic modelling tools and resources
Result is not skewed by proportion of existing flow in relation to growth flow	Requires significant technical assessment to identify existing capacity deficit, especially in a combined system
Deficiency ratio calculation provides equitable split of costs	Open to some subjectivity during assessment; what pipe, pipes etc. are included?
	Complex concept not easy to communicate to stakeholders
	Does not consider the end of life factor (e.g. If there is remaining capacity in the pipe (existing flow is 95 L/s) then there is no BTE, even if the pipe is 79 years old.)

Method 4 - Flow Ratio Approach

This approach is very similar to method 3. The difference is that existing capacity deficit is not calculated. It is just the existing versus growth flows that are assessed.

This is conceptually a very simple approach although requires an accurate hydraulic model or monitor data. BTE is calculated as the ratio between the existing sewer flows and the existing plus proposed growth flows.

BTE Calculated as existing flows / (growth flow + existing flows)

An Example: Peak flows in the existing sewer are 120l/s. New proposed growth flows equate to 40l/s. The resulting calculation is 120l/s (existing flows) / 160l/s (growth flow + existing flows) = 0.75 BTE factor.

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Provides a defined range of BTE estimates	Requires and relies on availability and quality of hydraulic modelling tools and resources
Potentially accurate calculation; project by project specific assessment	Concept and derivation of flow rates not easy to communicate to stakeholders
Easier to apply than the deficiency ratio approach	Not appropriate for combined systems where existing flows far exceed proposed growth flows.
Addresses the fact that the rate base is getting some benefit from the renewal of the existing pipe	If the existing pipe were only 5 years old, it does not address the fact that rate base doesn't need a new pipe (over charging the benefit to existing)

Method 5 – Default Percentage

This approach is the most simple and therefore requires the least amount of analysis. This approach has been used by municipalities for lump sum line items on DC programs before specific projects are defined.

An example could be that all projects within the regional centre are 50% development charges and 50% rate base.

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Most simple approach	Oversimplifies BTE calculation
No analysis required	No differentiation between different project scenarios
Understandable concept easy to communicate to stakeholders	Arbitrary split may not be equitable for individual projects but likely reasonable as an average.
Stakeholders more aware of eligible amounts	

The table below summarizes the advantages and disadvantages for each approach and assigns a score to each key criteria listed, where '✓' is the lowest or worst and '✓✓✓' is the highest or best score.

The categories used are described as follows:

- Simple concept: the ease of the approach to be understood by non-technical stakeholders
- Easy to apply: how easy and quickly the approach can be applied and the BTE calculation completed
- Technical Resources: the extent of technical staff and tools (software) required to complete the approach
- Potential Accuracy: how likely on a project by project basis the approach is able to calculate the most accurate BTE calculation
- Subject to Challenge: how many variables are used in the approach that could be subject to challenge by stakeholders
- Versatility: the ability of the approach to produce equitable results for various scenarios, project types and system types (i.e. combined, sanitary).
- Overall: a general assessment of the approach considering all criteria.

Method	Simple Concept	Easy to Apply	Technical Resources Required	Potential Accuracy	Subject to Challenge	Versatility	OVERALL
Method 1 – Age of Pipe	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓
Method 2 – Level of Service Range Approach	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓
Method 3 – Deficiency Ratio Approach	✓	✓	✓	✓✓✓	✓✓	✓✓✓	✓✓
Method 4 – Flow Ratio Approach	✓	✓	✓	✓	✓✓	✓	✓
Method 5 – Default Percentage	✓✓✓	✓✓✓	✓✓✓	✓	✓	✓✓	✓✓✓

6 Summary and Recommendations

6.1 Regional Development Charge

Halifax Water are committed to regular five-year reviews of the Regional Development Charge. It is recommended that aspects such as the calculation of Benefit to Existing that are presented in this memo be tested through application in the WRWIP project and finalized and documented in the upcoming RDC review. This will help ensure a robust and transparent RDC approach.

6.2 Benefit to Existing Calculation

It is recommended that each project be assessed individually to identify the BTE and RDC splits. No one method is applicable to every project and various data and tool limitations negate the effectiveness of others. New, all-pipe wastewater hydraulic models and updated water models are expected to be completed and available for use prior to the next full RDC application, expected in the fall of 2019.

Method 1: Age basis creates issues in the older systems where pipes are beyond service life assumptions but still provide adequate service. This issue highlights the need to look at some projects from an asset condition and performance or level of service rating perspective. Method 2: level of service overcomes the age and service life issues but mainly relies on a rule of thumb methodology which could be open to some subjectivity. Method 3: deficiency ratio and Method 4: flow ratio approach requires detailed hydraulic model tools and the approach does not allow flexibility for unique project factors.

During the 2013 RDC hearing the NSUARB commented favourably on the relationship of BTE to level of service. The goal of the approach is to create the most equitable splits of cost.

Regional Development Charge:

Stakeholder Update Meeting, August 22nd, 2019

Meeting Summary Information

Prepared by

GM BluePlan for:

Project No. 719008

August 2019

Date: 8/22/2019 File: 719008
Project: Regional Development Charge
Subject: Stakeholder Meeting #2: Summary Information

Halifax Water is undertaking a Regional Development Charges (RDC) Update. The aim of the update is to recalculate the existing RDC for water and wastewater infrastructure with more recent data and information to ensure appropriate funding and project cost allocation for future infrastructure requirements to service growth.

The overall intent of the RDC update project is to ensure that the correct rate is calculated, that funds collected are appropriate, and that the capital program is sustainably funded by growth development charges and user rates. A key concept of the RDC approach is to ensure that there is an appropriate balance between RDC funding the growth related costs and the existing customer base, through user rates, funding enhancements and requirements to the existing systems.

Stakeholder consultation is an integral aspect of the update which includes three scheduled, formal information sessions. In addition, stakeholders can arrange one on one or small group meetings with the Halifax Water team to discuss any matters required.

- Stakeholder Meeting #1: 20th June 2019.
- Stakeholder Meeting #2: 22nd August 2019.
    - Repeated Stakeholder Meeting #2: 12th September 2019.
- Stakeholder Meeting #3: 27th September 2019.

This document summarizes the information presented during Stakeholder Meeting #2, held at Halifax Water offices on 22nd August 2019 and 12th September 2019.

The information provided is summarized as follows:

- Presentation slides: this is the primary information as presented during the meeting.
- Wastewater RDC 2019 Program: Pages 1 and 2 provide the detailed project list with total project cost, Benefit to Existing (BTE) versus growth splits, post period benefit and residential and non-residential splits. Page 3 provides the detailed calculation of the per unit residential and non-residential RDC rate which includes all parameters used in the calculation prior to financial reconciliation.
- Water RDC 2019 Program: Pages 1 and 2 provide the detailed project list with total project cost, BTE versus growth splits, post period benefit and residential and non-residential splits. Page 3 provides the detailed calculation of the per unit residential and non-residential RDC rate which includes all parameters used in the calculation prior to financial reconciliation.
- RDC Comparison: this is a comparison table for information showing the existing RDC details (2012$) against the existing RDC details inflated to 2019 dollars and the new preliminary RDC details (2019$).

As noted on presentation slide 36, and presented during the session, this information at this time represents a draft preliminary charge and may be subject to change. Reconciliation and validation work is ongoing and is focused on the items noted on slide 36, listed as follows for convenience:

- RDC collections to date.
- Project completion and funding provided to date.
- Costing indexing and escalation.
- Interest reconciliation.
- Review of the rate of development and program implementation relative to projections.

All the above items have potential to impact the final RDC rate. Expanding on the scope of work pertaining to the last bullet point, regarding rate of development, important specifics relating to population projections are subject to continued review.

The total growth population and the people per unit (PPU) are fundamental aspects of the RDC calculation. The values currently used and presented in the summary materials are robust in their derivation, founded on best planning population projection information from HRM and current (2016) Statistics Canada Census PPU estimates. Due to the sensitivity of these values to the resulting RDC rate work is ongoing to ensure that final population projections appropriately account for serviced and non-serviced populations and that the final PPU used reflects a projected future rate as opposed to the 2016 Census rate which is historic in its derivation. The population and employment growth within the RDC period is also being confirmed to ensure that only the serviced area growth is considered and to ensure that the growth aligns with the capital program identified.

These reviews may result in adjustments to the total growth population and PPU used, impacting the final RDC rate. The projects themselves are expected to be subject to scrutiny and changes to projects included/excluded and to the growth and BTE splits are possible prior to the submission of the final rate.

Based on review of the program as presented at the stakeholder #2 meeting and the additional recent analysis, it is anticipated that the following revisions will be required:

i) Reconciliation of the service area population as well as confirmation of the in-period growth will result in a decrease of the growth projections.
ii) Reconciliation of the census derived PPU and the HRM projected housing type and resulting PPU's will likely result in a lowering of the current PPU.
iii) Reconciliation of financial components including program costs to date, interest costs and cost indexing over the planning period will likely result in a change to the total costs of the RDC eligible capital program.

It is intended to work though all feedback on the first draft calculation and in particular the three items noted above in a comprehensive manner prior to issuing an updated draft RDC calculation.

The intent of providing this expanded detail regarding the RDC rate is therefore twofold:

i) To acknowledge that the stakeholders are engaged in a collaborative process where input can be considered and included.
ii) That Halifax Water is continuing work to ensure that the correct, appropriate rate is calculated that will enable infrastructure that is required for growth is available when it's needed.

Halifax Water is committed to a collaborative stakeholder consultation process and is open to communications at any time, in addition to the defined process and meeting opportunities outlined in during the meeting presentation and in this information.

Wastewater RDC 2019 Program

Wastewater

Total 2046 Capital Program	$ 576,339,588
Total 2041 Capital Program	$ 552,363,588
Funding Subsidy	$ -
Benefit to Existing (BTE)	$ 147,951,647
Post Period Benefit	$ 72,292,157
Total Adjusted RDC Program	$ 332,119,783
Total Growth	192,315
Residential Growth	119,409
Residential Share (%)	62%
Employment Growth	72,906
Employment Share (%)	38%
Residential RDC Program	$ 206,214,238.14
Employment RDC Program	$ 125,905,545.19

											2016-2041			
											62%	38%		
Project ID	**Project Description**	**System**	**Projects Cost $ (2019)**	**Growth (%)**	**BTE (%)**	**BTE $ (2019)**	**Growth $ (2019)**	**Post Period Benefit (%)**	**Post Period Benefit $ (2019)**	**Adjusted RDC $ (2019)**	**Res RDC $ (2019)**	**Non-Res RDC $ (2019)**	**Period Req'd**	**Within RDC Horizon (Included/Not Included)**
AT2	Upgrade WWTF to service employment growth flows	Aerotech	$17,017,055	90%	10%	$1,701,705	$15,315,349	18%	$2,737,752	$12,577,597	$7,809,470	$4,768,127	2016-2021	Included
D1	LoWSCA: Canal Street Separation	Dartmouth	$1,842,000	75%	25%	$460,500	$1,381,500	18%	$246,955	$1,134,545	$704,443	$430,102	2016-2021	Included
D2a	LoWSCA: Wyse Road Separation - Phase 1	Dartmouth	$3,860,000	75%	25%	$965,000	$2,895,000	18%	$517,506	$2,377,494	$1,476,193	$901,300	2016-2021	Included
D2b	LoWSCA: Wyse Road Separation - Phase 2	Dartmouth	$2,802,000	25%	75%	$2,101,500	$700,500	18%	$125,220	$575,280	$357,193	$218,087	2021-2026	Included
D3	Additional Sewer Separation on Wyse Street	Dartmouth	$1,912,000	75%	25%	$478,000	$1,434,000	18%	$256,340	$1,177,660	$731,213	$446,447	2026-2031	Included
D5	Albro Lakes Watershed Separation	Dartmouth	$8,111,000	95%	5%	$405,550	$7,705,450	18%	$1,377,416	$6,328,034	$3,929,096	$2,398,937	2021-2026	Included
D6a	Maynard Lake and Clement Street Wetland Separation - Phase 1	Dartmouth	$642,000	95%	5%	$32,100	$609,900	18%	$109,025	$500,875	$310,995	$189,880	2026-2031	Included
D6b	Maynard Lake and Clement Street Wetland Separation - Phase 2	Dartmouth	$4,540,000	95%	5%	$227,000	$4,313,000	18%	$770,986	$3,542,014	$2,199,248	$1,342,766	2031-2036	Included
D6c	Maynard Lake and Clement Street Wetland Separation - Phase 3	Dartmouth	$1,155,000	95%	5%	$57,750	$1,097,250	18%	$196,143	$901,107	$559,500	$341,607	2031-2036	Included
D6d	Maynard Lake and Clement Street Wetland Separation - Phase 4	Dartmouth	$453,000	95%	5%	$22,650	$430,350	18%	$76,929	$353,421	$219,440	$133,981	2031-2036	Included
D7	New Valleyford Pumping Station	Dartmouth	$10,446,000	25%	75%	$7,834,500	$2,611,500	18%	$466,828	$2,144,672	$1,331,633	$813,038	2036-2041	Included
D8	390 Waverley Road Upgrades	Dartmouth	$11,361,000	100%	0%	$0	$11,361,000	18%	$2,030,878	$9,330,122	$5,793,103	$3,537,019	2021-2026	Included
D9	Anderson Pumping Station Upgrades	Dartmouth	$340,000	0%	100%	$340,000	$0	0%	$0	$0	$0	$0	2031-2036	Included
D10	Upgrades to Dartmouth WWTF	Dartmouth	$12,572,000	100%	0%	$0	$12,572,000	18%	$2,247,355	$10,324,645	$6,410,605	$3,914,040	2036-2041	Included
D11	I/I Reduction Program FMZ27	Dartmouth	$5,941,076	75%	25%	$1,485,269	$4,455,807	18%	$796,514	$3,659,293	$2,272,067	$1,387,226	2021-2026	Included
D12	I/I Reduction Program FMZ45	Dartmouth	$1,120,232	95%	5%	$56,012	$1,064,220	18%	$190,239	$873,981	$542,658	$331,324	2031-2036	Included
D13	Additional flow monitoring	Dartmouth	$420,000	10%	90%	$378,000	$42,000	18%	$7,508	$34,492	$21,416	$13,076	2016-2021	Included
D14	CSO Flow Management Plan	Dartmouth	$252,000	10%	90%	$226,800	$25,200	18%	$4,505	$20,695	$12,850	$7,846	2036-2041	Included
D15	Green St Upsize	Dartmouth	$513,000	0%	100%	$513,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
D16	Pinecrest Dr Upgrade	Dartmouth	$1,013,000	75%	25%	$253,250	$759,750	18%	$135,812	$623,938	$387,405	$236,533	2031-2036	Included
D17	Peddars Way Upgrade	Dartmouth	$555,000	75%	25%	$138,750	$416,250	18%	$74,408	$341,842	$212,251	$129,591	2031-2036	Included
D18	Atlantic Street Upgrade	Dartmouth	$3,831,000	95%	5%	$191,550	$3,639,450	18%	$650,583	$2,988,867	$1,855,797	$1,133,070	2021-2026	Included
D19	Akerley Blvd and Railway Alignment Upgrade	Dartmouth	$4,814,000	75%	25%	$1,203,500	$3,610,500	18%	$645,408	$2,965,092	$1,841,035	$1,124,057	2036-2041	Included
D20	Pleasant Street Upgrade	Dartmouth	$767,000	75%	25%	$191,750	$575,250	18%	$102,831	$472,419	$293,327	$179,093	2021-2026	Included
D21	Princess Margaret Blvd. Upgrade	Dartmouth	$3,106,000	95%	5%	$155,300	$2,950,700	18%	$527,463	$2,423,237	$1,504,595	$918,641	2031-2036	Included
D22	Anderson Lake Development Connection	Dartmouth	$7,609,000	100%	0%	$0	$7,609,000	18%	$1,360,175	$6,248,825	$3,879,915	$2,368,910	2036-2041	Included
D23	Marvin Connection	Dartmouth	$1,380,000	5%	95%	$1,311,000	$69,000	18%	$12,334	$56,666	$35,184	$21,482	2026-2031	Included
D24	King Street Diversion	Dartmouth	$78,000	5%	95%	$74,100	$3,900	18%	$697	$3,203	$1,989	$1,214	2026-2031	Included
D25	Diversion to Eastern Passage	Dartmouth	$12,113,000	100%	0%	$0	$12,113,000	18%	$2,165,304	$9,947,696	$6,176,556	$3,771,140	2036-2041	Included
EP1	Install new Gravity Pressure Sewer	Eastern Passage	$23,372,000	75%	25%	$5,843,000	$17,529,000	18%	$3,133,461	$14,395,539	$8,938,236	$5,457,303	2021-2026	Included
EP2	Connect Beaver Cres and Caldwell Forcemains to new 450mm pressure sewer	Eastern Passage	$78,000	75%	25%	$19,500	$58,500	18%	$10,457	$48,043	$29,830	$18,213	2026-2031	Included
EP3	Install new pump out stations	Eastern Passage	$1,676,000	75%	25%	$419,000	$1,257,000	18%	$224,700	$1,032,300	$640,959	$391,342	2026-2031	Included
EP4	Install gate valves at surge tank	Eastern Passage	$420,000	75%	25%	$105,000	$315,000	18%	$56,309	$258,691	$160,622	$98,069	2026-2031	Included
EP5	Decommission existing 450mm gravity pressure sewer	Eastern Passage	$559,000	75%	25%	$139,750	$419,250	18%	$74,945	$344,305	$213,780	$130,525	2041-2046	Not Included
EP6	Upgrade Quigley Corner Pumping Station	Eastern Passage	$2,875,000	5%	95%	$2,731,250	$143,750	18%	$25,697	$118,053	$73,300	$44,754	2021-2026	Included
EP7	Optimize Quigley's Corner PS	Eastern Passage	$336,000	5%	95%	$319,200	$16,800	18%	$3,003	$13,797	$8,567	$5,230	2021-2026	Included
EP8	Upgrade Memorial Drive Pumping Station	Eastern Passage	$2,633,000	0%	100%	$2,633,000	$0	0%	$0	$0	$0	$0	2031-2036	Included
EP9	Upgrade Beaver Crescent Pumping Station	Eastern Passage	$168,000	0%	100%	$168,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
EP10	Upgrade Bissett Lake Pumping Station	Eastern Passage	$2,934,000	50%	50%	$1,467,000	$1,467,000	18%	$262,239	$1,204,761	$748,040	$456,721	2036-2041	Included
EP11	Upgrade Caldwell Road Pumping Station	Eastern Passage	$631,000	75%	25%	$157,750	$473,250	18%	$84,598	$388,652	$241,316	$147,337	2036-2041	Included
EP12	I/I Reduction Program FMZ23	Eastern Passage	$3,204,580	95%	5%	$160,229	$3,044,351	18%	$544,204	$2,500,147	$1,552,349	$947,798	2031-2036	Included
EP13	I/I Reduction Program FMZ24	Eastern Passage	$1,570,040	95%	5%	$78,502	$1,491,538	18%	$266,625	$1,224,913	$760,552	$464,360	2016-2021	Included
EP14	I/I Reduction Program FMZ37	Eastern Passage	$2,479,704	95%	5%	$123,985	$2,355,718	18%	$421,105	$1,934,613	$1,201,208	$733,406	2016-2021	Included
EP15	Local network upgrades on Caldwell Road	Eastern Passage	$607,000	75%	25%	$151,750	$455,250	18%	$81,380	$373,870	$232,137	$141,733	2036-2041	Included
EP16	Local network upgrades on Colby Drive	Eastern Passage	$1,176,000	0%	100%	$1,176,000	$0	0%	$0	$0	$0	$0	2031-2061	Included
EP17	Local network upgrades on Forest Hill Parkway	Eastern Passage	$4,275,000	0%	100%	$4,275,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included

Wastewater RDC 2019 Program

Project ID	Project Description	System	Projects Cost $ (2019)	Growth (%)	BTE (%)	BTE $ (2019)	Growth $ (2019)	Post Period Benefit (%)	Post Period Benefit $ (2019)	Adjusted RDC $ (2019)	Res RDC $ (2019)	Non-Res RDC $ (2019)	Period Req'd	Within RDC Horizon (Included/Not Included)
MC1	Trunk Sewer Upgrades (Sackville Trunk Upgrades to 1200mm diameter)	Mill Cove	$5,101,000	75%	25%	$1,275,250	$3,825,750	18%	$683,886	$3,141,864	$1,950,793	$1,191,071	2036-2041	Included
MC2	Trunk Sewer Upgrades (Sackville Trunk Upgrades to 1050mm diameter)	Mill Cove	$8,246,000	75%	25%	$2,061,500	$6,184,500	18%	$1,105,533	$5,078,967	$3,153,547	$1,925,420	2036-2041	Included
MC3	Trunk Sewer Upgrades (Sackville Trunk Upgrades to 1500mm diameter)	Mill Cove	$144,000	50%	50%	$72,000	$72,000	18%	$12,871	$59,129	$36,714	$22,416	2036-2041	Included
MC4	Storage Tank	Mill Cove	$17,469,000	95%	5%	$873,450	$16,595,550	18%	$2,966,599	$13,628,951	$8,462,259	$5,166,692	2031-2036	Included
MC5	Fish Hatchery Park Pumping Station Upgrade	Mill Cove	$10,529,000	50%	50%	$5,264,500	$5,264,500	18%	$941,075	$4,323,425	$2,684,428	$1,638,996	2031-2036	Included
MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	Mill Cove	$1,090,000	95%	5%	$54,500	$1,035,500	18%	$185,105	$850,395	$528,013	$322,382	2036-2041	Included
MC7	Mill Cove Wastewater Treatment Plant Capacity Upgrade	Mill Cove	$148,758,000	50%	50%	$74,379,000	$74,379,000	18%	$13,295,894	$61,083,106	$37,926,696	$23,156,410	2016-2021	Included
MC8	I/I Reduction Program FMZ07, FMZ10, & FMZ40	Mill Cove	$9,288,248	95%	5%	$464,412	$8,823,836	18%	$1,577,337	$7,246,498	$4,499,374	$2,747,124	2016-2021	Included
MC9	I/I Reduction Program FMZ02 & FMZ03	Mill Cove	$8,023,065	95%	5%	$401,153	$7,621,912	18%	$1,362,483	$6,259,429	$3,886,499	$2,372,929	2031-2036	Included
MC10	Local network upgrades on Beaver Bank Rd. North on Glendale Dr.	Mill Cove	$2,086,000	25%	75%	$1,564,500	$521,500	18%	$93,223	$428,277	$265,919	$162,359	2021-2026	Included
MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	Mill Cove	$1,490,000	95%	5%	$74,500	$1,415,500	18%	$253,033	$1,162,467	$721,780	$440,688	2021-2026	Included
MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	Mill Cove	$1,667,000	25%	75%	$1,250,250	$416,750	18%	$74,498	$342,252	$212,506	$129,747	2021-2026	Included
MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	Mill Cove	$845,000	0%	100%	$845,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC14	Local network upgrades on Hallmark Ave.	Mill Cove	$437,000	0%	100%	$437,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC15	Local Sewer Upgrades for Waterfront Drive	Mill Cove	$500,000	0%	100%	$500,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC16	Springfield Lake Connection to Sackville	Mill Cove	$6,226,000	50%	50%	$3,113,000	$3,113,000	18%	$556,476	$2,556,524	$1,587,354	$969,170	2041-2046	Not Included
WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	$7,281,000	50%	50%	$3,640,500	$3,640,500	18%	$650,771	$2,989,729	$1,856,332	$1,133,397	2016-2021	Included
WR2	WRWIP: Young Street Area Sewer Separation	Halifax	$21,879,000	75%	25%	$5,469,750	$16,409,250	18%	$2,933,296	$13,475,954	$8,367,263	$5,108,691	2016-2021	Included
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	$14,752,000	95%	5%	$737,600	$14,014,400	18%	$2,505,196	$11,509,204	$7,146,102	$4,363,102	2016-2021	Included
WR4	WRWIP: Linear Upsize - Quinpool Road	Halifax	$437,000	0%	100%	$437,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	$221,000	0%	100%	$221,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	Halifax	$500,000	95%	5%	$25,000	$475,000	18%	$84,910	$390,090	$242,208	$147,882	2016-2021	Included
WR7	WRWIP: Young Pumping Station Upgrade	Halifax	$2,169,000	95%	5%	$108,450	$2,060,550	18%	$368,341	$1,692,209	$1,050,698	$641,511	2026-2031	Included
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	Halifax	$3,850,000	50%	50%	$1,925,000	$1,925,000	18%	$344,111	$1,580,889	$981,579	$599,310	2016-2021	Included
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	Halifax	$15,491,589	95%	5%	$774,579	$14,717,009	18%	$2,630,794	$12,086,216	$7,504,370	$4,581,846	2016-2021	Included
WR18	WRWIP: Fairview Cove Linear Upsize	Halifax	$19,781,000	75%	25%	$4,945,250	$14,835,750	18%	$2,652,020	$12,183,730	$7,564,917	$4,618,813	2016-2021	Included
WR20	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	$2,997,000	95%	5%	$149,850	$2,847,150	18%	$508,953	$2,338,197	$1,451,794	$886,403	2031-2036	Included
WR10	WRWIP: BLT WWTF Decommission - New Timberlea PS	BLT	$5,928,000	95%	5%	$296,400	$5,631,600	18%	$1,006,698	$4,624,902	$2,871,617	$1,753,286	2016-2021	Included
WR11	WRWIP: BLT WWTF Decommission - New Timberlea Forcemain	BLT	$19,436,000	95%	5%	$971,800	$18,464,200	18%	$3,300,637	$15,163,563	$9,415,105	$5,748,458	2016-2021	Included
WR12	WRWIP: BLT WWTF Decommission	BLT	$500,000	95%	5%	$25,000	$475,000	18%	$84,910	$390,090	$242,208	$147,882	2016-2021	Included
WR14	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive PS	BLT	$8,063,000	95%	5%	$403,150	$7,659,850	18%	$1,369,265	$6,290,585	$3,905,844	$2,384,741	2031-2036	Included
WR15	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain	BLT	$9,026,000	95%	5%	$451,300	$8,574,700	18%	$1,532,802	$7,041,898	$4,372,337	$2,669,561	2031-2036	Included
WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer (600mm)	BLT	$4,319,000	95%	5%	$215,950	$4,103,050	18%	$733,456	$3,369,594	$2,092,192	$1,277,402	2031-2036	Included
WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer (1050mm)	BLT	$3,266,000	95%	5%	$163,300	$3,102,700	18%	$554,635	$2,548,065	$1,582,102	$965,963	2031-2036	Included
WR17	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	$7,439,000	95%	5%	$371,950	$7,067,050	18%	$1,263,297	$5,803,753	$3,603,569	$2,200,184	2031-2036	Included
WR19	WRWIP: Halifax Treatment Plant Capacity Upgrade	Halifax	$25,142,000	95%	5%	$1,257,100	$23,884,900	18%	$4,269,634	$19,615,266	$12,179,182	$7,436,084	2036-2041	Included
WR8	WRWIP: New Fairfield Holding Tank	Halifax	$12,403,000	50%	50%	$6,201,500	$6,201,500	18%	$1,108,572	$5,092,928	$3,162,215	$1,930,713	2041-2046	Not Included
		TOTAL 2046 Projects	**$576,339,588**			**$162,193,897**	**$414,145,691**		**$74,032,150**	**$340,113,541**	**$211,177,588**	**$128,935,953**		
		TOTAL Post 2041 Projects	**$23,976,000**			**$14,242,250**	**$9,733,750**		**$1,739,993**	**$7,993,757**	**$4,963,350**	**$3,030,408**		
		TOTAL 2041 Projects	**$552,363,588**			**$147,951,647**	**$404,411,941**		**$72,292,157**	**$332,119,783**	**$206,214,238**	**$125,905,545**		

Wastewater 20 Year RDC Rate

RDC Summary

Base Info	Population	Cost
Adjusted RDC		$ 332,119,783
Residential	119,409	$ 206,214,238
Non-Residential	72,906	$ 125,905,545
Total	192,315	$ 332,119,783

Residential RDC Rate

Unit Type	Units	Unit DC	Res DC cost ($)	PPU	Unit Factor
SUD	23,363	**$ 4,847**	$ 113,248,803	3.35	1.46
MUD	28,554	**$ 3,256**	$ 92,965,435	2.25	0.9783
Total			$ 206,214,238		

Average Cost Per Unit

Averages	
PPU	2.3
Average Number of Units	51,917
Average Cost Per Unit	$ 3,972.00

Non-Residential RDC Rate

Employment Untis	Unit DC
Equivalent person ($/person)	$ 1,726.96
Employment Density (Sqft/Employee)	733
RDC Rate ($/sqft)	**$ 2.36**

Population Factors

Relative Factors	
Relative Density Factor	1.489
Relative Cost Factor	1.489
Relative Permit factor	0.8

Reference Table

Reference Values	Residential		Non-Residential Rate
	SUD	MUD	sqft/person
RDC April 1st 2015 (2012 $)	$ 4,080.80	$ 2,740.84	$ 2.24
RDC April 1st 2015 (2019 $)	$ 4,687.56	$ 3,148.36	$ 2.57

Percentage of Unit Type

Reference	Residential Splits (%)	
	SUD/TH	MUD
Average (2005-2018)	45%	55%

Water RDC 2019 Program

Water

Total 2046 Capital Program	$	279,597,000
Total 2041 Capital Program	$	257,875,000
Funding Subsidy	$	-
Benefit to Existing (BTE)	$	145,167,102
Post Period Benefit	$	20,147,519
Total Adjusted RDC Program	$	92,560,379
Total Growth		192,315
Residential Growth		119,409
Residential Share (%)		62%
Employment Growth		72,906
Employment Share (%)		38%
Residential RDC Program	$	57,471,036.09
Employment RDC Program	$	35,089,342.99

										2016-2041			
										62%	38%		
Project ID	**Project Description**	**System**	**Projects Cost $ (2019)**	**Growth (%)**	**BTE (%)**	**BTE $ (2019)**	**Growth $ (2019)**	**Post Period Benefit (%)**	**Post Period Benefit $ (2019)**	**Adjusted RDC $ (2019)**	**Res RDC $ (2019)**	**Non-Res RDC $ (2019)**	**Period Req'd**	**Within RDC Horizon (Included/Not Included)**
W06.1	Chain Control Transmission - Existing Peninsula Low Upsize	Pockwock - Peninsula	$3,841,000	75%	25%	$960,250	$2,880,750	18%	$514,959	$2,365,791	$1,468,927.12	$896,863.72	2021-2026	Included
W06.2	Chain Control Transmission - Existing Peninsula Intermediate Upsize	Pockwock - Peninsula	$2,650,000	75%	25%	$662,500	$1,987,500	18%	$355,283	$1,632,217	$1,013,448.81	$618,768	2021-2026	Included
W06.3	Pepperell Transmission	Pockwock - Peninsula	$2,702,000	75%	25%	$675,500	$2,026,500	18%	$362,255	$1,664,245	$1,033,335	$630,910	2036-2041	Included
W06.4	Chain Control Transmission - Existing Peninsula Low Lining	Pockwock - Peninsula	$2,916,000	75%	25%	$729,000	$2,187,000	18%	$390,945	$1,796,055	$1,115,176	$680,879	2036-2041	Included
W06.5	Chain Control Transmission - Valve Chambers	Pockwock - Peninsula	$1,258,000	75%	25%	$314,500	$943,500	18%	$168,659	$774,841	$481,101	$293,740	2036-2041	Included
W07	Replace High Risk Peninsula Transmission (Robie)	Pockwock - Peninsula	$17,312,000	0%	100%	$17,312,000	$0	0%	$0	$0	$0	$0	2026-2031	Included
W08	Peninsula Intermediate Looping - Quinpool Rd to Young St	Pockwock - Peninsula	$4,319,000	75%	25%	$1,079,750	$3,239,250	18%	$579,044	$2,660,206	$1,651,730	$1,008,476	2021-2026	Included
W10.1	Young St Upsize	Pockwock - Peninsula	$1,315,000	75%	25%	$328,750	$986,250	18%	$176,301	$809,949	$502,900	$307,049	2026-2031	Included
W10.2	Robie St Upsize	Pockwock - Peninsula	$956,000	75%	25%	$239,000	$717,000	18%	$128,170	$588,830	$365,606	$223,224	2026-2031	Included
W10.3	Almon St Upsize	Pockwock - Peninsula	$1,168,000	75%	25%	$292,000	$876,000	18%	$156,593	$719,407	$446,682	$272,725	2026-2031	Included
W10.4	Windsor St Upsize	Pockwock - Peninsula	$1,004,000	75%	25%	$251,000	$753,000	18%	$134,605	$618,395	$383,963	$234,431	2026-2031	Included
W01.1	Geizer 158 to Lakeside High Looping	Pockwock - Other	$2,249,000	0%	100%	$2,249,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W01.2	Gravity Supply to Brunello	Pockwock - Other	$2,328,000	0%	100%	$2,328,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W01.3	Dominion Cres Upsize	Pockwock - Other	$447,000	0%	100%	$447,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W01.4	Brunello Booster Pump Upgrades	Pockwock - Other	$236,000	0%	100%	$236,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W02	Geizer 158 Looping - Lacewood Dr	Pockwock - Other	$2,002,000	0%	100%	$2,002,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W03	Geizer Hill Booster Pump Upgrades	Pockwock - Other	$277,000	0%	100%	$277,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W04	Leiblin Booster Fire Pump	Pockwock - Other	$395,000	0%	100%	$395,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W05.1	Herring Cove Rd Twinning	Pockwock - Other	$3,585,000	0%	100%	$3,585,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W05.2	St Michaels Ave Upsize	Pockwock - Other	$502,000	0%	100%	$502,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W05.3	Herring Cove Rd Looping - McIntosh St	Pockwock - Other	$2,272,000	0%	100%	$2,272,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W12.1	Lucasville Rd Twinning (Phase 1)	Pockwock - Other	$8,117,000	100%	0%	$0	$8,117,000	18%	$1,450,984	$6,666,016	$4,138,950	$2,527,065	2016-2021	Included
W12.2	Lucasville Rd Twinning (Phase 2)	Pockwock - Other	$7,994,000	100%	0%	$0	$7,994,000	18%	$1,428,997	$6,565,003	$4,076,231	$2,488,772	2026-2031	Included
W13.1	New Primary Feed to Sackville High	Pockwock - Other	$4,953,000	100%	0%	$0	$4,953,000	18%	$885,392	$4,067,608	$2,525,591	$1,542,017	2026-2031	Included
W13.2	New Sackville Beaver Bank Valve Chamber	Pockwock - Other	$839,000	100%	0%	$0	$839,000	18%	$149,979	$689,021	$427,816	$261,206	2026-2031	Included
W13.3	Reconfiguration of Beaver Bank Booster	Pockwock - Other	$100,000	0%	100%	$100,000	$0	0%	$0	$0	$0	$0	2026-2031	Included
W13.4	New Sackville High PRV	Pockwock - Other	$420,000	100%	0%	$0	$420,000	18%	$75,079	$344,921	$214,163	$130,759	2026-2031	Included
W14.1	Cobequid High Looping	Pockwock - Other	$2,233,000	75%	25%	$558,250	$1,674,750	18%	$299,376	$1,375,374	$853,974	$521,400	2026-2031	Included
W14.2	Windgate Dr Upsize	Pockwock - Other	$882,000	75%	25%	$220,500	$661,500	18%	$118,249	$543,251	$337,306	$205,945	2026-2031	Included
W15	Lively Booster Pump Upgrades	Pockwock - Other	$38,000	0%	100%	$38,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
W16	New Hemlock Elevated Tank	Pockwock - Other	$6,209,000	41%	59%	$3,687,817	$2,521,183	18%	$450,683	$2,070,499	$1,285,580	$784,920	2016-2021	Included
W17	Pockwock Transmission Loop through Bedford	Pockwock - Other	$5,069,000	0%	100%	$5,069,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W20	Second Geizer 158 Feed	Pockwock - Other	$9,612,000	0%	100%	$9,612,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included

Water RDC 2019 Program

Project ID	Project Description	System	Projects Cost $ (2019)	Growth (%)	BTE (%)	BTE $ (2019)	Growth $ (2019)	Post Period Benefit (%)	Post Period Benefit $ (2019)	Adjusted RDC $ (2019)	Res RDC $ (2019)	Non-Res RDC $ (2019)	Period Req'd	Within RDC Horizon (Included/Not Included)
W22.1	New Main Street to Caledonia Road Connection	Lake Major	$3,512,000	0%	100%	$3,512,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W22.2	Caledonia Rd Twinning	Lake Major	$3,429,000	0%	100%	$3,429,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W22.3	New Breeze Dr Watermain	Lake Major	$5,801,000	0%	100%	$5,801,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W23	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	Lake Major	$3,740,000	0%	100%	$3,740,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W24	Windmill Rd Upsize	Lake Major	$6,104,000	75%	25%	$1,526,000	$4,578,000	18%	$818,357	$3,759,643	$2,334,374	$1,425,268	2026-2031	Included
W25	New Woodside Industrial Park Feed	Lake Major	$1,649,000	0%	100%	$1,649,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W26	Willowdale to Eastern Passage Connection	Lake Major	$6,290,000	0%	100%	$6,290,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
W28	Tacoma PRV Chamber	Lake Major	$420,000	0%	100%	$420,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W19.1	Pockwock Transmission Twinning - 60in	System Interconnections Pockwock Transmission WTP Decommissioning	$65,516,000	37%	63%	$41,340,987	$24,175,013	18%	$4,321,494	$19,853,518	$12,327,113	$7,526,405	2031-2036	Included
W19.2	Pockwock Transmission Twinning - 54in		$16,228,000	37%	63%	$10,239,965	$5,988,035	18%	$1,070,413	$4,917,622	$3,053,367	$1,864,255	2036-2041	Included
W21	Extension to Springfield Lake		$3,478,000	0%	100%	$3,478,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W29.1	Bedford-Burnside System Interconnection (Phase 1)		$21,800,000	47%	53%	$11,545,913	$10,254,087	18%	$1,833,007	$8,421,079	$5,228,675	$3,192,404	2036-2041	Included
W29.2	Bedford-Burnside System Interconnection (Phase 2)		$11,779,000	47%	53%	$6,238,501	$5,540,499	18%	$990,413	$4,550,087	$2,825,163	$1,724,923	2036-2041	Included
W30.1	Lyle Emergency Booster		$1,045,000	47%	53%	$553,462	$491,538	18%	$87,867	$403,671	$250,641	$153,030	2026-2031	Included
W30.2	Valving for Central Intermediate Boundary Change		$629,000	47%	53%	$333,137	$295,863	18%	$52,888	$242,975	$150,864	$92,111	2026-2031	Included
W31.1	Extension of Fall River to Bennery Lake (Phase 1)		$8,067,000	74%	26%	$2,095,566	$5,971,434	18%	$1,067,446	$4,903,989	$3,044,902	$1,859,086	2026-2031	Included
W31.2	Extension of Fall River to Bennery Lake (Phase 2)		$9,156,000	74%	26%	$2,378,455	$6,777,545	18%	$1,211,545	$5,566,000	$3,455,947	$2,110,053	2026-2031	Included
W31.3	Extension of Fall River to Bennery Lake (PS)		$1,310,000	74%	26%	$340,299	$969,701	18%	$173,343	$796,359	$494,462	$301,897	2026-2031	Included
W32.1	Decommission Miller Lake WSP - Linear		$628,000	0%	100%	$628,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W32.2	Decommission Miller Lake WSP		$61,000	0%	100%	$61,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W33.1	Decommission Collins Park WSP - Linear		$1,086,000	0%	100%	$1,086,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W33.2	Decommission Collins Park WSP		$168,000	0%	100%	$168,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W34.1	Decommission Silversands WSP - Linear		$1,931,000	0%	100%	$1,931,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W34.2	Decommission Silversands WSP		$168,000	0%	100%	$168,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W40	Aerotech Storage		$4,752,000	75%	25%	$1,188,000	$3,564,000	18%	$637,096	$2,926,904	$1,817,324	$1,109,580	2021-2026	Included
W18	Chain Lake Backup Supply Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,469	$20,531	$12,748	$7,783	2016-2021	Included
W27	Mt Edward Booster Fire Pump	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,469	$20,531	$12,748	$7,783	2016-2021	Included
W29.3	New Orchard Control Chamber	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,469	$20,531	$12,748	$7,783	2021-2026	Included
W30.3	Robie Emergency Booster	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,469	$20,531	$12,748	$7,783	2021-2026	Included
W35	Safe Yield Study	Studies	$100,000	50%	50%	$50,000	$50,000	18%	$8,938	$41,062	$25,496	$15,566	2016-2021	Included
W36	New Hydraulic Water Model (InfoWater)	Studies	$200,000	50%	50%	$100,000	$100,000	18%	$17,876	$82,124	$50,991	$31,133	2016-2021	Included
W37	Comprehensive PRV Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,469	$20,531	$12,748	$7,783	2016-2021	Included
W38	Transmission Main Risk Assessment and Prioritization Framework	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,469	$20,531	$12,748	$7,783	2016-2021	Included
W39	Tomahawk Lake Supply Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,469	$20,531	$12,748	$7,783	2036-2041	Included
		TOTAL 2046 Projects	**$279,597,000**			**$166,889,102**	**$112,707,898**		**$20,147,519**	**$92,560,379**	**$57,471,037**	**$35,089,343**		
		TOTAL Post 2041 Projects	**$21,722,000**			**$21,722,000.00**	**$0**		**$0**	**$0**	**$0**	**$0**		
		TOTAL 2041 Projects	**$257,875,000**			**$145,167,102**	**$112,707,898**		**$20,147,519**	**$92,560,379**	**$57,471,037**	**$35,089,343**		

Water 20 Year RDC Rate

RDC Summary

Base Info	Population	Cost
Adjusted RDC		$ 92,560,379
Residential	119,409	$ 57,471,036
Non-Residential	72,906	$ 35,089,343
Total	192,315	$ 92,560,379

Residential RDC Rate

Unit Type	Units	Unit DC	Res DC cost ($)	PPU	Unit Factor
SUD	23,363	**$ 1,351**	$ 31,561,962	3.35	1.46
MUD	28,554	**$ 907**	$ 25,909,074	2.25	0.9783
Total			$ 57,471,036		

Average Cost Per Unit

Averages	
PPU	2.3
Average Number of Units	51,917
Average Cost Per Unit	$ 1,106.98

Non-Residential RDC Rate

Employment Units	Unit DC
Equivalent person ($/person)	$ 481.30
Employment Density (Sqft/Employee)	733
RDC Rate ($/sqft)	**$ 0.66**

Population Factors

Relative Factors	
Relative Density Factor	1.489
Relative Cost Factor	1.489
Relative Permit factor	0.8

Reference Table

Reference Values	Residential		Non-Residential Rate
	SUD	MUD	sqft/person
RDC April 1st 2015 (2012 $)	$ 182.88	$ 122.83	$ 0.09
RDC April 1st 2015 (2019 $)	$ 210.07	$ 141.09	$ 0.10

Percentage of Unit Type

Reference	Residential Splits (%)	
	SUD/TH	MUD
Average (2005-2018)	45%	55%

RDC Comparison 2012-2019

WASTEWATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	192,315
Total Residential Growth	94,800	94,800	119,409
% Residential Growth	68.5%	68.5%	62.1%
Total Employment Growth	43,530	43,530	72,906
% Employment Growth	31.5%	31.5%	37.9%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.1%
2046 Capital Program	$ 645,257,222	$ 741,197,723	$ 576,339,588
20 year Capital Program	$ 450,518,078	$ 517,503,659	$ 552,363,588
Total Post Period and BTE ($)	$ 240,897,047	$ 276,714,985	$ 220,243,805
Total Res & Emp RDC Program ($)	$ 209,621,031	$ 240,788,674	$ 332,119,783
Total Residential RDC Program ($)	$ 132,710,213	$ 152,442,320	$ 206,214,238
SUD RDC Rate ($/unit)	$ 4,081	$ 4,688	$ 4,847
MUD RDC Rate ($/unit)	$ 2,741	$ 3,148	$ 3,256
Total Employment RDC Program ($)	$ 76,910,818	$ 88,346,354	$ 125,905,545
RDC Rate ($/sqft)	$ 2.24	$ 2.57	$ 2.36

WATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	192,315
Total Residential Growth	94,800	94,800	119,409
% Residential Growth	68.5%	68.5%	62.1%
Total Employment Growth	43,530	43,530	72,906
% Employment Growth	31.5%	31.5%	37.9%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.1%
2046 Capital Program	$ 51,225,710	$ 58,842,239	$ 279,597,000
20 year Capital Program	$ 38,577,400	$ 44,313,306	$ 257,875,000
Total Post Period and BTE ($)	$ 29,454,748	$ 33,834,247	$ 165,314,620
Total Res & Emp RDC Program ($)	$ 9,122,652	$ 10,479,059	$ 92,560,380
Total Residential RDC Program ($)	$ 5,947,407	$ 6,831,701	$ 57,471,037
SUD RDC Rate ($/unit)	$ 183	$ 210	$ 1,351
MUD RDC Rate ($/unit)	$ 123	$ 141	$ 907
Total Employment RDC Program ($)	$ 3,175,245	$ 3,647,358	$ 35,089,343
RDC Rate ($/sqft)	$ 0.09	$ 0.10	$ 0.66

Halifax Water Regional Development Charge

RDC Stakeholder Meeting #2

August 22th, 2019

AGENDA

1. Meeting Objectives
2. RDC Update Inputs
3. RDC Policies
4. Program Criteria/Splits
5. Preliminary RDC Program
6. Preliminary RDC Rate
7. Opportunities for Input
8. Schedule and Next Steps

Meeting Objectives:

1. Provide background on Inputs to the RDC Update
2. Present preliminary RDC program and rate
3. Feedback, Information for review and next steps

RDC Update Inputs

Infrastructure Master Plan

- Regional level Infrastructure Servicing Study to accommodate growth to 2046
- Includes Servicing Assessment of Water and Wastewater infrastructure for all Regions
- Incorporates the recently completed West Region Wastewater Infrastructure Plan (WRWIP)
- Based on best available population planning data, consistent with HRM estimates
- Detailed analysis of observed flow monitor data to inform I/I reduction priorities
- Utilizes updated and calibrated water and wastewater hydraulic models to replicate existing conditions and simulate future growth scenarios
- Supersedes the Regional Wastewater Functional Plan (RWWFP); the basis for the existing wastewater RDC rate.

Infrastructure Master Plan Strategy Goals

	Infrastructure Master Plan Strategy Goals
Environment	- Minimize construction in areas with limited access - Minimize watercourse/highway/railway crossings - Minimize proximity to environmentally sensitive features - Minimize proximity and/or conflict with existing infrastructure - Maintain existing services during and following construction
Technical	- Maximize use of existing infrastructure capacity, while minimizing capital upgrades where possible - Minimize capital cost and O & M costs - Maximize servicing via gravity (based on invert elevations of existing sanitary sewers) - Maximize routes along road rights of way and/or easements - Minimize need for land acquisition - Avoid challenging locations that adversely impact existing and future land uses where possible

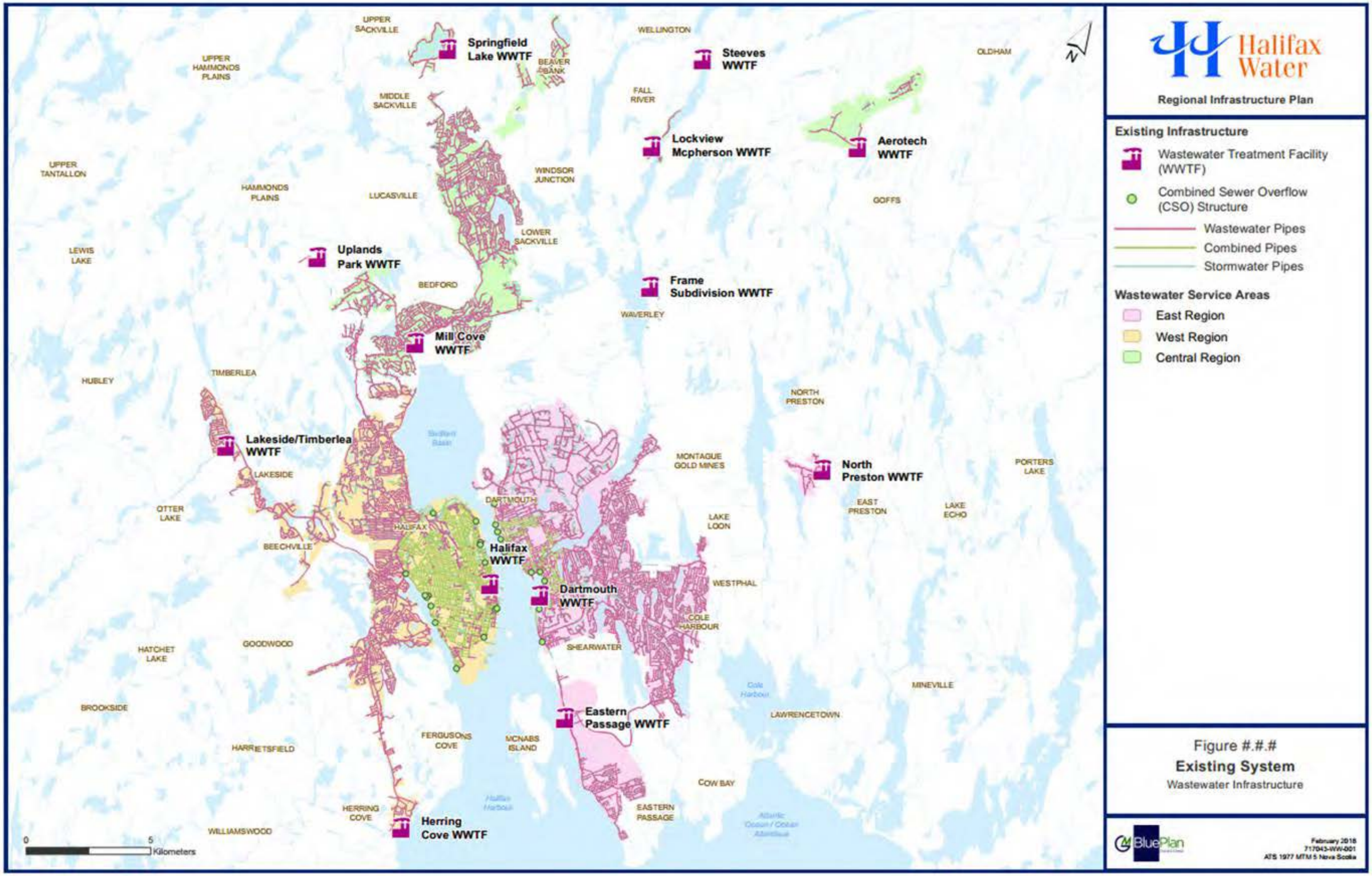
RDC Update Inputs

Infrastructure Master Plan Servicing Strategies:

- Demonstrate an integrated approach to address servicing needs
- Completed for East, Central and West service areas
- Primarily address growth needs
- Also address reliability, resiliency, Level of Service and system optimization
- Not all projects shown on subsequent maps are eligible for RDC cost sharing

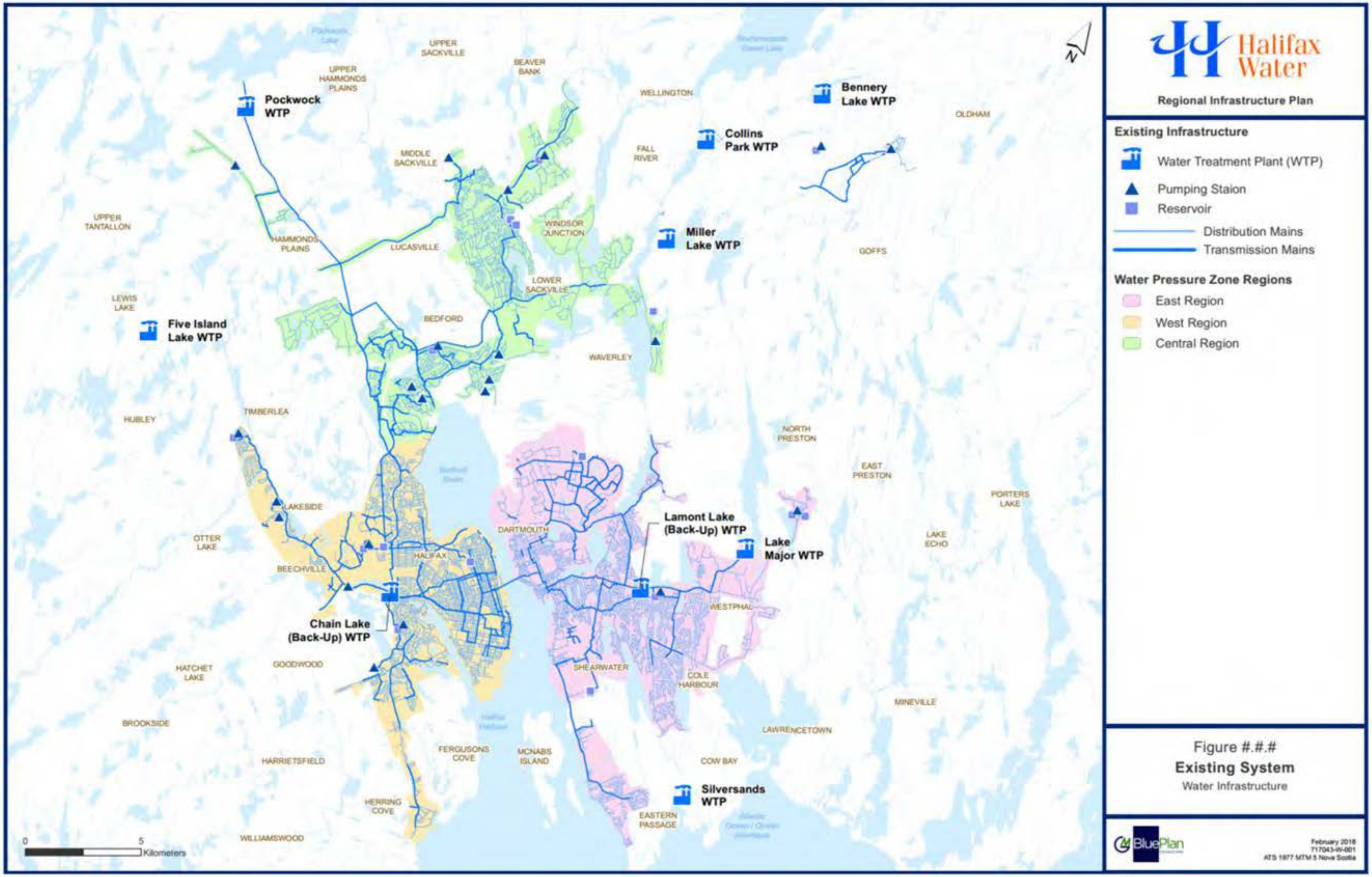
RDC Update Inputs

Infrastructure Master Plan Wastewater Map



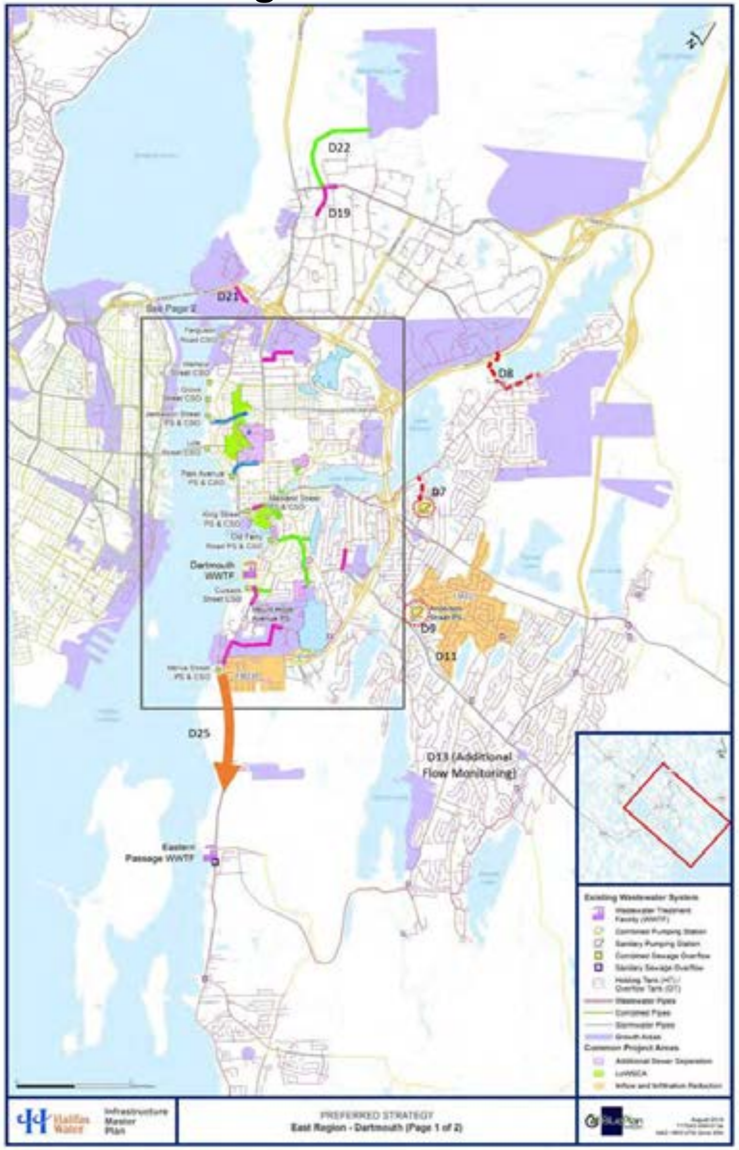
RDC Update Inputs

Infrastructure Master Plan Water Map

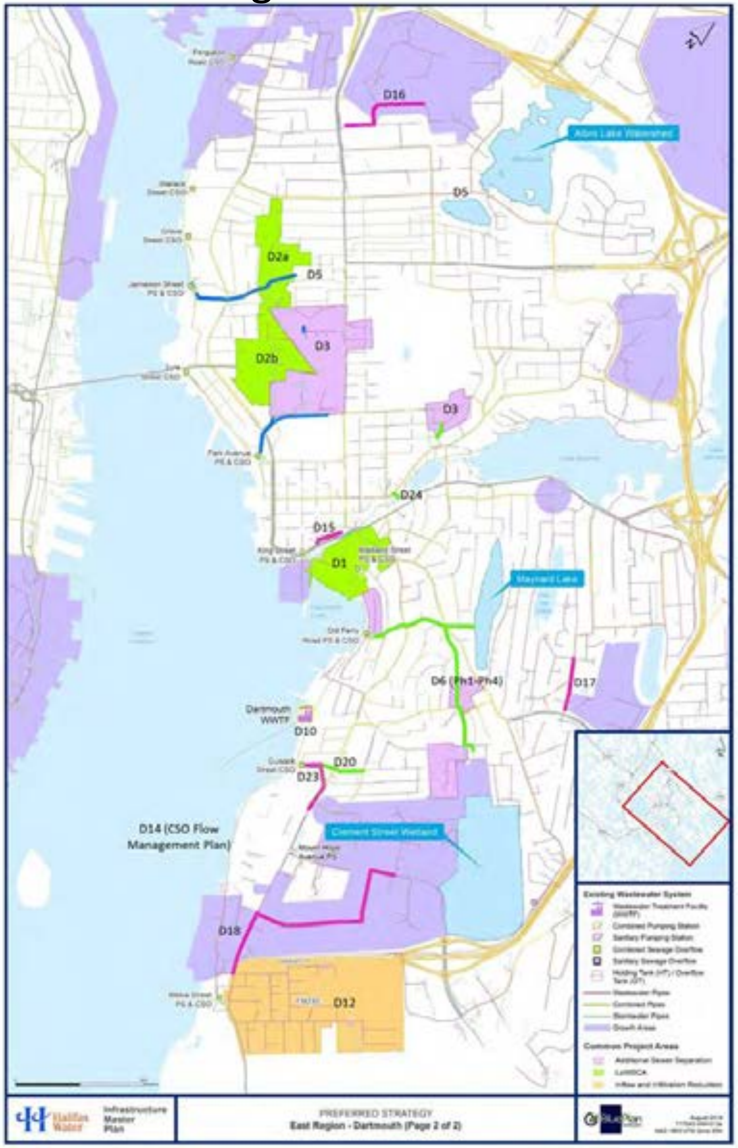


RDC Update Inputs

East Region Wastewater



East Region Wastewater

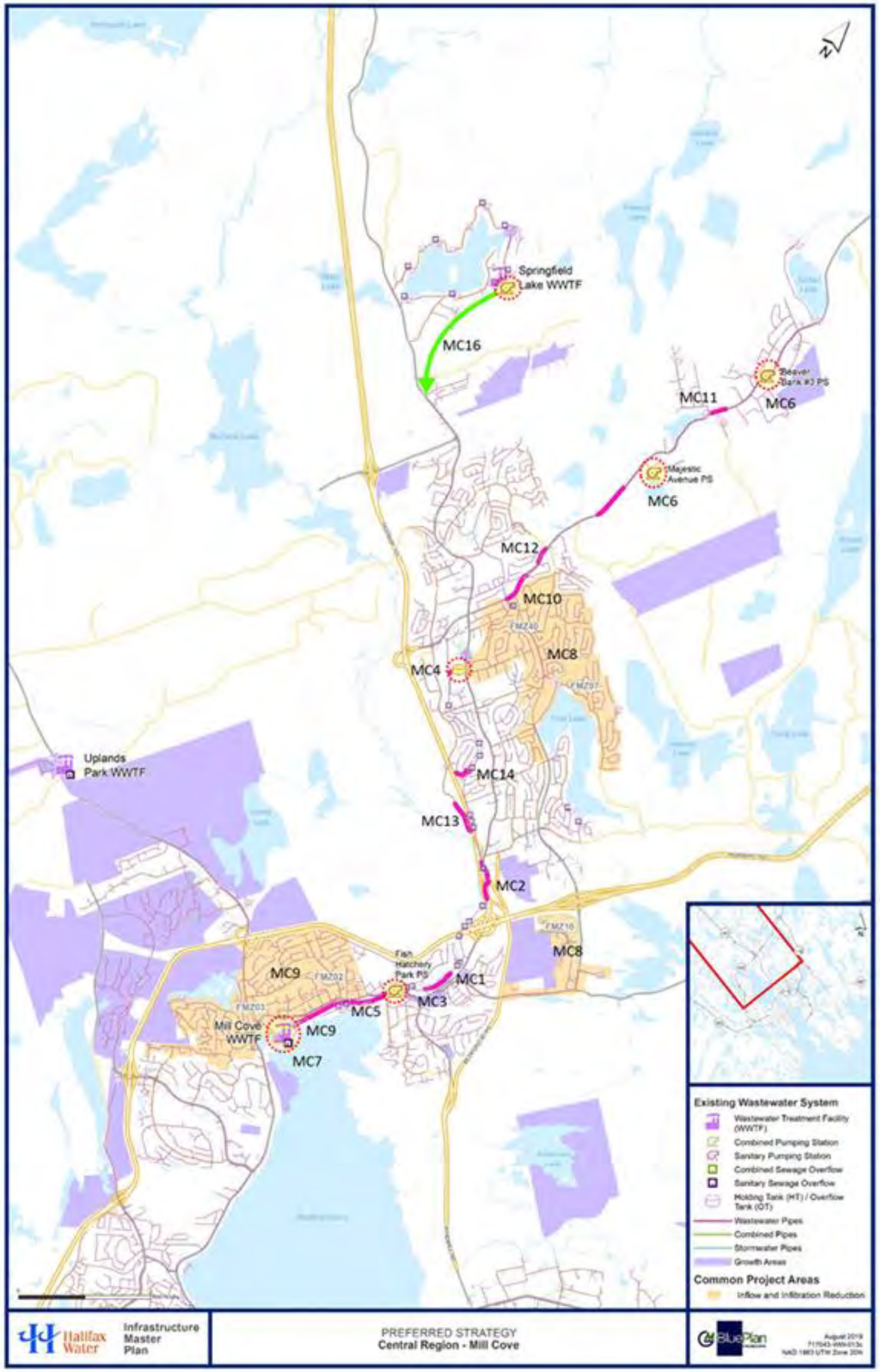


RDC Update Inputs

East Region Wastewater

- Sewer Separation
- I/I Reduction
- CSO Management
- WWTF Diversion
- Gravity Pressure Sewer Upgrades

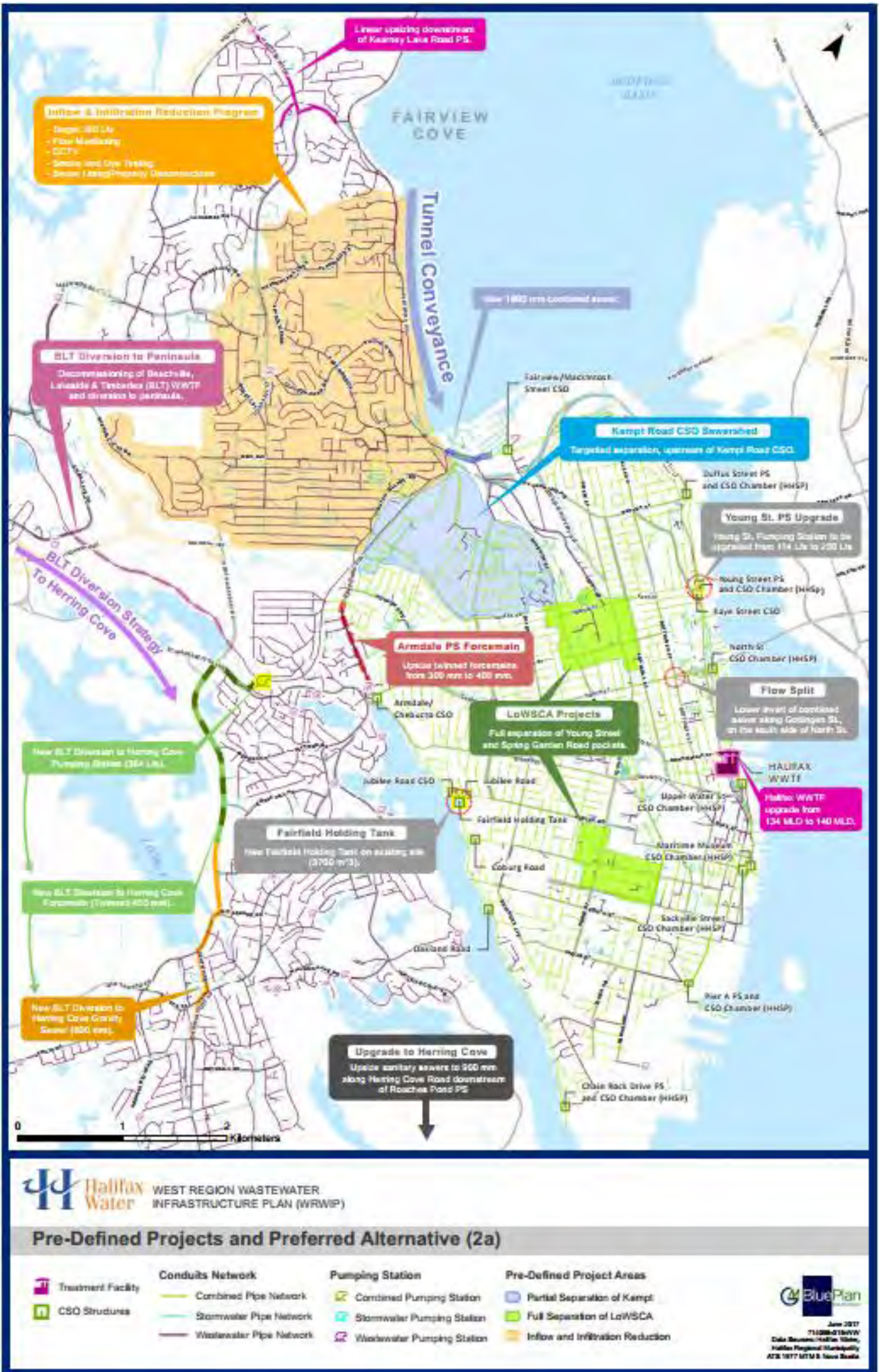
RDC Update Inputs



Central Region Wastewater

- WWTF Capacity Upgrade
- I/I Reduction
- Fish Hatchery PS Forcemain Upgrade
- Sackville Trunk Sewer Upgrades
- Storage Tank at Beaver Bank
- Springfield Lake Connection

RDC Update Inputs

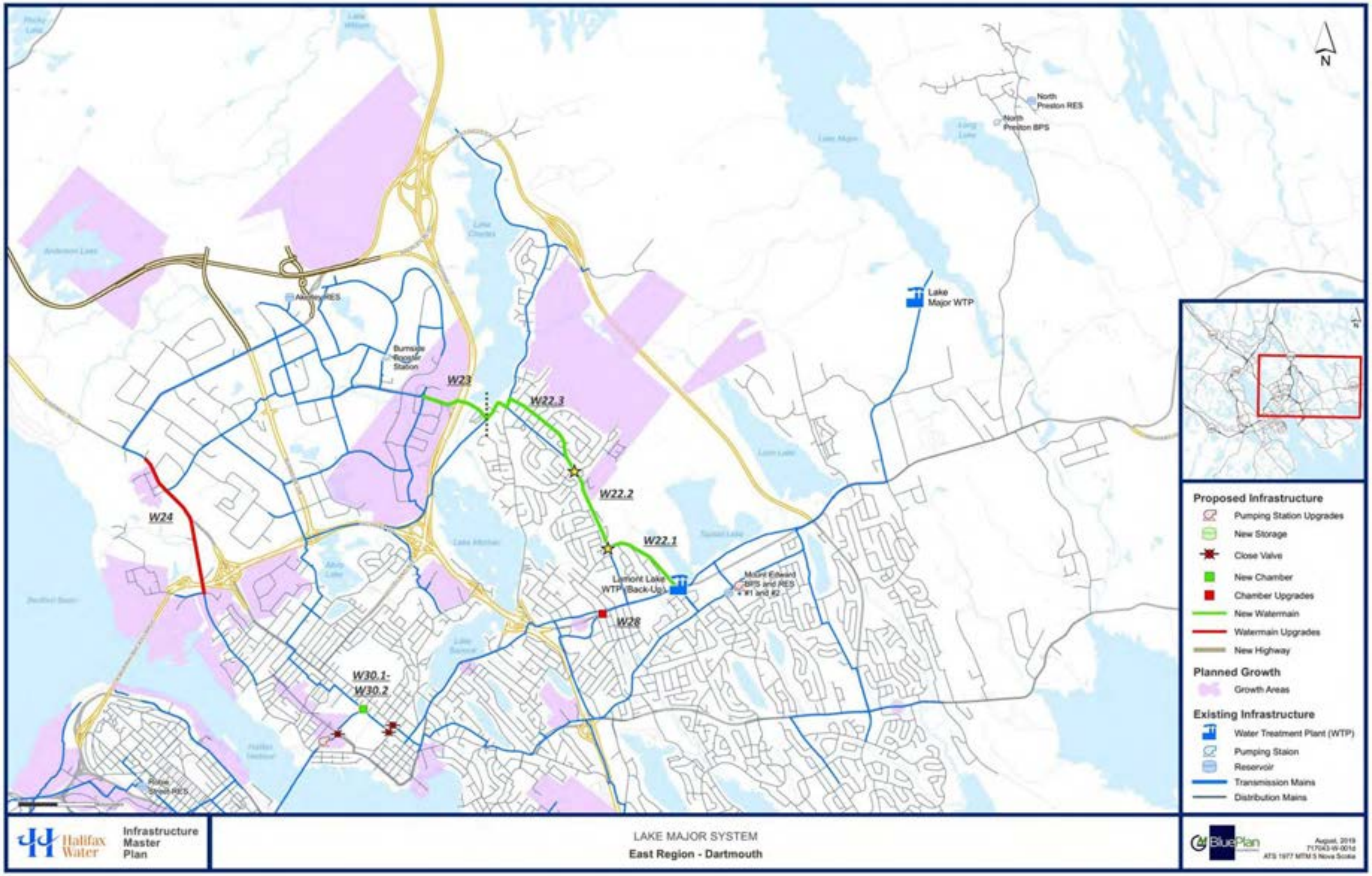


West Region Wastewater

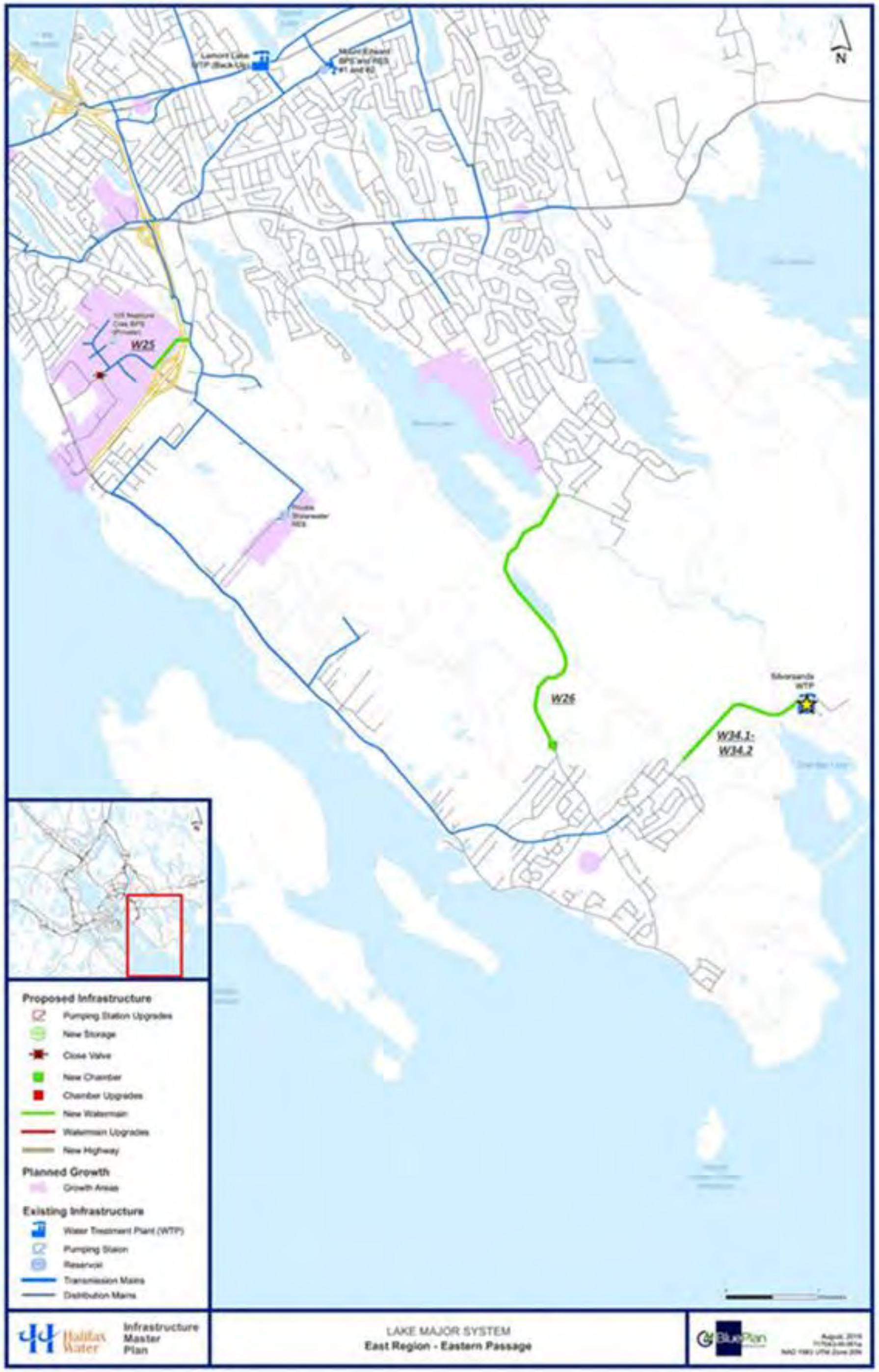
- Sewer Separation
- I/I Reduction
- Divert and Decommission BLT WWTF
- Fairview Cove Tunnel
- Halifax WWTF Capacity Increase

RDC Update Inputs

East Region Water



RDC Update Inputs

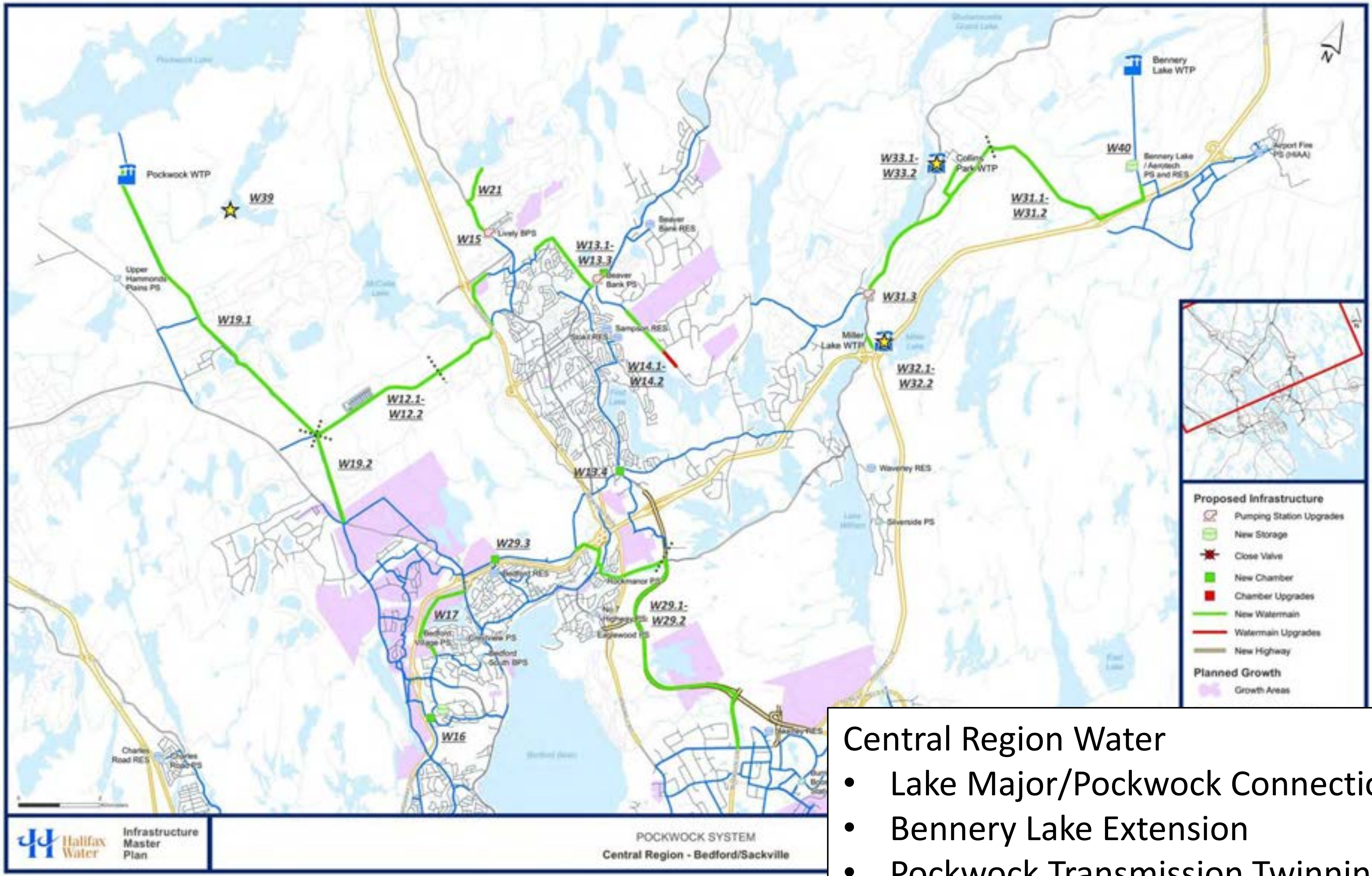


East Region Water

- Enhancements to existing system
- Some Upsizing for Growth
- Optimized Bridge Crossing

RDC Update Inputs

Central Region Water

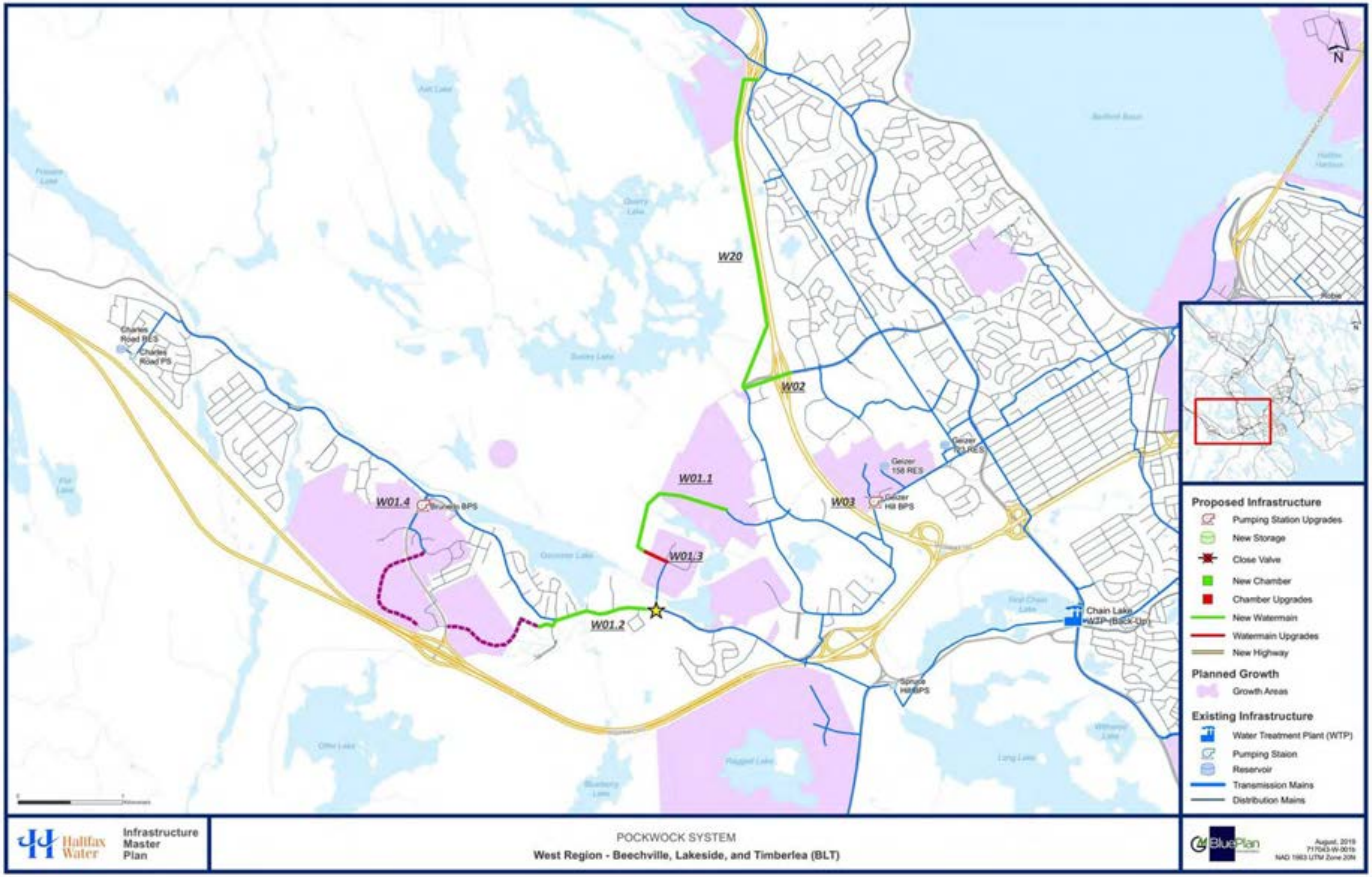


Central Region Water

- Lake Major/Pockwock Connection
- Bennery Lake Extension
- Pockwock Transmission Twinning
- Sackville Connection

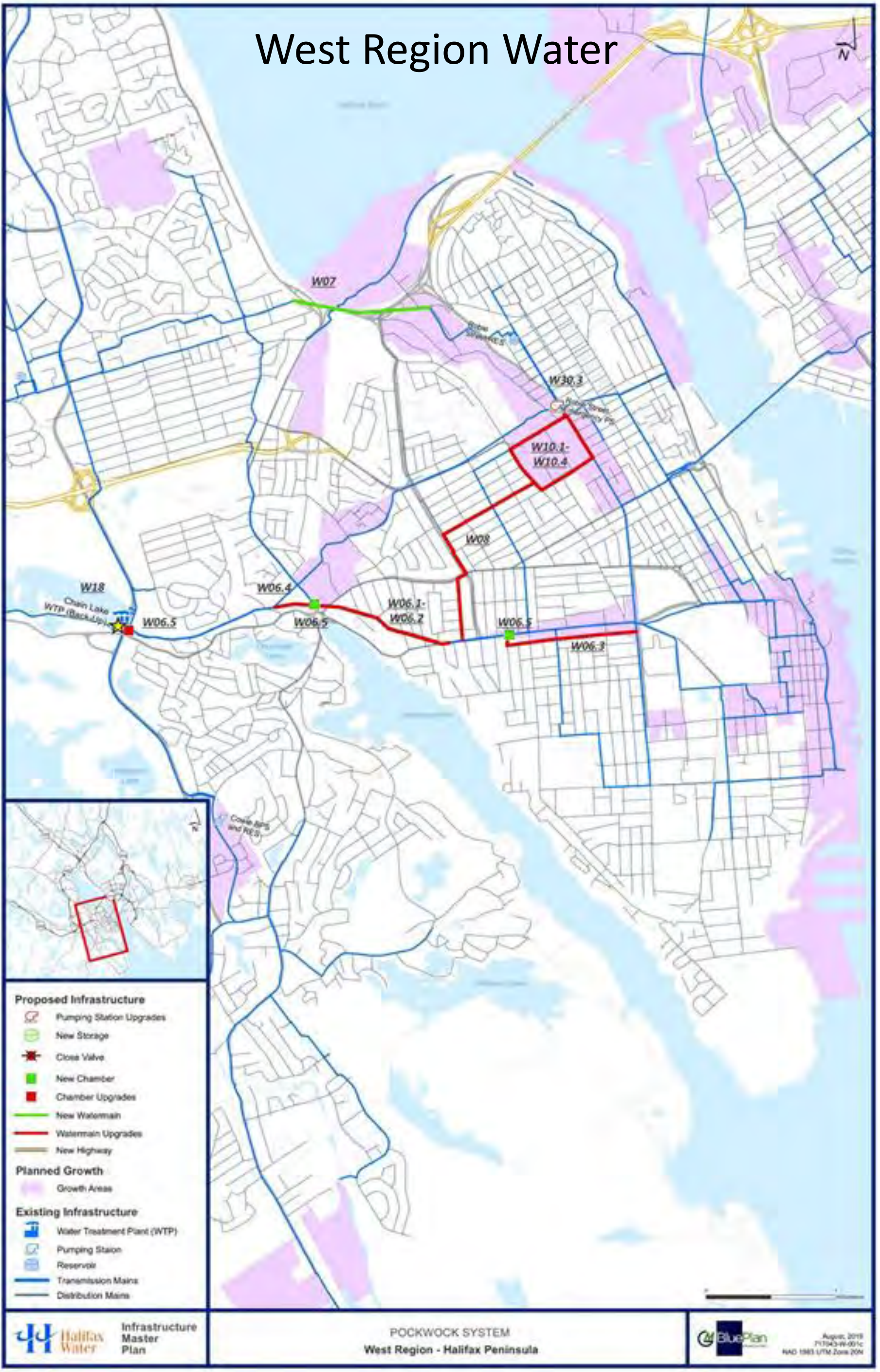
RDC Update Inputs

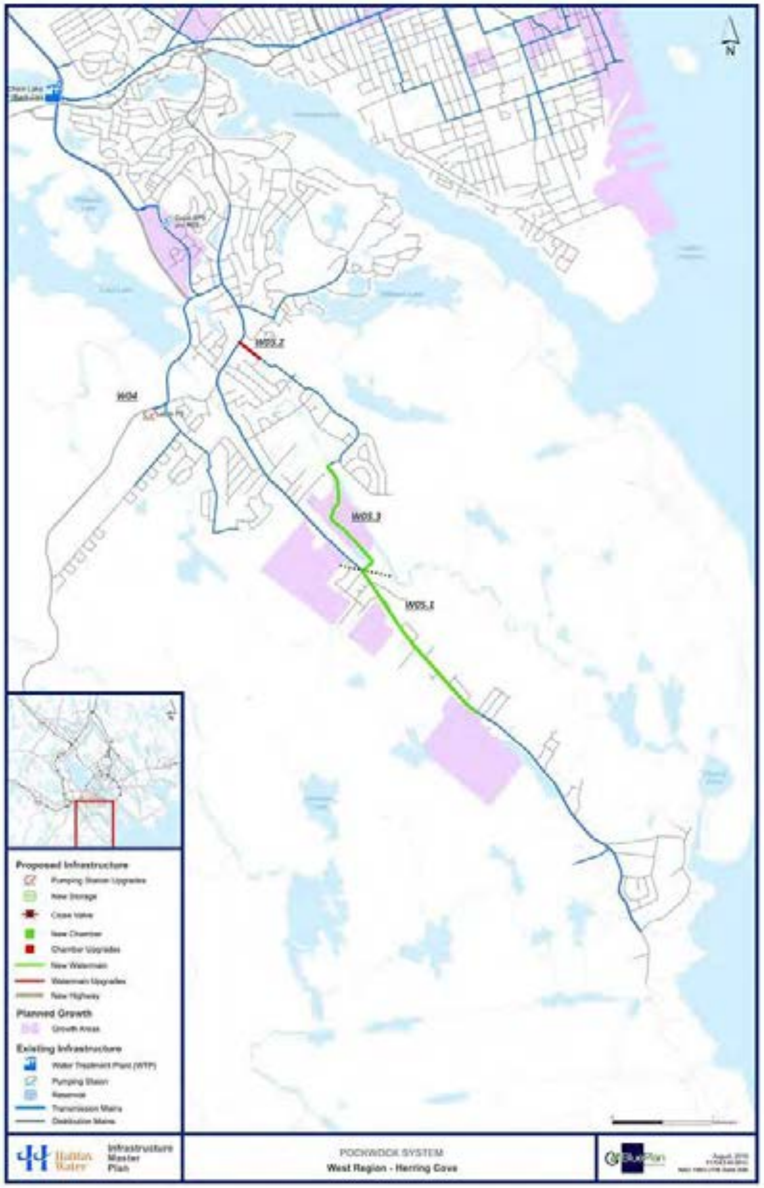
West Region Water



RDC Update Inputs

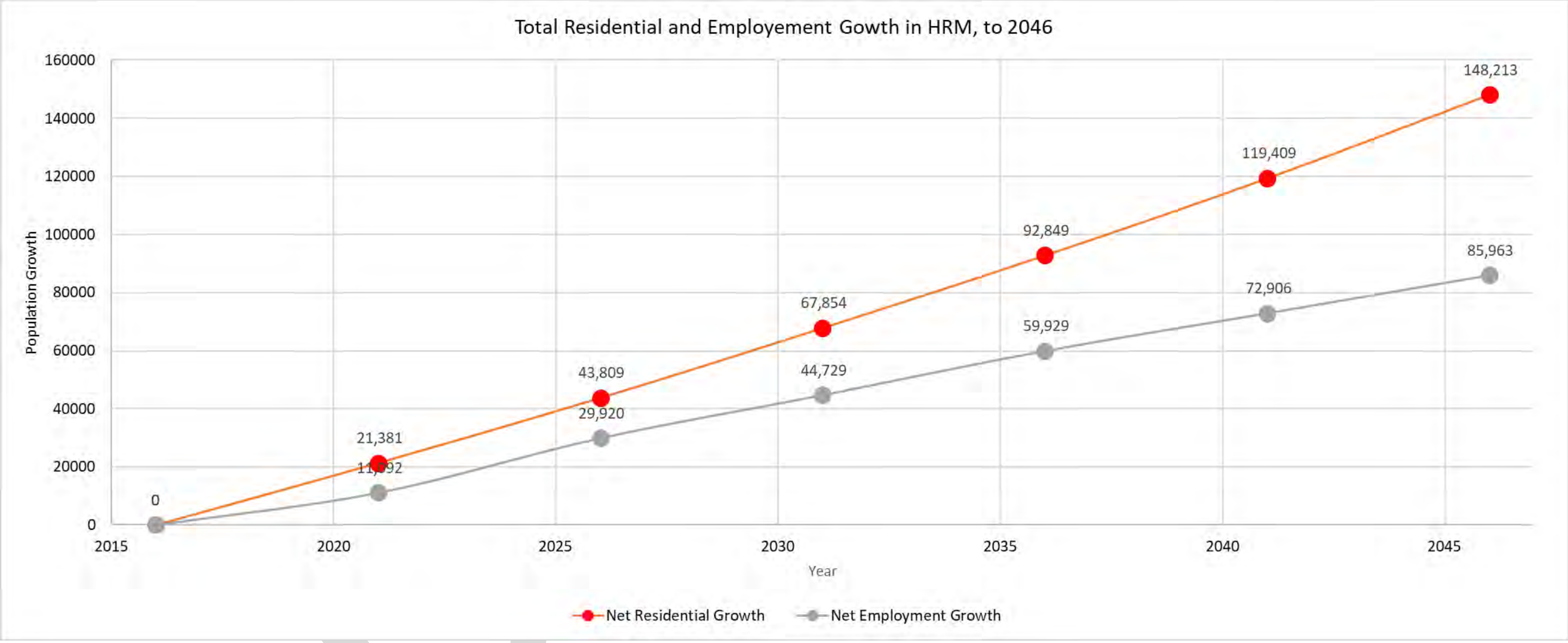
West Region Water





RDC Update Inputs

Population and Jobs Growth Projections:

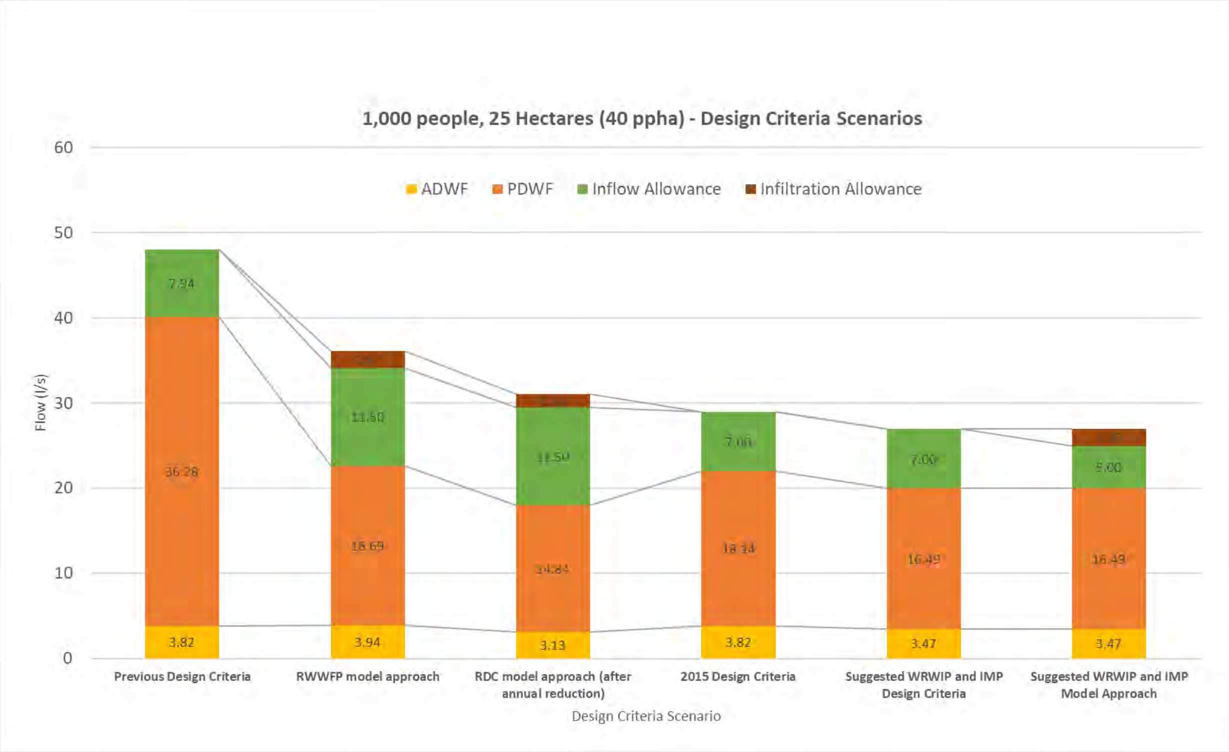


Year	Residential Growth	Employment Growth	Total
2041	119,409	72,906	192,315
2046	148,213	85,963	234,176

2041 to 2046 = 82% (18%)

Design Criteria: Wastewater

- Per capita sanitary flow 300 L/cap/d
- I/I allowance 0.28 L/s/ha
- RDC flow monitor analysis completed and shared
- Design Criteria only applied to growth population; existing population based on observed data



Design Criteria: Water

- Per capita average day demand 375 L/cap/d
  - A decrease from 410 L/cap/d based on demand analysis
  - Wastewater per capita is 80% of water production at 375 L/cap/d

Peaking Factors

Category	MDD	PHD
System Supply	1.30	-
Storage	1.80	-
Pumping and PRVs	-	3.60

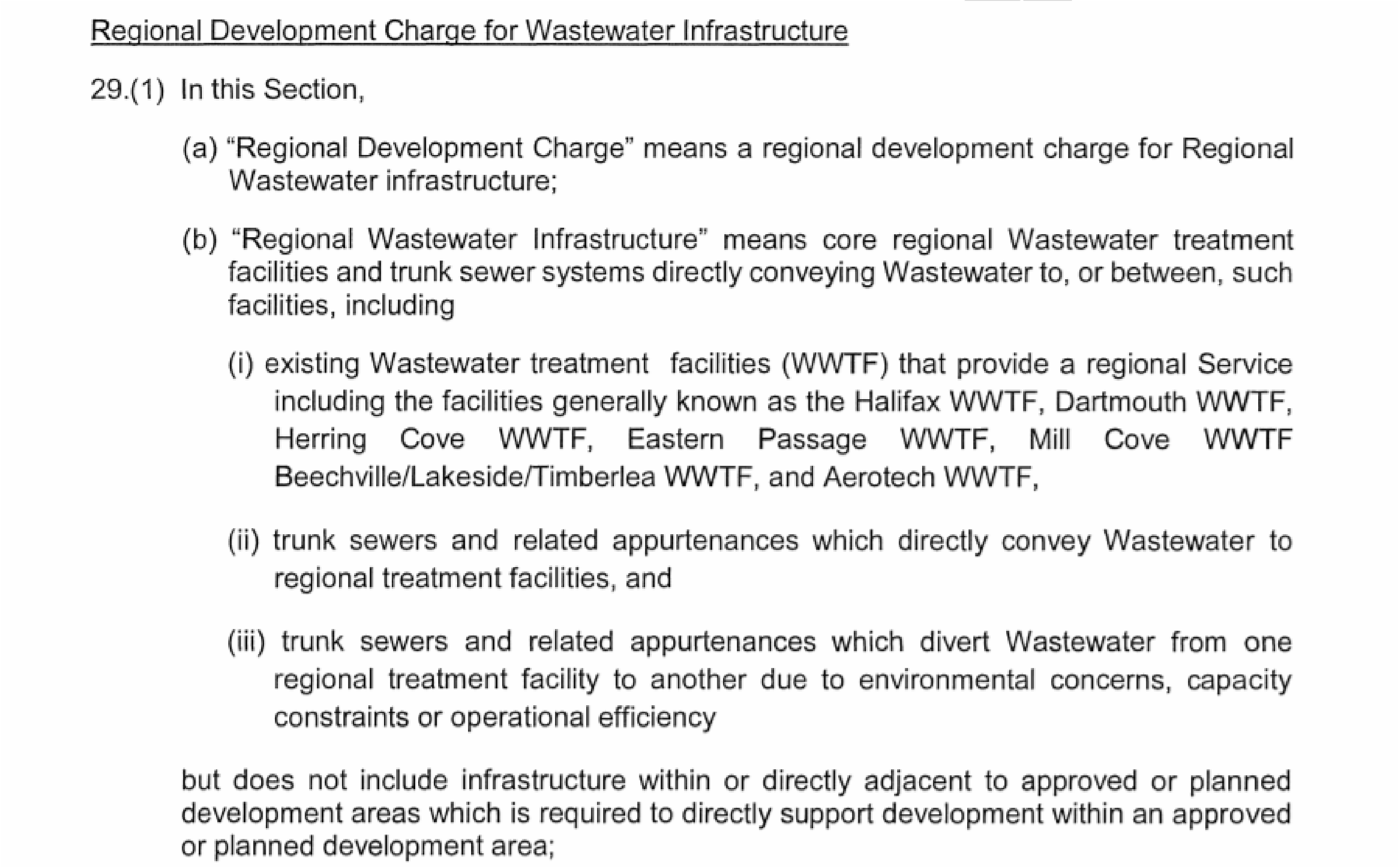
System Pressure LOS

Scenario	Level of Service Pressures (psi)
MDD and ADD	40-50 or 90-100
PHD and MDD	<40 or >100
MDD + FF	>22 psi

Fire Flow LOS

Land Use	Fire Flow (L/s)
Single unit dwellings	55
Two family dwellings	55
Townhouse	75.7
Multi-unit high rise	227
Commercial	227
Industrial	227
Institutional	227

RDC Policy: Wastewater



Regional Development Charge for Wastewater Infrastructure

29.(1) In this Section,

(a) "Regional Development Charge" means a regional development charge for Regional Wastewater infrastructure;

(b) "Regional Wastewater Infrastructure" means core regional Wastewater treatment facilities and trunk sewer systems directly conveying Wastewater to, or between, such facilities, including

(i) existing Wastewater treatment facilities (WWTF) that provide a regional Service including the facilities generally known as the Halifax WWTF, Dartmouth WWTF, Herring Cove WWTF, Eastern Passage WWTF, Mill Cove WWTF Beechville/Lakeside/Timberlea WWTF, and Aerotech WWTF,

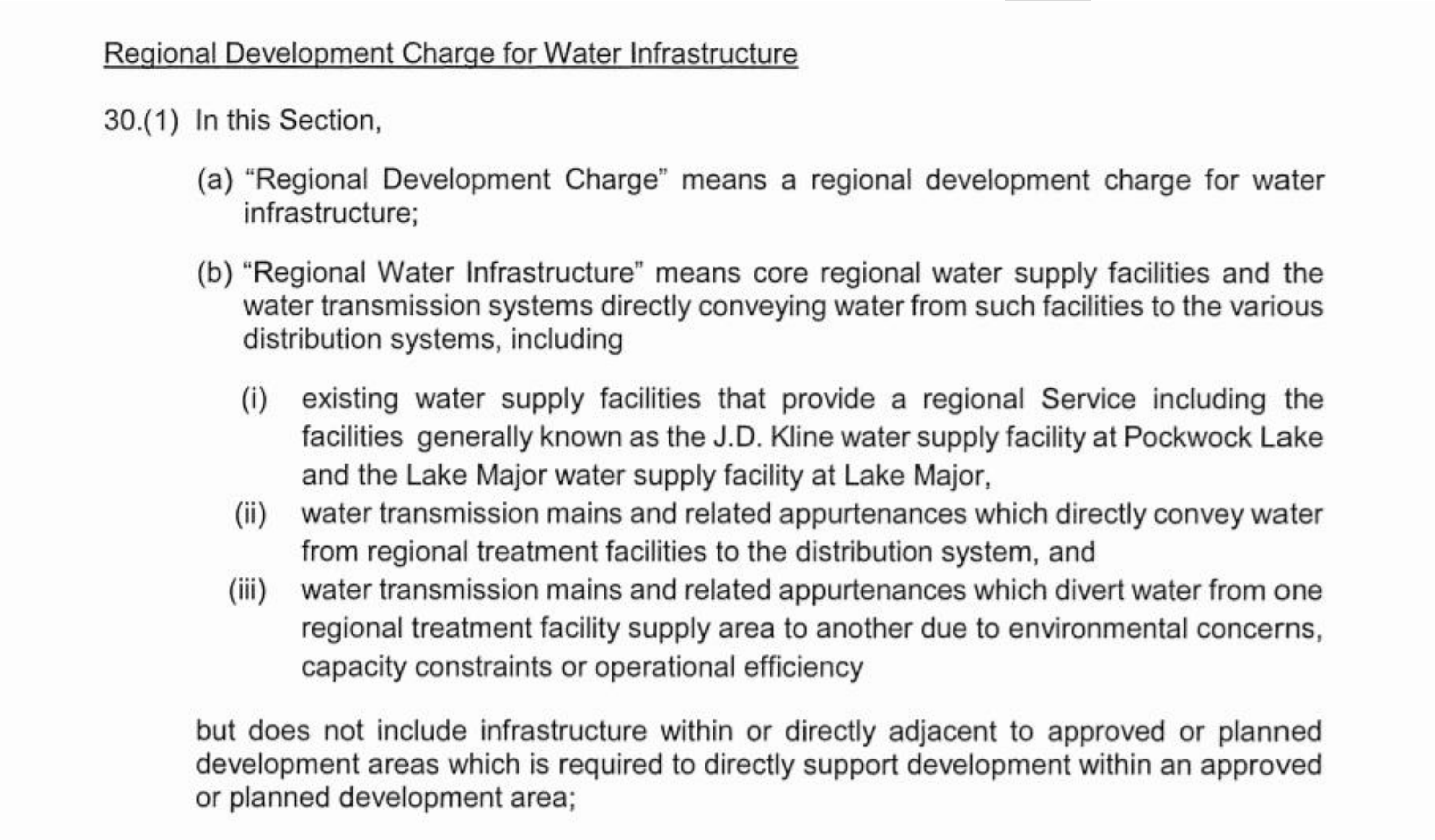
(ii) trunk sewers and related appurtenances which directly convey Wastewater to regional treatment facilities, and

(iii) trunk sewers and related appurtenances which divert Wastewater from one regional treatment facility to another due to environmental concerns, capacity constraints or operational efficiency

but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

Schedule of Rates, Rules & Regulations for Water, Wastewater and Stormwater Services, May 1, 2018, https://www.halifax.ca/sites/default/files/documents/home-property/water/RulesAndRegulationsHRWC_2018.pdf

RDC Policy: Water



Regional Development Charge for Water Infrastructure

30.(1) In this Section,

(a) "Regional Development Charge" means a regional development charge for water infrastructure;

(b) "Regional Water Infrastructure" means core regional water supply facilities and the water transmission systems directly conveying water from such facilities to the various distribution systems, including

(i) existing water supply facilities that provide a regional Service including the facilities generally known as the J.D. Kline water supply facility at Pockwock Lake and the Lake Major water supply facility at Lake Major,

(ii) water transmission mains and related appurtenances which directly convey water from regional treatment facilities to the distribution system, and

(iii) water transmission mains and related appurtenances which divert water from one regional treatment facility supply area to another due to environmental concerns, capacity constraints or operational efficiency

but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

Schedule of Rates, Rules & Regulations for Water, Wastewater and Stormwater Services, May 1, 2018, https://www.halifax.ca/sites/default/files/documents/home-property/water/RulesAndRegulationsHRWC_2018.pdf

RDC Policy

- Recommend a fourth definition that addresses the ability of solutions such as sewer separation and I/I reduction to negate the need for larger, new, regional infrastructure.
- Capacity recapture through I/I reduction and sewer separation is more cost effective, maximizes use of existing infrastructure, minimizes new infrastructure and associated O&M.

Program Criteria/Splits

- The total capital project costs were split between Regional Development Charges and Benefit to Existing (BTE) Costs
- The Benefit to Existing Position Paper (2019) provided methods for allocating cost splits, the Level of Service (LOS) and flow split method were used for splitting costs in this RDC
- Method 2 – Level of Service (LOS) Range Approach
  - Accounts for existing system deficiencies
  - This method provides transparency and understanding to everyone
- Method 4 – Flow Ratio Approach
  - BTE = Existing Flows / (Growth Flow + Existing Flow)
  - A simple method, but requires an accurate hydraulic model or flow monitor data

Program Criteria/Splits

Post Period Benefit

- Infrastructure Master Plan provides servicing strategy appropriate for 2046
- All projects required post 2041 not RDC eligible
- The post period benefit determined by calculating ratio of projected population growth between 2041 and 2046
- The post period benefit was calculated to be 17.9% and all of the Regional Development Charges were reduced by 17.9% to only account for growth to 2041

Horizon	Growth
2041	192,315
2046	234,176
Difference (%)	82.1%
Post Period Reduction	17.9%

Program Criteria/Splits

RDC Rate Inputs

- The pervious RDC used a PPU of 2.4, the PPU was updated to 2.3 based on the Stats Can 2016 Census
- The Single Unit Dwelling (SUD) and Multi Unit Dwelling (MUD) percentages were updated referencing development data from 2005-2018
- Resulting SUD/MUD ratio changed from 55/45 to 45/55

Horizon	2031 (2012 RDC)	2041 (2019 RDC)
PPU	2.4	2.3
SUD (%)	55	45
MUD (%)	45	55

Preliminary RDC Program: Wastewater

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
AT2	Upgrade WWTF to service employment growth flows	Aerotech	$17,017,055	$12,577,597
D1	LoWSCA: Canal Street Separation	Dartmouth	$1,842,000	$1,134,545
D2a	LoWSCA: Wyse Road Separation - Phase 1	Dartmouth	$3,860,000	$2,377,494
D2b	LoWSCA: Wyse Road Separation - Phase 2	Dartmouth	$2,802,000	$575,280
D3	Additional Sewer Separation on Wyse Street	Dartmouth	$1,912,000	$1,177,660
D5	Albro Lakes Watershed Separation	Dartmouth	$8,111,000	$6,328,034
D6a	Maynard Lake and Clement Street Wetland Separation - Phase 1	Dartmouth	$642,000	$500,875
D6b	Maynard Lake and Clement Street Wetland Separation - Phase 2	Dartmouth	$4,540,000	$3,542,014
D6c	Maynard Lake and Clement Street Wetland Separation - Phase 3	Dartmouth	$1,155,000	$901,107
D6d	Maynard Lake and Clement Street Wetland Separation - Phase 4	Dartmouth	$453,000	$353,421
D7	New Valleyford Pumping Station	Dartmouth	$10,446,000	$2,144,672
D8	390 Waverley Road Upgrades	Dartmouth	$11,361,000	$9,330,122
D9	Anderson Pumping Station Upgrades	Dartmouth	$340,000	$0
D10	Upgrades to Dartmouth WWTF	Dartmouth	$12,572,000	$10,324,645
D11	I/I Reduction Program FMZ27	Dartmouth	$5,941,076	$3,659,293
D12	I/I Reduction Program FMZ45	Dartmouth	$1,120,232	$873,981
D13	Additional flow monitoring	Dartmouth	$420,000	$34,492
D14	CSO Flow Management Plan	Dartmouth	$252,000	$20,695
D15	Green St Upsize	Dartmouth	$513,000	$0
D16	Pinecrest Dr Upgrade	Dartmouth	$1,013,000	$623,938
D17	Peddars Way Upgrade	Dartmouth	$555,000	$341,842
D18	Atlantic Street Upgrade	Dartmouth	$3,831,000	$2,988,867
D19	Akerley Blvd and Railway Alignment Upgrade	Dartmouth	$4,814,000	$2,965,092
D20	Pleasant Street Upgrade	Dartmouth	$767,000	$472,419
D21	Princess Margaret Blvd. Upgrade	Dartmouth	$3,106,000	$2,423,237
D22	Anderson Lake Development Connection	Dartmouth	$7,609,000	$6,248,825
D23	Marvin Connection	Dartmouth	$1,380,000	$56,666
D24	King Street Diversion	Dartmouth	$78,000	$3,203
D25	Diversion to Eastern Passage	Dartmouth	$12,113,000	$9,947,696

Preliminary RDC Program: Wastewater

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
EP1	Install new Gravity Pressure Sewer	Eastern Passage	$23,372,000	$14,395,539
EP2	Connect Beaver Crescent and Caldwell Forcemains to new 450mm gravity pressure sewer	Eastern Passage	$78,000	$48,043
EP3	Install new pump out stations	Eastern Passage	$1,676,000	$1,032,300
EP4	Install gate valves at surge tank	Eastern Passage	$420,000	$258,691
EP5	Decommission existing 450mm gravity pressure sewer	Eastern Passage	$559,000	$344,305
EP6	Upgrade Quigley Corner Pumping Station	Eastern Passage	$2,875,000	$118,053
EP7	Optimize Quigley's Corner PS	Eastern Passage	$336,000	$13,797
EP8	Upgrade Memorial Drive Pumping Station	Eastern Passage	$2,633,000	$0
EP9	Upgrade Beaver Crescent Pumping Station	Eastern Passage	$168,000	$0
EP10	Upgrade Bissett Lake Pumping Station	Eastern Passage	$2,934,000	$1,204,761
EP11	Upgrade Caldwell Road Pumping Station	Eastern Passage	$631,000	$388,652
EP12	I/I Reduction Program FMZ23	Eastern Passage	$3,204,580	$2,500,147
EP13	I/I Reduction Program FMZ24	Eastern Passage	$1,570,040	$1,224,913
EP14	I/I Reduction Program FMZ37	Eastern Passage	$2,479,704	$1,934,613
EP15	Local network upgrades on Caldwell Road	Eastern Passage	$607,000	$373,870
EP16	Local network upgrades on Colby Drive	Eastern Passage	$1,176,000	$0
EP17	Local network upgrades on Forest Hill Parkway	Eastern Passage	$4,275,000	$0

Preliminary RDC Program: Wastewater

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
MC1	Trunk Sewer Upgrades (Sackville Trunk Upgrades to 1200mm diameter)	Mill Cove	$5,101,000	$3,141,864
MC2	Trunk Sewer Upgrades (Sackville Trunk Upgrades to 1050mm diameter)	Mill Cove	$8,246,000	$5,078,967
MC3	Trunk Sewer Upgrades (Sackville Trunk Upgrades to 1500mm diameter)	Mill Cove	$144,000	$59,129
MC4	Storage Tank	Mill Cove	$17,469,000	$13,628,951
MC5	Fish Hatchery Park Pumping Station Upgrade	Mill Cove	$10,529,000	$4,323,425
MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	Mill Cove	$1,090,000	$850,395
MC7	Mill Cove Wastewater Treatment Plant Capacity Upgrade	Mill Cove	$148,758,000	$61,083,106
MC8	I/I Reduction Program FMZ07, FMZ10, & FMZ40	Mill Cove	$9,288,248	$7,246,498
MC9	I/I Reduction Program FMZ02 & FMZ03	Mill Cove	$8,023,065	$6,259,429
MC10	Local network upgrades on Beaver Bank Rd. North on Glendale Dr.	Mill Cove	$2,086,000	$428,277
MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	Mill Cove	$1,490,000	$1,162,467
MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	Mill Cove	$1,667,000	$342,252
MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	Mill Cove	$845,000	$0
MC14	Local network upgrades on Hallmark Ave.	Mill Cove	$437,000	$0
MC15	Local Sewer Upgrades for Waterfront Drive	Mill Cove	$500,000	$0
MC16	Springfield Lake Connection to Sackville	Mill Cove	$6,226,000	$2,556,524

Preliminary RDC Program: Wastewater

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	$7,281,000	$2,989,729
WR2	WRWIP: Young Street Area Sewer Separation	Halifax	$21,879,000	$13,475,954
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	$14,752,000	$11,509,204
WR4	WRWIP: Linear Upsize - Quinpool Road	Halifax	$437,000	$0
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	$221,000	$0
WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	Halifax	$500,000	$390,090
WR7	WRWIP: Young Pumping Station Upgrade	Halifax	$2,169,000	$1,692,209
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	Halifax	$3,850,000	$1,580,889
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	Halifax	$15,491,589	$12,086,216
WR18	WRWIP: Fairview Cove Linear Upsize	Halifax	$19,781,000	$12,183,730
WR20	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	$2,997,000	$2,338,197
WR10	WRWIP: BLT WWTF Decommission - New Timberlea PS	BLT	$5,928,000	$4,624,902
WR11	WRWIP: BLT WWTF Decommission - New Timberlea Forcemain	BLT	$19,436,000	$15,163,563
WR12	WRWIP: BLT WWTF Decommission	BLT	$500,000	$390,090
WR14	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Pumping Station	BLT	$8,063,000	$6,290,585
WR15	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain	BLT	$9,026,000	$7,041,898
WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer (600mm)	BLT	$4,319,000	$3,369,594
WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer (1050mm)	BLT	$3,266,000	$2,548,065
WR17	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	$7,439,000	$5,803,753
WR19	WRWIP: Halifax Treatment Plant Capacity Upgrade	Halifax	$25,142,000	$19,615,266
WR8	WRWIP: New Fairfield Holding Tank	Halifax	$12,403,000	$5,092,928

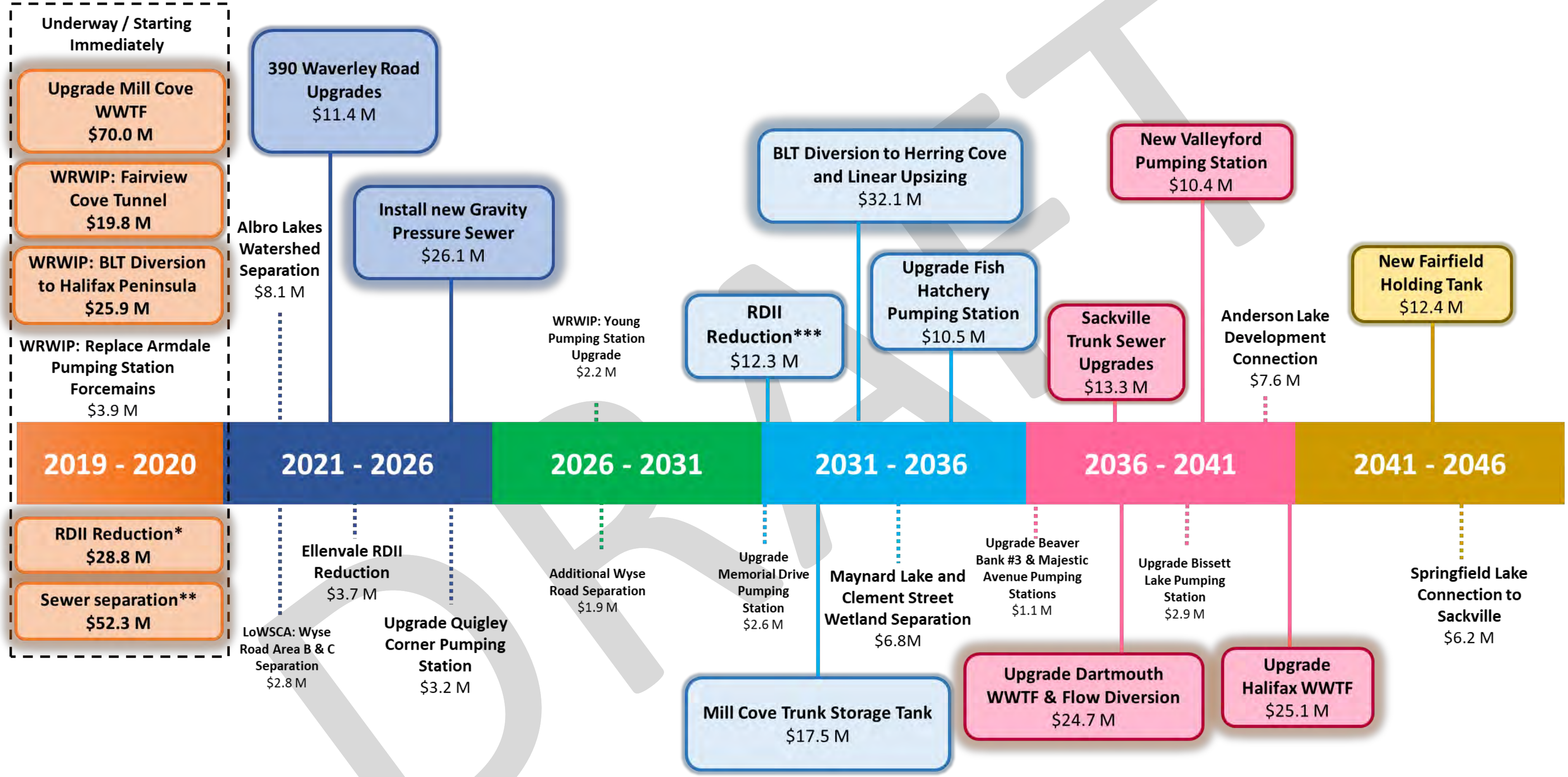
Preliminary RDC Program: Water

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
W06.1	Chain Control Transmission - Existing Peninsula Low Upsize	Pockwock - Peninsula	$3,841,000	$2,365,791
W06.2	Chain Control Transmission - Existing Peninsula Intermediate Upsize	Pockwock - Peninsula	$2,650,000	$1,632,217
W06.3	Pepperell Transmission	Pockwock - Peninsula	$2,702,000	$1,664,245
W06.4	Chain Control Transmission - Existing Peninsula Low Lining	Pockwock - Peninsula	$2,916,000	$1,796,055
W06.5	Chain Control Transmission - Valve Chambers	Pockwock - Peninsula	$1,258,000	$774,841
W07	Replace High Risk Peninsula Transmission (Robie)	Pockwock - Peninsula	$17,312,000	$0
W08	Peninsula Intermediate Looping - Quinpool Rd to Young St	Pockwock - Peninsula	$4,319,000	$2,660,206
W10.1	Young St Upsize	Pockwock - Peninsula	$1,315,000	$809,949
W10.2	Robie St Upsize	Pockwock - Peninsula	$956,000	$588,830
W10.3	Almon St Upsize	Pockwock - Peninsula	$1,168,000	$719,407
W10.4	Windsor St Upsize	Pockwock - Peninsula	$1,004,000	$618,395
W01.1	Geizer 158 to Lakeside High Looping	Pockwock - Other	$2,249,000	$0
W01.2	Gravity Supply to Brunello	Pockwock - Other	$2,328,000	$0
W01.3	Dominion Cres Upsize	Pockwock - Other	$447,000	$0
W01.4	Brunello Booster Pump Upgrades	Pockwock - Other	$236,000	$0
W02	Geizer 158 Looping - Lacewood Dr	Pockwock - Other	$2,002,000	$0
W03	Geizer Hill Booster Pump Upgrades	Pockwock - Other	$277,000	$0
W04	Leiblin Booster Fire Pump	Pockwock - Other	$395,000	$0
W05.1	Herring Cove Rd Twinning	Pockwock - Other	$3,585,000	$0
W05.2	St Michaels Ave Upsize	Pockwock - Other	$502,000	$0
W05.3	Herring Cove Rd Looping - McIntosh St	Pockwock - Other	$2,272,000	$0
W12.1	Lucasville Rd Twinning (Phase 1)	Pockwock - Other	$8,117,000	$6,666,016
W12.2	Lucasville Rd Twinning (Phase 2)	Pockwock - Other	$7,994,000	$6,565,003
W13.1	New Primary Feed to Sackville High	Pockwock - Other	$4,953,000	$4,067,608
W13.2	New Sackville Beaver Bank Valve Chamber	Pockwock - Other	$839,000	$689,021
W13.3	Reconfiguration of Beaver Bank Booster	Pockwock - Other	$100,000	$0
W13.4	New Sackville High PRV	Pockwock - Other	$420,000	$344,921
W14.1	Cobequid High Looping	Pockwock - Other	$2,233,000	$1,375,374
W14.2	Windgate Dr Upsize	Pockwock - Other	$882,000	$543,251
W15	Lively Booster Pump Upgrades	Pockwock - Other	$38,000	$0
W16	New Hemlock Elevated Tank	Pockwock - Other	$6,209,000	$2,070,499
W17	Pockwock Transmission Loop through Bedford	Pockwock - Other	$5,069,000	$0
W20	Second Geizer 158 Feed	Pockwock - Other	$9,612,000	$0

Preliminary RDC Program: Water

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
W22.1	New Main Street to Caledonia Road Connection	Lake Major	$3,512,000	$0
W22.2	Caledonia Rd Twinning	Lake Major	$3,429,000	$0
W22.3	New Breeze Dr Watermain	Lake Major	$5,801,000	$0
W23	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	Lake Major	$3,740,000	$0
W24	Windmill Rd Upsize	Lake Major	$6,104,000	$3,759,643
W25	New Woodside Industrial Park Feed	Lake Major	$1,649,000	$0
W26	Willowdale to Eastern Passage Connection	Lake Major	$6,290,000	$0
W28	Tacoma PRV Chamber	Lake Major	$420,000	$0
W19.1	Pockwock Transmission Twinning - 60in	System Interconnections Pockwock Transmission WTP Decommissioning	$65,516,000	$19,853,518
W19.2	Pockwock Transmission Twinning - 54in	System Interconnections Pockwock Transmission WTP Decommissioning	$16,228,000	$4,917,622
W21	Extension to Springfield Lake	System Interconnections Pockwock Transmission WTP Decommissioning	$3,478,000	$0
W29.1	Bedford-Burnside System Interconnection (Phase 1)	System Interconnections Pockwock Transmission WTP Decommissioning	$21,800,000	$8,421,079
W29.2	Bedford-Burnside System Interconnection (Phase 2)	System Interconnections Pockwock Transmission WTP Decommissioning	$11,779,000	$4,550,087
W30.1	Lyle Emergency Booster	System Interconnections Pockwock Transmission WTP Decommissioning	$1,045,000	$403,671
W30.2	Valving for Central Intermediate Boundary Change	System Interconnections Pockwock Transmission WTP Decommissioning	$629,000	$242,975
W31.1	Extension of Fall River to Bennery Lake (Phase 1)	System Interconnections Pockwock Transmission WTP Decommissioning	$8,067,000	$4,903,989
W31.2	Extension of Fall River to Bennery Lake (Phase 2)	System Interconnections Pockwock Transmission WTP Decommissioning	$9,156,000	$5,566,000
W31.3	Extension of Fall River to Bennery Lake (PS)	System Interconnections Pockwock Transmission WTP Decommissioning	$1,310,000	$796,359
W32.1	Decommission Miller Lake WSP - Linear	System Interconnections Pockwock Transmission WTP Decommissioning	$628,000	$0
W32.2	Decommission Miller Lake WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$61,000	$0
W33.1	Decommission Collins Park WSP - Linear	System Interconnections Pockwock Transmission WTP Decommissioning	$1,086,000	$0
W33.2	Decommission Collins Park WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$168,000	$0
W34.1	Decommission Silversands WSP - Linear	System Interconnections Pockwock Transmission WTP Decommissioning	$1,931,000	$0
W34.2	Decommission Silversands WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$168,000	$0
W40	Aerotech Storage	System Interconnections Pockwock Transmission WTP Decommissioning	$4,752,000	$2,926,904
W18	Chain Lake Backup Supply Study	Studies	$50,000	$20,531
W27	Mt Edward Booster Fire Pump	Studies	$50,000	$20,531
W29.3	New Orchard Control Chamber	Studies	$50,000	$20,531
W30.3	Robie Emergency Booster	Studies	$50,000	$20,531
W35	Safe Yield Study	Studies	$100,000	$41,062
W36	New Hydraulic Water Model (InfoWater)	Studies	$200,000	$82,124
W37	Comprehensive PRV Study	Studies	$50,000	$20,531
W38	Transmission Main Risk Assessment and Prioritization Framework	Studies	$50,000	$20,531
W39	Tomahawk Lake Supply Study	Studies	$50,000	$20,531

WASTEWATER CAPITAL PROGRAM TIMELINE 2019-2046



Underway / Starting Immediately

Upgrade Mill Cove WWTF
$70.0 M

WRWIP: Fairview Cove Tunnel
$19.8 M

WRWIP: BLT Diversion to Halifax Peninsula
$25.9 M

WRWIP: Replace Armdale Pumping Station Forcemains
$3.9 M

RDII Reduction*
$28.8 M

Sewer separation**
$52.3 M

2019 - 2020

2021 - 2026

390 Waverley Road Upgrades
$11.4 M

Albro Lakes Watershed Separation
$8.1 M

Install new Gravity Pressure Sewer
$26.1 M

LoWSCA: Wyse Road Area B & C Separation
$2.8 M

Ellenvale RDII Reduction
$3.7 M

Upgrade Quigley Corner Pumping Station
$3.2 M

2026 - 2031

WRWIP: Young Pumping Station Upgrade
$2.2 M

Additional Wyse Road Separation
$1.9 M

2031 - 2036

RDII Reduction***
$12.3 M

BLT Diversion to Herring Cove and Linear Upsizing
$32.1 M

Upgrade Fish Hatchery Pumping Station
$10.5 M

Upgrade Memorial Drive Pumping Station
$2.6 M

Mill Cove Trunk Storage Tank
$17.5 M

Maynard Lake and Clement Street Wetland Separation
$6.8M

2036 - 2041

Sackville Trunk Sewer Upgrades
$13.3 M

New Valleyford Pumping Station
$10.4 M

Anderson Lake Development Connection
$7.6 M

Upgrade Beaver Bank #3 & Majestic Avenue Pumping Stations
$1.1 M

Upgrade Dartmouth WWTF & Flow Diversion
$24.7 M

Upgrade Bissett Lake Pumping Station
$2.9 M

Upgrade Halifax WWTF
$25.1 M

2041 - 2046

New Fairfield Holding Tank
$12.4 M

Springfield Lake Connection to Sackville
$6.2 M

Studies and minor works

- Additional flow monitoring in Dartmouth (2019)
- Dartmouth CSO Management Plan (2036)
- Upgrade Anderson Pumping Station (2031)
- Upgrade Beaver Crescent Pumping Station (2036)
- Upgrade Caldwell Road Pumping Station (2039)

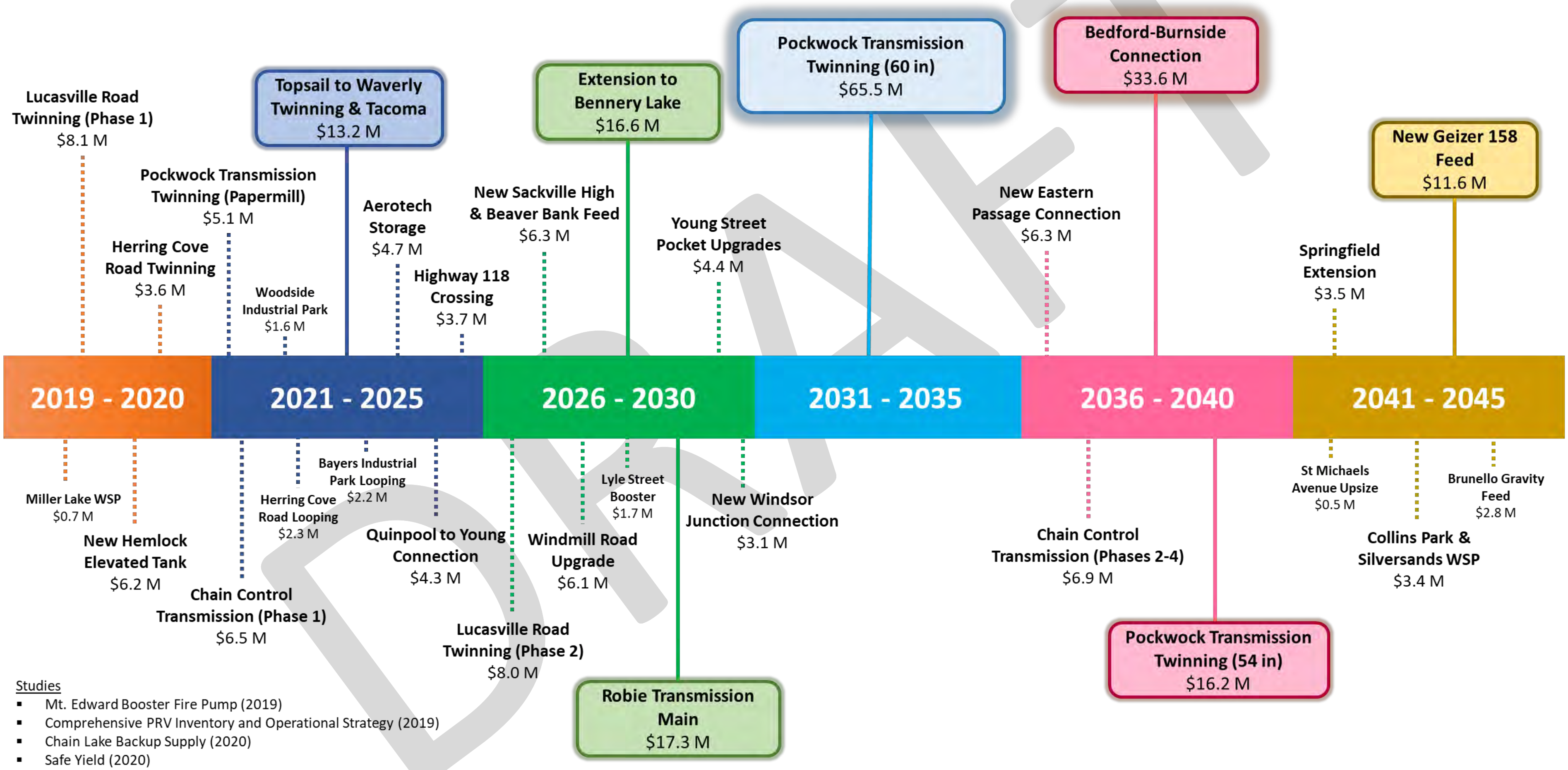
━━━ Capital Project ≥ $10 M ┈┈┈ Capital Project < $10 M

- *Including: Central (Lower Sackville and Bedford Common area), East (Loon Lake area, Eastern Passage area) and West (Bridgeview, Clayton Park and Fairview)*

*** Including: East (LoWSCA: Canal Street and Wyse Road Area A) and West (LoWSCA: Spring Garden Area and Young Street Area and Upstream of Kempt CSO)*

**** Including: Central (Glen Moir and Millview area) East (Cole Harbour and Woodside areas)*

WATER CAPITAL PROGRAM TIMELINE 2019-2046



Lucasville Road Twinning (Phase 1)
$8.1 M

Topsail to Waverly Twinning & Tacoma
$13.2 M

Pockwock Transmission Twinning (Papermill)
$5.1 M

Herring Cove Road Twinning
$3.6 M

Woodside Industrial Park
$1.6 M

Aerotech Storage
$4.7 M

Highway 118 Crossing
$3.7 M

New Sackville High & Beaver Bank Feed
$6.3 M

Extension to Bennery Lake
$16.6 M

Young Street Pocket Upgrades
$4.4 M

Pockwock Transmission Twinning (60 in)
$65.5 M

New Eastern Passage Connection
$6.3 M

Bedford-Burnside Connection
$33.6 M

Springfield Extension
$3.5 M

New Geizer 158 Feed
$11.6 M

2019 - 2020

2021 - 2025

2026 - 2030

2031 - 2035

2036 - 2040

2041 - 2045

Miller Lake WSP
$0.7 M

New Hemlock Elevated Tank
$6.2 M

Chain Control Transmission (Phase 1)
$6.5 M

Herring Cove Road Looping
$2.3 M

Bayers Industrial Park Looping
$2.2 M

Quinpool to Young Connection
$4.3 M

Lucasville Road Twinning (Phase 2)
$8.0 M

Windmill Road Upgrade
$6.1 M

Lyle Street Booster
$1.7 M

Robie Transmission Main
$17.3 M

New Windsor Junction Connection
$3.1 M

Chain Control Transmission (Phases 2-4)
$6.9 M

Pockwock Transmission Twinning (54 in)
$16.2 M

St Michaels Avenue Upsize
$0.5 M

Collins Park & Silversands WSP
$3.4 M

Brunello Gravity Feed
$2.8 M

Studies
- Mt. Edward Booster Fire Pump (2019)
- Comprehensive PRV Inventory and Operational Strategy (2019)
- Chain Lake Backup Supply (2020)
- Safe Yield (2020)
- New Hydraulic Water Model (2020)
- Transmission Main Risk Assessment and Prioritization Framework (2020)
- New Orchard Control Chamber (2021)
- Robie Emergency Booster (2021)
- Tomahawk Lake Supply (2036)

Pump Upgrades
- Leiblin (2019)
- Brunello (2021-2025)
- Geizer Hill (2021-2025)
- Lively (2036-2040)

━━━ Capital Project ≥ $10 M

┅┅┅ Capital Project < $10 M

Preliminary RDC Criteria and Rate: Wastewater

WASTEWATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	192,315
Total Residential Growth	94,800	94,800	119,409
% Residential Growth	68.5%	68.5%	62.1%
Total Employment Growth	43,530	43,530	72,906
% Employment Growth	31.5%	31.5%	37.9%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.1%
2046 Capital Program	$ 645,257,222	$ 741,197,723	$ 576,339,588
20 year Capital Program	$ 450,518,078	$ 517,503,659	$ 552,363,588
Total Post Period and BTE ($)	$ 240,897,047	$ 276,714,985	$ 220,243,805
Total Res & Emp RDC Program ($)	$ 209,621,031	$ 240,788,674	$ 332,119,783
Total Residential RDC Program ($)	$ 132,710,213	$ 152,442,320	$ 206,214,238
SUD RDC Rate ($/unit)	$ 4,081	$ 4,688	$ 4,847
MUD RDC Rate ($/unit)	$ 2,741	$ 3,148	$ 3,256
Total Employment RDC Program ($)	$ 76,910,818	$ 88,346,354	$ 125,905,545
RDC Rate ($/sqft)	$ 2.24	$ 2.57	$ 2.36

Preliminary RDC Criteria and Rate: Water

WATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	192,315
Total Residential Growth	94,800	94,800	119,409
% Residential Growth	68.5%	68.5%	62.1%
Total Employment Growth	43,530	43,530	72,906
% Employment Growth	31.5%	31.5%	37.9%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.1%
2046 Capital Program	$ 51,225,710	$ 58,842,239	$ 279,597,000
20 year Capital Program	$ 38,577,400	$ 44,313,306	$ 257,875,000
Total Post Period and BTE ($)	$ 29,454,748	$ 33,834,247	$ 165,314,620
Total Res & Emp RDC Program ($)	$ 9,122,652	$ 10,479,059	$ 92,560,380
Total Residential RDC Program ($)	$ 5,947,407	$ 6,831,701	$ 57,471,037
SUD RDC Rate ($/unit)	$ 183	$ 210	$ 1,351
MUD RDC Rate ($/unit)	$ 123	$ 141	$ 907
Total Employment RDC Program ($)	$ 3,175,245	$ 3,647,358	$ 35,089,343
RDC Rate ($/sqft)	$ 0.09	$ 0.10	$ 0.66

Preliminary RDC Rate Refinement

- Following the preliminary rate development through the water and wastewater analysis, additional financial reconciliation is required
- Areas for review include:
    - RDC collections to date
    - Project completion and funding provided to date
    - Costing indexing and escalation
    - Interest reconciliation
    - Review of the rate of development and program implementation relative to projections
- May result in an increase to the preliminary rate as shown through the water and wastewater analysis

Schedule and Next Steps

Schedule and Next Steps

One on One Stakeholder Meetings	August 23 – September 13, 2019
Stakeholder Meeting #2b (repeat)	September 12, 2019
Stakeholder Meeting #3	September 27, 2019
Halifax Water Special Board Meeting	October 31, 2019
RDC Application	November 1, 2019
RDC Application Information Request	November 1, 2019 – February 7, 2020
Application NSUARB Hearing	February 10 – February 14, 2020

Implementation and Application

Questions and Discussion

Regional Development Charge:

Stakeholder Update Meeting, September 27th, 2019

Meeting Summary Information

Prepared by

GM BluePlan for:

Halifax Water

Project No. 719008

September 2019

Wastewater RDC 2019 Program

Wastewater

Total 2046 Capital Program	$ 572,311,009
Total 2041 Capital Program	$ 548,894,009
Funding Subsidy	$ -
Benefit to Existing (BTE)	$ 162,411,290
Post Period Benefit	$ 69,613,190
Total Adjusted RDC Program	$ 316,869,530
Total Growth	172,420
Residential Growth	105,244
Residential Share (%)	61%
Employment Growth	67,176
Employment Share (%)	39%
Residential RDC Program	$ 193,415,014
Employment RDC Program	$ 123,454,515

												2016-2041			
												61%	39%		
Project ID	**Project Description**	**System**	**Projects Cost $ (2019)**	**Eligible RDC (Growth) (%)**	**Non-Eligible RDC (BTE/Local) (%)**	**Non-Eligible RDC Cost (BTE/Local) $ (2019)**	**Eligible RDC Cost (Growth) $ (2019)**	**Post Period Benefit (%)**	**Post Period Benefit $ (2019)**	**Adjusted RDC $ (2019)**	**Res RDC $ (2019)**	**Non-Res RDC $ (2019)**	**Period Req'd**	**Within RDC Horizon (Included/Not Included)**	
AT2	Upgrade WWTF to service employment growth flows	Aerotech	$9,997,476	90%	10%	$999,748	$8,997,728	18%	$1,620,669	$7,377,059	$4,502,907	$2,874,152	2016-2021	Included	
D1	LoWSCA: Canal Street Separation	Dartmouth	$1,842,000	75%	25%	$460,500	$1,381,500	18%	$248,836	$1,132,664	$691,371	$441,294	2016-2021	Included	
D2a	LoWSCA: Wyse Road Separation - Phase 1	Dartmouth	$3,860,000	75%	25%	$965,000	$2,895,000	18%	$521,447	$2,373,553	$1,448,801	$924,752	2016-2021	Included	
D2b	LoWSCA: Wyse Road Separation - Phase 2	Dartmouth	$2,802,000	25%	75%	$2,101,500	$700,500	18%	$126,174	$574,326	$350,565	$223,761	2021-2026	Included	
D3	Additional Sewer Separation on Wyse Street	Dartmouth	$1,912,000	75%	25%	$478,000	$1,434,000	18%	$258,292	$1,175,708	$717,644	$458,064	2026-2031	Included	
D5	Albro Lakes Watershed Separation	Dartmouth	$8,111,000	95%	5%	$405,550	$7,705,450	18%	$1,387,904	$6,317,546	$3,856,187	$2,461,359	2021-2026	Included	
D6a-D6d	Maynard Lake and Clement Street Wetland Separation	Dartmouth	$6,790,000	95%	5%	$339,500	$6,450,500	18%	$1,161,863	$5,288,637	$3,228,148	$2,060,489	2026-2036	Included	
D7	New Valleyford Pumping Station	Dartmouth	$10,446,000	25%	75%	$7,834,500	$2,611,500	18%	$470,383	$2,141,117	$1,306,923	$834,194	2036-2041	Included	
D8	390 Waverley Road Upgrades	Dartmouth	$11,361,000	100%	0%	$0	$11,361,000	18%	$2,046,341	$9,314,659	$5,685,605	$3,629,054	2021-2026	Included	
D9	Anderson Pumping Station Upgrades	Dartmouth	$340,000	0%	100%	$340,000	$0	0%	$0	$0	$0	$0	2031-2036	Included	
D10	Upgrades to Dartmouth WWTF	Dartmouth	$12,572,000	100%	0%	$0	$12,572,000	18%	$2,264,466	$10,307,534	$6,291,649	$4,015,885	2036-2041	Included	
D11	I/I Reduction Program FMZ27	Dartmouth	$5,941,076	75%	25%	$1,485,269	$4,455,807	18%	$802,579	$3,653,228	$2,229,906	$1,423,322	2021-2026	Included	
D12	I/I Reduction Program FMZ45	Dartmouth	$1,120,232	95%	5%	$56,012	$1,064,220	18%	$191,687	$872,533	$532,588	$339,945	2031-2036	Included	
D13	Additional flow monitoring	Dartmouth	$420,000	10%	90%	$378,000	$42,000	18%	$7,565	$34,435	$21,019	$13,416	2016-2021	Included	
D14	CSO Flow Management Plan	Dartmouth	$675,000	10%	90%	$607,500	$67,500	18%	$12,158	$55,342	$33,780	$21,562	2036-2041	Included	
D15	Green St Upsize	Dartmouth	$513,000	0%	100%	$513,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included	
D16	Pinecrest Dr Upgrade	Dartmouth	$1,013,000	0%	100%	$1,013,000	$0	0%	$0	$0	$0	$0	2031-2036	Included	
D17	Peddars Way Upgrade	Dartmouth	$555,000	0%	100%	$555,000	$0	0%	$0	$0	$0	$0	2031-2036	Included	
D18	Atlantic Street Upgrade	Dartmouth	$3,831,000	0%	100%	$3,831,000	$0	0%	$0	$0	$0	$0	2021-2026	Included	
D19	Akerley Blvd and Railway Alignment Upgrade	Dartmouth	$4,814,000	75%	25%	$1,203,500	$3,610,500	18%	$650,323	$2,960,177	$1,806,872	$1,153,305	2036-2041	Included	
D20	Pleasant Street Upgrade	Dartmouth	$767,000	0%	100%	$767,000	$0	0%	$0	$0	$0	$0	2021-2026	Included	
D21	Princess Margaret Blvd. Upgrade	Dartmouth	$3,106,000	0%	100%	$3,106,000	$0	0%	$0	$0	$0	$0	2031-2036	Included	
D22	Anderson Lake Development Connection	Dartmouth	$7,609,000	100%	0%	$0	$7,609,000	18%	$1,370,532	$6,238,468	$3,807,919	$2,430,550	2036-2041	Included	
D23	Marvin Connection	Dartmouth	$1,380,000	5%	95%	$1,311,000	$69,000	18%	$12,428	$56,572	$34,531	$22,041	2026-2031	Included	
D24	King Street Diversion	Dartmouth	$78,000	5%	95%	$74,100	$3,900	18%	$702	$3,198	$1,952	$1,246	2026-2031	Included	
D25	Diversion to Eastern Passage	Dartmouth	$12,113,000	100%	0%	$0	$12,113,000	18%	$2,181,791	$9,931,209	$6,061,943	$3,869,266	2036-2041	Included	
D26	SSO Flow Management Plan	Dartmouth	$555,000	0%	100%	$555,000	$0	0%	$0	$0	$0	$0	2016-2021	Included	
EP1-EP5	Gravity pressure sewer, pump out stations, surge tank gate valve, forcemain connections	Eastern Passage	$26,105,000	75%	25%	$6,526,250	$19,578,750	18%	$3,526,521	$16,052,229	$9,798,172	$6,254,057	2026-2031	Included	
EP6	Upgrade Quigley's Corner Pumping Station	Eastern Passage	$2,875,000	5%	95%	$2,731,250	$143,750	18%	$25,892	$117,858	$71,940	$45,918	2021-2026	Included	
EP7	Optimize Quigley's Corner PS	Eastern Passage	$336,000	5%	95%	$319,200	$16,800	18%	$3,026	$13,774	$8,408	$5,366	2021-2026	Included	
EP8	Upgrade Memorial Drive Pumping Station	Eastern Passage	$2,633,000	0%	100%	$2,633,000	$0	0%	$0	$0	$0	$0	2031-2036	Included	
EP9	Upgrade Beaver Crescent Pumping Station	Eastern Passage	$168,000	0%	100%	$168,000	$0	0%	$0	$0	$0	$0	2036-2041	Included	
EP10	Upgrade Bissett Lake Pumping Station	Eastern Passage	$2,934,000	50%	50%	$1,467,000	$1,467,000	18%	$264,236	$1,202,764	$734,159	$468,605	2036-2041	Included	
EP11	Upgrade Caldwell Road Pumping Station	Eastern Passage	$631,000	75%	25%	$157,750	$473,250	18%	$85,242	$388,008	$236,838	$151,171	2036-2041	Included	
EP12	I/I Reduction Program FMZ23	Eastern Passage	$3,204,580	95%	5%	$160,229	$3,044,351	18%	$548,348	$2,496,003	$1,523,543	$972,460	2031-2036	Included	
EP13	I/I Reduction Program FMZ24	Eastern Passage	$1,570,040	95%	5%	$78,502	$1,491,538	18%	$268,656	$1,222,882	$746,439	$476,443	2016-2021	Included	
EP14	I/I Reduction Program FMZ37	Eastern Passage	$2,479,704	95%	5%	$123,985	$2,355,718	18%	$424,312	$1,931,407	$1,178,918	$752,489	2016-2021	Included	
EP15	Local network upgrades on Caldwell Road	Eastern Passage	$607,000	75%	25%	$151,750	$455,250	18%	$82,000	$373,250	$227,830	$145,421	2036-2041	Included	
EP16	Local network upgrades on Colby Drive	Eastern Passage	$1,176,000	0%	100%	$1,176,000	$0	0%	$0	$0	$0	$0	2031-2061	Included	
EP17	Local network upgrades on Forest Hill Parkway	Eastern Passage	$4,275,000	0%	100%	$4,275,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included	
EP18	SSO Management Study	Eastern Passage	$484,000	0%	100%	$484,000	$0	0%	$0	$0	$0	$0	2021-2026	Included	

Wastewater RDC 2019 Program

Project ID	Project Description	System	Projects Cost $ (2019)	Eligible RDC (Growth) (%)	Non-Eligible RDC (BTE/Local) (%)	Non-Eligible RDC Cost (BTE/Local) $ (2019)	Eligible RDC Cost (Growth) $ (2019)	Post Period Benefit (%)	Post Period Benefit $ (2019)	Adjusted RDC $ (2019)	Res RDC $ (2019)	Non-Res RDC $ (2019)	Period Req'd	Within RDC Horizon (Included/Not Included)
MC1-MC3	Trunk Sewer Upgrades (Sackville Trunk Upgrades)	Mill Cove	$13,491,000	75%	25%	$3,372,750	$10,118,250	18%	$1,822,497	$8,295,753	$5,063,671	$3,232,082	2036-2041	Included
MC4	Storage Tank	Mill Cove	$17,469,000	95%	5%	$873,450	$16,595,550	18%	$2,989,187	$13,606,363	$8,305,232	$5,301,131	2031-2036	Included
MC5	Fish Hatchery Park Pumping Station Upgrade	Mill Cove	$10,529,000	50%	50%	$5,264,500	$5,264,500	18%	$948,241	$4,316,259	$2,634,615	$1,681,644	2031-2036	Included
MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	Mill Cove	$1,090,000	0%	100%	$1,090,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC7	Mill Cove Wastewater Treatment Plant Capacity Upgrade	Mill Cove	$148,758,000	50%	50%	$74,379,000	$74,379,000	18%	$13,397,131	$60,981,869	$37,222,920	$23,758,949	2016-2021	Included
MC8	I/I Reduction Program FMZ07, FMZ10, & FMZ40	Mill Cove	$9,288,248	95%	5%	$464,412	$8,823,836	18%	$1,589,348	$7,234,488	$4,415,883	$2,818,606	2016-2021	Included
MC9	I/I Reduction Program FMZ02 & FMZ03	Mill Cove	$8,023,065	95%	5%	$401,153	$7,621,912	18%	$1,372,857	$6,249,055	$3,814,381	$2,434,674	2031-2036	Included
MC10	Local network upgrades on Beaver Bank Rd. North on Glendale Dr.	Mill Cove	$2,086,000	0%	100%	$2,086,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	Mill Cove	$1,490,000	0%	100%	$1,490,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	Mill Cove	$1,667,000	0%	100%	$1,667,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	Mill Cove	$845,000	0%	100%	$845,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC14	Local network upgrades on Hallmark Ave.	Mill Cove	$437,000	0%	100%	$437,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC15	Local Sewer Upgrades for Waterfront Drive	Mill Cove	$500,000	0%	100%	$500,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC16	Springfield Lake Connection to Sackville	Mill Cove	$6,226,000	50%	50%	$3,113,000	$3,113,000	18%	$560,713	$2,552,287	$1,557,899	$994,388	2041-2046	Not Included
MC17	SSO Management Study	Mill Cove	$1,086,000	0%	100%	$1,086,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	$7,281,000	50%	50%	$3,640,500	$3,640,500	18%	$655,726	$2,984,774	$1,821,886	$1,162,888	2016-2021	Included
WR2	WRWIP: Young Street Area Sewer Separation	Halifax	$21,879,000	75%	25%	$5,469,750	$16,409,250	18%	$2,955,631	$13,453,619	$8,211,998	$5,241,621	2016-2021	Included
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	$14,752,000	95%	5%	$737,600	$14,014,400	18%	$2,524,271	$11,490,129	$7,013,497	$4,476,632	2016-2021	Included
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	$221,000	0%	100%	$221,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
WR7	WRWIP: Young Pumping Station Upgrade	Halifax	$2,169,000	95%	5%	$108,450	$2,060,550	18%	$371,146	$1,689,404	$1,031,201	$658,203	2026-2031	Included
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	Halifax	$3,850,000	50%	50%	$1,925,000	$1,925,000	18%	$346,731	$1,578,269	$963,365	$614,904	2016-2021	Included
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	Halifax	$15,491,589	95%	5%	$774,579	$14,717,009	18%	$2,650,825	$12,066,185	$7,365,117	$4,701,067	2016-2021	Included
WR19	WRWIP: Fairview Cove Linear Upsize	Halifax	$19,781,000	75%	25%	$4,945,250	$14,835,750	18%	$2,672,212	$12,163,538	$7,424,541	$4,738,997	2016-2021	Included
WR21	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	$2,997,000	95%	5%	$149,850	$2,847,150	18%	$512,828	$2,334,322	$1,424,854	$909,468	2031-2036	Included
WR10-WR12	WRWIP: BLT WWTF Decommission and new Timberlea PS & Forcemain	BLT	$25,864,000	95%	5%	$1,293,200	$24,570,800	18%	$4,425,688	$20,145,112	$12,296,440	$7,848,672	2016-2021	Included
WR14-WR17	WRWIP: BLT Flow Diversion to Herring Cove	BLT	$24,674,000	95%	5%	$1,233,700	$23,440,300	18%	$4,222,062	$19,218,238	$11,730,682	$7,487,556	2031-2036	Included
WR18	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	$7,439,000	95%	5%	$371,950	$7,067,050	18%	$1,272,916	$5,794,134	$3,536,700	$2,257,434	2031-2036	Included
WR22	Infrastructure Master Plan: CSO Management Study	Halifax	$965,000	10%	90%	$868,500	$96,500	18%	$17,382	$79,118	$48,293	$30,825	2016-2021	Included
WR23	Infrastructure Master Plan: SSO Management Study	Halifax	$415,000	0%	100%	$415,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
WR20	WRWIP: Halifax Treatment Plant Capacity Upgrade	Halifax	$25,142,000	95%	5%	$1,257,100	$23,884,900	18%	$4,302,143	$19,582,757	$11,953,182	$7,629,575	2036-2041	Included
WR8	WRWIP: New Fairfield Holding Tank	Halifax	$12,403,000	50%	50%	$6,201,500	$6,201,500	18%	$1,117,013	$5,084,487	$3,103,536	$1,980,951	2041-2046	Not Included
		TOTAL 2046 Projects	**$572,311,009**			**$176,513,790**	**$395,797,220**		**$71,290,916**	**$324,506,304**	**$198,076,450**	**$126,429,854**		
		TOTAL Post 2041 Projects	**$23,417,000**			**$14,102,500**	**$9,314,500**		**$1,677,726**	**$7,636,774**	**$4,661,435**	**$2,975,339**		
		TOTAL 2041 Projects	**$548,894,009**			**$162,411,290**	**$386,482,720**		**$69,613,190**	**$316,869,530**	**$193,415,014**	**$123,454,515**		

Water RDC 2019 Program

Water

Total 2046 Capital Program	$	279,597,000
Total 2041 Capital Program	$	257,875,000
Funding Subsidy	$	-
Benefit to Existing (BTE)	$	147,688,285
Post Period Benefit	$	19,846,809
Total Adjusted RDC Program	$	90,339,906
Total Growth		172,420
Residential Growth		105,244
Residential Share (%)		61%
Employment Growth		67,176
Employment Share (%)		39%
Residential RDC Program	$	55,142,867
Employment RDC Program	$	35,197,039

											2016-2041			
											61%	39%		
Project ID	**Project Description**	**System**	**Projects Cost $ (2019)**	**Eligible RDC (Growth) (%)**	**Non-Eligible RDC (BTE/Local) (%)**	**Non-Eligible RDC Cost (BTE/Local) $ (2019)**	**Eligible RDC Cost (Growth) $ (2019)**	**Post Period Benefit (%)**	**Post Period Benefit $ (2019)**	**Adjusted RDC $ (2019)**	**Res RDC $ (2019)**	**Non-Res RDC $ (2019)**	**Period Req'd**	**Within RDC Horizon (Included/Not Included)**
W06.1	Chain Control Transmission - Existing Peninsula Low Upsize	Pockwock - Peninsula	$3,841,000	75%	25%	$960,250	$2,880,750	18%	$518,880	$2,361,870	$1,441,669.38	$920,200.51	2021-2026	Included
W06.2	Chain Control Transmission - Existing Peninsula Intermediate Upsize	Pockwock - Peninsula	$2,650,000	75%	25%	$662,500	$1,987,500	18%	$357,988	$1,629,512	$994,643.02	$634,869	2021-2026	Included
W06.3	Pepperell Transmission	Pockwock - Peninsula	$2,702,000	75%	25%	$675,500	$2,026,500	18%	$365,013	$1,661,487	$1,014,161	$647,327	2036-2041	Included
W06.4	Chain Control Transmission - Existing Peninsula Low Lining	Pockwock - Peninsula	$2,916,000	75%	25%	$729,000	$2,187,000	18%	$393,922	$1,793,078	$1,094,483	$698,595	2036-2041	Included
W06.5	Chain Control Transmission - Valve Chambers	Pockwock - Peninsula	$1,258,000	75%	25%	$314,500	$943,500	18%	$169,943	$773,557	$472,174	$301,383	2036-2041	Included
W07	Replace High Risk Peninsula Transmission (Robie)	Pockwock - Peninsula	$17,312,000	0%	100%	$17,312,000	$0	0%	$0	$0	$0	$0	2026-2031	Included
W08	Peninsula Intermediate Looping - Quinpool Rd to Young St	Pockwock - Peninsula	$4,319,000	75%	25%	$1,079,750	$3,239,250	18%	$583,453	$2,655,797	$1,621,080	$1,034,716	2021-2026	Included
W10.1	Young St Upsize	Pockwock - Peninsula	$1,315,000	75%	25%	$328,750	$986,250	18%	$177,643	$808,607	$493,568	$315,039	2026-2031	Included
W10.2	Robie St Upsize	Pockwock - Peninsula	$956,000	75%	25%	$239,000	$717,000	18%	$129,146	$587,854	$358,822	$229,032	2026-2031	Included
W10.3	Almon St Upsize	Pockwock - Peninsula	$1,168,000	75%	25%	$292,000	$876,000	18%	$157,785	$718,215	$438,394	$279,821	2026-2031	Included
W10.4	Windsor St Upsize	Pockwock - Peninsula	$1,004,000	75%	25%	$251,000	$753,000	18%	$135,630	$617,370	$376,838	$240,531	2026-2031	Included
W01.1	Geizer 158 to Lakeside High Looping	Pockwock - Other	$2,249,000	0%	100%	$2,249,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W01.2	Gravity Supply to Brunello	Pockwock - Other	$2,328,000	0%	100%	$2,328,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W01.3	Dominion Cres Upsize	Pockwock - Other	$447,000	0%	100%	$447,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W01.4	Brunello Booster Pump Upgrades	Pockwock - Other	$236,000	0%	100%	$236,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W02	Geizer 158 Looping - Lacewood Dr	Pockwock - Other	$2,002,000	0%	100%	$2,002,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W03	Geizer Hill Booster Pump Upgrades	Pockwock - Other	$277,000	0%	100%	$277,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W04	Leiblin Booster Fire Pump	Pockwock - Other	$395,000	0%	100%	$395,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W05.1	Herring Cove Rd Twinning	Pockwock - Other	$3,585,000	0%	100%	$3,585,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W05.2	St Michaels Ave Upsize	Pockwock - Other	$502,000	0%	100%	$502,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W05.3	Herring Cove Rd Looping - McIntosh St	Pockwock - Other	$2,272,000	0%	100%	$2,272,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W12.1	Lucasville Rd Twinning (Phase 1)	Pockwock - Other	$8,117,000	100%	0%	$0	$8,117,000	18%	$1,462,032	$6,654,968	$4,062,147	$2,592,820	2016-2021	Included
W12.2	Lucasville Rd Twinning (Phase 2)	Pockwock - Other	$7,994,000	100%	0%	$0	$7,994,000	18%	$1,439,878	$6,554,122	$4,000,592	$2,553,530	2026-2031	Included
W13.1	New Primary Feed to Sackville High	Pockwock - Other	$4,953,000	100%	0%	$0	$4,953,000	18%	$892,133	$4,060,867	$2,478,725	$1,582,141	2026-2031	Included
W13.2	New Sackville Beaver Bank Valve Chamber	Pockwock - Other	$839,000	100%	0%	$0	$839,000	18%	$151,121	$687,879	$419,877	$268,003	2026-2031	Included
W13.3	Reconfiguration of Beaver Bank Booster	Pockwock - Other	$100,000	0%	100%	$100,000	$0	0%	$0	$0	$0	$0	2026-2031	Included
W13.4	New Sackville High PRV	Pockwock - Other	$420,000	100%	0%	$0	$420,000	18%	$75,650	$344,350	$210,189	$134,161	2026-2031	Included
W14.1	Cobequid High Looping	Pockwock - Other	$2,233,000	75%	25%	$558,250	$1,674,750	18%	$301,656	$1,373,094	$838,127	$534,967	2026-2031	Included
W14.2	Windgate Dr Upsize	Pockwock - Other	$882,000	75%	25%	$220,500	$661,500	18%	$119,149	$542,351	$331,047	$211,304	2026-2031	Included
W15	Lively Booster Pump Upgrades	Pockwock - Other	$38,000	0%	100%	$38,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
W17	Pockwock Transmission Loop through Bedford	Pockwock - Other	$5,069,000	0%	100%	$5,069,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W20	Second Geizer 158 Feed	Pockwock - Other	$9,612,000	0%	100%	$9,612,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included

Water RDC 2019 Program

Project ID	Project Description	System	Projects Cost $ (2019)	Eligible RDC (Growth) (%)	Non-Eligible RDC (BTE/Local) (%)	Non-Eligible RDC Cost (BTE/Local) $ (2019)	Eligible RDC Cost (Growth) $ (2019)	Post Period Benefit (%)	Post Period Benefit $ (2019)	Adjusted RDC $ (2019)	Res RDC $ (2019)	Non-Res RDC $ (2019)	Period Req'd	Within RDC Horizon (Included/Not Included)
W22.1	New Main Street to Caledonia Road Connection	Lake Major	$3,512,000	0%	100%	$3,512,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W22.2	Caledonia Rd Twinning	Lake Major	$3,429,000	0%	100%	$3,429,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W22.3	New Breeze Dr Watermain	Lake Major	$5,801,000	0%	100%	$5,801,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W23	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	Lake Major	$3,740,000	0%	100%	$3,740,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W24	Windmill Rd Upsize	Lake Major	$6,104,000	75%	25%	$1,526,000	$4,578,000	18%	$824,588	$3,753,412	$2,291,057	$1,462,355	2026-2031	Included
W25	New Woodside Industrial Park Feed	Lake Major	$1,649,000	0%	100%	$1,649,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W26	Willowdale to Eastern Passage Connection	Lake Major	$6,290,000	0%	100%	$6,290,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
W28	Tacoma PRV Chamber	Lake Major	$420,000	0%	100%	$420,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W19.1	Pockwock Transmission Twinning - 60in	System Interconnections Pockwock Transmission WTP Decommissioning	$65,516,000	37%	63%	$41,340,987	$24,175,013	18%	$4,354,398	$19,820,614	$12,098,369	$7,722,246	2031-2036	Included
W19.2	Pockwock Transmission Twinning - 54in		$16,228,000	37%	63%	$10,239,965	$5,988,035	18%	$1,078,564	$4,909,471	$2,996,708	$1,912,763	2036-2041	Included
W21	Extension to Springfield Lake		$3,478,000	0%	100%	$3,478,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W29.1-W29.2	Bedford-Burnside System Interconnection		$33,579,000	47%	53%	$17,784,414	$15,794,586	18%	$2,844,918	$12,949,668	$7,904,390	$5,045,278	2036-2041	Included
W30.1	Bedford-Burnside System Interconnection		$1,045,000	47%	53%	$553,462	$491,538	18%	$88,536	$403,002	$245,990	$157,012	2026-2031	Included
W30.2	Valving for Central Intermediate Boundary Change		$629,000	47%	53%	$333,137	$295,863	18%	$53,291	$242,572	$148,065	$94,508	2026-2031	Included
W31.1-W31.3	Extension of Fall River to Bennery Lake Airport System		$18,533,000	74%	26%	$4,814,320	$13,718,680	18%	$2,471,006	$11,247,674	$6,865,504	$4,382,170	2026-2031	Included
W32.1-W32.2	Decommission Miller Lake WSP		$689,000	0%	100%	$689,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W33.1-W33.2	Decommission Collins Park WSP		$1,254,000	0%	100%	$1,254,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W34.1-W34.2	Decommission Silversands WSP		$2,099,000	0%	100%	$2,099,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W40	Aerotech Storage		$4,752,000	75%	25%	$1,188,000	$3,564,000	18%	$641,947	$2,922,053	$1,783,601	$1,138,452	2021-2026	Included
W18	Chain Lake Backup Supply Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W27	Mt Edward Booster Fire Pump	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W29.3	New Orchard Control Chamber	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2021-2026	Included
W30.3	Robie Emergency Booster	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2021-2026	Included
W35	Safe Yield Study	Studies	$100,000	50%	50%	$50,000	$50,000	18%	$9,006	$40,994	$25,022	$15,972	2016-2021	Included
W36	New Hydraulic Water Model (InfoWater)	Studies	$200,000	50%	50%	$100,000	$100,000	18%	$18,012	$81,988	$50,045	$31,943	2016-2021	Included
W37	Comprehensive PRV Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W38	Transmission Main Risk Assessment and Prioritization Framework	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W39	Tomahawk Lake Supply Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2036-2041	Included
		TOTAL 2046 Projects	**$273,388,000**			**$163,201,285**	**$110,186,715**		**$19,846,809**	**$90,339,906**	**$55,142,867**	**$35,197,040**		
		TOTAL Post 2041 Projects	**$21,722,000**			**$21,722,000.00**	**$0**		**$0**	**$0**	**$0**	**$0**		
		TOTAL 2041 Projects	**$251,666,000**			**$141,479,285**	**$110,186,715**		**$19,846,809**	**$90,339,906**	**$55,142,867**	**$35,197,040**		

RDC Comparison 2012-2019

WASTEWATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	172,420
Total Residential Growth	94,800	94,800	105,244
% Residential Growth	68.5%	68.5%	61.0%
Total Employment Growth	43,530	43,530	67,176
% Employment Growth	31.5%	31.5%	39.0%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.0%
2046 Capital Program	$ 645,257,222	$ 741,197,723	$ 572,311,009
20 year Capital Program	$ 450,518,078	$ 517,503,659	$ 548,894,009
Total Post Period and BTE ($)	$ 240,897,047	$ 276,714,985	$ 232,024,480
Total Res & Emp RDC Program ($)	$ 209,621,031	$ 240,788,674	$ 316,869,530
Total Residential RDC Program ($)	$ 132,710,213	$ 152,442,320	$ 193,415,014
SUD RDC Rate ($/unit)	$ 4,081	$ 4,688	$ 5,158
MUD RDC Rate ($/unit)	$ 2,741	$ 3,148	$ 3,465
Total Employment RDC Program ($)	$ 76,910,818	$ 88,346,354	$ 123,454,515
RDC Rate ($/sqft)	$ 2.24	$ 2.57	$ 2.51

WATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	172,420
Total Residential Growth	94,800	94,800	105,244
% Residential Growth	68.5%	68.5%	61.0%
Total Employment Growth	43,530	43,530	67,176
% Employment Growth	31.5%	31.5%	39.0%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.0%
2046 Capital Program	$ 51,225,710	$ 58,842,239	$ 279,597,000
20 year Capital Program	$ 38,577,400	$ 44,313,306	$ 257,875,000
Total Post Period and BTE ($)	$ 29,454,748	$ 33,834,247	$ 167,535,093
Total Res & Emp RDC Program ($)	$ 9,122,652	$ 10,479,059	$ 90,339,907
Total Residential RDC Program ($)	$ 5,947,407	$ 6,831,701	$ 55,142,867
SUD RDC Rate ($/unit)	$ 183	$ 210	$ 1,471
MUD RDC Rate ($/unit)	$ 123	$ 141	$ 988
Total Employment RDC Program ($)	$ 3,175,245	$ 3,647,358	$ 35,197,040
RDC Rate ($/sqft)	$ 0.09	$ 0.10	$ 0.71

Halifax Water Regional Development Charge

RDC Stakeholder Meeting #3

September 27th, 2019

AGENDA

1. Meeting Objectives
2. Refresher
3. RDC Adjusted Inputs
4. Preferred RDC Program
5. Preferred RDC Rate
6. Schedule and Next Steps

Meeting Objectives:

1. Provide background on Inputs to the RDC Update
2. Present preferred RDC program and rate
3. Feedback, Information for review and next steps

Refresher

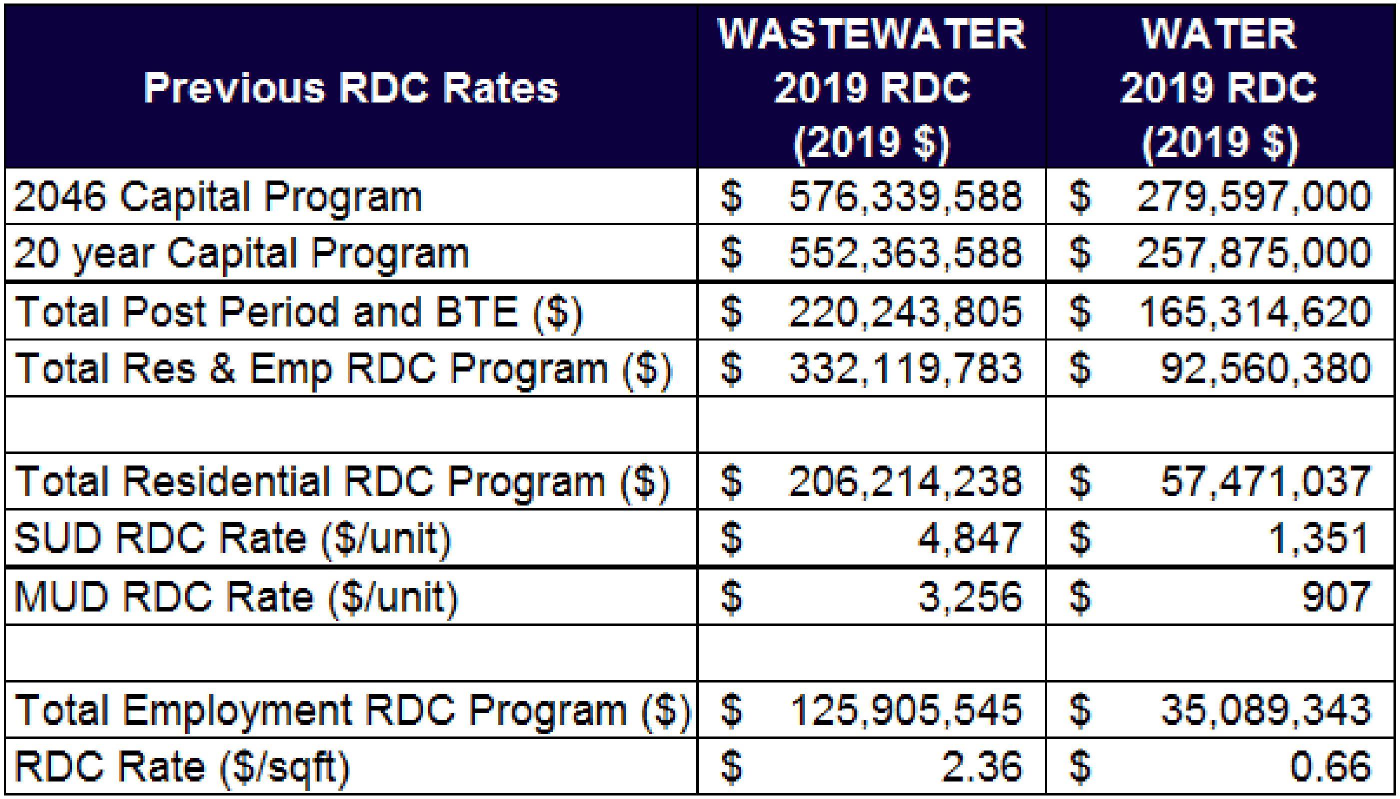
Stakeholder meeting #2 (August 22nd, September 12th)

Topics covered:

- Infrastructure Master Plan (IMP) approach and projects
- RDC policy and criteria
- Key drivers: BTE, res/ICI splits, I&I
- Population growth
- Design criteria for water and wastewater
- RDC Eligible/Non-Eligible split methodology and post period benefit
- Water and wastewater capital program (project list)

Refresher

Draft – as presented at Stakeholder Meeting #2, Aug 22 and Sept 12



Previous RDC Rates	WASTEWATER 2019 RDC (2019 $)	WATER 2019 RDC (2019 $)
2046 Capital Program	$ 576,339,588	$ 279,597,000
20 year Capital Program	$ 552,363,588	$ 257,875,000
Total Post Period and BTE ($)	$ 220,243,805	$ 165,314,620
Total Res & Emp RDC Program ($)	$ 332,119,783	$ 92,560,380
Total Residential RDC Program ($)	$ 206,214,238	$ 57,471,037
SUD RDC Rate ($/unit)	$ 4,847	$ 1,351
MUD RDC Rate ($/unit)	$ 3,256	$ 907
Total Employment RDC Program ($)	$ 125,905,545	$ 35,089,343
RDC Rate ($/sqft)	$ 2.36	$ 0.66

RDC Inputs

RDC Input Reviews and Revisions

- Reconciliation of the service area population and confirmation of the in-period growth
- Review of infrastructure plan projects and splits
- Review of the census derived PPU and the HRM projected housing type and resulting PPU's
- Reconciliation of financial components including program costs to date, interest costs and cost indexing over the planning period

RDC Adjusted Inputs

Adjusted RDC Population:

- The growth projection used for calculating the RDC unit rate was adjusted to more accurately reflect serviced area populations
- This was achieved by removing rural allocation of growth
- The Preferred RDC unit rate was calculated using a total growth value of 172,420

Adjusted Growth Projections

	Total Growth		**Adjusted RDC Growth (no rural)**	
	Residential	Employment	Residential	Employment
2016-2041	119,409	72,906	105,244	67,176
Percentage	62%	38%	61%	39%
Total	192,315		172,420	

Adjusted RDC Post Period Benefit

- The growth population change had a negligible impact on post period benefit calculation
- The post period benefit was calculated to be 18.0%, a change from 17.9%.
- All project costs were reduced by 18.0% to only account for growth to 2041

Horizon	Total Growth	Adjusted RDC Growth (no rural)
2041	192,315	172,420
2046	234,176	210,299
Difference (%)	82.1%	82.0%
Post Period Reduction	17.9%	18.0%

RDC Adjusted Inputs

RDC Rate Inputs

- The PPU, SUD (%) and MUD (%) remained the same since the Stakeholder #2 meeting

- The pervious RDC (2012) used a PPU of 2.4, the RDC (2019) PPU was updated to 2.3 based on 2016 census
- The Single Unit Dwelling (SUD) and Multi Unit Dwelling (MUD) percentages were obtained from referencing HRM permit development data from 2005-2015
- Resulting SUD/MUD ratio has been updated from previous RDC (2012) 55/45 to 45/55 in this RDC (2019)

Horizon	2012 RDC	2019 RDC
PPU	2.4	2.3
SUD (%)	55	45
MUD (%)	45	55

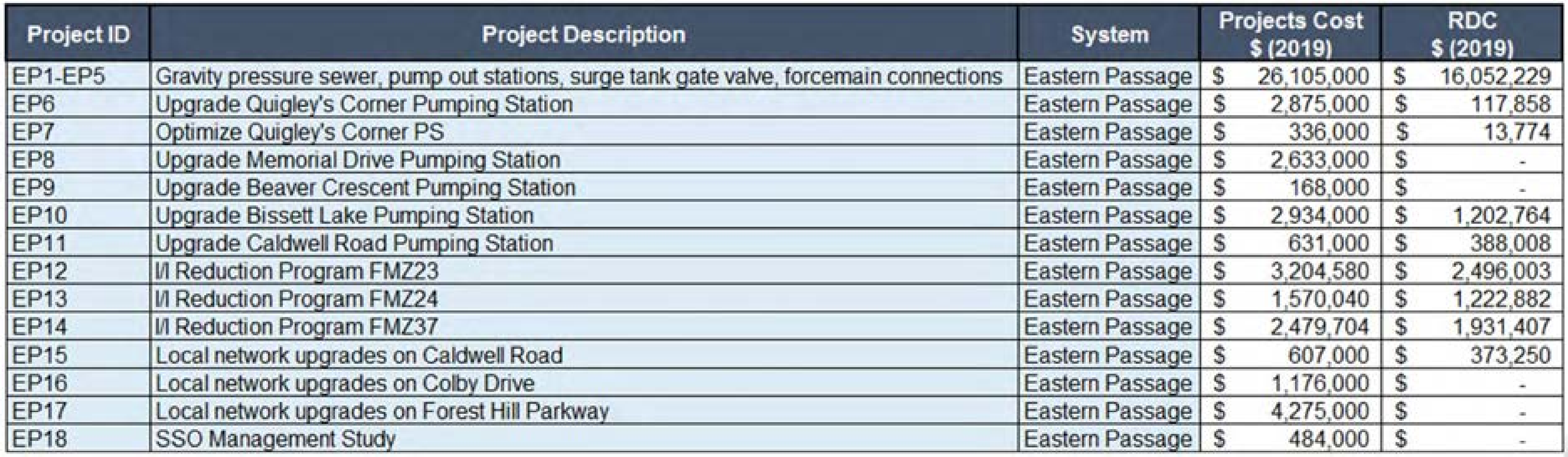
Preferred RDC Program

Preliminary RDC Program: Wastewater

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
AT2	Upgrade WWTF to service employment growth flows	Aerotech	$ 9,997,476	$ 7,377,059
D1	LoWSCA: Canal Street Separation	Dartmouth	$ 1,842,000	$ 1,132,664
D2a	LoWSCA: Wyse Road Separation - Phase 1	Dartmouth	$ 3,860,000	$ 2,373,553
D2b	LoWSCA: Wyse Road Separation - Phase 2	Dartmouth	$ 2,802,000	$ 574,326
D3	Additional Sewer Separation on Wyse Street	Dartmouth	$ 1,912,000	$ 1,175,708
D5	Albro Lakes Watershed Separation	Dartmouth	$ 8,111,000	$ 6,317,546
D6a-D6d	Maynard Lake and Clement Street Wetland Separation	Dartmouth	$ 6,790,000	$ 5,288,637
D7	New Valleyford Pumping Station	Dartmouth	$ 10,446,000	$ 2,141,117
D8	390 Waverley Road Upgrades	Dartmouth	$ 11,361,000	$ -
D9	Anderson Pumping Station Upgrades	Dartmouth	$ 340,000	$ -
D10	Upgrades to Dartmouth WWTF	Dartmouth	$ 12,572,000	$ 10,307,534
D11	I/I Reduction Program FMZ27	Dartmouth	$ 5,941,076	$ 3,653,228
D12	I/I Reduction Program FMZ45	Dartmouth	$ 1,120,232	$ 872,533
D13	Additional flow monitoring	Dartmouth	$ 420,000	$ 34,435
D14	CSO Flow Management Plan	Dartmouth	$ 675,000	$ 55,342
D15	Green St Upsize	Dartmouth	$ 513,000	$ -
D16	Pinecrest Dr Upgrade	Dartmouth	$ 1,013,000	$ -
D17	Peddars Way Upgrade	Dartmouth	$ 555,000	$ -
D18	Atlantic Street Upgrade	Dartmouth	$ 3,831,000	$ -
D19	Akerley Blvd and Railway Alignment Upgrade	Dartmouth	$ 4,814,000	$ 2,960,177
D20	Pleasant Street Upgrade	Dartmouth	$ 767,000	$ -
D21	Princess Margaret Blvd. Upgrade	Dartmouth	$ 3,106,000	$ -
D22	Anderson Lake Development Connection	Dartmouth	$ 7,609,000	$ -
D23	Marvin Connection	Dartmouth	$ 1,380,000	$ 56,572
D24	King Street Diversion	Dartmouth	$ 78,000	$ 3,198
D25	Diversion to Eastern Passage	Dartmouth	$ 12,113,000	$ 9,931,209
D26	SSO Flow Management Plan	Dartmouth	$555,000	$ -

Preferred RDC Program

Preliminary RDC Program: Wastewater



Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
EP1-EP5	Gravity pressure sewer, pump out stations, surge tank gate valve, forcemain connections	Eastern Passage	$ 26,105,000	$ 16,052,229
EP6	Upgrade Quigley's Corner Pumping Station	Eastern Passage	$ 2,875,000	$ 117,858
EP7	Optimize Quigley's Corner PS	Eastern Passage	$ 336,000	$ 13,774
EP8	Upgrade Memorial Drive Pumping Station	Eastern Passage	$ 2,633,000	$ -
EP9	Upgrade Beaver Crescent Pumping Station	Eastern Passage	$ 168,000	$ -
EP10	Upgrade Bissett Lake Pumping Station	Eastern Passage	$ 2,934,000	$ 1,202,764
EP11	Upgrade Caldwell Road Pumping Station	Eastern Passage	$ 631,000	$ 388,008
EP12	I/I Reduction Program FMZ23	Eastern Passage	$ 3,204,580	$ 2,496,003
EP13	I/I Reduction Program FMZ24	Eastern Passage	$ 1,570,040	$ 1,222,882
EP14	I/I Reduction Program FMZ37	Eastern Passage	$ 2,479,704	$ 1,931,407
EP15	Local network upgrades on Caldwell Road	Eastern Passage	$ 607,000	$ 373,250
EP16	Local network upgrades on Colby Drive	Eastern Passage	$ 1,176,000	$ -
EP17	Local network upgrades on Forest Hill Parkway	Eastern Passage	$ 4,275,000	$ -
EP18	SSO Management Study	Eastern Passage	$ 484,000	$ -

Preferred RDC Program

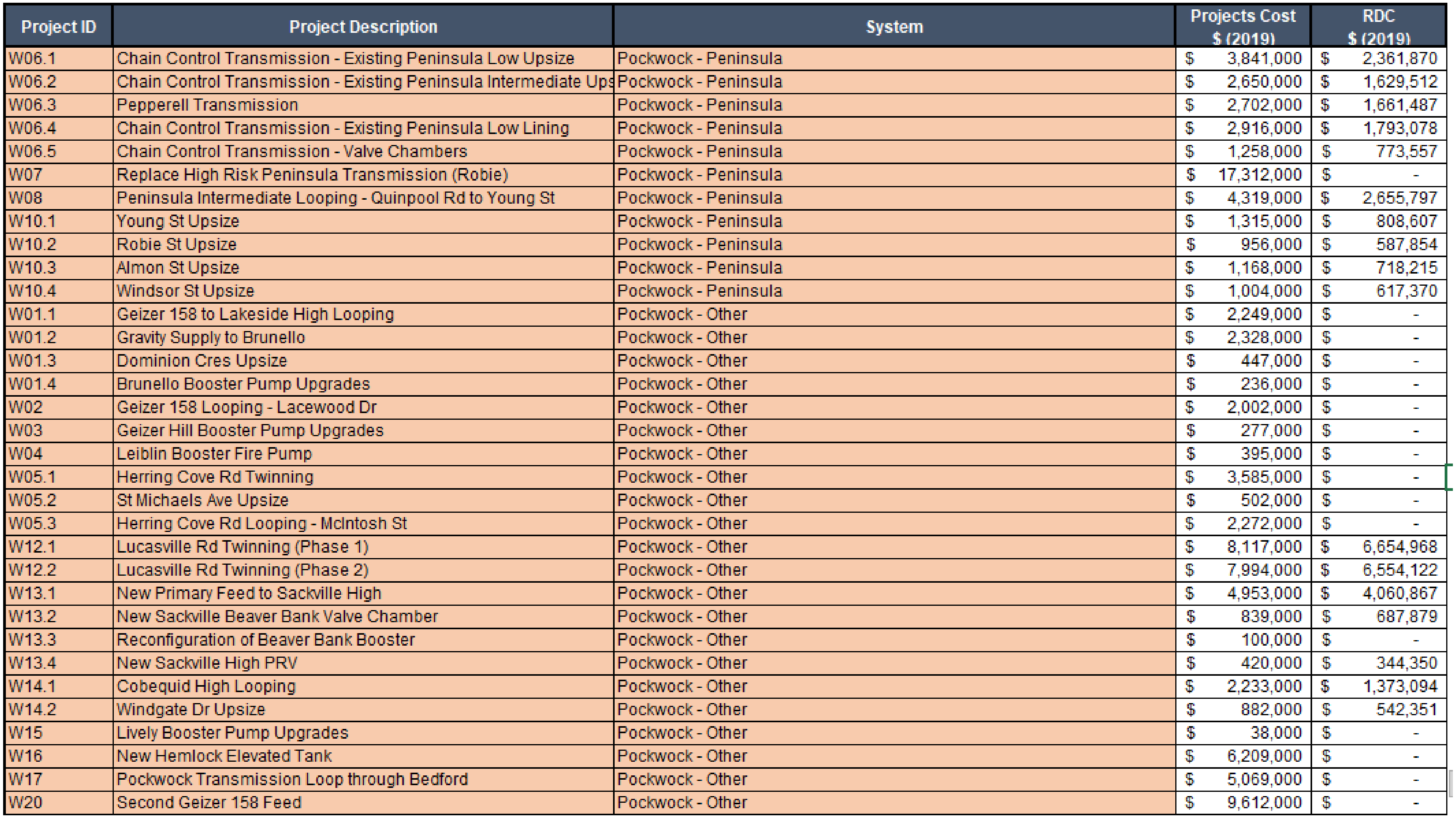
Preliminary RDC Program: Wastewater

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
MC1-MC3	Trunk Sewer Upgrades (Sackville Trunk Upgrades)	Mill Cove	$ 13,491,000	$ 8,295,753
MC4	Storage Tank	Mill Cove	$ 17,469,000	$ 13,606,363
MC5	Fish Hatchery Park Pumping Station Upgrade	Mill Cove	$ 10,529,000	$ 4,316,259
MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	Mill Cove	$ 1,090,000	$ -
MC7	Mill Cove Wastewater Treatment Plant Capacity Upgrade	Mill Cove	$ 148,758,000	$ 60,981,869
MC8	I/I Reduction Program FMZ07, FMZ10, & FMZ40	Mill Cove	$ 9,288,248	$ 7,234,488
MC9	I/I Reduction Program FMZ02 & FMZ03	Mill Cove	$ 8,023,065	$ 6,249,055
MC10	Local network upgrades on Beaver Bank Rd. North on Glendale Dr.	Mill Cove	$ 2,086,000	$ -
MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	Mill Cove	$ 1,490,000	$ -
MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	Mill Cove	$ 1,667,000	$ -
MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	Mill Cove	$ 845,000	$ -
MC14	Local network upgrades on Hallmark Ave.	Mill Cove	$ 437,000	$ -
MC15	Local Sewer Upgrades for Waterfront Drive	Mill Cove	$ 500,000	$ -
MC16	Springfield Lake Connection to Sackville	Mill Cove	$ 6,226,000	$ 2,552,287
MC17	SSO Management Study	Mill Cove	$ 1,086,000	$ -

Preliminary RDC Program: Wastewater

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	$ 7,281,000	$ 2,984,774
WR2	WRWIP: Young Street Area Sewer Separation	Halifax	$ 21,879,000	$ 13,453,619
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	$ 14,752,000	$ 11,490,129
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	$ 221,000	$ -
WR7	WRWIP: Young Pumping Station Upgrade	Halifax	$ 2,169,000	$ 1,689,404
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	Halifax	$ 3,850,000	$ 1,578,269
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	Halifax	$ 15,491,589	$ 12,066,185
WR19	WRWIP: Fairview Cove Linear Upsize	Halifax	$ 19,781,000	$ 12,163,538
WR21	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	$ 2,997,000	$ 2,334,322
WR10-WR12	WRWIP: BLT WWTF Decommission and new Timberlea PS & Forcemain	BLT	$ 25,864,000	$ 20,145,112
WR14-WR17	WRWIP: BLT Flow Diversion to Herring Cove	BLT	$ 24,674,000	$ 19,218,238
WR18	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	$ 7,439,000	$ 5,794,134
WR22	Infrastructure Master Plan: CSO Management Study	Halifax	$ 965,000	$ 79,118
WR23	Infrastructure Master Plan: SSO Management Study	Halifax	$ 415,000	$ -
WR20	WRWIP: Halifax Treatment Plant Capacity Upgrade	Halifax	$ 25,142,000	$ 19,582,757
WR8	WRWIP: New Fairfield Holding Tank	Halifax	$ 12,403,000	$ 5,084,487

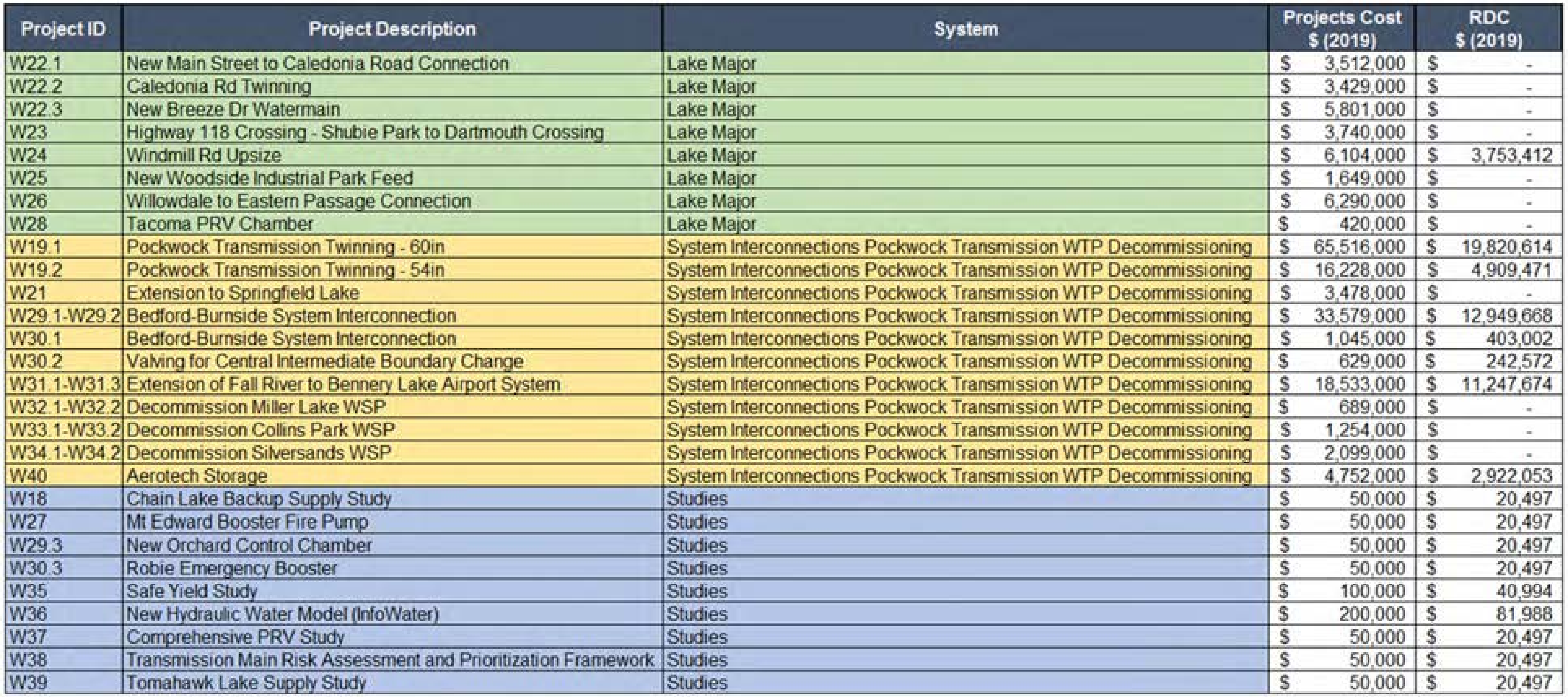
Preliminary RDC Program: Water



Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
W06.1	Chain Control Transmission - Existing Peninsula Low Upsize	Pockwock - Peninsula	$ 3,841,000	$ 2,361,870
W06.2	Chain Control Transmission - Existing Peninsula Intermediate Ups	Pockwock - Peninsula	$ 2,650,000	$ 1,629,512
W06.3	Pepperell Transmission	Pockwock - Peninsula	$ 2,702,000	$ 1,661,487
W06.4	Chain Control Transmission - Existing Peninsula Low Lining	Pockwock - Peninsula	$ 2,916,000	$ 1,793,078
W06.5	Chain Control Transmission - Valve Chambers	Pockwock - Peninsula	$ 1,258,000	$ 773,557
W07	Replace High Risk Peninsula Transmission (Robie)	Pockwock - Peninsula	$ 17,312,000	$ -
W08	Peninsula Intermediate Looping - Quinpool Rd to Young St	Pockwock - Peninsula	$ 4,319,000	$ 2,655,797
W10.1	Young St Upsize	Pockwock - Peninsula	$ 1,315,000	$ 808,607
W10.2	Robie St Upsize	Pockwock - Peninsula	$ 956,000	$ 587,854
W10.3	Almon St Upsize	Pockwock - Peninsula	$ 1,168,000	$ 718,215
W10.4	Windsor St Upsize	Pockwock - Peninsula	$ 1,004,000	$ 617,370
W01.1	Geizer 158 to Lakeside High Looping	Pockwock - Other	$ 2,249,000	$ -
W01.2	Gravity Supply to Brunello	Pockwock - Other	$ 2,328,000	$ -
W01.3	Dominion Cres Upsize	Pockwock - Other	$ 447,000	$ -
W01.4	Brunello Booster Pump Upgrades	Pockwock - Other	$ 236,000	$ -
W02	Geizer 158 Looping - Lacewood Dr	Pockwock - Other	$ 2,002,000	$ -
W03	Geizer Hill Booster Pump Upgrades	Pockwock - Other	$ 277,000	$ -
W04	Leiblin Booster Fire Pump	Pockwock - Other	$ 395,000	$ -
W05.1	Herring Cove Rd Twinning	Pockwock - Other	$ 3,585,000	$ -
W05.2	St Michaels Ave Upsize	Pockwock - Other	$ 502,000	$ -
W05.3	Herring Cove Rd Looping - McIntosh St	Pockwock - Other	$ 2,272,000	$ -
W12.1	Lucasville Rd Twinning (Phase 1)	Pockwock - Other	$ 8,117,000	$ 6,654,968
W12.2	Lucasville Rd Twinning (Phase 2)	Pockwock - Other	$ 7,994,000	$ 6,554,122
W13.1	New Primary Feed to Sackville High	Pockwock - Other	$ 4,953,000	$ 4,060,867
W13.2	New Sackville Beaver Bank Valve Chamber	Pockwock - Other	$ 839,000	$ 687,879
W13.3	Reconfiguration of Beaver Bank Booster	Pockwock - Other	$ 100,000	$ -
W13.4	New Sackville High PRV	Pockwock - Other	$ 420,000	$ 344,350
W14.1	Cobequid High Looping	Pockwock - Other	$ 2,233,000	$ 1,373,094
W14.2	Windgate Dr Upsize	Pockwock - Other	$ 882,000	$ 542,351
W15	Lively Booster Pump Upgrades	Pockwock - Other	$ 38,000	$ -
W16	New Hemlock Elevated Tank	Pockwock - Other	$ 6,209,000	$ -
W17	Pockwock Transmission Loop through Bedford	Pockwock - Other	$ 5,069,000	$ -
W20	Second Geizer 158 Feed	Pockwock - Other	$ 9,612,000	$ -

Preferred RDC Program

Preliminary RDC Program: Water



Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
W22.1	New Main Street to Caledonia Road Connection	Lake Major	$ 3,512,000	$ -
W22.2	Caledonia Rd Twinning	Lake Major	$ 3,429,000	$ -
W22.3	New Breeze Dr Watermain	Lake Major	$ 5,801,000	$ -
W23	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	Lake Major	$ 3,740,000	$ -
W24	Windmill Rd Upsize	Lake Major	$ 6,104,000	$ 3,753,412
W25	New Woodside Industrial Park Feed	Lake Major	$ 1,649,000	$ -
W26	Willowdale to Eastern Passage Connection	Lake Major	$ 6,290,000	$ -
W28	Tacoma PRV Chamber	Lake Major	$ 420,000	$ -
W19.1	Pockwock Transmission Twinning - 60in	System Interconnections Pockwock Transmission WTP Decommissioning	$ 65,516,000	$ 19,820,614
W19.2	Pockwock Transmission Twinning - 54in	System Interconnections Pockwock Transmission WTP Decommissioning	$ 16,228,000	$ 4,909,471
W21	Extension to Springfield Lake	System Interconnections Pockwock Transmission WTP Decommissioning	$ 3,478,000	$ -
W29.1-W29.2	Bedford-Burnside System Interconnection	System Interconnections Pockwock Transmission WTP Decommissioning	$ 33,579,000	$ 12,949,668
W30.1	Bedford-Burnside System Interconnection	System Interconnections Pockwock Transmission WTP Decommissioning	$ 1,045,000	$ 403,002
W30.2	Valving for Central Intermediate Boundary Change	System Interconnections Pockwock Transmission WTP Decommissioning	$ 629,000	$ 242,572
W31.1-W31.3	Extension of Fall River to Bennery Lake Airport System	System Interconnections Pockwock Transmission WTP Decommissioning	$ 18,533,000	$ 11,247,674
W32.1-W32.2	Decommission Miller Lake WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$ 689,000	$ -
W33.1-W33.2	Decommission Collins Park WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$ 1,254,000	$ -
W34.1-W34.2	Decommission Silversands WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$ 2,099,000	$ -
W40	Aerotech Storage	System Interconnections Pockwock Transmission WTP Decommissioning	$ 4,752,000	$ 2,922,053
W18	Chain Lake Backup Supply Study	Studies	$ 50,000	$ 20,497
W27	Mt Edward Booster Fire Pump	Studies	$ 50,000	$ 20,497
W29.3	New Orchard Control Chamber	Studies	$ 50,000	$ 20,497
W30.3	Robie Emergency Booster	Studies	$ 50,000	$ 20,497
W35	Safe Yield Study	Studies	$ 100,000	$ 40,994
W36	New Hydraulic Water Model (InfoWater)	Studies	$ 200,000	$ 81,988
W37	Comprehensive PRV Study	Studies	$ 50,000	$ 20,497
W38	Transmission Main Risk Assessment and Prioritization Framework	Studies	$ 50,000	$ 20,497
W39	Tomahawk Lake Supply Study	Studies	$ 50,000	$ 20,497

Preferred RDC Program

Project RDC Eligible/Non-Eligible Revisions

	Wastewater	Water
Preliminary RDC Eligible	$332,119,783	$92,560,380
Final RDC Eligible	$301,316,402	$90,339,907
Difference	($30,803,381)	($2,220,473)

Preferred RDC Rate

RDC Rate Refinement

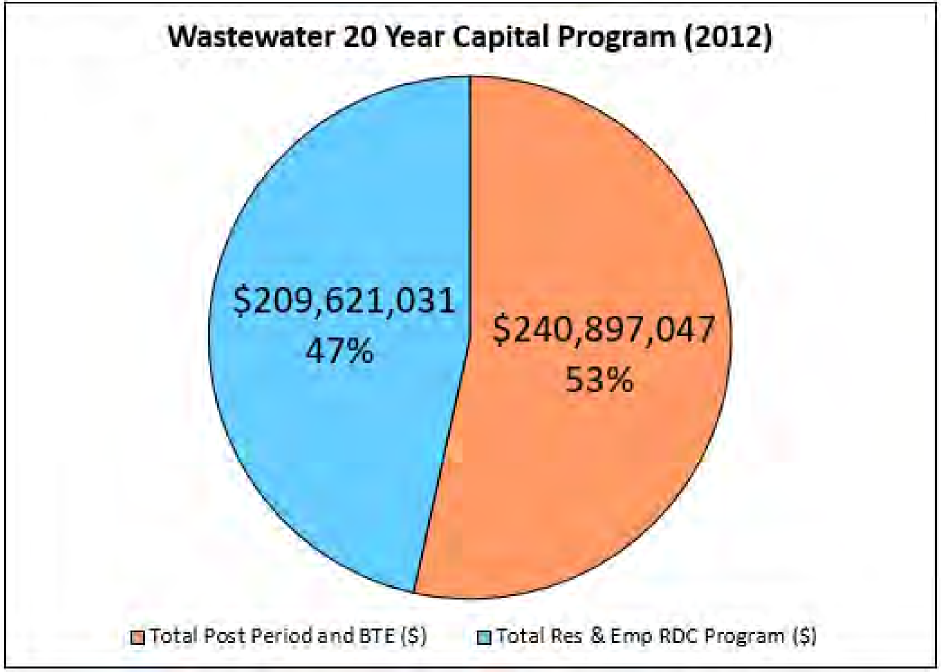
- Project Estimates are escalated to the project period
- Construction interest is applied to the project period
- Non eligible RDC benefit is removed
- Post period benefit is removed
- Balance financing applied
- Rate is escalated every period
- Net zero at 2041

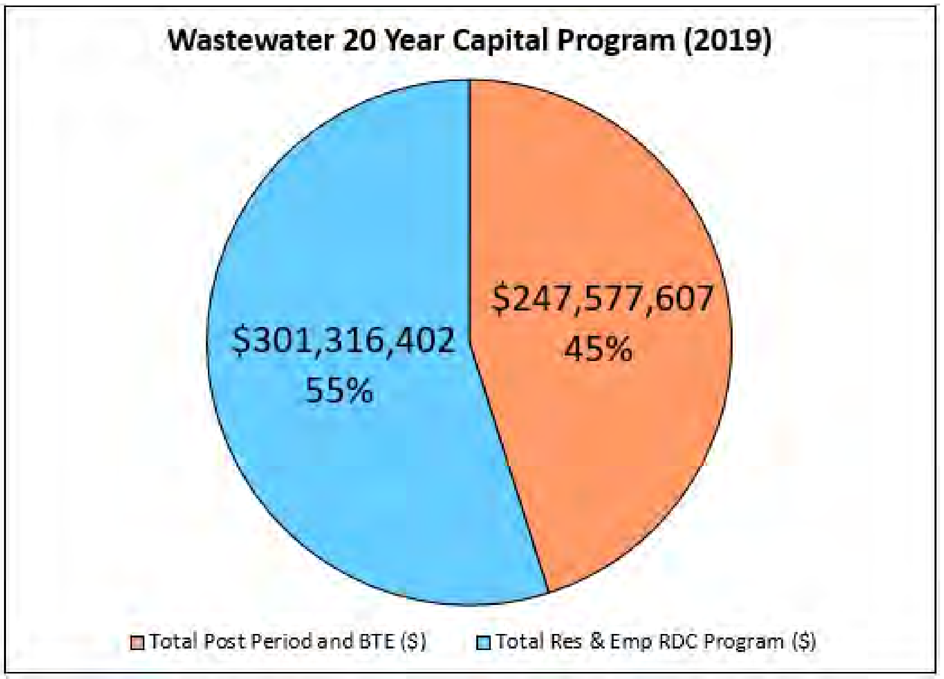
Preferred RDC Rate

Preferred RDC Criteria and Rate: Wastewater

WASTEWATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	172,420
Total Residential Growth	94,800	94,800	105,244
% Residential Growth	68.5%	68.5%	61.0%
Total Employment Growth	43,530	43,530	67,176
% Employment Growth	31.5%	31.5%	39.0%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.0%
2046 Capital Program	$ 645,257,222	$ 741,197,723	$ 572,311,009
20 year Capital Program	$ 450,518,078	$ 517,503,659	$ 548,894,009
Total Post Period and BTE ($)	$ 240,897,047	$ 276,714,985	$ 247,577,607
Total Res & Emp RDC Program ($)	$ 209,621,031	$ 240,788,674	$ 301,316,402
Total Residential RDC Program ($)	$ 132,710,213	$ 152,442,320	$ 183,921,491
SUD RDC Rate ($/unit)	$ 4,081	$ 4,688	$ 5,120
MUD RDC Rate ($/unit)	$ 2,741	$ 3,148	$ 3,439
Total Employment RDC Program ($)	$ 76,910,818	$ 88,346,354	$ 117,394,911
RDC Rate ($/sqft)	$ 2.24	$ 2.57	$ 2.49

Preferred RDC Rate





Total Program: $450,518,078 $548,894,009

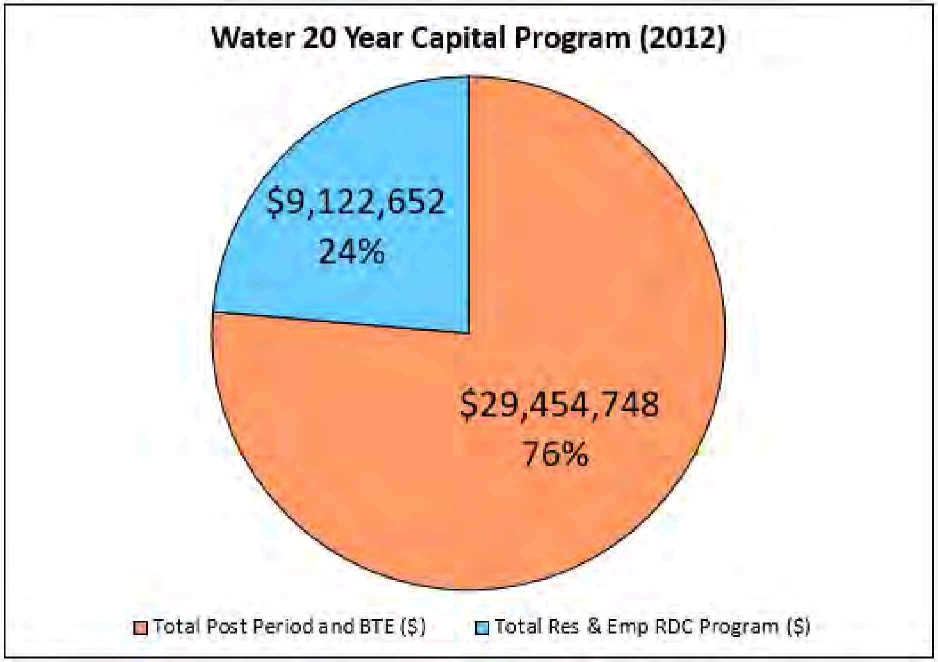
Wastewater	2012 RDC (April 1st 2015) (2012 $)	2019 RDC (2019 $)
Res SUD RDC Rate ($/unit)	$4,081	$5,120
Res MUD RDC Rate ($/unit)	$2,741	$3,439
Emp RDC Rate ($/sqft)	$2.24	$2.49

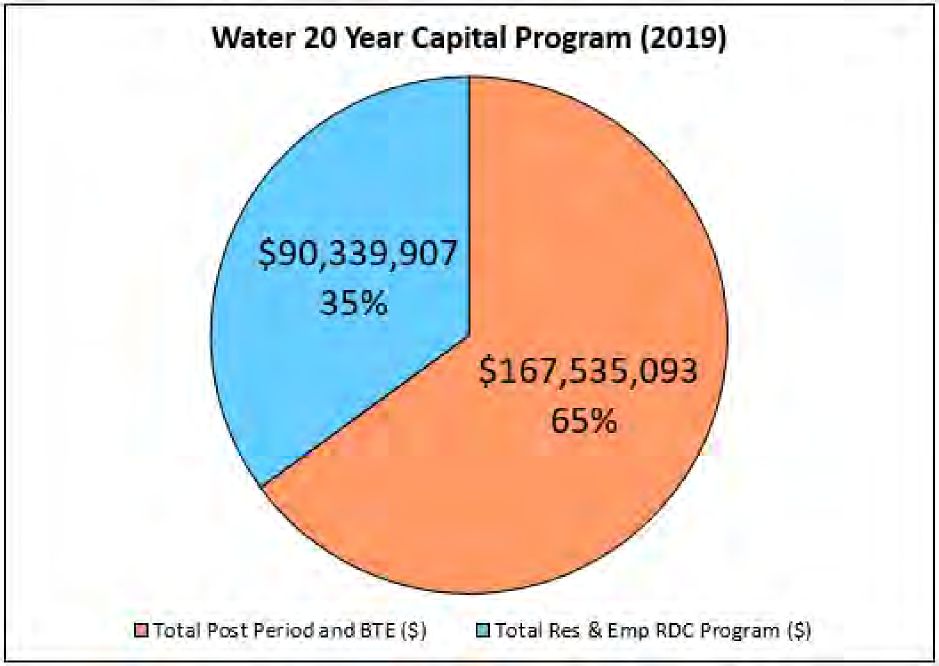
Preferred RDC Rate

Preferred RDC Criteria and Rate: Water

WATER	2012 RDC (April 1st 2015) (2012 $)	2012 RDC (April 1st 2015) (2019 $)	2019 RDC (2019 $)
20 Year RDC Planning Horizon	2031	2031	2041
Total Growth	138,330	138,330	172,420
Total Residential Growth	94,800	94,800	105,244
% Residential Growth	68.5%	68.5%	61.0%
Total Employment Growth	43,530	43,530	67,176
% Employment Growth	31.5%	31.5%	39.0%
Residential Average Density (PPU)	2.4	2.4	2.3
Relative Density Factor (SUD/MUD)	1.489	1.489	1.489
Employment Density (Sqft/Employee)	733	733	733
RDC in period ratio (%)	59.5%	59.5%	82.0%
2046 Capital Program	$ 51,225,710	$ 58,842,239	$ 279,597,000
20 year Capital Program	$ 38,577,400	$ 44,313,306	$ 257,875,000
Total Post Period and BTE ($)	$ 29,454,748	$ 33,834,247	$ 167,535,093
Total Res & Emp RDC Program ($)	$ 9,122,652	$ 10,479,059	$ 90,339,907
Total Residential RDC Program ($)	$ 5,947,407	$ 6,831,701	$ 55,142,867
SUD RDC Rate ($/unit)	$ 183	$ 210	$ 1,769
MUD RDC Rate ($/unit)	$ 123	$ 141	$ 1,188
Total Employment RDC Program ($)	$ 3,175,245	$ 3,647,358	$ 35,197,040
RDC Rate ($/sqft)	$ 0.09	$ 0.10	$ 0.86

Preferred RDC Rate





Total Program: $38,577,400 $257,875,000

Water	2012 RDC (April 1st 2015) (2012 $)	2019 RDC (2019 $)
Res SUD RDC Rate ($/unit)	$183	$1,769
Res MUD RDC Rate ($/unit)	$123	$1,188
Emp RDC Rate ($/sqft)	$0.09	$0.86

Schedule and Next Steps

• Halifax Water Special Board Meeting	October 31, 2019
• RDC Application	November 1, 2019
• RDC Application Information Request	November 1, 2019 – February 7, 2020
• Application NSUARB Hearing	February 10 – February 14, 2020

Questions and Discussion

Regional Development Charge Update 2019

Technical Memorandum

Prepared by GM BluePlan for:

Halifax Water

Project No. 719008

October 2019

Version 1

Document Use

This document provides the technical background and basis for the 2019 Regional Development Charge Update. It is expected to be a key reference document to provide the rationale and details of the rate calculation. It is not a legal document.

Feedback Welcomed

This document is intended to provide a transparent and easily understood guide documenting the basis for the RDC calculation. Feedback is welcomed and should be directed to Heather Miller, Heatherm@halifaxwater.ca

Version Updates

The following is a record of the changes/updates that have occurred on this document:

Version	Changes / Updates	Author	Reviewer	Date
1	DRAFT: for Review	James Jorgensen	Chris Campbell	October 2019
2				
3				

Contents

Table of Figures

Appendices

1 Introduction

GM BluePlan were commissioned by Halifax Water to undertake a 2019 Regional Development Charges (RDC) Update. This update builds on the existing 2014 RDC and seeks to update the charge based on recently completed infrastructure planning studies including the Infrastructure Master Plan (IMP).

The RDC is a regional charge based on the growth related infrastructure needs of the entire region. The foundation of the RDC is to ensure that costs associated with infrastructure required to service growth are fairly and appropriately paid by residential and employment development. The RDC is Halifax Water's mechanism to recover the cost of Regional infrastructure needed for growth.

The principal objective of the RDC update is to recommend new residential and employment development charges based on the most up to date information. The RDC update will incorporate new information that has been completed over the last five (5) years including updated planning information, updated infrastructure programs resulting from recent studies, and current infrastructure cost estimating.

The first RDC was established in 2014 with a requirement to update and review the charge every 5 years; the first five-year review period is triggered in July 2019. This update is part of Halifax Water's commitment to ensure that the charge is based on best available information. The RDC update seeks to provide a robust assessment base on which to calculate a transparent, justifiable and appropriate Regional Development Charges rate for the next planning period.

2 Goals and Objectives

The primary goal of the RDC Update is to establish new residential and employment development charges for water and wastewater services for the next 20-year planning horizon. The new RDC will be in effect up until the next 5 year review period: 2020 to 2025.

To achieve the goal the following objectives were completed:

- Identify amount, type and location of growth to 2041
- Identify water and wastewater infrastructure servicing needs to accommodate growth
- Identify infrastructure capital costs
- Identify and deduct:
    - Grants, subsidies and other contributions
    - Post period benefit
    - Benefit to Existing (BTE) allocations
- Calculate water and wastewater costs allocated between single unit and multi-unit residential dwellings and employment
- Complete financial modelling to account for interest, debt financing and calculate the base water and wastewater RDC rate

3 Background

In 2014 the Nova Scotia Utility and Review Board (NSUARB) approved Halifax Water's application for approval of amendments to the *Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services*, to establish separate Regional Development Charges (RDCs) for water and wastewater infrastructure, and to eliminate the charges for trunk sewer and sewer redevelopment and Regional Capital Cost Charges for Wastewater Treatment. The RDC is a regional charge based on the infrastructure needs of the entire region. The foundation of the RDC is to ensure that costs associated with infrastructure required to service growth are fairly and appropriately paid by residential and employment development.

The 2014 RDC for water and wastewater infrastructure was based on the 2012 Integrated Resource Plan (IRP) capital program. In turn, the IRP used the Regional Wastewater Functional Servicing Plan (RWWFP) capital program to inform the requirements and costs for wastewater infrastructure. At the time, there was no equivalent comprehensive study for water infrastructure. The process to generate the wastewater RDC rate involved identifying the projects in the RWWFP (and therefore the IRP) that were related to growth needs, considered regional infrastructure and required within the agreed 20 year development charges horizon (2033) to create a wastewater RDC rate to apply to all new development. A similar process was undertaken for water although project definition was based on expert judgement and as a result was not comprehensive and only addressed highest priority issues.

The NSUARB and Halifax Water agreed that the RDC would be updated every 5 years. In addition, a finding of the RDC approval requires that Halifax Water is to review the calculation of the RDC rate before any scheduled five year update in the event there are changes in circumstances which would result in a variance in the RDC by an amount greater than 15% (positive or negative).

In 2017 Halifax Water completed the West Region Wastewater Infrastructure Plan (WRWIP). This project looked specifically at wastewater needs for the Halifax, Beechville Lakeside Timberlea (BLT) and Herring Cove area (The West Region), considering the Central Region area as required, and recommended a new wastewater servicing strategy for the area. The WRWIP study resulted in new projects that superseded the strategy for the West Region recommended in the RWWFP. This work resulted in an interim review of the RDC in January 2018. The interim review examined the new strategy and associated projects in the WRWIP and determined that the new capital program would not significantly impact the RDC rate.

3.1 Studies Supporting the RDC

A Regional Development Charge should be based on a long-term projection of the capital investment required to service the planned growth in the Region's service area. The following studies are 'foundational' and 'supportive' of this new RDC 2019 Update and the long term servicing strategy defined for the Halifax Water.

3.1.1 Foundational Studies

3.1.1.1 The West Regional Wastewater Infrastructure Plan

The West Regional Wastewater Infrastructure Plan was the first infrastructure plan completed by Halifax Water and as previously mentioned, it continued to build on the work completed by the IRP and RWWFP. The purpose of the WRWIP was to formalize the foundational policies of regional infrastructure planning to identify servicing solutions and prepare preliminary designs of the wastewater infrastructure needed to service the West Region. The scope of the WRWIP included the wastewater treatment sewersheds of Halifax, Herring Cove, and Beechville Lakeside Timberlea (BLT). The Mill Cove sewershed was included within the scope in terms of flow allocation and diversion strategies; however, the definition of infrastructure needed for Mill Cove was not included in the scope of the project. The WRWIP used a project horizon from 2011-2046, the project lists from the WRWIP were updated and incorporated into this report to help identify the proper development charges for each project. The in-depth break down of each suggested project also helped identify the split between BTE and growth, this allowed an accurate RDC to be calculated for each project in the WRWIP. These splits were then used in the IMP and are included in this RDC report for calculating their respective Regional Development Charges

3.1.1.2 The Infrastructure Master Plan

The Infrastructure Master Plan is a long-term infrastructure planning and engineering study to identify the optimal regional water and wastewater infrastructure implementation plan for Halifax Water to service growth until 2046. The Infrastructure Master Plan expands work completed on the WRIWP to update the West Region, however, the report also provides servicing strategies for the remaining wastewater network, covering the Central and East Regions. The Infrastructure Master Plan also followed a similar approach for the water system by formalizing the foundational policies for regional water infrastructure planning and forming a preferred servicing strategy that covers the regional water network for Halifax Water. This report uses the Regional project lists generated by the Infrastructure Master Plan and updated WRIWP as well as the project descriptions to allocate the split between growth and BTE, so that development charges can be assigned to each project within the 2046 horizon. One of the goals of the Infrastructure Master Plan was to review existing criteria, level of service, policy, legislation and best practices related to long term infrastructure planning for water and wastewater networks. This goal incorporates Regional Development Charges as it enables Halifax Water and HRM to plan out their future infrastructure projects while assigning fair and equitable development charges so growth can continue to pay for growth.

3.1.2 Supportive Studies

3.1.2.1 Regional Development Charge Policy - Follow Up Discussion Paper – Utility Financing Principles June 2013.

The Halifax Regional Water Commission (HRWC) completed a review of Regional Development Charges (RDCs) for water, wastewater and stormwater infrastructure to determine an improved method of calculation and recovery of growth related capital costs. The resulting report “Regional Development Charge Policy Review – Interim Report” was filed as Appendix 10 of HRWC’s Rate Application filed January 9, 2013.

The January 2013 report laid out the background and foundation information used for stakeholder consultation, described the process and information presented to stakeholder groups, reviewed post-consultation analysis, and presented the recommended RDC and next steps for this process. The June 2013 paper was a further examination of utility financing principles and best practice, to address a question raised by stakeholders: Whether it is appropriate or not for some portion of the growth related costs to be paid for by the rate base.

3.1.2.2 Economic Impact Analysis, Gardiner Pinfold.

This economic impact analysis aimed to determine the impact of three proposed charges on the home buyer’s decision to purchase: impact to their mortgage; choice of location and the impact of the charges to the multi-unit builders.

3.1.2.3 The Halifax Regional Wastewater Function Plan (RWWFP)

The Halifax Regional Wastewater Functional Plan (RWWFP) was an engineering and planning process intended to provide Halifax Water with a wastewater servicing master plan for existing and planned serviced growth areas in the Halifax Region. The time horizon for the project was adjusted to 2046 to align with the Integrated Resource Plan (IRP) study. The RWWFP evaluated the Central, West and East region of Halifax and developed a list of projects to extend the life of existing wastewater infrastructure and identified areas to install new wastewater infrastructure to meet the demands of future growth. The project lists created by the RWWFP were used in the first RDC report (AECOM 2014) to develop the original wastewater development charges. The RWWFP laid a foundation for future studies like the WRWIP and IMP to build from, with regards to ensuring infrastructure services are adequately planned to provide the required infrastructure when development occurs for the 2046 horizon. This assisted in the development of the current projects lists used in this report for determining regional development charges.

4 Current Referenced Practices

4.1 Ontario - Canada

The approach to Halifax Water RDC is based on Ontario practice. Ontario has used Development Charges since the mid 1950's. Prior to 1989, the practice was generally evolved through case law. Since 1989, *the Ontario Development Charges Act* and its regulations have defined the approach for calculation. The Act provides for the following steps for Water and Wastewater services:

- Identify the amount, type and location of development
- Identify the servicing needs for the development
- Establish the capital costs for the servicing of the development
- Deduct:
    - Grants, subsidies and other contributions
    - Benefit to existing development
- Net costs then allocated between residential and non-residential benefit
- Net costs divided by growth to calculate the Development Charge

Within the Act, capital costs are defined to include costs to:

- acquire land,
- improve land,
- acquire, lease, construct or improve buildings and structures
- acquire, lease, construct or improve facilities
- costs to undertake studies in connection with the above
- costs of the Development Charge study
- interest on money borrowed to pay for costs above (including interim and long term borrowing costs)
- the Act requires that "local services" within the plan of subdivision or within the area to which the plan relates, be borne directly by the development and not included in the charge (note however that the over sizing cost of certain works is allowed for)

Once the Development Charge is passed by by-law, it may be indexed annually based on the Statistics Canada capital cost index.

Presently, over 210 municipalities in Ontario impose a Development Charge on developing lands. A very large proportion of these municipalities impose charges for water and wastewater services. Since 2001, water and wastewater charges have risen dramatically as a result of the Walkerton Inquiry and changes to environmental legislation. Listed below (Table 1: Single and Semi, Table 2: Commercial and Table 3: Industrial) are a sampling of the water and wastewater DC's for Regional Municipalities within the Greater Toronto Area[1].

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[1] *City of Hamilton By-Law No. 19-142, 19-009, June 12, 2019,* *https://d3fpllf1m7bbt3.cloudfront.net/sites/default/files/media/browser/2019-06-17/19-142-amended_version.pdf;*

Table 1: Single & Semi Detached Dwelling Developer Charges

Regional Municipality	Water	Wastewater	Total Water and Wastewater Charges
Peel	$ 28,000	$ 13,008	$ 41,008
Hamilton	$ 4,767	$ 9,463	$ 14,230
Durham	$ 9,910	$ 9,647	$ 19,557
York	$ 9,965	$ 20,486	$ 30,451

Table 2: Commercial Developer Charges - per ft²

Regional Municipality	Water	Wastewater	Total Water and Wastewater Charges
Peel	$ 7.83	$ 3.72	$ 11.55
Hamilton	$ 2.29	$ 4.56	$ 6.85
Durham	$ 3.69	$ 6.19	$ 9.88
York	$ 3.73	$ 7.63	$ 11.36

Table 3: Industrial Developer Charges - per ft²

Regional Municipality	Water	Wastewater	Total Water and Wastewater Charges
Peel	$ 7.83	$ 3.72	$ 11.55
Hamilton	$ 2.29	$ 4.56	$ 6.85
Durham	$ 0.90	$ 1.10	$ 2.00
York	$ 3.73	$ 7.63	$ 11.36

Regional Municipality of Durham Development Charge Information, July 2019, https://www.durham.ca/en/resources/Region-of-Durham-Region-wide-Development-Charge-Information.pdf; Region of Peel By-Law # 46-2015 Schedule A, https://www.peelregion.ca/finance/_media/current-indexed-development-charge-rates.pdf; York Region Development Charges, July 2019, https://www.york.ca/wps/portal/yorkhome/business/yr/landdevelopment/developmentcharges

5 RDC Definitions

The following sections provide detailed descriptions of the various terms that are relevant to Regional Development Charges policies. Some terms, such as oversizing and post period are similar in context but should be distinct in application. For the purposes of this report and future discussion it is recommended that these definitions remain and are understood by all involved stakeholders. It is imperative that the final agreed terminology adopted is used consistently by Halifax Water in all long-term infrastructure planning and development charge discussions.

5.1 Local and Regional Service Policy

A Local and Regional Service Policy sets out the fundamental criteria for what infrastructure is eligible for Development Charges.

For Halifax Water two charges are applicable. The area master infrastructure development charge, administered through the Capital Cost Contribution (CCC) policy and the regional infrastructure development charges, administered through the Regional Development Charge (RDC). Both have definitions of what infrastructure is eligible. The following text relates to the definition of regional infrastructure and by virtue of this definition all other infrastructure is considered local infrastructure.

For Halifax Water Regional Infrastructure is defined in the Schedule Of Rates, Rules & Regulations For Water, Wastewater, And Stormwater Services, effective July 1, 2013, as amended.Regional Wastewater Infrastructure means core regional wastewater treatment facilities and trunk sewer systems directly conveying wastewater to, or between, such facilities, including:

- Existing wastewater treatment facilities (WWTF) that provide a regional service including the facilities generally known as the Halifax WWTF, Dartmouth WWTF, Herring Cove WWTF, Eastern Passage WWTF, Mill Cove WWTF and Beechville / Lakeside/ Timberlea WWTF and Aerotech WWTF
- Trunk sewers and related appurtenances which directly convey wastewater to regional treatment facilities, and
- Trunk sewers and related appurtenances which divert wastewater from one regional treatment facility to another due to environmental concerns, capacity constraints or operational efficiency.

Regional Wastewater Infrastructure does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

Regional Water Infrastructure means core regional water supply facilities and the water transmission systems directly conveying water from such facilities to the various distribution systems, including:

- existing water supply facilities that provide a regional service including the facilities generally known as the J.D. Kline water supply facility at Pockwock Lake and the Lake Major water supply facility at Lake Major,
- water transmission mains and related appurtenances which directly convey water from regional treatment facilities to the distribution system, and
- water transmission mains and related appurtenances which divert water from one regional treatment facility supply area to another due to environmental concerns, capacity constraints or operational efficiency

Regional Water Infrastructure does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area.

5.2 Benefit to Existing (Non Growth)

Benefit to Existing (BTE) represents the non-growth components identified for certain projects which benefit the existing service area. These components are typically associated with upgrades to the existing systems or facilities necessary to continue to meet Level of Service targets for existing residential and ICI users. These projects may also involve or be triggered by upgrades or expansions which provide additional capacity to meet growth in the service area. A significant portion of HRM’s planned growth is focused in the Regional Centre, with aging infrastructure that has experienced Level of Service and capacity issues. Many projects identified in these areas have associated BTE components.

The premise is that any costs associated with BTE should be removed from the Regional Development Charge rate calculation.

5.3 Post period benefit

For Halifax Water’s RDC a rolling 20-year planning horizon is required, as directed by the NSUARB. For this RDC update the planning horizon is 2041. The projects that are defined in the Infrastructure Master Plan are sized to accommodate growth to 2046.

Post-period benefit is considered with projects that provide an additional allowance to service growth beyond the 20-year RDC horizon. Post period benefit is intended to remove the difference in cost associated with the recommended size of infrastructure to meet the RDC horizon and the size of infrastructure selected for strategic oversizing. The post period cost for growth would be front end funded by Halifax Water and collected through future RDC updates as the rolling RDC horizon captures and justifies the need.

Post-period benefit can be calculated by identifying the growth population percentage planned to occur post RDC horizon and using that percentage to reduce all project costs.

6 Methodology

Using the Infrastructure Master Plan capital plan as a foundation, the essence of the methodology is to identify the RDC eligible project costs and calculate a per unit (single and multi-unit dwelling) Regional Developer Charge for water and wastewater infrastructure.

The Capital Program output from the Infrastructure Master Plan was used as the basis for this assessment. The sections below describe the approach to identify and account for relevant factors such as consideration of the Benefit to Existing (BTE) customers, post period servicing and the appropriate residential to non-residential growth allocation be included within Regional Development Charges.

6.1 Planning Basis

The 2019 RDC Update is based on a 20 year planning horizon to the year 2041. The planning projections were developed by Halifax Regional Municipality (HRM) and were coordinated during the infrastructure master planning process. Population and employment projections for the service area only, no rural, are used to develop the RDC infrastructure programs and form the planning basis for the RDC.

Table 4: Planning Basis

	Total Growth		Adjusted RDC Growth (no rural)	
	Residential	Employment	Residential	Employment
2016 - 2041	119,409	72,906	105,244	67,176
Percentage	62%	38%	61%	39%
Total	192,315		172,420	

6.2 Infrastructure Capital Programs

The infrastructure capital programs utilized for the 2019 RDC Update have been developed through the recent Halifax Water Infrastructure Master Plan. The servicing strategy and projects developed under the Infrastructure Master Plan were developed with vision to a broader planning horizon to year 2046 and address broader region-wide servicing requirements. As part of the 2019 RDC Update process, the Infrastructure Master Plan infrastructure capital programs were further evaluated against RDC policy. The full capital program as it has been attributed to the 2019 RDC update for both water and wastewater servicing is provided in Appendix A. The executive summary for the Infrastructure Master Plan detailing the servicing strategy and listing the infrastructure projects is provided in Appendix C.

The water and wastewater infrastructure capital program, which forms the cost basis for the RDC, is summarized in the following table.

Table 5: Infrastructure Capital Program

	Wastewater	Water
Total Capital Program (2046)	$ 512,641,009	$ 278,497,000
Total 20-year Capital Program	$ 489,224,009	$ 257,210,000
Total RDC eligible Capital Program	$ 276,910,372	$ 92,169,494

6.3 Existing Capacity

The servicing strategy identified in the Infrastructure Master Plan is based on maximizing existing infrastructure capacity. This approach aligns with the Integrated Resource Plan objective 14: 'Manage flow and demand to maximize capacity for growth and minimize the need for new hard infrastructure'. The new hydraulic models used in the Infrastructure Master Plan were calibrated using observed flow monitor and customer billing data. This means that the assessment of existing capacity is based on actual known flows and demands. Only future growth population projections use design criteria values, as specified in the Infrastructure Master Plan.

6.4 Benefit to Existing (BTE)

The Benefit to Existing Position Paper (Appendix B) presents methods for applying the split between growth and BTE. For the Infrastructure Master Plan projects BTE has been assessed for each individual project, generally following the Level of Service method (method 2) and the Flow Split method (method 4). The outcome of the assessment and the corresponding BTE percentages applied are contained in the Appendix A, project tables.

These two methods were then applied to each capital program project to determine their respective BTE percentages. This review concluded that most projects should be considered to have some benefit to the existing population through improved level of service, reduced servicing costs and environmental improvements. Averaged across the applicable RDC eligible projects the BTE represents approximately 31.0% of the total capital program costs for wastewater and approximately 56.3% for water.

6.5 Funding Subsidy

Within the RDC project list (Appendix A) only the Aerotech WWTF project received external, federal funding. The external funding amount has been deducted from the capital project total cost before deducting BTE and post period benefit amounts.

6.6 Costs, Contingencies and Interest

Individual project costs have been generated using the Infrastructure Master Plan methodology, consistent with the Halifax Water Cost Estimation Framework. Overhead Contingencies were updated from 4% in the previous RDC (RWWFP and WRWIP) to 1% in the Infrastructure Master Plan. Refer to Section 9.3 Project Costing Volume 1 of the Infrastructure Master Plan.

6.7 Post Period

The Capital Program used for the RDC update is derived from the Infrastructure Master Plan which reflects servicing requirement needs to meet projected growth to 2046. The RDC is based on a horizon to 2041. A post period growth factor was applied to remove the additional five years of growth that had been accounted for in the capital program costs.

A post period of 18.0% was removed from the total growth costs to reflect the additional growth that had been included from the Infrastructure Master Plan. The post period percentage was calculated by comparing the difference of total growth from 2041 and 2046.

6.8 RDC Eligible Infrastructure

The capital program used for the RDC calculation reflects projects that are considered Regional. As per Halifax Water rules and regulations, regional infrastructure is required to provide core treatment, trunk sewer collection services and their associated appurtenances. This infrastructure provides benefit to the larger serviced community and extends across master plan areas, pressure districts or sewersheds. As such the RDC project list does not include local or area master level projects. However, the list does include flow (inflow and infiltration (I&I)) reduction projects which are not addressed in the previous definitions of regional infrastructure. These projects are preferable alternatives to new, hard infrastructure.

The definition of “Regional Infrastructure” and therefore, RDC eligibility, have been expanded to include flow and demand management projects. To qualify the flow and demand reduction projects must be shown as a clear alternative to the building of new, regional infrastructure to accommodate growth. This amendment provides alignment with the Integrated Resource Plan (IRP) objective 14: Manage flow and demand to maximize capacity for growth and minimize the need for new hard infrastructure.

For wastewater, flow management programs can target and reduce inflow and infiltration (I/I) from the wastewater system, allowing capacity for growth. This approach is eligible for RDC inclusion in the same way as the alternative of building a new pipe to service growth would be. There are several I/I reduction programs in the Infrastructure Master Plan. These plans were identified and evaluated to be the preferred solutions to provide capacity for growth. It is important that flow management projects be evaluated against hard infrastructure alternatives to ensure the most cost-effective approach is implemented.

Similarly, for water, if there are cost beneficial approaches focussed on demand management and reduction that could offset or remove the need for new, hard regional conveyance infrastructure then these too will be eligible for inclusion in the RDC.

In all cases the Benefit to Existing and post period deductions would follow from the initial project development and costing.

The additional definition to be added to the Rules and Regulations for water and wastewater are as follows:

Wastewater: In addition to the definitions of regional infrastructure (i,ii,iii) Inflow and Infiltration (I&I) flow reduction measures to provide capacity for growth and are a cost-effective alternative to new regional hard infrastructure are considered eligible for inclusion in the calculation of the RDC.

Water: In addition to the definitions of regional infrastructure (i,ii,iii) demand reduction measures to provide capacity for growth and are a cost-effective alternative to new regional hard infrastructure are considered eligible for inclusion in the calculation of the RDC.

6.9 Residential / Employment

The RDC eligible share of the capital program has been split residential and employment development. The Residential/Employment split is based on the growth projections defined under the Infrastructure Master Plan.

The rural/non-serviced population was excluded when determining the residential and employment population to accurately reflect future water and wastewater serviced areas. The residential growth (excluding rural growth) for the 20-year RDC horizon is 105,244 and employment was 67,176 for a total of 172,420 persons.

These numbers have been used to generate the Residential/Employment Split as shown in the Table 6 below.

Table 6: Residential/Employment Split

Category	Growth 2041	Growth 2046	Percentage Split 2041	Percentage Split 2046
Residential	105,244	131,213	61%	62%
Employment	67,176	79,086	39%	38%
Total	172,420	210,299	100%	100%

6.10 Residential / Non-Residential Allocation

For the RDC the density of single unit dwellings/townhouses (SUD/THs) is 3.35 persons per unit (PPU) and the density for multiple unit dwellings (MUDs) is 2.25.

This represents a ratio for SUD/THs to MUDs (relative density factor) of 1.5. These are the same values that were used for the previous 2014 RDC report and are also consistent with information available from Statistics Canada. For this report only SUD/THs and MUDs where evaluated, SUD/THs were determined to make up 45% of the residential units and MUDs make up the other 55%. This split is based on historical building permit data from HRM.

6.11 People Per Unit Calculation

The total growth population is divided by the People Per Unit (PPU) to estimated number of units which is then used to generate a RDC rate per unit. The previous 2014 RDC used 2.4PPU. The latest 2016 Census data states a PPU of 2.3, which has been applied to this RDC calculation.

Non-residential (i.e. commercial, industrial and institutional) RDCs are most often imposed on a cost per square feet of building space. For the Halifax Region a single, equally weighted, blended value of 733 sq. ft. per employee was agreed as the preferred option to represent ICI. This value is consistent with that used in the 2014 RDC.

6.12 Financial Modelling

Financial modelling incorporates actual RDCs collections, projected inflation, and balance financing. This approach is applied to projects that have a RDC benefit. The result is a regional development charge (base year 2019) which escalates yearly by Halifax CPI.

7 Recommended RDC Calculation

7.1 RDC Calculation Analysis

The 2019 RDC was calculated from the capital program list generated in the Infrastructure Master Plan, excluding projects that fell outside of the 2041 RDC horizon. The total RDC project cost was calculated by applying and removing the BTE, funding/subsides and post period benefit. The residential and non-residential percentage was then applied to each total RDC project cost to obtain the residential RDC and the non-residential RDC costs for water and wastewater.

The residential and non-residential RDC costs are allocated on a per unit basis to create the final RDC rates. The residential RDC unit rate was split into a SUD and MUD rate while the non-residential rate was based on floor area per person. These values underwent financial modelling analysis to include interest, debt financing and collections to date to produce the proposed 2020 RDC rates, effective May 1, 2020, as presented in Table 7 and Table 8.

Table 7: Residential RDC Unit Rate

Residential	Wastewater RDC Unit Rate ($/unit)	Water RDC Unit Rate ($/unit)	Total RDC Unit Rate ($/unit)
SUD	$ 4,941.04	$ 1,810.10	$ 6,751.14
MUD	$ 3,318.61	$ 1,215.74	$ 4,534.35

Table 8: Non-Residential RDC Unit Rate

Non-Residential	Wastewater RDC Unit Rate ($/sq m, $/sq ft)	Water RDC Unit Rate ($sq m, $/sq ft)	Total RDC Unit Rate ($sq m, $/sq ft)
Non-Residential	$25.83, $2.40	$9.47, $ 0.88	$35.30, $3.28

APPENDIX A

RDC CAPITAL PROGRAM

Wastewater RDC 2019 Program

Wastewater

Total 2046 Capital Program	$ 512,641,009
Total 2041 Capital Program	$ 489,224,009
Funding Subsidy	$ -
Benefit to Existing (BTE)	$ 151,479,090
Post Period Benefit	$ 60,834,547
Total Adjusted RDC Program	$ 276,910,372
Total Growth	172,420
Residential Growth	105,244
Residential Share (%)	61%
Employment Growth	67,176
Employment Share (%)	39%
Residential RDC Program	$ 169,024,215
Employment RDC Program	$ 107,886,157

										2016-2041			
										61%	39%		
Project ID	**Project Description**	**System**	**Projects Cost $ (2019)**	**Eligible RDC (Growth) (%)**	**Non-Eligible RDC (BTE/Local) (%)**	**Non-Eligible RDC Cost (BTE/Local) $ (2019)**	**Eligible RDC Cost (Growth) $ (2019)**	**Post Period Benefit (%)**	**Post Period Benefit $ (2019)**	**Adjusted RDC $ (2019)**	**Res RDC $ (2019)**	**Non-Res RDC $ (2019)**	**Period Req'd**	**Within RDC Horizon (Included/Not Included)**
AT2	Upgrade WWTF to service employment growth flows	Aerotech	$9,997,476	90%	10%	$999,748	$8,997,728	18%	$1,620,669	$7,377,059	$4,502,907	$2,874,152	2016-2021	Included
D1	LoWSCA: Canal Street Separation	Dartmouth	$1,842,000	75%	25%	$460,500	$1,381,500	18%	$248,836	$1,132,664	$691,371	$441,294	2016-2021	Included
D2a	LoWSCA: Wyse Road Separation - Phase 1	Dartmouth	$3,860,000	75%	25%	$965,000	$2,895,000	18%	$521,447	$2,373,553	$1,448,801	$924,752	2016-2021	Included
D2b	LoWSCA: Wyse Road Separation - Phase 2	Dartmouth	$2,802,000	25%	75%	$2,101,500	$700,500	18%	$126,174	$574,326	$350,565	$223,761	2021-2026	Included
D3	Additional Sewer Separation on Wyse Street	Dartmouth	$1,912,000	75%	25%	$478,000	$1,434,000	18%	$258,292	$1,175,708	$717,644	$458,064	2026-2031	Included
D5	Albro Lakes Watershed Separation	Dartmouth	$8,111,000	95%	5%	$405,550	$7,705,450	18%	$1,387,904	$6,317,546	$3,856,187	$2,461,359	2021-2026	Included
D6a-D6d	Maynard Lake and Clement Street Wetland Separation	Dartmouth	$6,790,000	95%	5%	$339,500	$6,450,500	18%	$1,161,863	$5,288,637	$3,228,148	$2,060,489	2026-2036	Included
D7	New Valleyford Pumping Station	Dartmouth	$10,446,000	25%	75%	$7,834,500	$2,611,500	18%	$470,383	$2,141,117	$1,306,923	$834,194	2036-2041	Included
D8	390 Waverley Road Upgrades	Dartmouth	$11,361,000	0%	100%	$11,361,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
D9	Anderson Pumping Station Upgrades	Dartmouth	$340,000	0%	100%	$340,000	$0	0%	$0	$0	$0	$0	2031-2036	Included
D10	Upgrades to Dartmouth WWTF	Dartmouth	$12,572,000	100%	0%	$0	$12,572,000	18%	$2,264,466	$10,307,534	$6,291,649	$4,015,885	2036-2041	Included
D11	I/I Reduction Program FMZ27	Dartmouth	$5,941,076	75%	25%	$1,485,269	$4,455,807	18%	$802,579	$3,653,228	$2,229,906	$1,423,322	2021-2026	Included
D12	I/I Reduction Program FMZ45	Dartmouth	$1,120,232	95%	5%	$56,012	$1,064,220	18%	$191,687	$872,533	$532,588	$339,945	2031-2036	Included
D13	Additional flow monitoring	Dartmouth	$252,000	10%	90%	$226,800	$25,200	18%	$4,539	$20,661	$12,611	$8,050	2016-2021	Included
D14	CSO Flow Management Plan	Dartmouth	$675,000	10%	90%	$607,500	$67,500	18%	$12,158	$55,342	$33,780	$21,562	2036-2041	Included
D15	Green St Upsize	Dartmouth	$513,000	0%	100%	$513,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
D16	Pinecrest Dr Upgrade	Dartmouth	$1,013,000	0%	100%	$1,013,000	$0	0%	$0	$0	$0	$0	2031-2036	Included
D17	Peddars Way Upgrade	Dartmouth	$555,000	0%	100%	$555,000	$0	0%	$0	$0	$0	$0	2031-2036	Included
D18	Atlantic Street Upgrade	Dartmouth	$3,831,000	0%	100%	$3,831,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
D19	Akerley Blvd and Railway Alignment Upgrade	Dartmouth	$4,814,000	75%	25%	$1,203,500	$3,610,500	18%	$650,323	$2,960,177	$1,806,872	$1,153,305	2036-2041	Included
D20	Pleasant Street Upgrade	Dartmouth	$767,000	0%	100%	$767,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
D21	Princess Margaret Blvd. Upgrade	Dartmouth	$3,106,000	0%	100%	$3,106,000	$0	0%	$0	$0	$0	$0	2031-2036	Included
D22	Anderson Lake Development Connection	Dartmouth	$7,609,000	0%	100%	$7,609,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
D23	Marvin Connection	Dartmouth	$1,380,000	5%	95%	$1,311,000	$69,000	18%	$12,428	$56,572	$34,531	$22,041	2026-2031	Included
D24	King Street Diversion	Dartmouth	$78,000	5%	95%	$74,100	$3,900	18%	$702	$3,198	$1,952	$1,246	2026-2031	Included
D25	Diversion to Eastern Passage	Dartmouth	$12,113,000	100%	0%	$0	$12,113,000	18%	$2,181,791	$9,931,209	$6,061,943	$3,869,266	2036-2041	Included
D26	SSO Flow Management Plan	Dartmouth	$555,000	0%	100%	$555,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
EP1-EP5	Gravity pressure sewer, pump out stations, surge tank gate valve, forcemain connections	Eastern Passage	$26,105,000	75%	25%	$6,526,250	$19,578,750	18%	$3,526,521	$16,052,229	$9,798,172	$6,254,057	2026-2031	Included
EP6	Upgrade Quigley's Corner Pumping Station	Eastern Passage	$2,875,000	5%	95%	$2,731,250	$143,750	18%	$25,892	$117,858	$71,940	$45,918	2021-2026	Included
EP7	Optimize Quigley's Corner PS	Eastern Passage	$336,000	5%	95%	$319,200	$16,800	18%	$3,026	$13,774	$8,408	$5,366	2021-2026	Included
EP8	Upgrade Memorial Drive Pumping Station	Eastern Passage	$2,633,000	0%	100%	$2,633,000	$0	0%	$0	$0	$0	$0	2031-2036	Included
EP9	Upgrade Beaver Crescent Pumping Station	Eastern Passage	$168,000	0%	100%	$168,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
EP10	Upgrade Bissett Lake Pumping Station	Eastern Passage	$2,934,000	50%	50%	$1,467,000	$1,467,000	18%	$264,236	$1,202,764	$734,159	$468,605	2036-2041	Included
EP11	Upgrade Caldwell Road Pumping Station	Eastern Passage	$631,000	75%	25%	$157,750	$473,250	18%	$85,242	$388,008	$236,838	$151,171	2036-2041	Included
EP12	I/I Reduction Program FMZ23	Eastern Passage	$3,204,580	95%	5%	$160,229	$3,044,351	18%	$548,348	$2,496,003	$1,523,543	$972,460	2031-2036	Included
EP13	I/I Reduction Program FMZ24	Eastern Passage	$1,570,040	95%	5%	$78,502	$1,491,538	18%	$268,656	$1,222,882	$746,439	$476,443	2016-2021	Included
EP14	I/I Reduction Program FMZ37	Eastern Passage	$2,479,704	95%	5%	$123,985	$2,355,718	18%	$424,312	$1,931,407	$1,178,918	$752,489	2016-2021	Included
EP15	Local network upgrades on Caldwell Road	Eastern Passage	$607,000	75%	25%	$151,750	$455,250	18%	$82,000	$373,250	$227,830	$145,421	2036-2041	Included
EP16	Local network upgrades on Colby Drive	Eastern Passage	$1,176,000	0%	100%	$1,176,000	$0	0%	$0	$0	$0	$0	2031-2061	Included
EP17	Local network upgrades on Forest Hill Parkway	Eastern Passage	$4,275,000	0%	100%	$4,275,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
EP18	SSO Management Study	Eastern Passage	$484,000	0%	100%	$484,000	$0	0%	$0	$0	$0	$0	2021-2026	Included

Wastewater RDC 2019 Program

Project ID	Project Description	System	Projects Cost $ (2019)	Eligible RDC (Growth) (%)	Non-Eligible RDC (BTE/Local) (%)	Non-Eligible RDC Cost (BTE/Local) $ (2019)	Eligible RDC Cost (Growth) $ (2019)	Post Period Benefit (%)	Post Period Benefit $ (2019)	Adjusted RDC $ (2019)	Res RDC $ (2019)	Non-Res RDC $ (2019)	Period Req'd	Within RDC Horizon (Included/Not Included)
MC1-MC3	Trunk Sewer Upgrades (Sackville Trunk Upgrades)	Mill Cove	$13,491,000	75%	25%	$3,372,750	$10,118,250	18%	$1,822,497	$8,295,753	$5,063,671	$3,232,082	2036-2041	Included
MC4	Storage Tank	Mill Cove	$17,469,000	95%	5%	$873,450	$16,595,550	18%	$2,989,187	$13,606,363	$8,305,232	$5,301,131	2031-2036	Included
MC5	Fish Hatchery Park Pumping Station Upgrade	Mill Cove	$10,529,000	50%	50%	$5,264,500	$5,264,500	18%	$948,241	$4,316,259	$2,634,615	$1,681,644	2031-2036	Included
MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	Mill Cove	$1,090,000	0%	100%	$1,090,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC7	Mill Cove Wastewater Treatment Plant Capacity Upgrade	Mill Cove	$89,256,000	50%	50%	$44,628,000	$44,628,000	18%	$8,038,386	$36,589,614	$22,334,052	$14,255,561	2021-2026	Included
MC8	I/I Reduction Program FMZ07, FMZ10, & FMZ40	Mill Cove	$9,288,248	95%	5%	$464,412	$8,823,836	18%	$1,589,348	$7,234,488	$4,415,883	$2,818,606	2016-2021	Included
MC9	I/I Reduction Program FMZ02 & FMZ03	Mill Cove	$8,023,065	95%	5%	$401,153	$7,621,912	18%	$1,372,857	$6,249,055	$3,814,381	$2,434,674	2031-2036	Included
MC10	Local network upgrades on Beaver Bank Rd. North on Glendale Dr.	Mill Cove	$2,086,000	0%	100%	$2,086,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	Mill Cove	$1,490,000	0%	100%	$1,490,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	Mill Cove	$1,667,000	0%	100%	$1,667,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	Mill Cove	$845,000	0%	100%	$845,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC14	Local network upgrades on Hallmark Ave.	Mill Cove	$437,000	0%	100%	$437,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC15	Local Sewer Upgrades for Waterfront Drive	Mill Cove	$500,000	0%	100%	$500,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
MC16	Springfield Lake Connection to Sackville	Mill Cove	$6,226,000	50%	50%	$3,113,000	$3,113,000	18%	$560,713	$2,552,287	$1,557,899	$994,388	2041-2046	Not Included
MC17	SSO Management Study	Mill Cove	$1,086,000	0%	100%	$1,086,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	$7,281,000	50%	50%	$3,640,500	$3,640,500	18%	$655,726	$2,984,774	$1,821,886	$1,162,888	2016-2021	Included
WR2	WRWIP: Young Street Area Sewer Separation	Halifax	$21,879,000	75%	25%	$5,469,750	$16,409,250	18%	$2,955,631	$13,453,619	$8,211,998	$5,241,621	2016-2021	Included
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	$14,752,000	95%	5%	$737,600	$14,014,400	18%	$2,524,271	$11,490,129	$7,013,497	$4,476,632	2016-2021	Included
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	$221,000	0%	100%	$221,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
WR7	WRWIP: Young Pumping Station Upgrade	Halifax	$2,169,000	95%	5%	$108,450	$2,060,550	18%	$371,146	$1,689,404	$1,031,201	$658,203	2026-2031	Included
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	Halifax	$3,850,000	50%	50%	$1,925,000	$1,925,000	18%	$346,731	$1,578,269	$963,365	$614,904	2016-2021	Included
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	Halifax	$15,491,589	95%	5%	$774,579	$14,717,009	18%	$2,650,825	$12,066,185	$7,365,117	$4,701,067	2016-2021	Included
WR19	WRWIP: Fairview Cove Linear Upsize	Halifax	$19,781,000	75%	25%	$4,945,250	$14,835,750	18%	$2,672,212	$12,163,538	$7,424,541	$4,738,997	2016-2021	Included
WR21	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	$2,997,000	95%	5%	$149,850	$2,847,150	18%	$512,828	$2,334,322	$1,424,854	$909,468	2031-2036	Included
WR10-WR12	WRWIP: BLT WWTF Decommission and new Timberlea PS & Forcemain	BLT	$25,864,000	95%	5%	$1,293,200	$24,570,800	18%	$4,425,688	$20,145,112	$12,296,440	$7,848,672	2016-2021	Included
WR14-WR17	WRWIP: BLT Flow Diversion to Herring Cove	BLT	$24,674,000	95%	5%	$1,233,700	$23,440,300	18%	$4,222,062	$19,218,238	$11,730,682	$7,487,556	2031-2036	Included
WR18	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	$7,439,000	95%	5%	$371,950	$7,067,050	18%	$1,272,916	$5,794,134	$3,536,700	$2,257,434	2031-2036	Included
WR22	Infrastructure Master Plan: CSO Management Study	Halifax	$965,000	10%	90%	$868,500	$96,500	18%	$17,382	$79,118	$48,293	$30,825	2016-2021	Included
WR23	Infrastructure Master Plan: SSO Management Study	Halifax	$415,000	0%	100%	$415,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
WR20	WRWIP: Halifax Treatment Plant Capacity Upgrade	Halifax	$25,142,000	95%	5%	$1,257,100	$23,884,900	18%	$4,302,143	$19,582,757	$11,953,182	$7,629,575	2036-2041	Included
WR8	WRWIP: New Fairfield Holding Tank	Halifax	$12,403,000	50%	50%	$6,201,500	$6,201,500	18%	$1,117,013	$5,084,487	$3,103,536	$1,980,951	2041-2046	Not Included
		TOTAL 2046 Projects	**$512,641,009**			**$165,581,590**	**$347,059,420**		**$62,512,273**	**$284,547,147**	**$173,685,651**	**$110,861,496**		
		TOTAL Post 2041 Projects	**$23,417,000**			**$14,102,500**	**$9,314,500**		**$1,677,726**	**$7,636,774**	**$4,661,435**	**$2,975,339**		
		TOTAL 2041 Projects	**$489,224,009**			**$151,479,090**	**$337,744,920**		**$60,834,547**	**$276,910,372**	**$169,024,215**	**$107,886,157**		

Water RDC 2019 Program

Water

Total 2046 Capital Program	$	278,497,000
Total 2041 Capital Program	$	257,210,000
Funding Subsidy	$	-
Benefit to Existing (BTE)	$	144,791,754
Post Period Benefit	$	20,248,752
Total Adjusted RDC Program	$	92,169,494
Total Growth		172,420
Residential Growth		105,244
Residential Share (%)		61%
Employment Growth		67,176
Employment Share (%)		39%
Residential RDC Program	$	56,259,635
Employment RDC Program	$	35,909,859

											2016-2041			
											61%	39%		
Project ID	**Project Description**	**System**	**Projects Cost $ (2019)**	**Eligible RDC (Growth) (%)**	**Non-Eligible RDC (BTE/Local) (%)**	**Non-Eligible RDC Cost (BTE/Local) $ (2019)**	**Eligible RDC Cost (Growth) $ (2019)**	**Post Period Benefit (%)**	**Post Period Benefit $ (2019)**	**Adjusted RDC $ (2019)**	**Res RDC $ (2019)**	**Non-Res RDC $ (2019)**	**Period Req'd**	**Within RDC Horizon (Included/Not Included)**
W06.1	Chain Control Transmission - Existing Peninsula Low Upsize	Pockwock - Peninsula	$3,841,000	75%	25%	$960,250	$2,880,750	18%	$518,880	$2,361,870	$1,441,669	$920,201	2021-2026	Included
W06.2	Chain Control Transmission - Existing Peninsula Intermediate Upsize	Pockwock - Peninsula	$2,650,000	75%	25%	$662,500	$1,987,500	18%	$357,988	$1,629,512	$994,643	$634,869	2021-2026	Included
W06.3	Pepperell Transmission	Pockwock - Peninsula	$2,702,000	75%	25%	$675,500	$2,026,500	18%	$365,013	$1,661,487	$1,014,161	$647,327	2036-2041	Included
W06.4	Chain Control Transmission - Existing Peninsula Low Lining	Pockwock - Peninsula	$2,916,000	75%	25%	$729,000	$2,187,000	18%	$393,922	$1,793,078	$1,094,483	$698,595	2036-2041	Included
W06.5	Chain Control Transmission - Valve Chambers	Pockwock - Peninsula	$1,258,000	75%	25%	$314,500	$943,500	18%	$169,943	$773,557	$472,174	$301,383	2036-2041	Included
W07	Replace High Risk Peninsula Transmission (Robie)	Pockwock - Peninsula	$17,312,000	0%	100%	$17,312,000	$0	0%	$0	$0	$0	$0	2026-2031	Included
W08	Peninsula Intermediate Looping - Quinpool Rd to Young St	Pockwock - Peninsula	$4,319,000	75%	25%	$1,079,750	$3,239,250	18%	$583,453	$2,655,797	$1,621,080	$1,034,716	2021-2026	Included
W10.1	Young St Upsize	Pockwock - Peninsula	$1,315,000	75%	25%	$328,750	$986,250	18%	$177,643	$808,607	$493,568	$315,039	2026-2031	Included
W10.2	Robie St Upsize	Pockwock - Peninsula	$956,000	75%	25%	$239,000	$717,000	18%	$129,146	$587,854	$358,822	$229,032	2026-2031	Included
W10.3	Almon St Upsize	Pockwock - Peninsula	$1,168,000	75%	25%	$292,000	$876,000	18%	$157,785	$718,215	$438,394	$279,821	2026-2031	Included
W10.4	Windsor St Upsize	Pockwock - Peninsula	$1,004,000	75%	25%	$251,000	$753,000	18%	$135,630	$617,370	$376,838	$240,531	2026-2031	Included
W01.1	Geizer 158 to Lakeside High Looping	Pockwock - Other	$2,249,000	0%	100%	$2,249,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W01.2	Gravity Supply to Brunello	Pockwock - Other	$2,328,000	0%	100%	$2,328,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W01.3	Dominion Cres Upsize	Pockwock - Other	$447,000	0%	100%	$447,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W01.4	Brunello Booster Pump Upgrades	Pockwock - Other	$236,000	0%	100%	$236,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W02	Geizer 158 Looping - Lacewood Dr	Pockwock - Other	$2,002,000	0%	100%	$2,002,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W03	Geizer Hill Booster Pump Upgrades	Pockwock - Other	$277,000	0%	100%	$277,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W04	Leiblin Booster Fire Pump	Pockwock - Other	$395,000	0%	100%	$395,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W05.1	Herring Cove Rd Twinning	Pockwock - Other	$3,585,000	0%	100%	$3,585,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W05.2	St Michaels Ave Upsize	Pockwock - Other	$502,000	0%	100%	$502,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W05.3	Herring Cove Rd Looping - McIntosh St	Pockwock - Other	$2,272,000	0%	100%	$2,272,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W12.1	Lucasville Rd Twinning (Phase 1)	Pockwock - Other	$8,117,000	100%	0%	$0	$8,117,000	18%	$1,462,032	$6,654,968	$4,062,147	$2,592,820	2016-2021	Included
W12.2	Lucasville Rd Twinning (Phase 2)	Pockwock - Other	$8,956,000	100%	0%	$0	$8,956,000	18%	$1,613,153	$7,342,847	$4,482,024	$2,860,823	2026-2031	Included
W13.1	New Primary Feed to Sackville High	Pockwock - Other	$4,953,000	100%	0%	$0	$4,953,000	18%	$892,133	$4,060,867	$2,478,725	$1,582,141	2026-2031	Included
W13.2	New Sackville Beaver Bank Valve Chamber	Pockwock - Other	$839,000	100%	0%	$0	$839,000	18%	$151,121	$687,879	$419,877	$268,003	2026-2031	Included
W13.3	Reconfiguration of Beaver Bank Booster	Pockwock - Other	$100,000	0%	100%	$100,000	$0	0%	$0	$0	$0	$0	2026-2031	Included
W13.4	New Sackville High PRV	Pockwock - Other	$420,000	100%	0%	$0	$420,000	18%	$75,650	$344,350	$210,189	$134,161	2026-2031	Included
W14.1	Cobequid High Looping	Pockwock - Other	$2,233,000	75%	25%	$558,250	$1,674,750	18%	$301,656	$1,373,094	$838,127	$534,967	2026-2031	Included
W14.2	Windgate Dr Upsize	Pockwock - Other	$882,000	75%	25%	$220,500	$661,500	18%	$119,149	$542,351	$331,047	$211,304	2026-2031	Included
W15	Lively Booster Pump Upgrades	Pockwock - Other	$38,000	0%	100%	$38,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
W17	Pockwock Transmission Loop through Bedford	Pockwock - Other	$5,069,000	0%	100%	$5,069,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W20	Second Geizer 158 Feed	Pockwock - Other	$9,612,000	0%	100%	$9,612,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included

Water RDC 2019 Program

Project ID	Project Description	System	Projects Cost $ (2019)	Eligible RDC (Growth) (%)	Non-Eligible RDC (BTE/Local) (%)	Non-Eligible RDC Cost (BTE/Local) $ (2019)	Eligible RDC Cost (Growth) $ (2019)	Post Period Benefit (%)	Post Period Benefit $ (2019)	Adjusted RDC $ (2019)	Res RDC $ (2019)	Non-Res RDC $ (2019)	Period Req'd	Within RDC Horizon (Included/Not Included)
W22.1	New Main Street to Caledonia Road Connection	Lake Major	$3,072,000	0%	100%	$3,072,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W22.2	Caledonia Rd Twinning	Lake Major	$3,429,000	0%	100%	$3,429,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W22.3	New Breeze Dr Watermain	Lake Major	$5,801,000	0%	100%	$5,801,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W23	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	Lake Major	$6,063,000	0%	100%	$6,063,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W24	Windmill Rd Upsize	Lake Major	$6,104,000	75%	25%	$1,526,000	$4,578,000	18%	$824,588	$3,753,412	$2,291,057	$1,462,355	2026-2031	Included
W25	New Woodside Industrial Park Feed	Lake Major	$1,649,000	0%	100%	$1,649,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W26	Willowdale to Eastern Passage Connection	Lake Major	$6,290,000	0%	100%	$6,290,000	$0	0%	$0	$0	$0	$0	2036-2041	Included
W28	Tacoma PRV Chamber	Lake Major	$420,000	0%	100%	$420,000	$0	0%	$0	$0	$0	$0	2021-2026	Included
W19.1	Pockwock Transmission Twinning - 60in	System Interconnections Pockwock Transmission WTP Decommissioning	$65,516,000	37%	63%	$41,340,987	$24,175,013	18%	$4,354,398	$19,820,614	$12,098,369	$7,722,246	2031-2036	Included
W19.2	Pockwock Transmission Twinning - 54in		$16,228,000	37%	63%	$10,239,965	$5,988,035	18%	$1,078,564	$4,909,471	$2,996,708	$1,912,763	2036-2041	Included
W21	Extension to Springfield Lake		$3,043,000	0%	100%	$3,043,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W29.1-W29.2	Bedford-Burnside System Interconnection		$36,278,000	47%	53%	$19,213,883	$17,064,117	18%	$3,073,585	$13,990,532	$8,539,726	$5,450,806	2036-2041	Included
W30.1	Lyle Emergency Booster		$1,045,000	47%	53%	$553,462	$491,538	18%	$88,536	$403,002	$245,990	$157,012	2026-2031	Included
W30.2	Valving for Central Intermediate Boundary Change		$629,000	47%	53%	$333,137	$295,863	18%	$53,291	$242,572	$148,065	$94,508	2026-2031	Included
W31.1-W31.3	Extension of Fall River to Bennery Lake Airport System		$18,533,000	74%	26%	$4,814,320	$13,718,680	18%	$2,471,006	$11,247,674	$6,865,504	$4,382,170	2026-2031	Included
W32.1-W32.2	Decommission Miller Lake WSP		$689,000	0%	100%	$689,000	$0	0%	$0	$0	$0	$0	2016-2021	Included
W33.1-W33.2	Decommission Collins Park WSP		$1,254,000	0%	100%	$1,254,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W34.1-W34.2	Decommission Silversands WSP		$2,099,000	0%	100%	$2,099,000	$0	0%	$0	$0	$0	$0	2041-2046	Not Included
W40	Aerotech Storage		$4,752,000	75%	25%	$1,188,000	$3,564,000	18%	$641,947	$2,922,053	$1,783,601	$1,138,452	2021-2026	Included
W18	Chain Lake Backup Supply Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W27	Mt Edward Booster Fire Pump	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W29.3	New Orchard Control Chamber	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2021-2026	Included
W30.3	Robie Emergency Booster	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2021-2026	Included
W35	Safe Yield Study	Studies	$100,000	50%	50%	$50,000	$50,000	18%	$9,006	$40,994	$25,022	$15,972	2016-2021	Included
W36	New Hydraulic Water Model (InfoWater)	Studies	$200,000	50%	50%	$100,000	$100,000	18%	$18,012	$81,988	$50,045	$31,943	2016-2021	Included
W37	Comprehensive PRV Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W38	Transmission Main Risk Assessment and Prioritization Framework	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2016-2021	Included
W39	Tomahawk Lake Supply Study	Studies	$50,000	50%	50%	$25,000	$25,000	18%	$4,503	$20,497	$12,511	$7,986	2036-2041	Included
		TOTAL 2046 Projects	**$278,497,000**			**$166,078,754**	**$112,418,246**		**$20,248,752**	**$92,169,494**	**$56,259,635**	**$35,909,860**		
		TOTAL Post 2041 Projects	**$21,287,000**			**$21,287,000**	**$0**		**$0**	**$0**	**$0**	**$0**		
		TOTAL 2041 Projects	**$257,210,000**			**$144,791,754**	**$112,418,246**		**$20,248,752**	**$92,169,494**	**$56,259,635**	**$35,909,860**		

APPENDIX B

BENEFIT TO EXISTING (BTE) POSITION PAPER

Benefit to Existing Position Paper

Technical Memorandum

2019 Regional Development Charge

Prepared by GM BluePlan for:

The Halifax Regional Water Commission

Project No. 719008

April 2019

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1 Introduction

1.1 Background and Context

Halifax Regional Water Commission (HRWC) retained GM BluePlan to undertake the West Region Wastewater Infrastructure Plan (WRWIP) project. The scope of the project included the development of a position paper regarding infrastructure costs resulting from development growth providing a Benefit to Existing (BTE) customers and ‘Out of Period’ oversizing of projects where the beneficiary of new infrastructure is beyond the 20 year time frame of the Regional Development Charge (RDC).

The regional infrastructure projects identified through Long Term Planning studies that are triggered by growth, should be paid for by growth. However, in some cases the projects and infrastructure that are recommended could provide tangible benefit to the existing population. For the initial RDC implementation this assessment was based on a review of the individual projects and an estimated reduction percentage BTE, generally 5%, 10% or 15%, was applied accordingly.

Further to understanding BTE and oversizing calculations in a regional infrastructure and greenfield development context, there is a lack of definition regarding intensification, brownfield developments and the appropriate split of costs, especially where existing capacity constraints are identified.

1.2 Development Charges

Many cities and towns face development pressure, which requires the expansion of existing or the installation of new infrastructure systems to support new development and its demand on utilities and services. However, the costs associated with these infrastructure requirements create significant public sector burden. Increasingly all governments are facing significant constraints in the use of general purpose taxation and have placed greater emphasis on the “user pay”, or “benefiter pay”, principle. In response to these pressures, Development Charges (DCs) have been utilized by municipal governments and utility providers as a cost recovery mechanism for apportioning infrastructure project costs amongst developers of land who will benefit from and require the servicing.

DCs allow monies to be pooled from many developers so that funds can be raised to construct the necessary services in an equitable manner. Simply, the municipality or utility owner can be considered to be the coordinator of the capital program and administrator of the funds collected. (Development Cost Charge Best Practices, British Columbia, Ministry of Community Services, 2000)

1.3 Purpose, Aims and Objectives

The purpose of this Memorandum is to provide a position paper to inform and provide decision support for Halifax Water to identify the approach to the cost splits of capital projects regarding growth, BTE and oversizing.

The paper will review and document industry best practices regarding the application of BTE and oversizing calculation, present options and recommend a preferred position.

The primary aim of the task is:

- To recommend preferred approaches to the identification of Benefit to Existing and ‘out of period’ oversizing infrastructure project cost allocation.

To achieve the aim, the objectives of the task are:

- To review and document industry best practice
- Document the key components of BTE and oversizing
- Consider the differences between greenfield and brownfield/intensification development.

2 Current Situation

2.1 Historic Overview

The following section summarizes the history of development charges in HRM.

In August 2000 Halifax Regional Municipality (HRM) undertook to develop a policy for implementing Infrastructure Charges in the Municipality. The result was the INFRASTRUCTURE CHARGES BEST PRACTICE GUIDE:

2.1.1 Capital Cost Contribution Policy (CCC)

This Guide addresses the legislation, policies and practices relevant to cost apportionment for new infrastructure in the Municipality on a site specific level. It proposes a policy for recovery of infrastructure charges in the Municipality. The charge recovered under the policy is intended to capture costs directly attributable to the subdivision of land - rather than all costs associated with new infrastructure required for the “core” area of the Municipality. The policy is designed to allow the Municipality to apportion the costs associated with new infrastructure without unduly impacting normal market forces and conditions.

The CCC Policy relates to specific areas or sites. The definition of the areas are confirmed through infrastructure planning studies. Once identified the cost of infrastructure required to service the site is calculated which is then apportioned amongst the developers of the site. The CCC does not include provision of costs related to regional infrastructure such as large trunk sewers, regional pumping stations or regional treatment facilities.

2.1.2 Regional Development Charge

In 2014 the Nova Scotia Utility and Review Board (NSUARB) approved Halifax Water’s application for approval of amendments to the *Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services*, to establish separate Regional Development Charges (RDCs) for water and wastewater, and to eliminate the charges for trunk sewer and sewer redevelopment. The RDC is a regional charge and is separate to the site specific CCC. The key premise of the RDC is to ensure that growth will pay for growth and is focused on the recovery of costs of only those infrastructure needs which are defined as regional.

The RDC charge for water and wastewater infrastructure was based on the Integrated Resource Plan (IRP) project list. The BTE of those projects was estimated based on the hydraulic modelling results, engineering judgement and industry averages. This resulted in many of the projects being allocated a BTE as a percentage of total project cost, generally between 0% and 15%. The approach was acknowledged as high-level and traceable although simplistic and provided an initial consideration of BTE. The NSUARB RDC hearing decision included the following summary and direction regarding BTE:

> “*The Board has considered the evidence and it appears that no one is opposed to the concept of BTE, but it is the amount and accuracy of the BTE which is questioned.*

> *[204] HRWC has calculated the BTE based on how other municipalities (particularly in Ontario) have calculated the BTE and whether the existing population will benefit. In addition, HRWC also considered the level of service and flooding improvements as factors in determining the BTE.*
>
> *[205] HRWC reviewed each project considering these factors and assigned BTE values of 0% to 15% based on its judgement. HRWC also indicated that these values will be updated for each project when it prepares detailed engineering design and tender documents for each project. No contrary evidence was led about the BTE percentages or their application to specific projects.*
>
> *[206] Based on the above understanding, the Board approves the BTE as calculated by HRWC in the Application. The Board expects HRWC to update the BTE amounts during the engineering and tendering process when more accurate information becomes available. The updated BTEs will be incorporated into the calculation of the RDC in the five year reviews.*"

The approach to the calculation of BTE for the RWWFP was made more appropriate by the Regional context of the plan. The majority of the growth areas assessed consisted of greenfield areas, which generally have a limited impact on the existing system users. However, in an intensification context, such as Peninsula Halifax the impact of BTE could be more pronounced. Peninsula Halifax is fully developed, has older infrastructure and has existing capacity constraints. Any new, improved, upsized infrastructure or measures to recapture capacity will most likely create a benefit to existing users. A key aim of this paper is to provide feasible options to approach this situation resulting in an equitable and transparent approach to BTE apportionment.

3 Definitions

The following sections provide detailed descriptions of the various terms that are relevant to Development Charges policies. Some terms, such as oversizing and post period are similar in context but should be distinct in application. For the purposes of this position paper and future discussion it is recommended that these definitions remain and are understood by all involved stakeholders. It is imperative that the final agreed terminology adopted is used consistently by Halifax Water in all long term infrastructure planning and development charge discussions.

3.1.1 Local and Regional Service Policy

A Local and Regional Service Policy sets out the fundamental criteria for what infrastructure is eligible for Development Charges.

For Halifax Water two charges are applicable. The area master infrastructure development charge, administered through the Capital Cost Contribution (CCC) policy and the regional infrastructure development charges, administered through the Regional Development Charge (RDC). Both have definitions of what infrastructure is eligible. The following text relates to the definition of regional infrastructure and by virtue of this definition all other infrastructure is considered local infrastructure.

For Halifax Water Regional Infrastructure is defined in the SCHEDULE OF RATES, RULES & REGULATIONS FOR WATER, WASTEWATER, and STORMWATER SERVICES
Effective July 1, 2013, as amended.

Wastewater Infrastructure means core regional wastewater treatment facilities and trunk sewer systems directly conveying wastewater to, or between, such facilities, including:

i. existing wastewater treatment facilities (WWTF) that provide a regional service including the facilities generally known as the Halifax WWTF, Dartmouth WWTF, Herring Cove WWTF, Eastern Passage WWTF, Mill Cove WWTF and Beechville/ Lakeside/ Timberlea WWTF,

ii. trunk sewers and related appurtenances which directly convey wastewater to regional treatment facilities, and

iii. trunk sewers and related appurtenances which divert wastewater from one regional treatment facility to another due to environmental concerns, capacity constraints or operational efficiency but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

Regional **Water Infrastructure** means core regional water supply facilities and the water transmission systems directly conveying water from such facilities to the various distribution systems, including:

i. existing water supply facilities that provide a regional service including the facilities generally known as the J.D. Kline water supply facility at Pockwock Lake and the
Lake Major water supply facility at Lake Major,

ii. water transmission mains and related appurtenances which directly convey water from regional treatment facilities to the distribution system, and

iii. water transmission mains and related appurtenances which divert water from one regional treatment facility supply area to another due to environmental concerns, capacity constraints or operational efficiency but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

3.1.2 Benefit to Existing (Non Growth)

Benefit to Existing (BTE) represents the non-growth components identified for certain projects which benefit the existing service area. These components are typically associated with upgrade to the existing systems or facilities necessary to continue to meet Level of Service targets for existing residential and ICI users. These projects may also involve or be triggered by upgrades or expansions which provide additional capacity to meet growth in the service area.

The premise is that any costs associated with BTE should be removed from the Regional Development Charge rate calculation. There are several ways to calculate BTE, each with advantages and disadvantages, which in many cases are dependent on the situation within which they are applied.

3.1.3 Post period benefit

Development charge planning horizons typically matches infrastructure master planning study horizons and are generally not less than 20 years. For Halifax Water's RDC a rolling 20 year horizon is required, as directed by the NSUARB. The RDC is to be updated every five years and supported by updated infrastructure master plan studies. The infrastructure master planning horizon is currently 30 years. It is good engineering and infrastructure planning practice to provide sufficient capacity to meet infrastructure servicing requirements beyond the RDC horizon (20 years), particularly for large diameter trunk piping and major structural components of facilities, based on assumed asset life, future projected growth beyond the RDC horizon and to mitigate impact of construction.

Post-period benefit is taken into account with projects that provide an additional allowance to service growth beyond the 20 year RDC horizon. The difference in cost for the recommended size of infrastructure to meet the RDC horizon (e.g. 20 years) and the size of infrastructure selected that would serve post period growth (e.g. to the 30 year master plan horizon) would be front end funded by Halifax Water and collected through future RDC updates as the rolling RDC horizon captures and justifies the need. Master plan 30 year horizon growth projections can be used to indicate the extent of additional flows beyond the planning horizon and used to assess the need and relative risk of oversizing.

4 Industry Review

4.1 Overview

To provide insight into the approach adopted by other utility providers the following provides a review of industry best practice. In particular, examples are taken from providers that have long established approaches, often substantiated with legislation to support them.

4.2 Ontario Development Charge Act (DCA)

Subsection 5(1) of the DCA sets out the method that must be used to determine development charges with the first step stating that:

"*The anticipated amount, type and location of development, for which development charges can be imposed, must be estimated.*"

Further steps refer to "*the increase in need for service attributable to the anticipated development.*" Therefore, the estimate of anticipated residential and non-residential development is a critical starting point to the process. Such development will generate increased servicing needs through its occupancy and use.

In Ontario the DCA requires that the amount, type and location of development be estimated. "Timing" is not referenced, other than indirectly, in Section 8 para 3 of O. Reg. 82/98, where capital costs to be incurred during the term of the proposed development charge by-law, must be set out. Also, s.s.5(1)4 of the Act restricts the estimate of the need for services other than water supply, wastewater, highways, storm water drainage and control … to a maximum of 10 years following the preparation of the Development Charges Background Study.

It is common practice in Ontario that water, wastewater and road service requirements are based on projected growth beyond the 10 year horizon to better capture the extended benefit, life and construction costs associated with longer term servicing requirement in a more equitable manner. The DC horizon is often based on Best Planning Estimates associated with Regional and Local Municipal Official Plans that are in conformity with Provincial Growth Targets. These horizons have been historically tied to projected census data years thus at 5 year intervals and out to Provincial target horizons of 2021, 2031 and 2041.

4.2.1 Development Charge Background Study

The Ontario Development Charges Act (DCA) requires that a Development Charge Background Study must be completed by Municipalities prior to passing a development charges by-law in an open and transparent manner. The Background Study should include:

- Anticipated amount, type and location of development
- Calculations for each service to which the development charge would relate to
- An examination, for each service to which the development charge by-law would relate, of the long term capital and operating costs for capital infrastructure required for the service
- Allocation of the estimated capital costs relating to each service between costs that would benefit new development and costs that would benefit existing development

- Total estimated capital costs relating to the service
- Total of the estimated capital costs relating to the service that will be incurred during the term of the proposed development charge
- Allocation of the total estimated capital costs between costs that would benefit new development and costs that would benefit existing development
- Estimated and actual value of credits that are being carried forward relating to the service

4.3 Best Practices: British Columbia

4.3.1 Program Time Frame

The appropriate time frame for the Development Cost Charges (DCC) program should be considered when developing a DCC bylaw. A certain time period is needed for looking at the estimation of new development and the capital projects required to service that new development. To this end, DCC programs can be established on either a “build out” or a “revolving” basis.

4.3.2 A Build-out Program

A build-out program, by definition, includes all the DCC projects which will need to be constructed to allow development to occur to the full extent and level defined by the Official Community Plan (OCP). The OCP usually involves a long time horizon, and the plan may not be fully realized for 20 or 25 years.

4.3.3 A Revolving Program

A revolving program is also consistent with the OCP, but consists of only those projects which are necessary to support development that is expected to occur in some defined time period such as five or ten years. In effect, a number of sequential revolving time windows together make up a build out program.

4.3.4 Criteria for Decision Making

Considerations regarding the decision to establish a build out or revolving program include:

- The type of capital projects in the DCC program (e.g., a sewage treatment plant would probably be constructed to build out service population);
- Cash flow requirements for DCC project construction, as monies may be collected faster with a shorter term program;
- The availability of long range plans for municipal servicing and land use;
- Cost-sharing equity between developers over time;
- DCC rate stability over time, as a revolving program may result in sharp increases/decreases;
- Flexibility to use DCC funds for projects where the timing has been advanced;
- Time and location sensitivity of development projections; and,
- Co-coordinating the time frame of the DCC program with the interval of time between major reviews of the OCP or the time period for a major amendment of the DCC and Zoning Bylaws.

4.3.5 Recommended Best Practice

The time frame for a DCC program should be tied into the time frame of a Financial Plan.

Beyond these considerations, reference is made to two other DCC issues: DCC recoverable costs and future bylaw administration. With respect to the former, the capital cost component should be consistent with the DCC time period. For example, the full costs associated with and the ultimate standard of construction (e.g., a multi-phased arterial road project) to be achieved within the next 20 years should not be included in a five year revolving DCC program. In this case, only the interim standard envisioned to be constructed in the next five years should be included in the immediate revolving program. Regarding the future administration of the bylaw, the time frame of the DCC program may impact how the various projects are monitored and tracked.

The inability to estimate future project costs adequately often makes creation of a build out program difficult. For road DCCs, long range corridors have to be sufficiently defined in the Master Transportation Plan. The level of information available from background stormwater management plans and studies, from sanitary sewer modelling and master sewerage plans, from water modelling studies, and from the Parks Master Plan and park policies in the OCP will affect whether compiling a build out program is feasible. However, a build out approach offers the most flexibility in relation to development sequencing and project construction timing, since all the projects needed to support build out of the entire OCP are included in the DCC program.

4.3.6 Development Charge Apportionment

It is acknowledged that the allocation of benefit may be difficult to quantify, especially if projects are being proposed for construction in ten or twenty years. Although an element of subjectivity will always exist, the rationale for apportionment of capital costs in the DCC bylaw should include supporting documentation, technically-based where possible.

Two approaches to allocating benefit are suggested below: a general “rule of thumb” approach, and a method based on some technical means. Either approach could be applied on a project by project basis or on the total value of the DCC program, depending on the types and nature of the capital improvements.

One way is to use the following “rule of thumb.” if construction of the proposed works would not proceed at all if there was no new development, then it would be fair to say that none of the costs should be paid by existing users. In other words, 100% of the costs would be attributable to new development and eligible for DCC recovery. In some cases, the marginal costs associated with “oversizing” may be assessed in this manner.

If it is evident that the existing public gains at least some benefit from new capital works and infrastructure improvements and that some benefit will be received by a component of growth that will not be reflected in new development units (and thus will not be subject to DCCs), then equitable assessment of that benefit is dependent upon selection of a suitable means for apportionment. For example, in the case of an arterial road, the capital costs could be apportioned according to traffic capacity, while for trunk sewers, costs could be split according to flow. Service population could also be a way of allocating benefit. If only a planning level of engineering analysis is available at the time of bylaw development, general ranges of benefit could be assigned based on technical data accompanied by good engineering judgement.

Example 1 Allocating Benefit	
Given: Sanitary Sewer Project Assumptions: • 250mm diameter pipe presently 50% full, good condition, no service issues. • 300mm diameter pipe required for new development	Using "rule of thumb" rationale, project would not proceed if it was not for new development needs. Therefore, benefit to new development = 100% and full cost for 300mm diameter sewer project are Developer funded through DCC.

Example 2 Allocating Benefit	
Given: Sanitary Sewer Project Assumptions: • 250mm diameter pipe presently leaking • replace with 300mm diameter pipe required for new development • 250mm diameter pipe replacement to cost $50,000 • 300mm diameter pipe replacement to cost $60,000	Allocating benefit according to the following rationale. The argument is that the sewer needs to be replaced anyway. Only apportion marginal cost between installation of 250mm diameter and 300mm diameter pipe to new development. Therefore benefits to new development = $10,000/ $60,000 = 17%

4.4 Cost Recovery Mechanism

4.4.1 British Columbia

Section 933 (5) of the Local Government Act states that DCCs are payable at the time of approval of subdivision or at the issuance of a building permit, as the case may be. In practice, DCCs are commonly collected:

- At the subdivision approval stage, or at the building permit stage for single family DCCs;
- Upon issuance of a building permit for multi-family, commercial and institutional DCCs; and,
- At subdivision approval or building permit issuance for industrial DCCs.

4.4.2 Ontario Development Charges Act

A development charge is payable for a development upon a building permit being issued for the development unless the development charge by-law provides otherwise under subsection (2). 1997, c. 27, s. 26 (1).

As a special case, for the approval of plan of subdivision a municipality may, in a development charge by-law, provide that a development charge for services set out in paragraphs 1, 2, 3, 4 or 5 of subsection 5 (5) for development that requires approval of a plan of subdivision under section 51 of the *Planning Act* or a consent under section 53 of the *Planning Act* and for which a subdivision agreement or consent agreement is entered into, be payable immediately upon the parties entering into the agreement. 1997, c. 27, s. 26 (2).

4.5 Review of Other Municipal Practices

GM BluePlan completed a review of other municipality's publically available information regarding Development Charges policy. Generally, the Development Charge rates are available but the specific details of approach, such as how was BTE actually calculated, was not readily available.

The case studies below, for the most part, are based on working knowledge and not publically available information. The examples have been chosen to highlight specific features relevant to the municipalities, such as: area specific DCs, approach to intensification DCs, inclusion of capacity gain projects (I/I reduction) and pre-defined DC growth/non growth splits.

4.5.1 Halton Region

4.5.1.1 Halton's Area Specific DC

The Region serves as an example of a municipality that has used an area specific approach to DCs in the past. One of the drivers for this was the "big pipe" transfer of lake-based water supply to the Town of Milton. The premise of separating the DCs for Milton from those of its neighbouring municipalities to the south, was based on the question of "*why should development outside of Milton help front the costs of infrastructure purely needed to meet growth in Milton?"* As a result, the Region adopted an area-specific DC for Milton.

4.5.1.2 Halton's Approach to Intensification Projects

Halton Region provides a good example of a municipality that demonstrates evolving DC policies over time. In 2012, the Region of Halton's DC Background Study identified specific intensification projects included in the DC. A new DC Eligibility Policy also included pipes smaller than the standard minimum size as defined through the Local Servicing Policy.

In the latest 2017 DC Background Study, projects have changed and Benefit to Existing review has been undertaken to include intensification projects. The Region of Halton's current DC policy framework accounts for residential versus employment growth, benefit to existing users of water and wastewater services, and benefit to growth beyond the Region's planning period (e.g. 2031). The Region recently underwent a process to review the need for infrastructure projects, which ranged from security/redundancy requirements, growth related, and non-growth related needs.

A Benefit to Existing (BTE) ratio was calculated as the ratio of the existing capacity deficiency, relative to the total increase in capacity required for both existing and growth needs. BTE was calculated as:

BTE = Existing deficiency / (growth flow + existing deficiency)

When considering intensification, critical security/redundancy requirements and impacts on critical existing trunk infrastructure were also considered. For projects involving construction in intensification areas, additional cost escalation factors were applied to project costs, providing additional provisions for utility coordination/relocation, urban reinstatement, and urban construction impacts.

The Region has adopted a capital implementation plan containing projects being classified into the following three categories:

1. ***Capacity:*** Projects related to Region-wide needs of water supply/wastewater treatment or supporting the transfer/conveyance of capacity.
2. ***Distribution – Greenfield:*** Projects that support service to Greenfield growth outside the current urban built boundary
3. ***Distribution – Built Boundary:*** Projects that support service to growth within the current urban built boundary, including infill and intensification within urban growth centres and corridors

Figure 1 illustrates the application of the above concept to a water distribution network. This simplified schematic shows a booster pumping station transferring water supply via a transmission watermain to the next subsequent pressure zone filling a reservoir within a greenfield area. The transmission watermain and pumping stations are Category 1 projects as they provide Region-wide capacity to the system. The reservoir is a Category 2 project as it supports growth to a greenfield area outside the built boundary. The local distribution watermains are Category 3 as they provide local distribution within the built boundary.

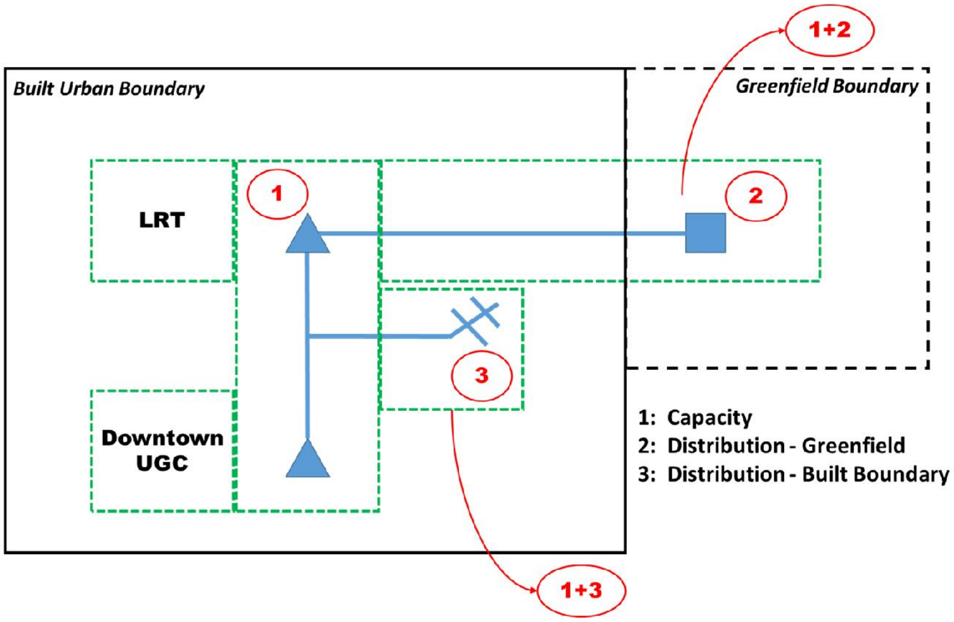

Figure 1. Project DC Classification Schematic

The cost of the distribution watermains will be split among Categories 1 and 3, as those projects benefit from the increased Region-wide capacity (Project 1) and from growth within the current urban built boundary (Project 3). Similarly, the cost of the reservoir will be split among Categories 1 and 2.

4.5.2 City of Hamilton: Pre-defined Growth/Non Growth Splits

The City of Hamilton identifies projects throughout the City and rolls the costs up into a uniform DC in order for the City to ensure securing DC funding for the budget year. The City now applies an intensification lump sum allowance, where the split is 50% development and 50% rate base.

The City of Hamilton has received full capital funding from the Province for a Light Rail Transit (LRT). Currently, the City is looking to initiate a study that will consider implications of the LRT on existing services, including relocation of existing infrastructure and sewer separation. This study will present an opportunity for the City to update the BTE approach specifically for intensification areas.

4.5.3 Region of Peel: Inclusion of I/I reduction costs in DCs

The Region of Peel's 2014 DC program resulted in additional programs that included $100 million for inflow and infiltration reduction mitigation measures and initiatives. The latest DC update includes a distribution and collection system review that will be used to identify further local water and wastewater projects. The Region, like the City of Hamilton, identifies all the projects and rolls them up into a uniform DC. However, with increased pressure for intensification growth and increased costs of infrastructure to extend services into greenfield areas, the Region is now undertaking area-specific cost reviews to assess value and cost of area-specific development (i.e. cost of infrastructure vs DC revenue).

4.5.4 City of Ottawa: Incentivizing Intensification Growth

DC rates sometimes reflect a municipality's desire to effect or promote more efficient land use. For instance, the City of Ottawa levies a lower DC ($16,447 / unit) for development within the inner boundary of the city's designated Greenbelt than areas beyond the outer boundary of the Greenbelt ($24,650 / unit).[1]

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[1] *Development Charge Consultation Document. Development Charges Act.*

5 Approaches to Calculation of BTE, Oversizing and Post Period Benefit

5.1 Benefit to Existing (BTE)

Benefit to Existing (BTE) represents the non-growth components identified for certain projects which benefit the existing service area. These components are typically associated with upgrades to the existing systems or facilities necessary to continue to provide or improve level of service to existing residential and business users. These projects may also involve upgrades or expansions which provide additional capacity to meet growth in the service area.

Described below are five approaches to the calculation of benefit to existing cost associated with infrastructure costs. Each has advantages and disadvantages in concept and application.

<u>Method 1 – Age of Pipe</u>

This approach is based on cost of pipe replacement, discounted for any residual life. The approach requires an assumption of pipe life expectancy, typically around 80 years. Where the existing pipe has exceeded the assumed life expectancy a default minimum percentage remaining (e.g. 10%) can be applied to acknowledge the fact that whilst the pipe has exceeded expected age it is still in serviceable condition and to acknowledge that infrastructure may exceed the estimated life in reality.

$$Unused\ life\ Credit = \frac{\text{Estimated Life} - \text{Current } Age}{\text{Estimated Life}}\ X\ (Cost\ of\ replacement)$$

The following provides a simplified hypothetical example to highlight the potential impact on the cost split calculation:

- Assume existing pipe is 300mmØ
- Assume existing pipe is 60 years old
- Assume life expectancy of 80 years
- Like for Like replacement value of 300mmØ is $800 k
- Under growth conditions a 400mmØ is required at a cost of $1 million

Cost of pipe replacement approach calculation:

Total growth project cost = $1 million
$1m - $800k (growth component only cost) = $200k (DC Cost)
80-60 = 20/80 = 0.25 (age factor) * $800k (cost of replacement) = $200k (DC Cost)
$800k (replacement cost) - $200k (BTE) = $600k (Total Rate Base Cost)
$200k (growth component cost) + $200k (age remaining cost) = $400k Total DC Cost

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Unused life credit provides estimate of BTE and allocates costs to Development	In downtown core many pipes exceed assumed life ages; no unused life credit but sewer still serviceable; does not take account of condition
Relatively easy to apply	Assumed life age definition subject to challenge
Understandable concept easy to communicate to stakeholders	Reliable pipe age data required to identify age of pipe
No specialist tools (e.g. hydraulic modelling software) required	Does not address new technologies that extends life expectancy of pipe infrastructure (i.e. structural pipe lining)

Method 2 - Level of Service Range Approach

The calculation of benefit to existing can be complicated. The following approach seeks to apply simplified rules that align with a utility's recognized levels of service. The simplicity of the approach provides transparency and understanding to all stakeholders.

The following defines suggested categories and associated cost splits that could apply for the varying potential circumstances.

Category	B.T.E. %	Description
B.T.E.1	5% B.T.E.	These projects are driven by growth and would not otherwise be considered. They could address some <u>very limited minor</u> existing deficiencies potentially related to level of service, security of supply, age, operational flexibility, condition or performance. **<u>EXAMPLE</u>**: • A replacement and upsizing is required to support growth in a new greenfield area • Replacement provides new service to new users and a replacement of the existing watermain • *Minor condition/age deficiency is addressed by construction of new watermain, therefore, 5% B.T.E. is applied*
B.T.E.2	25% B.T.E.	These projects are driven by growth and would not otherwise be considered. They will address <u>some known</u> existing deficiencies potentially related to operational issues or significant level of service, security of supply, age, operational flexibility, condition or performance. **<u>EXAMPLE:</u>** • A new development within an intensification area is to be serviced by an existing sewer which has known capacity deficiencies and modelled surcharging • A larger sewer is required to address the existing capacity constraint as well as to service growth

		- *Level of service / capacity deficiency is addressed by construction of new watermain, therefore 25% B.T.E. is applied*
B.T.E.3	50% B.T.E.	These projects equally provide additional capacity for growth as well as enhanced level of service in existing service areas. These projects address known existing deficiencies but also improve servicing conditions including security of supply/service. **EXAMPLE**: • A new development within an intensification area is to be serviced by an existing sewer which has significant known condition issues and significant capacity constraints including *modelled* surcharging and occasional *observed* surcharging and capacity constraints • A larger, new sewer is required to address the existing deficiencies as well as to service growth • *Level of service, capacity and condition/age deficiencies are addressed by construction of new sewer, therefore 50% B.T.E. is applied*
B.T.E.4	75% B.T.E.	These projects primarily provide enhanced level of service in existing service areas as well as provide additional capacity for growth. These projects address known existing deficiencies and also improve servicing conditions including security of supply/service. **EXAMPLE**: • A new development within an intensification area is to be serviced by an existing sewer which has significant known condition issues and significant capacity constraints including *modelled* flooding and occasional *observed* flooding and capacity constraints • A larger, new sewer is required to address the existing deficiencies as well as to service growth • *Level of service, capacity and condition/age deficiencies are primarily addressed by construction of new sewer, therefore 75% B.T.E. is applied*
B.T.E.5	Other	These projects do not fall within B.T.E.1-B.T.E.4 categories and may require a unique split based on project specific factors. **EXAMPLE**: • An existing sewage pumping station is deficient in pumping capacity, wet well storage capacity and standby power. Additionally, pumps and other mechanical equipment require replacement due to condition • Modifications to the station are recommended to address all issues, including pump replacement • The new pumps will be re-sized to accommodate both the increase in required existing flow as well as an additional marginal increase in capacity to accommodate small potential intensification developments • *Major capacity and level of service and condition constraints trigger the need for S.P.S. upgrade; only marginal increase in capacity is required, therefore an estimated 90% B.T.E. is applied to the project cost*

This approach applies cost splits as a predefined range based on Level of Service. Advantages and disadvantages are summarized as follows:

Advantages	Disadvantages
Provides a defined range of BTE estimates	High level rule of thumb methodology not supported by unique calculations
BTE splits relate directly to Level of Service	Open to some subjectivity
Understandable concept easy to communicate to stakeholders	Because of ranges applied some specific scenarios may not be accurately calculated
Allows for BTE differentiation between projects and scenarios	Requires availability of hydraulic modelling tools

Method 3 - Deficiency Ratio Approach

This approach requires the use of a hydraulic model to assess existing flows and existing capacity deficits to provide a ratio with proposed growth flows. The approach has been used by other municipalities for DC rate allocation. The analysis of capacity, in terms of which pipe to assess, can create some subjectivity and challenge to the approach. In addition, the technical nature of the method means that non-technical stakeholders can find it difficult to fully understand.

BTE share is ratio of the existing capacity deficiency, relative to the total increase in capacity required for both existing and growth scenarios.

BTE calculated as existing deficiency / (growth flow + existing deficiency)

An Example: an existing sewer has a pipe full capacity of 100l/s. Peak flows in the existing sewer are 120l/s. This results in an existing deficiency of 20l/s (120l/s – 100l/s = 20l/s). New proposed growth flows equate to 40l/s. The resulting equation is 20l/s (existing deficiency) / 60l/s (growth flow + existing deficiency) = 0.33 BTE factor.

*Could be applied on a sewershed basis

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Provides specific project by project BTE estimates	Requires and relies on availability and quality of hydraulic modelling tools and resources
Result is not skewed by proportion of existing flow in relation to growth flow	Requires significant technical assessment to identify existing capacity deficit, especially in a combined system
Deficiency ratio calculation provides equitable split of costs	Open to some subjectivity during assessment; what pipe, pipes etc. are included?
	Complex concept not easy to communicate to stakeholders
	Does not consider the end of life factor (e.g. If there is remaining capacity in the pipe (existing flow is 95 L/s) then there is no BTE, even if the pipe is 79 years old.)

Method 4 - Flow Ratio Approach

This approach is very similar to method 3. The difference is that existing capacity deficit is not calculated. It is just the existing versus growth flows that are assessed.

This is conceptually a very simple approach although requires an accurate hydraulic model or monitor data. BTE is calculated as the ratio between the existing sewer flows and the existing plus proposed growth flows.

BTE Calculated as existing flows / (growth flow + existing flows)

An Example: Peak flows in the existing sewer are 120l/s. New proposed growth flows equate to 40l/s. The resulting calculation is 120l/s (existing flows) / 160l/s (growth flow + existing flows) = 0.75 BTE factor.

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Provides a defined range of BTE estimates	Requires and relies on availability and quality of hydraulic modelling tools and resources
Potentially accurate calculation; project by project specific assessment	Concept and derivation of flow rates not easy to communicate to stakeholders
Easier to apply than the deficiency ratio approach	Not appropriate for combined systems where existing flows far exceed proposed growth flows.
Addresses the fact that the rate base is getting some benefit from the renewal of the existing pipe	If the existing pipe were only 5 years old, it does not address the fact that rate base doesn't need a new pipe (over charging the benefit to existing)

Method 5 – Default Percentage

This approach is the most simple and therefore requires the least amount of analysis. This approach has been used by municipalities for lump sum line items on DC programs before specific projects are defined.

An example could be that all projects within the regional centre are 50% development charges and 50% rate base.

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Most simple approach	Oversimplifies BTE calculation
No analysis required	No differentiation between different project scenarios
Understandable concept easy to communicate to stakeholders	Arbitrary split may not be equitable for individual projects but likely reasonable as an average.
Stakeholders more aware of eligible amounts	

The table below summarizes the advantages and disadvantages for each approach and assigns a score to each key criteria listed, where '✓' is the lowest or worst and '✓✓✓' is the highest or best score.

The categories used are described as follows:

- Simple concept: the ease of the approach to be understood by non-technical stakeholders
- Easy to apply: how easy and quickly the approach can be applied and the BTE calculation completed
- Technical Resources: the extent of technical staff and tools (software) required to complete the approach
- Potential Accuracy: how likely on a project by project basis the approach is able to calculate the most accurate BTE calculation
- Subject to Challenge: how many variables are used in the approach that could be subject to challenge by stakeholders
- Versatility: the ability of the approach to produce equitable results for various scenarios, project types and system types (i.e. combined, sanitary).
- Overall: a general assessment of the approach considering all criteria.

Method	Simple Concept	Easy to Apply	Technical Resources Required	Potential Accuracy	Subject to Challenge	Versatility	OVERALL
Method 1 – Age of Pipe	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓
Method 2 – Level of Service Range Approach	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓
Method 3 – Deficiency Ratio Approach	✓	✓	✓	✓✓✓	✓✓	✓✓✓	✓✓
Method 4 – Flow Ratio Approach	✓	✓	✓	✓	✓✓	✓	✓
Method 5 – Default Percentage	✓✓✓	✓✓✓	✓✓✓	✓	✓	✓✓	✓✓✓

6 Summary and Recommendations

6.1 Regional Development Charge

Halifax Water are committed to regular five-year reviews of the Regional Development Charge. It is recommended that aspects such as the calculation of Benefit to Existing that are presented in this memo be tested through application in the WRWIP project and finalized and documented in the upcoming RDC review. This will help ensure a robust and transparent RDC approach.

6.2 Benefit to Existing Calculation

It is recommended that each project be assessed individually to identify the BTE and RDC splits. No one method is applicable to every project and various data and tool limitations negate the effectiveness of others. New, all-pipe wastewater hydraulic models and updated water models are expected to be completed and available for use prior to the next full RDC application, expected in the fall of 2019.

Method 1: Age basis creates issues in the older systems where pipes are beyond service life assumptions but still provide adequate service. This issue highlights the need to look at some projects from an asset condition and performance or level of service rating perspective. Method 2: level of service overcomes the age and service life issues but mainly relies on a rule of thumb methodology which could be open to some subjectivity. Method 3: deficiency ratio and Method 4: flow ratio approach requires detailed hydraulic model tools and the approach does not allow flexibility for unique project factors.

During the 2013 RDC hearing the NSUARB commented favourably on the relationship of BTE to level of service. The goal of the approach is to create the most equitable splits of cost.

APPENDIX C

INFRASTRUCTURE MASTER PLAN EXECUTIVE SUMMARY

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

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EXECUTIVE SUMMARY

The Infrastructure Master Plan is a long-term infrastructure planning and engineering study to identify the optimal regional water and wastewater infrastructure implementation plan for Halifax Water to service growth until 2046.

The Infrastructure Master Plan expands on work completed by GM BluePlan under the West Region Wastewater Infrastructure Plan (WRWIP, 2017), which formalized the foundational policies of regional infrastructure planning in wastewater infrastructure needs and formed the servicing strategy for the West Region (Halifax, Beechville-Lakeside-Timberlea (BLT) and Herring Cove). The Infrastructure Master Plan incorporates the WRWIP and provides servicing strategies for the rest of the wastewater network, covering the Central and East Regions. The Infrastructure Master Plan then follows a similar approach for the water system, by formalizing the foundational policies of regional water infrastructure planning and forming a preferred servicing strategy that covers the regional water network for Halifax Water.

Aims and Objectives

The Infrastructure Master Plan has three distinct primary aims:

- To develop, evaluate, identify and detail the water and wastewater infrastructure servicing plans for Halifax Water to service growth to 2046.
- To integrate the WRWIP servicing strategy and its supporting studies into the Infrastructure Master Plan, forming a complete infrastructure master plan for Halifax Water.
- Provide value added through conceptual design and study scoping that support the Infrastructure Master Plan and enhance the preferred strategies.

To achieve the aims of the Infrastructure Master Plan the following objectives have been satisfied:

- Undertake a baseline review of the water and wastewater systems and update assumptions made in the WRWIP.
- In coordination with Halifax Regional Municipality (HRM) Planning Department and Halifax Water, determine baseline and growth planning projections for HRM.
- Review existing criteria, level of service, policy, legislation and best practices related to long term infrastructure planning for water and wastewater networks.
- Review and study potential wet weather management techniques that may be beneficial for overall system management (Wet Weather Flow Management Study).
- Create a Climate Change Management Framework and assess the impact of climate change on water and wastewater design standards.
- Host a series of workshops with Halifax Water Planning, Asset Management, Engineering and Operation staff to understand and document known opportunities and constraints in the water and wastewater networks.
- Build and enhance the modelling tools for Halifax Water through transitioning wastewater models to InfoWorks ICM and updating the existing WaterCAD models.
- Develop strategy solutions, cost estimates, and evaluate alternatives to identify preferred servicing strategies.
- Develop Capital Programs for the water and wastewater projects, studies and costs and identify an implementation phasing plan for the preferred servicing strategies.

- Undertake conceptual designs and study scoping for imminent projects were value can be added to the design.

Document Layout

The Infrastructure Master Plan is comprised of five Volumes as outlined in Executive Summary Figure 1.

VOLUMES:

- **Volume 1** – General Information and supporting studies
- **Volume 2** – Water Infrastructure for all Regions
- **Volume 3** – West Region Wastewater Infrastructure (Extracted from the WRWIP)
- **Volume 4** – Central Region Wastewater Infrastructure
- **Volume 5 –** East Region Wastewater Infrastructure

Executive Summary Figure 1: Infrastructure Master Plan Volume Layout

Volume 1 includes baseline information supporting the water and wastewater systems, the planning and growth projections, a summary of the standalone studies that were completed under the WRWIP and Infrastructure Master Plan, the general approach and methodologies used to develop the hydraulic model, strategy development processes used to form the final Capital Program, the conceptual designs completed and recommendations moving forward.

Volumes 2 to 5 cover the details within the water and wastewater networks, the unique features, opportunities and constraints in the networks, the assessment of alternatives and projects that lead to forming the preferred strategies, costing and phasing to form the Capital Programs.

As illustrated in Figure 1, the WRWIP has been incorporated into the Infrastructure Master Plan to form a complete master plan of the wastewater and water networks across Halifax Water.

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

VOLUME 1
GENERAL INFORMATION

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

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VOLUME 1 – GENERAL INFORMATION

Volume 1 covers the general information of the Infrastructure Master Plan. It starts out with outlining how the WRWIP has been integrated into the Infrastructure Master Plan, the aim and objectives, document layout, as described above. The subsequent sections of Volume 1 are summarized below.

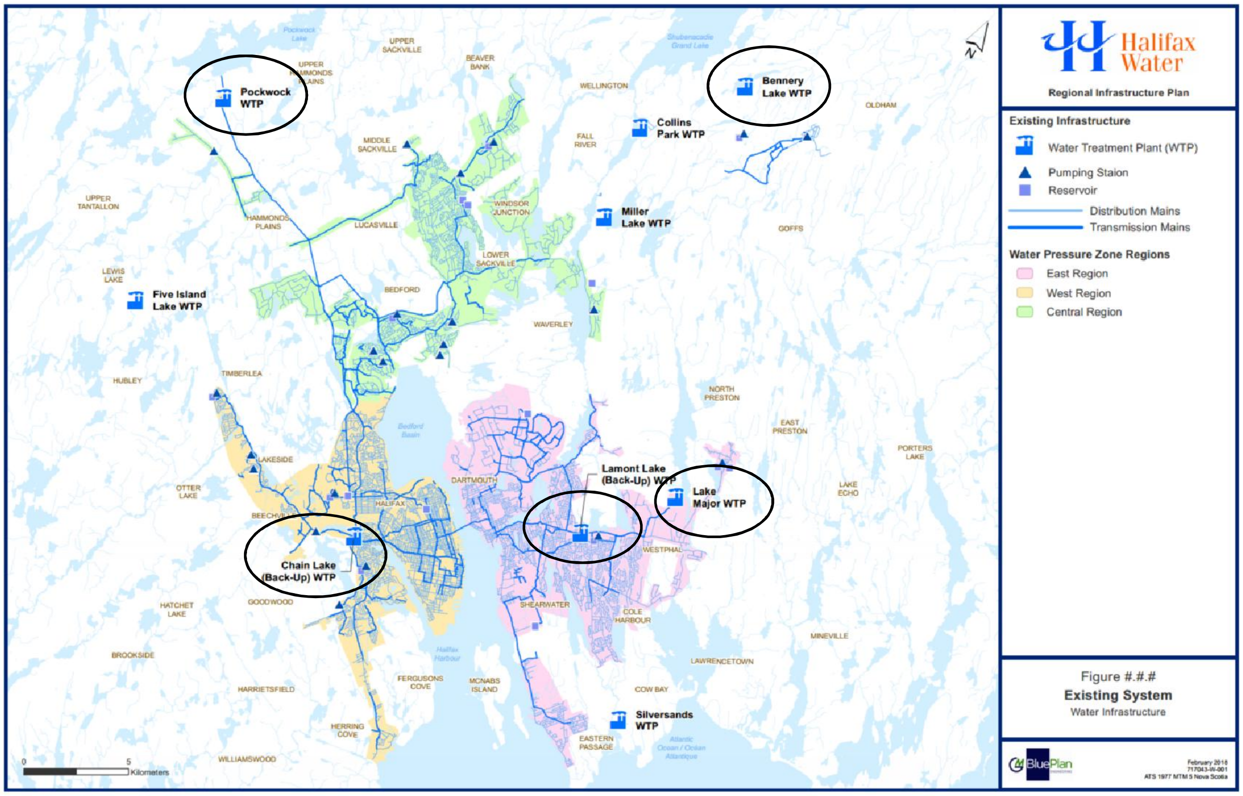
Baseline Review and Consultation

The baseline review and consultation process were completed to develop the team's project knowledge on the water and wastewater study areas, and form technically feasible and acceptable solutions. The background review included existing data available and past reports on infrastructure needs and requirements. The background review provided detailed understanding on the existing and potential future requirements on the water and wastewater study areas.

The Figures below provide a general overview of the systems and the location of the main water and wastewater facilities included in the Infrastructure Master Plan study.

WATER

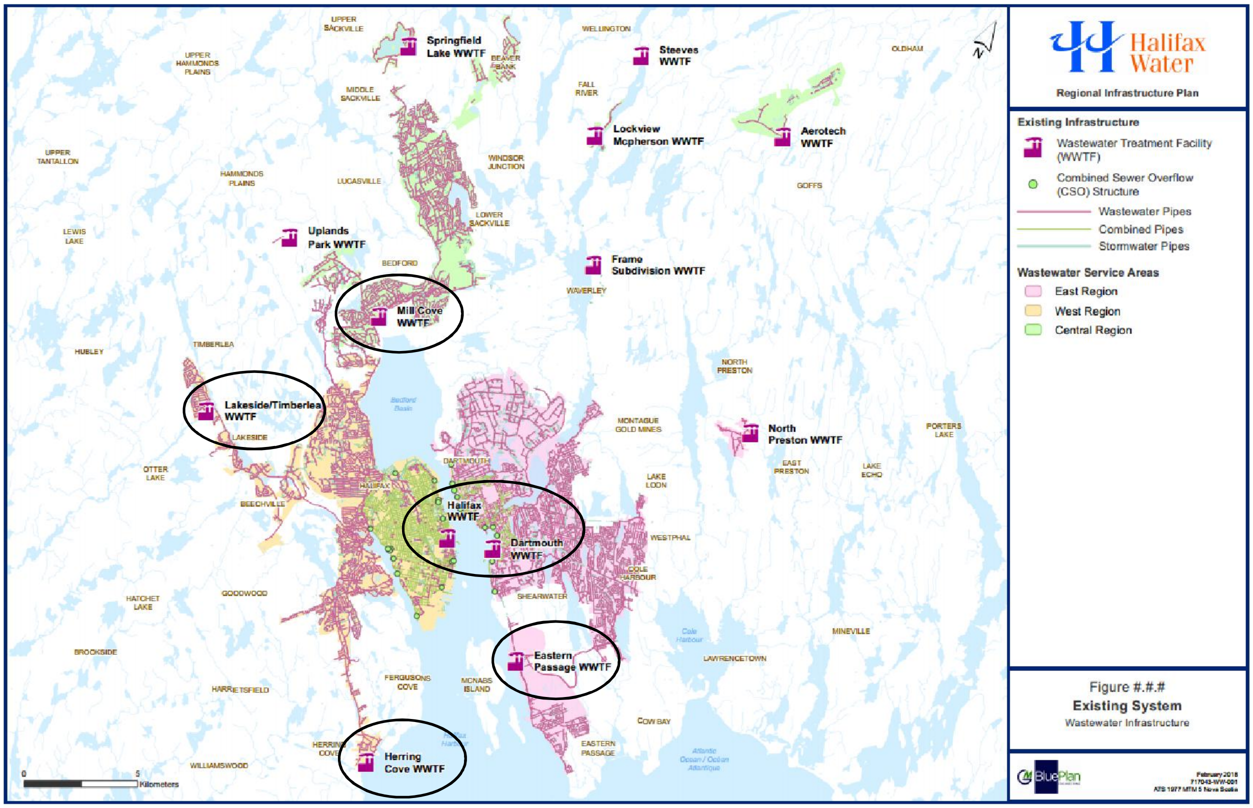
Executive Summary Figure 2 illustrates the delineation of the three main water distribution systems that are owned and operated by Halifax Water, and circles the main water supply plants (WSP) included in the Infrastructure Master Plan. The three main WSP are Pockwock, Lake Major and Bennery Lake WSPs, and the emergency back-ups supplies are Chain Lake and Lake Lamont.



Executive Summary Figure 2: Overview of the Water Distribution System, highlighting the WSPs

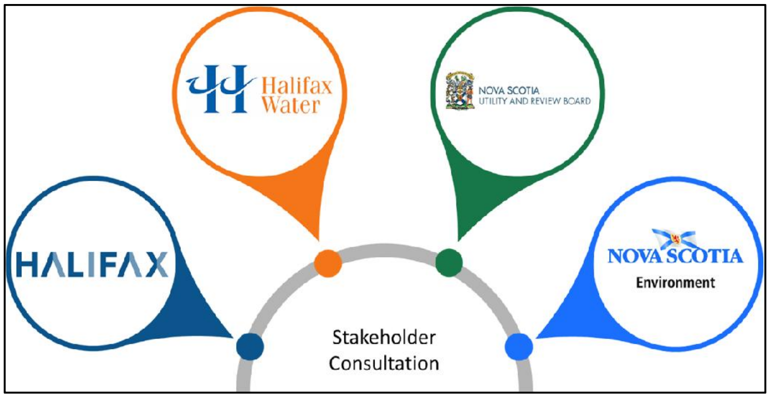
WASTEWATER

Executive Summary Figure 3 illustrated the wastewater treatment facilities systems that are owned and operated by Halifax Water and circles the main wastewater treatment facilities (WWTF) included in the Infrastructure Master Plan. The six main WWTF are Halifax, Herring Cove, Beechville Lakeside Timberlea (BLT), Mill Cove, Dartmouth and Eastern Passage.



Executive Summary Figure 3: Overview of the Wastewater Distribution System, highlighting WWTFs

An important component of the Infrastructure Master Plan is stakeholders' involvement and input throughout the consultation process. The main consultation teams involved in the Infrastructure Master Plan are outlined in Executive Summary Figure 4. GM BluePlan has been liaising with the consultation teams to confirm regulatory requirements, determine population growth figures, understand issues and constraints in the networks, and to inform parties on progress and decisions made.



Executive Summary Figure 4: Baseline Review Consultation Teams

Planning Data and Population Numbers

Halifax Water, GM BluePlan Engineering, and HRM Planning staff collaborated to define the planning projections dataset required to complete the Infrastructure Master Plan. Planning data and growth projections formed the baseline and growth demands on the systems, spanning the period from 2016-2046 (a 30-year planning horizon).

To form the baseline population numbers Census Data was used and distributed using dissemination blocks to civic address points, allowing existing population to be accurately added to the hydraulic models. The baseline employment numbers were determined from Industrial, Commercial and Institutional (ICI) customer billing points, that were then converted to population equivalent (PE), following design standards.

The growth projections defined under the Infrastructure Master Plan, reflect growth trends and planning guidelines to develop the Regional Centre, as outlined in the Centre Plan and Integrated Mobility Plan. Population growth was set to a 1% rate, and employment growth equating to 58% of population growth. Growth was divided between the Regions based on meeting the Integrated Mobility Plan population and employment growth splits and aligning with the Growth Areas and Allocation table, which included data on developments occurring over the project horizon.

Executive Summary Table 1: Growth Population Equivalent (PE) 2016-2046

Location	Employment Growth PE	Population Growth PE	Total Growth PE
Mill Cove	5,623	11,102	16,725[1]
Halifax	28,839	66,365	95,204
Herring Cove	-	3,814	3,814
BLT	-	4,473	4,473
Dartmouth	32,436	42,074	74,510
Eastern Passage	3,591	3,385	6,976
Aerotech	8,597	-	8,597
Rural	6,877	17,000	23,877
Total	**85,963**	**148,213**	**234,176**

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[1] *Total growth varied for Mill Cove between the water and wastewater systems. As two growth areas in the Central Region were only serviced by water the growth PE for wastewater was lower at 15,191.*

Supporting Studies

Several supporting studies have been completed to formalize the foundational policies of regional infrastructure planning and guide the development of the preferred servicing strategies through a robust and defensible process. The supporting studies are a compilation of studies completed under the WRWIP and Infrastructure Master Plan. The studies are as follows:

1. Design Criteria, Level of Service and Policy Review

A comprehensive review of Halifax Water's existing design criteria, level of service (LOS) objectives, and relevant policies, for water supply and wastewater collection was completed as part of the Infrastructure Master Plan and supported by the investigations completed under the WRWIP.

WASTEWATER

The WRWIP assessed the design criteria, LOS and policy review for the wastewater collection system, to guide the West Region servicing strategy. This document was reviewed under the Infrastructure Master Plan to confirm and update the underlying assumptions for the East and Central Regions covered in the Infrastructure Master Plan.

WATER

A full review of the design criteria, LOS and policy review for the water distribution system was completed under the Infrastructure Master Plan, to support the water servicing strategies. The review for water followed the same approach as the WRWIP, including trend analyses and an industry best practice to validate the appropriateness of the criteria and level of service objectives, as they relate to the Infrastructure Master Plan.

2. WRWIP Supporting Studies

The Long-Term Planning Framework and Cost Estimation Framework were developed under the WRWIP to guide infrastructure planning needs and costing guidance and have been included in the Infrastructure Master Plan, as studies that assisted in guiding the final strategies.

- The Long-Term Planning Framework document provides direction for long-term water, wastewater and stormwater infrastructure planning needs, in a holistic approach that integrates and considers infrastructure types together. The framework considers all drivers of infrastructure management including growth, asset renewal, regulatory compliance, and operability.
- The Cost Estimation Framework was developed to form a standardized process for costing infrastructure projects. Infrastructure project cost estimates are used to create short, medium, and long-term budgets and impact funding requirements, and ultimately customer and developer charges.

3. Wet Weather Flow Management Study

The Wet Weather Flow Management Study was initiated under the WRWIP to better understand the feasibility of alternative wastewater servicing strategies, that focus on wet weather flow management options. The Wet Weather Flow Management Study was initially completed on just the West Region and therefore under the Infrastructure Master Plan the study was revisited and updated to include the Central and East Regions.

The study focuses on three feasibility studies:

- Combined Sewer Separation Feasibility Study
- Low Impact Development (LID) Feasibility Study
- Rainfall Derived Inflow and Infiltration (RDII) Reduction Feasibility Study

COMBINED SEWER SEPARATION FEASIBILITY STUDY

The intent of this study is to identify the potential for strategic sewer separation within the combined networks (Halifax Peninsula and Dartmouth). Requirements to meet the Infrastructure Master Plan objectives and minimum local level of service of the wastewater infrastructure were considered against high level cost and feasibility.

It was ultimately determined that *Young Street, Kempt Road, and Connaught Avenue* in Halifax Peninsula and *Jamieson Street, Wyse Road, Nantucket Avenue, Thistle Street and Canal Street* in Dartmouth, are feasible areas for sewer separation and provide the greatest opportunities for flow reduction.

LOW IMPACT DEVELOPMENT FEASIBILITY STUDY

The intent of this study was to highlight areas across the combined networks with the greatest opportunities to implement Low Impact Development (LID) solutions. This study assessed the feasibility of LID solutions in terms of constructability, cost/benefit, and implementation.

Based on the feasibility study and background review, it is unlikely that LID practices can provide sufficient reductions in flow with confidence in the performance over the short and long term to be an overall solution for the Regional servicing plan. However, these practices can be incorporated into the larger solution, where feasible, to reduce the extent of other capital projects and set the stage for a potential LID programs that targets the private level.

INFLOW AND INFILTRATION REDUCTION FEASIBILITY STUDY

The intent of this study is to identify the potential for rainfall derived inflow and infiltration (RDII) reduction as part of the regional servicing strategy. The study covers the flow monitored separated networks across West, Central and East Regions. The RDII feasibility study provided RDII guidance for the West region under the WRWIP and was then expanded on under the Infrastructure Master Plan, for the Central and East Regions. A more in-depth assessment under the Infrastructure Master Plan led to providing pre-defined target RDII reduction areas that were incorporated into the preferred strategies for East and Central Regions.

4. Climate Change Study

The 2012 Integrated Resource Plan (IRP) identified the need to bring climate change considerations into municipal planning and meet a new objective of "adapting to future climate change". Through the Infrastructure Master Plan two climate change tasks were completed:

- Developing a "Vulnerability to Climate Change Risk Assessment" framework to create a robust framework that can be applied consistently across assets and be used to complete vulnerability assessments of existing infrastructure
- Review existing Design Standards and the Long-Term Planning Framework with climate change factors, allowing for future projects to include climate change considerations

The outcomes of the study led to climate change being included in the Infrastructure Master Plan as follows:

- Rainfall simulation events include a climate change factor of 16%
- Sea level rise was considered for infrastructure requirements
- A drought study was recommended on drinking water sources

5. Opportunities and Constraints Workshop

An Opportunities and Constraints workshop covering the wastewater and water systems was held at Halifax Water on March 6th, 2018. The workshop included Halifax Water's Operation Teams, Project Managers and Directors and the Halifax Water and GM BluePlan project teams. The workshop was set up to enable the project team to understand issues, constraints and opportunities within the wastewater and water supply networks. The GM BluePlan team then used the outcomes from the workshop to inform the overall servicing strategies that accommodate the Long-Term strategy drivers of growth, compliance, asset renewal, and operational optimization.

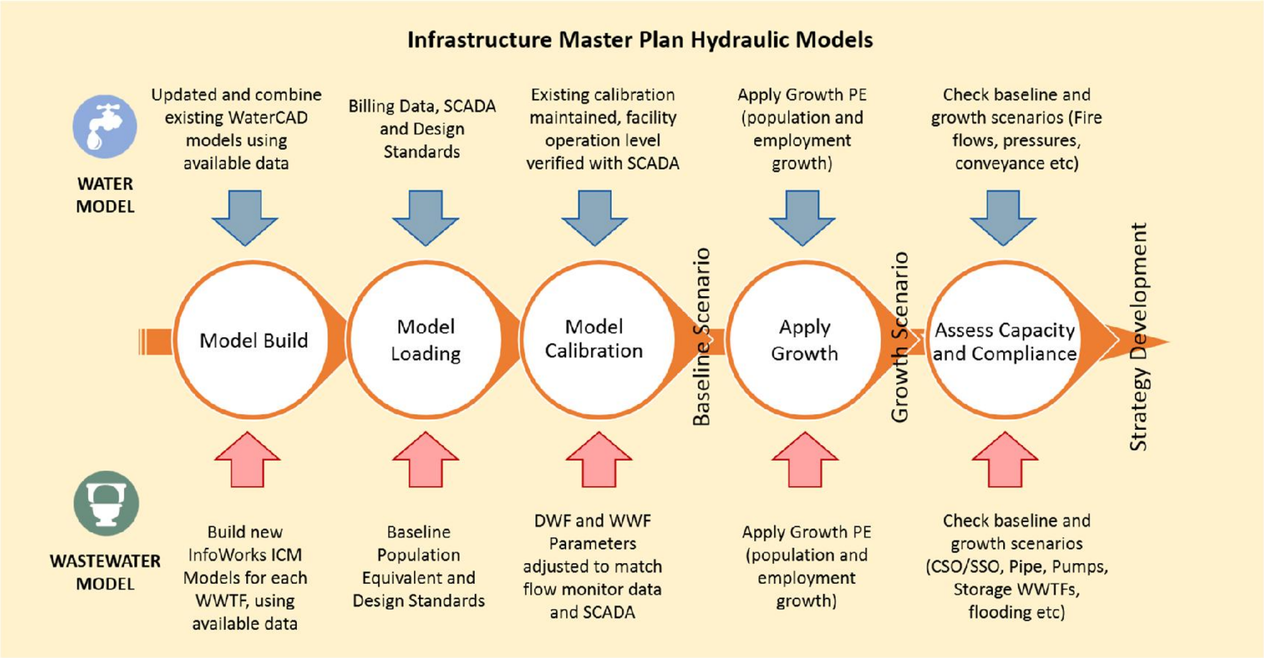
6. Unit Costing Workshop

Halifax Water's Unit Costing template is the main tool used for costing projects. The Unit Costing template has been refined over recent years, from costing capital projects under the IRP, being updated under the WRWIP to align with the Cost Estimation Framework, and further reviewed under the Infrastructure Master Plan at a Unit Costing Workshop. At the workshop the template was assessed to confirm current trends and updated to produce 2019 rates. The outcome of changes from a project cost perspective are relatively minor, and covered in the Project Evaluation and Costing section.

Hydraulic Modelling

A series of activities were completed to prepare and ultimately use the water and wastewater models to undertake the growth impact analysis on infrastructure requirements. The modelling process included model build, loading and calibration to form the baseline scenario, growth was then applied to the calibrated models to form the growth scenario, from there capacity and compliance was assessed, allowing the strategy development stage to occur. Executive Summary Figure 5 outlines the modelling stages with the processes and steps completed for both the water and wastewater models.

At the end of the modelling process the water systems were included in one model, while the wastewater models were divided by WWTFs. The combined water model was due to the interconnection and synergies between the water systems and strategies combining the regions serviced, while the wastewater models were distinctly separated by the existing WWTFs catchments.



Executive Summary Figure 5: Modelling Stages for the Water and Wastewater Models

To assist with future update to the models, guidelines on the modelling process are included in the appendices of Volume 1.

Capacity and Compliance

The newly calibrated models were used to assess system performance under both existing and growth scenarios. The results from these simulations were used to validate and identify the primary constraints within the system, and to evaluate opportunities to resolve these limitations.

Two other key sources of information were used for the capacity and compliance assessment, they were the opportunities and constrains workshop with Halifax Water staff and a facility desktop analyses. The desktop facility analysis included supply, storage and WSPs capacities for the water systems and WWTFs capacity for the wastewater systems.

The outcomes of the capacity and compliance assessment were used in the development of the servicing strategy for the water and wastewater systems.

Strategy Development

The strategy development process varied between the water and wastewater systems to align with service requirements and regulations. The processes are as follows.

WASTEWATER

The wastewater models followed the same strategy development process completed in the WRWIP. The opportunities and constraints identified for the Regions were used to inform the development of multiple servicing strategy alternatives, that were simulated using the model, costed and evaluated, to identify a preferred servicing strategy. Informed by the hydraulic model and various studies, the strategy development process began with the identification of projects common across all strategies, considered “Common Projects”. Once the Common Projects were defined different servicing strategies were tested in the models and compared, and the preferred servicing strategy was selected.

WATER

The water distribution strategy was developed using four key drivers; accommodate growth, provide security of supply and system resiliency, identify synergies with asset renewal, and where possible provide opportunities for system optimization. The strategy approach for growth followed a top-down approach starting with providing adequate supply to all systems, ensuring transmission networks can sufficiently convey the supply, and confirming local needs are met.

Project Evaluation and Costing Considerations

WASTEWATER

The selection of the preferred strategy was based on selecting the top three to five alternative strategies that would be evaluated against each other to determine the preferred strategy.

The first step was to remove less desirable strategies due to aspects of feasibility, cost and level of service. Then the top three to five alternative strategies were evaluated using the five-point evaluation factors (Technical, Financial, Legal/Jurisdictional, Environmental, and Socio/Cultural). Following stakeholder consultation, the final preferred strategy was presented with input from the project team.

PROJECT COSTING

A capital cost estimate (in 2019 dollars) was completed for all projects encompassed within the proposed strategies. Halifax Water’s Unit Costing template, a newly developed RDII Reduction Costing Template and existing knowledge on projects were used to build the final Capital Program costs.

The Unit Costing template is a detailed costing sheet that includes hard and soft cost components. Use of this template in the Infrastructure Master Plan resulted in Class 4 (Master Plan level) cost estimates (planning cost estimate with a 30% margin), in accordance to the Cost Estimation Framework. The costs are unit based and include an allowance for the following additional components:

- Engineering and Design
- Professional Fees/Geotechnical/Hydrogeological
- Construction Management/Contract Administration
- In-House Labour/Engineering/Wages/CAD
- Overheads
- Project Contingency

The Unit Cost template was reviewed and updated through the Infrastructure Master Plan, based on outcomes from the Unit Costing Workshop. The changes to the Unit Cost template included adjustments to unit rates for pipe construction, moving the location of the soft costs in the template and updating the overhead contingencies rate.

The impact of the above changes from a project cost perspective are relatively minor. The main change to costing projects was introducing a RDII Costing Template. The RDII Costing Template was developed to improve the accuracy of costing RDII reduction, through reviewing case studies and costing RDII based on catchment size, land use and volume of existing facilities in the catchment.

A cash flow analysis was completed to assess the annual lifecycle costs and net present value of each project. The individual project costs were added to determine the capital cost of each strategy.

PROJECT PHASING

A project phasing exercise was completed to identify the timing requirements for each project. Projects are either triggered immediately due to existing constraints, in the future when a specified capacity is reached because of growth, or dependent on the completion of other projects.

CAPITAL PROGRAMS

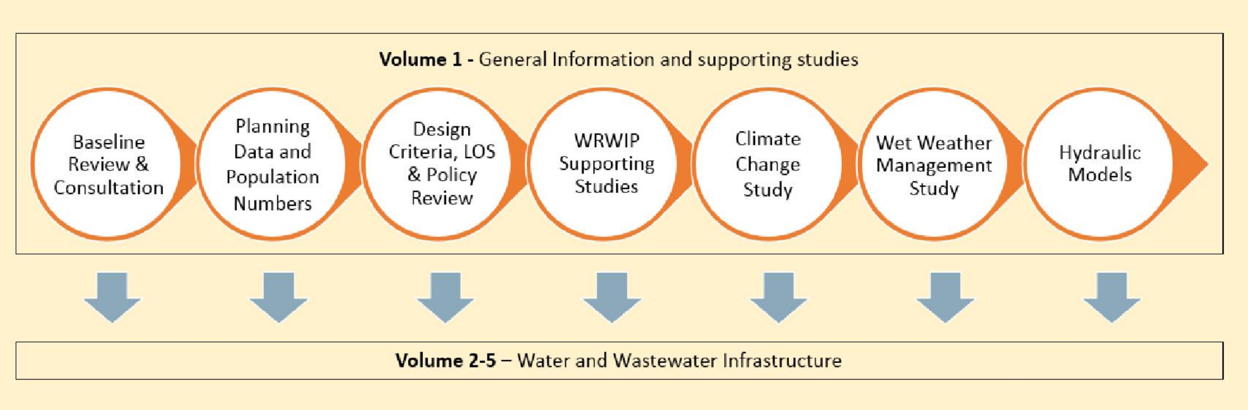
The final Capital Programs for wastewater are in Executive Summary Table 3 and for water are in Executive Summary Table 4, including project name, description, phasing, and capital cost. Executive Summary Table 2 summaries the capital cost per region for water and wastewater.

Executive Summary Table 2: Total Water and Wastewater Capital Costs Per Region

Location	Total Capital Cost (2019$)
West Region*	**$186,261,000**
Central – Mill Cove	**$163,483,000**
East – Eastern Passage	**$49,478,000**
East – Dartmouth	**$104,358,000**
Water all Regions	**$284,706,000**
Total	**$788,286,000**

*Cost updated from WRWIP to 2019 dollars using the updated Unit Costing and RDII Costing templates

As mentioned above, Volume 1 provides several supporting documents, methodologies and processes that feed into Volumes 2 to 5. Executive Summary Figure 6 summarizes the major components in Volume 1 that support the subsequent volumes.



Executive Summary Figure 6: Volume 1 Supporting Studies Summary

Executive Summary Table 3: Wastewater Capital Program Summary

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
West Region: Halifax	**Peninsula Halifax**	**WR1**	WRWIP: Spring Garden Area Sewer Separation	*Full separation of Spring Garden LoWSCA pocket - 5 individual projects*	2018-2023	2016-2021	$ 7,281,000
		WR2	WRWIP: Young Street Area Sewer Separation	*Full separation of Young Street LoWSCA pocket - 18 individual projects*	2018-2023	2016-2021	$ 21,879,000
		WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	*Full separation of a portion of the Kempt CSO sewershed - 17 individual projects*	2018-2025	2016-2021	$ 14,752,000
		WR4	WRWIP: Linear Upsize - Quinpool Road	*525mm ø combined sewer upsize along Quinpool Road (from Preston to Oxford)*	2020	2016-2021	$ 437,000
		WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	*750mm ø combined sewer upsize along Portland Place (from Saunders to Brunswick) + 900mm ø combined sewer upsize along Brunswick Street*	2020	2016-2021	$ 221,000
		WR6	WRWIP: Gottingen Street and North Street Intersection Flow Split	*Lower the invert of the combined sewer along Gottingen, on the south side of North Street*	2020	2016-2021	$ 500,000
		WR7	WRWIP: Young Pumping Station Upgrade	*New 300mm diameter alignment + Installation of new pumps to increase the station capacity from 114L/s to 250L/s*	2027	2026-2031	$ 2,169,000
		WR8	WRWIP: New Fairfield Holding Tank	*New 3,700 cubic metre holding tank at the existing Fairfield Holding Tank site*	2046	2041-2046	$ 12,403,000
		WR9	WRWIP: Replace Armdale Pumping Station Forcemains	*Upsize the existing 300mm ø Armdale Pumping Station forcemains with new twinned 400mm ø forcemains*	2020	2016-2021	$ 3,850,000
	Halifax Inflow and Infiltration	**WR13**	WRWIP: RDII Reduction Program	*Implement an Inflow and Infiltration Reduction Program within the Fairview, Clayton Park, and Bridgeview areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2020	2016-2021	$ 15,491,589
	Halifax Fairview Cove Tunnel	**WR19**	WRWIP: Fairview Cove Linear Upsize	*Upsize existing 1050mm ø tunnel to 1800mm ø*	2019	2016-2021	$ 19,781,000
	Wastewater Treatment Facility	**WR20**	WRWIP: Halifax Treatment Plant Capacity Upgrade	*Increase the rated capacity of Halifax WWTF from 134 MLD to 140 MLD*	2041	2036-2041	$ 25,142,000
	Halifax Greenfield	**WR21**	WRWIP: Linear Upgrades within the Kearney Lake Road Area	*Sanitary sewer upgrades downstream of the Kearney Lake Road Pumping Station*	2033	2031-2036	$ 2,997,000
	Halfax Flow Optimization	**WR22**	Infrastructure Master Plan: CSO Management Study	*Monitor and assess CSO facilities to mitigate discharges (16 facilities). Costed at $14,000/monitor and $15,000/CSO for assessment.*	2026	2016-2021	$ 965,000
		WR23	Infrastructure Master Plan: SSO Management Study	*Monitor and assess SSO facilities to mitigate discharges (6 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.*	2021	2016-2021	$ 415,000
	HALIFAX Total Wastewater Servicing Strategy Cost						**$ 128,283,589**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
West Region: BLT	**BLT WWTF Decommission**	**WR10**	WRWIP: BLT WWTF Decommission - New Timberlea PS	*New 247L/s Timberlea Pumping Station at existing BLT WWTF site*	2020	2016-2021	$ 5,928,000
		WR11	WRWIP: BLT WWTF Decommission - New Timberlea Forcemain	*New 450mm ø forcemain from new Timberlea Pumping Station to gravity sewer start near Bayers Lake*			$ 19,436,000
		WR12	WRWIP: BLT WWTF Decommission	*Decommissioning of BLT WWTF and site recovery*			$ 500,000
	BLT Diversion to Herring Cove	**WR14**	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Pumping Station	*Construct new 370L/s pumping station to divert all of BLT flow to Herring Cove*	2033	2031-2036	$ 8,063,000
		WR15	WRWIP: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain	*Construct new twinned 450mm ø forcemain along Northwest Arm Drive from new proposed Crown Drive Pumping Station to Cowie Hill*			$ 9,026,000
		WR16	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	*Construct new 600mm ø gravity sewer along Northwest Arm Drive from Cowie Hill to Herring Cove Road south of Levis Street*			$ 4,319,000
		WR17	WRWIP: BLT Flow Diversion to Herring Cove - New Gravity Sewer	*Construct new 1050mm ø gravity sewer from COLTA sewer to new Crown Drive Pumping Station*			$ 3,266,000
	BLT Total Wastewater Servicing Strategy Cost						**$ 50,538,000**
Herring Cove	**Herring Cove Linear Upsizing**	**WR18**	WRWIP: Herring Cove Road - Gravity Sewer Upsize	*Upsize sanitary sewers (to 900mm ø) downstream of Roaches Pond Pumping Station*	2033	2031-2036	$ 7,439,000
	HERRING COVE Total Wastewater Servicing Strategy Cost						**$ 7,439,000**
	WEST REGION Total Wastewater Servicing Strategy Cost						**$ 186,260,589**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
Central Region: Mill Cove and Springfield Lake	**Trunk Upgrades**	**MC1**	Trunk Sewer Upgrades	*Sackville Trunk Upgrades to 1200mm diameter*	2036	2036-2041	$ 5,101,000
		MC2	Trunk Sewer Upgrades	*Sackville Trunk Upgrades to 1050mm diameter*	2036	2036-2041	$ 8,246,000
		MC3	Trunk Sewer Upgrades	*Sackville Trunk Upgrades to 1500mm diameter*	2036	2036-2041	$ 144,000
	Storage tank Upgrades	**MC4**	Storage Tank	*Offline storage tank near Sackville Goodlife Fitness Centre (5ML)*	2031	2031-2036	$ 17,469,000
	Upgrades to Pumping Stations	**MC5**	Fish Hatchery Park Pumping Station Upgrade	*Upsize existing 450mm forcemain from Fish Hatchery Park PS to 675mm diameter and increase pumping capacity to 1500 L/s with an addition of 100 L/s capacity*	2036	2031-2036	$ 10,529,000
		MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	*Increase pumping capacity at Beaver Bank #3 PS from 55 L/s to 100 L/s, and increase pumping capacity of Majestic Avenue PS from 82 L/s to 165 L/s to eliminate growth-impacted SSO discharge*	2036	2036-2041	$ 1,090,000
	Wastewater Treatment Facility	**MC7**	Mill Cove Wastewater Treatment Plant Capacity Upgrade	*WWTF Upgrade*	2021	2021-2026	$ 89,256,000
	Inflow and Infiltration	**MC8**	RDII Reduction Program FMZ07, FMZ10, & FMZ40	*Implement an Inflow and Infiltration Reduction Program within the Lower Sackville areas FMZ07, FMZ10, & FMZ40 (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2020	2016-2021	$ 9,288,248
		MC9	RDII Reduction Program FMZ02 & FMZ03	*Implement an Inflow and Infiltration Reduction Program within Bedford areas FMZ02 & FMZ03 (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)*	2031	2031-2036	$ 8,023,065
	Local New Networks and Upgrades	**MC10**	Local network upgrades on Beaver Bank Rd. North of Glendale Dr.	*Upsize from 200mm to 450mm diameter gravity sewer along Beaver Bank Rd.*	2021	2021-2026	$ 2,086,000
		MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	*Upsize from 300mm to 450mm diameter gravity sewer along Beaver Bank Rd.*	2021	2021-2026	$ 1,490,000
		MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	*Upsize from 300mm to 375mm diameter gravity sewer along Beaver Bank Rd.*	2021	2021-2026	$ 1,667,000
		MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	*Upsize from 200mm to 375mm diameter gravity sewer along Old Sackville Road*	2036	2036-2041	$ 845,000
		MC14	Local network upgrades on on Hallmark Ave.	*Upsize from 200mm to 375mm diameter gravity sewer on Hallmark Ave.*	2036	2036-2041	$ 437,000
		MC15	Local Sewer Upgrades on Waterfront Drive	*375 mm Sewer Upgrade on Waterfront Drive*	2036	2036-2041	$ 500,000
	Springfield Lake	**MC16**	Springfield Lake Connection to Sackville	*Decommission Springfield Lake WWTF, divert all flow to Mill Cove WWTF via new pumping station and gravity sewer to connect at top of Sackville trunk sewer.*	2043	2041-2046	$ 6,226,000
	Flow Optimization	**MC17**	SSO Management Study	*Monitor and assess SSO facilities to mitigate discharges (18 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.*	2021	2021-2026	$ 1,086,000
	CENTRAL REGION Total Wastewater Servicing Strategy Cost						**$ 163,483,313**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

	Project Category	Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
East Region Eastern Passage	**Gravity Pressure Sewer**	**EP1**	Install new Gravity Pressure Sewer	*Install new 450 and 825mm Ø gravity pressure sewer*	2021	2021-2026	$ 23,372,000
		EP2	Connect Beaver Crescent and Caldwell Forcemains to new 450mm gravity pressure sewer	*Connect Beaver Crescent and Caldwell Forcemains to new gravity pressure sewer*	2026	2026-2031	$ 78,000
		EP3	Install new pump out stations	*Install 4 new pump out stations in the low point of the gravity pressure sewer*	2026	2026-2031	$ 1,676,000
		EP4	Install gate valves at surge tank	*Optimize flows at the surge tank through gate valves*	2026	2026-2031	$ 420,000
		EP5	Decommission existing 450mm gravity pressure sewer	*Grout fill the 450mm Ø asbestos gravity pressure sewer*	2043	2041-2046	$ 559,000
	Upgrades to Pumping Stations	**EP6**	Upgrade Quigley Corner Pumping Station	*Increase pumping capacity at Quigley to 570l/s with an addition of 343l/s*	2021	2021-2026	$ 2,875,000
		EP7	Optimize Quigley's Corner PS	*Forcemain optimization and SLR assessment*	2021	2021-2026	$ 336,000
		EP8	Upgrade Memorial Drive Pumping Station	*Increase pumping capacity at Memorial Drive PS with an addition of 65l/s. Install new dual 300mm ø forcemain*	2031	2031-2036	$ 2,633,000
		EP9	Upgrade Beaver Crescent Pumping Station	*Increase pumping capacity at Beaver Crescent PS with an addition of 20l/s*	2036	2036-2041	$ 168,000
		EP10	Upgrade Bissett Lake Pumping Station	*Increase pumping capacity at Bissett Lake PS with an addition of 350l/s*	2041	2036-2041	$ 2,934,000
		EP11	Upgrade Caldwell Road Pumping Station	*Increase pumping capacity at Caldwell Road PS with an addition of 70l/s. Install new dual 200mm ø forcemains*	2039	2036-2041	$ 631,000
	Inflow and Infiltration	**EP12**	RDII Reduction Program FMZ23	*Implement an Inflow and Infiltration Reduction Program within the Cole Harbour areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining) - FMZ23*	2031	2031-2036	$ 3,204,580
		EP13	RDII Reduction Program FMZ24	*Implement an Inflow and Infiltration Reduction Program within the Loon Lake areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)- FMZ24*	2020	2016-2021	$ 1,570,040
		EP14	RDII Reduction Program FMZ37	*Implement an Inflow and Infiltration Reduction Program within the Eastern Passage areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)- FMZ37*	2020	2016-2021	$ 2,479,704
	Local New Networks and Upgrades	**EP15**	Local network upgrades on Caldwell Road	*Upsize from 200 to 300mm ø gravity sewer along Caldwell Road*	2036	2036-2041	$ 607,000
		EP16	Local network upgrades on Colby Drive	*Upsize from 200 to 300mm ø gravity sewer along Colby Drive*	2031	2031-2036	$ 1,176,000
		EP17	Local network upgrades on Forest Hill Parkway	*Construct new 450mm ø gravity sewer along Forest Hill Parkway connect to pipeline on Nestor Crescent*	2041	2041-2046	$ 4,275,000
	Flow Optimization	**EP18**	SSO Management Study	*Monitor and assess SSO facilities to mitigate discharges (8 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.*	2021	2021-2026	$ 484,000
	EASTERN PASSAGE Total Wastewater Servicing Strategy Cost						**$ 49,478,324**

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

Project Category		Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
East Region : Dartmouth	Lakes and Sewer Separation	D1	LoWSCA: Canal Street Separation	Full separation of Canal Street LoWSCA pocket - 1 individual project. Install new stormwater pipelines, separate 35 properties and reconnect 8 catchbasins.	2020	2016-2021	$ 1,842,000
		D2	LoWSCA: Wyse Road Separation	Full separation of Wyse Road LoWSCA pocket - 3 individual project, two phases. Phase 1 - Install new stormwater pipelines along Albro Lake Road and Windmill Road, separate 43 properties and reconnect 18 catchbasins (Area A). Phase 2 - Install new stormwater pipelines along Wyse Road, connecting to Albro Lake stormwater pipe, separate 111 properties and reconnect 4 catchbasins (Area B). Install new sewer diversion from Lyle St Catchment to Jamieson(Area C).	2020	2016-2021	$ 3,860,000
					2021	2021-2026	$ 2,802,000
		D3	Additional Stormwater Separation on Wyse Street	450mm ø stormwater pipe connecting to Park Ave CSO, separate 6 properties and reconnect 1 catchbasin.	2031	2026-2031	$ 1,912,000
		D5	Albro Lakes Watershed Separation	Full separation of Albro Lakes Watershed, install new stormwater trunk line, connecting to Jamieson Street CSO outfall.	2021	2021-2026	$ 8,111,000
		D6	Maynard Lake and Clement Street Wetland Separation	Full separation of Maynard Lake and the Clement Street Wetland - 4 phases Phase 1 - Install 1050mm pipeline in Old Ferry Rd, connection to CSO outfall, connect stormwater pipeline from Hazlehurst Street and catchbasins en route Phase 2 - Install 750mm pipeline working upstream to the Wetland, continue to connect to catchbasin en route Phase 3 - Install 600mm pipeline connecting Maynard Lake to the pipeline Phase 4 - Connect to stormwater network for DSM and Fenwick Drive properties and separate North Woodside - Southdale Elementary and surrounding businesses	2031	2026-2031	$ 642,000
					2031	2031-2036	$ 4,540,000
					2033	2031-2036	$ 1,155,000
					2036	2031-2036	$ 453,000
	Upgrades to Pumping Stations	D7	New Valleyford Pumping Station	Install new pumping station by the Valleyford Holding Tank to a capacity of 300l/s. Install new forcemain down Raymond Street and Maple Drive, to connect to the trunk sewer	2041	2036-2041	$ 10,446,000
		D8	390 Waverley Road Upgrades	Install new dual 500mm ø forcemain following existing path with a diversion to the North Dartmouth Trunk Sewer, by Highway 118	2021	2021-2026	$ 11,361,000
		D9	Anderson Pumping Station Upgrades	Install new 300mm ø forcemain following existing path. Alter flow path from holding tank to PS by adjusting pipe grades between infrastructure	2031	2031-2036	$ 340,000
	Dartmouth WWTF Upgrades	D10	Upgrades to Dartmouth WWTF	Upgrade Dartmouth WWTF to meet demand at end of Project Horizon	2043	2036-2041	$ 12,572,000
	Inflow and Infiltration	D11	RDII Reduction Program	Implement an Inflow and Infiltration Reduction Program within the Ellenvale areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)	2021	2021-2026	$ 5,941,076
		D12	RDII Reduction Program	Implement an Inflow and Infiltration Reduction Program within the Woodside areas (CCTV, Smoke/Dye Testing, Property Disconnections, Sewer Lining)	2031	2031-2036	$ 1,120,232
		D13	Additional flow monitoring	Flow monitoring through the catchment to assess areas in model showing flooding	2020	2016-2021	$ 252,000

Executive Summary Table 3: Wastewater Capital Program Summary (continued)

Project Category		Project ID	Project Name	Project Description	Start Year	Planning Period	Total Capital Cost (2019$)
East Region : Dartmouth	Local New Networks and Upgrades	**D15**	Green St Upsize	*Common project - Upsize from 375 to 750mm ø gravity sewer along Green Street*	2041	2041-2046	$ 513,000
		D16	Pinecrest Dr Upgrade	*Common project - Upsize from 200 to 375mm ø gravity sewer along Pinecrest Drive*	2031	2031-2036	$ 1,013,000
		D17	Peddars Way Upgrade	*Common project - Upsize from 300 to 375mm ø gravity sewer along Peddars Way*	2031	2031-2036	$ 555,000
		D18	Atlantic Street Upgrade	*Common project - Upsize from 250 to 450mm ø gravity sewer along Atlantic St*	2021	2021-2026	$ 3,831,000
		D19	Akerley Blvd and Railway Alignment Upgrade	*Strategy project - Upsize from 250 to 600mm ø gravity sewer along Akerley Blvd and Railway easement towards Ferguson Road CSO*	2041	2036-2041	$ 4,814,000
		D20	Pleasant Street Upgrade	*Strategy project - Upsize from 200 to 450mm ø gravity sewer along Pleasant St, and towards Cuisack Street CSO*	2021	2021-2026	$ 767,000
		D21	Princess Margaret Blvd. Upgrade	*Strategy project - Upsize from 450 to 600mm ø gravity sewer along Princess Margaret Blvd.*	2031	2031-2036	$ 3,106,000
		D22	Anderson Lake Development Connection	*Strategy project - Construct new 450mm ø gravity sewer to connect Anderson Lake development to Akerley Blvd*	2036	2036-2041	$ 7,609,000
		D23	Marvin Connection	*Strategy project - Construct new 450mm ø gravity sewer in Marvin Street and connect to connect Cuisack Street CSO*	2026	2026-2031	$ 1,380,000
	Flow Diversion	**D24**	King Street Diversion	*Common Project - 450mm ø sewer diversion to NDTS*	2026	2026-2031	$ 78,000
		D25	Diversion to Eastern Passage	*Install new pumping station at Melva St CSO. Install new dual 600mm ø forcemain following Pleasant Street and connecting to existing gravity pipe in Eastern Passage network. Upgrade existing gravity pipe from a 200 to 600mm ø.*	2036	2036-2041	$ 12,113,000
	Flow Optimization	**D14**	CSO Flow Management Study	Monitor and assess CSO facilities to mitigate discharges (11 facilities). Costed at $14,000/monitor and $15,000/CSO for assessment.	2036	2036-2041	$ 675,000
		D26	SSO Flow Management Study	Monitor and assess SSO facilities to mitigate discharges (9 facilities). Costed at $14,000/monitor and $15,000/SSO for assessment.	2021	2016-2021	$ 555,000
	DARTMOUTH Total Wastewater Servicing Strategy Cost						**$ 104,358,308**
	EAST REGION Total Wastewater Servicing Strategy Cost						**$ 153,836,631**
	ALL REGIONS Total Wastewater Servicing Strategy Cost						**$ 563,082,533**

Executive Summary Table 4: Water Capital Program Summary

Project Category	Project Name	Project ID	Project Task	Start Year	Planning Period	Total Capital Cost (2019$)
Pockwock - Peninsula	Peninsula Transmission Upgrades (Chain Control)	**W06.1**	Chain Control Transmission - Existing Peninsula Low Upsize	2021	2021-2026	$ 3,841,000
		W06.2	Chain Control Transmission - Existing Peninsula Intermediate Upsize	2021	2021-2026	$ 2,650,000
		W06.3	Pepperell Transmission	2036	2036-2041	$ 2,702,000
		W06.4	Chain Control Transmission - Existing Peninsula Low Lining	2036	2036-2041	$ 2,916,000
		W06.5	Chain Control Transmission - Valve Chambers	2036	2036-2041	$ 1,258,000
	Twinning of Peninsula Transmission (Robie)	**W07**	Replace High Risk Peninsula Transmission (Robie)	2026	2026-2031	$ 17,312,000
	Quinpool to Young Connection	**W08**	Peninsula Intermediate Looping - Quinpool Rd to Young St	2021	2021-2026	$ 4,319,000
	Young Street Pocket Upgrades	**W10.1**	Young St Upsize	2026	2026-2031	$ 1,315,000
		W10.2	Robie St Upsize	2026	2026-2031	$ 956,000
		W10.3	Almon St Upsize	2026	2026-2031	$ 1,168,000
		W10.4	Windsor St Upsize	2026	2026-2031	$ 1,004,000
Pockwock - Other	Lakeside Projects	**W01.1**	Geizer 158 to Lakeside High Looping	2021	2021-2026	$ 2,249,000
		W01.2	Gravity Supply to Brunello	2041	2041-2046	$ 2,328,000
		W01.3	Dominion Cres Upsize	2041	2041-2046	$ 447,000
		W01.4	Brunello Booster Pump Upgrades	2021	2021-2026	$ 236,000
	Lively, Geizer Hill, and Leiblin Booster Pump Upgrades	**W03**	Geizer Hill Booster Pump Upgrades	2021	2021-2026	$ 277,000
		W04	Leiblin Booster Fire Pump	2019	2016-2021	$ 395,000
		W15	Lively Booster Pump Upgrades	2036	2036-2041	$ 38,000
	Herring Cover Upgrades	**W05.1**	Herring Cove Rd Twinning	2020	2016-2021	$ 3,585,000
		W05.2	St Michaels Ave Upsize	2041	2041-2046	$ 502,000
		W05.3	Herring Cove Rd Looping - McIntosh St	2021	2021-2026	$ 2,272,000
	Lucasville Road Twinning	**W12.1**	Lucasville Rd Twinning (Phase 1)	2019	2016-2021	$ 8,117,000
		W12.2	Lucasville Rd Twinning (Phase 2)	2026	2026-2031	$ 8,956,000
	New Primary Sackville High and Beaver Bank Supply	**W13.1**	New Primary Feed to Sackville High	2026	2026-2031	$ 4,953,000
		W13.2	New Sackville Beaver Bank Valve Chamber	2026	2026-2031	$ 839,000
		W13.3	Reconfiguration of Beaver Bank Booster	2026	2026-2031	$ 100,000
		W13.4	New Sackville High PRV	2026	2026-2031	$ 420,000
	Second Supply to Windsor Junction	**W14.1**	Cobequid High Looping	2026	2026-2031	$ 2,233,000
		W14.2	Windgate Dr Upsize	2026	2026-2031	$ 882,000
	New Hemlock Tank	**W16**	New Hemlock Elevated Tank	2020	2016-2021	$ 6,209,000
	Pockwock Transmission Looping	**W17**	Pockwock Transmission Loop through Bedford	2021	2021-2026	$ 5,069,000
	Second Geizer 158 Feed and Lacewood Drive Loop	**W02**	Geizer 158 Looping - Lacewood Dr	2041	2041-2046	$ 2,002,000
		W20	Second Geizer 158 Feed	2041	2041-2046	$ 9,612,000

Executive Summary Table 4: Water Capital Program Summary (continued)

Project Category	Project Name	Project ID	Project Task	Start Year	Planning Period	Total Capital Cost (2019$)
Lake Major	New Transmission from Topsail to Burnside	**W22.1**	New Main Street to Caledonia Road Connection	2021	2021-2026	$ 3,072,000
		W22.2	Caledonia Rd Twinning	2021	2021-2026	$ 3,429,000
		W22.3	New Breeze Dr Watermain	2021	2021-2026	$ 5,801,000
		W28	Tacoma PRV Chamber	2021	2021-2026	$ 420,000
	Highway 118 Crossing	**W23**	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	2021	2021-2026	$ 6,063,000
	Windmill Road Upgrade	**W24**	Windmill Rd Upsize	2026	2026-2031	$ 6,104,000
	New Woodside Industrial Park Feed	**W25**	New Woodside Industrial Park Feed	2021	2021-2026	$ 1,649,000
	Willowdale-Eastern Passage Connection	**W26**	Willowdale to Eastern Passage Connection	2036	2036-2041	$ 6,290,000
System Interconnections Pockwock Transmission WTP Decommissioning	Pockwock Transmission Twinning	**W19.1**	Pockwock Transmission Twinning - 60in	2031	2031-2036	$ 65,516,000
		W19.2	Pockwock Transmission Twinning - 54in	2036	2036-2041	$ 16,228,000
	Extension to Springfield Lake	**W21**	Extension to Springfield Lake	2041	2041-2046	$ 3,043,000
	Bedford-Burnside Interconnection	**W29.1**	Bedford-Burnside System Interconnection (Phase 1)	2036	2036-2041	$ 24,499,000
		W29.2	Bedford-Burnside System Interconnection (Phase 2)	2036	2036-2041	$ 11,779,000
	Dartmouth-Peninsula Interconnection	**W30.1**	Lyle Emergency Booster	2026	2026-2031	$ 1,045,000
		W30.2	Valving for Central Intermediate Boundary Change	2026	2026-2031	$ 629,000
	Pockwock-Bennery Interconnection	**W31.1**	Extension of Fall River to Bennery Lake (Phase 1)	2026	2026-2031	$ 8,067,000
		W31.2	Extension of Fall River to Bennery Lake (Phase 2)	2026	2026-2031	$ 9,156,000
		W31.3	Extension of Fall River to Bennery Lake (PS)	2026	2026-2031	$ 1,310,000
	WSP Decommissioning	**W32.1**	Decommission Miller Lake WSP - Linear	2019	2016-2021	$ 628,000
		W32.2	Decommission Miller Lake WSP	2019	2016-2021	$ 61,000
		W33.1	Decommission Collins Park WSP - Linear	2041	2041-2046	$ 1,086,000
		W33.2	Decommission Collins Park WSP	2041	2041-2046	$ 168,000
		W34.1	Decommission Silversands WSP - Linear	2041	2041-2046	$ 1,931,000
		W34.2	Decommission Silversands WSP	2041	2041-2046	$ 168,000
	Aerotech Storage	**W40**	Aerotech Storage	2021	2021-2026	$ 4,752,000
Studies	Studies	**W18**	Chain Lake Backup Supply Study	2020	2016-2021	$ 50,000
		W27	Mt Edward Booster Fire Pump	2019	2016-2021	$ 50,000
		W29.3	New Orchard Control Chamber	2021	2021-2026	$ 50,000
		W30.3	Robie Emergency Booster	2021	2021-2026	$ 50,000
		W35	Safe Yield Study	2020	2016-2021	$ 100,000
		W36	New Hydraulic Water Model (InfoWater)	2020	2016-2021	$ 200,000
		W37	Comprehensive PRV Study	2019	2016-2021	$ 50,000
		W38	Transmission Main Risk Assessment and Prioritization Framework	2020	2016-2021	$ 50,000
		W39	Tomahawk Lake Supply Study	2036	2036-2041	$ 50,000
Total Water Servicing Strategy Cost						**$ 284,706,000**

INFRASTRUCTURE MASTER PLAN

VOLUME 2
WATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

GUELPH | OWEN SOUND | LISTOWEL | KITCHENER | LONDON | HAMILTON | GTA
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VOLUME 2 – WATER INFRASTRUCTURE

Catchment Overview

Halifax Water currently owns and operates three main water supply plants (WSP), two back-up WSPs, and six smaller community supply plants:

Main WSPs

- J.D. Kline WSP (West Region and Central Region) – the Pockwock System
- Lake Major WSP (East Region) – the Lake Major System
- Bennery Lake WSP (Airport and Aerotech Business Park) – the Bennery System

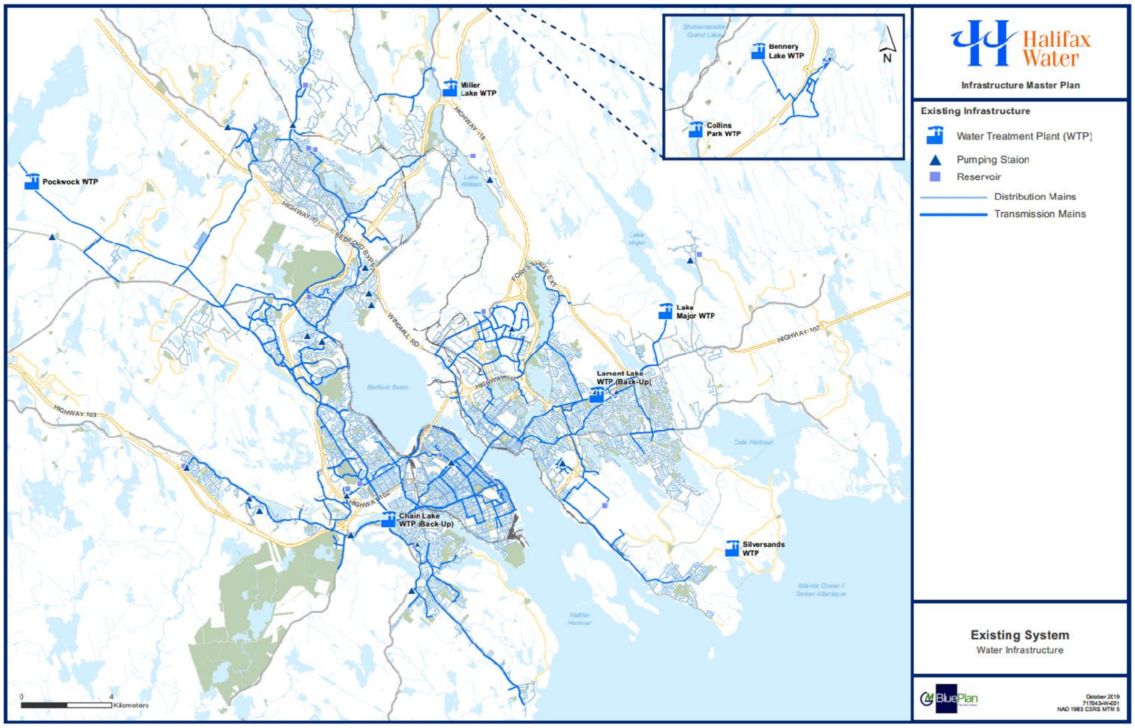
Back-up WSPs:

- Chain Lake
- Lake Lamont

Smaller Community WSPs

- Collins Park
- Silversands
- Miller Lake
- Five Island Lake
- Bomont
- Middle Musquodoboit

The water distribution systems are shown in Executive Summary Figure 7.



Executive Summary Figure 7: Existing Water Network Overview

Water Infrastructure Strategy Development

The water distribution servicing strategy has been developed with the primary aim of providing an adequate level of service to existing and future customers out to the 2046 planning horizon, and provides the following key drivers:

- Servicing strategy can accommodate the planned growth and 2046 future system demands;
- Water supply and overall system resiliency are secured, and risk of service interruption is minimized;
- The water distribution system is optimized to enhance operations and maintenance;
- Asset renewals and opportunities for synergy are considered.

The following inputs were used to complete the capacity and compliance analysis for the water distribution system under both existing and growth scenarios, and then assist in developing and testing multiple servicing strategies and selecting the preferred strategy:

Opportunities and Constraints Workshop with Halifax Water Staff

- Input from the Halifax Water staff knowledgebase through workshops and other correspondence was invaluable for the identification of system constraints, opportunities for optimization, operational concerns, growth pressures, and previously-recommended infrastructure solutions.

Supply, Pumping, and Storage Desktop Analysis

- The desktop analysis identified facilities and water supply sources with insufficient capacity to meet growth demands.

Hydraulic Modelling

- The updated WaterCAD hydraulic water model was used to highlight areas with limitations or constraints within the transmission network and validate the selected servicing strategy to ensure that overall servicing needs were met.

Water Infrastructure Preferred Strategy

The Capital Program for the Water Infrastructure Preferred Strategy is included in Volume 1 Executive Summary and supports the servicing of all regions. The Capital Costs for Water Infrastructure total approximately **$285M (in 2019 dollars).** The program costs are evenly distributed over the planning period as best as possible, by adjusting the implementation year of projects with flexible timing.

Projects to Accommodate Growth

System Supply

The servicing strategy aims to ensure sufficient system supply to meet 2046 growth demands for all three systems, with consideration given to post-2046 demands. Several concepts were reviewed to assess feasibility, social implications, and economic impacts.

i. Increase safe yield
ii. Water conservation
iii. New supply
iv. System interconnections

The following capital projects are proposed to accommodate system supply needs due to growth:

- Tomahawk Supply Study
- Lucasville Road Twinning
- New Primary Supply to Sackville High and Beaver Bank Boosted
- Orchard Control Chamber Study
- Bedford-Burnside Connection
- Second Supply to Windsor Junction
- Pockwock System Extension to Bennery Lake

Peninsula Supply

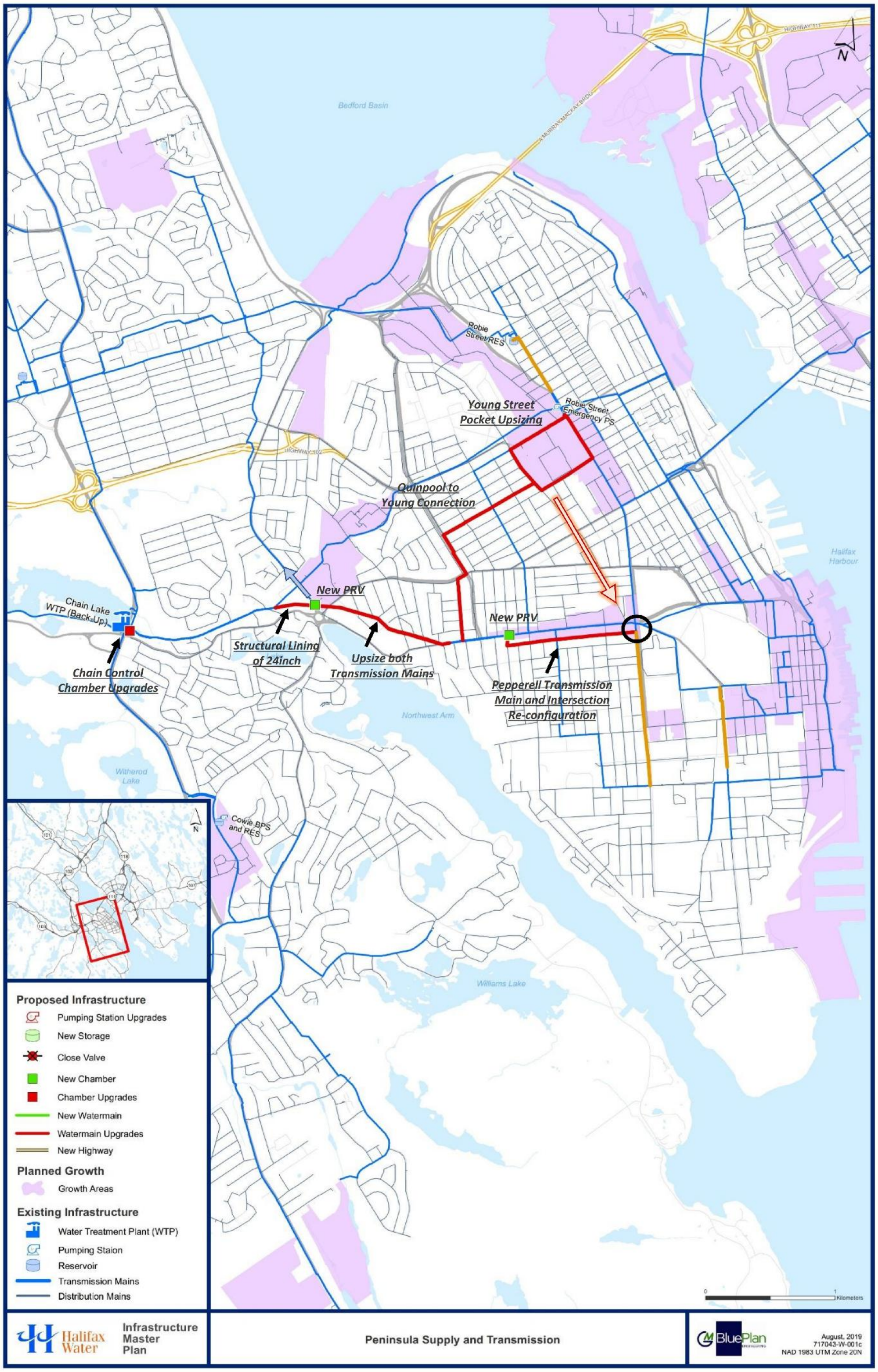
There is significant proposed growth on the Halifax Peninsula (approximately 51,000 population equivalent), and the existing transmission system is insufficient to meet 2046 demands. The preferred strategy for water supply to the Peninsula is through increased Chain Control transmission main capacity using a strategically-timed upsizing approach. The individual Peninsula supply strategy projects are shown in **Executive Summary** Figure 8.

Peninsula Transmission

Several opportunities have been identified to enhance the existing spine network to accommodate growth in the Peninsula, including:

- Young Street Pocket watermain upsizing
- Quinpool Road to Young Street transmission connection
- “Closing the Loop” strategy to enhance system resiliency from Young Street area to Quinpool/Robie intersection, as small old watermains are replaced
- Three (3) critical transmission mains in poor condition are to be strategically cleaned, lined, or replaced within the next 5 years as part of the Asset Management Program
- Local distribution watermains have not been focused on under the Infrastructure Master Plan; however, the replacement and/or upsizing of these local distribution mains will continue to improve localized pressure and fire flow capacity issues

These Peninsula transmission strategy opportunities are shown in **Executive Summary** Figure 8**.**



Executive Summary Figure 8: Peninsula Supply and Transmission Objectives and Projects

Hemlock Elevated Tank

A new storage facility is recommended within the Hemlock High pressure zone to support growth in the Bedford area, reduce peaking of water supply at Pockwock WSP, and improve overall system resiliency.

Aerotech Tank

The existing Aerotech Tank is currently operating at 90% of its design capacity. Proposed growth will require significantly more storage volume. A design study is recommended for storage tank replacement, as well as a review of tank location to identify opportunities for system optimization. The new storage facility should consider the proposed Fall River extension and new supply source.

Lakeside and Timberlea

The following projects are proposed to meet growth requirements in the Lakeside and Timberlea area:

- Brunello Booster Pump Upgrades
- Bayers Industrial Park Looping
- Gravity Supply to Brunello
- Dominion Crescent Watermain Upsize

Herring Cove

The previous water servicing strategy created in 2000 provided recommendations for the watermain extension along Herring Cove Road, a new reservoir, and local servicing throughout the Herring Cove area. The servicing strategy proposed in the Infrastructure Master Plan included a review of the previous water servicing strategy, and includes the following key projects:

- Twinning of Herring Cove Road watermain
- Upsize St. Michaels Avenue watermain and loop McIntosh Street watermain
- Extension of servicing along John Brackett Drive and Ketch Harbour Road (part of previous water servicing strategy) is likely to proceed

Lively (Berry Hills)

The Lively Booster was designed to meet peak domestic demands and provide fire flow capacity to the Lively subdivision. The existing capacity of the Lively Booster cannot meet the proposed 2046 growth demands, therefore future upgrades are needed. Demand monitoring is recommended as development comes online; when demands reach 80% of the existing capacity, the proposed upgrades should be implemented.

Geizer Hill

The Geizer Hill Booster was designed and constructed to meet domestic flows and provide fire flow capacity for current and future water demands. However, the existing capacity cannot meet the proposed growth demands to the 2046 planning horizon. Therefore, future upgrades are needed. Demand monitoring is recommended as development comes online; when demands reach 80% of the existing capacity, the proposed upgrades should be implemented.

Woodside Industrial Park

A gravity solution is recommended from the Woodlawn Intermediate transmission main to the Woodside Industrial Park, to accommodate the growth expansion. The existing Woodlawn Intermediate pressure zone HGL is adequate to service existing and future customers.

Shannon Park

Additional capacity is required within the Burnside Low pressure zone to accommodate significant growth in the Shannon Park and Wyse Road areas. It is recommended that the existing Windmill Road watermain is upsized to accommodate this growth.

Projects to Enhance System Resiliency

System resiliency is a key objective for the servicing strategy to minimize risk of loss of service, water quality issues, fire flow capacity, adaption to climate change, transmission main failure, etc. Numerous projects have been proposed in both the Pockwock and Lake Major systems that aim to enhance system resiliency.

Pockwock System

- Pockwock Lake has some redundancy available through Chain Lake emergency backup supply and will have additional redundancy through future Tomahawk Lake supply.
- Separate study for JD Kline WSP is recommended to review level of risk associated with the supply plant and the requirements to provide an adequate level of resiliency.
- Twinning of the single 60-inch transmission main servicing the Pockwock system from JD Kline WSP to provide capacity for post-2046 demands and allow the existing transmission main to be taken offline for rehabilitation.
- Twinning the single 54-inch transmission main from Lucasville Road to Hammonds Plains Road; however, this strategy should be reevaluated during the next Infrastructure Master Plan update.
- Loop watermain from Nine Mile Drive to Hammonds Plains Road to join the Pockwock transmission mains and provide redundancy to a large portion of the 48-inch transmission main, in addition to providing a second supply to Orchard Control, reducing risk for the existing single feed.
- The Peninsula transmission main from Geizer 123 to Robie does not require additional capacity to meet growth demands; however, as it is a critical piece of infrastructure and its current condition is not known, a detailed study is recommended to evaluate different strategies aimed at minimizing risk of failure.
- Twinning of the Geizer 158 transmission main is proposed, including looping of the Lacewood Drive watermain. This twinning would increase conveyance to the Geizer reservoirs, provide a second feed to Geizer 158 High zone, and enhance resiliency to Geizer-158 supported pressure zones.
- An investigation is proposed to determine the performance benefits of implementing an advanced operational system at the Robie 2 Emergency Booster (currently operated manually on an as-needed basis).
- The Chain Lake backup water supply does not provide major redundancy for the Pockwock transmission main. A comprehensive study is recommended to determine the requirements to activate Chain Lake WSP, the before and after conditions of the Pockwock system, and the overall additional resiliency that Chain Lake could provide.

Lake Major System

- A capacity increase is recommended from the Topsail Chamber to Burnside to improve system resiliency under the 2046 horizon. This will be achieved through a new 30-inch diameter watermain, and will allow increased conveyance to Akerley Reservoir, support the Bedford-Burnside connection, and allow for full Lake Major system resiliency.
- It is recommended that the flow capacity through Tacoma PRV is increased to eliminate the needs for significant linear upgrades. It is recommended that the PRV chamber is upgraded while the Topsail to Waverley projects are being constructed to strengthen and optimize system operations as demands increase with growth.
- The proposed Bedford-Burnside interconnection can provide over 60% of ADD supply to the Lake Major system; it is recommended that the Lyle Street Booster is designed to convey the other 40% of ADD supply, effectively providing complete redundancy to the Lake Major system in the event of catastrophic failure under 2046 demands. This redundancy would also negate the need for the Lake Lamont backup supply.

Projects to Provide System Optimization

Eastern Passage

The recommendation of the Infrastructure Master Plan is to construct a new feed to Eastern Passage from Willowdale (higher HGL) with a new PRV. This new 16-inch watermain would meet fire flow objectives, create a loop for improved resiliency, provide opportunities for improved water quality, and optimize system pressures.

Treatment Facilities

There are opportunities to connect three of the six smaller community WSP’s (Miller Lake, Collins Park, and Silversands) into the main networks and decommission the existing smaller facilities These projects are not growth-triggered, and their timing requirements are flexible.

Springfield Lake Connection

There is an opportunity to extend potable water distribution service to the Springfield Lake area via new watermain connection, through a synergy opportunity with the planned wastewater diversion along Sackville Drive. The Infrastructure Master Plan includes the service extension to Springfield Lake; a more detailed servicing study will be required to develop a specific plan for adequate customer servicing.

The extension of water service to Springfield Lake would require consultation with HRM on an extension of the water service boundary. The extension would depend on the desire of residents to receive water service as system extensions are typically paid for by the new customers who would be receiving service.

Mt. Edward Booster Fire Pump Upgrade

The capacity and compliance analysis desktop study concluded that the fire flow provided by Mt. Edward Booster is inadequate for some serviced buildings, including multiple schools. It was noted that this was a desktop review using master planning criteria and a review in greater detail should be completed using the Fire Underwriters Survey (FUS) calculation approach.

Leiblin Booster Fire Pump Upgrade

The capacity and compliance analysis desktop study concluded that the fire flow provided by Leiblin Booster is inadequate for some serviced buildings, including the school. It should be noted that a fire pump capacity upgrade at the booster station is already underway.

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY
VOLUME 3
WEST REGION WASTEWATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

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VOLUME 3 – WEST REGION WASTEWATER INFRASTRUCTURE

Catchment Overview

As the West Region's servicing strategy was completed under the WRWIP, this volume has taken components of the WRWIP relating directly to the West Region. The more generic components in the WRWIP have been included in Volume 1 of the Infrastructure Master Plan.

The West Regions includes the wastewater sewersheds of Halifax, Herring Cove and Beechville, Lakeside and Timberlea (BLT). Herring Cove and BLT are separated systems while Halifax, being an older system, is combined, particularly within Halifax Peninsula. The main unique features for the West Region are in the Halifax catchment surrounding the combined areas. Several major combined sewer overflow (CSO) facilities are located at pumping stations and other locations throughout the combined network of Halifax Peninsular, and discharge to the Halifax Harbour. Flow that bypass the CSO are either conveyed by the Northwest Arm Trunk Sewer along the southern side of Halifax Peninsula, or the Fairview Cove tunnel along the north side of Halifax Peninsula, to the Halifax WWTF. Real time control (RTC) set-up restricts flows entering Young Street Pumping Station and the amount of flows pumped from Duffus Street to the WWTF.

The primary constraints identified in the West Region were the Halifax and BLT WWTFs exceeding rated capacity, bottlenecks in the trunk sewer along Fairview Cove, limited capacity to accommodate significant growth in Young Street and Spring Garden Road areas, and limitations downstream of Roaches Pond forcemain discharge. The main opportunities in the West Region are surplus capacity at Herring Cove WWTF and an upgrade to Mill Cove WWTF, which would allow for Central Region to accommodate growth, removing the need for the major diversion towards the Peninsula as previously noted in the RWWFP.

Additionally, under the Infrastructure Master Plan, components of the WRWIP were updated to align with the overall Infrastructure Master Plan process. This included outlining the revised growth in the West Region in accordance to the *Planning Data and Population Numbers* study and the Capital Program costs updated to align with 2019 dollars and include the new RDII Costing Template.

Key Supporting Studies

WET WEATHER MANAGEMENT STUDY

The Wet Weather Management Study was developed under the WRWIP for the West Region. The combined areas in Halifax Peninsular were assessed under the sewer separation and LID feasibility studies, as outlined in Volume 1. For the RDII reduction feasibility study, it should be noted that the analysis was originally completed during the WRWIP for all areas within the West Region, including combined areas in the Peninsula. As part of the Infrastructure Master Plan, only the separated systems were carried forward for RDII reduction, as sewer separation is a more appropriate option for the combined sewer areas.

The outcome of the study for Halifax are as follows:

- The sewer separation study identified Young Street, Kempt Road, upstream of Bedford Hwy and Connaught Avenue as areas that were most feasible for sewer separation
- The RDII reduction study identified Bridgeview, Clayton Park and Fairview/Fairmount (flow monitor catchments FM-3, FM-4 and FM-6) as having significant issues of RDII and providing opportunities to remove wet weather from the separate sanitary system

- The study recommended that the RDII analysis was refined as a component of the overall strategy in the WRWIP, along with sewer separation

Adjustment to the RDII reduction areas made in the strategy, was to include only the Fairview area of FM-6 in the RDII reduction, this was done in recognition of Fairview being an old system and being located near other areas with high RDII.

ADDITIONAL STUDIES

In addition to the Supporting Studies in Volume 1, the other studies used to guide the preferred servicing strategies are as follows:

- Local Wastewater Servicing Capacity Analysis (LoWSCA)
- Northwest Arm Sewer Lining and Reconfiguration of Armdale Pumping Station
- Rehabilitation of Fairfield Holding Tank

West Region Strategy Development

The PCSWMM models and WRWIP growth numbers were used to complete the capacity and compliance analysis for the West Region under both existing and growth scenarios, and then assisted in developing and testing multiple servicing strategies and selecting the preferred strategy. Climate change was not considered in the West Region strategy as it is a new component under the Infrastructure Master Plan.

Common Projects in the strategies included: decommission BLT WWTF and divert flows, upgrades to Young Street and Armdale Pumping Stations, sewer separation in Young Street and Spring Garden LoWSCA areas and upstream of Kempt Road CSO, re-commission the Fairfield Holding Tank, North Street flow split configuration and RDII reduction.

Once the Common Projects were confirmed a range of serving strategies were assessed. In the West Region four (4) overarching servicing strategy alternatives were considered, including:

- One strategy that conveys all flows to Halifax WWTF (Strategy 1), including BLT flows.
- Two strategies with flow diversion to Herring Cove WWTF (Strategy 2a – 2b), to reduce upgrades to Halifax WWTF. Strategy 2a includes the BLT diversion to Herring Cove WWTF and reduced upgrades to Halifax WWTF. Strategy 2b include the BLT and Armdale diversion to Herring Cove WWTF to remove upgrades to Halifax WWTF but requires an expansion at Herring Cove WWTF.
- One strategy to protect the peninsula from upgrades (Strategy 3), through a major Highway 102 diversion and the BLT diversion to Herring Cove WWTF. With all flows diverted to Herring Cove WWTF, significant expansions at that facility are required.

West Region Preferred Strategy

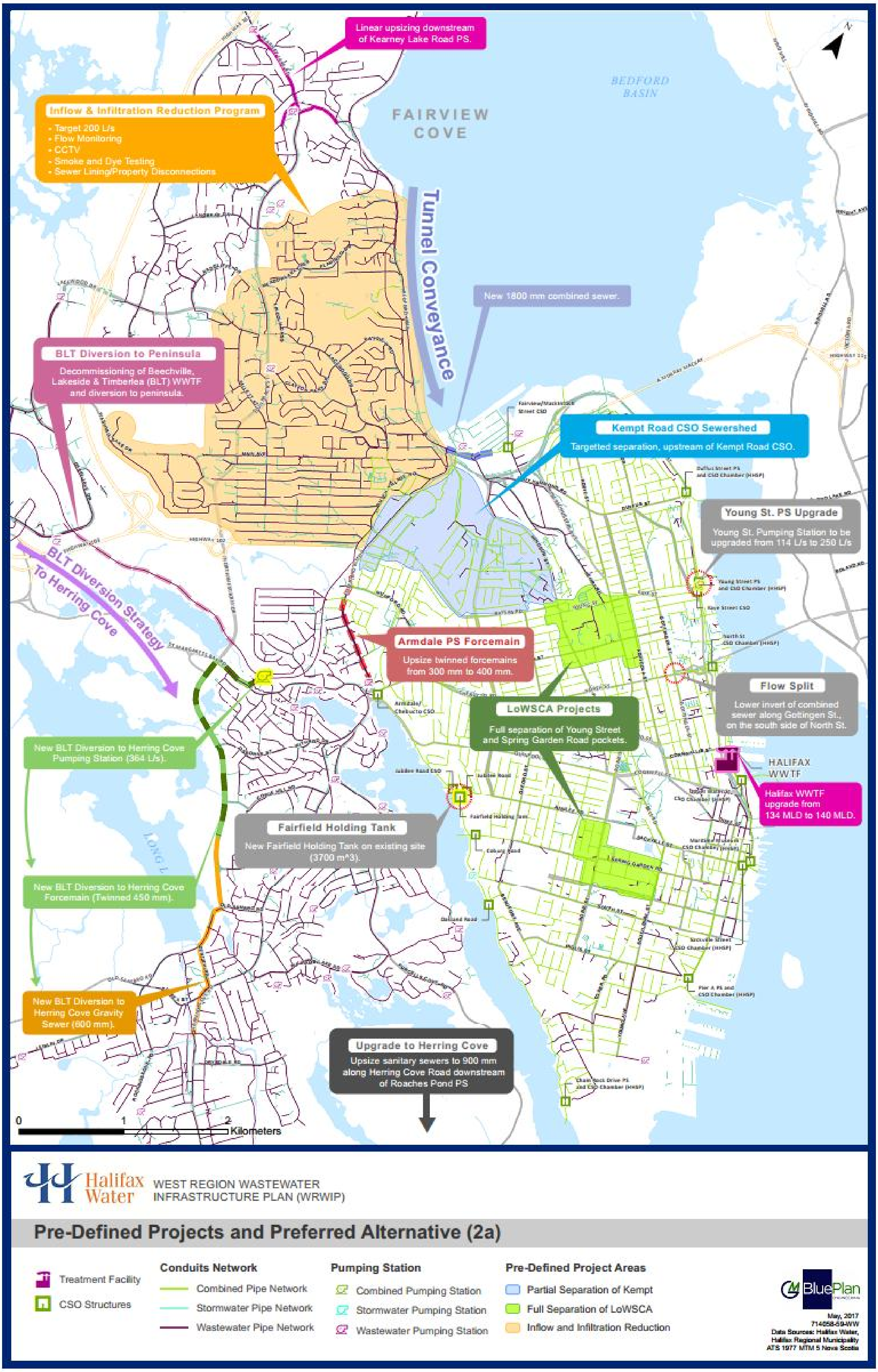
The preferred strategy for West region was Strategy 2a which is detailed in Executive Summary Figure 9: Preferred Servicing Strategy for the West Region. Strategy 2a was selected mainly due to providing greater flexibility, utilizes existing capacity at Herring Cove WWTF, ‘buys time’ on the Halifax WWTF upgrade, performing to an acceptable level of service, and being a cost-effective solution. In addition to selecting the preferred approach, two component evaluations were considered – Roaches Pond Pumping Station alternatives and determining the location of Crown Drive Pumping Station. The Roches Pond Pumping Station alternatives considered the pros and cons of removing the pumping station and replacing with a gravity pipe. Due to the expected difficulties, level of disruption and costs it was not recommended to proceed, instead more detailed investigation and data collection is recommended to properly identify the best operational strategy for this facility. The preferred strategy (2a) included a new pumping station within the Crown Drive and Northwest Arm Drive area. An exercise was completed to evaluate various locations and select a preferred location for the proposed Crown Drive Pumping Station.

The Capital Program for the West Region is included in Volume 1 Executive Summary. The capital cost for the WRWIP were updated under the Infrastructure Master Plan to be in 2019 dollars, including the updated RDII Costing Template and WRWIP Concept Design updates. This led to an increase in capital costs from **$165M (2018 dollars)** to **$186M (2019 dollars).**

The scope of work for the WRWIP project included conceptual design for all projects that are required within a 10-year horizon. The WRWIP preferred strategy Concept Design Projects were:

- New Fairview Cove Trunk Sewer
- New Crown Drive Pumping Station
- New BLT Pumping Station and Decommissioning of BLT WWTF
- Sewer Separation
- Young Street Pumping Station Upgrades

Refer to the WRWIP for the Conceptual Designs of the above projects.



Executive Summary Figure 9: Preferred Servicing Strategy for the West Region

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY

VOLUME 4

CENTRAL REGION WASTEWATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

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VOLUME 4 – CENTRAL REGION WASTEWATER INFRASTRUCTURE

Catchment Overview

Central Region servicing strategy was completed under the Infrastructure Master Plan, following the same process as the West Region under the WRWIP. The Central Region included Mill Cove WWTF, Springfield Lake WWTF, and Aerotech WWTF sewersheds.

The Springfield Lake catchment was not originally included in study area, however in recognition of the potential future benefits of diverting flows from Springfield Lake to Mill Cove WWTF, it was added to the Central Region study area.

The Aerotech wastewater collection system has been considered in the Infrastructure Master Plan; however, the only regional infrastructure features in the area is the Aerotech wastewater treatment facility itself. A significant facility upgrade was completed in 2016 on the WWTF, which included a full assessment of existing flows and future growth to evaluate capacity expansion requirements. As these upgrades have already been completed, the Aerotech WWTF system is not a primary focus area within the Infrastructure Master Plan.

The Mill Cove wastewater collection system is a separated system that covers the Sackville and Bedford areas and contains several key features that affect flow conveyance to the treatment facility.

- Main conveyance feature in Sackville is the Sackville trunk sewer, which drains by gravity to Fish Hatchery Pumping Station
- Fish Hatchery PS is located at the northernmost tip of the Bedford Basin and pumps all flow from the Sackville trunk sewer to Mill Cove WWTF
- Wastewater flows from the Bedford area converge via multiple smaller trunk sewers at the Bedford Pumping Station, located directly southwest of the Mill Cove WWTF
- Local wastewater network along Shore Drive that conveys wastewater flows directly to Mill Cove WWTF via Bedford Yacht Club Pumping Station.
- The Mill Cove Wastewater Treatment Facility is located near the Bedford Basin, and planning for major expansion to this treatment facility is currently underway

The Springfield Lake wastewater collection system is a separated system that surrounds Springfield Lake. Flows are conveyed to the Springfield WWTF through a chain of pumping stations due to the hilly topography around the lake. There is a localized low pressure system in the low-lying Falcon Crest Court peninsula catchment, that conveys flows to higher elevation without pumping.

Key Supporting Studies

WET WEATHER MANAGEMENT STUDY

As Mill Cove sewershed is a separated system the only Wet Weather Flow Management study incorporated into the strategy was the RDII Reduction Analysis. The Mill Cove flow monitoring catchments FMZ02 (Glen Moir), FMZ03 (Millview), FMZ10 (Bedford Common), and FMZ07 and FMZ40 (Lower Sackville), were highlighted as having significant RDII issues and provide an opportunity to remove wet weather from the separated sewer system.

ADDITIONAL STUDIES

In addition to the Supporting Studies in Volume 1, the other studies used to guide the preferred servicing strategies are as follows:

- The National Disaster Mitigation Program (NDMP) - identify thirty (30) key areas in HRM that are prone to frequent flooding during heavy rainfall events
- Fish Hatchery Forcemain Inspection Report

Central Region Strategy Development

The InfoWorks ICM model for the Central Region was used to complete the capacity and compliance analysis under both existing and growth scenarios, and then assist in developing and testing multiple servicing strategies and selecting the preferred strategy. Climate change was considered in the strategies through applying a climate change factor to the rainfall simulations as outlined in the Climate Change Study.

Common Projects in Central Region included upgrades to Mill Cove WWTF, decommission of Springfield WWTF and connection to Mill Cove sewershed, upgrades to Majestic Avenue, Beaver Bank #3 Pumping Stations, local pipe upgrades and the RDII reduction.

Once the Common Projects were confirmed a range of serving strategies were assessed. In Central Region there were six (6) overarching servicing strategy alternatives were considered, including:

- Two conveyance strategies (Strategy 1a – 1b) based on upsizes to the Sackville trunk with/without enhanced RDII to reduce catchment flows.
- Three storage strategies (Strategy 2a – 2c) based on installing storage tanks along the Sackville trunk, with/without upgrade to the Sackville trunk. Variations between strategies included tanks sized and applying enhanced RDII to reduce catchment flows.
- Two tunnel strategies (Strategy 3a – 3b) aim to decommission Fish Hatchery Pumping Station via the construction of a new tunnel to Mill Cove WWTF. Strategy 3a has the tunnel starting from Fish Hatchery PS and includes trench upgrades to the Sackville trunk upstream of Fish Hatchery. Strategy 3b extends the tunnel up to the Bedford Bypass crossing to remove trench upgrades.

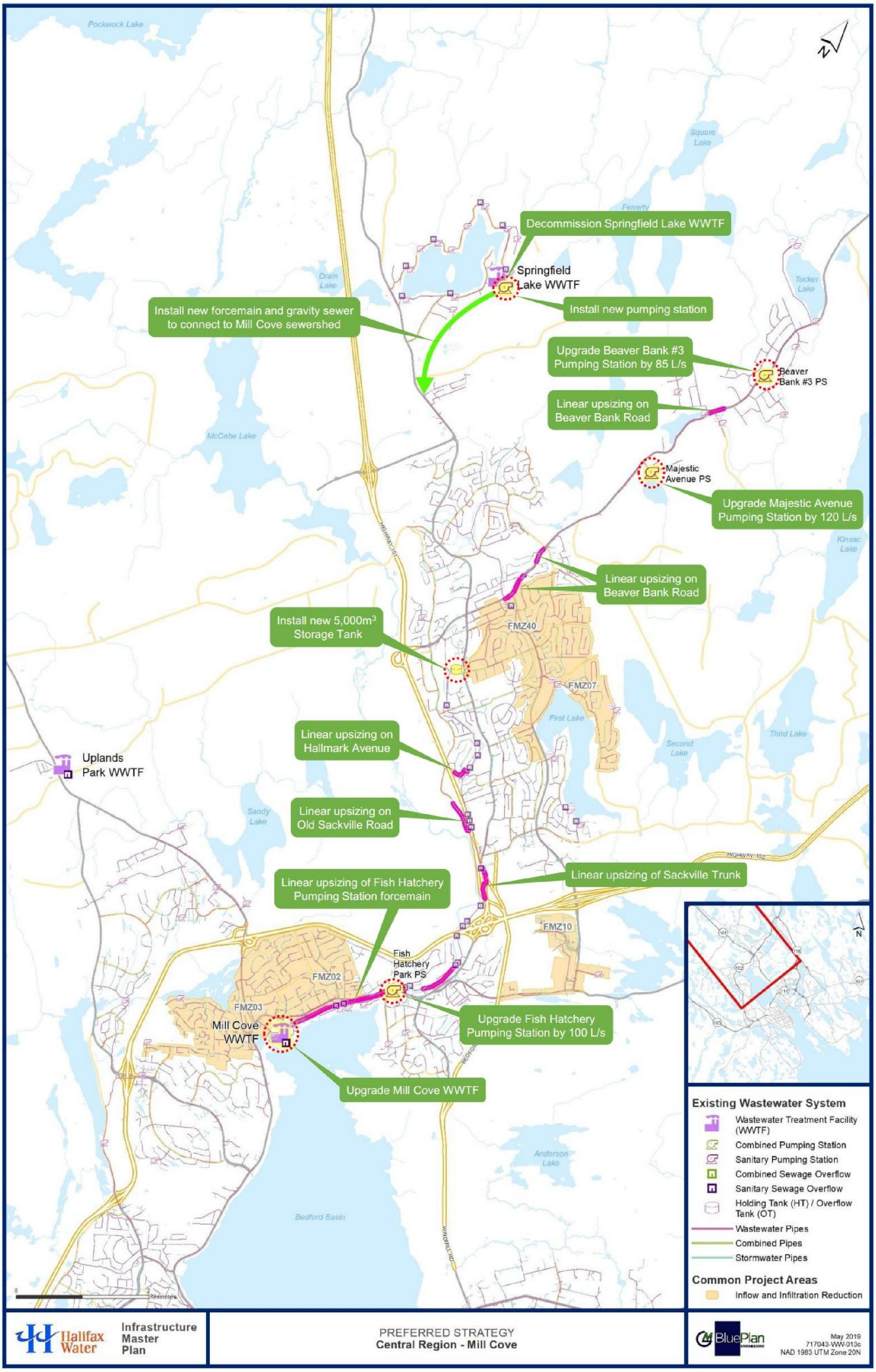
Central Region Preferred Strategy

The preferred strategy for Central was Strategy 2c which is detailed in Executive Summary Figure 10. Strategy 2c was selected mainly due to providing future flexibility, maximizes the use of existing assets, performing to an acceptable level of service, and being a cost-effective solution. In addition to selecting the preferred strategy for Central a component evaluation was done on RDII reduction rates and the impact on infrastructure requirements as RDII reduction directly affects tank sizing.

The Capital Program for the Central Region is included in Volume 1 Executive Summary. The Capital Costs for Central Region total **$163M (2019$).** The program is front heavy due to the cost associated with the upgrades to Mill Cove WWTF and the RDII reduction project required at the start of the project horizon.

The scope of work for the Infrastructure Master Plan included conceptual design for certain projects which are complex in feasibility and/or constructability. The projects selected for Conceptual Design were:

- Springfield Lake WWTF decommissioning and diversion to Mill Cove WWTF wastewater system
- Fish Hatchery PS forcemain upsizing (450mm to 675mm diameter)



Executive Summary Figure 10: Preferred Servicing Strategy for the Central Region

Halifax Water

INFRASTRUCTURE MASTER PLAN

EXECUTIVE SUMMARY
VOLUME 5
EAST REGION WASTEWATER INFRASTRUCTURE

Prepared by: GM BluePlan Engineering
For: Halifax Water
October 2019

GM BluePlan ENGINEERING

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VOLUME 5 – EAST REGION WASTEWATER INFRASTRUCTURE

Catchment Overview

East Region servicing strategy was completed under the Infrastructure Master Plan, following the same process as the West Region under the WRWIP. The East Region includes two wastewater sewersheds Eastern Passage and Dartmouth, and the sewersheds contain unique components and constraints with them.

The Eastern Passage is a separated system that covers the Cole Harbour and Eastern Passage areas. The main unique feature in the catchment is the gravity pressure sewer that connects the Cole Harbour area to the Eastern Passage treatment facility. Due to existing capacity constraints at the gravity pressure sewer there is a real time control (RTC) set-up that restricts flows from the main pumping station in Cole Harbour, Bisset Lake Pumping Station, to the surge tank at the start of the gravity pressure sewer. The main issues identified with the gravity pressure sewer include: flow restrictions causing spills at Bissett Lake, the condition of the asset affecting conveyance, odour control requirement and ongoing operational and maintenance concerns. Additional concerns in the catchment are Memorial Drive, Beaver Crescent and Quigley’s Corner Pumping Stations being under capacity, and Caldwell Crescent and Bissett Lake Pumping Stations being impacted by growth. The main opportunity in Eastern Passage is the newly upgraded WWTF. The treatment plant is located near Halifax Harbour and was expanded in 2014 to accommodate projected population growth in the serviceable boundary areas.

Dartmouth sewershed is an older system, largely comprised of combined systems within the Circumferential Highway, an area referred to as the Regional Centre. Outside the Regional Centre of the Dartmouth sewershed, it is considered a separated system. The combined system in Dartmouth includes flows from Albro Lake Watershed, Maynard Lake and the Clement Street Wetland located in the Southdale area, which leads to high peak flows and volumes being conveyed under storm events, causing capacity constraints on the system and combined sewer overflow (CSO) spills. Significant growth in the Dartmouth catchment will worsen conditions and lead to additional treatment capacity required at Dartmouth WWTF and increase flooding on Wyse Road and by Old Ferry Road CSO. In the separated areas upstream, there are existing constraints made worse by growth including SSO spills at Valleyford Holding Tank, Anderson Pumping Station and 111 Waverley Road Pumping Station.

Key Supporting Studies

WET WEATHER MANAGEMENT STUDY

It is evident from the background review and feasibility study outputs that there is significant potential for sewer separation within the combined system in Dartmouth and RDII reduction in the separated areas. The outcome of the wet weather management study for Dartmouth are as follows, and have been included in the strategy:

- The sewer separation study identified Jamieson Street, Wyse Road, Nantucket Avenue, Thistle Street, Rose Street and Canal Street as areas that were most feasible for sewer separation
- The Dartmouth flow monitoring catchments FMZ27 (Ellenvale) and FMZ45 (Woodside) were highlighted as having significant RDII issues and provide an opportunity to remove wet weather from the separated sewer system

As Eastern Passage sewershed is a separated system the only Wet Weather Flow Management strategy incorporated into the strategy was the RDII Reduction Analysis. The predefined flow monitor target areas were FMZ24 (Loon Lake), FLM23 and FMZ81 (Colby Village) and FMZ37 (Eastern Passage). All of the target areas were included with the exception of FMZ81, as the RDII reduction strategy did not alleviate flow restrictions observed along Colby Road making RDII reduction not the most cost-effective strategy.

ADDITIONAL STUDIES

In addition to the Supporting Studies in Volume 1, the other studies used to guide the preferred servicing strategies are as follows:

Dartmouth:

- Local Wastewater Servicing Capacity Analysis (LoWSCA)
- Gravity Stormwater Sewer from Little Albro Lake to Jamieson Street Pumping Station, Preliminary Design Report
- Port Wallace Master Plan Infrastructure Study
- National Disaster Mitigation Program (NDMP)

Eastern Passage:

- Eastern Passage WW Management Plan
- Quigley's Corner Preliminary Design Report
- Cow Bay Road Draining Investigation – Hydrologic and Hydraulic Analysis
- National Disaster Mitigation Program (NDMP)

Eastern Passage Strategy Development

The InfoWorks ICM models for the East Region were used to complete the capacity and compliance analysis under both existing and growth scenarios, and then assist in developing and testing multiple servicing strategies and the preferred strategy. Climate change was considered in the strategies through applying a climate change factor to the rainfall simulations and through looking at the impact of sea level rise on CSOs discharging to the Halifax Harbour in Dartmouth and SSOs in Eastern Passage.

Common Projects in Eastern Passage included upgrades to Memorial Drive, Beaver Crescent and Quigley's Corner Pumping Stations, local pipe upgrades and the RDII reduction.

Once the Common Projects were confirmed a range of servicing strategies were assessed. In Eastern Passage ten (10) overarching servicing strategy alternatives were considered, including:

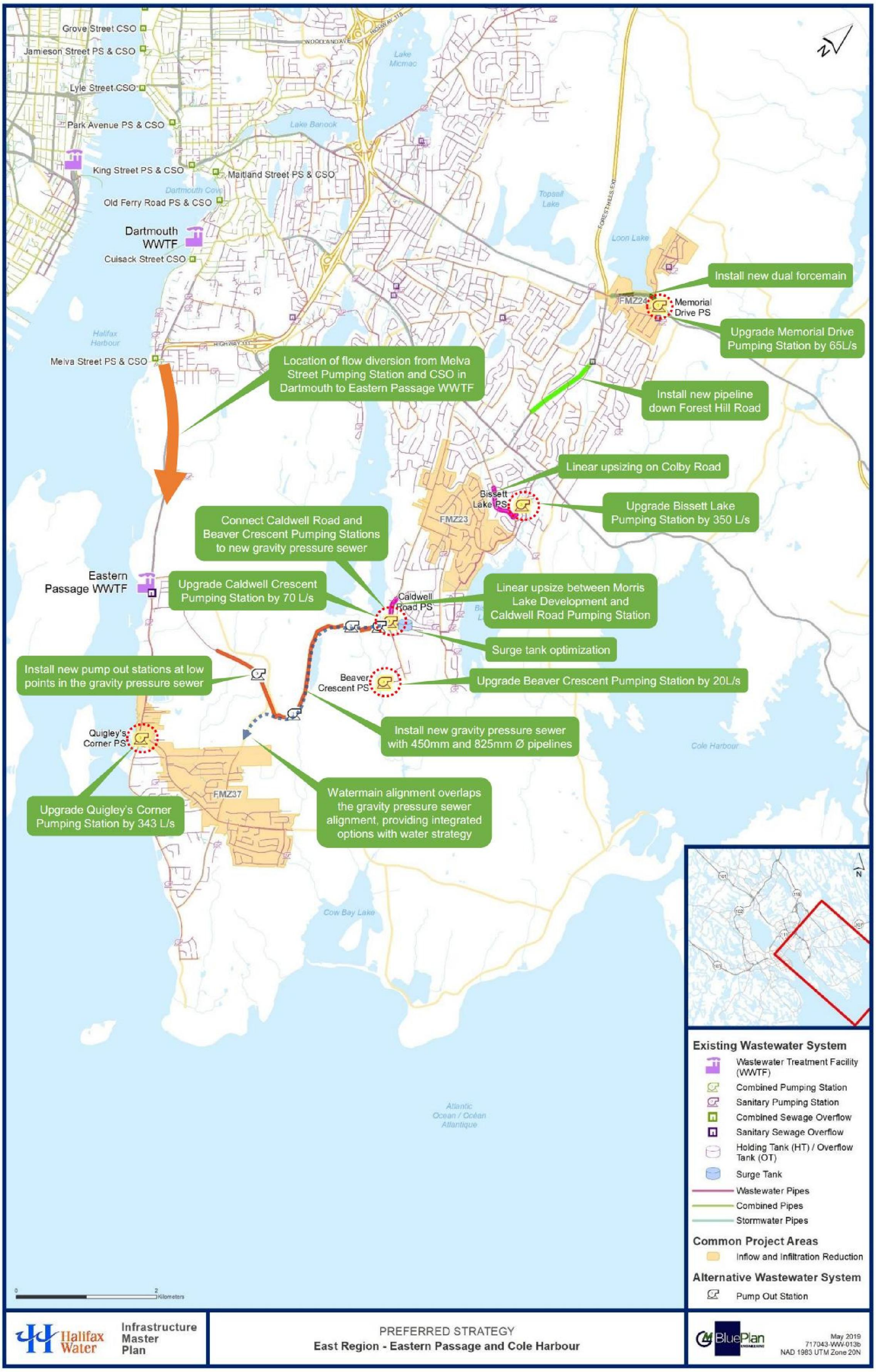
- Four conveyance strategies (Strategy 1a – 1d) based on installing a new gravity pressure sewer with pump out stations to improve conveyance and odour issues. Strategy 1d is a sub-option to all strategies where an alternate route for the gravity pressure sewer crossing under the Shearwater Airport is considered. Variation between Strategies 1a-1c included different pipe sizes and the use of enhanced RDII to reduce catchment flows.
- Four storage strategies (Strategy 2a – 2d) based on installing storage tanks, with/without upgrade to the gravity pressure sewer. Limited upgrades to the gravity pressure sewer meant the Strategies did not address odour issues. Variations between strategies included tanks sized to different level of services and applying enhanced RDII to reduce catchment flows.
- Two tunnel strategies (Strategy 3a – 3b) to remove the gravity pressure sewer. Strategy 3a installs a gravity tunnel from Bissett Lake Pumping Station to just upstream of Eastern Passage WWTF

and Strategy 3b is shortened alignment from the surge tank to the WWTF, including connections by Morris Lake to service growth in the area.

Eastern Passage Preferred Strategy

The preferred strategy for Eastern Passage was Strategy 1c which is detailed in Executive Summary Figure 11. Strategy 1c was selected mainly due to addressing the operations and maintenance issues surrounding the gravity pressure sewer, performing to an acceptable level of service, and being a cost-effective solution. The selected gravity pressure sewer alignment travels around the Shearwater Airport, forming an indirect path. It was recommended to revisit the cost saving of tunneling under the airport throughout the design stages. In recognition that additional assessment of the gravity pressure sewer could improve the design, it was included as one of the Conceptual Designs included under the Infrastructure Master Plan.

The Capital Program for Eastern Passage is included in Volume 1 Executive Summary. The program is front-heavy due to the cost associated with the gravity pressure sewer replacement which is required at the start of the project horizon.



Executive Summary Figure 11: Preferred Servicing Strategy for Eastern Passage

Dartmouth Strategy Development

Common Projects in Dartmouth included separation of Lake Albro, Maynard lake and the Clement Street Wetland, sewer separation in Wyse Road and Canal Street LoWSCA areas, Rose Street and Thistle Street, flow diversions in the Lyle Street and King Street CSO catchments, upgrades to Anderson Pumping Station, local pipe upgrades, RDII reduction, additional flow monitoring and a CSO Management Plan to improve CSO performance.

Once the Common Projects were confirmed a range of serving strategies were assessed. In Dartmouth seven (7) overarching servicing strategy alternatives were considered, including:

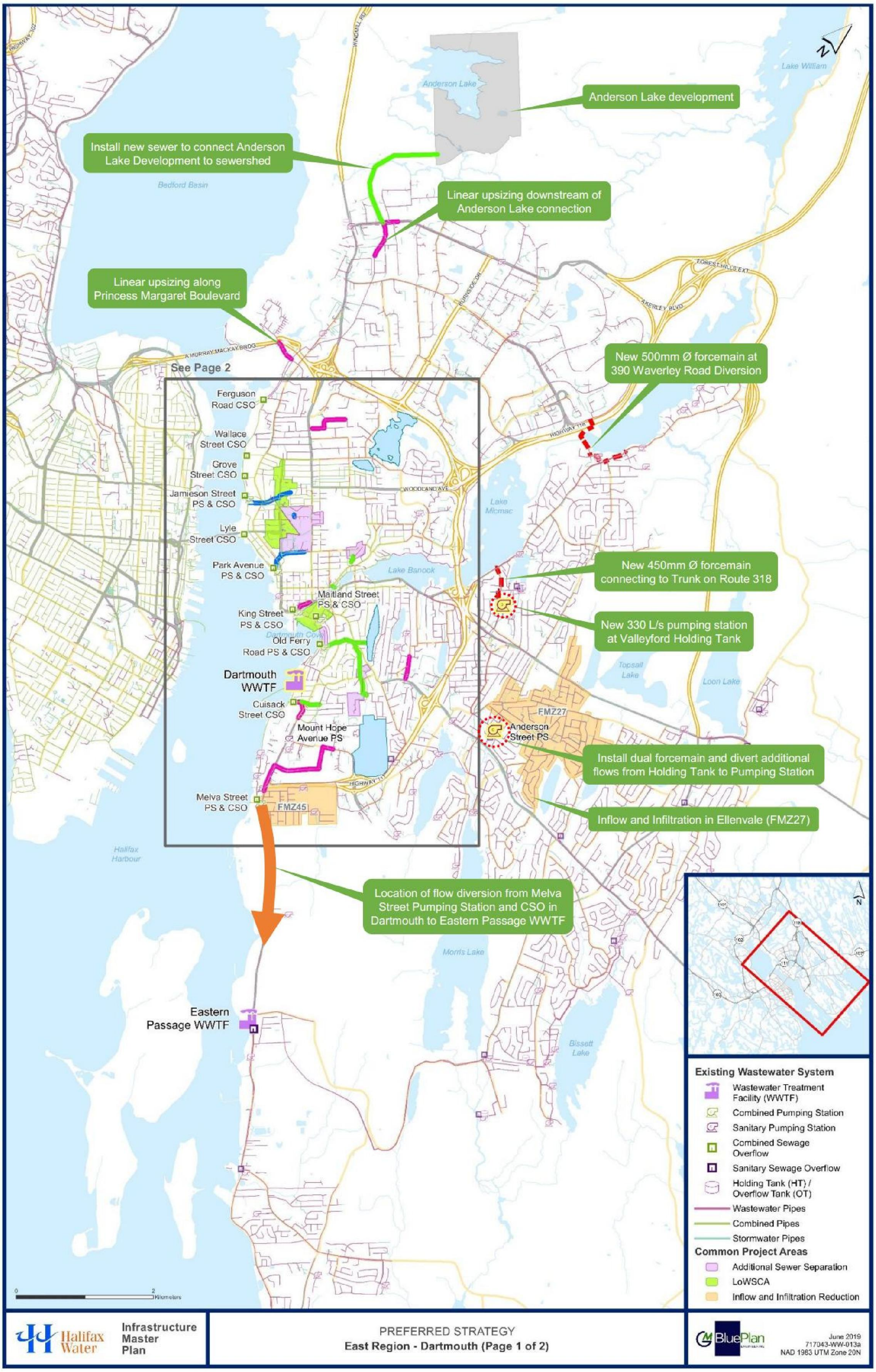
- Four conveyance strategies (Strategy 1a – 1d) include upgrades to existing alignment, reducing upgrades required through enhance RDII reduction and new conveyance alignments. Strategy 1d was a sub-option to all strategies with a diversion of Dartmouth flows to Eastern Passage WWTF to reduce the upgrades required at Dartmouth WWTF.
- Two storage strategies (Strategy 2a – 2b) consider installing storage tanks over conveyance upgrades to. Variations between strategies included tanks with/without applying enhanced RDII to reduce catchment flows.
- One tunnel strategies (Strategy 3) explores a tunnel option to eliminate CSO spills. The tunnel option is a cost on top of the other strategies, that address inner system constraints, making this strategy an expensive addition to the other strategies.

Dartmouth Preferred Strategy

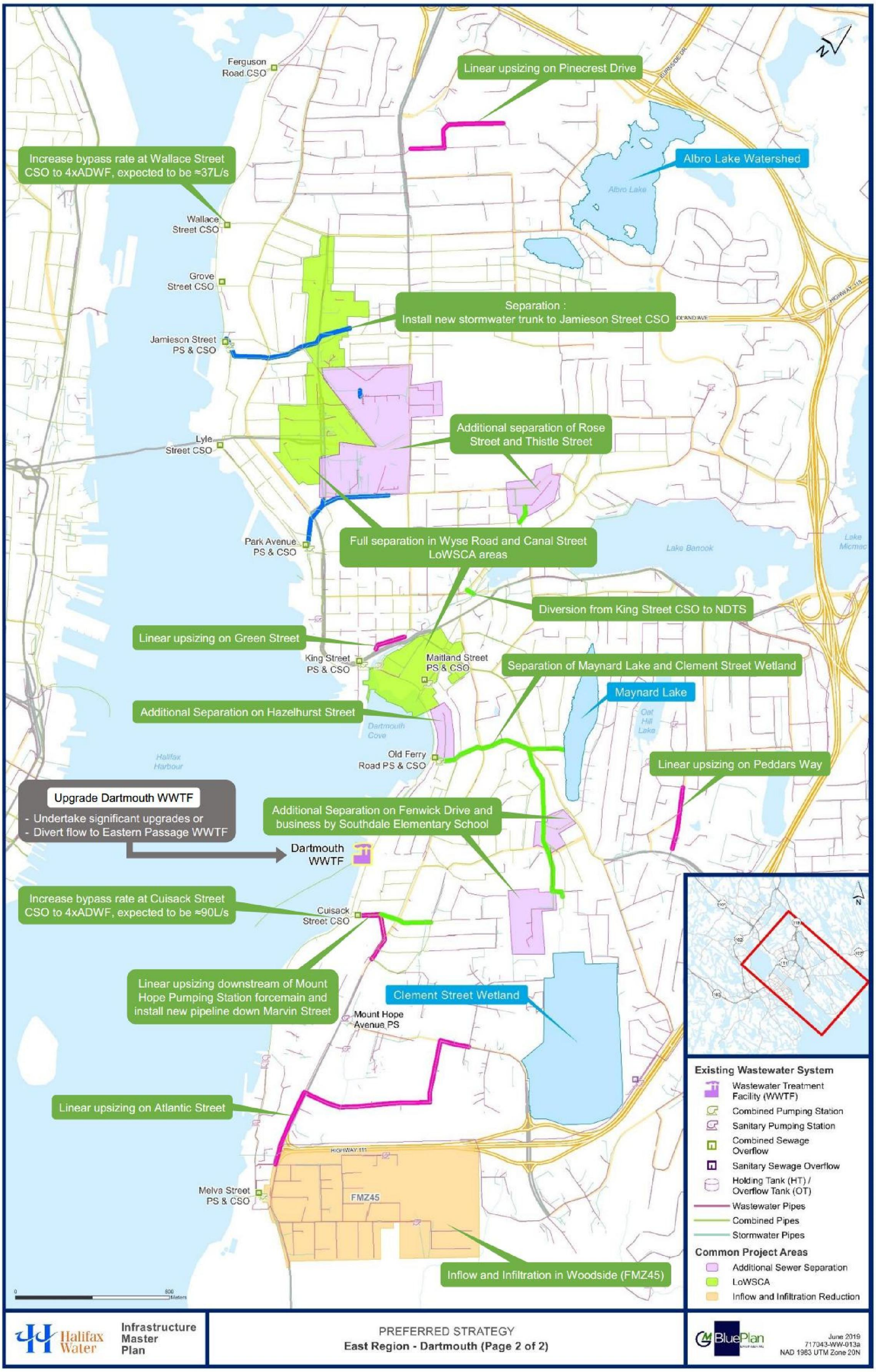
The preferred strategy for Dartmouth was Strategy 1c which is detailed in Executive Summary Figure 12. Strategy 1c was selected mainly due to providing future flexibility, balancing flows across system trunks, performing to an acceptable level of service, and being a cost-effective solution. In addition to selecting the preferred approach for inner system constraints two component evaluations were also considered - increasing the bypass rates at two CSOs and a flow diversion from Dartmouth to Eastern Passage WWTF (Strategy 1d). The CSO assessed were Cuisack and Wallace and based on the growth upstream the bypass rates were adjusted to match the CSO design rate of 4x average dry weather flow (ADWF). The rates were able to be increased due to the extent of sewer separation in the catchment and offsetting spill rates at other CSOs.

The flow diversions from Dartmouth to Eastern Passage WWTF was considered due to additional space for treatment being reserved at Eastern Passage WWTF, allowing for the rated capacity to be increased at a lower cost than upgrading Dartmouth WWTF. Upgrades to Dartmouth WWTF are expected to be high as the WWTF would likely require a system overhaul to accommodate growth while considering higher treatment standards and improved processes. The flow diversion therefore showed significant cost savings and ‘buys time’ on the upgrades to Dartmouth. As the diversion did not completely remove the need for increase capacity at Dartmouth WWTF a cost to upgrade Dartmouth WWTF by 3MLD was included in the strategy. The projects within Dartmouth that were brought forward to the Infrastructure Master Plan Concept Designs, were the separation of Lake Albro, Maynard lake and Clement Street Wetland, as sewer separation became a major component in the Dartmouth strategy and the projects showed potential for improvements to the designs.

The Capital Program for the East Region is included in Volume 1 Executive Summary. The Capital Costs for Eastern Passage total **$49M** and for Dartmouth are **$104M (2019$)** totaling **$153M** for the East Region.



Executive Summary Figure 12: Preferred Servicing Strategy for Dartmouth



Executive. Summary Figure 13: Preferred Servicing Strategy for Dartmouth

Regional Development Charge for Wastewater Infrastructure

29.(1) In this Section,

(a) "Regional Development Charge" means a regional development charge for Regional Wastewater infrastructure;

(b) "Regional Wastewater Infrastructure" means core regional Wastewater treatment facilities and trunk sewer systems directly conveying Wastewater to, or between, such facilities, including

(i) existing Wastewater treatment facilities (WWTF) that provide a regional Service including the facilities generally known as the Halifax WWTF, Dartmouth WWTF, Herring Cove WWTF, Eastern Passage WWTF, Mill Cove WWTF Beechville/Lakeside/Timberlea WWTF, and Aerotech WWTF,

(ii) trunk sewers and related appurtenances which directly convey Wastewater to regional treatment facilities,

(iii) trunk sewers and related appurtenances which divert Wastewater from one regional treatment facility to another due to environmental concerns, capacity constraints or operational efficiency, and

(iv) inflow and infiltration reduction and/or sewer separation projects for the purposes of gaining capacity within the wastewater system for the benefit of planned growth.

but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;

c) " Infrastructure Master Plan" a long-term infrastructure planning and engineering study that identifies the optimal regional water and wastewater infrastructure implementation plan for Halifax Water to service growth for 30 years.

(2) A Regional Development Charge shall be established to ensure the cost impact to Halifax Water is neutral to the design, construction and financing during construction of capacity expansion to Regional Wastewater Infrastructure related to planned growth.

(3) A Regional Development Charge applicable to new buildings that will be connected to a Wastewater System, as detailed in Table 4A, shall be paid to HRM as agent for Halifax Water prior to the issuance of a building permit or permit to connect to the Wastewater System, as applicable.

Table 4B. Regional Development Charge – Wastewater*

Type of Development	May 1, 2020
SUD/TH/RH[1]	$ 4,941.04
MUD[2]	$ 3,318.61
ICI[3] (m^2)	$ 25.83 ($ 2.40 ft^2)

* The wastewater Regional Development Charge shall be indexed each year on April 1st, in accordance with the indexing set out in the Consumer Price Index for Halifax, as published by Statistics Canada for the immediately preceding month, when compared to the same month for the immediately preceding year.

[1] SUD/TH – Single Unit Dwelling/Townhouse/Row Houses

[2] MUD – Multiple Unit Dwelling

[3] ICI – Industrial, Commercial or Institutional

(4) For new buildings, building additions and renovations that are undertaken as the redevelopment of an existing serviced building, the Regional Development Charge applicable under subsection (3) shall be based on the net increase in residential units and/or square footage of floor space for Non-Residential construction, as applicable, but not including interior or underground parking.

(5) When an un-serviced lot of land, occupied by a building, the Regional Development Charge applicable under subsection (3) shall be payable to Halifax Water, when the building is connected to the Wastewater System.

(6) A Regional Development Charge applicable to Industrial, Commercial or Institutional premises will be determined by applying the charge in subsection (3) to the area of the building.

(7) The Regional Development Charge set out in Table 4A shall be collected by HRM on behalf of Halifax Water at the time an application for construction approval is submitted.

(8) Funds collected under the Regional Development Charge shall be placed in a reserve account and shall be used for providing capacity in Regional Wastewater Infrastructure as defined in the current Infrastructure Master Plan.

(9) Subject to subsections (10) and (11) Halifax Water may consider and approve deferral of payment of a Regional Development Charge in its sole discretion where such Charge otherwise payable is $100,000 or greater.

(10) The deferral of payment referred to in subsection (9) may be, in Halifax Water`s sole discretion, up to 25% of the Regional Development Charge otherwise payable under this Section, which deferral shall be placed as a lienable charge on the property, to be collected by HRM, pursuant to clause 33(2)(a) of the Halifax Regional Water Commission Act.

(11) The regional level infrastructure to be supported by the Regional Development Charge is deemed to be for the benefit of the properties to be liened.

(12) The Regional Development Charge may be deferred for units considered within the Housing Affordability initiatives as defined by Halifax Regional Municipality. Deferrals may be considered for these units up to ten years. Interest will be charged after year two. Halifax Regional Municipality will place a lien on the Property to ensure payment of the RDC. ***[Note: If the Halifax Water Board supports development of a deferral mechanism for affordable housing, the wording may be modified prior to submission to the NSUARB pending outcome of discussions with the municipality and analysis of the impact deferrals would have on projected cash flows.]***

(13) Subject to subsections (14) and (15), the administration of the Regional Development Charge shall, every five years after, May 1, 2020, be reviewed by Halifax Water, including with reference to any changes to the Infrastructure Master Plan.

(14) In the event changes to the inputs to the Infrastructure Master Plan , including growth projections, land use, consumption rates, inflow/infiltration assumptions, capital costs, financing costs, and benefit to existing Customers, result in changes to the infrastructure requirements identified in the Infrastructure Master Plan, including the timing of their implementation, the Regional Development Charge, will be reviewed by Halifax Water and

adjusted, subject to Board approval, prior to a five year review described in subsection (13).

(15) In the event the changes to infrastructure requirements described in subsection (14) result in an impact of 15%, either in the positive or the negative, to the Regional Development Charge, Halifax Water will change the Regional Development Charge, subject to Board approval, to reflect such impact in infrastructure requirements.

Regional Development Charge for Water Infrastructure

30.(1) In this Section,

(a) "Regional Development Charge" means a regional development charge for water infrastructure;
(b) "Regional Water Infrastructure" means core regional water supply facilities and the water transmission systems directly conveying water from such facilities to the various distribution systems, including
  (i) existing water supply facilities that provide a regional Service including the facilities generally known as the J.D. Kline water supply facility at Pockwock Lake and the Lake Major water supply facility at Lake Major,
  (ii) water transmission mains and related appurtenances which directly convey water from regional treatment facilities to the distribution system,
  (iii) water transmission mains and related appurtenances which divert water from one regional treatment facility supply area to another due to environmental concerns, capacity constraints or operational efficiency, and
  (iv) demand reduction measures to provide capacity for growth and are a cost-effective alternative to new regional hard infrastructure are considered eligible.

but does not include infrastructure within or directly adjacent to approved or planned development areas which is required to directly support development within an approved or planned development area;
(c) "Infrastructure Master Plan" a long-term infrastructure planning and engineering study that identifies the optimal regional water and wastewater infrastructure implementation plan for Halifax Water to service growth for 30 years.

(2) A Regional Development Charge shall be established to ensure the cost impact to Halifax Water is neutral to the design, construction and financing during construction of capacity expansion to Regional Water Infrastructure related to planned growth.

(3) A Regional Development Charge applicable to new buildings that will be connected to a Water System, as detailed in Table 4B, shall be paid to HRM as agent for Halifax Water prior to the issuance of a building permit or application to connect to the water System, as applicable.

Table 4C. Regional Development Charge – Water*

Type of Development	May 1, 2020
SUD/TH/RH[1]	$ 1,810.10
MUD[2]	$ 1,215.74
ICI[3] (m^2)	$ 9.47 ($ 0.88 ft^2)

* The water Regional Development Charge shall be indexed each year on April 1st, in accordance with the indexing set out in the Consumer Price Index for Halifax, as published by Statistics Canada for the immediately preceding month, when compared to the same month for the immediately preceding year.

[1] SUD/TH – Single Unit Dwelling/Townhouse/Row Houses

[2] MUD – Multiple Unit Dwelling

[3] ICI – Industrial, Commercial or Institutional

(4) For new buildings, building additions and renovations that are undertaken as the redevelopment of an existing serviced building, the Regional Development Charge applicable under subsection (3) shall be based on the net increase in residential units and/or square foot of floor space for Non-Residential construction, as applicable, but not including interior or underground parking.

(5) When an un-serviced lot of land, occupied by a building, the Regional Development Charge applicable under subsection (3) shall be payable to Halifax Water, when the building is connected to the Water System.

(6) A Regional Development Charge applicable to Industrial, Commercial or Institutional premises will be determined by applying the charge in subsection (3) to the area of the building.

(7) The charge set out in Table 4B will be collected by HRM on behalf of Halifax Water at the time an application for construction approval is submitted.

(8) Funds collected under the Regional Development Charge shall be placed in a reserve account and shall be used for providing capacity in Regional Water Infrastructure as defined in the current Infrastructure Master Plan.

(9) Subject to subsections (10) and (11) Halifax Water may consider and approve deferral of payment of a Regional Development Charge in its sole discretion where such Charge otherwise payable is $100,000 or greater.

(10) The deferral of payment referred to in subsection (9) may be, in Halifax Water`s sole discretion, up to 25% of the Regional Development Charge otherwise payable under this Section, which deferral shall be placed as a lienable charge on the property, to be collected by HRM pursuant to clause 33(2)(a) of the Halifax Regional Water Commission Act.

(11) The regional level infrastructure to be supported by the Regional Development Charge is deemed to be for the benefit of the properties to be liened.

(12) The Regional Development Charge may be deferred for units considered within the Housing Affordability initiatives as defined by Halifax Regional Municipality. Deferrals may be considered for these units up to ten years. Interest will be charged after year two. Halifax Regional Municipality will place a lien on the Property to ensure payment of the

RDC. ***[Note: If the Halifax Water Board supports development of a deferral mechanism for affordable housing, the wording may be modified prior to submission to the NSUARB pending outcome of discussions with the municipality and analysis of the impact deferrals would have on projected cash flows.]***

(13) Subject to subsections (14) and (15), the administration of the Regional Development Charge shall, every five years after, May 1, 2020, be reviewed by Halifax Water, including with reference to any changes to the Infrastructure Master Plan.

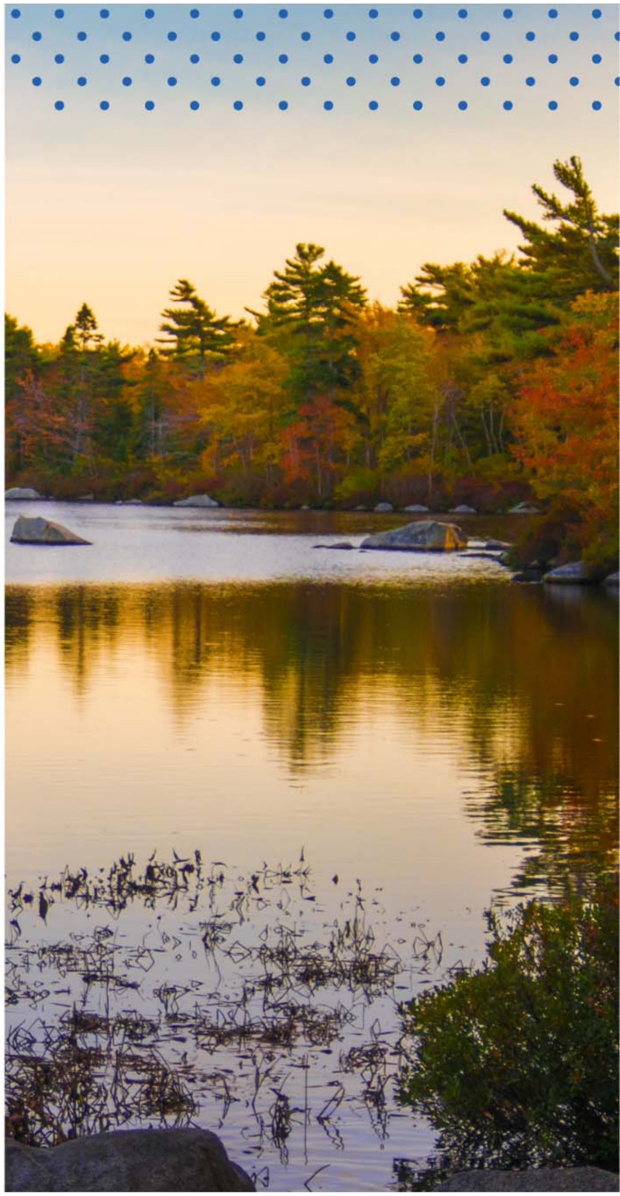
(14) In the event changes to the inputs to the Infrastructure Master Plan, including growth projections, land use, consumption rates, inflow/infiltration assumptions, capital costs, financing costs, and benefit to existing Customers, result in changes to the infrastructure requirements identified in the Infrastructure Master Plan, including the timing of their implementation, the Regional Development Charge, will be reviewed by Halifax Water and adjusted, subject to Board approval, prior to a five year review described in subsection (13).

(15) In the event the changes to infrastructure requirements described in subsection (14) result in an impact of 15%, either in the positive or the negative, to the Regional Development Charge, Halifax Water will change the Regional Development Charge, subject to Board approval, to reflect such impact in infrastructure requirements.

Regional Development Charge

October 31, 2019

STRAIGHT from the SOURCE



Regional Development Charge

- Funds infrastructure to enable growth
- Proportion charges to ensure equity and “cost causer pay”, equity between developers and also equity between the existing rate payers and future customers
- Develop a financial model to account for interest, debt financing and calculate the base water and wastewater RDC rate
- Conduct 5-year updates to ensure currency in costs, strategy and technology unless a key assumption causes a change of +/- 15%
- The primary goal of the RDC Update is to establish new residential and non-residential growth charges for water and wastewater services for the next 20-year planning horizon.

Current RDC

- RDC was approved in July 2014, (phased in)
- 3 different Charges:

Charge	Wastewater	Water
Single unit & Townhouse units	$4,080.80	$182.88
Multi Unit	$2,740.80	$122.83
Industrial/Commercial/ Institutional (ICI)	$2.24/sq.ft.	$0.09/sq.ft.

Regional Infrastructure

- Halifax Water’s Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services define regional infrastructure
- Rules and Regulations will be expanded to include flow and demand management projects for wastewater and water infrastructure as these projects create capacity for growth and help reduce the need for new infrastructure
- Wastewater addition

  29(1)(b) (iv) inflow and infiltration reduction and/or sewer separation projects for the purposes of gaining capacity within the wastewater system for the benefit of planned growth.
- Water addition

  30(1)(b)(iv) demand reduction measures to provide capacity for growth and are a cost-effective alternative to new regional hard infrastructure are considered eligible.

RDC Inputs

Infrastructure Master Plan

- Regional level Infrastructure Servicing Study to accommodate growth to 2046
- Includes servicing assessment of water and wastewater infrastructure for all regions
- Incorporates the recently completed West Region Wastewater Infrastructure Plan (WRWIP)
- Based on best available population planning data, consistent with HRM estimates
- Detailed analysis of observed flow monitor data to inform I/I reduction priorities
- Utilizes updated and calibrated water and wastewater hydraulic models to replicate existing conditions and simulate future growth scenarios
- Supersedes the Regional Wastewater Functional Plan (RWWFP)

Halifax Water
INFRASTRUCTURE MASTER PLAN
VOLUME 1
GENERAL INFORMATION

Halifax Water
INFRASTRUCTURE MASTER PLAN
VOLUME 2
WATER INFRASTRUCTURE

Halifax Water
INFRASTRUCTURE MASTER PLAN
VOLUME 3
WEST REGION WASTEWATER INFRASTRUCTURE

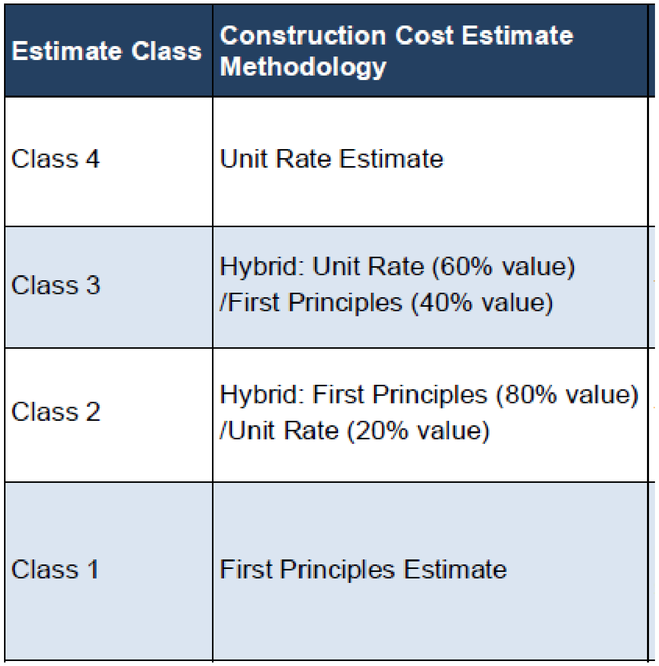
Halifax Water
INFRASTRUCTURE MASTER PLAN
VOLUME 4
CENTRAL REGION WASTEWATER INFRASTRUCTURE

Halifax Water
INFRASTRUCTURE MASTER PLAN
VOLUME 5
EAST REGION WASTEWATER INFRASTRUCTURE

RDC Rate Inputs

Project Costing

- All project costs are Class 4 Estimates in alignment with Halifax Water's Cost Estimation Framework
- Unit rates were developed for the Infrastructure Master Plan
- All project costs are in 2019 dollars

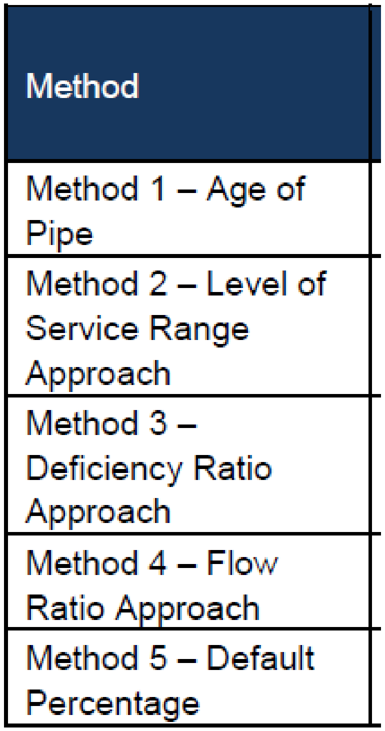


Estimate Class	Construction Cost Estimate Methodology
Class 4	Unit Rate Estimate
Class 3	Hybrid: Unit Rate (60% value) /First Principles (40% value)
Class 2	Hybrid: First Principles (80% value) /Unit Rate (20% value)
Class 1	First Principles Estimate

RDC Rate Inputs

Benefit to Existing Review

- Benefit to Existing memo highlights five methods to account for benefit to existing customers
- Represents the non-growth components identified for certain projects which benefit the existing service area
- Upgrades that are required to continue to meet the level of service for existing customers



Method
Method 1 – Age of Pipe
Method 2 – Level of Service Range Approach
Method 3 – Deficiency Ratio Approach
Method 4 – Flow Ratio Approach
Method 5 – Default Percentage

RDC Rate Inputs

- The PPU (people per unit), SUD (single unit dwelling) (%) and MUD (multi unit dwelling) (%)

Horizon	2012 RDC	2019 RDC
PPU	2.4	2.3
SUD (%)	55	45
MUD (%)	45	55

- The previous RDC (2012) used a PPU of 2.4, the RDC (2019) PPU was updated to 2.3 based on 2016 Stats Canada census data
- The Single Unit Dwelling (SUD) and Multi Unit Dwelling (MUD) percentages were obtained from referencing HRM permit development data from 2005-2015
- Resulting SUD/MUD ratio has been updated from previous RDC (2012) 55/45 to 45/55 in this RDC (2019)

Stakeholder Engagement

- 3 Workshops were hosted to review the inputs
- Individual meetings and emails were accepted and reviewed
- Issues Raised:
  - Water conservation measures
  - Housing Affordability
  - Multiple rates based on number of bedrooms
  - Tracking of money collected and growth projections
  - Review of flows for 5 and 10 year old growth areas
  - Benefit to Existing (BTE) appropriate splits

Rules and Regulations – Housing Affordability

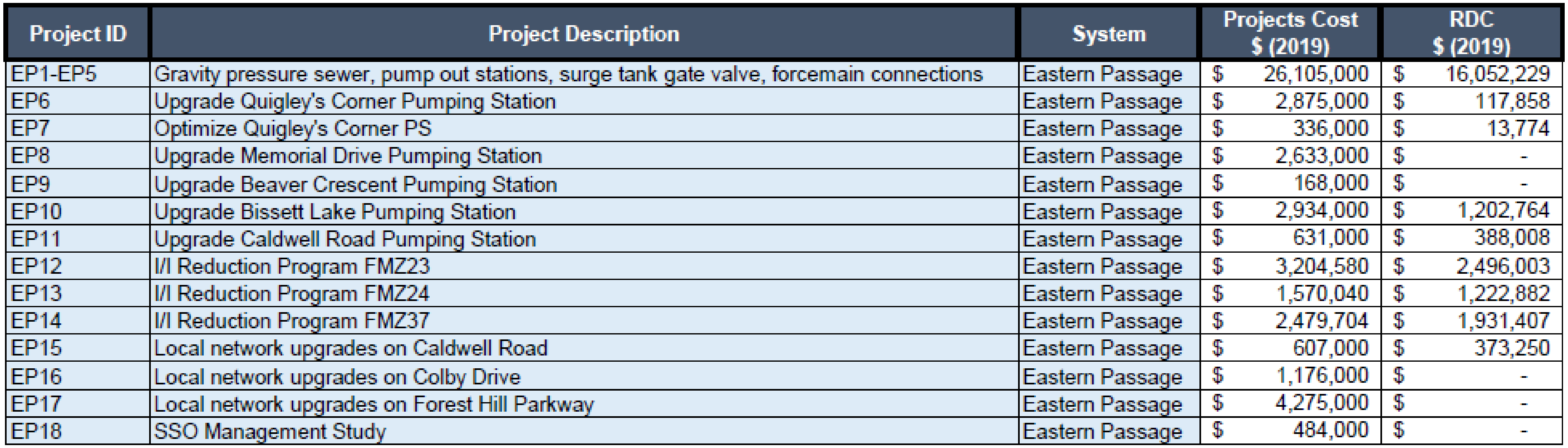
- A proposed change to the Schedule for Rates, Rules and Regulations for housing affordability
  - The Regional Development Charge may be deferred for units considered within the Housing Affordability initiatives as defined by Halifax Regional Municipality. Deferrals may be considered for these units up to ten years. Interest will be charged after year two. Halifax Regional Municipality will place a lien on the Property to ensure payment of the RDC.

If the Halifax Water Board supports development of a deferral mechanism for affordable housing, the wording may be modified prior to submission to the NSUARB pending outcome of discussions with the municipality and analysis of the impact deferrals would have on projected cash flows.]

RDC Program: Wastewater

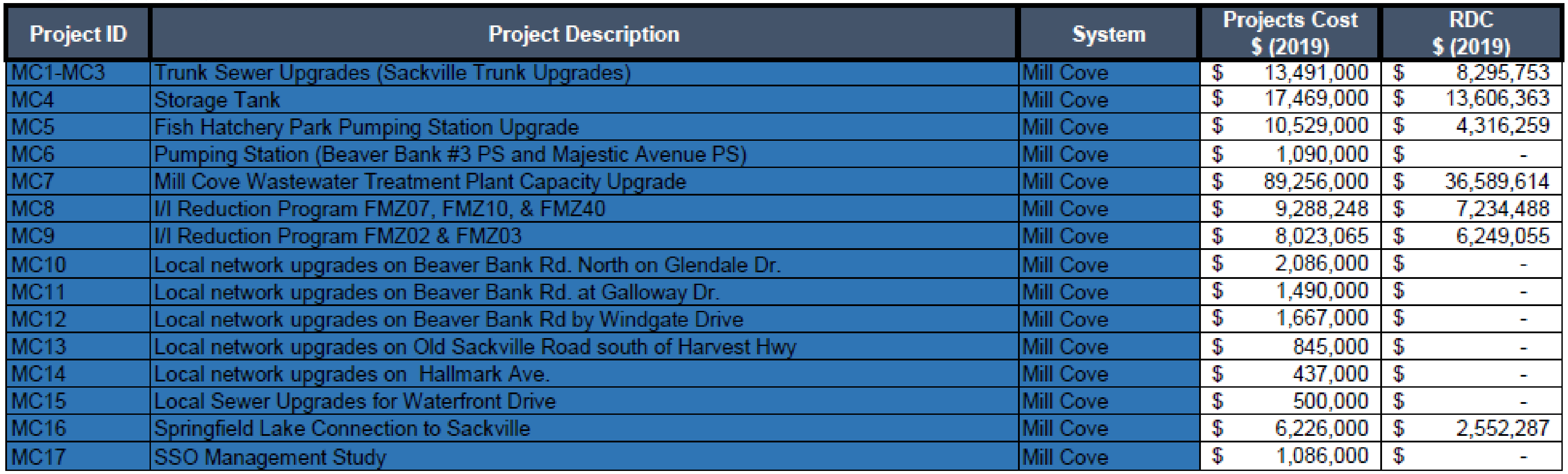
Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
AT2	Upgrade WWTF to service employment growth flows	Aerotech	$ 9,997,476	$ 7,377,059
D1	LoWSCA: Canal Street Separation	Dartmouth	$ 1,842,000	$ 1,132,664
D2a	LoWSCA: Wyse Road Separation - Phase 1	Dartmouth	$ 3,860,000	$ 2,373,553
D2b	LoWSCA: Wyse Road Separation - Phase 2	Dartmouth	$ 2,802,000	$ 574,326
D3	Additional Sewer Separation on Wyse Street	Dartmouth	$ 1,912,000	$ 1,175,708
D5	Albro Lakes Watershed Separation	Dartmouth	$ 8,111,000	$ 6,317,546
D6a-D6d	Maynard Lake and Clement Street Wetland Separation	Dartmouth	$ 6,790,000	$ 5,288,637
D7	New Valleyford Pumping Station	Dartmouth	$ 10,446,000	$ 2,141,117
D8	390 Waverley Road Upgrades	Dartmouth	$ 11,361,000	$ -
D9	Anderson Pumping Station Upgrades	Dartmouth	$ 340,000	$ -
D10	Upgrades to Dartmouth WWTF	Dartmouth	$ 12,572,000	$ 10,307,534
D11	I/I Reduction Program FMZ27	Dartmouth	$ 5,941,076	$ 3,653,228
D12	I/I Reduction Program FMZ45	Dartmouth	$ 1,120,232	$ 872,533
D13	Additional flow monitoring	Dartmouth	$ 252,000	$ 20,661
D14	CSO Flow Management Plan	Dartmouth	$ 675,000	$ 55,342
D15	Green St Upsize	Dartmouth	$ 513,000	$ -
D16	Pinecrest Dr Upgrade	Dartmouth	$ 1,013,000	$ -
D17	Peddars Way Upgrade	Dartmouth	$ 555,000	$ -
D18	Atlantic Street Upgrade	Dartmouth	$ 3,831,000	$ -
D19	Akerley Blvd and Railway Alignment Upgrade	Dartmouth	$ 4,814,000	$ 2,960,177
D20	Pleasant Street Upgrade	Dartmouth	$ 767,000	$ -
D21	Princess Margaret Blvd. Upgrade	Dartmouth	$ 3,106,000	$ -
D22	Anderson Lake Development Connection	Dartmouth	$ 7,609,000	$ -
D23	Marvin Connection	Dartmouth	$ 1,380,000	$ 56,572
D24	King Street Diversion	Dartmouth	$ 78,000	$ 3,198
D25	Diversion to Eastern Passage	Dartmouth	$ 12,113,000	$ 9,931,209
D26	SSO Flow Management Plan	Dartmouth	$ 555,000	$ -

RDC Program: Wastewater



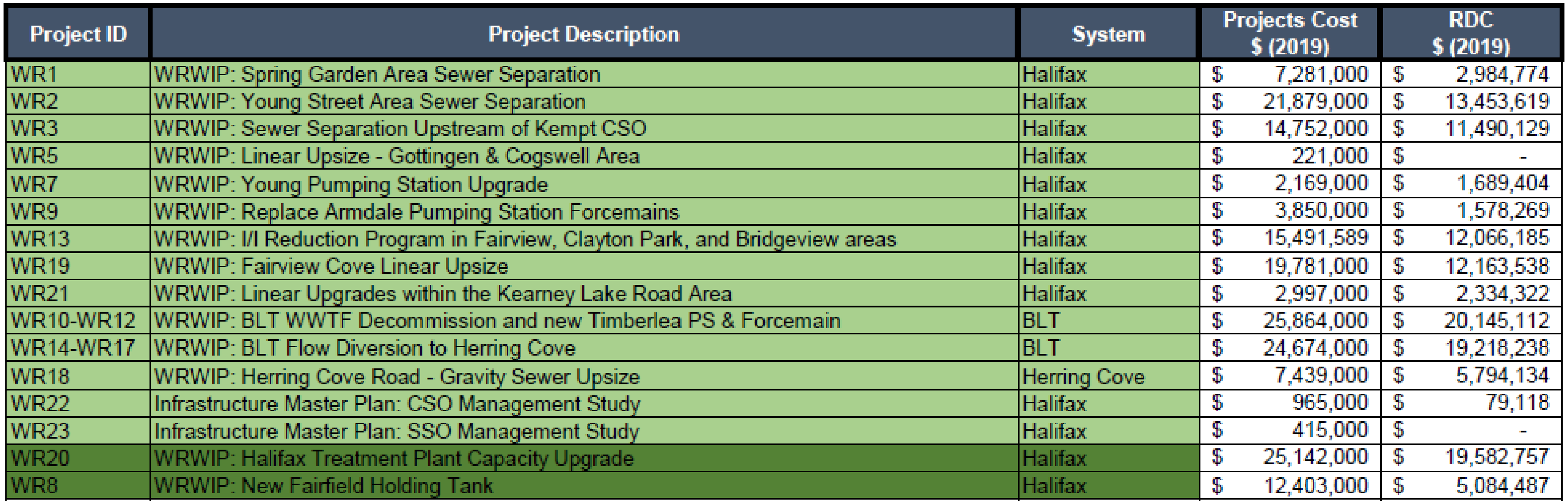
Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
EP1-EP5	Gravity pressure sewer, pump out stations, surge tank gate valve, forcemain connections	Eastern Passage	$ 26,105,000	$ 16,052,229
EP6	Upgrade Quigley's Corner Pumping Station	Eastern Passage	$ 2,875,000	$ 117,858
EP7	Optimize Quigley's Corner PS	Eastern Passage	$ 336,000	$ 13,774
EP8	Upgrade Memorial Drive Pumping Station	Eastern Passage	$ 2,633,000	$ -
EP9	Upgrade Beaver Crescent Pumping Station	Eastern Passage	$ 168,000	$ -
EP10	Upgrade Bissett Lake Pumping Station	Eastern Passage	$ 2,934,000	$ 1,202,764
EP11	Upgrade Caldwell Road Pumping Station	Eastern Passage	$ 631,000	$ 388,008
EP12	I/I Reduction Program FMZ23	Eastern Passage	$ 3,204,580	$ 2,496,003
EP13	I/I Reduction Program FMZ24	Eastern Passage	$ 1,570,040	$ 1,222,882
EP14	I/I Reduction Program FMZ37	Eastern Passage	$ 2,479,704	$ 1,931,407
EP15	Local network upgrades on Caldwell Road	Eastern Passage	$ 607,000	$ 373,250
EP16	Local network upgrades on Colby Drive	Eastern Passage	$ 1,176,000	$ -
EP17	Local network upgrades on Forest Hill Parkway	Eastern Passage	$ 4,275,000	$ -
EP18	SSO Management Study	Eastern Passage	$ 484,000	$ -

RDC Program: Wastewater



Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
MC1-MC3	Trunk Sewer Upgrades (Sackville Trunk Upgrades)	Mill Cove	$ 13,491,000	$ 8,295,753
MC4	Storage Tank	Mill Cove	$ 17,469,000	$ 13,606,363
MC5	Fish Hatchery Park Pumping Station Upgrade	Mill Cove	$ 10,529,000	$ 4,316,259
MC6	Pumping Station (Beaver Bank #3 PS and Majestic Avenue PS)	Mill Cove	$ 1,090,000	$ -
MC7	Mill Cove Wastewater Treatment Plant Capacity Upgrade	Mill Cove	$ 89,256,000	$ 36,589,614
MC8	I/I Reduction Program FMZ07, FMZ10, & FMZ40	Mill Cove	$ 9,288,248	$ 7,234,488
MC9	I/I Reduction Program FMZ02 & FMZ03	Mill Cove	$ 8,023,065	$ 6,249,055
MC10	Local network upgrades on Beaver Bank Rd. North on Glendale Dr.	Mill Cove	$ 2,086,000	$ -
MC11	Local network upgrades on Beaver Bank Rd. at Galloway Dr.	Mill Cove	$ 1,490,000	$ -
MC12	Local network upgrades on Beaver Bank Rd by Windgate Drive	Mill Cove	$ 1,667,000	$ -
MC13	Local network upgrades on Old Sackville Road south of Harvest Hwy	Mill Cove	$ 845,000	$ -
MC14	Local network upgrades on Hallmark Ave.	Mill Cove	$ 437,000	$ -
MC15	Local Sewer Upgrades for Waterfront Drive	Mill Cove	$ 500,000	$ -
MC16	Springfield Lake Connection to Sackville	Mill Cove	$ 6,226,000	$ 2,552,287
MC17	SSO Management Study	Mill Cove	$ 1,086,000	$ -

RDC Program: Wastewater

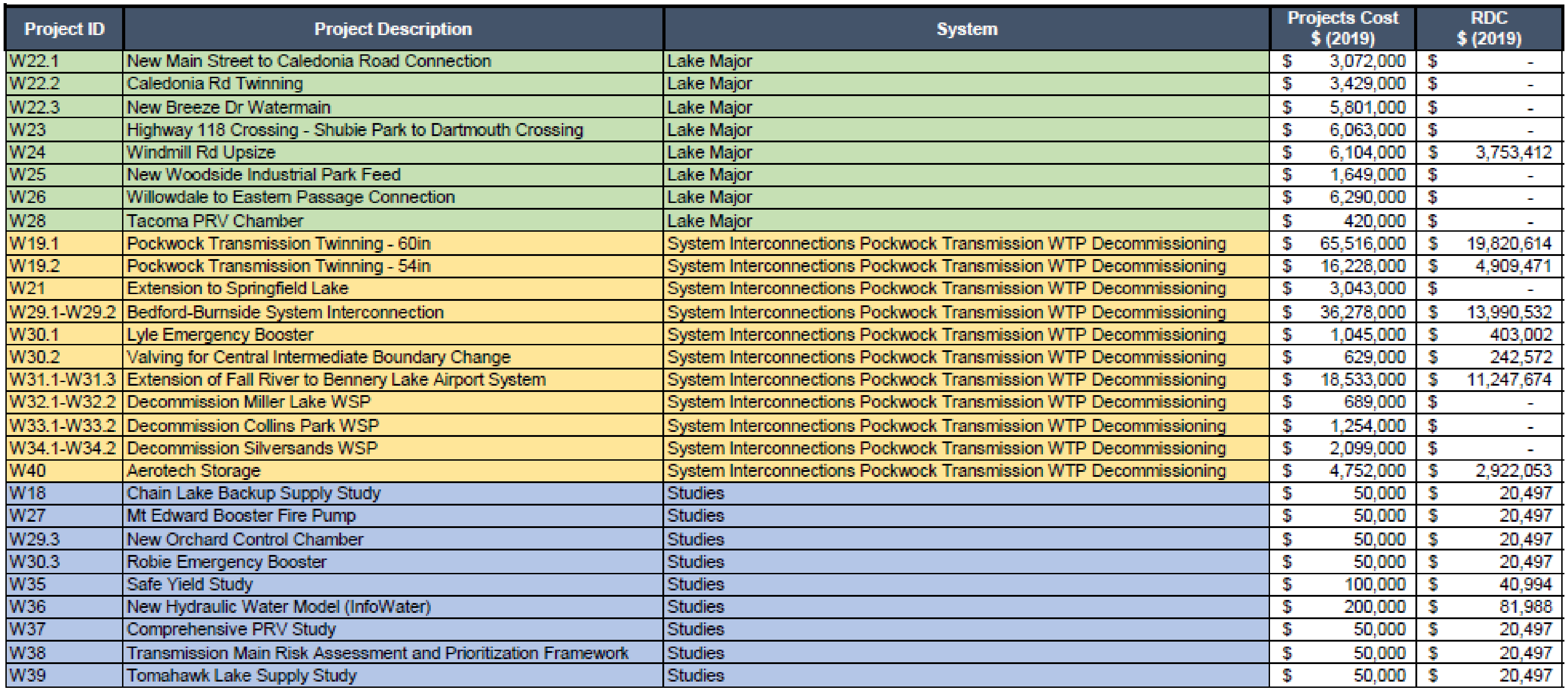


Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
WR1	WRWIP: Spring Garden Area Sewer Separation	Halifax	$ 7,281,000	$ 2,984,774
WR2	WRWIP: Young Street Area Sewer Separation	Halifax	$ 21,879,000	$ 13,453,619
WR3	WRWIP: Sewer Separation Upstream of Kempt CSO	Halifax	$ 14,752,000	$ 11,490,129
WR5	WRWIP: Linear Upsize - Gottingen & Cogswell Area	Halifax	$ 221,000	$ -
WR7	WRWIP: Young Pumping Station Upgrade	Halifax	$ 2,169,000	$ 1,689,404
WR9	WRWIP: Replace Armdale Pumping Station Forcemains	Halifax	$ 3,850,000	$ 1,578,269
WR13	WRWIP: I/I Reduction Program in Fairview, Clayton Park, and Bridgeview areas	Halifax	$ 15,491,589	$ 12,066,185
WR19	WRWIP: Fairview Cove Linear Upsize	Halifax	$ 19,781,000	$ 12,163,538
WR21	WRWIP: Linear Upgrades within the Kearney Lake Road Area	Halifax	$ 2,997,000	$ 2,334,322
WR10-WR12	WRWIP: BLT WWTF Decommission and new Timberlea PS & Forcemain	BLT	$ 25,864,000	$ 20,145,112
WR14-WR17	WRWIP: BLT Flow Diversion to Herring Cove	BLT	$ 24,674,000	$ 19,218,238
WR18	WRWIP: Herring Cove Road - Gravity Sewer Upsize	Herring Cove	$ 7,439,000	$ 5,794,134
WR22	Infrastructure Master Plan: CSO Management Study	Halifax	$ 965,000	$ 79,118
WR23	Infrastructure Master Plan: SSO Management Study	Halifax	$ 415,000	$ -
WR20	WRWIP: Halifax Treatment Plant Capacity Upgrade	Halifax	$ 25,142,000	$ 19,582,757
WR8	WRWIP: New Fairfield Holding Tank	Halifax	$ 12,403,000	$ 5,084,487

RDC Program: Water

Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
W06.1	Chain Control Transmission - Existing Peninsula Low Upsize	Pockwock - Peninsula	$ 3,841,000	$ 2,361,870
W06.2	Chain Control Transmission - Existing Peninsula Intermediate Upsize	Pockwock - Peninsula	$ 2,650,000	$ 1,629,512
W06.3	Pepperell Transmission	Pockwock - Peninsula	$ 2,702,000	$ 1,661,487
W06.4	Chain Control Transmission - Existing Peninsula Low Lining	Pockwock - Peninsula	$ 2,916,000	$ 1,793,078
W06.5	Chain Control Transmission - Valve Chambers	Pockwock - Peninsula	$ 1,258,000	$ 773,557
W07	Replace High Risk Peninsula Transmission (Robie)	Pockwock - Peninsula	$ 17,312,000	$ -
W08	Peninsula Intermediate Looping - Quinpool Rd to Young St	Pockwock - Peninsula	$ 4,319,000	$ 2,655,797
W10.1	Young St Upsize	Pockwock - Peninsula	$ 1,315,000	$ 808,607
W10.2	Robie St Upsize	Pockwock - Peninsula	$ 956,000	$ 587,854
W10.3	Almon St Upsize	Pockwock - Peninsula	$ 1,168,000	$ 718,215
W10.4	Windsor St Upsize	Pockwock - Peninsula	$ 1,004,000	$ 617,370
W01.1	Geizer 158 to Lakeside High Looping	Pockwock - Other	$ 2,249,000	$ -
W01.2	Gravity Supply to Brunello	Pockwock - Other	$ 2,328,000	$ -
W01.3	Dominion Cres Upsize	Pockwock - Other	$ 447,000	$ -
W01.4	Brunello Booster Pump Upgrades	Pockwock - Other	$ 236,000	$ -
W02	Geizer 158 Looping - Lacewood Dr	Pockwock - Other	$ 2,002,000	$ -
W03	Geizer Hill Booster Pump Upgrades	Pockwock - Other	$ 277,000	$ -
W04	Leiblin Booster Fire Pump	Pockwock - Other	$ 395,000	$ -
W05.1	Herring Cove Rd Twinning	Pockwock - Other	$ 3,585,000	$ -
W05.2	St Michaels Ave Upsize	Pockwock - Other	$ 502,000	$ -
W05.3	Herring Cove Rd Looping - McIntosh St	Pockwock - Other	$ 2,272,000	$ -
W12.1	Lucasville Rd Twinning (Phase 1)	Pockwock - Other	$ 8,117,000	$ 6,654,968
W12.2	Lucasville Rd Twinning (Phase 2)	Pockwock - Other	$ 8,956,000	$ 7,342,847
W13.1	New Primary Feed to Sackville High	Pockwock - Other	$ 4,953,000	$ 4,060,867
W13.2	New Sackville Beaver Bank Valve Chamber	Pockwock - Other	$ 839,000	$ 687,879
W13.3	Reconfiguration of Beaver Bank Booster	Pockwock - Other	$ 100,000	$ -
W13.4	New Sackville High PRV	Pockwock - Other	$ 420,000	$ 344,350
W14.1	Cobequid High Looping	Pockwock - Other	$ 2,233,000	$ 1,373,094
W14.2	Windgate Dr Upsize	Pockwock - Other	$ 882,000	$ 542,351
W15	Lively Booster Pump Upgrades	Pockwock - Other	$ 38,000	$ -
W17	Pockwock Transmission Loop through Bedford	Pockwock - Other	$ 5,069,000	$ -
W20	Second Geizer 158 Feed	Pockwock - Other	$ 9,612,000	$ -

RDC Program: Water



Project ID	Project Description	System	Projects Cost $ (2019)	RDC $ (2019)
W22.1	New Main Street to Caledonia Road Connection	Lake Major	$ 3,072,000	$ -
W22.2	Caledonia Rd Twinning	Lake Major	$ 3,429,000	$ -
W22.3	New Breeze Dr Watermain	Lake Major	$ 5,801,000	$ -
W23	Highway 118 Crossing - Shubie Park to Dartmouth Crossing	Lake Major	$ 6,063,000	$ -
W24	Windmill Rd Upsize	Lake Major	$ 6,104,000	$ 3,753,412
W25	New Woodside Industrial Park Feed	Lake Major	$ 1,649,000	$ -
W26	Willowdale to Eastern Passage Connection	Lake Major	$ 6,290,000	$ -
W28	Tacoma PRV Chamber	Lake Major	$ 420,000	$ -
W19.1	Pockwock Transmission Twinning - 60in	System Interconnections Pockwock Transmission WTP Decommissioning	$ 65,516,000	$ 19,820,614
W19.2	Pockwock Transmission Twinning - 54in	System Interconnections Pockwock Transmission WTP Decommissioning	$ 16,228,000	$ 4,909,471
W21	Extension to Springfield Lake	System Interconnections Pockwock Transmission WTP Decommissioning	$ 3,043,000	$ -
W29.1-W29.2	Bedford-Burnside System Interconnection	System Interconnections Pockwock Transmission WTP Decommissioning	$ 36,278,000	$ 13,990,532
W30.1	Lyle Emergency Booster	System Interconnections Pockwock Transmission WTP Decommissioning	$ 1,045,000	$ 403,002
W30.2	Valving for Central Intermediate Boundary Change	System Interconnections Pockwock Transmission WTP Decommissioning	$ 629,000	$ 242,572
W31.1-W31.3	Extension of Fall River to Bennery Lake Airport System	System Interconnections Pockwock Transmission WTP Decommissioning	$ 18,533,000	$ 11,247,674
W32.1-W32.2	Decommission Miller Lake WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$ 689,000	$ -
W33.1-W33.2	Decommission Collins Park WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$ 1,254,000	$ -
W34.1-W34.2	Decommission Silversands WSP	System Interconnections Pockwock Transmission WTP Decommissioning	$ 2,099,000	$ -
W40	Aerotech Storage	System Interconnections Pockwock Transmission WTP Decommissioning	$ 4,752,000	$ 2,922,053
W18	Chain Lake Backup Supply Study	Studies	$ 50,000	$ 20,497
W27	Mt Edward Booster Fire Pump	Studies	$ 50,000	$ 20,497
W29.3	New Orchard Control Chamber	Studies	$ 50,000	$ 20,497
W30.3	Robie Emergency Booster	Studies	$ 50,000	$ 20,497
W35	Safe Yield Study	Studies	$ 100,000	$ 40,994
W36	New Hydraulic Water Model (InfoWater)	Studies	$ 200,000	$ 81,988
W37	Comprehensive PRV Study	Studies	$ 50,000	$ 20,497
W38	Transmission Main Risk Assessment and Prioritization Framework	Studies	$ 50,000	$ 20,497
W39	Tomahawk Lake Supply Study	Studies	$ 50,000	$ 20,497

Project Cost Estimation

- Project cost estimates include:
    - Construction cost estimation in 2019 dollars
    - Project engineering design
    - Geotechnical fees
    - Construction management
    - Project contingency
    - Net HST
    - Overhead
    - Halifax Water staff

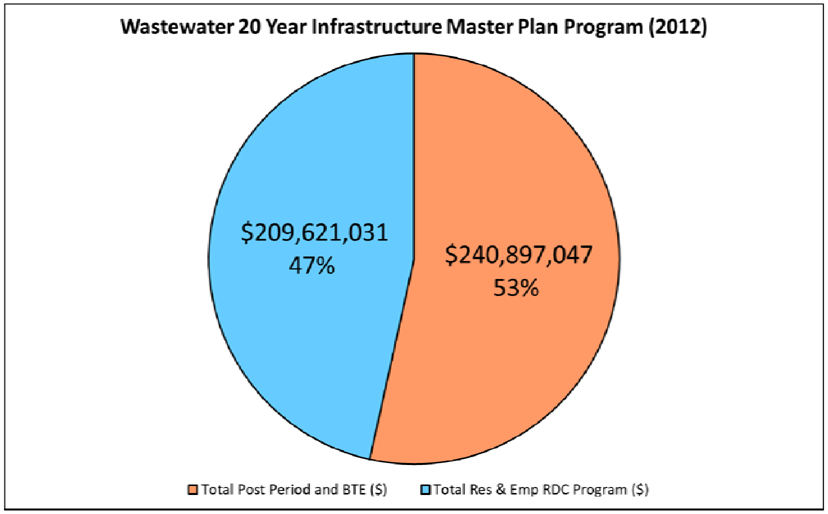
Charge Calculation – Project Inputs

- Projects group in five year blocks
    - Escalation factor applied to projects
        - Statistics Canada, Non-residential building construction price index
        - Blend of five year and twenty year average, blended with national average
    - Construction interest is applied to the project period
        - Non eligible benefit is removed
        - Post period benefit is removed

Charge Calculation – Financial Model

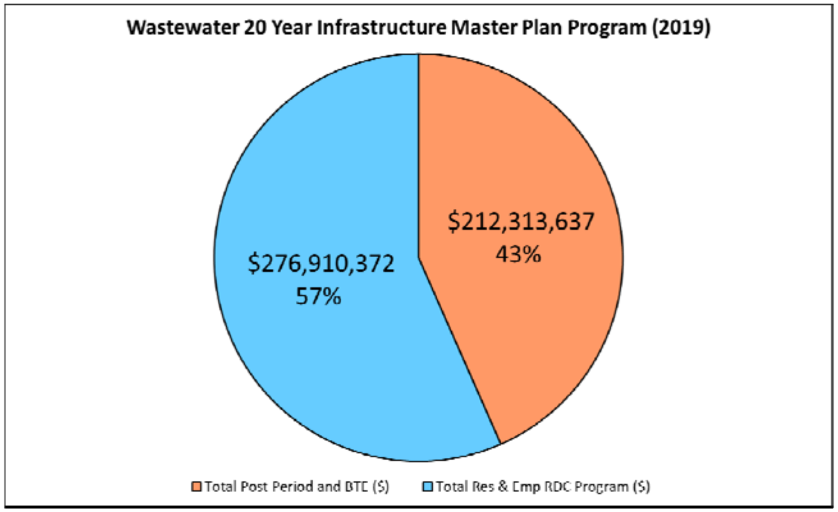
- Population Estimates
    - Single unit dwellings
    - Multi unit dwellings
    - Non-residential
- Charge Escalation
    - Model projects escalation based on a blend of five year and twenty year CPI
    - Actual annual based on posted Halifax CPI.
- Balance Financing
    - Debt rate
    - Surplus Rate
- Net Zero March 31, 2041

RDC Rate: Wastewater



Wastewater 20 Year Infrastructure Master Plan Program (2012)

Total Program: $450,518,078

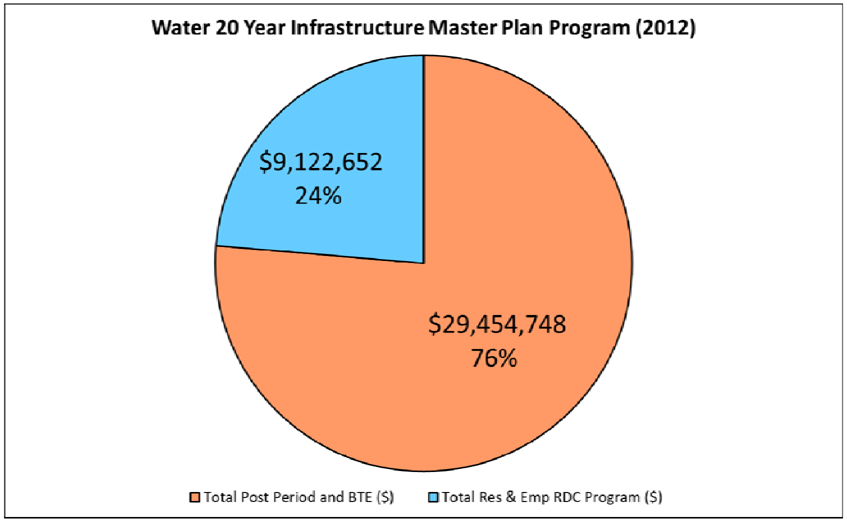


Wastewater 20 Year Infrastructure Master Plan Program (2019)

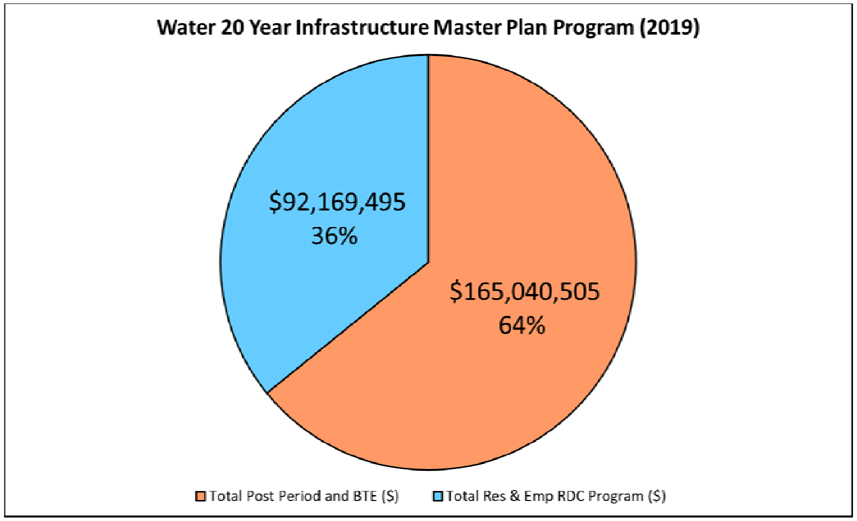
Total Program: $489,224,009

Wastewater	2012 RDC (April 1st 2015) (2012 $)	2019 RDC (2019 $)
Res SUD RDC Rate ($/unit)	$4,081	$4,941.04
Res MUD RDC Rate ($/unit)	$2,741	$3,318.61
Emp RDC Rate ($/m^2)	$24.11 ($2.24/sq.ft.)	$25.83 ($2.40/sq.ft.)

RDC Rate: Water



Total Program: $38,577,400



Total Program: $257,210,000

Water	2012 RDC (April 1st 2015) (2012 $)	2019 RDC (2019 $)
Res SUD RDC Rate ($/unit)	$183	$1,810
Res MUD RDC Rate ($/unit)	$123	$1,216
Emp RDC Rate ($/m^2)	$0.97 ($0.09/sq.ft.)	$9.47 ($0.88/sq.ft.)

Next Steps

- Review by Halifax Water Board
- Submission to NSUARB
- Interventions, submission of evidence, further engagement with stakeholders
- Hearing Date scheduled for March 23 – 27, 2020

Questions or Comments?

ITEM # 1-I

HRWC Board

October 31, 2019

TO: Craig MacMullin, MBA, CPA, CGA Chair and Members of the Halifax Regional Water Commission Board

SUBMITTED BY: *Original signed by:*

Jamie Hannam, P.Eng.
Director, Engineering & Information Services

APPROVED: *Original signed by:*

Cathie O'Toole, MBA, CPA, CGA, ICD.D
General Manager

DATE: October 24, 2019

SUBJECT: **Integrated Resource Plan - Update**

INFORMATION REPORT

ORIGIN

The Halifax Water 2018/19 Capital Budget.

BACKGROUND

Halifax Water completed its first comprehensive Integrated Resource Plan (IRP) in October 2012. Halifax Water defines integrated resource planning as a long-term planning initiative that incorporates the key drivers (asset renewal, compliance, and growth) across the water, wastewater, and stormwater infrastructure. Integration involves bringing together all factors that may influence the capital needs over the planning horizon. The IRP is essentially a sustainable cost-effective capital infrastructure investment plan.

Several recommendations of the IRP including continued implementation of the asset management program, development of a wet weather management program, filling data gaps, and further detailed infrastructure planning studies were identified. Following the completion of many of these projects, studies, and the commencement of key programs, Halifax Water initiated the Integrated Resource Plan Update project in fall 2018. The IRP is closely linked to several other corporate planning exercises including:

Infrastructure Master Plan – together with the outputs from the recently completed West Region Wastewater Infrastructure Plan, the Infrastructure Master Plan continues the wastewater growth planning into the East and Central regions and incorporates water growth planning for all regions into a single plan. Going forward, the Infrastructure Master Plan is intended to be periodically updated (likely on a five-year cycle) to enable input into the successive IRP Updates.

Asset Management Plans – form the basis of outlining the current state of good repair and a projection of reinvestment needs over a 30-year horizon for fourteen (14) asset classes over the water, wastewater, and stormwater infrastructure systems. At present, the Asset Management Plan (AMP) is updated annually owing to ongoing resolution and clarification of data gaps, maintenance practices, and business processes around how Halifax Water manages each asset class. The AMPs have also resulted in establishing Asset Management Implementation Teams (AMITs) with representatives from engineering, operations, and asset management as core members and additional support from other departments as needed.

Compliance Plan – recently completed draft of Halifax Water's Compliance Plan intended to provide understanding of the current state of compliance for the utility, emerging compliance issues, and plans to enable Halifax Water to meet current and future compliance requirements. The Compliance Plan covers water and wastewater infrastructure systems.

Regional Development Charge Update – based on the growth related direction from the Infrastructure Master Plan, development charges related to regional level infrastructure must be updated periodically (again, typically done on a 5-year cycle). The Regional Development Charge (RDC) Update follows and is informed by the completion of the Infrastructure Master Plan.

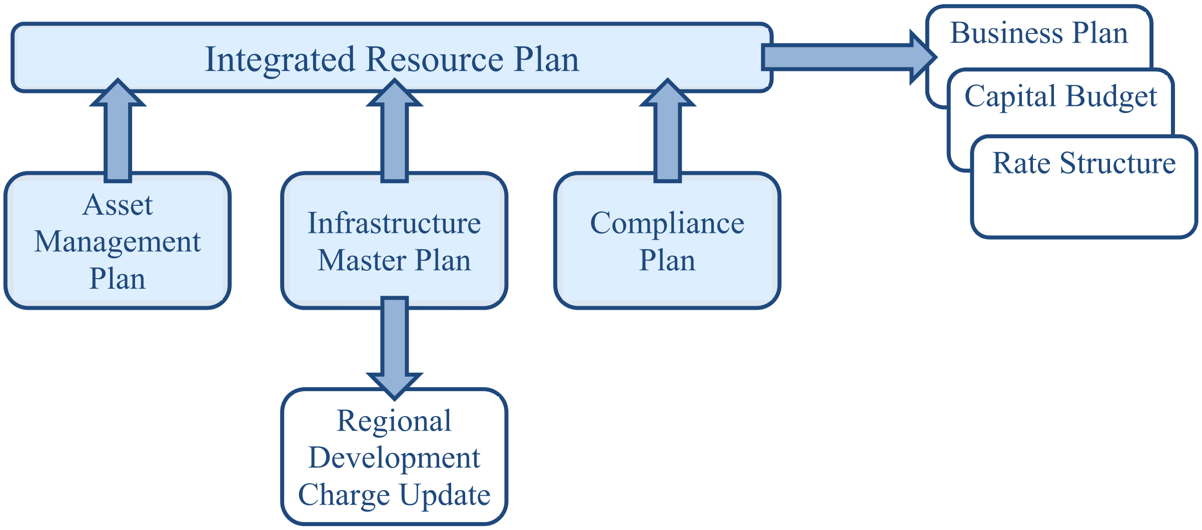


Figure 1 - Relationship of IRP to Other Initiatives

DISCUSSION

The IRP Update is nearing completion. The project team is finalizing and smoothing the IRP capital program. There remain a few outstanding items: feedback from staff, programs for water supply plants need to be added, final costing adjustments for some water projects from the Infrastructure Master Plan, and final updates to the IRP capital program. We are also in our final stages of collaboration and review with the NSUARB consultants which may provide additional enhancements to the final report.

The intended schedule highlights are as follows:

- IRP Capital Program ready for end of October 2019
- Meeting with NSUARB Consultants in early November 2019
- Submit final IRP report for Halifax Water Board approval at the November 2019 Board meeting

BUDGET IMPLICATIONS

This is an Information Report and has no direct budget implications. If the IRP is not finalized by the end of November there are significant financial implications to the utility as the updated Five Year Business Plan, 2020/21 Budgets, and the 2020 Rate Application will be delayed.

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