Halifax Water

STRAIGHT from the SOURCE

2018/19 to 2022/23 Five-Year Business Plan

Approved by Halifax Water Board
January 25, 2018

Glossary

AM	Asset Management
AMI	Advanced Metering Infrastructure
AWWA	American Water Works Association
BMPs	Best Management Practices
BOD5	Biochemical Oxygen Demand (5 Day Period)
BPF	Biosolids Processing Facility
CBOD	Carbonaceous Biochemical Oxygen Demand
CCC	Capital Cost Contribution
CCME	Canadian Council of Ministers of the Environment
CCTV	Closed Circuit Television
CIP	Capital Infrastructure Program
COSM	Cost of Service Manual
CSO	Combined Sewer Overflow
CUPE	Canadian Union of Public Employees
DIA.	Diameter
EM	Environmental Management
EMO	Energy Management Opportunities
EP	Environmental Protection
ERA	Environmental Risk Assessment
HHSP	Halifax Harbour Solutions Project
I&I	Inflow & Infiltration
ICI	Industrial, Commercial & Institutional
IFRS	International Financial Reporting Standards
IRS	Internal Responsibility System
IS	Information Systems
JOHSC	Joint Occupation Health & Safety Committee
LSL	Lead Service Line
m3	Cubic Metre
NSE	Nova Scotia Environment
NSERC	Natural Sciences and Engineering Research Council
NSUARB	Nova Scotia Utility and Review Board
P2	Pollution Prevention
RWWFP	Regional Wastewater Functional Plan.
SSO	Sanitary Sewer Overflow
TRC	Total Residual Chlorine
TSS	Total Suspended Solids
UV	Ultraviolet
WEF	Water Environment Federation
WSER	Wastewater Systems Effluent Regulations
WWM	Wet Weather Management
WWTF	Wastewater Treatment Facility
WQMP	Water Quality Master Plan

HALIFAX WATER
Five-Year Business Plan
2018/19 to 2022/23

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APPENDICES

1. EXECUTIVE SUMMARY

With the completion of ten years of operation as an integrated water, wastewater and stormwater utility, Halifax Water is well positioned to continue its mission of stewardship. This responsibility extends to existing and future customers in the spirit of intergenerational equity, a key tenet of the Public Utilities Act. In that regard the utility intends to update the Integrated Resource Plan during the next fiscal year to take a long view of the investments required to deliver on the strategic drivers of asset renewal, growth and regulatory compliance. The IRP is foundational to the business plans of the utility along with the Cost of Service Manual (COSM) and Debt Strategy, which are both at a high level of maturation. Changes to the cost of service were approved by the Nova Scotia Utility and Review Board (NSUARB) in 2017 after the utility revised its rate structure for stormwater service. Of particular note, in accordance with industry best practice and feedback from customers, stormwater charges include an incentive for non-residential customers to reduce peak runoff and rates for residential customers include a tiered approach.

The Debt Strategy adopted by the utility for an efficient capital funding structure recommends a maximum debt service ratio of 35% and a debt to equity ratio of 40 to 60 %. As the sole shareholder, the Halifax Regional Municipality previously approved a blanket guarantee of Halifax Water debt as long as the debt service ratio is less than 35%, and a Dividend Agreement that expires in 2020.

It is acknowledged that the IRP developed in 2012 is not at a mature state and will benefit greatly from additional information collected since then and master plans that will be completed this coming year. Of the three strategic drivers included in the IRP, asset renewal will present the greatest challenge recognizing the backlog of investments in relation to the replacement of aging infrastructure.

The Business Plan for the five year period from 2018/19 to 2022/23 is being developed in recognition that the previous five year Business Plan is three years old and can benefit from revised projections based on current information. Several challenges and opportunities, of an operational and capital nature, will garner the attention of the utility over the next five years, namely:

- **Impact of Significant Current and Imminent Capital Projects –** There is a need to accommodate new debt payments and depreciation for the Aerotech Wastewater Treatment Facility expansion, the new main on the MacDonald Bridge, the Northwest Arm sewer rehabilitation, the Halifax peninsula transmission main renewal, Sullivan's Pond storm sewer upgrade, Lake Major dam renewal, water treatment plant upgrades and the implementation of Advanced Metering Infrastructure.

- **Future Capital Demands –** The current water, wastewater and stormwater rates are insufficient to meet the capital needs for sustainable infrastructure as identified in the IRP. The IRP acknowledges that wastewater and stormwater assets have been grossly underfunded historically. Institutional capacity will have to increase over the term of this Business Plan in order to deliver the expected capital projects.

- **Enhanced Customer Service** – The expectation of customers is increasing rapidly and the adoption of new technologies and business process is paramount to provide the best in customer service. Halifax Water has and will continue to invest in computerized maintenance management systems, new meter technology and a new telephony system that will enhance the customer experience through its Customer Care Centre.

- **Increasing Energy and Chemical Costs –** electricity and chemical costs will continue to increase at a rate higher than inflation.

- **Wastewater Research –** building on the success of the current drinking water research program with Dalhousie University, the utility is in the process of expanding the program to include wastewater to ensure that treatment plants are optimized and upgraded to meet the current federal wastewater regulations at the lowest cost.

- **Wet Weather Management** - the level of service offered by the utility can be increased if innovative business processes and technology are embedded in day to day operations for the ultimate protection of the environment.

- **Lead Line Replacement Program –** the utility will be ramping up its program to replace all lead service lines on the Halifax peninsula and downtown Dartmouth areas. This is based on industry best practice and recent research conducted in partnership with Dalhousie University. As Halifax Water is in the health protection business, complete lead service line renewal will be pursued for public health outcomes.

Although the previous business plan indicated a need to increase capital spending to match the requirements of the 2012 IRP, which stipulated average annual investments of $131 million, this business plan presents a more gradual increase. This is to ensure customers do not experience rate shock and rates remain affordable. A rate smoothing strategy will be employed to keep annual increases in the single digit range. Capital budgets are anticipated to range from a low of $72.5 million in 2018/19 to a high of $109.4 million in 2020/21. As capital budgets increase, the utility will see related increases in debt and depreciation expense, the key drivers for revenue requirements.

Over the course of the Business Plan, most operating expenses (excluding depreciation, energy and chemical costs) are projected to be stable with annual increases tracking at or below the Halifax Consumer Price Index [CPI. To mitigate cost increases associated with energy and chemicals, Halifax Water has a formal energy management program more fully described in this document.

Over the next five years, Halifax Water will likely file one rate application in the fall of 2019, for rate increases beginning in the 2020/21 fiscal year. Overall annual revenues will need to increase approximately 25% over the five-year period with the primary focus on the capital needs of wastewater and stormwater assets. Halifax Water is not alone in its quest for more sustainable funding. Unfortunately, wastewater and stormwater assets have been underfunded throughout North America, and other municipalities/utilities have made, or are making plans to increase rates. The projected rate increases associated with this business plan have been viewed in the context of customer affordability, with proposed rates less than 1% of median household income. The utility is proposing to continue with the H20 (Help to Others) program to support low income customers, with funding from unregulated activities.

Inherent in the business activities for Halifax Water is an obligation to provide value for customers as stewards of essential services. To that end, the business plan highlights very formal programs to deliver efficient and effective service through Asset Management, Energy Management, and Wet Weather Management programs. The Wet Weather Management program, in particular, presents an opportunity to improve service delivery at a lower cost and has already shown positive results. A structured approach is in place, similar to the process used by the utility for water loss control. Halifax Water is recognized as a world leader in water loss control and the corporate goal is to put wet weather management in the same category.

2. INTRODUCTION

In August of 2017, Halifax Water completed ten years as a "One Water" utility after the transfer of wastewater and stormwater assets from the Halifax Regional Municipality in 2007. The transfer was carried out in recognition that wastewater and stormwater assets were underfunded and only two of fifteen wastewater treatment facilities were in compliance with regulations. This was further documented in 2012 when the utility completed its first Integrated Resource Plan [IRP] to identify investments over a thirty year period under the strategic drivers of asset renewal, regulatory compliance and growth. As outlined in its last Five Year Business Plan for the 2015/16 to 2019/20 period, plans were put in place to make progress on all three strategic drivers. Over the last three years, Halifax Water made significant progress on wastewater treatment facility compliance and after the upgrade to the Aerotech plant is completed in early 2018, all wastewater treatment facilities will be compliant with the new federal wastewater system effluent regulations or operate under approved transitional authorizations. The utility has also kept pace with growth within the municipality and helped facilitate development while ensuring cost neutrality to the existing rate base, consistent with the Public Utilities Act. With respect to asset renewal, there has been steady progress to increase capital investments as contemplated in the IRP, although at a more moderate pace. These capital investments continue to benefit from better information and data collected over the last ten years.

The last five years were particularly rewarding for Halifax Water with the integration of water, wastewater, and stormwater service delivery. In conjunction with the established sustainability framework, key projects were advanced to take advantage of federal infrastructure programs, namely, the Building Canada Fund and the recent Clean Water and Wastewater Fund [CWWF]. Of particular note, $20 million in funding was secured for the Aerotech WWTF upgrade from the Building Canada Fund and $40 million was secured through the CWWF. The CWWF program was targeted towards infrastructure renewal projects and included; the replacement of old transmission water mains on the Halifax peninsula; the rehabilitation of the Northwest Arm trunk sewer by trenchless technology; replacement of the Lake Major dam; renewal of filter underdrains and media at the J.D. Kline water supply plant; and the upgrade and replacement of a deteriorated storm system downstream of Sullivan's Pond.

In order to close the gap on asset renewal funding, future rate increases are inevitable. These rate increases must follow the principle of gradualism to balance rate shock and affordability to customers. Accordingly, Halifax Water will attempt to implement its infrastructure investments with a smoothing strategy in mind. In conformance with the Public Utilities Act, all of these collective investments and associated funding must be based on cost causation principles and occur within the context of intergenerational equity. It is anticipated that additional funding from federal programs will be available to mitigate the impact on Halifax Water's rate base and thus temper otherwise higher rate increases.

At the start of the next five year business cycle, Halifax Water will complete the next iteration of the IRP for maturation of its strategic focus to not only upgrade deteriorating infrastructure and achieve compliance with regulations, but mitigate and adapt to climate change. Recent research indicates that climate change is accelerating, as evidenced by projections of sea level rise, more intense storm events, and changing precipitation patterns.

The next five years will see a renewed focus on customer service recognizing that the customer of today is not the customer of tomorrow. In keeping with this theme, Halifax Water has embarked on a transformational path to engage the customer through its Customer Connect project which will see the implementation of Advanced Metering Infrastructure across the entire service area. This project will complement the roll out of the operations maintenance management system [City Works] to ensure timely and accurate information for the Customer Care Centre to respond to the needs of the customer.

3. CURRENT RATE STRUCTURES

Halifax Water has a Cost of Service based rate structure for water, wastewater and stormwater service, as approved by the Nova Scotia Utility and Review Board [NSUARB]. Rates are adjusted periodically when the cost of providing the service is out of line with the revenue generated by the existing rates. When an adjustment is required, Halifax Water makes an application to the NSUARB, and a formal public hearing process is held to ensure proposed rates are thoroughly reviewed in an open, objective and transparent manner.

Halifax Water has programs in place to contain costs, monitor rate affordability, and project and smooth future revenue requirements to ensure that customers are not shocked by sudden or dramatic rate increases.

3.1 Water Service

The existing charges for water service have been in place since April 1, 2016 and consist of two components – a base charge, and a charge that varies according to consumption of water. Water base rates vary by meter size and range from $13.00 per month for a 15 mm (5/8") diameter meter to $1,575.00 per month for a 250 mm (10") diameter meter. The consumption charge for water service is $0.976 per m^3. The water-rate structure also provides for a public fire-protection charge to the municipality based on a formula approved by the NSUARB.

3.2 Wastewater Service

The existing charges for wastewater service have been in place since April 1, 2016 and consist of two components – a base charge, and a discharge rate that varies in relation to water consumption. Wastewater base rates vary by meter size and range from $14.00 per month for a 15 mm (5/8") diameter meter to $1,923.00 per month for a 250 mm (10") diameter meter. The wastewater discharge rate is based on metered water consumption, and is $1.753 per m^3.

Halifax Water has a wastewater rebate program that is available to customers who use more than 1,000 m3 of water in a 12 month period and can demonstrate the volume of wastewater they discharge is less than the volume of water they use. This is covered by Section 22 of Halifax Water's Rules and Regulations. As an example, large buildings or complexes with cooling towers may qualify for this rebate.

3.3 Stormwater Service

Stormwater rates are established based on impervious area. The current rates for stormwater service have been in place since July 1, 2017. There are two stormwater rates – one billed to all customers to recoup the cost of collecting and managing stormwater from private property (Site Related Flow Charge) and one billed to the Halifax Regional Municipality (HRM) for collecting and managing stormwater from the street right of way (HRM ROW Charge). HRM, in turn, charges properties within the stormwater serviceable boundary to cover their portion of the ROW Charge, and Halifax Water collects and administers this charge on HRM's behalf.

The Site Related Flow Charge for non-residential customers if $0.135 per m^2 of impervious area. The Site Related Flow Charge for residential customers is based on the same rate per m^2 but residential customers are billed according to a flat rate per tier. There are five tiers and properties are grouped according to the amount of impervious area. The lowest tier is comprised of properties with less than 50 m^2 of impervious area – and they are exempt from the charge. The largest properties – those with 810 m^2 or more of impervious area, are charge $81 a year. Most residential properties fall in Tier 2 or 3 and are charged $14 or $27 per year respectively

Effective October 1, 2017 Halifax Water is collecting the ROW charge on behalf of HRM, and the charge is currently set at $39 per year, per property.

Properties that do not receive stormwater service are exempt from both the Site Related Flow Charge and the ROW Charge.

A stormwater credit program was implemented for Non-residential (Institutional, Commercial, Industrial) customers effective July 1, 2017. Non-residential properties with stormwater Best Management Practices (BMPs) like retention ponds that help manage peak flows may be eligible for a credit. Non-residential properties include multi-unit dwellings of four or more units.

3.4 Regional Development Charge

The Halifax Water Regional Development Charge (RDC) is a fee payable at the building permit stage of a new development to fund regional water and wastewater infrastructure expansion requirements related to growth. The RDC replaced the HRM Sewer Redevelopment and Trunk Sewer Charges and provides fairness across the rate base ensuring current customers do not subsidize new growth and development.

The Application for the Regional Development Charge (RDC) was presented to the Nova Scotia Utility and Review Board (NSUARB) on July 26, 2013. A Hearing in support of the Application was held December 2 to 5, 2013. On July 9, 2014, the NSUARB approved the first

RDC rates, which included separate rates for the Urban Core and Satellite systems and the Airport/Aerotech system. These rates were subsequently consolidated when the two systems were combined for the purpose of cost recovery. The current rates for RDC have been in place since April 1, 2015 and there are separate rates for water and wastewater, which vary according to type of development – Single Unit Development, Multi-Unit Development, or Institutional Commercial Industrial [ICI] Development.

Money collected from the RDC funds upgrades and improvements to the regional wastewater and water systems that are required to accommodate growth anticipated within the municipality's Regional Plan. The infrastructure requirements were identified through the Regional Wastewater Functional Plan with growth related costs estimated at $521 million, based on a 30 year growth horizon. Through the application process with the NSUARB, and input from Interveners, the growth horizon, and subsequently the infrastructure components were reduced to a 20 year growth horizon. The approved RDC reflected that change.

When the RDC rates were approved, Halifax Water committed to update the RDC on a 5 year cycle, or mid-cycle if any of the assumptions used in determining the RDC impact the value of the charge by +/- 15%. Since approving the RDC, Halifax Water has completed a more detailed Infrastructure Plan for the West Region of Halifax refining a portion of the overall plan to service projected growth. Halifax Water is presently securing consulting services to complete Infrastructure Plans for the East and Central regions. The completion of this study will enable an update to the RDC in 2018/2019.

In the interim, Halifax Water will be filing the updated infrastructure list with the NSUARB for the West Region in early 2018 to allow for on-going implementation of the infrastructure plan and uninterrupted growth. Prior to this application, Halifax Water will be conducting formalized stakeholder consultation.

With the next RDC update, Halifax Water will seek approval from the NSUARB to ensure the infrastructure plan and cost recovery are accurate and fair to the existing rate base and the development community.

4. COST OF SERVICE/RATE DESIGN

Halifax Water has Cost of Service based rates developed using industry best practice. There is a Cost of Service (COS) Manual which clearly guides how rates are calculated for water, wastewater and stormwater service. The Cost of Service Manual was based on American Water Works Association (AWWA) and Water Environment Federation (WEF) methodologies for cost of service/rate design.

The COS Manual was developed through a process of engagement with interested parties, including prior rate case interveners and the NSUARB. The COS Manual is a living document which is periodically updated to reflect current data and new information, to support any proposed changes in rates. All changes to the COS Manual must be approved by the NSUARB.

The current rates are in line with the COS Manual, and are a true reflection of the cost of providing service in all respects except for one aspect. Halifax Water has not included depreciation as an expense on contributed water and wastewater assets, and most stormwater assets.

5. WASTEWATER SYSTEM EFFLUENT REGULATIONS

The final Wastewater System Effluent Regulations [WSER] were enacted in June 2012. These regulations, made under the Fisheries Act, implement those aspects of the Canadian Council of the Ministers of the Environment [CCME] Strategy for the Management of Municipal Wastewater Effluent which fall under federal jurisdiction, namely the discharge of deleterious substances to fish habitat. The WSER defines the following as deleterious substances, and sets national standards for their discharge:

- 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^{0}C ± 1^{0}C.

Wastewater treatment facilities [WWTFs] are authorized to discharge these substances at levels below the defined limits, provided that the effluent is not acutely lethal to trout as determined by standard toxicity testing. Facilities not in compliance with the limits were required to apply for a Transitional Authorization [TA] to deposit effluent exceeding those limits. The Authorization is valid for a period of 10, 20 or 30 years, depending on the risk level associated with the effluent, as determined by a defined risk-ranking system in the WSER.

Halifax Water obtained TAs effective January 1, 2015, for the Halifax and Dartmouth WWTFs, which remain in effect until December 31 of 2040. Both Halifax and Dartmouth WWTFs are medium risk, and would normally have 20 years to achieve compliance. However, both of these systems have Combined Sewer Overflows [CSOs] which are higher risk than the WWTFs. The WSER provides that for systems having at least one CSO which is higher risk than the WWTF, the compliance period for high or medium risk WWTFs may be extended from 10 or 20 years respectively, to 30 years (from 2010). CSO discharges must also be reduced beginning in 2041, after the TA has expired. Although there are no further details in the WSER regarding the reduction, such as extent and timing, Environment Canada staff have indicated by email that *"a significant reduction … must be achieved immediately after the TA's expiry date".*

Well before 2040, Halifax Water will need to begin planning and design, with associated funding, to reduce CSO discharges. This will require early identification of reduction mechanisms, and construction of such mechanisms, so that they will be in place prior to 2040. Upgrades to the Halifax and Dartmouth WWTFs will also be required, to comply with the WSER discharge limits by 2040 when the TAs expire.

All other WWTFs must remain in compliance with the WSER discharge limits. Any WWTF which begins to exceed these limits will require an appropriate upgrade to ensure continued compliance.

Wastewater treatment facilities having effluent which is acutely lethal due to Un-ionized Ammonia must apply for a Temporary Authorization to Deposit Un-ionized Ammonia. Such Authorizations are valid for three years, and may be renewed. Effluent which is acutely lethal due to substances other than Un-ionized Ammonia is not authorized under the WSER, and is in contravention of the Fisheries Act. No Halifax Water facility has had toxicity due to un-ionized ammonia levels in the treated effluent. Instances of detected toxicity have been due to chlorine levels (where chlorine is used as a disinfectant), or are of unknown cause, and under continuing investigation. It is recognized that pH drift during the tests can be a factor, and a pH-stabilized version of the toxicity test is in use for the Mill Cove and Eastern Passage WWTFs. The Lakeside-Timberlea WWTF is the only remaining WWTF using chlorine for disinfection (all others use Ultra Violet systems), and includes a de-chlorination process prior to discharge to meet the WSER chlorine limit.

As required under the WSER, an Identification Report was submitted by May 15, 2013 for each WWTF, documenting various data and information including the location of all overflow points. In addition, for those systems which include CSOs, a CSO report is submitted by February 15 of each calendar year for the prior year. The report documents the occurrence, duration and measured or estimated volume of each CSO overflow event. Halifax Water is able to calculate overflow event volumes for most CSO locations using data from in-situ water level sensors. Volumes for older CSOs on the North-West Arm without such sensors may be estimated using modeling. Environment Canada has confirmed that hydraulic modeling results are acceptable as CSO volume estimates.

Recently, Halifax Water had 3-D scans completed for the CSOs in Dartmouth and will be completing scans for Halifax CSOs this coming year. This enables staff to calibrate the model, ensuring the estimated overflows are accurate.

The WSER also requires annual or quarterly Monitoring Reports for each WWTF [depending on size], documenting the daily effluent volume and the concentrations of CBOD, TSS, and Un-ionized Ammonia. These reports have all been submitted as required by the WSER, since 2013.

6. DRINKING WATER REGULATIONS

Drinking Water regulations have gone through several years of stability compared to the post-Walkerton years of 2002-2012. That being said, there are a few business regulatory issues related to drinking water which Halifax Water will need to monitor closely.

Manganese

Manganese is a metal which is ubiquitous in most Nova Scotia groundwater and surface water sources. The most common effects of manganese have been black staining on plumbing fixtures and laundry and has to date been regulated as an aesthetic objective (AO) in the Guidelines for Canadian Drinking Water Quality. In Nova Scotia, AO parameters serve only as a guidepost to utilities that problems will ensue if the AO value is exceeded. They are not a regulatory compliance issue.

In June, 2016, Health Canada proposed a new manganese guideline for public consultation. The new guideline decreases the AO value from 0.05 to 0.02 ug/L, but more importantly creates a health related value or maximum acceptable concentration (MAC) of 0.1 ug/L. Health Canada has created the MAC because they believe that manganese can have effects similar to lead in drinking water. Health Canada is still reviewing public comments, including comments from Halifax Water. A new final guideline may be published in late 2017 or the spring of 2018.

While manganese exists in most of our water sources to some degree, the level is such that it is easily removed. Two of our systems, Bennery Lake and Silver Sands have more challenging manganese issues. Both supplies have appropriate treatment systems to keep manganese below the MAC level continuously. Manganese treatment systems, however, are easily upset and it is foreseeable that an MAC value for manganese may create the occasional need for a water use advisory based on treatment plant upset. There is no practical effect in lowering the AO value as we currently provide treatment that is aesthetically acceptable to customers the vast majority of the time.

Halifax Water is concerned about how manganese will be regulated in Nova Scotia. Compared to other MAC parameters, manganese is difficult to measure in a treatment plant. On line manganese instruments are not readily available so knowing that the treatment process is always running optimally may be challenging.

Manganese may also be a concern as it relates to distribution system water quality. When Halifax Water has a discoloured water event, Halifax Water has been able to assure its customers that the water remains safe based on routine and follow up bacteriological monitoring. Due to the ubiquity of manganese in Nova Scotia water, manganese deposits build up in distribution pipes. Halifax Water has confirmed, that when a discoloured water event does occur, some component of the colour in the water is manganese. What measures

Halifax Water will need to take will depend on the final guideline from Health Canada. Depending on the approach by Nova Scotia Environment, public advisories may need to change in response to water main breaks and other events which cause discoloured water.

Lead

In January of 2017, Health Canada issued a new guideline for lead. Health Canada's previous guideline was outdated, not based on the most recent science, and did not serve to protect public health. The proposed guideline, however, will likely create widespread non-compliance in Canada particularly among utilities that have not carried out characterization studies to understand lead occurrence. Halifax Water participated in a coordinated utility response to the proposed lead guideline.

If the guideline is implemented as proposed, and provinces adopt the guideline, there exists a possibility for widespread utility non-compliance with regulations. Halifax Water has done more than most utilities in Canada and America, and is better prepared to address customer concerns regarding lead. Lead in drinking water in Halifax is an artifact of lead service lines. With approval from the Halifax Water Board on actions to address lead, there are ample programs in place to incent customers to replace their lead service line.

Depending on how NSE implements a new Health Canada guideline, there may be increased early demands on our lead service line replacement program, beyond what was anticipated. Also, depending on the final guideline and how it's adopted, there may be a need for additional sampling and monitoring resources.

Nova Scotia Environment Operating Approvals

Approvals for operating all water systems expire on March 31, 2018. Halifax Water staff are currently working on the application process for renewal.

In the immediate period after Walkerton, Nova Scotia was a leading province in adopting more progressive drinking water regulation. This was a large step change in Nova Scotia and was appropriate at the time and demanded significant resources from utilities and NSE.

Nova Scotia is now at a point where utilities are largely compliant with new drinking water standards. As a result, NSE efforts have moved from standard adoption to operational monitoring. Halifax Water staff have observed a trend to a more prescriptive approach to drinking water regulation and anticipate increased requirements for reporting and verification in conjunction with operating permit renewals.

7. FINANCIAL PROGRAMS & PRO FORMA BUDGETS

7.1 Capital Program

7.1.1 Asset Management Program

The Asset Management division of the Engineering & IS Department provides services related to Infrastructure Planning (master planning, hydraulic system modelling, and flow monitoring), Asset Management Plans, and Capital Budget Development.

Priorities for the Asset Management group have focused on gathering data on asset attributes (size, material, age, and condition information as a minimum), and preparing a formal Asset Management Plan (AMP). Data refinements benefited from the completion of the Wastewater Treatment Facility Condition Assessment project, the Wastewater Pumping Station Condition Assessment project, the Stormwater Culvert Inventory and Condition Assessment, and sewer condition assessments. The formal condition assessments provided data needed to complete the AMPs for those asset classes. For the remaining asset classes, staff relied on best available information with the understanding that future AMPs will be refined as better information is collected.

With the sewer inspection program moving to the Asset Management portfolio, staff have worked with contractors for both manhole inspection (zoom camera technology) and conventional closed circuit television (CCTV) inspection of mainlines and laterals as well as with the inspection software provider.. Staff have explored using widely available tools such as ArcGIS Online to make results simpler to view.

Staff prepare the capital budget annually through a defined process. The process includes using the capital project planning database and generating summary reports to support items in the capital budget.

The Infrastructure Planning group have leveraged the Regional Wastewater Functional Plan (RWWFP) and the first Integrated Resource Plan (IRP) to complete the West Region Wastewater Infrastructure Plan (WRWIP), assuming responsibility for the corporate flow monitoring program, and completing the hydraulic modelling tools assessment and strategy.

The WRWIP identified and confirmed the wastewater infrastructure servicing plan for the west region over the next 30 years. The project also included developing conceptual designs for projects falling within the first 10 years and developing the Cost Estimating Framework and the Long-Term Planning Framework (LTPF). The LTPF provides a process for streamlining long-term infrastructure planning needs for Halifax Water and integrating with Halifax Regional Municipality's regional planning process. Halifax Water has also decided to consolidate the infrastructure planning studies to migrate to a single water and wastewater infrastructure plan over time. The inclusion of water infrastructure for all regions and the remaining wastewater infrastructure for east and central regions into the upcoming

Regional Infrastructure Plan allows an interim step to achieving a single infrastructure plan in the future and will enable an update to the IRP in 2018.

The migration of the corporate flow monitoring program to the Asset Management division has allowed staff to implement a comprehensive network of flow monitors (77) and rain gauges (14) with a heavy focus on data accuracy and reliability. Similar to the data collection effort undertaken with the sewer inspection program, emphasis has been placed on usability and accessibility of the data collected. Staff have worked with the service provider to create tools to simplify data extraction and display of monitoring and gauging results.

Staff completed a hydraulic modelling tools assessment and strategy to confirm hydraulic modelling software needs for Halifax Water and lay out the proposed approach to modelling of the infrastructure systems. The assessment resulted in a recommendation to move to more advanced software to model the characteristics and challenges of all systems. Migration to the new software will be immediate for the wastewater system and be part of the Regional Infrastructure Plan. Migration to the new water modelling software will be phased in to allow for improved demand loading from the ongoing Advanced Metering Infrastructure (AMI) project.

A number of previous initiatives identified in the Asset Management Roadmap Implementation (AMRI) have been reprioritized to be compatible with the AMP recommendations, to allow for an in-house approach by asset management staff, or due to resourcing constraints. Anticipated projects and programs for the Asset Management division are outlined below and within Table 1.

Update Asset Management Plan (Annual)

Building on the first Asset Management Plan (AMP), staff will continue to fill data gaps by asset class and update the AMP annually with a March publication.

Asset Management Program Development

Priorities are based on direction from the Executive Team in concert with other corporate priorities. There is a need to balance the number of corporate implementation programs as often they require resources from multiple departments and these same resources are involved in other corporate programs (Cityworks implementation, Advanced Metering Infrastructure implementation, SharePoint roll-out, etc.). Elements of the program may include:

- Expand Prioritization Methodology
- Develop Strategic Maintenance Management Program
- Review Levels of Service and Enhance Performance Measurement
- Enhance Capital Budget Supporting Tools
- Develop Asset Management Resource Library
- Assess Suitability of Current Data Management Tools

Condition Assessments by Asset Class

With priorities established from the Asset Management Plan and direction from the Executive Team, staff will continue to develop condition assessments for each asset class. Initial focus is to be on developing factors influencing condition and performance of pressure pipe networks (water transmission/distribution and wastewater forcemains). Additional asset classes will be considered based on resource availability in both the Asset Management division and the respective Engineering and Operations departments.

Sewer Inspection Program (Annual)

This is the key program for determining condition information about the sewer systems. The program involves both manhole inspection using zoom camera technology, and conventional CCTV inspection for the mainline sewers and laterals. The advantage of using the zoom technology is it allows an initial look at the pipes connected to each manhole with sufficient information to determine if mainline cleaning is needed or if full CCTV inspection is warranted. Zoom inspection is considerably less expensive than CCTV inspection. However while zoom camera technology provides excellent information of the structures, it cannot capture detail on locations of defects in the mainline sewers. This program is an annual program that may grow in size as Halifax Water and its service providers fine-tune the inspection processes. These inspections are critical for decision making related to near term integrated project priorities and the wet weather program.

IT Strategy Projects

Some projects identified in the IT Strategy will require involvement of Asset Management division staff during implementation. Early projects that will involve AM resources are expected to include:

- Asset Registry
- Data Governance
- Analytics Dashboard
- Electronic Data Warehouse
- Portfolio and Project Lifecycle
- Enterprise Forms, Collaboration and Content Management

Regional Infrastructure Plan

The Regional Infrastructure Plan will build on the work completed during the WRWIP and incorporate the remaining infrastructure studies to develop a comprehensive preferred water and wastewater servicing strategy for regional infrastructure. The Regional Infrastructure Plan will meet the growth, asset renewal, and regulatory compliance drivers for the next 30 years. Additionally, the servicing strategy will consider optimizing system operability, efficiency, reliability, and resiliency. Similar to the WRWIP, the Regional Infrastructure Plan will include conceptual designs for projects in the first 10 years. Also added into the project is the wastewater model build in the new software, the water model build for the Bennery Lake system, and development of a work plan for how to adapt to future climate change.

Corporate Flow Monitoring Program (Annual)

Staff will continue to manage the corporate flow monitoring program including ongoing data management of the network of monitors currently in the field as well as the anticipate growth of the network in 2018/19. Efforts to improve how data is shared will continue.

Review Flow Monitoring and Rain Gauge Strategy

Staff will also review the flow monitoring and rain gauge network for adequacy in overall system understanding and use for calibrating the hydraulic models. The review will include an assessment of the current monitoring/gauging locations, recommended adjustments, and a report on the effectiveness of the program as a whole.

Implement Hydraulic Models

Building on the modelling tools assessment and strategy, and as part of the Regional Infrastructure Plan, staff will begin to implement the new hydraulic models. For the wastewater infrastructure, this will be a complete all-pipes model re-build. For the water infrastructure, the new software will be used to develop the Bennery Lake water model as a pilot. Full build out of the water infrastructure model in the new software will be phased to enable consumption/demand loading to be leveraged from the current Advanced Metering Infrastructure project.

Integrated Resource Plan Update

Based on information and recommendations from the Regional Infrastructure Plan, the Asset Management Plan, and the Compliance Plans (being undertaken by others), Halifax Water will compile an update to the 2012 Integrated Resource Plan (IRP) in 2018. The update is predicated on an ambitious schedule for the Regional Infrastructure Plan, however staff feel sufficient recommendations will be available to inform the IRP update.

Table 1: Asset Management and Infrastructure Planning Initiatives

Initiative or Program	**Implementation Year (2018/19 to 2022/23)**				
	2018/19	2019/20	2020/21	2021/22	2022/23
Update Asset Management Plan (Annual)	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team
Asset Management Program Development	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team
Condition Assessments by Asset Class	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team		
Sewer Inspection Program (Annual)	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team
IT Strategy Projects	Projects with AM Team participation	Projects with AM Team participation	Projects with AM Team participation	Projects with AM Team participation	
Regional Infrastructure Plan	Projects led by AM Team	Projects led by AM Team			
Corporate Flow Monitoring Program (Annual)	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team	Projects led by AM Team
Review Flow Monitoring & Rain Gauge Strategy	Projects led by AM Team				
Implement Hydraulic Models	Projects led by AM Team	Projects led by AM Team			
Integrated Resource Plan Update	Projects led by AM Team				

Projects led by AM Team (blue) — Projects with AM Team participation (grey)

7.1.2 Five-Year Capital Budget – General Overview

As part of the utility's overall mission, the annual capital budget provides funds for the acquisition, replacement, or rehabilitation of capital assets. Capital assets include all equipment; facilities; and linear infrastructures that have an asset value that exceeds $5,000 and a useful life that exceeds one year. The capital budget funding and subsequent project delivery help ensure that services are provided in a cost-effective and efficient manner with a focus on long-term integrity of systems.

As discussed in Section 7.1.1, the development of the annual and long-term capital budget has its foundation with the Engineering & IS department's core Asset Management program. This program organizes, evaluates, and prioritizes all infrastructures by individual asset class. The core asset-class priorities are reviewed and coordinated with staff from Engineering & IS and Operations departments to identify the highest-priority projects. These projects are further reviewed with technical staff from the municipality's Transportation and Public Works group to review integration opportunities with the proposed Streets Program. A detailed overview of the major projects within the proposed five-year capital budget is provided in Section 7.1.3.

In addition to the core infrastructure projects within the capital budget, employees from all departments define annual capital-equipment requirements to meet their operational mandates. These include equipment classes such as fleet, large tools, computer equipment, and consumption meters.

The capital budget is funded from a variety of sources. The core funding is from capital-asset depreciation accounts and long-term debt. This core funding is enhanced with regional development charges, external grants, and operating surplus, when available. The base funding amount for capital projects from depreciation increases on an annual basis as the underlying capital-asset value increases.

The historical overall level of capital funding is well below requirements relative to current infrastructure deficiencies and projected long-term sustainable requirements. The required increase in capital infrastructure investments is defined in detail within the Integrated Resource Plan (IRP) that was filed with the NSUARB in October 2012. The proposed five year capital budget shows a transition from historical spending levels towards the level recommended within the IRP. A transitional period allows for the development of institutional capacity to deliver the increased volume of projects, increased funding, and enhanced Asset Management protocols to identify and prioritize specific projects.

The formal infrastructure projects within the capital budget are delivered by the Project Management Team within Engineering & IS. The group of project managers and their technical staff utilize a standard project management approach to consistently deliver the planning, design, construction, and commissioning phases of each project.

The full five-year capital budget is shown in Appendix E. The year-one (2018/2019) budget has a total project value of $25,033,500 for water, $39,818,800 for wastewater, and $8,595,700 for stormwater, with a five-year total project value of $148,277,000 for water, $264,626,000 for wastewater, and $57,168,000 for stormwater.

In the context of the five year capital plan, the Municipality is currently proceeding with the design phase of the Cogswell Redevelopment Project. The municipality's Cogswell redevelopment team is completing the 60 percent design development to incorporate the higher level detailing of the approved design elements as well as major infrastructure requirements. The project timeline propose the completion of the 60 percent design and a presentation to Regional Council for a project go/no-go decision within the second quarter of 2018. Pending Council approval, the project may proceed to construction in 2019 with an approximate three year construction phase. Should the project proceed, there will be many impacts to the utility's water, wastewater and stormwater infrastructure. All net new infrastructure required to provide service to new buildings would be part of the municipal project cost. However, the relocation of existing infrastructure, required due to road alignment changes would be the responsibility of Halifax Water, based on the Municipal Streets By-law. The review of the order of magnitude of the required infrastructure relocations is in progress as the 60 percent design is developed. Should the project proceed, there would be no costs incurred in the 2018/19 fiscal year, however, the following three years may see several million dollars in infrastructure relocations. These estimates have not been included within the current five year plan due to project uncertainty, however, the next version of the capital budget for 2019/20 would include specific project costs, as required.

7.1.3 Major Projects

Integrated Capital Projects:

Project: Halifax Water Infrastructure Renewal Integrated with Halifax Municipal Street Renewal Program

Asset Class: Water Distribution, Wastewater and Stormwater Collection

Description: This program involves the renewal of water distribution, wastewater collection and stormwater collection infrastructure in an integrated approach with the municipality's annual Street renewal program. Water, wastewater and stormwater pipes and appurtenances are replaced or rehabilitated when approaching or exceeding their useful life cost effectively while the host municipal street is being renewed. The integrated program reduces the total project cost and minimizes the overall disturbance on community neighbourhoods. Halifax Water's planned expenditures on this program are approximately $6M per year.

Water Capital Projects:

Project: Lucasville Road Transmission Main

Asset Class: Water – Transmission Main

Description: Halifax Water is working to construct a new 600 mm diameter transmission main from the Pockwock Transmission Main to the Sackville-Beaver Bank area to help address emergency back-up water supply capacity/redundancy issues. This new main would run parallel to the existing 400 mm diameter main along the Lucasville Road and would eventually extend to the Beaver Bank Road near the railway crossing. Some sections of the transmission main have already been installed through cost sharing/oversizing of mains in recently developed areas of Middle Sackville. The overall cost estimate for this project is approximately $11,000,000. The design work for the next phase of the project, the section along the Lucasville Road, is slated for 2019/20 with construction to be completed in 2020/21. The full project is expected to extend over approximately 8-10 years as opportunities progress.

Project: Cowie Hill Reservoir Rehabilitation

Asset Class: Water – Structures

Description: The Cowie Hill Reservoir is a 2.4 MG gunite water storage reservoir that was constructed in 1972. The reservoir underwent a significant rehabilitation from 1990 to 1996. The recent Gunite Reservoir Inspection program identified the Cowie Reservoir as a priority for rehabilitation work in order to stabilize the condition of the reservoir and in order to extend its expected life. The internal and external inspection found numerous locations where the gunite covering had spalled off leaving the underlying steel reinforcing wires exposed and rusting. There are numerous locations on the wall that show evidence of cracks and leakage through the wall of the reservoir.

The project will involve retaining a consulting engineer to design and prepare a rehabilitation plan. It is anticipated that the design work be undertaken in 2018 and the work will then be tendered and constructed in the summer of 2019.

Project: J.D. Kline Water Supply Plant

Asset Class: Water – Treatment Facilities

Description: The J.D. Kline Water Supply Plant was commissioned in 1977 to service the City of Halifax, Town of Bedford, and parts of Halifax County. Due to the age of the facility, process equipment is nearing the end of its useful life. As well, certain treatment technologies from 30 years ago no longer meet current standards.

Raw Water Intake Traveling Screen Replacement: There are three vertical traveling screens at the Raw Water Pumping Station at Pockwock Lake that have reached their useful life expectancy. Recent assessments of the screen system by Plant Operations found that one of the traveling screens is non-operational due to severe corrosion. The screens and the supports have rusted and the individual screen panels have pulled apart. In addition, structural concrete supports for the screens have some cracking and are showing signs of distress. The other two traveling screen systems are functional but showing similar signs of corrosion.

It is recommended that all three traveling screens be replaced as part of a programmed replacement. A detailed assessment of all components of the traveling screen system has not been completed yet but it is likely that the full system will need to be replaced for all three screens. This would begin with retaining an engineering specialist to assess the existing components and to help develop the plan for replacement. It is assumed that the controls for the operation of the screens will be upgraded as part of the project.

Replace the CO2 Feeders: The existing Carbon Dioxide (CO_2) feeders are original to the plant and hence are over 37 years old. The performance of these CO_2 feeders is deteriorating and replacement parts are getting harder to find due to the age of the equipment. The current feeders are not automatically paced according to the raw water flow and the feeders cannot provide information back to the computer human machine interface (HMI). The project will include carrying out a preliminary and final design by a consultant. The new feeders will be flow- paced for dosing and will also provide feedback to the HMI of the plant. This will result in better process optimization. The estimated cost for this work is approximately $660,000 and it is projected to be completed in 2019/20.

Wastewater Capital Projects:

Project: Weybridge Lane Pump Station, Kearney Lake Road Forcemain Extension, and Trunk Sewer Upgrade

Asset Class: Wastewater – Structure, Forcemain and Trunk Sewer

Description: The initial core wastewater infrastructure for the Bedford West Subdivision was completed in 2015. Growth within the development is such that it is anticipated that the final phase of the wastewater infrastructure will be required by 2019. This infrastructure will include the permanent Weybridge Pump Station, which will replace a temporary pump station activated in 2015, a 625m extension of the forcemain system on Kearney Lake Road, and an upgrade of the 1.1km trunk sewer on Kearney Lake Road. The design of this infrastructure has commenced and it is expected that construction will be undertaken in 2018 and 2019.

The $10M cost of the Weybridge Lane Pumping Station has three sources of capital funding. These include an allocation to Halifax Water for the new benefit to existing customers, an allocation to a future Sandy Lake development area and the Bedford West Capital Cost Contribution Charge. The $4.4M cost of the Forcemain Extension and Sewer Upgrade will be funded by the Regional Development Charge.

Project: New Timberlea Pump Station and Forcemain System

Asset Class: Wastewater – Structures and Forcemains

Description: The Beechville-Lakeside-Timberlea [BLT] WWTF was commissioned in 1982, with a capacity of one million gallons per day [MGD] and the original intent was to increase the facility's capacity as required to provide service to the ultimate flow generated from the lands within the prescribed boundary. The BLT WWTF Environmental Risk Assessment and the BLT Area Wastewater Servicing Options – Concept Development Studies were completed in 2011 and 2012 respectively. Based on the results of these studies and the Regional Wastewater Functional Plan, it was determined that the phased diversion of wastewater from the BLT sewershed toward the Halifax system was the preferred approach for addressing the wastewater capacity issue in this sewershed.

In 2015 the first phase of this diversion was completed when the Lakeside PS Diversion project was undertaken. In 2017 the West Region Wastewater Infrastructure Plan was completed and it reconfirmed that the best approach was full diversion of the BLT sewershed to Halifax and that to complete this diversion a new Timberlea PS and related forcemain system is required for an estimated cost of $21M. The project will result in the decommissioning of the BLT WWTF.

Project: Bedford to Halifax Trunk Sewer Upgrade

Asset Class: Wastewater – Trunk Sewers

Description: There is existing constraint within the trunk sewer which conveys wastewater along the Bedford Highway from Kearney Lake Road to the Duffus Street Pump Station. A section of this trunk sewer is a 1050mm dia. pipe and is located near Fairview Cove. The upstream sewer is a 2100mm x 1650mm pipe and the downstream sewer is an 1800mm dia. pipe. During major wet weather events, the Kempt Road CSO is activated resulting in discharge to the Fairview Cove Basin. There is observed flooding upstream along the Bedford Highway during mid-size events (< 1 in 2 year events) and the highway has been closed in the past due to flooding as a result of this constraint.

The concept is to twin the 1050mm dia. pipe with a new 1200mm sewer using micro tunneling and access shafts. The total length of the new tunnel will be approximately 900 metres and is estimated to cost $20M. It is anticipated that the design will commence in 2018 and construction will be completed by 2020.

Project: Autoport Pump Station Replacement

Asset Class: Wastewater – Structures

Description: The Autoport Pump Station was constructed in the mid 70's and requires replacement due to a number of concerns which include: the equipment has reached the end of its useful life; the pump station is located within the public right-of-way such that specific measures are required in order for staff to safely access the facility; the upstream wastewater collection system was reconfigured as a result of the EPWWTF project resulting in an increased hydraulic demand on the pump station; and capacity is exceeded in some wet weather events which results in the deployment of vacuum trucks.

In order for this project to proceed there will be the need to purchase land. Assuming that the land can be secured in 2018 then the new pump station would be constructed in 2019 for an estimated cost of $3,000,000.

Project: Russell Lake Pump Station Upgrade

Asset Class: Wastewater – Structures

Description: This capital works project is being funded through the CCC program for the Russell Lake West area of Dartmouth. The existing pumping station building is at the end of its service life and needs to be replaced. Included in the work scope is the installation of a back-up power system and associated mechanical and electrical equipment. Construction is expected to take place in 2019/20 at an estimated cost of $2 M.

Project: Wanda Lane Sanitary Sewer Replacement

Asset Class: Wastewater – Collection System

Description: This capital works project is an integrated project involving HRM, local residents, and Halifax Water. The proposed work scope includes street reconstruction, new sidewalk, bridge replacement on Tobin Drive, walkway bridge replacement, Ellenvale Run channel upgrades, new sanitary sewer, conversion of the old sanitary sewer to a clear water or deep storm sewer, and water main renewal. Construction is expected to take place in 2019/20 for an estimated cost of $2.2 M.

Stormwater Capital Projects:

Project: Sullivan's Pond Storm Sewer System Replacement (Phase 2)

Asset Class: Stormwater – Pipes

Description: The Sullivan's Pond storm sewer system is the outlet for Sullivan's Pond/Lake Banook watershed which is approximately 1500 hectares in size. The system was constructed in the early 1970s and is at the end of its service life. The system is designed for the major flood event (runoff resulting from a 1 in 100 yr. rainfall event). In 2017/18 the first phase and upper section of the system was constructed between Sullivan's Pond and Irish Town Road. This project involves the lower downstream section from Irish Town Road all of the way to Halifax Harbour. Construction of the second phase will be challenging considering the congested urbanized environment in which the system is located. Construction of this second phase is expected to proceed in 2021/22 at a cost in the order of $11 M.

Project: Ellenvale Run Retaining Wall Replacement Program

Asset Class: Stormwater – Structures

Description: The Ellenvale Run is a highly urbanized watercourse that runs from Lake Lemont to Morris Lake in Dartmouth. The approximately 3.5 km long watercourse has been rerouted and encroached upon as a result of adjacent development. This has resulted in the stream being contained within culverts and channels made of retaining walls. The majority of the retaining walls are at the end of their service life and need to be replaced. The system is designed for the major flood event (runoff resulting from a 1 in 100 yr. rainfall event). This program involves the systematic replacement of the retaining walls over the period of 2018 – 2022. The estimated cost of the program is $10 M.

Project: Cross Culvert Replacement Program

Asset Class: Stormwater – Culverts/Ditches

Description: Halifax Water owns and maintains approximately 1700 cross road culverts. This infrastructure is a distinct asset class in addition to driveway culverts. They convey stormwater under roads and are less than three metres in diameter. Approximately five percent of the inventory of cross road culverts are in critical condition and another seven percent in poor condition. This program involves the systematic replacement of cross road culverts at the end of their service life. The estimated annual cost of this program is $2 M.

Project: Halifax Water Sewer Separation Program

Asset Class: Wastewater and Stormwater Collection

Description: This program involves the separation of existing combined sewers in key areas of the Halifax peninsula to divert storm flows from the wastewater system as a key component to providing increased wastewater capacity for proposed growth within the Halifax WWTF sewershed. The sewer separation program will generally involve the installation of a new storm sewer on local streets for the collection of surface drainage and select building connections. The program will be focused on the Young Street, Kempt Road and Spring Garden Road areas. This program is primarily funded from the Regional Development Charge program. Halifax Water's planned expenditures on this program are approximately $6M per year.

<u>Corporate Projects</u>:

Project: Information Technology Strategic Plan Implementation

Asset Class: Water, Wastewater and Stormwater

Description: Halifax Water completed an IT Strategic Plan in 2017. The Plan provides a five year program and investment roadmap consisting of a series of defined initiatives, each supporting a key strategic theme and each contributing to the continuous improvement of one or more facets of the IT environment: organization, applications and infrastructure. Halifax Water's planned expenditures on this program are approximately $8M per year.

7.1.4 IT Strategic Plan

Halifax Water last developed an IT Strategic Plan in 2001. Since then, the utility has been very progressive in using technology to improve organizational efficiency, effectiveness and customer service. Key Investments include SAP, GIS, Cityworks, and recently Advanced Metering Infrastructure.

With this success in place, a new and enhanced IT Strategic Plan was developed in 2017 to guide the next 5 years of investments.

The following Strategic Business Drivers shape the information technology environment:

- Provide world class services to our customers and our environment
- Retain leadership position as an integrated water, wastewater and stormwater utility
- Retain position as a top utility in all Lines of Business focused on:
    - Public and Employee Safety
    - Water Quality
    - Sustainable Infrastructure and Asset Renewal
    - Regulatory Compliance and Growth
    - Environmental Stewardship
- Integrated Resource Plan (IRP) Framework

Halifax Water wants to ensure that IT investments meet the future needs of the utility, supporting the efficient and safe delivery of world class end-to-end service in all its lines of business (Water, Wastewater, Stormwater), while being an innovative user of established technology to enhance customer experience, improve performance, engage employees, and manage the inherent risk of providing an essential public service in a safe and cost effective manner.

The development of the Plan is centered on six **Strategic Themes** that characterize the focus for the next five years of IT investment:

- **Customer Experience –** Providing customers with the ability to access most services using the online site or smartphone.
- **Information Integration with Location** - Having all necessary data linked together and also tracked through a geographic lens.
- **Analytics Driven Decision Making** - Able to model using all customer usage, financial, environmental, and infrastructure data across the Water, Wastewater and Stormwater systems. Able to tie data together into business intelligence.
- **Managed Knowledge and Workflow** - Key content is captured and stored logically and easily accessible by those that require it.
- **Enable Employees Anywhere** - Employees can access, capture and update the information they need to effectively do their job and support others, wherever they may be working.

- **Secure IT Foundation** - Infrastructure is resilient, cost effective, well supported, and recoverable within clearly defined requirements. The IT function (Planning, Delivery and Operations) is effectively managed.

The specific project details and implementation framework are provided in a comprehensive five year IT Strategic Plan Roadmap (See Appendix F). The Strategic IT Roadmap is a high level snapshot of the sequence of programs and investments to deliver on the approved technology vision and recommended architecture. The five year plan has an estimated total cost of $40,000,000.

A summary of some of the key IT initiatives within the new five year plan include:

- New Website Development with Customer Portal
- Enhanced Customer Relationship Management (CRM) Application
- Corporate Data Analytics and Enterprise Data Warehouse functionality
- Expansion of Computerized Maintenance Management System (CMMS)
- AMI Completion
- Document/Content Management
- Permit Approval application
- Asset Management applications
- Continued growth of corporate SAP and GIS application/functionality
- Improved IT System Resiliency and Redundancy

7.1.5 Integrated Resource Plan

Halifax Water completed its first formal Integrated Resource Plan (IRP) in October 2012 with the intention that it would be updated periodically. The IRP was done in collaboration with the NSUARB's consultant who initially recommended an IRP update in three years. However, the consultant also acknowledged the data limitations encountered during the completion of the IRP and recommended that Halifax Water work to fill the data gaps before the IRP was next updated.

Several important initiatives aimed at filling the data gaps have been underway since the completion of the first IRP. These included:

- Implementing the Wet Weather Management Program (with inflow and infiltration pilot projects);

- Continuing the implementation of the Asset Management Program (foundational elements from the Roadmap;
- Resolving asset attribute information in GIS, and specific inventory and condition assessment projects);
- Developing plans by asset class;
- Implementing the Corporate Flow Monitoring Program;
- Implementing the Sewer Inspection Program (conventional CCTV and zoom camera inspections);
- Completing the Hydraulic Modelling Assessment and Strategy;
- Completing the West Region Wastewater Infrastructure Plan (WRWIP).

The Regional Infrastructure Plan project currently underway will cover the balance of the wastewater infrastructure planning for east and central regions, be inclusive of the program developed in the WRWIP, and include a water infrastructure plan for all regions. The project also includes a climate change assessment and policy component to develop a climate change adaptation plan and a systems optimization plan. Its completion will streamline a number of prior and long-term planning initiatives to facilitate regular Regional Infrastructure Plan updates on a five-year cycle for water and wastewater infrastructure.

The IRP update will incorporate findings from work completed or planned to support the drivers of regulatory compliance, asset renewal, and growth.

The goal is to develop an updated IRP that recalibrates the $2.6 billion long-term investment identified in the first IRP (2012), and positions the utility for future updating on a five-year cycle.

Halifax Water expects to build on the key initiatives already underway to provide a revised IRP in late 2018.

7.2 Five-Year Operating Budgets

Budgets have been developed to cover the period from 2018/19 to 2022/23, as shown in Appendix G. The operating budgets reveal that rate increases will be required to maintain current levels of service, deliver projects already in progress or approved, meet changing environmental requirements, and generate more funding to meet infrastructure investment demands.

Halifax Water has a goal to keep rates for combined services below 2% of median household income; which is well below the rate affordability threshold of 4% for combined services recommended in several industry studies which are referred to as best practice. The cost of annual combined services for an average household is currently estimated as 0.92% of median household income in 2017/18.

Halifax Water completed a review of rate affordability in 2017/18 and in September 2017, the Halifax Water Board approved expansion of the existing customer assistance program - Help to Others (H2O) program. The H2O program provides dedicated funding for low income households to offset water bills, administered through the Salvation Army, similar to other heating fuel or electricity bill assistance programs. Funds for the program are derived from unregulated activities of the utility. In 2018/19 it is anticipated that due to the program expansion, more customer with low incomes will be able to participate in the assistance program.

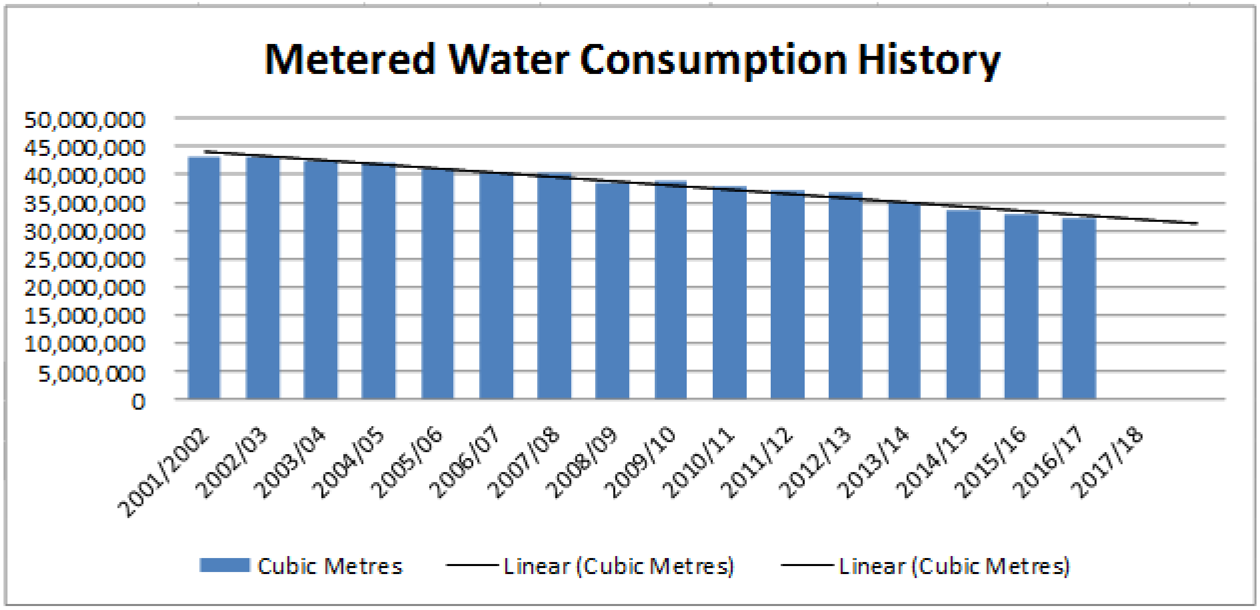
Some of the primary operating budget drivers and assumptions are:

Revenues

- Consumption will continue to decline related to water and wastewater service. Consumption is projected to decrease 2.5% per annum.

Halifax Water has experienced net metered consumption decreases of 2.2% per year on average, over the past fifteen years, as indicated in Figure 1. The total decrease since 2001/02 is a staggering 22% reduction, which has been managed predominantly through changing rate structures to align fixed and variables costs, diversifying rate structures (stormwater with a different billing determinant), increasing rates, increasing unregulated revenue and controlling costs.

For short term planning purposes, in relation to setting rates, we previously used a rolling historic 4 year average (net reduction) – which is currently 3.4%. Consumption is impacted by timing of development, form of development and new customer growth. The net decrease in consumption last year, and so far in 2017/18 is less than recent previous years and less than the historic average.



Median	-2.3%
Total decrease since 2001/02	-22%
Rolling Historic 4 Year Average Decrease	-3.4%
Average	-2.2%

Figure 1: Metered Water Consumption History

- The amount of impervious area and number of properties receiving stormwater services is projected to increase gradually over the course of the next five years.

- 700 or roughly 0.8% new customer connections are projected each year, based on the 4 year historic average (2011/12 -2014/15), and the actual customer growth in the last two fiscal years (2015/16 and 2016/17).

- Revenues from unregulated business activities are increasingly important to mitigate future revenue requirements from rates. These are described in more detail in Section 7.4. Unregulated revenues will be used to fund unregulated expenses and generate additional unregulated revenues for the benefit of the rate base.

Expenses

Halifax Water's Five Year Operating Budget is completed on an accrual basis to provide better information for decision making and be reflective of best practice for budgeting. Accrued amounts include a liability for future employee benefits (pension) as calculated under the International Financial Reporting Standards (IFRS).

The NSUARB Accounting and Reporting Handbook for Water Utilities is used in determining the revenue requirements for rate making purposes. If accrued pension expenses were omitted, projected net losses would be less as shown in Table 2. There is sufficient accumulated operating surplus to offset the budgeted operating loss in 2018/19, however, rate adjustments will likely be required following losses in 2019/20.

The largest components of Halifax Water's consolidated operating budgets are salaries & benefits, electricity, furnace oil and natural gas, debt financing, depreciation, dividend and chemical costs.

Salaries and Benefits - The annual salary increase allowance is 2%, with an additional allowance made to address the impact of step increases within salary bands or reclassification of positions; and increases in benefits. Any planned new hires are reflected within the budgets.

Electricity – 1.5% in year 1, 2% each year thereafter. The impact of these increases is expected to be partially offset by the formal Energy Management Program.

Furnace Oil and Natural Gas – 5% in years 1 and 2, and 2% (~CPI) in years 3, 4 and 5;

Debt Financing – New debt payments are budgeted to support the five-year capital projects. Over the course of the next five years, debt payments are projected to increase significantly. The amount and timing of the increases will be determined by timing of the completion of the projects and the financing rates and options available. Halifax Water's capital financing strategy is designed to maintain a debt service ratio of 35% or less; and to use a mixture of infrastructure funding, development related charges (reserves), depreciation; and debt. It is assumed new debt issuances are serial bond debentures with 20 year amortization and 10 year terms with balloon payments refinanced, or straight 20 year term debentures. The cost of borrowing is based on the weighted average cost of capital of 3.64%.

Depreciation - As Halifax Water's assets and future capital budgets increase so do depreciation expenses. Depreciation is an integral funding source to support rehabilitation of the existing infrastructure as well as new infrastructure and upgrades to meet future capital requirements necessitated by both servicing demands and changing environmental regulation. The depreciation expenses shown in the five year business plan are net of depreciation on contributed assets for contributed water and wastewater assets. In the next rate application, Halifax Water will be requesting permission to phase in depreciation on contributed water and wastewater assets.

Dividend to Halifax Regional Municipality - The water dividend agreement was renewed in September, 2014 for a 5 year term (April 1, 2015 - March, 2020). The dividend is projected to grow from $5.1 M in 2018/19 to $6.0 M by 2022/23.

Chemical Costs – Chemicals are tendered annually in January for optimal pricing. Chemical cost increases of 5% are anticipated for years 1 and 2, with a 2% increase for years 3, 4 and 5. Long range chemical prices are difficult to predict due to the volatility of the market which is closely linked with energy prices and fluctuations in supply and demand.

Energy and electricity cost assumptions are described in Table 7 within Section 13.11 of the Business Plan.

On a consolidated basis, the projected five-year operating budgets are shown in Table 2. Over the next five years, operating expenses are projected to increase from $111.7 million in 2018/19 to $124.4 million in 2022/23, or 11.3%, while operating revenues are projected to decrease by $6.5 million or 4.8% due to declining consumption. Non-operating revenues are projected to decrease by $2 million due to the end of a Provincial grant related to debt servicing for the Halifax Harbour Solutions Project. Non-operating expenses will increase by 8.8% or $3.4million over 2017/18 levels due to increased debt-servicing costs based on current projections.

Table 2: Pro-Forma Income Summary 2018/19 to 2022/23

Pro Forma Income Summary

	Actual 2016/17	Approved Budget 2017/18	**Proposed Budget 2018/19**	**Business Plan** Year 2 2019/20	Year 3 2020/21	Year 4 2021/22	Year 5 2022/23
Operating Revenues	$137,997	$135,587	$135,182	$133,526	$131,878	$130,279	$128,729
Operating Expenditures	$97,839	$106,241	$111,710	$115,020	$117,845	$121,273	$124,367
Operating Profit	$40,158	$29,346	$23,472	$18,507	$14,033	$9,006	$4,362
Non-Operating Revenues	$3,322	$2,787	$1,006	$1,013	$1,032	$964	$966
Non-Operating Expenditures	$34,622	$38,882	$36,564	$37,953	$39,380	$41,137	$42,318
Net Surplus (Deficit)	$8,858	($6,750)	($12,086)	($18,434)	($24,316)	($31,167)	($36,990)

Note:

Consolidated numbers reported above include regulated and unregulated activities of the Urban Core, Satellite and Airport/AeroTech Systems.

The net surplus (deficit) reported for the 2018/19 Proposed Budget and years 2 through 5 of the Business Plan are reported on the accrual basis. Under the NSUARB Accounting and Reporting Handbook some accrued future employment expense liabilities are excluded for the purposes of rate making.

Rate increases will be required to maintain or enhance the existing level of service and invest in the renewal of aging infrastructure. Based on figures presented in Table 2, revenue increases are required over the next five years. Halifax Water will not be able to deliver the requirements for growth, asset renewal and compliance identified in the IRP without revenue increases. Halifax Water has a rate smoothing strategy that promotes gradual rate increases to avoid rate shock and maintain affordability.

As of March 31, 2017, Halifax Water had an accumulated operating surplus of $16.7 M, based on audited financial statements. This coupled with a forecasted future operating surplus in 2017/18 means that the utility can likely defer an application to increase rates until fall of 2019. Results for the year to date have been reviewed by budget managers in conjunction with plans for the remainder of the year. Halifax Water is forecasting a profit for the 2017/18 fiscal year of $4.7 million of which $2.5 million is net profit from operations and $2.2 is Other Comprehensive Income.

Projections for 2018/19 and beyond are based on expected normal weather patterns. Should weather patterns deviate from the norm, operating results could be impacted accordingly as significant rain events, prolonged periods of deep cold, or droughts, impact operating costs for the utility.

As new and more current information becomes available, five-year projections will change. The five year plan is sensitive to changes in consumption, weather, interest rates, availability of external infrastructure funding, level of development activity and operating results.

7.3 Debt Strategy

Halifax Water has an efficient capital financing structure which has been reviewed and accepted by the NSUARB and was developed based on the policies of other utilities, its longer-term capital needs, and consideration of fairness to present and future ratepayers. Utilization of debt is a key component of the capital financing structure. Debt impacts the operating budget and, therefore, the future rate requirements in several ways:

1. Increased debt payments need to be accommodated through rates.
2. Increased depreciation related to growth in the capital program needs to be accommodated through rates.
3. Operating costs of new capital assets need to be accommodated through rates.
4. Capital requirements not funded by debt will increase the requirement of capital from operating funding through rates.

Different financing alternatives were considered taking into account rate stability and affordability, Halifax Water long term financial sustainability, and intergenerational equity.

The debt strategy approved for Halifax Water concludes that appropriate financial ratios for Halifax Water to utilize are:

1. Target Maximum Debt Service Ratio of 35%
2. Target Debt/Equity Ratio of 40%/60%

In essence, the two targets serve as a framework for Halifax Water's utilization of debt. Long-term debt is projected to increase from $224.9 million at March 31, 2017[1], to $283.6 by March 31, 2023. It is estimated that additional debt servicing will increase from $31.4 million in 2018/19 to $36.3 million in 2022/23, and the debt service ratio will increase from 23.0% to 28.0% during this five year period.

The amount of timing of issuance of debt is dependent on the timing of capital projects and also on availability of infrastructure funding from other levels of government. Any changes in capital plans or availability of other funding sources will impact the requirement for new debt.

7.4 Alternative Revenue

Revenues from unregulated business activities are increasingly important to mitigate future revenue requirements from rates. Unregulated revenues help to pay for some expenses which would otherwise be funded by rate-regulated activities, and are also used to fund unregulated expenses. Halifax Water has had success generating alternative revenues aside from user fees on both the regulated and unregulated side of the business. On the regulated side, Halifax Water has entered into agreements for the sale of land deemed to be no longer used or useful for utility purposes. With NSUARB approval, revenue from land sales can be used as a source of funds for capital projects related to the delivery of water services in recognition that the land was originally purchased with water-rate base funds. As much of the surplus land has been sold, this will not be a significant source of funds in the future.

Notwithstanding limitations for generating revenue from the regulated side of the business, there has and will continue to be opportunities from the unregulated side. Currently, Halifax Water generates revenue from third-party contracts for water and wastewater treatment operations, septage tipping fees, and treatment of airline effluent.

Halifax Water also generates revenue for the lease of land for telecommunications facilities throughout the municipality in recognition that reservoir and watershed sites are located on higher elevations that afford more direct line of site for telemetry. In conjunction with these leases, Halifax Water installs telecommunications equipment on these facilities for its own needs for the ultimate benefit of the water, wastewater, and stormwater rate base. As Halifax Water continues to expand the Supervisory Control and Data Acquisition (SCADA) system in accordance with its master plan, further opportunities for leases and hosting of Halifax Water equipment will be realized.

In recognition of Halifax Water's expertise in water-loss control, the utility offers a wide range of related services to generate revenue. These range from leak-detection services for Halifax Water customers and other municipalities to consulting services under contract to

[1] March 31, 2017 Audited Financial Statements

municipalities and First Nation communities. There is great potential to expand these services to generate additional revenue and, at the same time, provide professional development opportunities for staff.

Halifax Water also recognizes that its assets can be leveraged to bring in revenue from energy generation. This includes projects to generate electricity from wind turbines and control chambers where water pressure is reduced. Both of these opportunities have been developed for interface with the Nova Scotia Department of Energy's Community Feed-In Tariff (COMFIT) program, which provides preferential rates to feed electricity into Nova Scotia Power Incorporated (NSPI) distribution grid. Through efforts of Halifax Water staff, a Ministerial Directive was issued through the Department of Energy (DOE) in 2012 to approve the recovery of renewable energy within water distribution systems at "run-of-the–river" rates. To that end, Halifax Water has completed the installation of a hydrokinetic turbine in the Orchard control chamber in Bedford. The Orchard installation went into commercial operation in October, 2014. The projected net revenues are in the current business plan. These projects are structured to ensure they are compliant with the Public Utilities Act with the recognition that regulated activities cannot subsidize the unregulated side of the business.

In partnership with Halifax Regional Municipality, Halifax Water has also studied the potential for a green thermal utility whereby energy can be extracted from the heat in sewage and delivered through a local distribution system in the vicinity of treatment facilities. The planned redevelopment of the Cogswell interchange in Halifax will provide an opportunity to advance this concept since the Halifax WWTF is adjacent to the Cogswell interchange. This project is currently being pursued as a regulated activity subject to the approval of the NSUARB.

In an effort to be open and transparent to stakeholders including the NSUARB, Halifax Water discloses revenue and expenses associated with unregulated business separately within the financial statements and budgets. Net gains from these activities ultimately go to the benefit of the rate base as they are closed out to accumulated operating surplus/(deficit) each fiscal year.

Rates for some the main sources of unregulated revenue – septage tipping fees and treatment of airline effluent will increase effective April 1, 2018. Halifax Water periodically reviews and adjusts these rates. The rates have not been increased since April 1, 2015.

Unregulated revenues are projected to be $1.7 million in 2018/19 and will grow to $1.8 by 2022/23.

8. CORPORATE CUSTOMER SERVICE STRATETGY

Over the past two years, Halifax Water has enhanced customer service by centralizing all water, wastewater and stormwater calls with the Halifax Water Customer Care Centre. A corporate communications strategy was developed in 2017/18, a new phone number was launched (H20-WATR) and a new Customer Complaint/Dispute Resolution Process was implemented.

There will be continued enhancement of customer care with improvements to the website, development of a Customer Portal in conjunction with the Customer Connect (AMI) project, and installation of a new telephony system. One of the next steps in improving service to customers will be approving service standards to respond to customer issues and implementation of monitoring and reporting mechanisms to ensure all departments are meeting agreed upon serve levels.

Halifax Water's Five-Year Information Technology (IT) Strategic Plan (Section 7.1.4) includes significant investment in systems and tools to modernize how customer service is provided. By 2022/23, customers will be able to request many services on line, the Halifax Water website will be easier for customers to use and navigate, and there will be increased functionality for customers to receive information about their account, water consumption, property characteristics used to bill for stormwater, and receive and pay bills electronically.

Halifax Regional Municipality completed a Corporate Customer Service Strategy in April 2017 and upgraded their telephony system in 2017. Halifax Water is now in position to follow suit, and are working on a corporate customer service strategy for Halifax Water that will ensure alignment with HRM and partnership wherever possible.

With all water, wastewater, and stormwater calls directed to the Customer Care Centre, the utility is well positioned to implement a corporate customer service strategy and utilize information received through AMI and the computerized maintenance management system (CMMS) to track resolution of customer requests.

9. ENERGY MANAGEMENT

9.1 Energy Management Program

Through its Energy Management Program, Halifax Water is committed to creating and ensuring an ongoing focus on sustainability and energy efficiency throughout all operating areas. This program defines the goals, objectives, accountabilities, and structure for activities related to sustainability and responsible energy use.

In support of this program, Halifax Water's Energy Management Policy defines longer-term goals and commits Halifax Water to the principles of responsible energy management. This includes reducing dependence on fossil fuels through energy conservation and best practices; identifying and implementing cost-effective energy-reduction initiatives; developing alternative and renewable forms of energy from utility assets; and reducing pollution by increasing the usage of energy supplied from sources that are less greenhouse gas intensive.

Program Structure

The Energy Management Program is coordinated through the Manager of Energy Efficiency reporting to the Energy Management Steering Committee (EMSC). The EMSC comprises the Directors of Engineering & IS, Water Operations and Wastewater/Stormwater Operations, and the Manager, Energy Efficiency.

Reporting to the EMSC on a bi-monthly basis, the Manager of Energy Efficiency is responsible for the creation and implementation of the corporate Energy Management Action Plan (EMAP) and any other activities defined by the EMSC. Reporting typically consists of progress reports on the energy-related activities of Halifax Water including details of energy consumption, key performance indicators, and progress on energy projects and other related activities.

Energy Management Action Plan

The EMAP includes details of energy-management activities that will be developed and undertaken by Halifax Water each year. Key activities contained in the action plan include:

- Delegation of the responsibility for achieving energy goals;
- Assignment of team members as required to meet goals;
- Development of an employee-awareness strategy to facilitate energy savings at work and home;
- Establishment of an energy accounting system that allows for collection, monitoring, and reporting of all data on energy-consuming assets, energy consumption, energy costs, energy savings, and key performance indicators;
- Preparation of energy audits on all facilities on a priority basis;
- Implementation of identified energy projects based on sound financial principles;
- Benchmarking of Halifax Water's facilities and establishment of annual energy-reduction targets;
- Identification of funding requirements and external funding sources for the EMAP;
- Refinement of contract and purchasing policies to incorporate energy-efficient practices; and
- Development of renewable energy generation projects.

Greenhouse Gas (GHG) Emissions

Following on its recent endorsement of the Pan-Canadian Framework on Clean Growth and Climate Change, the government of Nova Scotia intends to implement a carbon "Cap & Trade" program in 2018 to comply with the federal government's carbon pricing regulations. This new program is expected to apply only to very large industrial GHG emitters (> 100,000 tonnes CO_2e per year), electric utilities, petroleum product suppliers and natural gas distributors. Halifax Water's GHG emissions at source are currently very low, and do not currently meet the industrial threshold expected to be implemented. As such, Halifax Water will continue to monitor the provincial Cap & Trade program, and will continue to track energy usage, GHG emissions, and energy savings achieved through energy efficiency projects.

9.2 Renewable-Energy Generation

Halifax Water has identified renewable energy as an important way of offsetting energy costs and increasing revenue that will help the utility to significantly reduce energy use and greenhouse gas emissions in the region.

To date, two key project areas have been identified: renewable energy and energy recovery from both water and wastewater systems.

9.2.1 Wind Energy

The Pockwock watershed comprises 5,661 hectares of land surrounding Pockwock Lake and has a significant wind profile. Through a land lease arrangement with Pockwock Wind GP, Ltd., five 2.0 MW wind turbines were installed in 2014 under the provincial COMFIT program, and began commercial operation in early 2015. On average, the wind farm is forecasted to produce approx. 34,000 MWh of energy each year (an amount equivalent to approx. 3,800 NS households) and reduce provincial GHG emissions by approx. 24,000 tonnes CO2e. The wind farm will continue to contribute significant revenues to Halifax Water, and revenues and GHG savings to the community at large over the 20 to 25 year life of the wind farm.

Other opportunities may be explored for additional small wind developments on Halifax Water owned lands, and will be pursued based on technical and financial viability.

9.2.2 Hydrokinetic Turbines

An opportunity has been identified to use inline turbines to recover energy from the water supply system in place of pressure-reducing valves (PRVs), widely used by water utilities to reduce pressure more suitable for downstream distribution systems. While PRVs release energy to reduce pressure, they do not perform any useful work with that energy. Inline hydrokinetic turbines can be used to reduce line pressure, and recover energy and convert it to electrical energy.

Halifax Water has investigated a number of potential projects for the installation of inline hydrokinetic turbines. Of the projects identified, the one located at the Orchard Control Chamber in Bedford was completed in the fall of 2014 under the provincial COMFIT program. The Orchard Energy Recovery Turbine has, on average, recovered over 235,000 kWh of energy each year, an amount equivalent to approx. 26 NS households, and reduced provincial GHG emissions by approx. 165 tonnes CO2e.

Halifax Water may explore other opportunities for additional energy recovery projects in the future, based on technical and financial viability.

9.3 Resource Recovery

Energy recovery from process or waste streams is recognized as one of the biggest opportunities available to society. Recoverable energy is everywhere – in solid municipal/residential waste streams, industrial by-products, and water and wastewater streams. Halifax Water has significant recoverable energy resources available in both its water and wastewater streams. Specifically, as noted in the previous section, inline hydrokinetic turbines can be used in place of pressure reducing valves (PRVs) to recover energy from water distribution systems. In the wastewater system, energy can be recovered from the waste sludge produced by wastewater treatment facilities, heat exchangers and highly efficient industrial heat pumps can be used to transfer energy from one system to another, energy can be supplied for heating or removed for cooling, and bio-gas can be produced to fuel a combined heat and power (CHP) system to generate electrical energy and heat from the combustion process that can then be used for treatment process or building heat.

Reducing the cost of wastewater collection and treatment has been an important issue and has been on the radar of most utilities. Over the years, the field of wastewater has seen a gradual progression with a focus changing from sewage treatment to water reclamation to resource recovery. Following best practices in the industry, utilities currently view wastewater as a valuable resource with several European utilities leading the industry. The four components of resource are being termed as BNEW; biosolids, nutrients, energy and water. From this resource, water can be reused to minimize impacts of exploiting new sources of supply. Nutrients, such as phosphorus, can be recovered in various forms for use in agricultural fertilizers. Energy from wastewater and biosolids, in the form of heat and electricity, can be extracted from organics to offset power demands of the facility. Halifax Water has been progressing several initiatives over the years on all four forms of resources available from wastewater. These efforts will continue in the future.

9.3.1 Biosolids Strategy

Halifax Water currently supplies over 35,000 tonnes per year of partially de-watered sewage sludge to its Aerotech Bio-Solids Processing Facility (BPF). Currently, this sludge is turned into a soil amendment that can be used as fertilizer for topsoil manufacturing, sod growing, horticulture, and land reclamation.

Energy recovery from biosolids is one of the most developed opportunities for treatment plants. This is commonly achieved through anaerobic digestion of wastewater sludge. Halifax Water's Mill Cove WWTF and Lakeside Timberlea WWTF are equipped with anaerobic digesters and the gas generated is utilized for digester operation and excess gas is used for space heating in the plants. The Mill Cove WWTF digesters were cleaned and refurbished in 2017; it is expected that the gas yield will increase as a result. The HHSP facilities and other small facilities have sludge dewatering equipment on site such that the biosolids are utilized as soil amendment for beneficial use. Halifax Water expects to continue this practice in the near future considering that the agricultural soil amendment program is very successful. There are several emerging technologies in the industry that show promise for alternative uses of biosolids for energy production; Halifax Water staff have been reviewing these technologies to exploit opportunities; however, it must be developed cognizant of the risk that are associated with the complex issue of biosolids management.

9.3.2 Wastewater Effluent Heat Recovery

The volume of wastewater effluent flowing out of wastewater treatment facilities is immense. The capacity of water to store energy in the form of heat is also immense, as noted in the table below. This combination presents a real and readily available resource for an efficient, cost-effective heat sync that can be used, at a minimum, to provide or remove energy to and from wastewater treatment facilities, or to the local community at large.

Table 3: Wastewater Effluent Heat-Recovery Potential

Facility	Annual Flow (m^3/yr.)	Available Power Capacity(1) (MW)
Halifax WWTF	36,825,000	59.7
Dartmouth WWTF	22,100,000	35.3
Herring Cove WWTF	4,630,000	7.4
Totals	**63,555,000**	**102.4**

Notes: Total available power based on an average effluent temperature of 12°C.
Based on 2013/14 usage and cost data.

Halifax Water has completed studies at the three Harbour Solutions plants to determine and understand the technical and financial challenges associated with these types of energy-recovery systems, and then implement the projects that make sense from an energy efficiency and financial perspective.

Cogswell District Energy System

A study was completed in 2016 to determine the feasibility and preliminary business case for an Ambient Temperature District Energy System [ATDES] within the Cogswell Redevelopment Area of downtown Halifax. The feasibility of the DES is predicated on the assumption that connection to the DES will be mandatory within the redevelopment area. To that end, HRM is pursuing amendments to its Charter through the Legislature in spring 2018 to facilitate this authorization. Work on the Cogswell ATDES continues with stakeholder consultation, and preliminary and detailed design work slated to be completed in early 2018, in conjunction with HRM's effort to advance the Cogswell Redevelopment project.

9.3.3 Bio-Gas Energy Optimization

Halifax Water's Mill Cove WWTF is a secondary treatment plant that utilizes a mesophilic anaerobic digestion process. Anaerobic digestion reduces sludge volumes and generates a significant amount of bio-gas in the form of methane that is burned to provide process heat to support the digestion process and space heating for facility buildings, thereby offsetting the use of conventional heating oil and the associated GHG emissions.

9.3.4 Water Reuse

The treated effluent in some of the wastewater treatment facilities has been used for internal plant use for several years primarily for the purposes of cleaning tanks, channels and equipment. On occasions, Halifax Water has been trying to maximize use of the treated effluent by using it for chemical and polymer mixing. With plant optimizations and effluent quality enhancements over the years, the use of effluent water has been increasing in the facilities and will continue into the future. Water reuse is given due consideration during the design of any upgrades or replacement of Halifax Water's WWTFs

10. CONTINUOUS IMPROVEMENT

10.1 Organizational Cultural Change

Halifax Water has approximately 470 employees, 3/4 of which are unionized under CUPE Locals 227 and 1431. Changing culture within a large organization takes time, but is often accelerated by new technology or societal events. Halifax Water will go through an accelerated period of change during the next five years, prompted by new technology, new business processes, new policies and turnover in key positions as a result of demographics and retirement. One advantage Halifax Water has as employer implementing change, is that turnover is low relative to other public sector organizations, and employee satisfaction is generally high.

In 2016 Halifax Water participated in a Workforce Management Planning Survey led by the Municipal Auditor General's Office. The survey results found that 87% surveyed believe the organization is a good place to work, and 94% feel engaged. The survey also identified some challenges from the perspective of employees.

Halifax Water has a succession plan in place for key positions, and has an approach to total compensation that supports attraction and retention of employees. Many initiatives are underway, or planned that will help maintain a positive culture within the organization and build resilience to respond to new challenges such as:

- Promoting a workplace that is respectful and civil for all employees, Civility and Respect in the Workplace training was carried out for all employees in 2016. A report was received in 2017 and a committee has been struck to develop and implement an action plan.
- Additional training for supervisors with respect to their responsibilities around safety, and their role in orienting new employees, return to work initiatives and the duty to accommodate.

- Continued roll out of a Health and Wellness program introduced in 2017and adoption of the Canadian Psychological Health and Safety Standards and initiatives to support mental health awareness.

10.2 Cost Containment

Halifax Water reports semi-annually to the HRWC Board, and annually to the NSUARB on the results of cost containment activities. The next cost containment report will be filed with the NSUARB by June 30, 2018. Some of these are on-going, and some are one time in nature. The containment initiatives from last year (2016/17) along with amounts of an ongoing nature from 2013/14 to 2015/16 inclusive reflect cost savings of $5.1 million. The inclusion of initiatives and amounts from prior years reflects an intentional focus on sustainable results over the long term.

Halifax Water continues to promote and develop a cost containment culture. As salaries and benefits are the largest element in the operating budget, the most significant opportunity identified is to improve workforce planning and the staffing process. Another area of opportunity is focusing on productivity through enhanced business processes and technology, performance management, and improving time and attendance tracking.

10.3 Advanced Metering Infrastructure (AMI)

Halifax Water began looking at the feasibility of Advanced metering Infrastructure (AMI) in 2012. AMI is a system whereby, in lieu of meter readers walking routes, or driving routes to read meters with radio devices (AMR) a network of radio devices is established over the service area to read meters on a much more frequent basis (typically hourly). Based on an initial positive business case, Halifax Water went to market in October, 2015 to purchase an AMI technology system. The Halifax Water Board approved adoption of AMI in principle subject to concluding a negotiation with an AMI vendor that results in a positive business case. Upon approval by the NSUARB in the fall of 2016, Halifax Water launched the Customer Connect project in December 2016.

Since the project was launched, AMI software was configured and installed, the AMI network design was completed and the network mostly installed, a stakeholder engagement program was launched, pilot deployments were successfully completed and the mass deployment phase was initiated in August of 2017. Mass deployment, whereby all premise meters are replaced or upgraded will continue until the fall of 2019. While mass deployment is ongoing, several other initiatives which are part of Customer Connect will continue including network installation, staff training, business process conversion and software installation.

In addition to streamlining the meter reading process and reducing its cost, Customer Connect promises many features that will improve the level of service Halifax Water can offer its customers. These include:

- The ability to offer monthly billing to residential and small commercial customers thus making it easier to for customers to manage cash flow and automated payments.
- Billing errors and estimated meter readings will be reduced.
- Capability to alert customers to high consumption due to plumbing leaks [almost as they happen], reducing billing disputes and high bill amounts.
- Customers will have the ability, through a web portal, to manage their water consumption in near real time and see the effect of any conservation measures they take. The web portal will provide access to information about their account and billing for all three services – water, wastewater and stormwater; and eventually customers will be able to receive and pay their bills on-line through this portal.

Development of the customer web portal will be an important indicator of the success of Customer Connect. The promise of the ability for customers to monitor their water usage online, has been an important part of maintaining customer support for the project. Web portal development is scheduled to be complete in 2019, based on the recently completed IT strategic plan.

Customer Connect will provide much more data about customer consumption and distribution system operations. This will enable more refinement of business processes for earlier identification of distribution system leaks. Overall it will improve the customer focus of the organization by providing the ability to identify and rectify customer issues proactively rather than after the fact upon the customer's receipt of a high bill. This will result in reduced costs for billing and collection and reduce the need for the high cost activity of sending technicians to customer homes.

10.4 Computerized Maintenance Management System (CMMS)

Halifax Water has successfully implemented a corporate CMMS utilizing the Cityworks software within Water Distribution and Wastewater/Stormwater Collections as well as within a select number of Treatment Facilities.

The next steps of the CMMS program will include both a continual improvement of the existing deployments and an expansion of Cityworks to additional business units.

The proposed continual improvement of Cityworks CMMS application will include:

- Review / assessment of current implementation of Cityworks, including assessment of Work Order Types, and Work Order Life Cycle looking for process inconsistencies, improvement opportunities.
- Analysis of information / reporting requirements to best communicate operational effectiveness statistics from Cityworks to Management.
- Enhanced integration with – Procurement, Skilled/Resources, Fleet Management, Non Moving Assets, Finance, GIS, Asset Management, Customer Experience, Work order/Resource routing through system interfaces or business process improvements.

The expansion of Cityworks CMMS to additional business units will include:

- Implementation of Cityworks for the Technical Services group to enhance their maintenance management practices and interactions with other areas already using Cityworks
- Continue Cityworks roll-out across all Water Supply Plant or Wastewater Treatment Facilities not completed in Deployment 3.
- Implement Cityworks Storeroom functionality for Facilities needing tighter control of consumables

10.5 Water Quality Master Plan

Halifax Water began developing its first Water Quality Master Plan [WQMP] in 2005 to assess its water quality program and to keep in front of the rapidly changing drinking water regulations. The initial WQMP established a road map towards more effective water quality management and staff determined at the time that a water quality research program was the most effective way to achieve the plan goals.

In 2006, Halifax Water executed a research agreement with Dr. Graham Gagnon of Dalhousie to execute the WQMP research. Subsequently, Dr. Gagnon applied to the Natural Sciences and Engineering Research Council [NSERC] for an Industrial Research Chair (IRC). Under the research chair, NSERC matches all funds provided to Dr. Gagnon by research chair partners, effectively doubling Halifax Water's investment.

In April 2017, Dr. Gagnon was awarded a third, five year research chair term and the chair has grown to include other partners including Cape Breton Regional Municipality, CBCL Limited consulting engineers and several water analysis technology companies, further multiplying the value of Halifax Water's investment.

Since its beginning in 2007, the IRC has created many benefits. Through our collective efforts, Dr. Gagnon and Halifax Water have emerged as leaders in North America on drinking water quality. Dr. Gagnon has trained many graduate students who have found employment, in some cases, at Halifax Water, and also in prominent roles in the drinking water sector.

Direct benefits of this Chair to Halifax Water include:

- Documentation for NSE that there was no public health benefit to install filter-to-waste at the JD Kline water supply plant, thus avoiding a $5 million capital cost and ongoing organizational risk. Halifax Water did improve public health as part of this process by adopting new filter washing practices at minimal cost.

- Halifax Water chose not to adopt chloramines as a secondary disinfectant, which was a preferred strategy for disinfection byproduct removal when research showed that chloramines would have adverse effects for lead levels in drinking water.

- Identifying the need to increase corrosion control levels, reducing lead levels in drinking water by 35%.

- Adoption of biofiltration at the JD Kline plant saving $40,000 per year in chlorine costs and reducing disinfection by-product levels by 40%. Longer term plans are in place to convert Lake Major to biofiltration.

- Determination that partial replacement of lead service lines was not protective of public health and possibly harmful. Halifax Water was one of the first utilities to take this stand in 2012, a position that is now commonly held in the water industry.

- Identified the phenomenon of lake recovery. This is a process where lakes are experiencing increasing pH as a result of the reduction of sulfur oxide emissions into the atmosphere. This process has negative consequences for water treatment and early discovery has led to a head start on planning treatment upgrades.

Halifax Water published its third WQMP in September 2017 and it was subsequently approved by the Halifax Water Board. The WQMP guides Halifax Water's WQ work and also guides the research chair. There are four themes in the current WQMP as follows:

1. **Understanding Lake Recovery:** As indicated above, lake recovery is a process whereby improved air quality and the reduction on acid rain is allowing lakes to recover to their previous state. Unfortunately, this process has resulted in increasing levels of total organic carbon (TOC) which is a critical treatment parameter and increasing levels of biotic activity in the lakes. The increasing levels of biotic activity are an explanation for the geosmin episodes experienced since 2012. Increasing levels of biotic activity are also a potential precursor to other taste and odour causing compounds as well as potentially harmful algal toxins such as microcystsin-LR. As well, the increasing levels of TOC are challenging the ability of the water supply plants

to operate efficiently and may eventually reach levels beyond what the plants were designed to deal with. Plant improvements will be required in the medium term and understanding how far the process of lake recovery will go is necessary to design the plant processes of the future.

2. **Adapting to Lake Recovery:** As indicated above, lake recovery is already impacting the treatment plants. While treated water quality still meets Halifax Water goals, the plants are more difficult and more expensive to operate. Short and medium term strategies and operating approaches are necessary to continue to produce high quality drinking water. This includes planning for a new intake for Lake Major to get access to more treatable and more consistent water quality as well as maximizing the utilization of biofiltration.

3. **Maintaining Distribution System Water Quality:** Maintaining water quality between the water treatment plant and the customer's tap is an important part of the multiple barrier approach to providing safe drinking water. Continuing our research into lead occurrence and corrosion control chemistry will remain a focal point. This theme will also explore maintaining water quality during emergencies such as water main breaks and continuing to optimize disinfection in the distribution system to maintain chlorine residuals while reducing disinfection by-products.

4. **Water Quality Data Mining:** Ten years of research and source water protection work has resulted in an immense resource of water quality data. New resources recruited as part of the Lead Service Line Program include a data analyst whose long term responsibility will be to work with water quality data sets to gain new insights into water quality issues and employ data analytics techniques for processes like distribution system water quality modelling.

Lead Service Line Replacement Program

One significant new program that has grown out of water quality master planning has been the adoption of a formal lead service line replacement program. Halifax Water has approximately 2,500 lead service lines remaining in the public right of way and up to 15,000 remaining on private property. Halifax Water has adopted a program intended to remove all lead service lines by 2050, consistent with the recommendation made to the USEPA by the National Drinking Water Advisory Council [NDWAC]. The program has the following five pillars:

1. **Replace all lead service lines by 2050**, both those owned by the utility and those owned by customers. A key part of this is working in partnership with customers to get the private side work done. It will also require a 3-4 times increase in our current level of lead service line replacements.

2. **Inventory:** Getting an accurate inventory of where lead service lines are, both public and private is key to working with customers and executing an effective program. Resources and new business process will be dedicated to building an accurate inventory of lead service lines.

3. **Customer communication:** The NDWAC recommendations require direct communication with customers who have a lead service line, a minimum of once every three years until the LSL is removed. Further, to encourage customers to replace LSL's, it will be necessary to provide more information on our web site and interactive tools to see what type of service they have. It will also be necessary to provide them more frequent and better information on the replacement process, how to access funding programs, how to hire a contractor and the health risks associated with LSL's.

4. Continuation of **customer sampling programs**. Sampling properly for lead detection is expensive and intrusive for the customer. It is important that Halifax Water continue to offer free lead sampling for at risk homeowners in order to engage them in the issue and provide public health information. Through our partnership with Dalhousie University we have been able to provide very cost effective lead sampling.

5. **Corrosion control:** Providing corrosion control treatment at the treatment plant is an important part of a comprehensive lead strategy. Effective corrosion control reduces lead levels where service lines exist and will continue to protect customers from lead found in solder and brass fixtures well after lead service lines are removed.

Halifax Water launched its new lead program on April 1, 2017. In August 2017, the NSUARB approved a program to enable Halifax Water to provide a 25% rebate for customers replacing a lead service line and to replace lead service lines that are disturbed during emergency repairs, at the utilities expense. This makes Halifax Water one of the first utilities in North America to take this step. Approximately 90% of customers who have had the public LSL removed will not remove the private service on their own initiative. To get customers to come along when we replace the public portion, it will be necessary to identify the barriers to lead service line replacement and assist customers who are stopped by those barriers. The ability for the utility to help customers overcome the financial barrier is important. To that end, Halifax Water has applied to the NSUARB to allow Halifax Water to offer customers a financing program for the balance of the replacement cost.

10.6 Wastewater Quality Master Plan

Halifax Water has consistently worked towards achieving the goals of the Compliance Plan that was developed in 2014. Building on the success and continuous improvement opportunities identified in the Water Quality Master Plan, it is prudent to develop a similar Wastewater Quality Master Plan [WWQMP]. The primary difference between a Compliance Plan and a WWQMP is that the former address the current issues and stays in compliance with the current legislation, while the latter is a forward thinking plan that addresses the utilities vision and considers future legislation that might impact the utility. Since the introduction of the Wastewater System Effluent Regulations, NS Environment has been reviewing and renewing Halifax Water's operating permits with steady increase in the compliance and reporting requirements. It is anticipated the wastewater regulations will continue to emerge rapidly over the next several years.

Halifax Water has been in active discussions with Dalhousie University to create a research partnership for the utility's wastewater initiatives. The Industrial Research Chair program is well established at Dalhousie University as a partnership with Halifax Water to support its water quality and treatment initiatives. Halifax Water anticipates entering into a formal agreement with Dalhousie in 2018/19 and begin the development of a WWQMP. At a very conceptual level, this plan will focus on current wastewater treatment and collection challenges, the defined issues of the future and emerging issues. The plan will focus on optimization of the HHSP WWTFs to be compliant with WSER well before the 2040 compliance timeline, biosolids management and resource recovery.

10.7 Wastewater Treatment Facilities Compliance Plan

The Regulatory Compliance division of Regulatory Services has established a tracking system to monitor trends of non-compliance and associated sources for all of the wastewater treatment facilities (WWTF). A working group has been established between Asset Management, Operations and Design Services staff to track and plan for the upgrades to maintain compliance with Provincial and Federal regulations. As of next year, all treatment facilities will be in compliance with WSER or have approval for operational variances consistent with the CCME Municipal Wastewater Effluent Strategy.

10.8 Environmental Management System Expansion

Halifax Water has an extensive history with an environmental management system [EMS] since certifying its first water supply plant at Pockwock Lake, in 2003, to ISO 14001, an international standard for environmental management systems. The benefit of implementing an EMS is that it drives a process of continual improvement towards meeting defined environmental goals and objectives. Minimizing environmental impacts becomes one of the defined primary goals, and standard processes are put in place to identify issues and direct improvements through documented standard operating procedures. The standard pertaining to Environmental Management Systems (EMS) is 14001- 2004 and requires an organization to:

1. Establish an environmental policy.
2. Identify environmental aspects that can impact the environment.
3. Identify our applicable legal requirements.
4. Set appropriate environmental objectives and targets.
5. Establish programs to implement our policy, achieve objectives and meet targets.
6. Periodically audit and review activities to ensure that the policy is complied with and the environmental management system remains appropriate.
7. Be capable of adapting to changing circumstances.

In 2016, Halifax Water obtained the ISO 14001-2004 Designation for the Herring Cove Wastewater Treatment facility expanding the previous scope of the Bennery, Pockwock and Lake Major water treatment facilities. The certification of the Herring Cove WWTF marked the first wastewater facility to obtain certification in Atlantic Canada.

In September 2015, ISO issued a new ISO 14001-2015 Standard and the EMS must be upgraded to be compliant with the new Standard by September 2018. The near term goal is to ensure the currently designated facilities meets the new standard by the specified date. To achieve this, EMS Awareness sessions on the new standard will be completed in November 2017 and an internal audit is scheduled for February 2018.

With the completion of this exercise, Halifax Water will work towards getting the remaining wastewater facilities certified, starting with Dartmouth in 2018. It is anticipated that all the major WWTFs will achieve the ISO Designation by 2020.

10.9 Wet Weather Management

Like many municipalities and utilities across North America, Halifax Water's sanitary sewer system is subject to dramatic flow increases in response to precipitation events. Wet weather flows can lead to sanitary sewer releases, sewer backups/basement flooding, increased operation and maintenance cost, treatment process upsets, and treatment facility effluent quality & capacity issues. Recognizing the impacts of wet weather generated flows on the system, Halifax Water developed a proactive program to systematically address the negative impacts of wet weather on the collection system and wastewater treatment processes. The Halifax Water wet weather management program (WWMP) developed a strategy to efficiently manage the impacts of wet weather generated flows within the sanitary sewer system, while monitoring and separating the combined sewer systems when practical to do so. The program is long term in nature and follows a phased implementation to meet the strategy.

Halifax Water maintains approximately 1,000 km of wastewater sewers, 300 km of combined sewers, 14 wastewater treatment facilities, and 172 wastewater pumping stations. Based on age, historical construction practices, maintenance, number of connections as well as other factors, there is significant opportunity for infiltration/inflow (I/I) to enter the wastewater system. The WWMP intends to systematically identify opportunities to employ wet weather management strategies to:

1. Volumetrically reduce the quantity of sanitary sewer that is collected, pumped, and treated.
2. Store the flow during the wet weather period and then treat this flow post when the system has capacity.

The WWMP intends to apply the most cost effective strategy to successfully manage the wet weather flow generated in each sewershed. At the macro level, wet weather management can be divided into three main categories:

1. Peak flow reduction
2. Peak flow attenuation, and
3. Capacity increase

For each sewershed, the WWMP implements the most cost effective strategy to manage the wet weather generated flows. Where possible, all three strategies are employed based on cost benefit analysis and the primary driver for flow reduction with regulatory compliance being the high priority.

I/I sources can be grouped into two contributing areas: Public Infrastructure (Mains, manholes, laterals up to the property line, etc.) and Private Infrastructure (laterals from property line up to and including connections within buildings). There are a number of challenges when dealing with either of the primary contributing areas and specific strategies must be employed. The program employs a variety of strategies to reduce wet weather impacts such as pipe condition assessments, cured in place pipe (CIPP) rehabilitation, sewer separation, flow monitoring, illegal connection investigations, public communications, and modeling. To effectively address all the issues that contribute to the wet weather problem within the sewershed, resources from multiple business units within Halifax Water are required to work together to satisfy the goals of the program. Figure 2 indicates the working relationships between the contributing business activities.

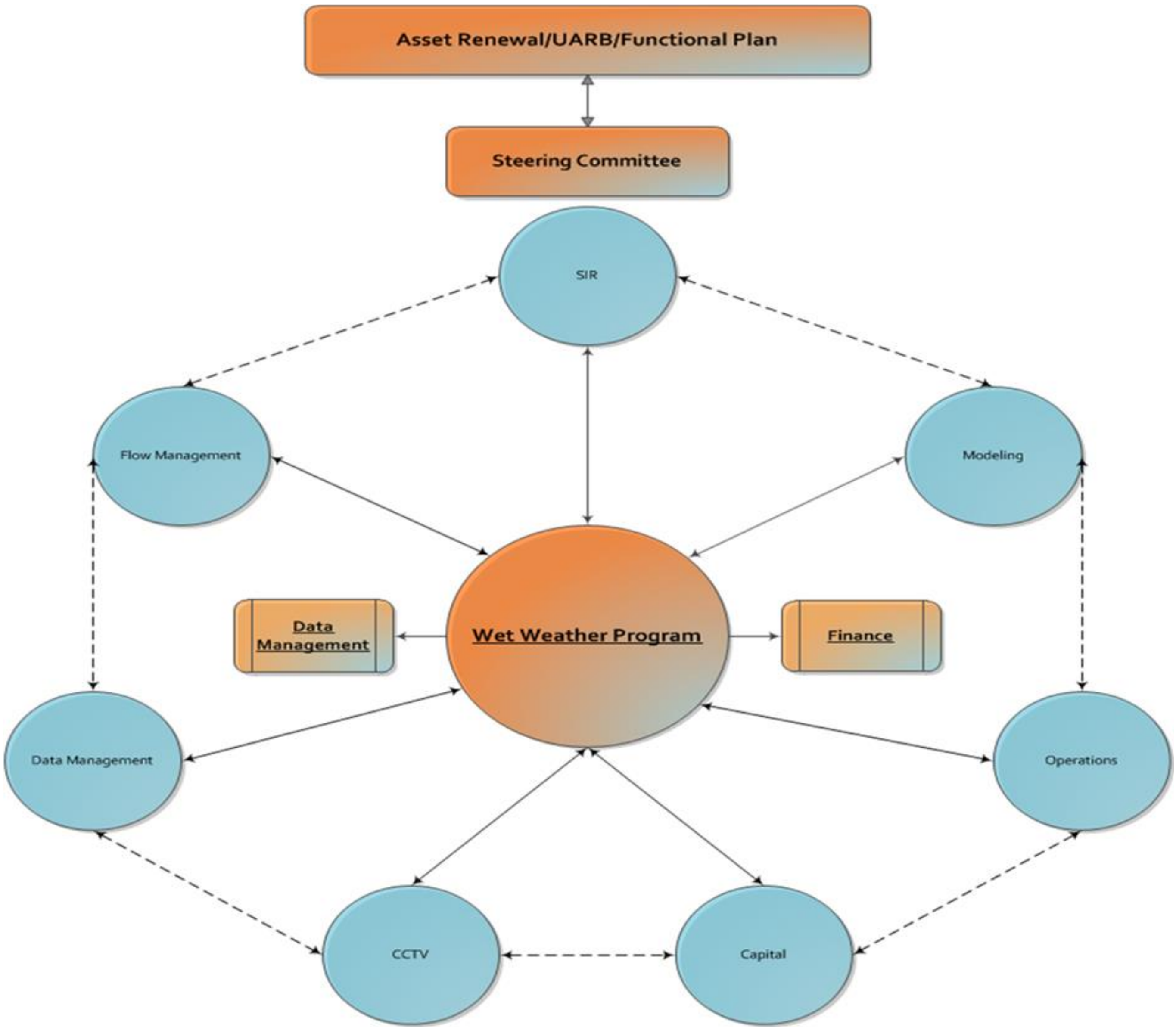


Figure 2: Contributing Business Activities of Wet Weather Management

The benefits of reducing the volumetric wet weather flow include a reduction in untreated discharges to the environment, reduction of effluent excursions at WWTFs, reduction in O&M costs, and an increase in available system capacity.

Halifax Water's WWMP is structured to gain location specific information with respect to various wet weather management techniques. Once sufficient data has been collected and analyzed, staff apply that knowledge to make the most cost effective recommendation to manage wet weather flows for each sewershed. A phased approach is being followed to implement this strategy. While the program phasing is prescriptive; it is important to revisit the objectives of the program periodically and adjust where necessary.

- **Phase I:** The initial phase of the WWMP involved initiation of the program and its structure. It was realized early that there is no "one size fits all" solution to wet weather management and the program needed to reflect this when implementing strategies. The initial program organizational structure was comprised of a wet weather steering committee and a wet weather action committee. This structure has been revisited in the last year to ensure that key contributors to the program are engaged.

- **Phase II:** Phase II of the program required identifying individual sewersheds that demonstrated a need for wet weather management. There was limited flow information available to make informed prioritization decisions within the service boundary. In the absence of measured flow information, pump station run time information was used as a surrogate for flow data. The entire service boundary was characterized using existing flow information and pump run time data.

- **Phase III:** Pilot sewersheds were identified from the prioritization matrix from phase II. The pilots were selected strategically so that specific wet weather management techniques could be assessed. Pre and post project flows are being analyzed and compared in the individual sewersheds and a cost benefit analysis will be conducted on the projects with respect to wet weather flow reductions. This pilot program is intended to gather sound information on the costs of various wet weather management techniques and the possible impact they can have on the flow response to wet weather.

- **Phase IV:** As information from phase III is matured it will be applied to the service boundary to recommend and implement wet weather management projects in specific sewersheds. This will allow Halifax Water to implement the most cost effective strategies to manage Halifax Waters wet weather flows. Since the initiation of the program; 205 sewersheds have been identified with varying degrees of impacts from wet weather events.

In the absence of historical flow data for individual sewersheds, the WWMP utilized the available SCADA records for operation of the 172 sanitary pumping stations within the service boundary. This approach enabled a comprehensive review of all pumping station and wastewater treatment facility sewersheds based primarily on Rainfall Derived Inflow and Infiltration (RDII) analysis. RDII directly represents the extraneous flows entering a collection system resulting from wet weather events.

Recognizing the importance of flow monitoring and infrastructure condition assessment, Halifax Water enhanced service delivery of the flow monitoring and CCTV programs. Both programs have performance based contracts to ensure accurate, defendable, and dependable data delivery to the industry standard.

The methodology used to systematically prioritize Halifax Water's 172 pumping station areas as they respond to RDII was to compare a station's average day to its wet days and calculate its peaking factor. The peaking factor used for this level of evaluation is the ratio of the maximum flow rate to the average daily flow rate. This concept has long been used as an indicator of the magnitude of response to rainfall inflow and groundwater infiltration entering the wastewater collection system. A high peaking factor indicates severe wet weather influences while a low peaking factor would indicate minimal wet weather impacts.

This effort reviewed all existing data to support objective ranking of all sewersheds, regardless of whether separated or combined system, and removed any anecdotal evaluations of rainfall response. To accomplish this, a single spreadsheet, listing all facility sewershed areas, was developed with quantitative data populated per area. Gathering all data into a single tabular format allows for flexible data analysis to aid in strategic decision making.

While RDII evaluation was the primary ranking factor, three other indicators were used to further refine the ranking:

1. Regulatory constrained sites: either an identified overflow site or a wastewater treatment facility with non-compliant effluent discharge or both.

2. Known wet weather sites that require significant operations effort to maintain regulatory compliance.

3. Separated & combined systems: separated ranked higher than combined sites since combined sites are designed to carry wet weather flows and provide primary level of treatment prior to discharge into a marine environment per the operating permit.

The result is a prioritized list with separated systems that experience regulatory challenges due to wet weather impacts. Figure 3 below indicates the sewershed priorities within the service boundary as indicated by the heat map.

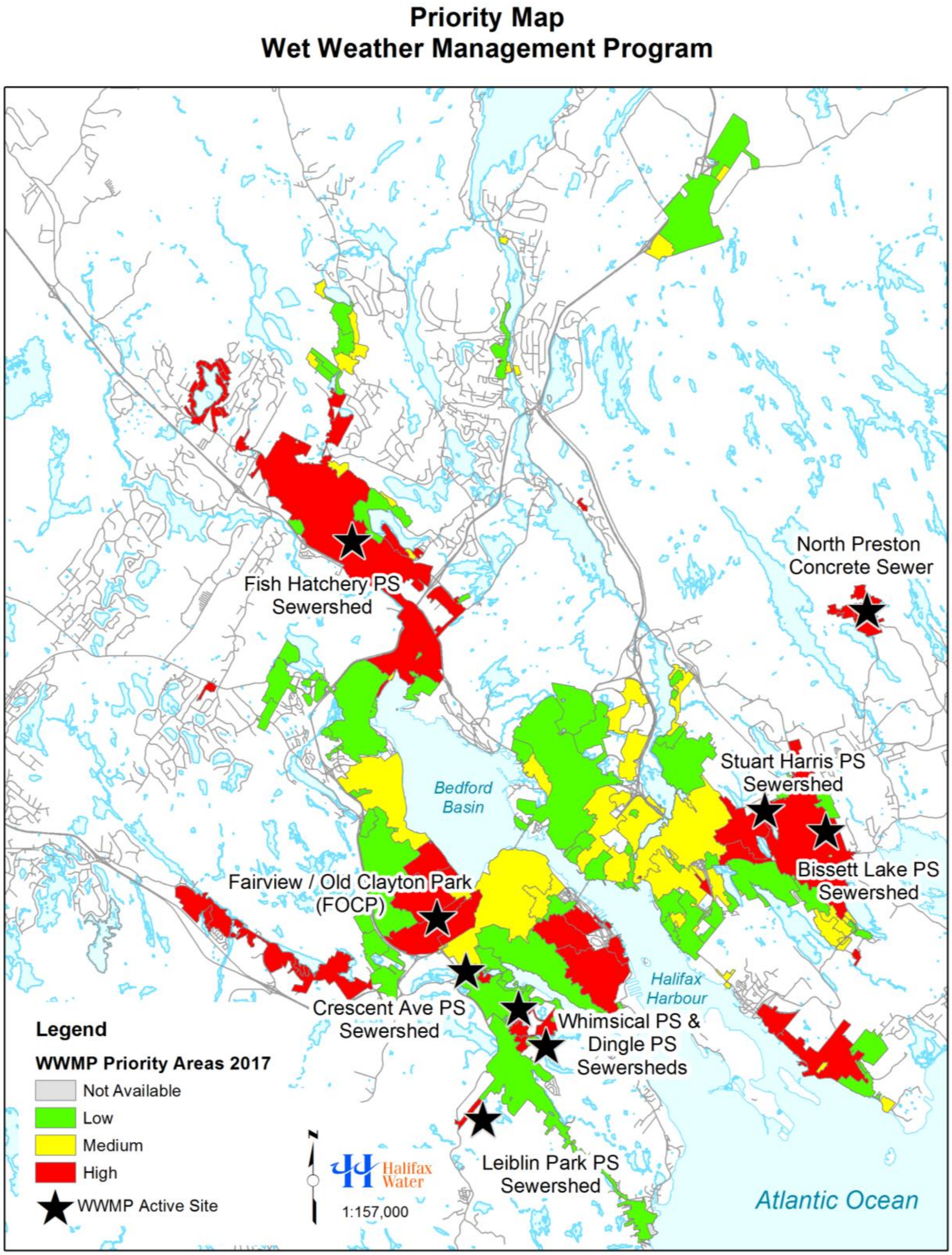


Figure 3: WWMP Sewershed Priority Map

In most cases, more information was required to support strategic decision making. The WWMP considered more evaluation criteria to differentiate sites based on more detailed wet weather indicators. Data subcategories allow for further refinement to the prioritization matrix and generally include:

1. Age of install, pipe diameter, pipe material,
2. Availability of deep storm connection,
3. # of SSOs per year,
4. Anecdotal wet weather commentary from operations, and
5. Near-term planned development.

In the absence of flow data for each pumping station, as mentioned above, it was determined that pump runtimes could be used as a surrogate for flow data to calculate each station's peaking factor.

The pumping stations' runtime graph effectively shows how the station responds and operates during normal daily flow conditions. Analysis during rain events showed a very different response for stations impacted by RDII.

Halifax Water's WWMP is currently running 5 pilot projects: Stuart Harris Sewershed, Cow Bay Rd, Leiblin Park, North Preston, and Crescent Ave. These pilot basins were chosen strategically to enable Halifax Water to validate what RDII reduction can be accomplished via various I/I reduction strategies. Industry indicates that approximately 50% of RDII is generated from public infrastructure and 50% is generated from private infrastructure. Specific strategies must be employed to each portion of the sewershed to address RDII globally in the catchment. Halifax Water intends to validate these statements through review of the flow data from the pilot projects. It is expected that the pilots will support the notion that comprehensive rehabilitation on both the public and private portion will be required to significantly reduce I/I, however in some cases public side pipe rehabilitation may be sufficient to achieve the desired targets.

RDII analysis has been conducted on pre and post activity for each pilot. Figure 4 below illustrates the reduction in RDII peak flow rate for the Crescent Ave pilot project. This particular pilot underwent a three phase rehabilitation:

1. Mainline renewal;
2. Lateral Renewal; and
3. Manhole Renewal.

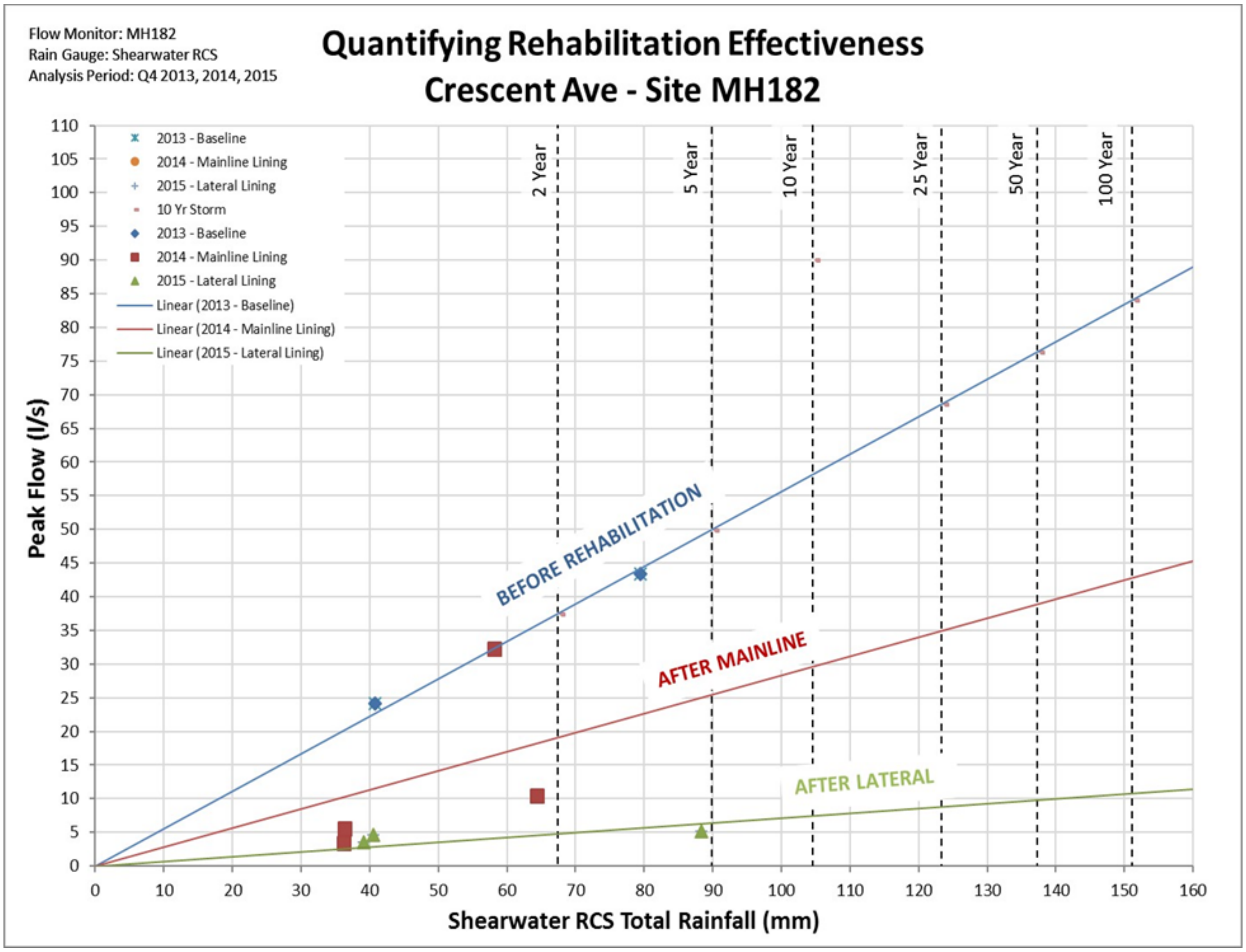


Figure 4: Crescent Ave Pilot Project RDII Peak Flow Reduction by Rehabilitation Phase

Phase IV of the WWMP involves applying a cost benefit analysis of the various strategies to manage Halifax Water's wet weather flows throughout the entire service boundary. As expected, the pilot sewersheds are demonstrating a measured reduction in RDII as the various wet weather management strategies are implemented. The financial cost of the RDII reduction will be normalized so that the information can be applied to the entire service boundary and compared to more traditional approaches to wet weather management such as capacity increase and storage. In order to complete the cost benefit analysis, it is important that the correct information is collected and assessed during the pilot stage. Information to support the cost benefit analysis will be assessed for each pilot as information becomes available. This information was assessed for all pilot programs to date and is presented in Table 4 below.

Table 4: Pilot Program Summary of Flow Reduction and Costs

	Quarter		24 hr - 10 Yr Storm Return		Unit Reduction		Costs		
Projects (CIPP Renew)	ADF Reduction m^3/day	ADF Reduction (%)	Peak Flow Reduction l/s	Peak Reduction (%)	m^3 of ADF Reduced per m of pipe	l/s of Peak Flow Reduced per m of pipe	Capital Expenditure ($)	Cost / ADF Reduction	Cost / Peak Reduction
Crescent Ave Pumping Station									
2014 Mainline (MH182 Crescent)	129	-30%	29	-49%	0.37	0.08	$ 275,385	$ 2,135	$ 9,647
2014 Mainline (MH174 Alderwood)	141	-75%	39	-86%	0.70	0.19	$ 159,251	$ 1,129	$ 4,136
2015 Laterals (MH182 Crescent)	29	-10%	20	-69%	1.04	0.73	$ 438,767	$ 15,130	$ 21,478
2015 Laterals (MH174 Alderwood)	24	-52%	-2	34%	1.85	-0.16	$ 203,713	$ 8,460	$ (97,867)
Comprehensive Rehab (MH182)	158	-37%	49	-84%			$ 714,151	$ 4,520	$ 14,582
Comprehensive Rehab (MH174)	165	-88%	36	-82%			$ 362,964	$ 2,198	$ 9,966
Stuart Harris PS Pilot Project									
2015 Mainline	19	-20%	21	-61%	0.02	0.02	$ 286,482	$ 15,078	$ 13,763
Leiblin Dr PS Pilot Project									
2016 Mainline	65	-15%	40	-23%	0.03	0.02	$ 507,228	$ 7,858	$ 12,668
North Preston - concrete sewer									
2016 Mainline	13	-2%	27	-24%	0.02	0.04	$ 177,113	$ 13,767	$ 6,512
Rosebank Ave - combined system									
2016 Mainline	-68	56%	-4	5%	-0.19	-0.01	$ 98,402	$ (1,441)	$ (25,396)

The information in this table has been compiled over the first three years of the formalized WWMP at Halifax Water. The program is structured to evaluate all wet weather activities using the same methodology. This effectively builds the knowledge base of wet weather management to enable Halifax Water to employ the most cost effective strategy to each sub area of the service boundary.

Practical application of this dataset is the goal of the program. To that end, information on expected I/I removal and reduction rates can be made on future projects using the knowledge gained from previous projects.

The West Region Wastewater infrastructure Plan (WRWIP - finalized 2017) identified a number of predefined projects that are essential to the regional infrastructure plan. One of the identified projects was a wet weather management project in the Fairview/Old Clayton Park (FOCP) area. The project scope includes the removal of approximately 200 liters per second of wet weather generated flow. This project was formally initiated by the WWMP in the summer of 2017 with a 10 year implementation deadline to support the regional infrastructure plan. In year one, the WWMP has installed the flow monitoring required to measure the impact of the project which will be used to validate success. CCTV inspection of half of the project area is complete. Future years will see the completion of the sanitary sewershed evaluation study that will finalize the detailed execution of the project. The near term project objectives include strategy evalutation, selection and implementaiotn of preferred solution, and execution by 2022. Flow monitoring and wet weather analysis will continue for the duration of the project to validate efforts. This timeline will allow for alternative strategies in the event that the program objective of 200 LPS peak flow is not realized in the first field execution.

The Asset Management team will be completing a Wastewater Regional Infrastructure Plan in the East and Central regions with expected completion in 2018. The WWMP will work with the project team in strategy selection for management of wet weather flows. It is anticipated that wet weather flow managemnt will be a part of the overall wastewater strategy for the region.

In addition to supporting the asset management program, the WWMP is methdoically working through the prioritization matrix and identifying areas that can be improved in the most cost effective manner. This effort will expand over the next five years and will identify and implement projects as well as increase the base dataset that is used in decision making for wet weather management at Halifax Water.

The planned WWMP activities for the next five years are listed in Table 2 (WWMP Preliminary 5 Year Plan) below. Note that year 1 and 2 activiiteis are firm plans and are unlikely to change wihtout significant unpredicted influences. The activies identfied in years 3-5 are subject to change as information is gathered and reviewed.

Table 5: WWMP Preliminary 5 Year Plan

2018/19	Refresh Prioritization Matrix
	SSES Activity (CCTV & Flow Monitoring)
	Central Region: Fish Hatchery Park PS Sewershed - SSES
	East Region: Bissett Lake PS Sewershed - SSES
	West Region: Dingle PS & Whimsical PS Sewersheds - SSES
	Rehabilitation: Capital Projects
	West Region: FOCP - Mainline
	Pilot Project: Stuart Harris PS - Lateral

2019/20	Refresh Prioritization Matrix
	SSES Activity (CCTV & Flow Monitoring)
	Central Region: Fish Hatchery Park PS Sewershed- SSES cont'd
	East Region: Bissett Lake PS Sewershed - SSES cont'd
	West Region: Dingle PS & Whimsical PS Sewershed - SSES cont'd
	Rehabilitation: Capital Projects
	West Region: FOCP - Mainline Cont'd
	West Region: Crescent Ave PS Sewershed - Mainline
	Pilot Project: Leiblin Park PS Sewershed - Lateral

2020/21*	Refresh Prioritization Matrix
	SSES Activity (CCTV & Flow Monitoring)
	Central Region: Fish Hatchery Park PS Sewershed- SSES cont'd
	Central & East Regional Infrastructure Plan - SSES
	West Region: Pending Prioritization Matrix Refresh
	Rehabilitation: Capital Projects
	West Region: FOCP - Mainline Cont'd
	Pilot Project: North Preston Concrete Sewer - Lateral
	Mainline: Pending SSES outcomes

2021/22*	Refresh Prioritization Matrix
	SSES Activity (CCTV & Flow Monitoring)
	Central & East Regional Infrastructure Plan - SSES cont'd
	West Region: Pending Prioritization Matrix Refresh
	Rehabilitation: Capital Projects
	West Region: FOCP - Mainline Cont'd
	Mainline: Pending SSES outcomes

2022/23*	Refresh Prioritization Matrix
	SSES Activity (CCTV & Flow Monitoring)
	Central & East Regional Infrastructure Plan - SSES cont'd
	West Region: Pending Prioritization Matrix Refresh
	Rehabilitation: Capital Projects
	West Region: FOCP - Mainline Cont'd
	West Region: FOCP - Lateral
	Mainline: Pending SSES outcomes

**Subject to change due to data review supporting refresh of prioritization matrix*

10.10 National Water and Wastewater Benchmarking Initiative (NWWBI)

The Nova Scotia Utility and Review Board approved Halifax Water participation in the Canadian National Water and Wastewater Benchmarking Initiative (NWWBI) as a recommendation from a previous rate review process. The Canadian NWWBI was started in 1998 and has since grown to 55 member municipalities and utilities participating in water, wastewater and stormwater benchmarking. The participating group is comprised largely of progressive utilities and municipalities that leverage benchmarking to assist decision making in business processes.

The success of the initiative comes from how data is collected to ensure quality. To guarantee that data is collected on a like-for-like basis between utilities, significant effort is placed on the definition of each performance measure and the data items that are collected. Halifax Water has participated in the initiative since 2014 and has been refining the data collection process in that time.

Initial data collection efforts in the first three years of participation were challenging and NWWBI consultants cautioned Halifax Water that initial years would require extra effort around data collection. The effort was front loaded and entering the fourth year of data collection, Halifax Water has a more streamlined approach to data collection.

Halifax Water's operations departments are divided amongst three sub geographical areas: East Region, Central Region, and West Region. Involvement in NWWBI was strategically arranged to collect data across the three sub service areas as discrete datasets. This approach permits benchmarking at the national level as well as across service regions. As the datasets mature, optimization across service boundaries can increase efficiencies at the local level.

While Halifax Water participation in NWWBI is relatively new, internal data collection procedures have matured quickly and will continue to streamline as Cityworks is implemented across the service areas. The results of the annual surveys reveal industry trends and identify individual diversions from normal. Halifax Water then dissects the trends and diversions to identify areas of improvement within the business. Initial results of Halifax Water's participation in NWWBI indicate that Halifax Water is not an outlier in any particular business area that data is collected and compared.

10.11 Succession Planning

Halifax Water has a succession plan for key positions, and in 2017, commenced a review of the existing succession planning process to tailor it for demographic and technological changes. It is going to become increasingly important since, as at last count, 100 employees could retire in the next 5 years, representing 22% of the workforce. The next phase of succession planning will cascade plans to deeper levels within the organization and will involve more interaction with employees. Succession planning, if done badly, can damage morale and employee engagement. If done well, it can positively impact employee engagement. By the end of the period covered by the Five Year Business Plan, individual professional development plans and training programs will be tailored to support succession planning.

11. CLIMATE CHANGE

Climate change has been a documented global phenomenon for a number of years. Climate data indicate a warming progression since the beginning of the industrial era. The Intergovernmental Panel on Climate Change forecasts continued warming with global increases of between 2-4 degrees Celsius or more by the end of this century. Changes will be gradual, progressive, and will impact communities and natural systems well before the end of the century. Climate change may have a number of effects on the water cycle and natural water systems, with resulting impacts on water, wastewater and stormwater operations and infrastructure.

Climate change effects may include greater weather variability (more extreme wet-weather events and more dry-weather periods), greater intensity of precipitation during extreme events, greater risk of hurricanes in the Maritimes, increased stormwater runoff, increased risk of flooding and sea level rise up to 1 metre by 2100, decreased water supplies during dry weather, and ecological changes from nuisance or disease-causing organisms. As a consequence, the impact to utilities may include increased stormwater flows during extreme events, increased risk of erosion, increased flows during snow melt events, increased flows within combined systems during extreme events (increased risk of inflow/infiltration and overflows for wastewater systems), increased water demand and storage requirements during dry summer weather, increased uncertainty regarding water supply, reservoir replenishment and groundwater recharge due to uncertainty of local annual precipitation patterns, increased risk of power failures during extreme weather events, and infrastructure impacts due to sea-level rise.

These effects and impacts of climate change will require that water/wastewater /stormwater utilities be proactive in planning for contingencies and emergencies. The Regional Infrastructure Plan, referenced in Section 7 includes a task on Climate Change Assessment and Policy. This task involves developing a work plan for Halifax Water to identify how to adapt to future climate change. The first part of the assignment will be to conduct an industry scan of what other municipalities and water/wastewater/stormwater utilities are doing in this area.

Using the findings of the industry scan, a work plan is to be developed for a "Vulnerability to Climate Change" asset assessment framework. The work plan (to be developed in consultation with Halifax Water staff through workshops) will include identifying the priority for assessing assets within each infrastructure area (water/ wastewater/stormwater), and the critical factors to be used for assessing each asset class.

The "Vulnerability to Climate Change" framework will also develop a simple rating system to rank the sensitivity and severity of climate change impacts relative to the individual asset. The framework will also suggest a workflow for how an assessed asset progresses from the assessment stage to the stage where an adaption plan has been implemented for that asset.

This component of the Regional Infrastructure Plan will require the development of a separate policy paper addressing climate change as it relates to Design Standards and Long Term Planning. It will review the current "Design Specification for Water, Wastewater & Stormwater Systems" and suggest changes to address future climate change. The policy paper task will also include a review of Halifax Water's Long Term Planning Framework and make suggestions to how Halifax Water should account for future climate change in the development of this and future Regional Infrastructure Plans. In the meantime, Halifax Water's infrastructure design protocol gives consideration for best available information on future sea level rise (including surge) and rainfall intensity/duration/frequency for the design of assets impacted by rainfall and/or sea level issues.

12. SAFETY & SECURITY

12.1 Occupational Health & Safety Programs

Halifax Water's Occupational Health and Safety Program is based on the Internal Responsibility System (IRS), which is the foundation of the Nova Scotia Occupational Health and Safety Act. The IRS is an internal system that provides for direct responsibility for health and safety for all staff in an organization.

The Safety and Security Division of Regulatory Services has principal duties and responsibilities as part of the IRS as follows:

- Assist in formulating and supervising the execution of the utility's Occupational Health and Safety Program, and assist management to fulfill, to the greatest degree possible, its responsibilities for safety.
- Co-ordinate and/or provide safety training to staff in an effort to prevent accidents, minimize losses, increase productivity and efficiency, and ensure compliance with safety legislation and policies.
- Conduct safety audits in the workplace to identify safety hazards and recommend control measures.
- Assist in the development and maintenance of a system of accident investigation, reporting, and follow-up.
- Provide program education for job safety.
- Act as a resource to the Joint Occupational Health and Safety Committee (JOHSC).
- Maintain liaison with federal, provincial, and local safety organizations by taking part in the activities and services of these groups.

Halifax Water has established and maintains an Occupational Health and Safety Program in consultation with the Joint Occupational Health and Safety Committees.

In November 2015, Halifax Water engaged in the ***Preventing Workplace Injury (PWI)*** Program with the Workers Compensation Board. An initial survey was conducted, with 247 employees participating. The survey was designed to gauge individual's perceptions on the current safety culture at Halifax Water and the awareness and understanding of safety policies and practices.
After the completion of the survey a committee known as the Team of Doers was established in February of 2016.

The Team of Doers met monthly for 18 months to review the outcomes of the survey and develop strategies to enhance the safety culture and awareness throughout Halifax Water.
One of the first objectives of the team was to establish a Vision to provide direction on the activities for the Team.

Working together for an injury free and healthy workplace through empowering employees for positive change, so we will all return home safely.

The Team proceeded to review the results of the November 2015 survey to get a sense of some of the issues and perceptions surrounding Halifax Water's safety culture. Some of the common themes related to communications of safety issues, lack of formalized follow ups and understanding of safety and the related human resource policies.

The follow-up survey will be completed in November 2017. The outcomes from the survey will assist in planning future initiatives improve the safety culture at Halifax Water.

Technical Services has taken the lead in developing an ***Electrical Safety Plan (ESP)*** to enhance the current OH&S Manual. The ESP will provide staff with the tools for establishing safe operating and maintenance practices and procedures for working with energized electrical equipment and systems that are low or high voltage. Using the ESP, staff can develop risk and hazard assessment forms to complete when undertaking work around energized equipment. As well, the appropriate job-specific training requirements can be created and the existing training matrix, managed by Human Resources, can be updated. The Plan will be completed and rolled out in 2018.

The updates to the ***Safety Site*** will be completed by the end of 2017 with suggested enhancements to the electronic forms. Feedback with continue to be received from staff and updates will be made to the OH&S manual and associated forms as required.

In 2019, to assist with the management of the safety program, it is proposed to implement an ***ISO 45001***, International Standard that specifies requirements for an occupational health and safety (OH&S) management system, with guidance for its use, to enable an organization to proactively improve its OH&S performance in preventing injury and ill-health.

12.2 Corporate Security Program

Halifax Water's Security Program is based on enterprise assets protection and is designed to protect three types of assets: people, property, and information. It also considers intangible assets such as the organization's reputation, relationships, and creditworthiness. The program has been developed to take an all-hazards approach, be it from natural, intentional, or accidental hazards, when reviewing risks to the organization.

Halifax Water uses the three basic elements of a physical security system to protect its assets.

> ***Protection:*** The protection element is the physical barrier that delays the determined adversary and the opportunist in accomplishing their goals. Halifax Water uses barriers such as building fabric, fences, doors, door hardware, and containers to protect its assets.
>
> ***Detection:*** The detection element indicates and may also verify an actual or attempted overt or covert penetration. Halifax Water uses intrusion alarms, access control systems, CCTV, and patrols to protect its assets.
>
> ***Response:*** This element is the reaction to an attempted or actual penetration. Halifax Water works closely with local and national police and security agencies to ensure a rapid response to events.

Emergency Management Planning

Safe and reliable drinking water, sanitation and environmental protection are vital to the sustainability of communities within Halifax Regional Municipality. In recognition of this, Halifax Water maintains an Emergency Management Plan (EMP), as required by the provincial Emergency Management Act.

The purpose of the EMP is to establish an organizational structure and procedures for response to water and wastewater/stormwater incidents. It assigns roles and responsibilities for the activation and implementation of the plan during an emergency, using the Incident Command System (ICS). The preparation and exercising of an EMP can save lives, reduce risk to public health, enhance system security, minimize property damage, and lessen liability.

Starting in 2017, HRM will be developing a response plan to extreme flooding events. Halifax Water will assist in the development of the plan, providing information on critical infrastructure, known drainage restrictions and flood prone areas.

13. BUSINESS RISKS & MITIGATION STRATEGIES

13.1 Declining Water Consumption

HRWC has experienced net metered consumption decreases of 2.2% per year on average, over the past fifteen years, as indicated in Figure 1 in Section 7.2. The total decrease since 2001/02 is a 22% reduction, which has been managed through changing rate structures, diversifying revenues (stormwater with a different billing determinant), controlling costs, and increasing rates. Timing of development, form of development and new customer growth is difficult to predict, and the net decrease in consumption last fiscal year (2016/17), and so far in 2017/18 is less than recent previous years and less than the historic average. Water consumption is sensitive to a combination of factors including development activity, customer growth, weather, and economic pricing signals. The Five Year Business Plan assumes reductions in consumption of 2.5% per year, which is less than the yearly reduction assumed in the last rate hearing, and less than the Rolling Historic 4 Year Average Decrease of 3.4%. Halifax Water manages the risk of decreasing consumption by making prudent assumptions when preparing budgets and financial models.

13.2 Nova Scotia Environment (NSE) Regulatory Compliance

Wastewater

Since the last Five Year Business Plan was completed, a number of upgrades, optimizations, system enhancements and one decommissioning has occurred to achieve compliance with the WSER for all WTTFs.

Halifax Water meets and communicates regularly with NSE staff, with the objective of achieving consensus on priorities. Regulatory compliance plans are being updated on a continual basis through consultation with NSE.

Funding of capital improvements for a number of the wastewater treatment facilities has already been approved, or are in process in the Five-Year Capital Budget, namely:

- Aerotech upgrade and expansion will be commissioning in early20118,
- Belmont decommissioning has been completed in 2017,
- Beechville-Lakeside-Timberlea is piloting improvements to disinfection and is undergoing further optimization.
- Springfield Lake, recently converted from Chlorine disinfection to UV disinfection and is subject to wet weather influences. The WWMP and I/I reduction Program are targeting this system to reduce the wet weather influences.

- Uplands, is undergoing further optimizations and is subject to wet weather influences. The WWMP and I/I reduction Program are targeting this system to reduce the wet weather influences.

Given the success for the two seasonal disinfection pilot programs, applications were submitted in August 2017 to modify the permits for Eastern Passage, Dartmouth, Halifax and Herring Cove WWTF to allow for permanent seasonal disinfection at each facility. Halifax Water received approval from NS Environment for these facilities in late November, 2017.

Amendment requests have also been approved to allow for flexibility in the management of sludge and septage within the systems listed above, and at Mill Cove and Aerotech. This request will enable operators to direct the sludge or septage to the facility that can better manage it on that particular day.

Water

The Approvals for the water treatment facilities expire in March of 2018. Renewal applications have been submitted to NSE at the end of 2017.

The Bennery Lake withdrawal permit requires options for the continued supply of water to the Airport and Aerotech areas be established. A master plan will be completed in 2018 to review alternatives to the continued use of Bennery Lake.

Halifax Water staff have also been engaged in the review of proposed changes to Health Canada Guidelines relating to Lead and Manganese.

System Assessments

Halifax Water is committed to supplying safe and clean water, and effective wastewater collection and treatment. In support of these goals, Halifax Water undertakes assessments of all water and wastewater systems, in conformance with NSE regulations.

It is a regulatory requirement that Water System Assessments be completed every ten years with the latest reports for all water systems submitted to NSE in 2013, except for Bomont, which was prepared in 2015. Assessments of municipal drinking water systems are conducted to evaluate the capability of the system to consistently and reliably deliver an adequate quantity of safe drinking water; to verify compliance with regulatory requirements; and provide preliminary costs and timelines to address any identified deficiencies and/or concerns. Corrective Action Plans are in place where required by NSE, as follow-up to the Water System Assessments.

Wastewater System Assessments (similar to water system assessments) are currently not a regulatory requirement. However, Halifax Water regularly reports to NSE on the performance of some components of the wastewater system for conformance with regulatory requirements. Additionally, Halifax Water conducts wet weather flow studies on parts of the wastewater system. These studies are similar to system assessments, but are not as comprehensive.

13.3 WSER Regulations

On February 14, 2009, the Canadian Council of Ministers of the Environment (CCME) adopted a national strategy for the management of municipal wastewater. The strategy advocates a risk-based approach to management of wastewater effluent whereby requirements are based on environmental and health-risk assessments that are to be carried out for all treatment facilities. However, the strategy also includes a prescriptive approach with a requirement for a uniform minimum standard for all effluent equivalent to secondary treatment. Halifax Water's inland treatment facilities that discharge to fresh water already provide secondary or better treatment, as does the Mill Cove facility in Bedford and the Eastern Passage facility. However, the three Halifax Harbour Solutions Project (HHSP) facilities are advanced-primary. Upgrading to secondary level is required for the HHSP facilities under the WSER, with estimated capital costs in the order of $425 M. As outlined in Section 5 of this Business Plan (Wastewater System Effluent Regulations), the upgrade deadlines could be up to 30 years for Halifax and Dartmouth WWTFs under Transitional Authorizations sought under the WSER, due to high-risk CSOs. The Herring Cove WWTF currently is able to meet the WSER discharge limits since it is well under capacity, although it was designed as an advanced-primary facility. As growth in the Herring Cove sewershed brings the facility closer to its rated capacity, effluent quality may come closer to exceeding WSER limits. In this case, advance planning for an upgrade will be required so that the facility remains compliant.

A more immediate operational/regulatory issue with Halifax Water's wastewater system is wet weather flow and resultant overflows into the environment as detailed in Section 8.5. Many of the sewers in the municipality are combined, built many decades ago with many greater than 100 years in age. Combined sewers have not been permitted since the early sixties, but even the older, separate sanitary sewers experience significant I&I problems.

Of the approximately 170 wastewater pumping stations owned by Halifax Water, some 30-40 experience regular overflows. Many of these overflows go to inland receiving waters and, as such, represent higher environmental and health risks than marine discharge of primary treated effluent. As an initial step, a program is underway to provide sensors to detect overflow conditions and estimate volumes for the sanitary sewer overflows. Eighteen such installations are complete. Halifax Water staff are utilizing a combination of flow monitoring and estimating of overflows to provide the additional flow volumes.

Much of the capital and operating budgets have been allocated to mitigate these wet weather flow problems based on a priority-ranking process. It is preferred that resources be allocated based on risk and assessed priority, rather than on the basis of a national standard (the CCME/WSER) that does not consider local conditions. Identification of funding mechanisms and cost-sharing arrangements with senior levels of government will be critical now that the WSER regulations are in force.

13.4 Pension Plan

Halifax Water has a defined benefit pension plan (Halifax Water Employees' Pension Plan) which was redesigned effective January 1, 2016 to make the plan more affordable and sustainable for current and future Halifax Water employees. Pension plan re-design was achieved through collective bargaining. Employer contributions in 2016 on pensionable earnings decreased from 12.95% to 9.85%, with employees experiencing a similar decrease from 12.95% to 10.65%. A savings of $20.2 million for the employer is projected over the next 14 years, with a 50% likelihood the plan will be fully funded within 10 years.

The financial position of the plan, based on the most recent audited financial statements, is shown in Table 6 below. As at December 31, 2016 there were $107 million in assets, and $114 million in pension obligations, for a deficiency of $7 million. Assets of the Plan are invested as part of the Halifax Regional Municipality Master Trust, and represent 6.0% (2015, 5.9%) of the Master Trust's assets. An actuarial evaluation of the Pension Plan will be completed in early 2019 for an effective date of January 1, 2019.

Table 6: Statement of Financial Position as of December 31st

Statement of financial position December 31			Change	
	2016	2015	$	%
Net assets available for benefits (note 4)	$107,067,996	$100,434,444	$6,633,552	6.6%
Pension obligations (note 5)	$114,046,900	$108,055,300	$5,991,600	5.5%
Deficiency	($6,978,904)	($7,620,856)	$641,952	-8.4%

Halifax Water also has almost 100 employees that joined the utility as part of the 2007 Wastewater/Stormwater Transfer, that are members of the HRM Pension Plan.

13.5 Development Pressures and Obligations

As growth is a strategic driver of the Integrated Resource Plan, Halifax Water continues to work closely with the development community to facilitate infrastructure necessary for a rapidly growing municipality. HRM completed the last Regional Plan update in 2014 with a current focus on the completion of the Centre Plan. In that regard, Halifax Water project managed the Local Wastewater Collection System Assessment for HRM in support of the potential growth within the city centre.

With the initiation of the Regional Wastewater Infrastructure Plan (East and Central), HRM staff will be requested to provide population estimates for growth within those two areas.

Staff are currently updating the Bedford West Capital Cost Contribution plan to reflect the modifications to the wastewater and water servicing scenarios. Stakeholder Consultation will commence in 2017, with an Application to the Nova Scotia Utility and Review Board (NSUARB) by spring 2018.

The land owners of the Port Wallace Master Plan area are currently seeking secondary planning approvals and Halifax Water has been providing technical support to the Master Infrastructure Plan. With the completion of the plan, Halifax Water will be able to evaluate whether the Port Wallace area will include a new capital cost contribution charge.

This past year saw the implementation of an interim solution to the Service Approval Module, using SharePoint, to replace the legacy HP3000. Halifax Water is currently engaged with HRM to support their replacement of the permitting software, HANSEN and move to a digital platform for development approvals.

13.6 Biosolids

The plant upgrades at Eastern Passage and installation of dewatering equipment at Mill Cove WWTF has strengthened Halifax Water's capacity to dewater sludge from its facilities. The Aerotech facility, after its upgrade is completed in early 2018, will further enhance this capability. These initiatives have reduced the risk of a dewatering facility malfunction and as a result the overall plant operational risk has reduced.

The Biosolids Processing Facility [BPF] is operated by Walker Environment Group with overall responsibility for operating the facility to produce a soil amendment in conformance with Canadian Food Inspection Agency (CFIA) regulations and marketing the product for beneficial reuse. The BPF is a highly mechanized facility that operates in very tough environmental conditions with high concentrations of dust, humidity and ammonia. The contractor has been operating the facility efficiently for approximately 11 years. The current asset management plan developed in cooperation with the contractor addresses the parts replacement/upgrade needs of the facility. With the improvement in performance of treatment plants, the WWTFs are producing an increased quantity of sludge. The contract agreements with Walker Environmental expires at the end of March 2019. The BPF is also approaching its design capacity, therefore, staff will be reviewing the overall operation over the next year, while simultaneously working on the requirements of the new operating contract. The future BPF could utilize completely different technology with a different operating contractor. Since this will potentially be a long term contract, there is a medium level risk with potential changes, considering the complexities associated with the management of biosolids.

Transportation Contract

The transportation contract with Seaboard expired on October 31, 2017. Through a public tendering process, Halifax Water has recently hired Elmsdale Landscaping to provide the biosolids transportation service. There are minimal business risks with this contract since the procedures are mature. The specialty trailers which are owned by Halifax Water are over 10 years old and are approaching the end of their service life. This equipment may need upgrades or suffer breakdowns, which introduces some risk in the transportation services. Halifax Water has mitigated this risk by purchasing a new trailer and the current business plan anticipates replacing a trailer every 2 to 3 years. The contractor has also been instructed to purchase critical spare parts in advance and have them available at a short notice.

13.7 Leachate Treatment

Halifax Water continues to treat leachate from the Mirror Group facility at Otter Lake under a contract with the municipality. The new UV disinfection system recently installed at Mill Cove as reduced the risk associated with these extraneous loads. Notwithstanding the current situation, HRM is also exploring the potential to install piped infrastructure to transfer effluent from the Otter Lake facility direct to the collection system and ultimately for treatment at the Halifax WWTF.

13.8 Halifax Harbour Solutions Project (HHSP) Facilities

The HHSP facilities' operations have been optimized over the years to meet the requirements of the NSE permits and the compliance plan. Since the facilities are highly mechanized, the facilities have ever increasing demand of highly skilled technicians Halifax Water has been mitigating this risk through effective planning and optimizing its resources. The operating costs of these facilities are on the rise because of increased maintenance, repair and replacement of the equipment. The recently completed asset condition assessment and asset management plans help mitigate this risk to some degree. There facilities have experienced low flows over the past two summer seasons. As a result of the septic inflow to the plants, the odour control systems have required extra replacement of some consumable chemicals.

The dry weather and low flows are potentially an impact of climate change; if the pattern continues, the utility may have to implement further odour control measures in the collection systems. However, the odour controls systems at the WWTFs are currently meeting the requirements with very few odour complaints from customers. On a related note, Halifax Water has upgraded odour control systems at Mill Cove WWTF and in the collection system near the Bissett Lake area of Dartmouth. There are other areas in the system where the monitoring of odour causing compounds have been enhanced.

13.9 Small to Medium Wastewater Treatment Facilities

Halifax Water has seven community based WWTFs in the communities of Springfield Lake, Frame Subdivision, Middle Musquodoboit, Uplands Park, North Preston, Fall River and Wellington. Besides these facilities, there are other medium sized facilities located in the Aerotech Business Park and at Beechville-Lakeside-Timberlea. Since the 2015-16 Business Plan, all of these facilities have undergone operational and capital upgrades. The Aerotech facility is being expanded and upgraded with “state of the art” membrane technology.

These facilities are generally compliant with their NSE permits with a few exceptions of non-compliances in nutrient removal; although the nutrient removal performance has improved over the years. These sewersheds suffer from impacts of wet weather issues leading to high flows in the system. These issues are being addressed as a part of the Wet Weather Management Program. There are minimal risks in operating these facilities, however, further optimization and asset management investments must continue to maintain and improve compliance. As regional development encroaches on these systems, there are opportunities to connect them to the larger core systems.

Although regulatory requirements are being met, small systems are challenging to operate because of the inherent low resilience to changing conditions of the sewershed and the upsets of the treatment process.

13.10 Energy Costs

Through its Energy Management Program, Halifax Water has committed to an ongoing focus on sustainability and energy efficiency throughout the utility, including water and wastewater operations. This program serves to define the goals, objectives, accountabilities, and structure for activities related to responsible energy use.

The Water and Wastewater/Stormwater departments operating budgets are significantly impacted by energy costs that are expected to increase over the life of this business plan and beyond. Table 7 provides projected energy cost impacts over the next five years:

Table 7: Projected Energy Cost Increases and Budget Impacts

Year	Electricity	Fuel Oil	Natural Gas	Water Budget Impact	Wastewater Budget Impact	Total Budget Impact
2018/19	2%	5%	10%	$48,000	$127,000	$175,000
2019/20	2%	5%	10%	$49,000	$131,000	$180,000
2020/21	2%	2%	2%	$47,000	$112,000	$159,000
2021/22	2%	2%	2%	$48,000	$114,000	$162,000
2022/23	2%	2%	2%	$49,000	$116,000	$165,000

The Energy Management Action Plan identifies energy reduction targets for Water and Wastewater Operations over a five-year planning period. Targets will be reviewed each year and adjusted for future years based on the previous year's performance, operating and capital budget allocations, and anticipated energy price increases.

Water and Wastewater Operation's energy-reduction targets over the next five years are outlined in Table 8:

Table 8: Energy Reduction Targets

Year	Water Operations Projected Savings		Wastewater Operations Projected Savings	
	Energy Reduction Target	Energy Savings (kWhe)	Energy Reduction Target	Energy Savings (kWhe)
2018/19	2.0%	383,000	2.0%	831,000
2019/20	2.0%	375,000	2.0%	814,000
2020/21	2.0%	367,000	2.0%	798,000
2021/22	2.0%	360,000	2.0%	782,000
2022/23	2.0%	353,000	2.0%	766,000

As a result of Halifax Water's Energy Management Action Plan, presented with the last general rate application, Halifax Water was able to reduce revenue requirements associated with energy by 2%. Presently the Five-Year Business Plan operating budgets do not incorporate the energy reduction targets outlined in Table 8. As future electricity rates become known with greater certainty and the energy savings of various initiatives are measured, budgets will be adjusted on an annual basis. The projected savings shown above are also contingent on the availability of human and capital resources as approved in the annual operating and capital budgets. As capital budgets are approved or amended, actual energy savings may need to be adjusted on an annual basis.

To date, a number of potential energy-management opportunities (EMOs) have been identified through low to mid-level energy audits in a number of facilities.

For Water Operations, EMOs include HVAC system upgrades, retro-commissioning of PRV-station HVAC systems, lighting retrofits; reactive power correction, variable frequency drive upgrades, pumping system performance upgrades, and new construction design review for energy efficiency.

For Wastewater Operations, EMOs include effluent stream and ventilation system heat recovery, retro-commissioning of WWTF and pumping station HVAC systems, UV disinfection system upgrades, UV system channel isolation, odour control system upgrades, lighting retrofits, reactive power correction, variable frequency drive upgrades, and new construction design review for energy efficiency.

A number of these EMOs have been successfully implemented, and some have been partially funded through Efficiency Nova Scotia's various programs.

As new or existing facility construction projects occur, those projects are also evaluated for energy efficiency improvements. Recently completed projects include the new Aerotech Wastewater Treatment Facility, the Eastern Passage WWTF upgrade, the Bedford West Trunk Sewer and Pumping Station Upgrade, the Lakeside/Bayer's Lake PS Upgrade, the Bedford pump station upgrade, and the Herring Cove sanitary pump station. Energy efficiency is now an integral part of the overall project evaluation and design process ensuring improvements are incorporated prior to the construction phase of a given project.

A number of Halifax Water's standard design specifications have also been reviewed to ensure energy efficiency is taken into account in any future new construction activities (e.g., wastewater pumping stations, booster stations, treatment plants).

13.11 Chemical Costs

Water treatment chemicals represent 30% of the cost of running our large water treatment facilities, totally approximately $2,000,000 per year.

Chemicals for water treatment are a secondary markets for many chemical manufactures. For example, chlorine and caustic soda markets are driven by the demand for PVC plastic in the construction and home building industries. Phosphates for corrosion control, and fluoride are secondary markets to the agriculture industry. As a result, demand created by these primary industries can put cost pressure on chemicals consumed by water utilities.

The last five years have been ones of relatively low and stable prices for drinking water chemicals. It is inevitable that, at some time in the next five years, some of the products we purchase will see significant price pressure beyond normal annual increases. Caustic Soda pricing is currently running 30% greater than the fall of 2016 due to consolidation of production capacity in China. At the height of the last economic boom, it was not unusual to experience temporary increases of 30-40% in a year for several chemicals. Should this situation reoccur, it is possible to see increases in total chemical cost to of 30-40% in a given year.

Other factors which may increase costs for drinking water chemicals include:

- Increased, or decreased costs for corrosion control chemicals as we continue our research to optimize corrosion control chemistry.
- Atlantic Canada is a monopoly market for chlorine used for disinfection.
- Coagulants. Halifax Water uses aluminum sulfate (alum) as a coagulant. Alum is a commodity product and the least expensive coagulant available. As we continue to build strategies to deal with lake recovery we may be required to adopt more specialized coagulants which have a slightly higher cost.

Wastewater and Stormwater Services uses chemicals for wastewater treatment, sludge processing, and odour control. The chemicals represent 13% of the cost of running our WWTFs, at approximately $2,750,000 per year.

All of the WWTFs use UV systems for disinfection with the exception of one community plant in Timberlea which uses chlorine based products. The cost fluctuation risk is mitigated by the very small quantities that is required. Halifax Water has seen stable prices for wastewater treatment chemicals over the last 5 years. Alum and polymers are the largest share of the cost and quantity. The recent contract for polymers is a 3 year term and the price per kilogram is 6% lower than the 2017-18 pricing. As mentioned above, alum is a commodity product. Halifax Water has experienced stable pricing over the years, and it is expected to remain stable over the 5 year period.

Wastewater Collection Services use Bioxide for odour control in the collection system. This proprietary product is proven in the industry to be most effective. Currently, this product is used in Dartmouth at an approximate cost of $300,000 per year. The utility will continue to explore other opportunities or make system enhancements in order to reduce this cost. However, it is expected that the chemical price will remain stable in the near future.

13.12 Lake Recovery

Lake recovery will ultimately require modifications or upgrades to the Pockwock and Lake Major plants. It is also possible that the Bennery lake plant will require upgrades, however that plant is just completing a multi-year optimization program that should equip it well enough to deal with water quality challenges for the next several years.

A three pronged approach has been implemented to deal with lake recovery as follows:

Immediate: Operational improvements have been made at all three treatment plants to make them more robust and better equipped to deal with treatment challenges. This includes upgrading and adding instrumentation to provide better information for operators, upgrading chemical delivery systems, and instituting a filter surveillance program so that operators have the best available information about filter performance.

Short term: Several short term plant improvements are underway which will improve plant performance. This includes upgrading filter media and underdrains and installing air scour at Pockwock, and continuing through a ten year upgrade program at Lake Major which will make the plant more flexible and provide better quality water. Lake Major projects include replacing clarifier plates and tubes, and planning for construction of a new intake and pumping station.

Medium term: Preparation for plant upgrades have begun on a number of fronts. As mentioned above, understanding the impact of lake recovery and studying the impact on the plants makes up two of three research themes through the NSERC Industrial Research Chair with Dalhousie University. Staff also pursuing a Tailored Collaboration Project through the Water Research Foundation which will provide guidance on designing a new plant process while water quality is changing. All of these activities will position the utility to begin a plant upgrade process for Pockwock in the next 3-5 years, while achieving significant process improvements at Lake Major as the upgrade program is executed there.

13.13 External Funding

The five-year business plan was developed with assumptions with respect to external funding – grants from provincial or federal government partners. The five year business plan assumes $47,732,000 in external funding broken down as follows:

- Wastewater - $15,798,000
- Stormwater - $8,298,000
- Water - $23,636,000

It is anticipated that the federal government will announce another round of infrastructure funding in 2018 for implementation beginning in 2019/20.

13.14 Flood Plain Delineation

HRM has completed an exercise to re-map the flood plain limits in the Sackville River area and is completing a LIDAR project to map the coast line in Halifax and Dartmouth. This information will assist HRM in the planning exercises relating to the placement for new development projects. As well, it will allow for risk assessments and emergency planning to occur relating to existing critical infrastructure and transportation routes.

Halifax Water cost shared this exercise with HRM in relation to the National Disaster Mitigation plan to prioritize known drainage issues and flood prone areas. It looked at stormwater impacts on life safety, transportation, private property damage and use of property. With input from Halifax Water, HRM has selected 10 candidate projects to begin planning, design and /or construction to mitigate impacts from flooding. It is anticipated that in the coming years a financial plan will be developed to deliver programmed projects to address the high to medium priority flooding and drainage issues. Halifax Water will provide technical support for this program and where applicable cost share or initiate relevant projects.

13.15 Extraneous Connections

In managing the wastewater and stormwater systems, Halifax Water monitors influences from Customer connections through the Pollution Prevention (P2) and Infiltration/Inflow (I/I) programs within Environmental Engineering. Chemical or biological contaminants, not naturally occurring in wastewater or with increased concentrations may have a negative impacts on the treatment system. As well, physical contaminant such as rags, wipes, fats and grease may clog the collection system resulting in increased operational cleaning or pump failures.

In some areas where there is no deep storm sewer, customers may connect sump pumps, roof leader or footing drains to the wastewater system causing undue loading on the wastewater collection and treatment systems.

The Halifax Water Rules and Regulations provide acceptable limits and parameter to promote efficient and compliant operations of our systems.

Over the next two years, the P2 and I/I programs will identify high to medium risk customers and develop a business process for tracking and inspecting their connections to our systems. It is anticipated in 2020, the groups will be able to use Cityworks in assigning work orders relating to programmed inspections and complaint driven inquiries.

As well, in delivering these programs, a focus will be placed on changing customer behaviors through education and awareness. Halifax Water has also recently applied to the NSUARB to seek approval of a financing program to support customers who want to install new laterals or replace defective ones.

14. FUTURE RATE APPLICATION

Halifax Water maintains a long range financial model that projects future impacts on revenue requirements, but not rates. It is not possible to accurately project rates, as updated demand analyses and rate studies would have to be conducted for each service prior to an application.

The projected five year financial model indicates that rate increases will be required after the 2019/20 fiscal year. Halifax Water is tentatively planning to prepare an application to increase rates for water and wastewater service in the fall of 2019, for rate increases over a two year test period. No increases or changes in stormwater rates are contemplated at this time.

Appendix A

Mission, Vision, Values

&

Corporate Balanced Scorecard

STRAIGHT from the SOURCE

Our Mission:

"To provide world class services
for our customers and our environment"

Our Vision:

- *We will provide our customers with high quality water, wastewater, and stormwater services.*

- *Through adoption of best practices, we will place the highest value on public health, customer service, fiscal responsibility, workplace safety and security, asset management, regulatory compliance, and stewardship of the environment.*

- *We will fully engage employees through teamwork, innovation, and professional development.*

Our Values:

Halifax Water promotes a culture that:

- *Engages employees, partners and stakeholders in achieving success;*
- *Encourages openness and transparency;*
- *Demonstrates individual and corporate accountability for results;*
- *Fosters innovation and progressive thinking;*
- *Respects diverse ideas, opinions and people;*
- *Is committed to service excellence; and*
- *Nurtures leadership at all levels.*

STRAIGHT from the SOURCE

Halifax Water

Measuring Performance Through a Corporate Balanced Scorecard

Critical Success Factors

- High Quality Drinking Water
- Service Excellence
- Responsible Financial Management
- Effective Asset Management
- Workplace Safety and Security
- Regulatory Compliance
- Environmental Stewardship
- Motivated and Satisfied Employees

Organizational Indicators

- Organizational Indicators (OI's) are the measures of our performance within each CSF and provide the definition and detail to best understand them. The OI's are organizational, not individual measures.
- The OI's provide both a detailed clarification of the CSF and allow a target or goal for performance to be established and tracked.

Organizational Performance Award Program

- Based on a subset [12] of our strategic OI's which are the most objective.
- Program pays for itself by meeting operating expense to revenue ratio target; ratio is reduced from approved budget to accommodate the award program potential.
- It is not a given; a threshold of 7.0 in scoring must be reached in a given year.
- To be eligible for the award, employees must work a minimum of nine months during the fiscal year [April 1st to March 31st]

The CBS Targets for 2016/17 Fiscal Year

- Organizational Indicators with a star * are tied to the Award Program

CSF: High Quality Drinking Water

Organizational Indicator: *

- Adherence with 5 objectives from the Water Quality Master Plan for all water systems; we must own system for one year to include results.

Objective	Total Sites	Result to March 31/17 (% of Sites Achieving Target)	Target	Distrib. Pts.
Disinfection – Chlorine Residual	65	98.5%	80 – 100%	19/20
Disinfection By-products (THMs)	24	100%	< 80 ug/l	20/20
Disinfection By-products (HAAs)	25	95%	< 60 ug/l	15/20
Particle Removal	5	100%	<0.2 &< 1.0 NTU	20/20
Corrosion Control	n/a	6.1 ug/L	Lead; <15 ug/l	20/20
Summary Total				94/100

Disinfection – Achieve 0.2 mg/L at all sites (100% of sites achieving residual of 0.2 on 95% of tests)
THMs – Annual Avg. of < 80 ug/L at all THM sampling sites
HAAs - Annual Avg. of < 60 ug/L at all HAA sampling sites
Particle removal – Surface water plant achieves turbidity of <0.2 NTU 95% of the time and <1.0 100% of the time
Corrosion Control – Achieve 90th percentile standing lead sample of <15 ug/L for all sample sites

CSF: High Quality Drinking Water

Organizational Indicator:

- Bacteriological tests [monthly target of 99.3% free of Total Coliform]

	% Samples Free of Coliform	Target
2016/17	99.9%	99.3%

CSF: High Quality Drinking Water

Organizational Indicator: *

- Customer satisfaction about water quality [Target of 85% rating water quality as good to excellent]

	Survey Results (actual)	Target
From Fall 2016 Survey	88%	75% - 85%

**New target approved by Board March 30/17*

2017/18 Target
80% - 85%

CSF: Service Excellence

Organizational Indicator: *

- Customer satisfaction with service [Target of 90% satisfied or very satisfied]

	Survey Result (actual)	Target
From Fall 2016 Survey	95%	80% - 90%

**New target approved by Board March 30/17*

2017/18 Target
85% - 90%

Halifax Water

CSF: Service Excellence

Organizational Indicator:

- Service outages of water [# connection hours / 1000 customers]

	Hours (actual)	Target
2016/17	149	200

Halifax Water

CSF: Service Excellence

Organizational Indicator:

- Service outages of wastewater [# connection hours / 1000 customers]. (N.B. the clock starts after we know it is our problem)

	Hours (actual)	Target
2016/17	4.6	8

Halifax Water

CSF: Service Excellence

Organizational Indicator:

- Average call wait time over the year

	Seconds	Target
2016/17	51	90

**New target approved by Board March 30/17*

2017/18 Target
80

Halifax Water

CSF: Responsible Financial Management

Organizational Indicator:

*

- Operating Expense/Revenue Ratio [based on annual operating budget]

	Exp/Rev ratio (actual)	Target
2016/17	0.669	0.732

**New target approved by Board March 30/17*

2017/18 Target
0.748

CSF: Responsible Financial Management

Organizational Indicator:

- Annual Cost per Customer Connection [Water]

	Cost/connection	Target
2016/17	$407	$439

**New target approved by Board March 30/17*

2017/18 Target
$458

CSF: Responsible Financial Management

Organizational Indicator:

- Annual Cost per Customer Connection [Wastewater]

	Cost/connection	Target
2016/17	$625	$664

**New target approved by Board March 30/17*

2017/18 Target
$667

Halifax Water

CSF: Effective Asset Management

Organizational Indicator: *

- Water Loss Control; target leakage allowance of 190 Litres/Service Connection/Day

	Leakage Actual	Target
2016/17	227	180 - 190

Note: Target adjusted in 2015/16 to be consistent with the latest IWA/AWWA methodology.

Halifax Water

CSF: Effective Asset Management

Organizational Indicator: *

- Inflow and Infiltration [I&I] Reduction; # of inspections on private property in relation to discharge of stormwater into the wastewater system.

	I&I Inspections	Target
2016/17	904	500

**New target approved by Board March 30/17*

2017/18 Target
600

CSF: Effective Asset Management

Organizational Indicator: *

- % of Water, Wastewater and Stormwater Network Available on GIS

	% Available	Target
2016/17	96.9 %	92% - 93%

**New target approved by Board March 30/17*

2017/18 Target
98.0% - 99.0%

CSF: Effective Asset Management

Organizational Indicator

- Capital Budget Expenditures – Maximize annual funds approved by NS Utility and Review Board by March 31, 2017

	Maximize Annual Capital Budget Expenditures	Target
2016/17	46.0 %	85% to 95% approved

**New target approved by Board March 30/17*

2017/18 Target
80% - 90% spent

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CSF: Workplace Safety & Security

Organizational Indicator:

- # of Incidents with written Compliance Orders received from NS Labour and Advanced Education

	Labour Infractions	Target
2016/17	1	0 - 2 (max.)

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Halifax Water

CSF: Workplace Safety & Security

Organizational Indicator: *

- Lost Time Accidents [# of accidents resulting in lost time per 100 employee (FTE pro-rated)]

	Lost time accidents	Target
2016/17	3.4	3.0 – 4.0 per 100 employees (with a maximum of 4.5)

Note: This is a gateway indicator with an award program contingent on results of <4.5 lost time accidents per 100 employees

CSF: Workplace Safety & Security

Organizational Indicator: *

- # of Traffic Accidents per 1,000,000 km

	Traffic Accidents / 1,000,000 Kms	Target
2016/17	4.84	4.0 per 1,000,000 km (maximum of 5)

CSF: Workplace Safety & Security

Organizational Indicator:

- Employees are retrained or recertified before due date

	% of Employees Retrained or Recertified Before Due Date	Target
2016/17	81%	80% - 90%

Halifax Water

CSF: Workplace Safety & Security

Organizational Indicator:

- Supervisors complete weekly or bi-weekly safety talks

	% of Completed Safety Talks	Target
2016/17	80%	80% - 90%

Halifax Water

CSF: Regulatory Compliance

Organizational Indicator:

- # of public health and environmental regulatory infractions resulting in an Environmental Warning Report, Summary Offence Ticket, Ministerial Order or prosecution.

	Public Health & Env. Infract.	Target
2016/17	0	0 - 2 (max.)

CSF: Regulatory Compliance

Organizational Indicator: *

- % of WWTFs complying with NSE approval permits.

	% of WWTF samples meeting NSE discharge limits	Target
2016/17	91.4%	85% - 90%

CSF: Environmental Stewardship

Organizational Indicator:

- # of ICI properties in HRM inspected by Pollution Prevention [P2] Section each year

	Actual Inspected	Target
2016/17	528	400

CSF: Environmental Stewardship

Organizational Indicator:

*

- Energy Management [kwh/m3] ; % energy reduction associated with capital projects

	% Energy Reduction	Target
2016/17	3.8 %	2%

CSF: Environmental Stewardship

Organizational Indicator: *

- Bio-solid Residuals Handling; % of sludge meeting solids concentration target - 96% of samples meet a minimum solids concentration of:
  - ✓ **25% from HHSP plants**
  - ✓ **18% from Aerotech Dewatering Facility**

	% Meet Solids Concentration Target	Target
2016/17	99.4%	97 %

CSF: Motivated and Satisfied Employees

Organizational Indicator:

- # of arbitrations divided by total # of grievances.

	Arbitrations/Grievances	Target
2016/17	0/18	0 Arbitrations

CSF: Motivated and Satisfied Employees

Organizational Indicator:

- % of jobs filled from within Halifax Water [excluding entry level jobs].

	% Jobs filled within	Target
2016/17	71%	80%

CSF: Motivated and Satisfied Employees

Organizational Indicator:

- Employee satisfaction survey. [2009 was the benchmark year with a B result].

	Survey Result (actual)	Target
Survey in 2016	B	A-

CSF: Motivated and Satisfied Employees

Organizational Indicator:

- Average number of days of absenteeism

	Avg. No. of days absenteeism	Target
2016/17	7.51	< 7 days

Halifax Water

Based on a subset of 12 OIs which are the most objective:

Organizational Indicator	Max. Score
Water Quality Master Plan Objectives	1.0
Customer Water Quality Survey Results	1.0
Customer Service Survey Results	1.0
Operating Expense/Revenue Ratio *[Gateway Indicator]*	1.0
Water Loss Control Reduction	1.0
Inflow & Infiltration Reduction	1.0
Percentage of Network on GIS	1.0
# of Lost Time Accidents per 100 Employees *[Gateway Indicator]*	1.0
# of Traffic Accidents per 1,000,000 km	1.0
Percentage of WWTFs Compliant with NS Environment Permits	1.0
Energy Management – Water & Wastewater	1.0
Biosolids Residual Handling	1.0
TOTAL MAXIMUM SCORE	**12.0**

Halifax Water

2016/17 Organizational Award (**Actual** Results)

Organizational Indicator	2015/16 Results
Water Quality Master Plan Objectives	0.94
Customer Water Quality Survey Results	1.00
Customer Service Survey Results	1.00
Operating Expense/Revenue Ratio *[Gateway Indicator]*	1.00
Water Loss Control Reduction	0.00
Inflow & Infiltration Reduction	1.00
Percentage of Network on GIS	1.00
Energy Management – Water & Wastewater	1.00
Biosolids Residual Handling	1.00
# of Lost Time Accidents per 100 Employees *[Gateway Indicator]*	0.6
# of Traffic Accidents per 1,000,000 km	0.2
Percentage of WWTFs Compliant with NS Environment Permits	1.0
TOTAL SCORE	**9.74**

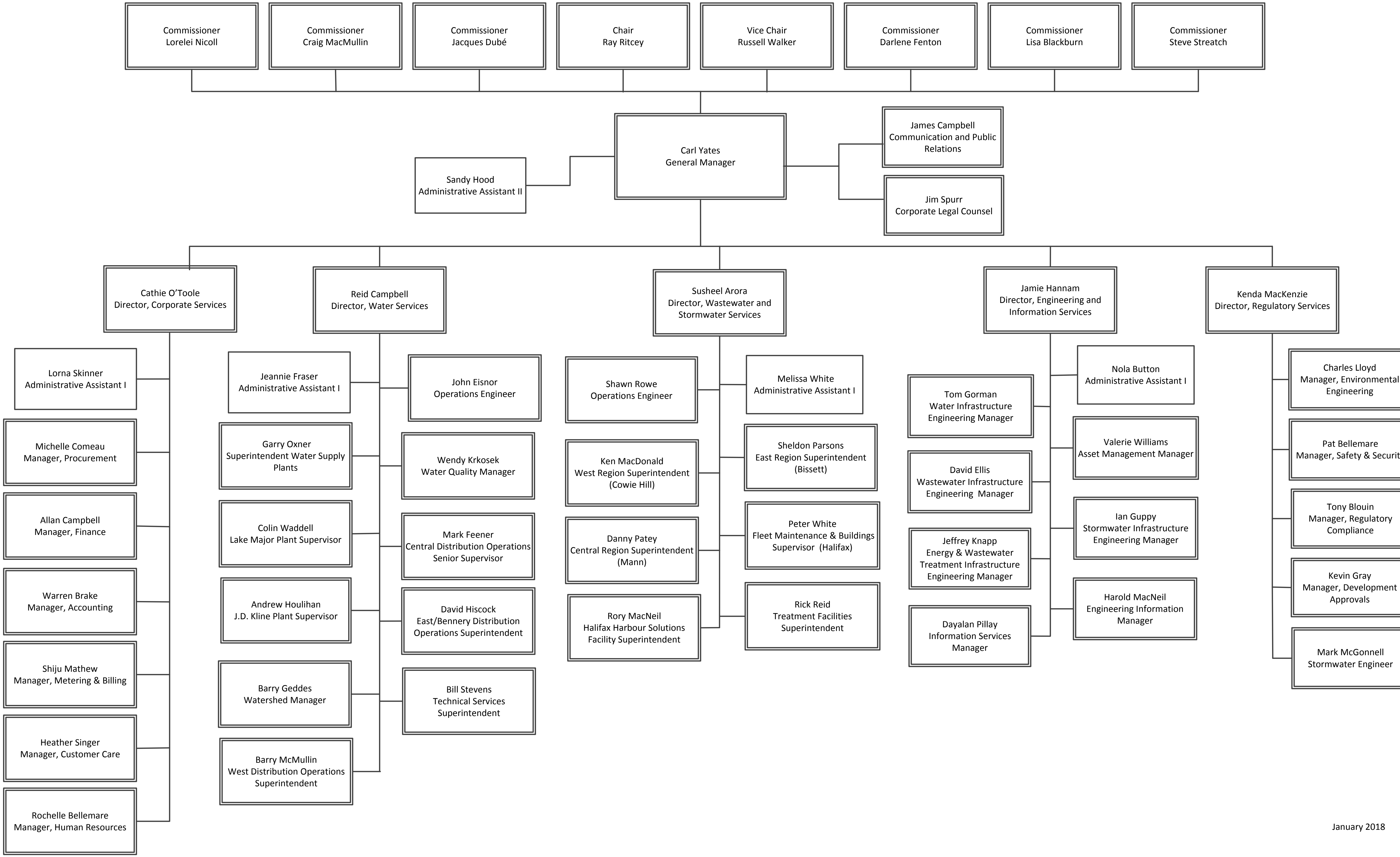
Halifax Water

Appendix B

Organizational Chart

STRAIGHT from the SOURCE

HALIFAX WATER ORGANIZATIONAL STRUCTURE

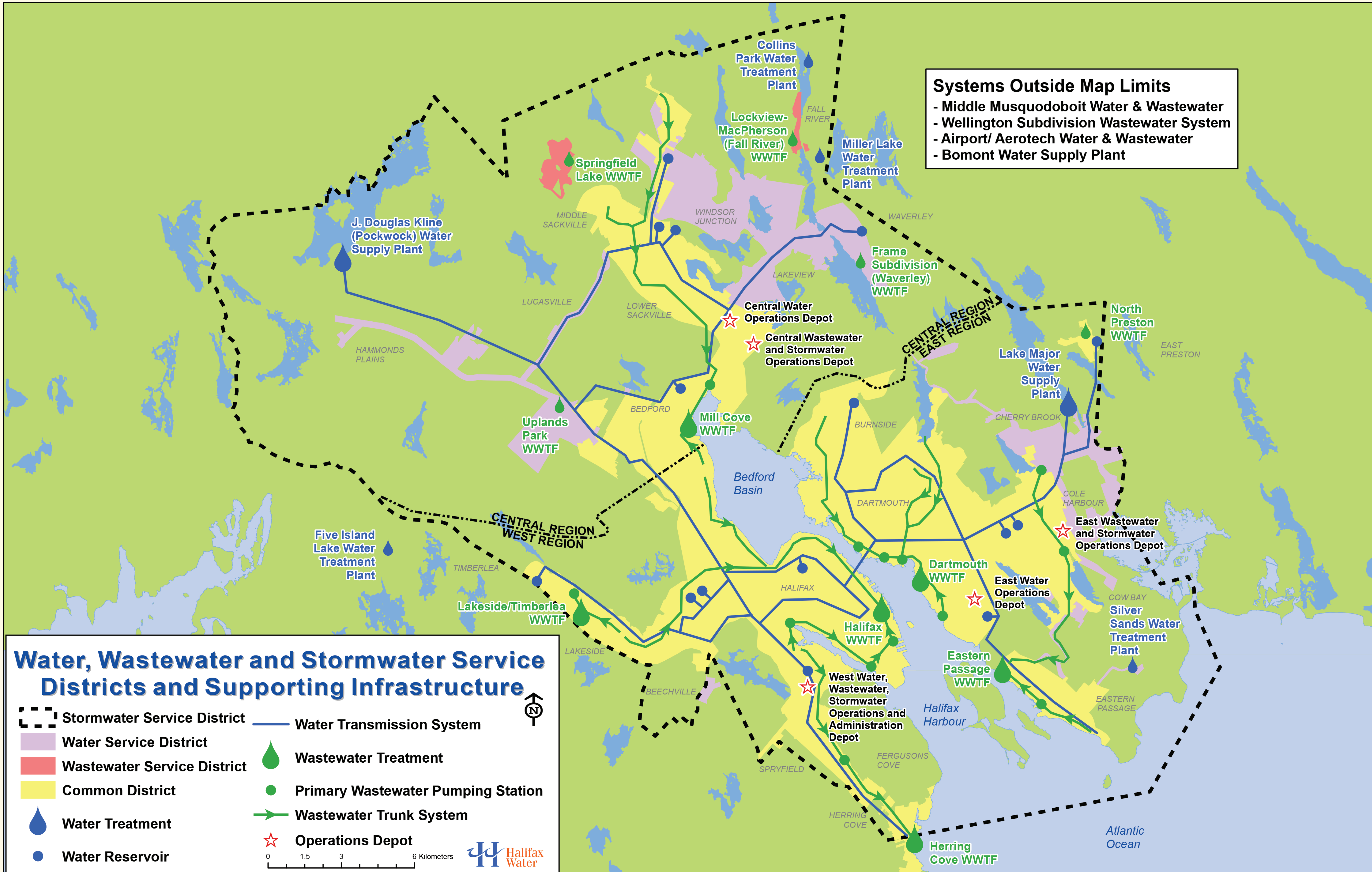


January 2018

Appendix C

Water, Wastewater and Stormwater Service Districts and Supporting Infrastructure

STRAIGHT from the SOURCE


Water, Wastewater and Stormwater Service Districts and Supporting Infrastructure
Stormwater Service District
Water Service District
Wastewater Service District
Common District
Water Treatment
Water Reservoir
Water Transmission System
Wastewater Treatment
Primary Wastewater Pumping Station
Wastewater Trunk System
Operations Depot
0 1.5 3 6 Kilometers
Halifax Water
Systems Outside Map Limits
- Middle Musquodoboit Water & Wastewater
- Wellington Subdivision Wastewater System
- Airport/ Aerotech Water & Wastewater
- Bomont Water Supply Plant
Collins Park Water Treatment Plant
Lockview-MacPherson (Fall River) WWTF
FALL RIVER
Miller Lake Water Treatment Plant
Springfield Lake WWTF
J. Douglas Kline (Pockwock) Water Supply Plant
MIDDLE SACKVILLE
WINDSOR JUNCTION
WAVERLEY
Frame Subdivision (Waverley) WWTF
LAKEVIEW
LUCASVILLE
LOWER SACKVILLE
Central Water Operations Depot
Central Wastewater and Stormwater Operations Depot
CENTRAL REGION
EAST REGION
North Preston WWTF
EAST PRESTON
Lake Major Water Supply Plant
HAMMONDS PLAINS
BEDFORD
Mill Cove WWTF
Uplands Park WWTF
BURNSIDE
CHERRY BROOK
Bedford Basin
DARTMOUTH
COLE HARBOUR
East Wastewater and Stormwater Operations Depot
CENTRAL REGION
WEST REGION
Five Island Lake Water Treatment Plant
TIMBERLEA
Dartmouth WWTF
East Water Operations Depot
HALIFAX
COW BAY
Silver Sands Water Treatment Plant
Lakeside/Timberlea WWTF
Halifax WWTF
LAKESIDE
Eastern Passage WWTF
West Water, Wastewater, Stormwater Operations and Administration Depot
BEECHVILLE
Halifax Harbour
EASTERN PASSAGE
FERGUSONS COVE
SPRYFIELD
HERRING COVE
Herring Cove WWTF
Atlantic Ocean

Appendix D

Approved Capital Budget

2017/18

STRAIGHT from the SOURCE

HALIFAX WATER

Capital Budget 2017/18

Summary

Asset Category	Project Costs
Water - Land -- T O T A L	$760,000
Water - Transmission -- T O T A L	$13,150,717
Water - Distribution -- T O T A L	$2,890,000
Water - Structures -- T O T A L	$10,029,391
Water - Treatment Facilities -- T O T A L	$10,405,060
Water - Energy -- T O T A L	$656,352
Water - Security -- T O T A L	$150,000
Water - Equipment -- T O T A L	$50,000
Water - Corporate Projects - T O T A L	$9,671,000
TOTAL - Water	**$47,762,520**

Wastewater - Trunk Sewers -- T O T A L	$19,843,168
Wastewater - Collection System -- T O T A L	$9,144,000
Wastewater - Forcemains -- T O T A L	$260,000
Wastewater Structures -- T O T A L	$2,440,000
Wastewater - Treatment Facility -- T O T A L	$2,528,000
Wastewater - Energy -- T O T A L	$2,455,813
Wastewater - Security -- T O T A L	$200,000
Wastewater - Equipment -- T O T A L	$95,000
Wastewater - Corporate Projects -- T O T A L	$9,694,800
TOTAL - Wastewater	**$46,660,781**

HALIFAX WATER

Capital Budget 2017/18

Summary

Asset Category	Project Costs
Stormwater - Pipes -- T O T A L	$9,942,000
Stormwater - Culverts -- T O T A L	$2,736,000
Stormwater - Structures -- T O T A L	$1,535,000
Stormwater - Corporate Projects -- T O T A L	$871,200
TOTAL - Stormwater	**$15,084,200**
G R A N D T O T A L	**$109,507,501**

HALIFAX WATER

Capital Budget 2017/18

Water

Project Number	Project Name	Project Cost
	Water - Land	
3.36	Bennery Lake Watershed Land Purchase	$210,000
3.383	Bennery Lake Watershed Land Purchase	$330,000
3.384	Tomahawk Lake Watershed Land Purchase	$220,000
	Water - Land -- T O T A L	**$760,000**
	Water - Transmission	
3.293	Penisula Low North Transmission Main Replacement (Windsor at Young)	$435,000
3.006	Bedford Connector 750mm Replacement - Phase 3	$4,569,717
3.234	Windsor Junction Transmission Main Oversizing	$330,000
3.011	Peninsula Low South Transmission Main Rehabilitation	$7,505,000
3.045	Bedford West Capital Cost Contribution - Various Phases	$11,000
3.343	Northgate Oversizing	$135,000
3.232	MacIntosh Estates Phase 1 Oversizing	$115,000
3.373	Regional Development Charge Studies	$50,000
	Water - Transmission -- T O T A L	**$13,150,717**
	Water - Distribution	
3.022	Water Distribution - Main Renewal Program	$1,900,000
3.067	Valve Renewals	$125,000
3.068	Hydrant Renewals	$75,000
3.069	Service Line Renewals	$100,000
3.390	Lead Service Line Replacement Program	$400,000
3.294	Automated Flushing Program	$20,000
3.346	Bulk Fill Stations - Site Work Improvements	$110,000
3.296	Water Sampling Station Relocation Program	$30,000
3.375	Re-Chlorination Stations - Sampson and Stokil Reservoirs	$30,000
	Distribution System Chlorine Residual Analyzer Upgrade Program	$100,000
	Water - Distribution -- T O T A L	**$2,890,000**

HALIFAX WATER

Capital Budget 2017/18

Water

Project Number	Project Name	Project Cost
	Water - Structures	
3.387	Geizer 158 Reservoir Floor Replacement	$2,750,000
3.173	Lake Major Dam Replacement	$7,089,391
3.342	Crestview Booster Station PRV Conversion	$57,000
3.357	Silverside Booster Station - Control Panel Replacement	$50,000
3.358	Blue Mountain Meter Replacement	$20,000
3.381	Geizer 158 Reservoir Drainage Improvements	$53,000
3.382	Pratt & Whitney PRV Communications Upgrade	$10,000
	Water - Structures -- T O T A L	**$10,029,391**
	Water - Treatment Facilities	
3.211	Chlorine Analyzer Replacement Program	$23,000
3.276	Inline Zeta Potential Meters for Water Plants	$100,000
3.377	450 Cowie - New DR7000 for Lab	$14,000
3.376	Chlorine Analyzer Relocation - Geizer 158 Reservoir	$33,000
	J D Kline Water Supply Plant:	
3.157	Filter Media and Underdrain Replacement Program	$4,447,060
3.353	Effluent Valve Actuator Replacement Program	$50,000
3.352	New Mixers in Pre-Mix Chamber	$277,000
3.319	Lime Feed and Delivery System Replacement	$300,000
3.361	Turbidity Meters	$50,000
3.236	Ampgard III to Vacuum Contactor Conversion	$40,000
3.363	Chlorine Storage Room - System Modifications	$70,000
3.351	Westinghouse Electrical Panels Replacement	$5,000
3.368	pH Meter Replacements	$10,000
3.369	Raw Water Pumping Station Ladder Extension and Fall Protection Equipment	$9,000
3.370	VTS Alarm System Upgrade	$7,000

HALIFAX WATER

Capital Budget 2017/18

Water

Project Number	Project Name	Project Cost
3.372	Bench-top Turbidimeter	$6,000
3.386	Slide Gate Actuators to Lagoons	$44,000
3.280	Roof Replacement	$220,000
	Lake Major Water Supply Plant:	
3.159	MCC Contactors Replacement	$34,000
3.162	Butterfly valve replacement program	$100,000
3.207	Treatment Train Isolation	$222,000
3.195	Filter Media Replacement	$200,000
3.161	Lime Feed and Delivery System Replacement	$380,000
3.278	Clarifier Upgrades	$285,000
3.160	PLC Upgrade	$420,000
3.320	New Raw Water Low Lift Pump	$500,000
3.304	Dry Polymer Feed System Replacement	$380,000
3.300	Dedicated Service Water Pumping Station	$285,000
3.325	Basin Mixing Enhancements	$800,000
3.193	Carbon Dioxide Feed System	$215,000
3.366	Bench Top Turbidimeter	$6,000
3.315	Blower Vent	$35,000
	Bennery Lake Water Supply Plant:	
3.272	Low Lift VFD Pump Replacement Program	$110,000
3.347	Plant MCC Replacement	$530,000
3.348	Post Filter Chemical Addition Optimization	$62,000
3.274	Power Monitoring	$20,000
3.359	Culvert Replacement	$20,000
3.349	New Magnetic Flow Meters	$29,000
3.350	New Chlorine Analyzer	$14,000
3.378	Sludge Pumps and Valves Replacement	$53,000
	Water - Treatment Facilities -- T O T A L	**$10,405,060**

HALIFAX WATER

Capital Budget 2017/18

Water

Project Number	Project Name	Project Cost
	Water - Energy	
3.107	Chamber HVAC Retro-Commissioning Program	$100,000
3.367	Lake Major WSP - HVAC Upgrades	$556,352
	Water - Energy -- T O T A L	**$656,352**
	Water - Security	
4.009	Security Upgrade Program	$150,000
	Water - Security -- T O T A L	**$150,000**
	Water - Equipment	
3.101	Miscellaneous Equipment Replacement	$50,000
	Water - Equipment -- T O T A L	**$50,000**
	Water - Corporate Projects - T O T A L	**$9,671,000**
	GRAND TOTAL - WATER	**$47,762,520**

HALIFAX WATER

Capital Budget 2017/18

Wastewater

Project Number	Project Name	Project Cost
	Wastewater - Trunk Sewers	
2.067	Northwest Arm Sewer Rehabilitation	$19,493,168
2.467	Kearney Lake Road Wastewater Sewer Upgrades	$350,000
	Wastewater - Trunk Sewers - -- T O T A L	**$19,843,168**
	Wastewater - Collection System	
2.052	Integrated Wastewater Projects - Program	$1,000,000
2.460	Leiblin Pumping Station Gravity Sewer	$3,495,000
2.437	Hines Road Rider Sewer Extension	$50,000
2.462	Wastewater Conveyance System Upgrade - Dingle PS to Roach's PS via William's Lake PS	$145,000
2.547	Balsam/Monroe Subdivision Sewer Upgrade	$165,000
2.357	Manhole Renewals	$29,000
2.358	Lateral Replacements (non-tree roots)	$1,300,000
2.563	Lateral Replacements (tree roots)	$600,000
2.223	Wet Weather Management Program	$100,000
2.523	Sewer Condition Assessment	$300,000
2.043	Corporate Flow Monitoring Program	$1,000,000
2.558	East and Central Region Infrastructure Plan	$600,000
2.559	West Region Infrastructure Plan - Ph.2	$250,000
2.074	Bedford West Collection System CCC	$60,000
2.548	Regional Development Charge Studies	$50,000
	Wastewater - Collection System -- T O T A L	**$9,144,000**
	Wastewater - Forcemains	
2.543	Kearney Lake Road Forcemain Extension	$260,000
	Wastewater - Forcemains -- T O T A L	**$260,000**

HALIFAX WATER

Capital Budget 2017/18

Wastewater

Project Number	Project Name	Project Cost
	Wastewater - Structures	
2.42	Emergency Pumping Station Pump replacements	$250,000
2.442	Wastewater Pumping Station Component Replacement Program - West Region	$200,000
2.443	Wastewater Pumping Station Component Replacement Program - East Region	$200,000
2.444	Wastewater Pumping Station Component Replacement Program - Central Region	$200,000
2.512	Hines Road Sewer - Odour Management	$100,000
2.466	Weybridge Lane Pumping Station CCC	$540,000
2.005	Autoport Pleasant Street Pumping Station Replacement	$750,000
2.366	Shipyard Road Pumping Station Upgrade	$175,000
2.561	Outfall Location Inventory	$25,000
	Wastewater Structures -- T O T A L	**$2,440,000**
	Wastewater - Treatment Facility	
2.056	Plant Optimization Audit Program	$125,000
2.522	Emergency Wastewater Treatment Facility equipment replacements	$400,000
2.564	HSP Plants - Carbon replacement	$400,000
	Halifax Wastewater Treatment Facility:	
2.535	Screenings Compactor Replacement	$200,000
2.532	Duct Work Replacement	$150,000
	Dartmouth Wastewater Treatment Facility:	
2.502	Duct Work Replacement	$150,000
2.565	Odour Control Study	$50,000
	Herring Cove Wastewater Treatment Facility:	
2.539	Densadeg Inlet Penstocks Actuator Installation	$50,000
2.55	Window Installation for Natural Light	$20,000
2.566	Overhead Door	$20,000
	Mill Cove Wastewater Treatment Facility:	
2.531	Admin Building HVAC Renewal Preliminary Engineering	$25,000
2.546	Odour Control Upgrade	$530,000
2.567	Process Upgrade Options	$50,000

HALIFAX WATER

Capital Budget 2017/18

Wastewater

Project Number	Project Name	Project Cost
	Eastern Passage Wastewater Treatment Facility:	
2.551	Control Building HVAC Upgrade	$8,000
	Biosolids Processing Facility:	
2.126	Asset Renewal Program	$250,000
2.568	Biosolids Management Plan	$100,000
	Wastewater - Treatment Facility -- T O T A L	**$2,528,000**
	Wastewater - Energy	
2.491	Pump Station HVAC Retro-Commissioning Program	$100,000
2.554	Wastewater Pumping Station Performance Testing	$250,000
	Dartmouth Wastewater Treatment Facility:	
2.235	Ventilation Air Heat Recovery	$250,000
2.553	MCC Ventilation Upgrades	$100,000
	Halifax Wastewater Treatment Facility:	
2.555	Effluent Heat Recovery	$25,000
2.552	MCC Ventilation Upgrades	$130,813
	Cogswell Area District Energy System	$1,600,000
	Wastewater - Energy -- T O T A L	**$2,455,813**
	Wastewater - Security	
4.008	Security Upgrade Program	$200,000
	Wastewater - Security -- T O T A L	**$200,000**
	Wastewater - Equipment	
2.161	I&I Reduction (SIR) Program Flow Meters and Related Equipment	$25,000
2.451	Miscellaneous Equipment Replacement	$70,000
	Wastewater - Equipment -- T O T A L	**$95,000**
	Wastewater - Corporate Projects -- T O T A L	**$9,694,800**
	GRAND TOTAL - WASTEWATER	**$46,660,781**

HALIFAX WATER

Capital Budget 2017/18

Stormwater

Project Number	Project Name	Project Cost
	Stormwater - Pipes	
1.038	Integrated Stormwater Projects - Program	$1,060,000
1.043	Sullivan's Pond Storm Sewer System Replacement - Phase 1	$8,632,000
1.156	Storm Sewer Condition Assessment	$150,000
1.102	Manhole Renewals	$24,000
1.103	Catchbasin Renewals	$36,000
1.135	Lateral Replacements	$15,000
1.019	Drainage Remediation Program Surveys/Studies	$25,000
	Stormwater - Pipes -- T O T A L	**$9,942,000**
	Stormwater - Culverts/Ditches	
1.104	Driveway Culvert Replacements	$700,000
	Street Specific Culvert Replacements:	
1.146	John Cross Drive (near #40)	$200,000
1.147	Cole Harbour Road (near #1560)	$210,000
1.148	Montague Road (near #1044)	$155,000
1.15	Fletcher Drive (near #52)	$270,000
1.151	Softwind Lane (near #31)	$105,000
1.152	Yankeetown Road (near #16)	$205,000
1.153	Terradore Lane (near #7)	$96,000
1.154	Waverley Road (near #4132)	$115,000
1.136	Blue Hill Road (near #77)	$130,000
1.01	Kipawa Crescent (near #14)	$220,000
1.012	Lucasville Road (near #1419)	$170,000
1.023	Cobequid Road (near #510)	$160,000
	Stormwater - Culverts/Ditches -- T O T A L	**$2,736,000**
	Stormwater - Structures	
1.133	Ellenvale Run Retaining Wall System - Replacement	$1,535,000
	Stormwater - Structures -- T O T A L	**$1,535,000**
	Stormwater - Corporate Projects -- T O T A L	**$871,200**
	GRAND TOTAL - STORMWATER	**$15,084,200**

HALIFAX WATER

Capital Budget 2017/18

Corporate Projects

Project Number	Project Name	Project Cost
	Corporate - Information Technology	
4.011	Desktop Computer Replacement Program	$290,000
4.012	Network Infrastructure Upgrades	$220,000
4.013	Document Management Program	$100,000
4.070	Computerized Maintenance Management System Phase 2	$2,000,000
4.024	Sharepoint Implementation	$100,000
4.043	AMI Meter System Upgrades (50 Water / 50 Wastewater)	$11,685,000
4.014	IT Disaster Recovery Site	$300,000
4.048	SAP Rate Structure Support	$220,000
4.074	Asset Registry Build	$600,000
	Corporate - Information Technology -- T O T A L	**$15,515,000**
	Corporate - GIS	
4.040	GIS Data Program	$1,000,000
4.038	GIS Hardware/Software Program	$100,000
4.039	GIS Application Support Program	$250,000
	Corporate - GIS -- T O T A L	**$1,350,000**
	Corporate - Asset Management	
4.079	Climate Change Assessment and Policy	$150,000
4.020	Asset Management Program Development	$150,000
4.052	Long Term Planning Coordination Strategy (50 Water / 50 Wastewater)	$75,000
4.049	Expand Prioritization Methodology	$125,000
4.054	Assess AM Software and Tools	$100,000
	Corporate - Asset Management -- T O T A L	**$600,000**
	Corporate - Facility	
4.076	Heating / Ventilation Upgrades in New Phase 450 Cowie Hill Building	$100,000
4.078	450 Cowie Renovation	$75,000
	Corporate - Facility -- T O T A L	**$175,000**

HALIFAX WATER

Capital Budget 2017/18

Corporate Projects

Project Number	Project Name	Project Cost
	Corporate - SCADA & Other Equipment	
3.38	Total Station Survey Prisms	$32,000
4.004	SCADA Control System Enhancements (50 Water / 50 Wastewater)	$200,000
4.080	Large and New Customer Meters (50 Water / 50 Wastewater)	$460,000
	Corporate - SCADA & Other Equipment -- T O T A L	**$692,000**
	Corporate - Fleet	
4.006	Fleet Upgrade Program Stormwater	$280,000
4.006	Fleet Upgrade Program Wastewater	$1,120,000
4.007	Fleet Upgrade Program Water	$505,000
	Corporate - Fleet -- T O T A L	**$1,905,000**
	GRAND TOTAL - Corporate Projects	**$20,237,000**
	ALLOCATION BREAKDOWN:	
	Water - Corporate Projects - T O T A L	$9,671,000
	Wastewater - Corporate Projects -- T O T A L	$9,694,800
	Stormwater - Corporate Projects -- T O T A L	$871,200
	GRAND TOTAL - Corporate Projects	**$20,237,000**

Note: All corporate projects are allocated as follows:

50% Water

40% Wastewater

10% Stormwater

(unless otherwise noted)

Halifax Water

Appendix E

Projected Capital Budgets for 2018/19 to 2022/23

STRAIGHT from the SOURCE

2018 - 19 to 2022 - 23 Capital Expenditure Program	TOTALS					
	All $ in 000's					
	Y1	Y2	Y3	Y4	Y5	Y1 to Y5
	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	Totals
Water / Wastewater / Stormwater Budget Summary						
Water - Land	$100	$100	$100	$100	$100	$500
Water - Transmission	$382	$7,088	$8,675	$404	$15,634	$32,183
Water - Distribution	$4,647	$3,850	$4,920	$4,820	$4,820	$23,057
Water - Structures	$1,954	$8,645	$350	$3,310	$3,190	$17,449
Water - Treatment Facilities	$7,653	$4,360	$5,291	$13,358	$6,198	$36,860
Water - Energy	$175	$1,525	$500	$500	$500	$3,200
Water - Security	$50	$50	$50	$50	$50	$250
Water - Equipment	$50	$50	$50	$50	$50	$250
Water - Corporate Projects	$10,023	$6,439	$9,545	$6,065	$2,456	$34,528
Sub Total - Water	$25,034	$32,107	$29,481	$28,657	$32,998	$148,277
Wastewater - Trunk Sewers	$1,700	$10,330	$9,690	$2,000	$2,000	$25,720
Wastewater - Collection System	$12,120	$19,691	$13,981	$16,515	$18,800	$81,107
Wastewater - Forcemains	$1,253	$1,365	$15,600	$1,100	$1,300	$20,618
Wastewater - Structures	$9,750	$10,170	$14,570	$11,950	$24,750	$71,190
Wastewater - Treatment Facilities	$2,878	$3,690	$3,515	$3,700	$3,430	$17,213
Wastewater - Energy	$475	$1,230	$650	$600	$600	$3,555
Wastewater - Security	$200	$200	$200	$200	$200	$1,000
Wastewater - Equipment	$95	$95	$95	$95	$95	$475
Wastewater - Corporate Projects	$11,347	$8,844	$10,670	$7,787	$5,100	$43,748
Sub Total - Wastewater	$39,818	$55,615	$68,971	$43,947	$56,275	$264,626
Stormwater - Pipes	$1,861	$1,913	$3,388	$12,041	$6,037	$25,240
Stormwater - Culverts/Ditches	$2,725	$2,812	$2,828	$2,848	$2,866	$14,079
Stormwater - Structures	$2,525	$2,525	$2,525	$2,525	$0	$10,100
Stormwater - Security	$0	$0	$0	$0	$0	$0
Stormwater - Equipment	$0	$0	$0	$0	$0	$0
Stormwater - Corporate Projects	$1,486	$1,660	$2,235	$1,518	$850	$7,749
Sub Total - Stormwater	$8,597	$8,910	$10,976	$18,932	$9,753	$57,168
TOTALS - Water/Wastewater/Stormwater	$73,449	$96,632	$109,428	$91,536	$99,026	$470,071

Five Year Capital Budget - Water									
Project ID	Project Name	Region	All $ in 000's						
			Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
Water - Land									
3.033	Watershed Land Acquisition	HRM	$100	$100	$100	$100	$100	$500	$0
Water - Land -- T O T A L S			**$100**	**$100**	**$100**	**$100**	**$100**	**$500**	**$0**
Water - Transmission									
3.042	Critical Valve Replacement Program	HRM	$0	$300	$300	$300	$300	$1,200	$0
3.250	Critical Valve Replacement Program - Gottingen Street	West	$210					$210	$0
3.291	Port Wallace Transmission Main - Caledonia Section	East	$120	$6,270				$6,390	$0
3.397	Willow Tree Transmission Main Improvements	West					$4,050	$4,050	$0
3.395	Peninsula Low Transmission Main Quinpool Road Beech to Robie	West					$6,320	$6,320	$0
3.396	Peninsula Low Transmission Main Replacement Crown to Parkwood	West							$8,850
3.436	Pockwock Transmission Main Twinning - WSP to Hammonds Plain Road	West					$200	$200	$53,650
3.292	Lucasville Road Transmission Main - Beaverbank Connection	Central							$6,170
3.013	Windmill Road Transmission Main Replacement - Ph 1 (Wright to Princess Marg)	East							$4,500
3.014	Windmill Road Transmission Main Replacement - Ph 2 (Princess Marg to Albro Lake Rd)	East					$4,350	$4,350	$0
3.019	Lucasville Road Transmission Main - Phase 1	Central		$150	$7,610			$7,760	$0
3.020	Lucasville Road Transmission Main - Phase 2 (C3 - North of Hwy 101)	Central							$8,110
3.021	Burnside - Bedford Connector Transmission Main	East			$750			$750	$12,250
3.010	North End Feeder Tunnel 36" Transmission Main Rehab (W3)	West				$100	$300	$400	$9,400
3.326	Robie Street Intermediate Transmission Main Structural Liner	West							$5,950
3.018	Port Wallace Transmission Main - Phase 1 (E3)	East							$5,930
3.108	Herring Cove Road Transmission Main Replacement Sussex Drive to Princeton Avenue	West							$4,700
3.045	Bedford West CCC - Various Phases	Central	$2	$83	$13	$2	$114	$214	$0
3.260	Morris (Russell) Lake Estates CCC	East		$15				$15	$0
3.261	Lakeside Timberlea CCC	West			$2	$2		$4	$0
3.343	Northgate Oversizing	Central		$145				$145	$0
3.232	MacIntosh Estates Phase 1 Oversizing	West		$125				$125	$0
3.373	Regional Development Charge Studies	HRM	$50					$50	$0
Water - Transmission -- T O T A L S			**$382**	**$7,088**	**$8,675**	**$404**	**$15,634**	**$32,183**	**$119,510**
Water - Distribution									
3.022	Water Distribution - Main Renewal Program	HRM	$3,500	$2,500	$3,500	$3,500	$3,500	$16,500	$0
3.067	Valves Renewals	HRM	$125	$125	$125	$125	$125	$625	$0
3.068	Hydrants Renewals	HRM	$75	$75	$75	$75	$75	$375	$0
3.069	Service Lines Renewals	HRM	$100	$100	$100	$100	$100	$500	$0
3.390	Lead Service Line Replacement Program	HRM	$600	$1,000	$1,000	$1,000	$1,000	$4,600	$0
3.294	Automated Flushing Program	HRM	$20	$20	$20	$20	$20	$100	$0
3.296	Water Sampling Station Relocation Program	HRM	$30	$30				$60	$0
3.333	Quinpool Road Bridge Watermain Replacement	West	$197					$197	$0
3.334	Coburg Road Bridge Watermain Replacement	West			$100			$100	$0
Water - Distribution -- T O T A L S			**$4,647**	**$3,850**	**$4,920**	**$4,820**	**$4,820**	**$23,057**	**$0**

Five Year Capital Budget - Water

Project ID	Project Name	Region	All $ in 000's Y1 2018-2019	Y2 2019-2020	Y3 2020-2021	Y4 2021-2022	Y5 2022-2023	Total Y1 to Y5	Future Years
Water - Structures									
3.262	Chambers, Pumping Stations and Distribution Monitoring Asset Renewal Program	HRM	$0	$350	$350	$750	$750	$2,200	$0
3.391	Lake Major Dam Monitoring Program	East		$245				$245	$0
3.403	Cowie Hill Reservoir Rehabilitaton	West	$100	$2,000				$2,100	$0
3.411	Sampson and Stokil Reservoirs Rechlorination System	Central	$390					$390	$0
3.404	Bluewater PRV Chamber CSE Retorfit	Central	$76					$76	$0
3.408	Beaver Bank Reservoir Meter Upgrade	Central	$35					$35	$0
3.407	Brunello Booster Station - Pump Control Modifications	West	$27					$27	$0
3.400	Ritcey Crescent PRV - New Meter	East	$11					$11	$0
3.401	Golf View Drive PRV Chamber Rehabilition	East	$18					$18	$0
3.405	Eaglewood Pumping Station - Upgrades	Central	$9					$9	
3.406	Parkdale Booster Station Decommissioning	West	$22					$22	
3.426	Robie 2 Emergency Pump - Pump Control Review and Optimization	West	$105					$105	
3.427	Lyle Street Pumping Station Upgrades	East	$235					$235	
3.440	Bulk Fill Service connection for the Cowie Hill Operations Depot	West	$51					$51	
3.441	Main Control Chamber Annubar Meter Replacement	West	$55					$55	$0
3.402	Steel Reservoir Inspection and Assessment Study	HRM	$175					$175	$0
3.414	Dam Safety Review	HRM		$300				$300	$0
3.116	Bedford South (Hemlock) Reservoir CCC	West	$250	$5,750				$6,000	
3.288	Akerley Reservoir Rehabilitation	East				$2,560		$2,560	
3.115	Herring Cove Reservoir CCC	West						$0	$2,990
3.344	Leiblin Drive Booster Station - Replacement of Diesel Fire Pump	West	$395					$395	
3.379	Aerotech Reservoir Twinning	Aerotech					$2,440	$2,440	
3.110	Mount Edward Reservoir Replacement	East						$0	$7,910
3.309	Cowie Hill Reservoir Replacement	West						$0	$4,570
Water - Structures -- T O T A L S			**$1,954**	**$8,645**	**$350**	**$3,310**	**$3,190**	**$17,449**	**$15,470**
Water - Treatment Facilities									
	JD Kline Water Supply Plant:								
3.264	JD Kline WSP Upgrade Program	W/C	$0	$0	$0	$300	$300	$600	$0
3.417	JD Kline WSP - Process Review Study	W/C		$235				$235	$0
3.393	JD Kline WSP - Process Upgrade/Replacement Program	W/C	$0	$0	$0	$500	$500	$1,000	$0
3.157	JD Kline WSP - Underdrains and Filter Media Replacement Program	W/C	$4,100					$4,100	$0
3.415	JD Kline WSP - Raw Water Intake Traveling Screen Replacement Program	W/C	$905	$905	$905			$2,715	$0
3.374	JD Kline WSP - Replace Filter Isolation Gates	W/C	$50		$590			$640	$0
3.413	JD Kline WSP - Storage Building Improvements	W/C	$76					$76	$0
3.409	JD Kline WSP - Purchase New Boat for Lake Sampling	W/C	$32					$32	$0
3.424	JD Kline WSP - Replace Existing 4160 Transformer in Low Lift Station	W/C	$26					$26	$0
3.423	JD Kline WSP - New Grounding Bar for Crane	W/C	$17					$17	$0
3.428	JD Kline WSP - Caustic Tank Liner Replacements	W/C	$13	$13				$26	$0

Five Year Capital Budget - Water

Project ID	Project Name	Region	Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			All $ in 000's						
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
3.353	J D Kline WSP - Effluent Valve Actuator Replacement Program	W/C	$100	$100	$100			$300	$0
3.242	JD Kline WSP - Replace CO2 Feeders	W/C	$70	$590				$660	$0
3.338	J D Kline WSP - Upgrades to the Process Wastewater Lagoons	W/C	$50	$540				$590	$0
3.361	JD Kline WSP - Replace Turbidity Meters	W/C	$50					$50	$0
3.236	JD Kline WSP - Ampgard III to Vacuum Contactor Conversion	W/C	$40					$40	$0
3.439	JD Kline WSP - Filter Gallery Electrical Wiring Upgrades	W/C	$55					$55	$0
3.443	JD Kline WSP - Pilot Plant PLC Upgrade	W/C	$19					$19	$0
3.352	JD Kline WSP - New Mixers in Pre-Mix Chamber	W/C			$580			$580	$0
3.354	JD Kline WSP - Upgrade the PLC	W/C		$420				$420	$0
3.341	JD Kiline WSP - Roof Replacement	W/C		$270				$270	$0
3.431	JD Kiline WSP - Fluoride Tank Liner Replacement	W/C			$13			$13	$0
3.365	JD Kline WSP - Raw Water Transmission Main Replacement	W/C				$200	$4,500	$4,700	$0
3.351	JD Kline WSP - Replace Westinghouse Electrical Panels	W/C	$5	$5	$5	$5		$20	$0
3.388	JD Kiline WSP - Access Road & Low Lift Parking Lot Asphalt Rehabilitation	W/C				$925		$925	$0
3.134	J D Kline WSP - Removal of Aluminium in the process wastewater	W/C						$0	$2,710
3.137	JD Kline WSP - Flow Splitting Improvements in the Pre-Mix	W/C						$0	$1,300
3.136	JD Kline WSP - Lobby Upgrades	W/C						$0	$180
3.138	J D Kline WSP - Replace Pump Motors #1 and #3	W/C						$0	$280
3.142	JD Kline WSP - Mechanical Mixers in the Mixing Tanks	W/C						$0	$1,000
	Lake Major Water Supply Plant:								
3.265	Lake Major WSP Upgrade program	East	$0	$0	$0	$100	$100	$200	$0
3.279	Lake Major WSP - Replace Raw Water Pumping Station - Design	East	$250					$250	$0
3.392	Lake Major WSP - Replace Raw Water Pumping Station - Construction	East				$8,580		$8,580	$0
3.159	Lake Major WSP - Replace Contactors in the MCC	East	$34	$17				$51	$0
3.162	Lake Major WSP - Butterfly valve replacement program	East	$100	$100	$100	$100	$100	$500	$0
3.278	Lake Major WSP - Clarifier Repair	East	$285					$285	$0
3.422	Lake Major WSP - New Alum and Fluoride Tanks	East	$145					$145	$0
3.421	Lake Major WSP - Improved access to Pipe Gallery	East	$50					$50	$0
3.429	Lake Major WSP - Purchase H-Frame for Fall Arrest System	East	$9					$9	$0
3.430	Lake Major WSP - Pre-Oxidation Strategy Study	East	$120	$320				$440	$0
3.420	Lake Major WSP - Yard Drainage and Parking Area Improvements	East	$160					$160	$0
3.314	Lake Major WSP - East Lake Dam Repairs	East	$65		$600			$665	$0
3.302	Lake Major WSP - Dechlorination System Design	East	$75					$75	$0
3.444	Lake Major WSP - Motor Protection Relays	East	$60					$60	$0
3.195	Lake Major WSP - Filtration System Replacement	East			$2,000	$2,000		$4,000	$0
3.161	Lake Major WSP - Replace the Lime Feed and Delivery System	East		$380				$380	$0
3.313	Lake Major WSP - Optimize Post Filter Chemical Injection Points	East		$60				$60	$0
3.318	Lake Major WSP - Waste Residuals Management - Construction	East				$250		$250	$7,790
3.323	Lake Major WSP - Purchase/Install a Pilot Plant Process Optimization	East					$300	$300	$0

Five Year Capital Budget - Water									
			All $ in 000's						
Project ID	Project Name	Region	Y1 2018-2019	Y2 2019-2020	Y3 2020-2021	Y4 2021-2022	Y5 2022-2023	Total Y1 to Y5	Future Years
3.312	Lake Major WSP - Install Air Gaps on Filter to Waste Piping	East						$0	$200
	Bennery Lake Water Supply Plant:								
3.267	Bennery Lake WSP - Upgrade Program	Bennery		$225	$225	$225	$225	$900	$0
3.41	Bennery Lake WSP - Access Road Improvements Study Phase Only	Bennery	$130					$130	$0
3.418	Bennery Lake WSP - Sludge Valve Replacement Program	Bennery	$7	$7				$14	$0
3.433	Bennery Lake WSP - Actuator for Backwash Control Valve	Bennery	$13					$13	$0
3.272	Bennery Lake WSP - New Low Lift VFD Pump Replacement Program	Bennery	$110					$110	$0
3.434	Bennery Lake WSP - Manganese Removal Strategy Study	Bennery	$60					$60	$0
3.275	Bennery Lake WSP - Filter Media Replacement	Bennery						$0	$925
3.192	Bennery Lake WSP - Oxygenation	Bennery						$0	$435
	Non - Urban Core Water Supply Plant:								
3.266	Non-Urban Core WSP Upgrade program	HRM	$0	$150	$150	$150	$150	$600	$0
3.412	Miller Lake Small System - Supply Treatment Improvements	Central	$235					$235	$0
3.425	Miller Lake Small System - Water Storage Tank	Central	$16					$16	$0
3.445	Collins Park WSP - Air Exchange System	Central	$26					$26	$0
3.435	Lake Lamont - Replace Suction Piping and Chlorine Injection	East	$72					$72	$0
3.211	Chlorine Analyzer Replacement Program	HRM	$23	$23	$23	$23	$23	$115	$0
Water - Treatment Facilities -- T O T A L S			**$7,653**	**$4,360**	**$5,291**	**$13,358**	**$6,198**	**$36,860**	**$14,820**
Water - Energy									
3.221	Energy Management Capital Program (Water)	HRM	$0	$0	$150	$400	$400	$950	$0
3.107	Chamber HVAC Retro-Commissioning Program	HRM	$0	$100	$100	$100	$100	$400	$0
3.438	JD Kiline WSP - 2nd Boiler Replacement	W/C	$100					$100	$0
3.437	Lake Major WSP - Process Area HVAC Upgrades	East	$75	$675				$750	$0
3.254	Bennery Lake WSP - MCC Replacement	Bennery		$750				$750	$0
3.269	Bennery - HVAC Upgrades	East			$250			$250	$0
Water - Energy -- T O T A L S			**$175**	**$1,525**	**$500**	**$500**	**$500**	**$3,200**	**$0**
Water - Security									
4.009	Security Upgrade Program	HRM	$50	$50	$50	$50	$50	$250	$0
Water - Security -- T O T A L S			**$50**	**$50**	**$50**	**$50**	**$50**	**$250**	**$0**
Water - Equipment									
3.101	Miscellaneous Equipment Replacement	HRM	$50	$50	$50	$50	$50	$250	$0
Water - Equipment -- T O T A L S			**$50**	**$50**	**$50**	**$50**	**$50**	**$250**	**$0**
TOTALS - Water			**$15,011**	**$25,668**	**$19,936**	**$22,592**	**$30,542**	**$113,749**	**$149,800**

Five Year Capital Budget - Wastewater

Project ID	Project Name	Region	Y1 2018-2019	Y2 2019-2020	Y3 2020-2021	Y4 2021-2022	Y5 2022-2023	Total Y1 to Y5	Future Years
			All $ in 000's						
Wastewater - Trunk Sewers									
2.526	Wastewater Trunk Sewer Asset Renewal Program	HRM				$2,000	$2,000	$4,000	$0
2.467	Kearney Lake Road Wastewater Sewer Upgrades	West	$1,200	$640				$1,840	$0
2.384	RWWFP Project MC4 - Localized Upgrade to Sackville Trunk Sewer	Central						$0	$16,740
2.070	Bedford Sackville Trunk Sewer - Maintenance Access Routes	Central						$0	$1,500
2.584	Bedford to Halifax Trunk Sewer Upgrade	West	$500	$9,690	$9,690			$19,880	$0
Wastewater - Trunk Sewers -- T O T A L S			**$1,700**	**$10,330**	**$9,690**	**$2,000**	**$2,000**	**$25,720**	**$18,240**
Wastewater - Collection System									
2.052	Integrated Wastewater Projects - Program	HRM	$1,915	$1,500	$1,500	$1,500	$1,500	$7,915	$0
2.168	Wastewater System - Trenchless Rehabilitation Program	HRM	$1,490	$3,000	$3,000	$3,000	$3,000	$13,490	$0
2.504	Collection System Asset Renewal Program	HRM			$2,000	$2,000	$2,000	$6,000	$0
2.658	Wastewater Lateral Lining	HRM	$2,100					$2,100	$0
2.659	Fairview Clayton Park Bridgeview I/I Reduction	HRM	$2,880					$2,880	$0
2.649	Inglis Street Sewer / Pier A PS - Ventilation/Odour Control Modifications	West	$80					$80	$0
2.013	Wanda Lane Sanitary Sewer Replacement	East	$50	$2,150				$2,200	$0
2.356	Auburn Avenue Sanitary Sewer	West	$25	$525				$550	$0
2.657	Glendale Drive to Sackville Trunk Sewer - System Upgrade	Central	$400					$400	$0
2.557	Punch Bowl PS Eliminiation	West			$35	$2,365		$2,400	$0
2.437	Hines Road Rider Sewer Extension	East		$405				$405	$0
2.195	Gravity sewer from Little Albro Lake to Jamieson St PS (DA1) from RWWFP	East						$0	$4,200
2.196	Sewer Improvements from Fenwick Street to Old Ferry Rd Pumping Station with the addition of Maynard Street	East						$0	$3,120
2.390	RWWFP Project DA3 - Sewer Twinning Albro Lake/Slayter Street to Old Ferry Road	East				$150	$300	$450	$8,750
2.163	Barrington Street Combined Sewer Upgrade	West						$0	$900
2.439	RWWFP Project SP3 - Gravity Sewer for Connection of Springfield Lake to Sackville System	Central						$0	$1,090
2.357	Manhole Renewals WW	HRM	$25	$25	$25	$28	$28	$131	$0
2.358	Lateral Replacements WW (non-tree roots)	HRM	$1,650	$1,685	$1,720	$1,750	$1,785	$8,590	$0
2.563	Lateral Replacements WW (tree roots)	HRM	$520	$526	$541	$552	$567	$2,706	$0
2.223	Wet Weather Management Program	HRM	$225	$250	$250	$250	$250	$1,225	$0
2.548	Regional Development Charge Studies	HRM	$50					$50	$0
2.074	Bedford West Collection System CCC	West	$15	$50				$65	$0
2.009	North Preston Sewershed - Wastewater Collection System Replacement Program	East						$0	$3,200
2.086	Ellenvale Holding Tank Sewershed	East						$0	$7,000
2.011	Eastern Passage Sewage Collection System Upgrades	East						$0	$54,500
2.145	Dorothea Drive Sanitary Sewer Upgrade	East						$0	$300
2.075	Beaver Crescent Collection System Replacement	East						$0	$4,100
	- WRWIP PROJECTS							$0	$0
	Young Street - Sewer Separation	West	$100	$1,430				$1,530	$0
	Kempt Road Phase 1 - Sewer Separation	West	$200	$2,780				$2,980	$0
	South Park Street - Sewer Separation	West			$1,780			$1,780	$0
	Bayers Road Phase 1 - Sewer Separation	West	$75	$1,045				$1,120	$0
	Joseph Howe Drive - Sewer Separation	West	$100	$1,375				$1,475	$0

Five Year Capital Budget - Wastewater									
			All $ in 000's						
Project ID	Project Name	Region	Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
	Romans - Federal Avenues - Sewer Separation	West	$170	$2,435				$2,605	$0
	Robie Street - Sewer Separation	West			$2,610			$2,610	$0
	College Street - Sewer Separation	West				$3,530		$3,530	$0
	Bayers Road Phase 2 - Sewer Separation	West				$1,390		$1,390	$0
	Kempt Road Phase 2 - Sewer Separation	West					$9,370	$9,370	$0
	Windsor - Almon - Sewer Separation	West						$0	$2,285
	Spring Garden Road Phase 1 - Sewer Separation	West						$0	$885
	Young Street Pocket - Sewer Separation - Side Streets	West						$0	$1,760
	Spring Garden Road Phase 2 - Sewer Separation	West						$0	$550
	Conaught - Windsor Pocket - Sewer Separation	West						$0	$3,505
	Conaught Avenue - Sewer Separation	West						$0	$2,810
	Bayers Road Phase 3 - Sewer Separation	West						$0	$1,675
	- WRWIP PROJECTS							$0	$0
2.610	Combined Sewer Upgrade - Quinpool from Preston to Oxford	West		$35	$345			$380	$0
2.636	Gottingen/North Flow Split -Alteration to Combined Sewer	West	$50	$450				$500	$0
2.586	Combined Sewer Upgrade - Portland Place & Brunswick Street	West		$25	$175			$200	$0
2.581	WRWIP_CrownDrive: BLT Flow Diversion to Herring Cove - New Gravity Sewer Connection_(Crown_G_Connection)	West						$0	$3,290
2.582	WRWIP_CrownDrive: BLT Flow Diversion to Herring Cove - New Gravity Sewer_Crown_G(Crown_G)	West						$0	$3,920
2.587	WRWIP_HerringCove: Herring Cove Road - Gravity Sewer Upgrades_HCR_G	West						$0	$6,810
2.588	WRWIP_Kearney: Linear Upgrade - Donaldson Avenue_KLR_G1	West						$0	$660
Wastewater - Collection System -- T O T A L S			**$12,120**	**$19,691**	**$13,981**	**$16,515**	**$18,800**	**$81,107**	**$115,310**
Wastewater - Forcemains									
2.080	Forcemain Replacement Program	HRM	$0	$500	$500	$1,000	$1,000	$3,000	$0
2.543	Kearney Lake Road Forcemain Extension	West	$1,253	$665				$1,918	$0
2.40	RWWFP Project DA7 - Forcemain for Old Ferry Road Pumping Station	East				$100	$300	$400	$2,460
2.494	RWWFP Project SP1 - Springfield Forcemain	Central						$0	$2,380
2.079	North Preston #3 - Johnson Rd Forcemain - Capacity Upgrade	East						$0	$800
	- WRWIP PROJECTS							$0	
2.58	Armdale Pumping Station Forcemain Replacement	West						$0	$3,040
2.608	New Timberlea Pump Station Forcemain System	West		$200	$15,100			$15,300	$0
2.62	WRWIP_YoungeStreet: Upgrade Young Pumping Station Capacity - Forcemain_TYNG_FM	West						$0	$115
2.579	WRWIP_CrownDrive: BLT Flow Diversion to Herring Cove - New Crown Drive Forcemain_Crown_FM(Crown_FM)	West						$0	$8,150
Wastewater - Forcemains -- T O T A L S			**$1,253**	**$1,365**	**$15,600**	**$1,100**	**$1,300**	**$20,618**	**$16,945**
Wastewater - Structures									
2.420	Emergency Pumping Station Pump replacements	HRM	$250	$250	$250	$250	$250	$1,250	$0
2.442	Wastewater Pumping Station Component Replacement Program - West Region		$0	$200	$200	$200	$200	$800	$0
2.443	Wastewater Pumping Station Component Replacement Program - East Region		$200	$200	$200	$200	$200	$1,000	$0
2.444	Wastewater Pumping Station Component Replacement Program - Central Region		$150	$100	$100	$100	$100	$550	$0
2.476	Wastewater Pumping Station Asset Renewal Program	HRM				$2,500	$5,000	$7,500	$0
	Wastewater Pumping Station Asset Renewal Program (CWWF)	HRM					$10,000	$10,000	$10,000

Five Year Capital Budget - Wastewater									
Project ID	Project Name	Region	All $ in 000's						
			Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
2.466	Weybridge Lane Pump Station CCC	West	$5,060	$4,140				$9,200	$0
2.005	Autoport Pleasant Street PS Replacement	East		$3,000				$3,000	$0
2.66	Bissett PS Component Upgrade	East	$50	$1,200				$1,250	$0
2.655	Roach's Pond PS Component Upgrade	West	$275		$400			$675	$0
2.366	Shipyard Road PS	Central	$915					$915	$0
2.088	Russell Lake PS Upgrade	East		$100	$2,400			$2,500	$0
2.093	Windmill Road PS Replacement	East	$1,455					$1,455	$0
2.654	PS Control Panel / Electrical Replacement	HRM	$1,050					$1,050	$0
2.665	CSO Upgrade Program	HRM	$300	$300	$300	$300	$300	$1,500	$8,710
2.459	William's Lake PS Rehabilition	West		$150	$2,660			$2,810	$8,180
2.661	Bayers Lake Phase V Pumping Station	West		$130				$130	$22,400
2.669	Halifax CSO Surveying	West	$45					$45	$0
2.081	Main Street, Memorial Drive, O'Dell Drive, Humber Park PS Upgrades	East						$0	$5,000
2.008	Gaston Rd PS Upgrade	East						$0	$900
2.405	RWWFP Project DA6 - Upgrade Old Ferry Pumping Station	East				$200	$500	$700	$8,710
2.447	RWWFP Projects MC2, MC3 - Wastewater Storage	Central			$2,500	$8,200	$8,200	$18,900	$21,255
2.493	RWWFP Project SP2 - Springfield Lake PS	Central						$0	$1,460
2.089	Fairfield Holding Tank Rehabilitation	West						$0	$6,050
2.006	Valleyford Holding Tank	East						$0	$1,100
2.111	Armdale Roundabout CSO screening	West						$0	$3,000
2.112	Quinpool Road CSO screening	West						$0	$3,000
2.113	Coburg Road CSO screening	West						$0	$3,000
2.114	South Street CSO screening	West						$0	$3,000
2.115	Beaufort Avenue CSO screening	West						$0	$3,000
2.450	Quigley's Corner Pump Replacement and PS Upgrade	East						$0	$5,500
2.583	* DUPLICATE WITH EXISTING PROJECT?* WRWIP_Fairfield: New Fairfield Holding Tank_FLD_HT	West						$0	$12,470
2.609	New Timberlea Pumping Station	West		$400	$5,560			$5,960	$0
2.617	WRWIP_YoungeStreet: Upgrade Young Pumping Station Capacity - Pumps_YNG_PS	West						$0	$2,110
2.580	WRWIP_CrownDrive: BLT Flow Diversion to Herring Cove - New Crown Drive Pumping Station_Crown_PS_(Crown_PS)	West						$0	$8,110
Wastewater Structures -- T O T A L S			**$9,750**	**$10,170**	**$14,570**	**$11,950**	**$24,750**	**$71,190**	**$136,955**
Wastewater - Treatment Facility									
2.056	Plant Optimization Program	HRM	$125	$125	$125	$125	$125	$625	$0
2.522	Emergency Wastewater Treatment Facility equipment replacements	HRM	$400	$400	$400	$400	$400	$2,000	$0
2.668	Wastewater Treatment Research Program	HRM		$200				$200	$0
2.044	Wastewater Treatment Facilities - Backup Power Upgrade Program (Various Locations)	HRM						$0	$1,889

Five Year Capital Budget - Wastewater

Project ID	Project Name	Region	All $ in 000's						
			Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
	Halifax Wastewater Treatment Facility:								
2.506	Halifax WWTF - Asset Renewal Program	West	$0	$350	$350	$750	$750	$2,200	$0
2.532	Halifax WWTF - Duct Work Replacement	West	$50	$50	$50	$25	$25	$200	$0
2.653	Halifax WWTF - New Raw Water Pumps	West	$350	$350	$350			$1,050	$0
2.536	Halifax WWTF - Sludge Dewatering Equipment Renewal	West						$0	$3,000
	Dartmouth Wastewater Treatment Facility:								
2.507	Dartmouth WWTF - Asset Renewal Program	East	$0	$500	$500	$500	$500	$2,000	$0
2.502	Dartmouth WWTF - Duct Work Replacement	East	$25	$25	$25	$15	$15	$105	$0
2.499	Dartmouth WWTF - Sludge Dewatering Equipment Renewal	East						$0	$3,000
2.416	Dartmouth WWTF Upgrade (DA8) (Was project ID 2.822 in IRP)	East						$0	$39,200
	Herring Cove Wastewater Treatment Facility:								
2.508	Herring Cove WWTF - Asset Renewal Program	West	$0	$250	$250	$250	$250	$1,000	$0
2.639	Herring Cove WWTF - Duct Work Replacement Program	West	$25	$25	$25	$15	$15	$105	$0
2.652	Herring Cove WWTF - Densadeg Flow Meters	West	$75					$75	$0
	Mill Cove Wastewater Treatment Facility:								
2.505	Mill Cove WWTF - Asset Renewal Program	Central	$0	$250	$350	$350	$350	$1,300	$0
2.644	Mill Cove WWTF - Civil Asset Condition Assessment	Central	$75					$75	$0
2.645	Mill Cove WWTF - Compactor/Conveyor Replacement	Central	$300					$300	$0
2.662	Mill Cove WWTF - RAS Piping Replacement	Central	$200					$200	$0
2.642	Mill Cove WWTF - South Secondary Splitter Box Rehabilitation	Central		$30		$270		$300	$0
2.643	Mill Cove WWTF - RAS Pump Upgrade	Central		$85				$85	$0
2.567	Mill Cove WWTF - Process Upgrade - Conceptual Design	Central	$50					$50	$0
2.640	Mill Cove WWTF - MBR Process Upgrades - Preliminary + Detailed Design	Central		$150				$150	$0
2.021	Mill Cove WWTF Upgrade	Central						$0	$50,000
	Eastern Passage Wastewater Treatment Facility:								
2.666	Asset Renewal Program	East	$0	$0	$100	$150	$150	$400	$0
2.468	Process Upgrade Program	East	$50	$50	$50	$50	$50	$250	$0
2.646	Secondary Launder Covers	East	$150					$150	$0
	Aerotech Wastewater Treatment Facility:								
2.667	Asset Renewal Program	Aerotech	$0	$100	$100	$150	$150	$500	$0
2.510	Process Upgrade Program	Aerotech	$50	$50	$50	$100	$100	$350	$0
	Timberlea Wastewater Treatment Facility:								
2.509	Asset Renewal Program	West	$50	$50	$50	$50	$50	$250	$0
2.647	Decommissioning	West						$0	$500
	Community Wastewater Treatment Facility:								
2.050	Community WWTFs - Asset Renewal Program	HRM	$0	$250	$250	$250	$250	$1,000	$0
2.648	Uplands WWTF - New Screening Facility	HRM	$290					$290	$0
2.663	Fall River/Lockview WWTF - Waterline Replacement	HRM	$25					$25	$0
2.664	Fall River/Lockview WWTF - Driveway Replacement	HRM	$38					$38	$0

Five Year Capital Budget - Wastewater									
Project ID	Project Name	Region	All $ in 000's						
			Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
	Biosolids Processing Facility:								
2.126	Biosolids Processing Facility -	HRM	$250	$400	$400	$250	$250	$1,550	$0
2.656	Dryer Bypass Conveyor	HRM	$300					$300	$0
2.513	Silo Painting	HRM			$90			$90	$0
Wastewater - Treatment Facility -- T O T A L S			**$2,878**	**$3,690**	**$3,515**	**$3,700**	**$3,430**	**$17,213**	**$97,589**
Wastewater - Energy									
2.362	Energy Management Capital Program (Wastewater)	HRM	$0	$500	$500	$500	$500	$2,000	$0
2.491	Pump Station HVAC Retro-Commissioning Program	HRM	$100	$100	$100	$100	$100	$500	$0
2.650	HHSP - BAS + HVAC Recommissioning	HRM	$50	$50	$50			$150	$0
2.651	Wastewater Pump Stations - NSPI Meter Relocations	HRM	$50					$50	$0
2.637	Halifax WWTF - UV Channel/Densadeg Gate Actuators	East	$120					$120	$0
2.638	Dartmouth WWTF - UV Channel/Densadeg Gate Actuators	East	$155					$155	$0
2.488	Mill Cove WWTF - Admin Building HVAC Renewal	Central		$330				$330	$0
2.554	Wastewater Pumping Station Performance Testing	HRM	$0	$250				$250	$0
	Dartmouth WWTF - Waste Heat Recovery	East						$0	$750
	Halifax WWTF - Waste Heat Recovery	Central						$0	$750
Wastewater - Energy -- T O T A L S			**$475**	**$1,230**	**$650**	**$600**	**$600**	**$3,555**	**$1,500**
Wastewater - Security									
4.008	Security Upgrade Program	HRM	$200	$200	$200	$200	$200	$1,000	$0
Wastewater - Security -- T O T A L S			**$200**	**$200**	**$200**	**$200**	**$200**	**$1,000**	
Wastewater - Equipment									
2.161	I&I Reduction (SIR) Program Flow Meters and Related Equipment	HRM	$25	$25	$25	$25	$25	$125	$0
2.451	Miscellaneous Equipment Replacement	HRM	$70	$70	$70	$70	$70	$350	$0
Wastewater - Equipment -- T O T A L S			**$95**	**$95**	**$95**	**$95**	**$95**	**$475**	**$0**
TOTALS - Wastewater			**$28,471**	**$46,771**	**$58,301**	**$36,160**	**$51,175**	**$220,878**	**$386,539**

Five Year Capital Budget - Stormwater

Project ID	Project Name	Region	Y1 2018-2019	Y2 2019-2020	Y3 2020-2021	Y4 2021-2022	Y5 2022-2023	Total Y1 to Y5	Future Years
			All $ in 000's						
Stormwater - Pipes									
1.108	Stormwater Pipe Asset Renewal Program	HRM		$450	$1,000	$0	$1,500	$2,950	$0
1.163	Doyle Street Storm Sewer	Central	$250					$250	$0
1.140	Stormwater Main Sewer Lining	HRM	$0	$100	$100	$100	$100	$400	$0
1.038	Integrated Stormwater Projects - Program	HRM	$1,500	$750	$750	$750	$750	$4,500	$0
1.042	Deep Storm Sewer Installation Program	HRM		$500	$1,000	$0	$1,500	$3,000	$0
1.145	Sullivan's Pond Storm Sewer System Replacement - Phase 2 Irishtown Rd to Harbour	East			$350	$11,000		$11,350	$0
1.034	Raymond Street, Phase 2 - Storm Sewer Rehabilitation	East					$1,990	$1,990	$0
1.102	Manhole Renewals SW	HRM	$21	$21	$21	$21	$24	$108	$0
1.103	Catchbasin Renewals SW	HRM	$50	$52	$52	$55	$55	$264	$0
1.135	Lateral Replacements SW	HRM	$15	$15	$15	$15	$18	$78	$0
1.019	Drainage Remediation Program Surveys/Studies	HRM	$25	$25	$25	$25	$25	$125	$0
1.134	Stormwater Quality Compliance Needs Assessment from IRP	HRM			$75	$75	$75	$225	$0
1.025	Pinehill Drive Embankment Protection	Central						$0	$166
1.050	Alder - Piper Park Stormwater System Replacement	East						$0	$1,000
1.066	Winston Drive Stormwater Cross-Connection - Churchill Estates, Herring Cove	West						$0	$100
1.071	Kempt Road Stormwater Sewer	West						$0	$500
1.129	Separation/resewerage - New storm sewers for Springfield Lake Stormwater Collection System (SP5 in RWWFP)	Central						$0	$10,742
1.014	Perth Street, Wardour Street, Fort Sackville Road - Deep Storm Sewer Installation	Central						$0	$1,205
1.028	Cavalier Drive Storm Sewer Outfall - Erosion Remediation	Central						$0	$200
1.053	Barrington Street Storm Sewer Separation	West						$0	$300
1.070	Lake Drive Stormwater Sewer	West						$0	$11
								$0	$75
Stormwater - Pipes -- T O T A L S			**$1,861**	**$1,913**	**$3,388**	**$12,041**	**$6,037**	**$25,240**	**$14,299**
Stormwater - Culverts/Ditches									
1.104	Driveway Culvert Replacements	HRM	$795	$812	$828	$848	$866	$4,149	$0
1.109	Cross Culvert Renewal Program	HRM	$0	$2,000	$2,000	$2,000	$2,000	$8,000	$0
	Street Specific Culvert Replacement:								
	ST MARGARETS BAY RD, 2797		$82					$82	$0
	LAKE MAJOR RD, near civic 190		$77					$77	$0
	CLARENCE ST, near civic 4		$80					$80	$0
	WINDGATE DR, near civic 107		$80					$80	$0
	ORCHARD DR, near civic 32		$88					$88	$0
	NOTTINGHAM DR, near civic 53		$90					$90	$0
	PENNY LANE AT WINDSOR DR		$90					$90	$0
	KNIGHT BRIDGE DR at BUCKINGHAM DR		$81					$81	$0
	ALLENBY DR, near civic 34		$83					$83	$0
	ALLENBY DR, near civic 2		$83					$83	$0
	MINNA DR, near civic 6		$85					$85	$0
	ST MARGARETS BAY RD, near civic 2916		$91					$91	$0
	STELLA CRT, near civic 1		$76					$76	$0

Five Year Capital Budget - Stormwater

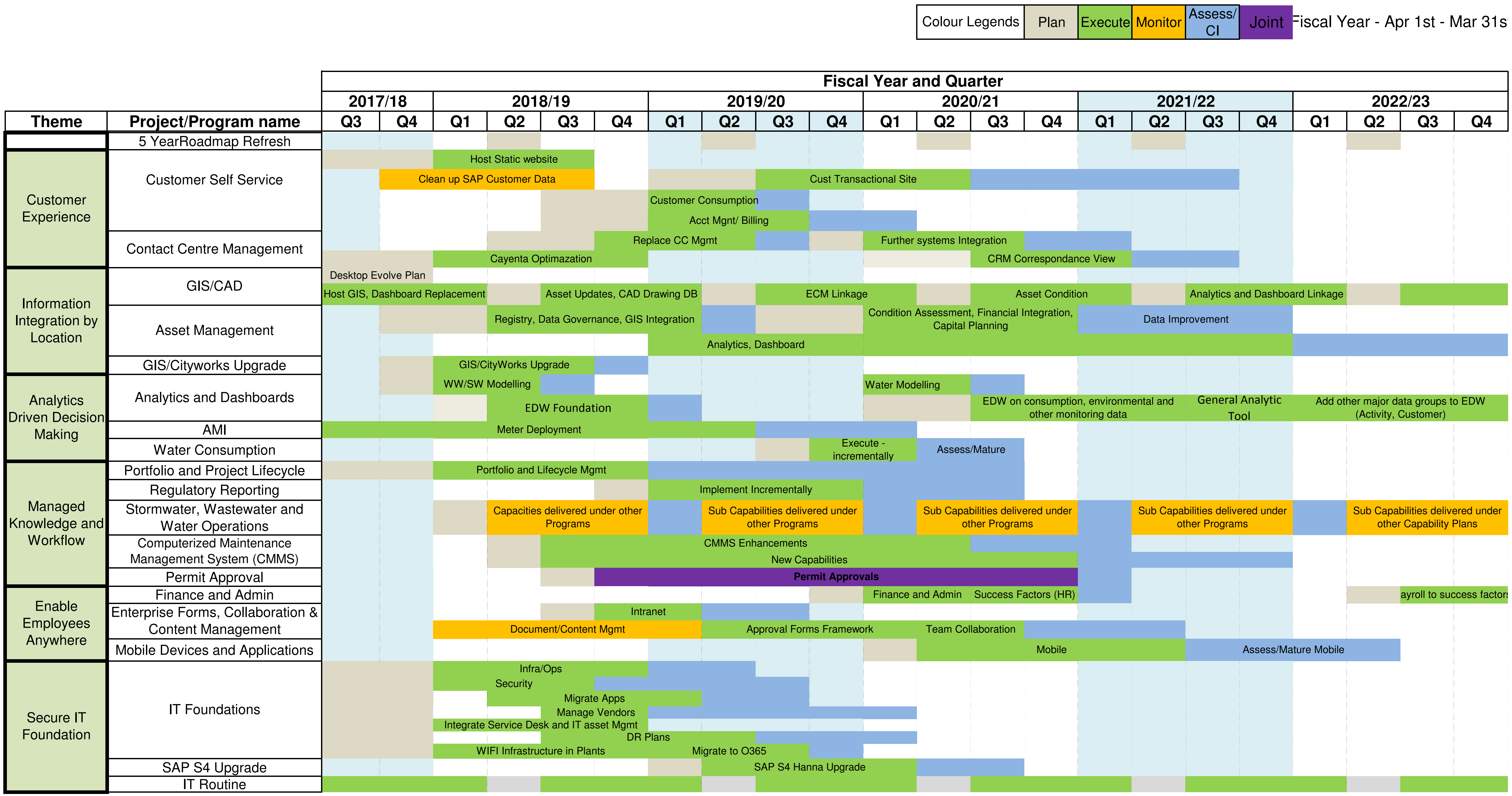
Project ID	Project Name	Region	Y1 2018-2019	Y2 2019-2020	Y3 2020-2021	Y4 2021-2022	Y5 2022-2023	Total Y1 to Y5	Future Years
			All $ in 000's						
	RAMAR DR, near civic 6		$93					$93	$0
	ST MARGARETS BAY RD, near Second Chain Lake		$91					$91	$0
	ROSS RD, near civic 241		$74					$74	$0
	CLARENCE AVE, AT HOWARD AVE		$76					$76	$0
	CLARENCE AVE, NEAR MORRIS AVE		$69					$69	$0
	BRAESIDE AVE, near civic 2		$105					$105	$0
	COW BAY RD, near civic 1174		$76					$76	$0
	SHORE RD, near civic 1796		$88					$88	$0
	HINES RD, near civic 195		$82					$82	$0
	RITCEY CRES, near civic 1		$90					$90	$0
1.125	Coronet Avenue Driveway Culvert Replacement Project	West						$0	$586
1.015	Hammonds Plains Road & Bluewater Road Intersection - Drainage Improvements	Central						$0	$475
1.064	Culvert replacement - Civic # 215 Village Rd, Herring Cove	West						$0	$75
1.060	Civic #150 Kaye Street, Lower Sackville - Cross Culvert replacement	Central						$0	$100
Stormwater - Culverts/Ditches -- T O T A L S			**$2,725**	**$2,812**	**$2,828**	**$2,848**	**$2,866**	**$14,079**	**$1,236**
Stormwater - Structures									
1.133	Ellenvale Run Retaining Wall System - Replacement	East	$2,525	$2,525	$2,525	$2,525	$0	$10,100	$0
Stormwater - Structures -- T O T A L S			**$2,525**	**$2,525**	**$2,525**	**$2,525**	**$0**	**$10,100**	**$0**
TOTALS - Stormwater			**$7,111**	**$7,250**	**$8,741**	**$17,414**	**$8,903**	**$49,419**	**$15,535**

Five Year Capital Budget - Corporate Projects									
Project ID	Project Name	Region	All $ in 000's						
			Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
Corporate - Information Technology									
4.011	Desktop Computer Replacement Program	HRM	$290	$290	$290	$290	$290	$1,450	$0
4.012	Network Infrastructure Upgrades	HRM	$220	$220	$220	$220	$220	$1,100	$0
4.013	Document Management Program	HRM	$100					$100	$0
4.083	Computerized Maintenance Management System Enhancements	HRM	$1,000	$1,000	$1,000	$1,000	$1,000	$5,000	$0
4.024	Sharepoint Implementation	HRM	$100					$100	$0
4.043	AMI/AMR Meter System Upgrades	HRM	$9,730	$1,667	$0			$11,397	$0
4.048	SAP Rate Structure Support	HRM	$220		$220			$440	$0
4.074	Asset Registry Build	HRM	$100	$200				$300	$0
4.084	Halifax Water Website	HRM	$500					$500	$0
4.085	Portfolio and Project Lifecycle	HRM	$380					$380	$0
4.086	IT Foundations	HRM	$2,000	$90				$2,090	$0
4.087	Wi-Fi Design and Build	HRM	$700					$700	$0
4.088	Cayenta Optimization	HRM	$240					$240	$0
4.089	Telephony	HRM	$120	$90				$210	$0
4.09	Intranet	HRM	$110					$110	$0
4.091	Permit Approvals	HRM	$75	$770				$845	$0
1.161	Stormwater Billing Support	HRM	$200	$225				$425	$0
4.092	Customer Self Service	HRM		$500	$600	$200		$1,300	$0
	Contact Centre Management	HRM			$1,300	$300		$1,600	$0
	Asset Management	HRM		$1,000	$1,000	$1,000		$3,000	$0
	Analytics and Dashboards	HRM	$240		$500	$500	$1,000	$2,240	$0
	Water Consumption	HRM		$150				$150	$0
	Regulatory Reporting	HRM		$400				$400	$0
	Finance and Admin	HRM			$1,400			$1,400	$0
	Enterprise Forms, Collaboration & Content Management	HRM		$800	$600			$1,400	$0
	Mobile Devices and Applications	HRM			$800			$800	$0
	SAP S4 Upgrade	HRM		$2,000	$2,000			$4,000	$0
Corporate - Information Technology -- T O T A L S			**$16,325**	**$9,402**	**$9,930**	**$3,510**	**$2,510**	**$41,677**	**$0**
Corporate - GIS									
4.040	GIS Data Program	HRM		$250	$250	$250	$250	$1,000	$0
4.038	GIS Hardware/Software Program	HRM		$100		$100		$200	$0
4.039	GIS Application Support Program	HRM	$50	$250	$250	$150	$150	$850	$0
4.059	Water Database Model	HRM		$50	$250	$50		$350	$0
	Dashboard Replacement	HRM	$200					$200	$0
	Data Governance	HRM	$50	$150				$200	$0
	GIS Upgrade/Cityworks upgrade	HRM	$350		$200		$200	$750	$0
	Desktop Progression Plan	HRM	$100		$100		$100	$300	$0
	GIS Data Build - Services	HRM	$250	$250	$150		$150	$800	$0

Five Year Capital Budget - Corporate Projects									
			All $ in 000's						
Project ID	Project Name	Region	Y1	Y2	Y3	Y4	Y5	Total Y1 to Y5	Future Years
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023		
	CAD Drawing Database	HRM	$100	$200				$300	$0
	Asset Condition Integration	HRM			$200	$250		$450	$0
Corporate - GIS -- T O T A L S			**$1,100**	**$1,250**	**$1,400**	**$800**	**$850**	**$5,400**	**$0**
Corporate - Asset Management									
4.020	Asset Management Program Development	HRM	$0	$100	$100	$100	$100	$400	$0
4.021	Integrated Resource Plan Update	HRM	$500					$500	$2,500
2.523	Sewer Condition Assessment	HRM	$170	$175	$180	$185	$190	$900	$0
1.156	Storm Sewer Condition Assessment	HRM	$110	$115	$120	$125	$130	$600	$0
1.162	Driveway Culvert Data Collection Program	HRM	$80					$80	$0
2.043	Corporate Flow Monitoring Program	HRM	$1,700	$1,700	$1,700	$1,700	$1,700	$8,500	$0
2.560	Regional Infrastructure Plan - Ph.2 (ITFV)	HRM		$200				$200	$2,500
2.562	Outfall Assessment Project	HRM		$250				$250	$0
3.398	Hydraulic Water Model Build	HRM	$50	$190				$240	$0
Corporate - Asset Management -- T O T A L S			**$2,610**	**$2,730**	**$2,100**	**$2,110**	**$2,120**	**$11,670**	**$5,000**
Corporate - Facility									
2.176	East/Central Regional Operational Facility	East	$100	$500	$6,000	$6,000		$12,600	$0
4.077	Building Capital Improvements	West	$100	$100	$100	$100	$100	$500	$0
Corporate - Facility -- T O T A L S			**$200**	**$600**	**$6,100**	**$6,100**	**$100**	**$13,100**	**$0**
Corporate - SCADA & Other Equipment									
4.093	GPS Units - Replacement	HRM	$42					$42	$0
4.082	GNSS Receiver for Asset Management Data Collection	HRM	$8					$8	$0
4.004	SCADA Control System Enhancements	HRM	$0	$200	$200	$200	$200	$800	$0
4.08	Large and New Customer Meters	HRM	$460	$460	$460	$460	$460	$2,300	$0
Corporate - SCADA & Other Equipment -- T O T A L S			**$510**	**$660**	**$660**	**$660**	**$660**	**$3,150**	**$0**
Corporate - Fleet									
4.006	Fleet Upgrade Program - Stormwater	HRM	$271	$389	$362	$342	$364	$1,728	$0
4.006	Fleet Upgrade Program - Wastewater	HRM	$1,084	$1,556	$1,448	$1,368	$1,456	$6,912	$0
4.007	Fleet Upgrade Program - Water	HRM	$755	$355	$450	$480	$346	$2,386	$0
Corporate - Fleet -- T O T A L S			**$2,110**	**$2,300**	**$2,260**	**$2,190**	**$2,166**	**$11,026**	**$0**
TOTALS - Corporate Projects			**$22,855**	**$16,942**	**$22,450**	**$15,370**	**$8,406**	**$86,023**	**$5,000**

Appendix F

IT Strategy – Five Year Roadmap


Colour Legends
Plan
Execute
Monitor
Assess/ CI
Joint
Fiscal Year - Apr 1st - Mar 31s
Fiscal Year and Quarter
2017/18
2018/19
2019/20
2020/21
2021/22
2022/23
Theme
Project/Program name
Q3
Q4
Q1
Q2
Q3
Q4
Q1
Q2
Q3
Q4
Q1
Q2
Q3
Q4
Q1
Q2
Q3
Q4
Q1
Q2
Q3
Q4
5 YearRoadmap Refresh
Customer Experience
Customer Self Service
Host Static website
Clean up SAP Customer Data
Cust Transactional Site
Customer Consumption
Acct Mgmt/ Billing
Contact Centre Management
Replace CC Mgmt
Further systems Integration
Cayenta Optimazation
CRM Correspondance View
Information Integration by Location
GIS/CAD
Desktop Evolve Plan
Host GIS, Dashboard Replacement
Asset Updates, CAD Drawing DB
ECM Linkage
Asset Condition
Analytics and Dashboard Linkage
Asset Management
Registry, Data Governance, GIS Integration
Condition Assessment, Financial Integration, Capital Planning
Data Improvement
Analytics, Dashboard
GIS/Cityworks Upgrade
GIS/CityWorks Upgrade
Analytics Driven Decision Making
Analytics and Dashboards
WW/SW Modelling
Water Modelling
EDW Foundation
EDW on consumption, environmental and other monitoring data
General Analytic Tool
Add other major data groups to EDW (Activity, Customer)
AMI
Meter Deployment
Water Consumption
Execute - incrementally
Assess/Mature
Managed Knowledge and Workflow
Portfolio and Project Lifecycle
Portfolio and Lifecycle Mgmt
Regulatory Reporting
Implement Incrementally
Stormwater, Wastewater and Water Operations
Capacities delivered under other Programs
Sub Capabilities delivered under other Programs
Sub Capabilities delivered under other Programs
Sub Capabilities delivered under other Programs
Sub Capabilities delivered under other Capability Plans
Computerized Maintenance Management System (CMMS)
CMMS Enhancements
New Capabilities
Permit Approval
Permit Approvals
Enable Employees Anywhere
Finance and Admin
Finance and Admin
Success Factors (HR)
ayroll to success factors
Enterprise Forms, Collaboration & Content Management
Intranet
Document/Content Mgmt
Approval Forms Framework
Team Collaboration
Mobile Devices and Applications
Mobile
Assess/Mature Mobile
Secure IT Foundation
IT Foundations
Infra/Ops
Security
Migrate Apps
Manage Vendors
Integrate Service Desk and IT asset Mgmt
DR Plans
WIFI Infrastructure in Plants
Migrate to O365
SAP S4 Upgrade
SAP S4 Hanna Upgrade
IT Routine

Halifax Water

Appendix G

Projected Operating Statements - Consolidated

STRAIGHT from the SOURCE

HALIFAX WATER
CONSOLIDATED SUMMARY OF ESTIMATED REVENUES & EXPENDITURES
PROPOSED OPERATING BUDGET
APRIL 1, 2018 to MARCH 31, 2023
(in thousands)

DESCRIPTION	ACTUAL APR 1/16 MAR 31/17	APPROVED BUDGET * APR 1/17 MAR 31/18	BUSINESS PLAN: PROPOSED BUDGET APR 1/18 MAR 31/19	YEAR 2 APR 1/19 MAR 31/20	YEAR 3 APR 1/20 MAR 31/21	YEAR 4 APR 1/21 MAR 31/22	YEAR 5 APR 1/22 MAR 31/23
OPERATING REVENUES	$137,997	$135,587	**$135,182**	**$133,526**	**$131,878**	**$130,279**	**$128,729**
OPERATING EXPENDITURES	$97,839	$106,241	**$111,710**	**$115,020**	**$117,845**	**$121,273**	**$124,367**
OPERATING PROFIT	$40,158	$29,346	**$23,472**	**$18,507**	**$14,033**	**$9,006**	**$4,362**
FINANCIAL REVENUES (NON-OPERATING)							
INVESTMENT INCOME	$780	$346	**$480**	**$480**	**$480**	**$480**	**$480**
PNS FUNDING HHSP DEBT	$2,000	$2,000	**$0**	**$0**	**$0**	**$0**	**$0**
MISCELLANEOUS	$542	$441	**$526**	**$533**	**$552**	**$484**	**$486**
	$3,322	$2,787	**$1,006**	**$1,013**	**$1,032**	**$964**	**$966**
FINANCIAL EXPENDITURES (NON-OPERATING)							
LONG TERM DEBT INTEREST	$8,475	$9,532	**$8,560**	**$9,928**	**$10,115**	**$10,397**	**$10,039**
LONG TERM DEBT PRINCIPAL	$21,320	$24,291	**$22,601**	**$22,372**	**$23,382**	**$24,631**	**$25,947**
AMORTIZATION DEBT DISCOUNT	$199	$217	**$245**	**$251**	**$280**	**$306**	**$329**
DIVIDEND/GRANT IN LIEU OF TAXES	$4,578	$4,827	**$5,142**	**$5,383**	**$5,583**	**$5,783**	**$5,983**
MISCELLANEOUS	$49	$15	**$16**	**$21**	**$21**	**$20**	**$20**
	$34,622	$38,882	**$36,564**	**$37,953**	**$39,380**	**$41,137**	**$42,318**
NET PROFIT (LOSS) AVAILABLE FOR CAPITAL EXPENDITURES	$8,858	($6,750)	**($12,086)**	**($18,434)**	**($24,316)**	**($31,167)**	**($36,990)**
Adjustments:							
Pension accrual	*$5,006*	*$4,358*	*$2,940*	*$3,087*	*$3,241*	*$3,403*	*$3,574*
Net Profit (Loss) on a Cash Basis	*$13,864*	*($2,392)*	*($9,146)*	*($15,347)*	*($21,074)*	*($27,764)*	*($33,416)*

** 2017/18 Operating Budget approved by the Board of Directors, February 2, 2017.*

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HALIFAX WATER
ESTIMATED REVENUES AND EXPENDITURES - WATER OPERATIONS
PROPOSED OPERATING BUDGET
APRIL 1, 2018 to MARCH 31, 2023
(in thousands)

DESCRIPTION	ACTUAL APR 1/16 MAR 31/17	APPROVED BUDGET * APR 1/17 MAR 31/18	BUSINESS PLAN: PROPOSED BUDGET APR 1/18 MAR 31/19	YEAR 2 APR 1/19 MAR 31/20	YEAR 3 APR 1/20 MAR 31/21	YEAR 4 APR 1/21 MAR 31/22	YEAR 5 APR 1/22 MAR 31/23
REVENUES							
METERED SALES	$47,183	$46,600	**$46,141**	**$45,546**	**$44,969**	**$44,411**	**$43,870**
FIRE PROTECTION	$7,074	$7,074	**$7,074**	**$7,074**	**$7,074**	**$7,074**	**$7,074**
PRIVATE FIRE PROTECTION SERVICES	$831	$857	**$860**	**$869**	**$879**	**$888**	**$897**
BULK WATER STATIONS	$330	$314	**$329**	**$329**	**$329**	**$329**	**$329**
CUSTOMER LATE PAY./COLLECTION FEES	$282	$212	**$233**	**$231**	**$229**	**$227**	**$225**
MISCELLANEOUS	$153	$149	**$166**	**$166**	**$167**	**$167**	**$168**
	$55,853	$55,207	**$54,803**	**$54,216**	**$53,647**	**$53,097**	**$52,564**
EXPENDITURES							
WATER SUPPLY & TREATMENT	$7,028	$8,565	**$8,750**	**$8,946**	**$9,116**	**$9,298**	**$9,484**
TRANSMISSION & DISTRIBUTION	$8,223	$8,969	**$10,323**	**$10,515**	**$9,858**	**$10,055**	**$10,256**
SMALL SYSTEMS (incl. Contract Systems)	$1,022	$1,073	**$1,194**	**$1,209**	**$1,233**	**$1,258**	**$1,283**
TECHNICAL SERVICES (SCADA)	$774	$873	**$965**	**$1,051**	**$1,072**	**$1,094**	**$1,116**
ENGINEERING & INFORMATION SERVICES	$3,828	$3,515	**$3,681**	**$3,750**	**$3,825**	**$3,901**	**$3,980**
REGULATORY SERVICES	$493	$1,034	**$997**	**$974**	**$994**	**$1,014**	**$1,034**
CUSTOMER SERVICE	$2,290	$2,357	**$2,813**	**$2,816**	**$2,872**	**$2,930**	**$2,988**
ADMINISTRATION & PENSION	$5,966	$5,836	**$5,538**	**$5,579**	**$5,691**	**$5,804**	**$5,921**
DEPRECIATION	$7,756	$9,218	**$9,229**	**$9,836**	**$10,511**	**$11,066**	**$11,468**
	$37,379	$41,441	**$43,489**	**$44,676**	**$45,171**	**$46,419**	**$47,529**
OPERATING PROFIT	$18,474	$13,766	**$11,314**	**$9,540**	**$8,476**	**$6,678**	**$5,035**
FINANCIAL REVENUES (NON-OPERATING)							
INVESTMENT INCOME	$351	$156	**$216**	**$216**	**$216**	**$216**	**$216**
MISCELLANEOUS	$375	$428	**$428**	**$435**	**$453**	**$385**	**$387**
	$725	$583	**$644**	**$651**	**$669**	**$601**	**$603**
FINANCIAL EXPENDITURES (NON-OPERATING)							
LONG TERM DEBT INTEREST	$2,378	$2,685	**$2,363**	**$3,008**	**$3,259**	**$3,410**	**$3,474**
LONG TERM DEBT PRINCIPAL	$8,400	$9,014	**$8,227**	**$6,272**	**$6,705**	**$7,017**	**$7,346**
AMORTIZATION DEBT DISCOUNT	$95	$98	**$108**	**$91**	**$100**	**$107**	**$114**
DIVIDEND/GRANT IN LIEU OF TAXES	$4,578	$4,827	**$5,142**	**$5,383**	**$5,583**	**$5,783**	**$5,983**
MISCELLANEOUS	$17	$15	**$11**	**$16**	**$16**	**$15**	**$15**
	$15,468	$16,639	**$15,850**	**$14,770**	**$15,662**	**$16,331**	**$16,931**
NET PROFIT (LOSS) AVAILABLE FOR CAPITAL EXPENDITURES	$3,731	($2,291)	**($3,892)**	**($4,579)**	**($6,517)**	**($9,053)**	**($11,294)**

** 2017/18 Operating Budget approved by the Board of Directors, February 2, 2017.*

HALIFAX WATER
ESTIMATED REVENUES AND EXPENDITURES - WASTEWATER OPERATIONS
PROPOSED OPERATING BUDGET
APRIL 1, 2018 to MARCH 31, 2023
(in thousands)

			BUSINESS PLAN				
DESCRIPTION	ACTUAL APR 1/16 MAR 31/17	APPROVED BUDGET * APR 1/17 MAR 31/18	PROPOSED BUDGET APR 1/18 MAR 31/19	YEAR 2 APR 1/19 MAR 31/20	YEAR 3 APR 1/20 MAR 31/21	YEAR 4 APR 1/21 MAR 31/22	YEAR 5 APR 1/22 MAR 31/23
REVENUES							
METERED SALES	$69,475	$67,756	**$67,601**	**$66,485**	**$65,401**	**$64,349**	**$63,326**
WASTEWATER OVERSTRENGTH AGREEMENTS	$23	$0	**$0**	**$0**	**$0**	**$0**	**$0**
LEACHATE	$357	$389	**$387**	**$395**	**$403**	**$411**	**$419**
CONTRACT REVENUE	$83	$86	**$86**	**$86**	**$86**	**$86**	**$86**
SEPTAGE TIPPING FEES	$909	$775	**$915**	**$959**	**$959**	**$959**	**$959**
DEWATERING FACILITY/ SLUDGE LAGOON	$210	$210	**$210**	**$210**	**$210**	**$210**	**$210**
AIRLINE EFFLUENT	$89	$86	**$118**	**$118**	**$118**	**$118**	**$118**
CUSTOMER LATE PAY./COLLECTION FEES	$189	$240	**$237**	**$233**	**$230**	**$226**	**$223**
MISCELLANEOUS	$129	$129	**$128**	**$128**	**$128**	**$128**	**$128**
	$71,463	$69,670	**$69,682**	**$68,614**	**$67,534**	**$66,486**	**$65,469**
EXPENDITURES							
WASTEWATER COLLECTION	$10,347	$9,653	**$10,622**	**$10,889**	**$11,106**	**$11,328**	**$11,555**
WASTEWATER TREATMENT PLANTS	$17,797	$19,251	**$19,160**	**$19,400**	**$19,788**	**$20,184**	**$20,588**
SMALL SYSTEMS	$1,182	$1,276	**$1,323**	**$1,324**	**$1,351**	**$1,378**	**$1,405**
DEWATERING FACILITY/ SLUDGE MGM'T	$434	$380	**$331**	**$318**	**$324**	**$330**	**$337**
BIOSOLIDS TREATMENT	$71	$101	**$101**	**$101**	**$103**	**$105**	**$107**
LEACHATE CONTRACT	$309	$341	**$337**	**$343**	**$350**	**$357**	**$364**
TECHNICAL SERVICES (SCADA)	$1,292	$1,306	**$1,563**	**$1,809**	**$1,845**	**$1,882**	**$1,920**
ENGINEERING & INFORMATION SERVICES	$3,223	$3,431	**$3,400**	**$3,484**	**$3,553**	**$3,624**	**$3,697**
REGULATORY SERVICES	$1,095	$1,434	**$1,465**	**$1,462**	**$1,491**	**$1,521**	**$1,552**
CUSTOMER SERVICE	$1,842	$2,064	**$2,455**	**$2,439**	**$2,487**	**$2,537**	**$2,588**
ADMINISTRATION & PENSION	$5,017	$4,833	**$4,585**	**$4,620**	**$4,712**	**$4,806**	**$4,902**
DEPRECIATION	$10,669	$12,465	**$13,251**	**$14,217**	**$15,233**	**$16,091**	**$16,774**
	$53,278	$56,534	**$58,594**	**$60,405**	**$62,345**	**$64,144**	**$65,789**
OPERATING PROFIT	$18,185	$13,136	**$11,088**	**$8,209**	**$5,189**	**$2,342**	**($320)**
FINANCIAL REVENUES (NON-OPERATING)							
INVESTMENT INCOME	$351	$156	**$216**	**$216**	**$216**	**$216**	**$216**
PNS FUNDING HHSP DEBT	$2,000	$2,000	**$0**	**$0**	**$0**	**$0**	**$0**
MISCELLANEOUS	$168	$14	**$97**	**$98**	**$98**	**$99**	**$99**
	$2,519	$2,169	**$313**	**$314**	**$314**	**$315**	**$315**
FINANCIAL EXPENDITURES (NON-OPERATING)							
LONG TERM DEBT INTEREST	$5,509	$6,022	**$5,427**	**$5,853**	**$5,592**	**$5,490**	**$4,874**
LONG TERM DEBT PRINCIPAL	$11,699	$13,699	**$12,783**	**$14,023**	**$14,226**	**$14,713**	**$15,284**
AMORTIZATION DEBT DISCOUNT	$95	$107	**$119**	**$135**	**$150**	**$161**	**$171**
MISCELLANEOUS	$32	$0	**$5**	**$5**	**$5**	**$5**	**$5**
	$17,335	$19,828	**$18,334**	**$20,016**	**$19,973**	**$20,369**	**$20,334**
NET PROFIT (LOSS) AVAILABLE FOR CAPITAL EXPENDITURES	$3,369	($4,523)	**($6,933)**	**($11,493)**	**($14,469)**	**($17,713)**	**($20,339)**

** 2017/18 Operating Budget approved by the Board of Directors, February 2, 2017.*

HALIFAX WATER
ESTIMATED REVENUES AND EXPENDITURES - STORMWATER OPERATIONS
PROPOSED OPERATING BUDGET
APRIL 1, 2018 to MARCH 31, 2023
(in thousands)

DESCRIPTION	ACTUAL APR 1/16 MAR 31/17	APPROVED BUDGET * APR 1/17 MAR 31/18	BUSINESS PLAN: PROPOSED BUDGET APR 1/18 MAR 31/19	YEAR 2 APR 1/19 MAR 31/20	YEAR 3 APR 1/20 MAR 31/21	YEAR 4 APR 1/21 MAR 31/22	YEAR 5 APR 1/22 MAR 31/23
REVENUES							
STORMWATER SITE RELATED SERVICE	$6,661	$6,700	**$6,752**	**$6,752**	**$6,752**	**$6,752**	**$6,752**
STORMWATER RIGHT-OF-WAY SERVICE	$3,881	$3,881	**$3,835**	**$3,835**	**$3,835**	**$3,835**	**$3,835**
CUSTOMER LATE PAY./COLLECTION FEES	$51	$39	**$21**	**$21**	**$21**	**$21**	**$21**
MISCELLANEOUS	$88	$89	**$89**	**$89**	**$89**	**$89**	**$89**
	$10,681	$10,710	**$10,696**	**$10,696**	**$10,696**	**$10,696**	**$10,696**
EXPENDITURES							
STORMWATER COLLECTION	$4,053	$4,589	**$5,239**	**$5,308**	**$5,414**	**$5,522**	**$5,633**
TECHNICAL SERVICES (SCADA)	$43	$31	**$37**	**$41**	**$41**	**$42**	**$43**
ENGINEERING & INFORMATION SERVICES	$525	$558	**$1,095**	**$1,110**	**$1,132**	**$1,155**	**$1,178**
REGULATORY SERVICES	$768	$1,242	**$1,302**	**$1,316**	**$1,342**	**$1,369**	**$1,396**
CUSTOMER SERVICE	$300	$205	**$253**	**$272**	**$278**	**$283**	**$289**
ADMINISTRATION & PENSION	$816	$786	**$746**	**$751**	**$766**	**$782**	**$797**
DEPRECIATION	$677	$855	**$954**	**$1,141**	**$1,355**	**$1,556**	**$1,713**
	$7,182	$8,266	**$9,626**	**$9,939**	**$10,329**	**$10,710**	**$11,049**
OPERATING PROFIT	$3,499	$2,444	**$1,070**	**$758**	**$368**	**($13)**	**($353)**
FINANCIAL REVENUES (NON-OPERATING)							
INVESTMENT INCOME	$78	$35	**$48**	**$48**	**$48**	**$48**	**$48**
MISCELLANEOUS	$0	$0	**$0**	**$0**	**$0**	**$0**	**$0**
	$78	$35	**$48**	**$48**	**$48**	**$48**	**$48**
FINANCIAL EXPENDITURES (NON-OPERATING)							
LONG TERM DEBT INTEREST	$588	$825	**$770**	**$1,067**	**$1,263**	**$1,498**	**$1,690**
LONG TERM DEBT PRINCIPAL	$1,221	$1,577	**$1,591**	**$2,077**	**$2,452**	**$2,901**	**$3,317**
AMORTIZATION DEBT DISCOUNT	$9	$12	**$18**	**$24**	**$30**	**$38**	**$45**
MISCELLANEOUS	$0	$0	**$0**	**$0**	**$0**	**$0**	**$0**
	$1,818	$2,414	**$2,379**	**$3,168**	**$3,745**	**$4,436**	**$5,053**
NET PROFIT (LOSS) AVAILABLE FOR CAPITAL EXPENDITURES	$1,759	$64	**($1,261)**	**($2,362)**	**($3,330)**	**($4,402)**	**($5,357)**

** 2017/18 Operating Budget approved by the Board of Directors, February 2, 2017.*

HALIFAX WATER
ESTIMATED REVENUES & EXPENDITURES, SEGREGATED BY REGULATED AND UNREGULATED ACTIVITIES
PROPOSED OPERATING BUDGET
APRIL 1, 2018 to MARCH 31, 2023
(in thousands)

DESCRIPTION	ACTUAL APR 1/16 MAR 31/17	APPROVED BUDGET * APR 1/17 MAR 31/18	BUSINESS PLAN: PROPOSED BUDGET APR 1/18 MAR 31/19	YEAR 2 APR 1/19 MAR 31/20	YEAR 3 APR 1/20 MAR 31/21	YEAR 4 APR 1/21 MAR 31/22	YEAR 5 APR 1/22 MAR 31/23
REGULATED ACTIVITIES							
REVENUES							
METERED SALES	$116,658	$114,356	$113,742	$112,031	$110,371	$108,760	$107,197
FIRE PROTECTION	$7,074	$7,074	$7,074	$7,074	$7,074	$7,074	$7,074
PRIVATE FIRE PROTECTION	$831	$857	$860	$869	$879	$888	$897
STORMWATER SITE RELATED SERVICE	$6,661	$6,700	$6,752	$6,752	$6,752	$6,752	$6,752
STORMWATER RIGHT-OF-WAY SERVICE	$3,881	$3,881	$3,835	$3,835	$3,835	$3,835	$3,835
OTHER OPERATING REVENUE	$1,207	$1,151	$1,165	$1,159	$1,154	$1,148	$1,143
	$136,312	$134,020	$133,429	$131,721	$130,064	$128,457	$126,898
EXPENDITURES							
WATER SUPPLY & TREATMENT	$7,028	$8,559	$8,744	$8,940	$9,109	$9,292	$9,478
TRANSMISSION & DISTRIBUTION	$8,223	$8,969	$10,323	$10,515	$9,858	$10,055	$10,256
WASTEWATER COLLECTION	$10,332	$9,640	$10,501	$10,733	$10,947	$11,166	$11,390
STORMWATER COLLECTION	$4,053	$4,589	$5,239	$5,308	$5,414	$5,522	$5,633
WASTEWATER TREATMENT PLANTS	$17,797	$19,251	$19,160	$19,400	$19,788	$20,184	$20,588
SMALL SYSTEMS	$2,188	$2,324	$2,492	$2,507	$2,557	$2,608	$2,661
SCADA, CONTROL & PUMPING	$2,109	$2,209	$2,564	$2,900	$2,958	$3,017	$3,078
ENGINEERING & INFORMATION SERVICES	$7,576	$7,495	$8,171	$8,338	$8,504	$8,674	$8,848
REGULATORY SERVICES	$2,356	$3,710	$3,763	$3,752	$3,827	$3,904	$3,982
CUSTOMER SERVICE	$4,396	$4,591	$5,487	$5,492	$5,602	$5,714	$5,828
ADMINISTRATION & PENSION	$11,768	$11,363	$10,569	$10,654	$10,867	$11,085	$11,307
DEPRECIATION	$19,095	$22,538	$23,302	$24,975	$26,806	$28,366	$29,579
	$96,922	$105,238	$110,315	$113,514	$116,239	$119,587	$122,625
OPERATING PROFIT	$39,391	$28,782	$23,114	$18,207	$13,825	$8,869	$4,273
FINANCIAL REVENUES (NON-OPERATING)							
INVESTMENT INCOME	$780	$346	$480	$480	$480	$480	$480
MISCELLANEOUS	$2,289	$1,948	$110	$110	$110	$40	$40
	$3,069	$2,293	$590	$590	$590	$520	$520
FINANCIAL EXPENDITURES (NON-OPERATING)							
LONG TERM DEBT INTEREST	$8,475	$9,474	$8,540	$9,869	$10,036	$10,319	$9,960
LONG TERM DEBT PRINCIPAL	$21,320	$24,212	$22,576	$22,297	$23,307	$24,556	$25,872
AMORTIZATION DEBT DISCOUNT	$199	$217	$245	$250	$279	$304	$327
DIVIDEND/GRANT IN LIEU OF TAXES	$4,578	$4,827	$5,142	$5,383	$5,583	$5,783	$5,983
MISCELLANEOUS	$0	$0	$0	$0	$0	$0	$0
	$34,573	$38,730	$36,503	$37,798	$39,205	$40,961	$42,142
NET PROFIT (LOSS) AVAILABLE FOR CAPITAL EXPENDITURES - REGULATED ACTIVITIES	$7,887	($7,655)	($12,799)	($19,001)	($24,790)	($31,572)	($37,350)
UNREGULATED ACTIVITIES							
REVENUES							
AEROTECH SEPTAGE TIPPING FEES	$909	$775	$915	$959	$959	$959	$959
LEACHATE	$357	$389	$387	$395	$403	$411	$419
CONTRACT REVENUE	$83	$86	$86	$86	$86	$86	$86
DEWATERING FACILITY/ SLUDGE LAGOON	$210	$210	$210	$210	$210	$210	$210
AIRLINE EFFLUENT	$89	$86	$118	$118	$118	$118	$118
MISCELLANEOUS	$37	$22	$37	$38	$38	$39	$39
	$1,685	$1,566	$1,753	$1,805	$1,814	$1,822	$1,831
EXPENDITURES							
- DIRECT							
WATER SUPPLY & TREATMENT	$16	$25	$25	$26	$26	$27	$27
WASTEWATER COLLECTION	$16	$0	$108	$142	$145	$148	$151
WASTEWATER TREATMENT	$814	$821	$769	$762	$777	$792	$808
SPONSORSHIPS & DONATIONS	$66	$66	$266	$260	$265	$270	$275
DEPRECIATION	$6	$0	$132	$218	$292	$346	$375
	$917	$912	$1,300	$1,408	$1,506	$1,584	$1,638
- INDIRECT (ADMINISTRATION)	$0	$91	$95	$98	$100	$102	$104
	$917	$1,003	$1,395	$1,506	$1,605	$1,686	$1,741
OPERATING PROFIT	$767	$564	$358	$300	$208	$137	$90
FINANCIAL REVENUES (NON-OPERATING)							
MISCELLANEOUS	$298	$494	$416	$423	$442	$444	$446
FINANCIAL EXPENDITURES (NON-OPERATING)							
LONG TERM DEBT INTEREST	$0	$58	$23	$65	$85	$85	$85
LONG TERM DEBT PRINCIPAL	$0	$79	$27	$79	$79	$79	$79
AMORTIZATION DEBT DISCOUNT	$0	$0	$0	$1	$1	$2	$2
MISCELLANEOUS	$94	$15	$10	$10	$10	$10	$10
	$94	$152	$61	$155	$175	$176	$175
NET PROFIT (LOSS) AVAILABLE FOR CAPITAL EXPENDITURES - UNREGULATED ACTIVITIES	$971	$905	$713	$567	$475	$405	$360
NET PROFIT (LOSS) AVAILABLE FOR CAPITAL EXPENDITURES - COMBINED ACTIVITIES	$8,858	($6,750)	($12,086)	($18,434)	($24,316)	($31,167)	($36,990)

** 2017/18 Operating Budget approved by the Board of Directors, February 2, 2017.*

Appendix H

Water Quality Master Plan – Version 3.0

Water Quality Master Plan

V3.0

September 2016

Reid Campbell and Wendy Krkosek

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1 Introduction

Halifax Water has consistently produced drinking water that has safeguarded public health and achieved regulatory compliance, despite the challenges that occur as regulations become more stringent, infrastructure ages and once current technologies are eclipsed by more modern designs to meet the new regulatory environment. One important tool Halifax Water uses is water quality strategic planning which is formally executed through a Water Quality Master Plan (WQMP). Water quality master planning describes the process whereby a water utility assesses the public's expectations for water quality and the direction of water quality regulations and trends, sets corresponding water quality goals and then plans for necessary capital or operational improvements.

In 2006, Halifax Water completed its first formal WQMP. This plan was designed to set goals for water quality that exceed regulatory requirements and to set a path for Halifax Water to achieve those goals while treating water at an optimal cost. In 2011, the WQMP Version 2.0 was created and focused mainly on upgrades and investigations concerning the JD Kline Water Treatment Plant; Halifax Water's most mature treatment facility.

WQMP Version 3.0 has a shift in focus away from one plant in particular and focuses more on source water quality and its impact on treatment processes and distribution system water quality as a whole. There are two main drivers for this change in focus. Firstly, recent research indicates that lakes in Nova Scotia may be experiencing a recovery from acid rain, as sulphur emissions have drastically decreased over the past few years. Recovery results in higher pH, increased productivity, and increased total organic carbon. Both the Lake Major and J.D. Kline plants have been dealing with recent changing source water quality which has been challenging the treatment process at both plants, resulting in higher chemical usage and increased stress on treatment processes. WQMP V3.0 will focus efforts on identification of lake recovery processes, what this means for future source water quality, and also how to provide effective and robust treatment with existing infrastructure in the short term, while developing a plan for capital upgrades to address changing source water quality and aging infrastructure in the long term. Secondly, with the recent events in Flint Michigan around lead exposure in homes, outcomes of research with Dalhousie University, and a shift in the industry approach (via American Water Works Association policy) towards managing lead in the distribution system, WQMP V3.0 will focus on developing a plan for removal of both public and private lead service lines by 2050, while concurrently optimizing corrosion control treatment. It is likely that a Canadian regulatory requirement will be adopted in the coming years in this direction and Halifax Water wants to ensure they are at the forefront of this change in industry approach. Lead is a shared responsibility between the utility and the homeowner, and as such, the focus will be a shift away from sampling and towards public engagement and policy as new ways of engaging the public in uptake of replacement programs will need to be identified and pursued.

Implementation of the WQMP is a combined effort between Halifax Water staff and a research partnership with Dr. Graham Gagnon at Dalhousie University, and ultimately consulting engineers and contractors who design and construct identified necessary changes. The NSERC/Halifax Water Industrial Research Chair in Water Quality and Treatment is an integral part of conducting the research that leads to internal policy and operational changes, treatment optimization opportunities, and ensures that

Halifax Water is at the forefront of water quality research and active in the development of best practice for water utilities.

2 Research Accomplishments

Numerous research accomplishments since inception of the IRC program have led to both public health benefits and cost savings for Halifax Water. The following table provides an overview of some of the major discoveries and their associated impacts to Halifax Water of water quality research with the Dalhousie Research Chair. Many of these discoveries form the basis of the direction of WQMP V3.0.

Discovery	Impact to Halifax Water
A) Identification of Lake Recovery. Discovered through assessment of plant data over a 20-year period that both Pockwock and Lake Major are experiencing increased pH, color and TOC due to decreases in sulphur deposition.	• Increased dosing of coagulant at both Lake Major and J.D. Kline but J.D. Kline is pushing the limits of a direct filtration plant • Decreased filter run times • Potential explanation for algal occurrence and geosmin
B) Development of NOM Monitoring Tools. Developed a new method for oxygen demand in water industry: peCOD. Developed a new model for Fluorescence excitation-emission matrix (FEEM) analysis.	• peCOD is a new tool for assessing NOM that has ideal applications for oxidation processes, and shows promise for detecting subtle changes in organic profiles over traditional TOC/DOC techniques. • FEEM models will lead to online tools for improved treatment operation
C) Coagulant Mixing. Demonstrated that coagulation mixing energy can be reduced by 4-5 times without compromising NOM removal	• Outside of pumping, mixing represents the highest energy costs to water plants • Applied new particle analysis technology to demonstrate discovery
D) Biological Removal of NOM in Direct Filtration. Successfully demonstrated that biofiltration can be applied in a direct filtration plant without pre-oxidation	• Biofiltration reduced THM concentrations by 40% for Halifax Water • Bio filtration was reliable under broad temperature range (4-25°C) • Reduced chlorine costs by $30,000 per year
E) Monitoring Biological Filtration. Demonstrated that biomass measurements of ATP evolve operationally and within filter cycles	• Applied ATP as an emerging monitoring technology for biofiltration • Developed protocols to demonstrate appropriate ATP range and application to be used as performance monitoring tools moving forward
F) Partial Lead Service Lines. Demonstrated that PLSLs are an inappropriate solution for Halifax Water	• Research based on 5-years of water sample analysis by Dalhousie students • Led to policy change at Halifax Water in 2012, partials are no longer conducted unless part of an existing disruption. • Neither PVC or copper provide decreased lead concentrations post PLSLs
G) Lead Exposure. Demonstrated that current	• Halifax Water now uses a 4L profile sampling to

Health Canada guideline for sampling does not give true indication of lead exposure	monitor lead concentrations rather than a first draw sample.
H) Impact of Iron on Lead. Developed a fundamental understanding of the relationship between iron particles and lead	• Established that cast iron water mains interact with lead materials • Developed new analytical method for quantifying colloidal lead in water and a new procedure to evaluate iron mineral and lead interaction • Allows Halifax Water to target specific areas of the distribution for future LSL replacement programs
I) Role of Phosphate in Distribution System. Demonstrated that phosphate has a significant role in stabilizing iron particles and controlling lead release	• Halifax Water increased phosphate dose to reduce lead in water and continues to study the impact of this increase in customers' homes
J) Lead Release in Large Buildings Showed how localized lead release can be in large buildings and demonstrated long-term risks of fountains to children with researchers from École Polytechnique	• Halifax Water has developed sampling protocols for large buildings • Halifax Water was part of a national survey of lead management in Canada
K) Avoided Unintended Consequences of Disinfectant Changeover. Demonstrated that conversion from free chlorine to chloramines would lead to increased lead exposure	• Halifax Water was able to avoid negative consequences of lead exposure by avoiding a planned disinfectant changeover
L) Filter-to-Waste. Demonstrated that there was no public health benefit to implementing filter-to-waste at J.D. Kline.	• NSE accepted evaluation, which saved Halifax Water from a $5 Million capital investment. Led to changes in NSE Treatment Standard • Implemented zero cost filter resting procedures in place of filter-to-waste

In addition to these major discoveries, the IRC has published a total of 45 peer reviewed publications since 2006 that are directly related to Halifax Water operations or research questions. Of these publications, 5 have been in the Journal of the American Water Works Association, which is the most widely read journal by utilities in North America. The two figures below show the publications by year and also by topic area. Research through the IRC has generated 111 conference posters or presentations provided by IRC staff and students since 2006. Dr. Gagnon has trained 20 PhDs, 50 MASc students, 6 Post Doctoral students and numerous undergrad students. Four of these graduate students are now employed with Halifax Water, several more are working as consultants for key local firms, and a few are employed in government, at both the provincial and federal levels. Bi-annual symposia are held twice per year where research findings and current issues are transferred to Halifax Water Engineering and Water Services staff. Furthermore, treatment plant operators are trained by Dalhousie twice per year on specific relevant operational issues. This knoweldge transfer between the Chair and Halifax Water staff ensures the utility is at the forefront of water research discovery and engages and elevates staff to be able to address complex operational issues with a solid knowledge base.

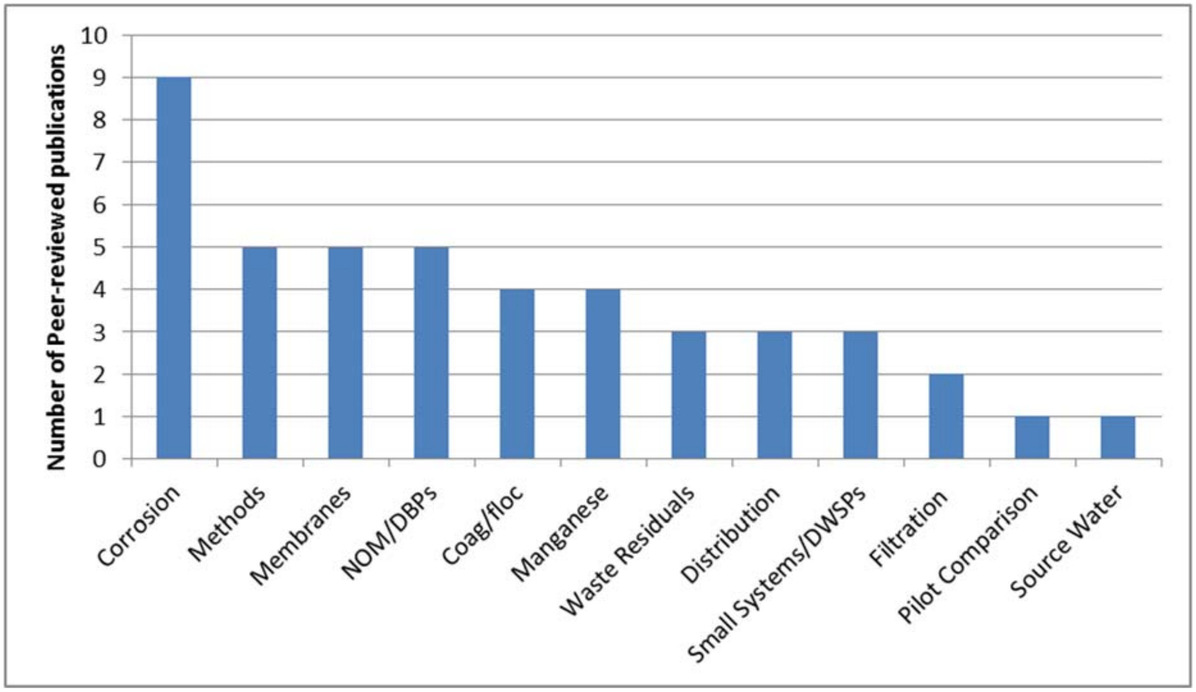

Figure 1 – Number of peer-reviewed publications by the IRC since 2006, by topic area.

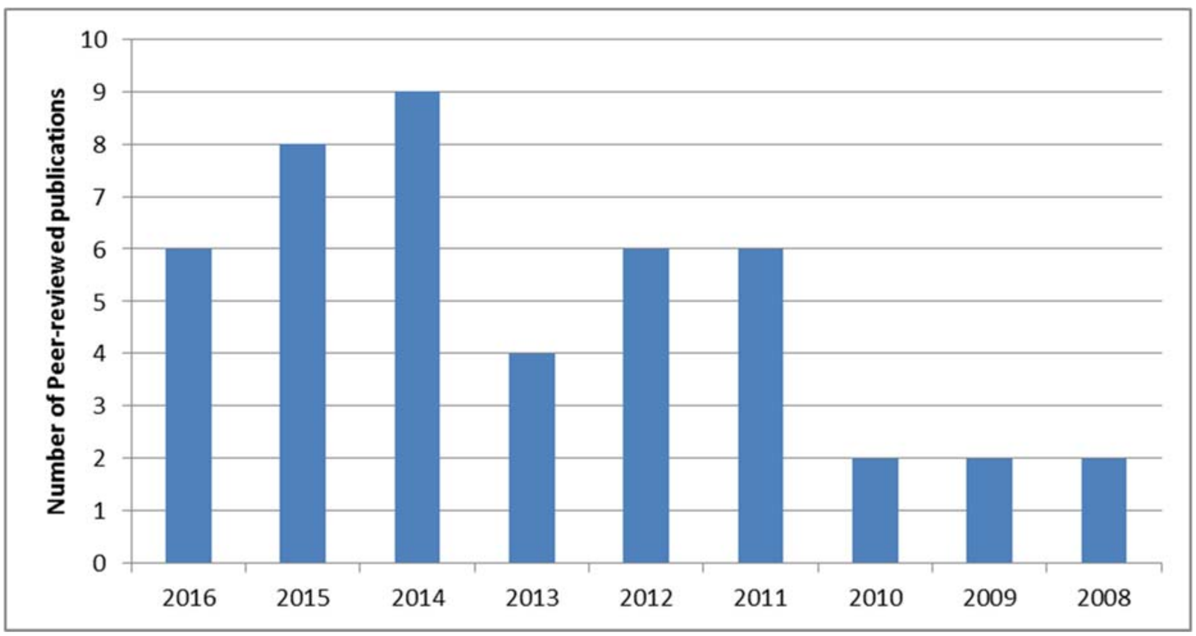

Figure 2 – Number of peer-reviewed publications by the IRC by year since 2006.

3 WQMP Direction

The overall water quality goals identified in the original WQMP remain on the priority list of Halifax Water. There are also other water quality objectives that the utility has identified as being significant to improving or strengthening water quality management and performance within the utility. Efforts will also be placed on shifting the focus of Halifax Water's strategic planning partially away from long term WQ goals and more towards what can be done to support treatment plant operations and improve water quality from a day to day perspective.

Over the course of the last five years, several water quality challenges have emerged that will challenge Halifax Water's ability to meet its water quality goals on an ongoing basis. There challenges are listed as follows:

- Changing Source Water Quality. Due to lake recovery from reductions in acid rain, and the effects of climate change, Halifax Water's primary water sources are undergoing a quality change that will challenge the capabilities of our treatment plants.
- Water Treatment. The effects of aging plants, and source water quality changes are requiring Halifax Water to look at the effectiveness of our treatment processes. There is a need to determine if the current processes are suitable for long term efforts and also to come up with short term solution to provide effective robust treatment capability while long term solutions are explored.
- Lead. Research has revealed that removing lead service lines from the system, combined with optimal corrosion control is the best way to protect customers from exposure to lead.
- Data. Halifax Water has accumulated an immense resource of water quality data. The appropriate tools and business processes need to be brought to bear to ensure that water quality is well managed and that the investments in water quality and treatment are sound.

The research and operations plan (Appendix A) is organized according to four themes aligning with these identified challenges.

3.1 Source Water: Lake Recovery and Changing Source Water Quality

Source Water quality is changing as a result of the effects of lake recovery from acid rain and possibly climate change. This is being realized through increased difficulty in operating both the JD Kline and Lake Major water supply plants. It manifests itself in increased chemical costs at Lake Major and in high head loss and shorter filter runs at JD Kline. JD Kline is now operating near the margins of its design capability. The major emphasis of this theme will include:

- Identification of Changing Source Water Quality. Existing water and air quality data will be mined and analyzed to better understand how the phenomenon affects water quality from both a biological and physical/chemical point of view. Paleolimnological work will be continued to better understand the effects of industrialization on water quality and what the natural or post recovery water quality might be.
- Lake Recovery Monitoring. The water quality response to lake recovery will be evaluated and characterized. This will include evaluation of the effects of lake recovery on algal activity and the

occurrence of taste and odour causing compounds. Existing programs to sample and monitor lakes will be evaluated to ensure that the appropriate monitoring is being undertaken. Also a program to monitor algae throughout the growing season will be developed to understand its occurrence and plan an appropriate response.

- Asssessment of Intake Structure Locations. The Lake Major Water Supply Plant optimization study identified diurnally changing source water quality as a limitation on plant performance. A new intake that draws a more consistent water quality is predicted to improve plant performance. Evaluating intake location and design at other facilities, including JD Kline, is also seen as a way to mitigate impacts of changing source water quality broadly and issues like geosmin occurrence more specifically.

3.2 Treatment

Treatment processes are being challenged due to the lake recovery phenomenon. It is necessary to develop both long term strategies and short term mitigation approaches to dealing with the effects of changing source water. Additionally, the recently completed Lake Major Water Supply Plant Optimization Study identified over one hundred plant improvements to address process deficiencies and component obsolescence. Further investigation is required to ensure that plant improvements consider other treatment factors and the changing source water. This theme will also include provision for shorter term research that is intended to assist plant operations staff with specific short term treatment challenges that may arise. Major components, listed by plant, include:

- JD. Kline Water Supply Plant. Previous research has identified deficiencies in pre-treatment and flocculation processes. Work will be conducted to further evaluate improvement opportunities and identify physical improvement projects and treatment strategies. Flocculation will be evaluated to consider whether the proposed investment in mechanical flocculation is worthwhile, or whether improved flocculation can be realized with changes to existing hydraulic flocculator operation. Filter performance will be evaluated through a formalized filter surveillance program. Further research will be conducted on passive biofiltration to see if it can be enhanced through changes to pre-oxidation strategies or nutrient addition and through a greater understanding of biofiltration processes. Further work will be conducted on coagulant optimization to improve filter headloss performance and to ensure that the plant can source coagulants that perform optimally and consistently. Further work will be conducted to optimize backwash and air scour cycles and monitoring the effects of new media, underdrains and air scour capability on treatment performance .
- Lake Major Water Supply Plant. A ten year capital program was developed as an output of the Lake Major Optimization Study. Research will be aimed at supporting and enhancing the ten year capital improvement plan and will include research to support determination of a new intake location, premix optimization, coagulant selection, clarification process optimization, possible consideration of biofiltration, manganese optimization, and all aspects of filter operation and filter performance. This theme will also support improvements in the process waste system.

- Bennery Lake Water Supply Plant. This plant is nearing the end of an optimization cycle. Remaining significant improvements include installation of plate settlers, the establishment of filter surveillance, and continued optimization of manganese optimization.

3.3 Distribution System Water Quality

Historically, within Halifax Water and the water industry as a whole, distribution system water quality has received less attention than treatment process operations and performance. Recently, there has been an increased focus on possible risk factors to public health associated with distribution systems, a good example of this is the recent attention being focused on the health risks associated with lead pipe in the distribution system and the lack of understanding of the appropriate methods to replace such materials without presenting additional health risks to people directly affected by replacement efforts. In light of the increasingly stringent regulations surrounding distribution water quality, and to remain loyal to the multi-barrier approach to water quality management, Halifax Water will direct efforts towards actively monitoring and assessing both distribution system water quality and physical integrity, and understanding the interrelationships between the two. Establishing a baseline of distribution water quality, hydraulic and integrity information will allow the utility to integrate water quality and hydraulic goals into the operation of the distribution system and focus attention on identifying and mitigating areas that are a high risk for contamination or sensitive to significant water quality fluctuations. The results of the monitoring program will be used to improve distribution system practices and implement another layer of protection to public health. The main components of this theme include:

- Lead. Based on operational experience and previous research, Halifax Water has determined that the removal of lead service lines and optimized corrosion control treatment are required to protect customers from exposure to lead. This will be realized through operationally adopting the 2015 recommendations of the National Drinking Water Advisory Council (NDWAC). The program will support this transformational initiative while continuing to grow the understanding of the occurrence of lead in our local systems in order to continue to optimize corrosion control practices.
- Distribution System Water Quality and Integrity Monitoring. Programs to monitor the integrity of distribution system water quality will be continued. This will include incorporation of the Partnership for Safe Water distribution program. Success of a recent fluoride tracer study in the Lake Major system conducted to understand water age will be translated to other systems. This will provide staff with an understanding of hydraulics and impacts on water quality throughout the distribution system. Programs to monitor biological water quality will be evaluated and operational strategies to optimize disinfection residuals will be identified and implemented. Development of water quality integrity protocols through distribution systems events will also be developed to ensure continuous safe water delivery.
- Disinfection Efficiency and Minimizing Disinfection By Product Formation. Significant work has been done in monitoring and minimizing DBP formation. However, there is further opportunity for improvement in this area, including work on chlorine age in water storage facilities and optimal chlorine dosing.

3.4 Data Management

Better tools and processes are required to use and integrate the large quantity of water quality data that exists. Enhanced data management tools will allow for better monitoring, day to day operational decisions and sound investment in process improvements. Data management tools and business processes will be explored and integrated.

4 Water Quality Goals

Water Quality Goals are based on the outcomes of previous terms of the WQMP combined with what has been achieved by other "best in class" utilities that have adopted similar programs. These goals are intended to ensure that Halifax Water not only meets current regulatory requirements, but will be well positioned to meet predicted regulatory changes and maintain water quality that well exceeds the current regulatory requirements. Though many of these goals remain the same, there are some additional goals being added to this version of the WQMP to reflect overall direction and focus of the WQMP and to set a standard for the associated research tasks. Many of these goals are a product of the utility's commitment to adapting a more proactive approach to water quality management, monitoring and optimization.

Halifax Water has developed both global and specific water quality goals. The global goals are very general and are intended to describe the overall objectives of the specific water quality goals. The specific goals clearly define measurable objectives associated with priority water quality targets identified by Halifax Water.

4.1 Overall Objectives:

4.1.1 Compliance

- Full compliance with Guidelines for Canadian Drinking Water Quality.
- Full permit compliance

4.1.2 Source Water Quality

- Proactively protect our source water quality.
- Monitor source water quality to provide early warning of potential problems.

4.1.3 Water Quality and Treatment

- Adapt a pro-active approach to water quality monitoring and operations.
- Develop indicators of pending non-compliance events.
- Provide required training to improve operator knowledge of operational, treatment and water quality objectives.
- Actively optimize treatment processes through monitoring and assessing the relationships between treatment operations and finished water quality.
- Develop facility specific water quality and operational goals.

4.1.4 Distribution System Water Quality

- Integrate water quality goals into the operation of the distribution system.
- Actively monitor and understand water quality and physical integrity in the distribution system.

- Identify distribution system contamination vulnerabilities and clearly identify communication plans, responsibilities and accountabilities.

4.1.5 Customer Expectations

- Maintain customer perception of water quality that exceeds corporate strategic objectives.
- Incorporate our understanding of customer perspectives when developing overall water quality goals.

4.2 Specific Goals:

4.2.1 Particle/Precursor Removal Goals

These goals describe HW's efforts to optimize the basic treatment process to improve particle removal, which is the fundamental pathogen barrier, while at the same time also optimizing for TOC removal.

- 2 to 3 log removal of giardia by filtration
- 3/4/4 log removal for giardia/viruses/cryptosporidium
- Individual filter turbidity values <0.1NTU: 95%, 0.3 NTU: 100%

DBP Goals: *These goals describe how HW will improve disinfection which is one of the primary barriers to protect public health, while at the same time also lowering disinfection by-products such as THM's and HAA's.*

- THM's < 80 ug/L (LRAA)
- HAA's < 60 ug/L (LRAA)

4.2.2 Distribution Water Quality Goals

These goals recognize that water quality is managed not only at the treatment plant but also to the customers tap. They also recognize that the distribution system and water quality can positively or negatively affect each other.

- Minimum distribution chlorine residual of 0.2 mg/L at all locations
- Develop and achieve distribution system HPC targets
- Maintain 90th percentile residential lead levels below 15-µg/L
- Removal of 100 public lead service lines per year
- Removal of all public and private lead service lines by 2050

4.2.3 Waste Treatment Goals

These goals recognize that plant waste processing is a significant operating cost and that waste management costs can be impacted by process changes. While secondary to public health issues, plant process improvements must also consider the impact on waste treatment.

- Optimize residual disposal costs
- Achieve wastewater permit requirements

5 Overall Strategy to Achieve Goals

Based on the research findings to date and an overview of industry best practices, Halifax Water has identified a number of tasks to be carried out to achieve the goals outlined above and to address facility specific and system wide operational and treatment challenges that have been identified since the initial WQMP was completed. Some tasks will serve to achieve multiple goals and others are focused on very specific research tasks pertaining to the optimization of a specific treatment process. These tasks take the form of several different types of activities such as the following:

- Pilot scale research studies.
- Consultant studies.
- Data collection and surveillance techniques.
- Development/evaluation of long-term monitoring programs.
- Best practice adoption.
- Operational changes.
- Training programs.

Some tasks will be completed by means of a well-defined research project over a relatively short period of time and others, specifically treatment and distribution monitoring and optimization programs, will require a significantly larger time commitment. Such programs encompass multiple planning, development and implementation stages which may include identifying and setting achievable and realistic goals, the development and implementation of monitoring programs, baseline performance assessments, operator training programs, and the development of optimization plans, to name a few.

All of the tasks have been organized into the WQMP research and operations plan (Appendix A). Justification and description of the themes in this plan were provided in section 3. As tasks are completed, process changes, some resulting in capital projects, will be identified. These modifications will be scheduled as resources and financing allow.

6 Research Plan and Execution

The overall program will be governed by a steering committee consisting of staff from Halifax Water and Dalhousie University. The steering committee will periodically review research projects and progress. The steering committee will meet quarterly to review research proposals for upcoming research and the results of previous and ongoing research. At this time, Dalhousie will present detailed research results in a seminar format to the steering committee and Halifax Water staff that are directly impacted by the particular research tasks. Technical reports will be submitted as requested for specific research tasks. Bi-annual symposia will be held to update a broader group of Halifax Water Operations and Water Services staff on relevant research.

Depending on the specific research and expertise requirements, individual research tasks will be executed either internally by Halifax Water staff or externally by the Dalhousie University research team or external consultants, as required. An outline of parties responsible for each task is provided in Appendix B.

6.1 Halifax Water Research Team

Tasks that involve the optimization of day-to-day process operations or monitoring programs will be completed internally using in-house staff and resources. The Water Quality Manager has been assigned a leadership role in the provision of high quality drinking water; specifically related to treatment, water quality and distribution operations optimization, monitoring and research. This person will play a lead role in conducting water quality research, solving water quality, treatment and distribution problems, pro-actively monitoring and improving treatment and distribution operations and methodologies, and developing, implementing and monitoring water quality plans.

The Water Quality Manager has the role of advocate for the development and implementation of water quality strategic plans and research programs. However, implementation of these programs will require cooperation and commitment of several other stakeholders within the utility structure including the general management, plant managers and operations superintendents, distribution superintendents, and all directly impacted operations staff.

As Halifax Water undertakes the transformational lead service line replacement program, a new lead team will be developed at Halifax Water to ensure that adequate resources are put towards the program to achieve goals. The team will report to the Water Quality Manager, and will consist of a Lead Program coordinator, a Data Analyst and a Water Quality Inspector specific to lead. These three staff will work with staff in a variety of other departments, including Operations, GIS, Customer Service, metering, and Water Services to implement new initiatives.

Water Quality Master Plan

V3.0

Appendix A – Research and Operating Plan

September 2016

Wendy Krkosek, Ph.D., P.Eng.
Water Quality Manager

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Theme 1: Source Water: Lake Recovery and Variable Source Water Quality

As a result of successful air emissions control, a number of studies have shown evidence of lake recovery from acidification, mainly in parts of Europe and the UK. The impact of recovery is healthier ecosystems as measured by changes in natural organic matter, pH and changes in biological activity and species.

In the fall of 2016, through both an analysis of basic historical data, and noticeable operational changes at both J.D. Kline and Lake Major, it became apparent that there has been a change in source water quality resulting in higher colour, TOC and pH. At J.D. Kline, the source water quality is approaching the upper limits of design for a direct filtration plant, including a TOC of 3.5 mg/L and colour of 20 TCU. At Lake Major, colour has gone from 20 to 45 TCU since commissioning of the plant, and as a result, the alum dose to remove the increased organics has gone from 15 to 50 mg/L over this time frame. These observed changes challenge earlier thinking of scientists studying the recovery from acidification in Atlantic Canada but are consistent with the observations of drinking water operators in the UK and Scandinavia. The Atlantic Canadian studies were published in 2007 and 2011, and many of the changes described have occurred within the past five years, so it is possible that water quality has recently hit a threshold that has allowed for recovery.

Very recent changes to sulphur emissions from marine fuels and continuing conversion of coal plants to natural gas in the Northeastern United States will continue to result in lower sulphur deposition, thus it can be expected that source waters will continue to change, which is expected to produce more challenges for Halifax Water treatment plants.

A large component of the research activities associated with this Water Quality Master Plan involve issues related to lake recovery, including:

- Identifying changes to source water quality,
- Developing appropriate monitoring strategies for changing source water quality,
- Developing operational tools to assist with plant operations in the short term, and
- Developing long term capital plans for robust design or retrofit of existing treatment plants to deal with a moving target of source water quality.

Task 1.1 Identification of Changing Source Water Quality

The major objective of this task is to develop an understanding of possible lake recovery and changing source water quality in Halifax Water's source waters after years of acidification caused by sulphur deposition, and to understand how this phenomenon impacts water chemistry from a drinking water quality standpoint. This research activity will:

- Mine currently available source water and air quality data to understand changing water quality both biologically and chemical/physical including changes to organic matter, pH, sulphate, nutrients, and biological species and richness.
- Expand and update currently available paleolimnological sediment analyses to include key source waters to estimate pre-industrial lake chemistry, and response of lakes to changes in land management practices.

- Determine which source waters and tributaries are susceptible to experiencing algal blooms in the future, and where these blooms may occur.

Task 1.2 Lake Recovery Monitoring

The overall research objective of this task is to identify responses to lake recovery in source water through a comprehensive monitoring program. Building on data mining and related activity conducted in Task 1.1, this research activity will look for changes in water chemistry and biology in response to trends found in task 1.1. Specifically, the objectives are to:

1. Evaluate the effect of lake recovery on algal activity, including algal organic matter (AOM) and the occurrence of commonly affiliated taste and odour compounds, including determination of which source water and tributaries are susceptible to experiencing algal blooms in the future, and potential management options to reduce bloom occurrence.
2. Monitor for trends in organic matter concentration and characterization in response to lake recovery.
3. Review existing watershed and deep lake sampling programs to ensure that parameters of interest are being collected with an appropriate frequency at appropriate locations.
4. Additionally, a program to monitor presence and composition of algae throughout the growing season will be developed for Pockwock, Major and Bennery, to understand areas that are vulnerable to blue/green algae, taste and odour presence and potential algal toxins.

Task 1.3 Assessment of Intake Locations and Structures

Optimizing the location of the intake structures and depth of intakes have been discussed for Lake Major, Bennery Lake, Pockwock Lake and The Shubenacadie River for Bomont. Pockwock and Lake Major both have fixed depth intakes that are susceptible to large daily fluctuations in water temperature which can pose downstream treatment challenges, and the intake at Bennery is susceptible to seasonal fluctuations in manganese concentrations.

1.3.1 Lake Major Intake Structure

The current intake for LMWSP is susceptible to significant diurnal temperature changes that pose operational challenges downstream, particularly with the sludge blanket in the UltraPulsators. A new-multi-level intake would allow for control of incoming water quality, thus reducing the operational burden downstream. In order to determine a suitable location, a research program will be initiated that involves monthly sampling year round at different depths at several locations within 200 m of the existing intake to identify an optimum location for a future intake. A bathymetric map will be developed to help in assessment of future intake locations. While conducting the bathymetric assessment, temperature profiling will also be conducted to provide an indication of areas of upwelling which could also provide a more consistent water quality.

A detailed raw water quality investigation of the existing raw water source will be used to understand water quality in terms of NOM, algal activity, and AOM in Lake Major, and to determine whether specific fractions of NOM are more pronounced compared to previous studies. Initially, this research will utilize conventional online water quality measurements in addition to novel online NOM characterization tools in order to understand the potential changes in NOM composition. Grab samples will be collected from the raw water intake in order to confirm measurements from online instruments. A new at-line system to measure photoelectrochemical oxygen has been installed at Lake Major as part of this initiative.

If the existing transmission main will be used with the new intake, an evaluation of the manganese coating should be undertaken to ensure no negative impacts on raw water quality will occur with a change in intake location.

1.3.2 Pockwock Lake Intake Structure

For Pockwock, there is some discussion as to the impact of the berm location and structure on influent water quality, particularly because high geosmin concentrations are often found at the boat launch nect to the berm. A research program will utilize paleolimnological assessment to evaluate the impact of construction of the berm on organic loading in the intake area. Further characterization of geosmin in the area will also be done to provide indication of its impact on raw water quality and whether there are control measures that could mitigate the situation. A bathymetric map will be developed to help in assessment of future intake locations. While conducting the bathymetric assessment, temperature profiling will also be conducted to provide an indication of areas of upwelling which could also provide a more consistent water quality.

1.3.3 Bennery Lake Intake Structure

At Bennery Lake, the stratification in the summer creates an anoxic zone in the hypolimnion which leads to increases in dissolved manganese at the depth of the current drinking water intake. Concentrations increase significantly which poses downstream treatment challenges. There are two potential solutions to this seasonal problem. The first is to install a hypolimnic aeration system to prevent the formation of dissolved manganese at the intake, or to install a multi-level intake, which would allow plant staff to change the intake level to eliminate the elevated manganese levels in raw water and focus on plant removal of TOC. The current plan is to collect background information (bathymetry) and develop a design for an aeration system to submit to Nova Scotia Environment for approval.

Upon installation of the aeration system, a rigorous raw water monitoring program will be developed for 1-2 years to provide baseline water quality data to aid plant staff in understanding seasonal treatment requirements.

1.3.4 Bomont Community Water Supply Plant

Following precipitation events, there is runoff from neighbouring fields which increases turbidity in the Shubenacadie River, resulting in deteriorated water quality, which forces shutdown of the plant. While the plant is offline, water is trucked into the facility, increasing the cost of providing drinking water to customers. The possibility of installing riverbank filtration will be explored as a way to mitigate the fluctuations in raw water quality, thus eliminating the need for plant shutdown and expense of trucked water.

Theme 2: Treatment

Task 2.1 Roadmap for Robust Treatment Plant Design for a Changing Source Water Quality

Historically, treatment plants have been designed for a specific and narrow range of source water quality, leading to specific unit processes, often with limitations, such as those posed by direct filtration at J.D. Kline. The challenges with treating a moving target of source water quality due to lake recovery, combined with the occurrence of more extreme weather events due to climate change, is leading to a paradigm shift in treatment plant design. The need for more robust and adaptable unit processes for a wider range of water qualities is becoming increasing important for water utilities. Halifax Water has undertaken a consultant study to look at unit treatment processes for the removal of geosmin, but in looking at geosmin occurrence through the larger lens of lake recovery and changing source water quality, it has become clear that a more holistic approach to design is necessary.

To address this larger design question, Halifax Water will pursue a Tailored Collaboration project with the Water Research Foundation to bring together leading consultants and utilities in North America to develop a roadmap for robust water treatment plant design in a climate of changing source water quality. The outcome of this project will provide a path forward specifically for the J.D. Kline Water Supply Plant, but will also provide value for future considerations at all other Halifax Water surface water treatment plants.

Task 2.2 J.D. Kline Water Supply Plant

The following section describes shorter term operational tasks for optimizing existing treatment strategies to manage changing source water quality as water quality reaches the threshold for direct filtration design parameters, while longer term measures for capital improvements to treatment plant design are explored through the Tailored Collaboration in Task 2.1.

2.2.1 Improvement of pre-mix and pre-oxidation processes

With an increased TOC load in the raw water and potential changes to iron and manganese cycling, it is possible that a different pre-oxidation step (either higher permanganate dose or alternative oxidant) could provide manganese oxidation as well as provide some pre-oxidation of organics so that organics are in a more assimilable form for biofiltration.

A study conducted in 2016 identified several locations within the pre-mix that could be optimized in terms of chemical addition points, and mixing speeds. Specifically, experiments will be conducted in modified jar tests and at pilot scale to evaluate point of application of polymer to optimize floc formation. Evaluation of the premix process will be conducted to determine whether the point of CO_2 addition can be moved towards the head of the plant and away from concurrent addition with Alum to increase coagulant performance.

2.2.2 Flocculation optimization

Previous research by the Dalhousie Industrial Research Chair has shown that the conversion to mechanical mixers would provide significant benefit to the existing hydraulic mixing process. However, this comes at an increased capital cost. Another alternative is to only run 2 of 4 floc trains at one time. As the plant is running under 50% capacity at this time, it is conceivable that running all four 4 floc trains does not provide adequate velocity for collisions and mixing and that speeding the water up by taking two trains offline might enhance mixing and eliminate the need for an increased alum dose and subsequent aluminum breakthrough.

2.2.3 Improved filter performance

2.2.3.1 Filter Surveillance

The objective of this task is to Implement a filter surveillance program to monitor existing filter performance and backwash routines, and to help identify deficiencies or opportunities for optimization. Samples will be analyzed for typical filter surveillance target parameters (i.e., turbidity and aluminum). However, the investigation will also include measurement of other inorganic and organic potential foulants by performing acid digestion and scans for additional metals (i.e., iron and manganese) and measuring NOM surrogates (i.e., TOC, DOC, PeCOD, UV_{254}, FEEM). Analysis of different FEEM regions will provide an indication of the relative fulvic, humic and protein content of NOM. To understand the fouling contribution of biological material, biomass will be quantified using ATP and cell counting, and extracellular polymeric substances (EPS) will be quantified as glucose and as proteins.

Implementation of a filter surveillance program would involve development of a filter surveillance team and data collection templates and procedures so that data is accessible and can be compiled and used by plant and water quality staff.

2.2.3.2 Biofiltration optimization

Currently the filters at J.D. Kline are running as passive biofilters as there are no chemical or nutrient enhancements to the process. Research using the pilot plant can provide insight on whether addition of pre-oxidants and/or nutrients could provide enhanced organics removal through biofiltration processes. Additionally, monitoring tools and operational controls to measure biofilter performance and health need to be developed and added to operational monitoring programs.

Extracellular polymeric substances (EPS) can contribute to headloss in biofilters. The direct biofiltration process at the JD Kline WTP does not incorporate sedimentation prior to filtration. The purpose of this investigation will be to understand the interaction between floc material and biomass and determine the extent to which alum floc competes with biomass for space in the filter bed and if alum toxicity limits biomass concentration (as measured by ATP), potentially reducing the capability of the filter to perform biodegradation of substrate, or impacts the formation of EPS, potentially contributing to filter clogging.

2.2.3.3 Coagulant optimization

Research conducted by Knowles in 2011 showed that coagulation with alum as currently practiced provided the longest filter run times combined with minimal downstream unintended consequences. With the change in source water quality, these studies should be revisited. Additionally, the chemical supplier recently changed the supplier and process for alum production from bauxite to trihydrate, which has had an impact on plant performance. Bauxite is being phased out as a type of alum and thus it is important to determine an appropriate coagulant for the new source water quality which maximizes filter run times while minimizing downstream unintended consequences.

Research at the pilot scale will be conducted to determine whether increasing alum doses or using alternative coagulants can overcome increasing NOM concentrations, while given the constraints of current treatment process design (i.e. particle loads for direct filtration, downstream water quality impacts).

2.2.3.4 Backwash optimization

Following conversion of the JD Kline WTP filters to biofilters, operational strategies (e.g., backwash, loading rate) have remained fundamentally unchanged. Results following the conversion showed that the biofilters could be operated in the same manner as before and still meet effluent turbidity requirements and previous benchmarks for initial and terminal headloss, loading rate and unit filter run volume. However, recent filter surveillance shows that there is significant material remaining in the lower third of the biofilters, post backwash. Adjustments to the backwash protocol, loading rate and empty bed contact time could potentially optimize this process and increase biofiltration hydraulic performance.

2.2.3.5 Filter media replacement and addition of air scour

The existing filter media is original to the plant and recent filter assessment by consultants has indicated that both filter media and underdrains require replacement. A capital project is underway to replace both filter media and underdrains in all filters, with a completion date of March 2018. Air scour equipment will be installed at the same time to provide enhanced backwash performance. The filter media design has been altered slightly (slightly larger effective size) to be more compatible with biofiltration processes. New backwash routines for air scour will be developed post installation, and filter health will be monitored using filter surveillance techniques.

Task 2.3 Lake Major Water Supply Plant (LMWSP)

In 2015/16 a Lake Major Water Supply Plant Process Optimization Study was completed by CBCL Limited and HDR Engineering Inc. The report provides an implementation strategy based on recommendations, and research requirements. Halifax Water staff have developed a 10 year Capital Improvement Plan based on this report, which includes both capital upgrades and research requirements. The research requirements over the next five years are highlighted in the following sections.

As described in Theme 1, Lake Major has seen recent changes in source water quality which have resulted in increases in chemical dosage to remove increased organic loads. The LMWSP has been able to adapt to an increased alum dosage of approximately 50 mg/L due to the presence of upflow clarifiers prior to filtration, however the plant is experiencing challenges with coagulant performance, disinfection byproducts and residuals handling. The research and operational tasks presented below detail improvements that can be made to existing operations with enhanced monitoring of process change outcomes and bench-scale testing. The longer term research plan, beyond the scope of this 5 year WQMP, would be to install and operate a pilot plant at Lake Major to further optimize treatment processes once initial improvements have been made.

2.3.1 Premix optimization

There is a need for optimization of pre-mix chemical types and injection location as well as mixing speeds. The impact of increasing mixing intensity will be evaluated as the current mixing speed is below that of rapid mix but above a floc mixing intensity. The current lime system is in need of an overhaul, and prior to this occurring, investigation of the use of soda ash instead of lime for pH/alkalinity control should be explored in more detail at the bench scale.

2.3.2 Coagulant changeover

LMWSP has experienced the same challenges as J.D. Kline with respect to the type of alum used (bauxite versus trihydrate). With the current increased cost of bauxite and eventual discontinuation of the product, it is prudent to perform coagulant changeover studies to develop a suitable process moving forward. This research task will incorporate bench-scale jar testing to evaluate different coagulant types. However, due to the plant configuration as upflow clarification, jar tests can provide good initial insight, but results may not be representative of full-scale operation. Therefore, a way to simulate upflow clarification at the bench scale will be explored to provide more replicable data for comparison to full-scale operation. Further pilot scale testing would then be conducted upon installation of a pilot plant, beyond year 2022. In addition to evaluating filter performance and organics removal with alternative coagulants, impacts on corrosion downstream need to be evaluated to ensure that changing the chloride:sulphate mass ratio does not lead to increased corrosion in the distribution system.

2.3.3 Clarification

The UltraPulsator technology is not seen as ideal for the application of clarification at LMWSP. The current tubes and plates are in need of replacement so a capital inspection and replacement project will be initiated. With installation of a new intake with consistent daily temperatures and water quality, improvements in pre-mix chemistry and injection, optimization of coagulants and replacement of tubes and plates within the UltraPulsators, it is possible that improvements in operation and finished water quality will provide an extended life for the existing units. Enhanced water quality monitoring post tube and plate replacement will be conducted to help with optimizing performance.

2.3.4 Manganese oxidation

LMWSP was originally designed to use potassium permanganate for manganese oxidation. Shortly after plant commissioning, potassium permanganate was shutoff and manganese was oxidized with pre-filtration chlorination. This has allowed the filter media to become coated with manganese dioxide over time which acts as a catalyst for manganese oxidation. Although effective for oxidizing manganese, pre-filter chlorination can lead to increased disinfection byproduct formation through reactions between remaining organics and chlorine prior to filtration. With the anticipation of replacement of filter media, it is a good time to remove the pre-filter chlorination step and provide manganese oxidation at the head of the plant. The filter media has been operating with pre-chlorination for so long that it is likely that manganese from the filter media could leach into finished water if the pre-chlorine is turned off while existing media is still in place. Different manganese oxidation strategies will be tested to determine a suitable process moving forward for post filter media replacement.

2.3.5 Improved filter performance

2.3.5.1 Filter Surveillance

LMWSP has implemented a filter surveillance program to monitor existing filter performance and backwash routines, and to help identify deficiencies or opportunities for optimization. As mentioned for J.D. Kline, a team and consistent data collection procedures and templates will be developed so that data is accessible and can be compiled and used by plant and water quality staff. In addition to the regular filter surveillance program, additional parameters may be measured periodically to provide a more detailed picture of filter performance. This will be important once new filter media is installed and pre-chlorine is shut off to monitor the conversion to passive biofiltration. In order to monitor the performance of the biofilters, the investigation will also include measurement of other inorganic and organic potential foulants by performing acid digestion and scans for additional metals (i.e., iron and manganese) and measuring NOM surrogates (i.e., TOC, DOC, PeCOD, UV_{254}, FEEM). Analysis of different FEEM regions will provide an indication of the relative fulvic, humic and protein content of NOM. To understand the fouling contribution of biological material, biomass will be quantified using ATP and cell counting, and EPS will be quantified as glucose and as proteins.

2.3.5.1 Filter media replacement

Filter excavation box tests indicate that there is poor stratification of filter media, and that garnet layers are mismatched with sand and anthracite. Additionally, as previously described, there is a likelihood that manganese dioxide has built up on the media due to pre-filter chlorination. Further sieve analysis and characterization of organics and metals through filter surveillance will be conducted to determine whether media should be replaced, or whether washing media to remove manganese dioxide could be adequate to restore filter integrity. Following a conversion in manganese oxidation strategy and media wash or replacement, the filters will then begin to operate as passive biofilters like those at Pockwock. Monitoring of performance and establishment of biofilm will be conducted through filter surveillance.

2.3.5.2 Backwash optimization

Existing filter surveillance data suggests that media particularly between 18-24 inches is not being sufficiently cleaned, and thus optimizing backwash rates and times to achieve enhanced particle removal would be beneficial. Extended subfluidization terminal wash (ETSW) procedures could also be investigated to determine whether ETSW would reduce filter ripening times. Additionally, upon conversion to passive biofiltration, buildup of EPS and biofilm could lead to changes in filter operation and performance as well as a requirement for different backwash procedures.

2.3.6 Waste residuals management study

The current waste residuals process does not meet the water quality discharge guidelines for aluminum. There are two options moving forward to address this issue. The existing residuals management process could be modified in order to meet the existing water quality discharge guidelines and maximize treatment efficiency, reliability and capacity. Alternatively, the residuals could be discharged to a new sanitary sewer without treatment. Both of these options will be explored in detail from a cost/benefit perspective.

Task 2.4 Bennery Lake Water Supply Plant (BLWSP)

2.4.1 Installation of plate settlers

The sedimentation basins were originally designed to contain plate settlers, but the plates were never installed. The basins currently operate under a high overflow rate and particles are travelling through the sedimentation basin and being deposited in the filters, compromising filter integrity. Plate settlers will be installed in 2016-2017. Upon installation, detailed water quality investigations throughout the treatment train will be conducted to help with process optimization. Installation of the plate settlers will likely improve filter turbidity and runtime and will also require optimization of the backwash process with the new water quality reaching the filters.

2.4.2 Filter Surveillance

The 2013 optimization study completed by Stantec suggests that the media should be evaluated due to its age. Similar to JD Kline, and LMWSP, BLWSP will implement a filter surveillance program to monitor filter performance, health and backwash routines, and to help identify deficiencies or opportunities for optimization, as well as to determine whether media needs to be replaced. The same suite of biotic and abiotic parameters will be evaluated as part of filter surveillance to provide the same breadth of analysis as mentioned for J.D. Kline and LMWSP.

Theme 3: Distribution System Water Quality

Task 3.1 Lead – Implementing NDWAC Recommendations

In 2015, the USEPA convened the National Drinking Water Advisory Council (NDWAC) to advise the USEPA on how to change the way lead in drinking water is regulated. The NDWAC recommended to the USEPA that the only truly effective solution is for utilities to commit to replacing all lead service lines (public and private) by 2050. To accomplish this, utilities must: develop an accurate inventory of lead service lines, reach out to customers who have lead service lines, work with customers to find a way for them to replace the private portion, and do much more sampling for customers. The NDWAC recommendations were endorsed by the American Water Works Association in March 2016.

Halifax Water has an estimated 2500 public lead service lines, most of which are in Halifax. The number of private lead service lines is unknown but expected to be much higher. Developing strategies for both public and private renewals is a major culture shift, as historically utilities have not taken responsibility for private lead service lines from an ownership, or inventory perspective.

Halifax Water's new approach to manage its customer's exposure to lead is designed to be consistent with the NDWAC recommendations, to the degree they can be applied in Canada and do not conflict with local regulatory requirements. The following five sections describe the research and operational approach that will be taken to address each of the main NDWAC themes:

1. Development of an inventory of lead service lines – both public and private
2. Development of a LSL replacement strategy to meet complete LSL removal by 2050
3. Enhanced public outreach on risks, shared responsibility, results, programs

4. Enhanced customer based sampling, using a variety of types of sampling, chosen from a menu to reflect certain uses. All customer sampling will be used to develop a 3-year continuous 90th percentile that must be below a specified system action level.
5. Enhanced water quality parameter monitoring and evaluation of corrosion control treatment.

3.1.1 Lead Service Line Inventory

The NDWAC recommendations require that utilities inventory the amount and location of LSL's and further take the approach that in areas developed before the cessation of LSL's that the service should be assumed to be made of lead unless proven otherwise. This makes development of an inventory complex but is crucial to other programs and ensuring all of the lead service lines are removed by the target date.

For public services, the existing inventory is fairly reliable but is still populated with a number of "unknown" services. The private inventory is much less reliable. This is due to the fact that there is no positive mechanism that requires a customer to contact us upon renewal of a service but also due to the fact that the pre-existing utilities exercised varying and inconsistent levels of attention to the private service lateral database.

As a first step, areas of the distribution system that would have been serviced by a central water system and potentially had lead service lines installed prior to 1960 has been developed. This is a baseline map that can be used to narrow down the presence of lead on a house by house basis. Some techniques that will be used to update the inventory include:

- Analysis of existing records for anything that contains lead or unknown on the public or private portion of the service lines.
- When new meters are being installed as part of the Advanced Metering Infrastructure (AMI) program, all staff that will be in homes will be trained to identify lead service lines, and will report information back to be included in service cards.
- Gathering and recording information anytime there is work done on a sewer line or a service box in the area with potential lead service lines.
- Participation in industry research to explore and test methodologies for non-intrusive identification of LSL material.
- Conducting a pilot trial for successful identification using more invasive techniques (i.e. hydro-vac excavation at the service box) to determine composition of both public and private portions.

3.1.2 Lead service line replacement strategy

HW will develop a strategy for replacing all public and private lead service lines by 2050. The current rate of 20-30- replacements per year will need to be tripled to about 100 per year in order to replace all of the public portions of the lead service line within this timeframe. The number of private renewals requiring replacement per year is expected to be much higher as there are significantly more private than public lead service lines.

Up until 2012, Halifax Water proactively replaced lead service lines in the distribution system in conjunction with municipal street-paving and sidewalk renewal projects, water main replacement projects and other distribution system infrastructure upgrades. In light of recent national and internal research initiatives, including research with Dalhousie University, which demonstrate the increase in lead concentrations at the tap following partial service line replacements, Halifax Water has changed its policy regarding service line replacements to minimize the occurrence of partial lead service lines in the distribution system. This practice is expected to continue even with the increased replacement goals. Following are some strategies that will be used to increase the number of lead service lines replaced each year, while continuing to avoid partial replacements to protect public health.

- Halifax Water will explore options with the UARB to allow access to private property to replace the full service line during emergency events when Halifax Water replaces the public portion due to a leak or work on the main.
- Halifax Water will develop a business case to present to UARB that will identify potential cost savings of doing full LSL replacement (private and public) in coordination with HRM paving and sidewalk renewal projects. Cost savings on the public portion would include only one mobilization for multiple services, and a significant reduction in reinstatement costs as this would be covered by the HRM paving project. Being able to coordinate with HRM paving projects would allow for a significant increase in the numbers of renewals per year.
- Halifax Water will continue to provide a program where there is a standing contract with several contractors to replace the public portion of the service line in conjunction with the private portion. This program was initiated in 2016, and provides the option to minimize any potential time with a partial replacement between coordination of the private and public renewals, and also streamlines the process for customers.
- Following any disturbance or replacement of a lead service line, home owners will be provided with instructions for appropriate flushing procedures to carry out immediately following disturbance and protocols to follow to minimize lead exposure for a defined period of time following a LSL replacement. Homeowners will also be provided with a pitcher style water filter and cartridges for one year following disturbance. Different pitcher style filters will be tested for removal of high concentrations of lead post-disturbance to ensure filters provided are adequate for the conditions expected.
- A significant barrier to private uptake of lead service line replacement is expected to be financial challenges. HW will develop a financial enabling program for residents to pay for private LSL replacement. HW will work to ensure that financial enabling strategies are accessible to all customers, to ensure that all demographics have access and ability to replace lead service lines. It is expected that challenges will exist with low-income households, long-time homeowners and also rental units.

3.1.3 Communications

Communications and outreach will be critical components to the success of the lead service line replacement program. Customers must have access to transparent, easy to understand information on the risks associated with lead, and programs available to help with getting lead out of the system. Contact with customers will need to occur through the website, through mail-outs and targeted campaigns in areas that may have lead service lines and vulnerable populations. Significant efforts will be placed on meeting with realtor groups, building inspectors and plumbers to disseminate information about lead service lines. A real estate transaction is a great opportunity to renew service lines. As such, customer service staff will flag any new customers in the lead hot spot areas so that appropriate information can be mailed out to them when they open an account.

A research program will be initiated to determine effective means of customer communications, so that programs put into place will be an effective use of resources and will provide positive outcomes for private side LSL replacement.

3.1.4 Corrosion Control Treatment

Halifax Water maintains an effective corrosion control program to minimize the corrosion of lead and other materials in the distribution system by controlling pH and using zinc ortho-phosphate for corrosion control.

Recent changes have been made to the corrosion control product and the dose. In 2015, poly phosphate was removed from the product due to research showing it can negatively impact lead release, and in April 2016, the dose was doubled from 0.5 to 1.0 mg/L as PO_4 for both J.D. Kline and Lake Major based on recommendations from consultant reviews of Halifax Water's programs, and research conducted by Dalhousie that shows a decrease in lead concentrations after an increased dose of orthophosphate.

There is a need to further understand the influence of general water chemistry, presence of other metals (i.e. iron, manganese and aluminum) and seasonality on lead release. Research is also required to understand lead phosphate deposition rates following adjustment of orthophosphate dose or changes to source chemicals (i.e. zinc orthophosphate, orthophosphate and phosphoric acid to optimize corrosion control), while balancing costs, minimizing lead release and minimizing unintended consequences.

3.1.5 Water Quality Monitoring

Currently, the effectiveness of the corrosion inhibitor is monitored by Water Quality Inspectors through:

- biweekly distribution system sampling at 25 sites for pH, orthophosphate, zinc, iron, manganese, alkalinity, chloride, sulphate, aluminum and turbidity
- quarterly monitoring of metal coupons (copper, lead and steel placed at 10 locations in the distribution system; and
- bench and pilot scale research conducted in coordination with Dalhousie University,

Additionally, samples are taken from residential homes through three different programs:

- Annual Health Canada lead and copper residential program
    - 100 homes, half lead and half copper, 4 L profile and a flush sample, in August
- Customer initiated sampling
    - Year-round, 4 L profile and a flush sample, any time of year
- LSL replacement sampling program
    - Pre and 72 hrs, 1 month, 3 months and 6 months post construction samples, 4 L profile and flush sample.

Although this is a robust monitoring program, there is room for improvement through evaluation of the program. There is some question as to the value of the coupon monitoring, which will be explored. Additionally, the corrosion sampling sites should be reviewed to ensure their representation of the system. Finally, customer sampling is the only way to provide an indication of lead concentrations in homes, however it relies on the customer to take the sample, which can lead to sample integrity issues. Furthermore it is difficult to compare data from year to year because customers often opt to replace their service line once they find out their lead concentrations. To provide a more robust and stable way to monitor lead concentrations at the tap, Halifax Water will install permanent lead pipe racks in at least 4 places in the distribution system (one in Dartmouth and three in Halifax) to mimic lead levels at the tap. These pipe racks would be similar to those used by Dalhousie University at J.D. Kline previously but would be located in Halifax Water infrastructure in the distribution system to be more representative of at the tap concentrations. This would allow for routine lead sampling to monitor corrosion control, and would also allow for exploration of different stagnation time sample regimes. Pipe racks would also allow monitoring of changes to corrosion control chemistry and impacts from seasonal variations in water quality, including metals, temperature, etc.

Task 3.2 Distribution System Water Quality and Integrity Monitoring

Halifax Water has a comprehensive program to actively monitor and assess both distribution system water quality and physical integrity, through programs such as HPC monitoring, reservoir water quality monitoring, and corrosion monitoring. Data is currently compiled into technical memos and distributed to appropriate staff for review. The monitoring programs are constantly being reviewed for relevance and completeness and this should continue, to ensure that there is appropriate data collection but also interpretation to help understand and predict water quality in the distribution system. One example would be the use of ATP to monitor biological growth in correlation with HPCs. ATP is a rapid test that can be done within minutes versus 7 days for an HPC test. Therefore, understanding the correlation between ATP and HPCs would be very useful for monitoring biological health when low chlorine residuals are present in the warmer months. ATP data collection has started, but should continue to develop a database that provides relationships between ATP and other water quality parameters in the distribution system.

A fluoride tracer study for LMWSP distribution system showed that water age depends on a number of factors including distance from the plant, time of day and reservoir operation. A fluoride tracer study will be repeated on targeted areas within the LMWSP to determine whether there are operational changes that can be made (operation of valves) to decrease water age to some regions of the distribution system. A fluoride tracer study will also be completed for the JDKWSP to provide an overview of water age within the distribution system. Having an indication of water age, particularly at extents of the system and around reservoirs provides valuable information and insight for optimizing water quality, maintaining chlorine residuals and minimizing DBP formation.

As part of the Partnership for Safe Water program, conducting a review of existing chlorine residual monitoring sites and ensuring that sites are representative of the distribution system, including extents, is an important part of understanding distribution system integrity. The fluoride tracer studies will also provide valuable information for assessing the relevance of existing monitoring locations.

Task 3.3 Disinfection efficiency and minimizing disinfection byproduct formation

Although significant work has been done on minimizing distribution system disinfection byproducts both through treatment process changes (removal of pre-chlorine at JDKWSP) and installation of chlorine booster stations on reservoir outflows (North Preston), there is still work that can be done to both reduce DBP formation and also manage reservoir operation to ensure adequate chlorine residuals in all extents of the distribution system, throughout all seasons. Targeted chlorine investigations and review of reservoir monitoring data will provide insight on changes to reservoir operation processes such as installing rechlorination stations, changes in reservoir cycling (volume and timing), installation of mixers, or point of use treatment for removal of disinfection by products that can be implemented to increase disinfection efficiency while minimizing DBP formation.

Theme 4: Theme 4: Data Management

Task 4.1 Adoption of a Data Management Tool

Water Quality Data collected by Halifax Water staff currently gets stored in several different places. Some is entered into WaterTrax, some exists in Pi, and some is stored in spreadsheets at various locations on the K Drive. There is no central place to store, extract and analyze data. Similarly, all water quality data generated by consultants, IRC students and staff is generally contained within reports, student theses, and on personal computers. As this dataset grows, it is becoming clear that there needs to be a mechanism to manage and store all of these data sources, so that data is not lost and both staff and students have access to historical data. This is also becoming increasingly important in the context of Lake Recovery and changing source water quality.

This task will aim to identify, compare, select and integrate a data management approach for water quality data. There exist commercial solutions, provided by companies such as Kisters, EarthFX, Locus Technologies, Aquatic Informatics, Etc. that provide geocoded solutions to water quality data management and analysis. Other options could include development of a Laboratory Information Management System (LIMS), or design of a custom solution. This data management tool will be used to pull all data sources into one central system.

The primary objective of this exercise is to ensure that the valuable resource of water quality data is utilized both as an operational tool to make sound day to day operating decisions and also to ensure that sound investment decisions are made when considering capital improvements to treatment plants and other water quality investments.

Appendix B - Research and Operations Approach

Theme and Task	Halifax Water Role	Dalhousie Role	Comments
Theme 1: Source Water: Lake Recovery and Variable Source Water Quality			
Task 1.1: Identification of Changing Source Water Quality	Sampling	Research lead	
Task 1.2: Lake Recovery Monitoring	Program Evaluation	Research lead	
Task 1.3: Assessment of Intake Locations and Structures			
Task 1.3.1: Lake Major	Bathymetry	Research lead	
Task 1.3.2: Pockwock Lake	Bathymetry	Research lead	Paleolimnological studies
Task 1.3.3: Bennery Lake	Bathymetry and equipment installation	Research lead	HW and Dal to develop raw water monitoring program
Task 1.3.4: Bomont	Lead investigation		
Theme 2: Treatment			
Task 2.1: Roadmap for Robust Treatment Plant Design for a Changing Source Water Quality	Lead tailored collaboration through WRF	Act as in-kind partner	
Task 2.2: J.D. Kline Water Supply Plant			
Task 2.2.1: Improvement of pre-mix and pre-oxidation processes	Capital improvements	Pilot research lead	
Task 2.2.2: Flocculation Optimization	Implement process changes	Monitoring lead	
Task 2.2.3: Improved Filter Performance			
Task 2.2.3.1: Filter Surveillance	Develop and lead Filter Surveillance Team	Lead filter WQ analysis	
Task 2.2.3.2: Biofiltration Optimization		Lead pilot research	
Task 2.2.3.3: Coagulant Optimization		Lead pilot research	
Task 2.2.3.4: Backwash Optimization	Full-scale testing	Lead pilot research	
Task 2.2.3.5: Filter media replacement and addition of air scour	Capital improvements and filter surveillance	Lead filter WQ analysis	
Task 2.3: Lake Major Water Supply Plant			
Task 2.3.1: Premix Optimization	Capital improvements	Lead bench-scale testing	Bench-scale testing for pH/alkalinity control
Task 2.3.2: Coagulant Changeover		Research Lead	
Task 2.3.3: Clarification	Capital improvements and optimization	Monitoring lead	
Task 2.3.4: Manganese Oxidation		Research Lead	
Task 2.3.5: Improved Filter Performance			
Task 2.3.5.1: Filter Surveillance	Develop and lead Filter Surveillance Team	Lead filter WQ analysis	
Task 2.3.5.2: Filter Media Replacement	Capital improvements	Lead filter WQ analysis	
Task 2.3.5.3: Backwash Optimization	Make process changes	Lead filter WQ analysis	
Task 2.3.6: Waste Residuals Management Study	Lead study		Will utilize previous Dal research
Task 2.4: Bennery Lake Water Supply Plant			
Task. 2.4.1: Installation of Plate Settlers	Capital improvements and optimization		
Task 2.4.2: Filter Surveillance	Develop and lead Filter Surveillance Team	Lead filter WQ analysis	
Theme 3: Distribution System Water Quality			
Task 3.1: Lead - Implementing NDWAC Recommendations			
Task 3.1.1: Lead Service Line Inventory	Initiate and manage program, participate in WRF projects		
Task 3.1.2: Lead Service Line Replacement Strategy	Initiate and manage program	Provide technical guidance	
Task 3.1.3: Communications and Outreach	Initiate and manage program	Lead research on customer buy-in	
Task 3.1.4: Corrosion Control Treatment		Research lead	
Task 3.1.5: Water Quality Monitoring	Evaluate and update program		
Task 3.2: Distribution System Water Quality and Integrity Monitoring	Conduct review and research		
Task 3.3: Disinfection Efficiency and Minimizing Disinfection Byproduct Formation	Monitoring lead	Research Lead	
Theme 4: Data Management			
Task 4.1: Adoption of a Data Management Tool	Research, procurement and adoption	Partner as appropriate	Dal to develop integrative data tools