VOLUME 3 – APPENDIX A

Water System Review

HALIFAX WATER
INTEGRATED RESOURCE PLAN
VOLUME 3 APPENDIX A – WATER SYSTEM REPORT

SUMMARY OF REPORT

The Water System Report will provide detail to the following:

- Water Supply Plants: highlighting source water, current conditions, and future improvements.
- Dams for the drinking water supplies.
- Water quality and future considerations.
- Water operating cost methodology used in the IRP's Financial Model.
- Halifax Water's Leakage Reduction Program.
- The existing transmission and distribution system.
- Water CAD model developed for the IRP using existing and future conditions.

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1. INTRODUCTION

1.1 BACKGROUND

In June 2011, the consulting team of GENIVAR Inc., XCG Consultants Ltd., and Halcrow were retained by the Halifax Regional Water Commission (HRWC) to conduct an Integrated Resource Plan (IRP) that identifies the long-term needs for HRWC's water, wastewater, and storm water infrastructure. The following section examines the water infrastructure side of the IRP.

Halifax Water is the municipal water and wastewater utility for the Halifax Regional Municipality (HRM). The HRWC operates three (3) large water supply plants (WSP) and six (6) small WSP. The large WSP, J.D. Kline WSP, Lake Major WSP, and Bennery Lake WSP serve the core area of HRM and the Aerotech/Halifax International Airport. The six (6) small WSP, Five Island Lake, Collins Park, Middle Musquodoboit, Silver Sands, Miller Lake, and Bomont, service small rural populations are suburban area. Halifax Water also own 81 PRVs, approximately 1187km of distribution main, 220km of transmission mains, 20 water pumping stations, 6 dams on the drinking water supply, and 16 storage reservoirs.

2. WATER SUPPLY PLANTS

2.1 OVERVIEW

The following describes a brief overview of the WSP Halifax Water operates.
The locations of the water supply infrastructure are presented in Volume 1 Appendix D, which contains the major maps for Volume 1.

Large WSP

- **J.D. Kline WSP –** The J.D. Kline WSP is located in the Pockwock Watershed in Upper Hammonds Plains. The source water is Pockwock Lake. In 1977, the J.D. Kline WSP was commissioned. The WSP is a direct dual media filtration plant. The current average daily production is 90MLD. The design capacity of the WSP is 220MLDay. The J.D. Kline WSP serves the communities of Halifax, Bedford, Sackville, Fall River, Waverley, and Timberlea.
- Lake Major WSP – The Lake Major WSP is located in Dartmouth. The source water is Lake Major. The Lake Major WSP was commissioned in 1999. The treatment process includes sedimentation with multimedia filtration. The current average daily production is 43MLD. The design capacity is 90MLD. The WSP serves the communities of Dartmouth, Eastern Passage, Cole Harbour, and Westphal.

- Bennery Lake WSP – The Bennery Lake WSP located between the Grand Lake and Highway 102, west of the Halifax International Airport (HIAA) and the Aerotech Business Park. The source water is Bennery Lake. The WSP was commissioned in 1986. It is a direct filtration plant with duel media filtration. The HRM owned the system before the transfer to HRWC in 2006. The current average daily production is 1.2MLD. The plant capacity is 7.95MLD. The WSP serves the HIAA and the Aerotech business park.

Small WSP

- **Five Island Lake –** The Five Island Lake WSP obtains water by a drilled well. The treatment process uses UV to disinfect the water with no filtration. The water services the Five Island Lake community. In 1994, the HRWC commissioned the WSP.
- **Collins Park –** The Collins Park WSP obtains source water from Lake Fletcher. The water is treated using micro-filtration followed by ultra-filtration. Disinfection is done with ultra violet and then with chlorine. The WSP was commissioned in 2010 and serves 83 customers in Wellington.
- **Middle Musquodoboit** – The Middle Musquodoboit WSP obtains source water from the Musquodoboit River. The water is treated with micro-filtration followed by ultra-filtration. Disinfection is obtained with UV then chlorine. The plant was commissioned in 2010 and serves 96 customers in Middle Musquodoboit.
- **Silver Sands** – The Sliver Sands WSP is located in the Cow Bay area to the East of Dartmouth. The source of water is from two (2) wells. There are approximately 300 ha of wellhead protection. The treatment process uses green sand pressure filtration for iron and manganese removal. The HRWC acquired the WSP in 1999.
- **Miller Lake** – The Miler Lake WSP is located in the community of Fall River. The source of water is from three (3) wells. The wellhead protection area covers approximately 232 hectares. The treatment process uses G2 media for arsenic removal and chlorine for disinfection. The HRWC acquired the WSP in 2002.
- **Bomont** – The Bomont WSP is located in Elmsdale, near Lantz. The source water is the Shubenacadie River. HRWC acquired the WSP in 2012. The WSP is being upgraded in 2011-12 with ultra-filtration and ion exchange resins for treatment.

2.2 SOURCE WATER

The HRWC currently manages eight (8) watersheds (Pockwock Lake, Tomahawk Lake, Lake Major, Bennery Lake, First Chain Lake, Lake Lamont, Lake Fletcher, and Musquodoboit River) and three (3) ground water sources (Five Island Lake Wellhead, Miller Lake Wellhead, and Silver Sands Wellhead). Once the new small water supply system in Bomont is commissioned in early 2012, the Shubenacadie River will be included.

Tomahawk Lake is reserved as potential future source water for the J.D. Kline WSP. First Chain Lake and Lake Lamont serve as emergency water supplies for the J.D. Kline WSP and Lake Major WSP, respectively. Lake Fletcher is the source water for Collin's Park. Additional information is provided in each water system's individual section.

2.3 J. D. KLINE WSP

2.3.1 Permitting and Approvals

The Pockwock Water Supply System obtains its primary source of water through the J. D. Kline Water Supply Plant (WSP), with a backup system operated from the Chain Lakes. Figure 2.1 shows an aerial view of the J.D. Kline WSP site. Figure 2.1 shows an aerial view of the Chain Lake emergency supply. The J. D. Kline WSP currently operates under NSE Approval to Operate # 2008-061444-R03, which expires on December 31, 2012.

Figure 2. J.D. Kline Water Supply Plant - Aerial View

Figure 2.1 Chain Lake Water Supply Plant (Emergency Supply) - Street View

The J. D. Kline WSP produces potable water to service the western and central regions of the Pockwock service area. The J. D. WSP currently operates with two (2) Withdrawal Permits as summarized in Figure 2.2.

Table 2.1 J. Douglas Kline WSP Summary of Withdrawal Permits

Source	Permit #	ADF	MDF
Pockwock	71-W-32	131.8 MLD	171.4 MLD
Tomahawk Lake	71-W-33	36.4 MLD	47.3 MLD
Total		168.2 MLD	218.7 MLD

The Chain Lakes WSP is a backup system to be used only when there is a supply problem from the J. D. Kline WSP. The Chain Lakes WSP provides only chlorination and hence does not produce potable water. The Chain Lakes WSP operates with one Withdrawal Permit from the First and Second lakes in the Chain Lakes System. The Chain Lakes WSP operates under Approval to Operate/Withdraw #2010-072107-A01, which expires on June 10, 2021. The Approval permits the distribution of up to 82 MLD from the Chain Lake system in emergencies.

2.3.2 Source Water

The raw water for the J. D. Kline WSP is provided by the Pockwock Lake watershed. This protected watershed contains 4,858 hectares of crown land (88% of the watershed) and 650 hectares outside of the crown land, for which the HRWC owns 428 hectares (6% of the watershed). The safe yield of Pockwock Lake is 145.5 MLD. The Pockwock Lake Watershed is designated a protected water area as defined in Nova Scotia's

Environment Act, subsection 106(5) and (6). When available, Halifax Water will purchase land near the Pockwock Lake Watershed.

If more water is required due to long term growth, Lake Tomahawk can be used to supplement the supply.

Presented in Table 2. and

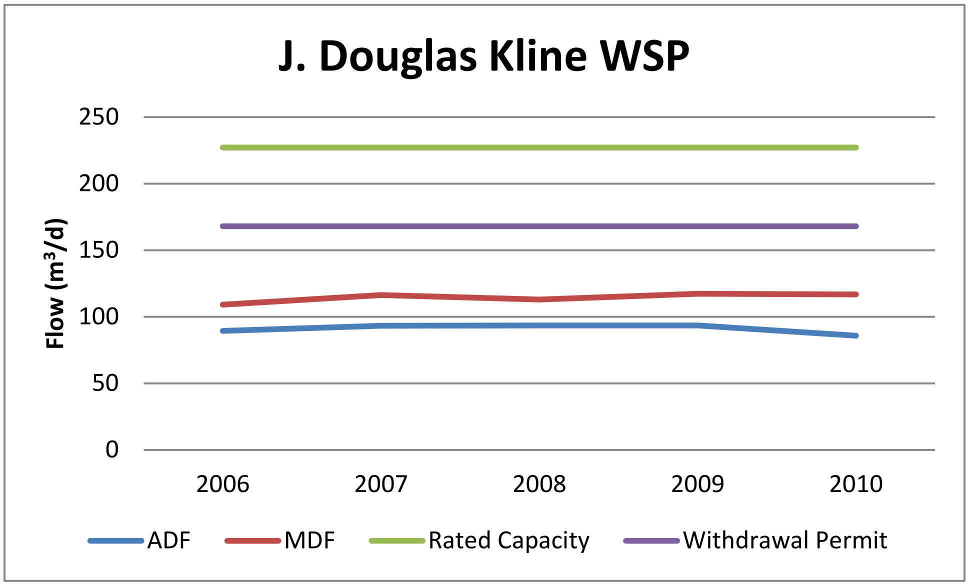


Figure 2.2 are the raw water and treated water flows from 2008 to 2010.

Table 2. J. D. Kline WSP Flow Information

Year	Rated Capacity	Withdrawal Permit	Average Daily Flow	Maximum Daily Flow
2008	227MLD	168 MLD	93.3MLD	112.8 MLD
2009			93.5 MLD	117.2 MLD
2010			85.7 MLD	116.8 MLD
2011			86.5 MLD	98.3 MLD

Note:
Historic flows from Halifax Water Annual Water Reports

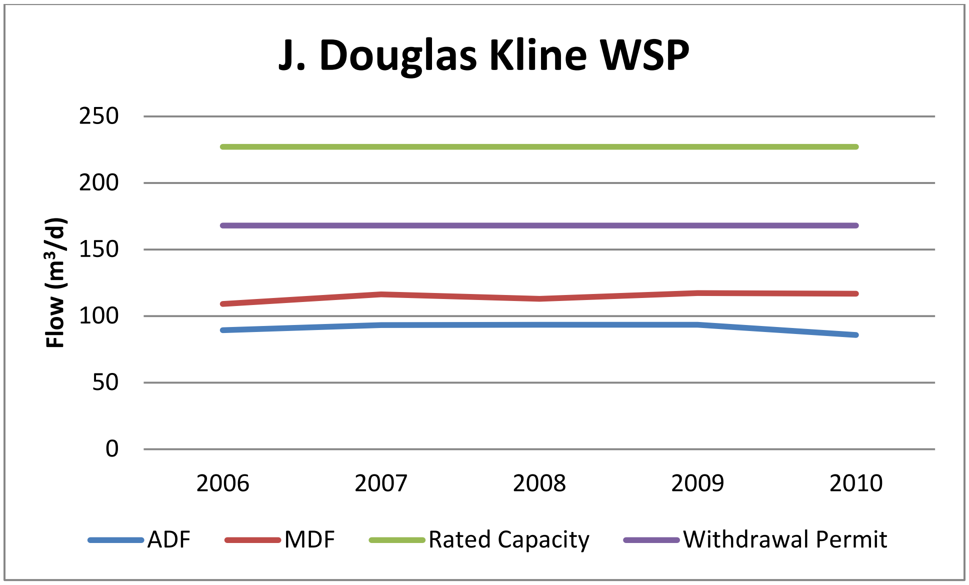


Figure 2.2 J.D. Kline WSP Flow Information

The average daily flow and maximum daily flow are well below the withdrawal permit and rated capacity of the J.D. Kline WSP.

2.3.3 Treated Water Quality

The treated water quality is shown in Appendix F. The annual average treated water quality is exception, in comparison to the Canadian Drinking Water Quality Standards. Although chlorinated disinfection by-products are lower than the requirements of the Canadian Drinking Water Quality Standards they are just under the cusp of attaining the Halifax Water objectives. Halifax Water has several research projects investigating on the best approach to minimize the formation of THMs and HAAs at the J.D. Kline WSP.

The raw water quality is shown in Appendix F. The raw water quality is exception, in comparison to the Canadian Drinking Water Quality Standards, with the exception of slightly elevated colour, turbidity and manganese and slightly low pH. According to the Guidelines for Canadian Drinking Water Quality (GCDWQ) the J.D. Kline WSP for 2010 had no Maximum Acceptable Concentration (MAC) or Interim Maximum Acceptable Concentration (IMAC) exceedances.

2.3.4 Process Description

The J.D. Kline WSP is a direct filtration plant which obtains its raw water from Pockwock Lake at a pumping station located adjacent to the lake. Raw water is pumped to the water supply plant where it first enters the rapid mix tanks where potassium permanganate, carbon dioxide, alum, and chlorine area added. The water is then split up into 4 trains, which have 6 cells each, where hydraulic flocculation is employed. The water is then filtered through dual media filters made of anthracite and sand. The filtered water is then held in a clear well. Chlorine, fluoride, zinc ortho/polyphosphate (75/25), and sodium hydroxide are added to the water before it is sent to the distribution system.

The process schematic of the J.D. Kline WSP is provided in Appendix D.

2.3.5 Capacity Evaluation

The terms of reference for the assessment were provided by Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems

(September 2004 prepared by CBCL) available at http://www.gov.ns.ca/nse/water/docs/WaterSystemGuidelines.pdf)

In Appendix A, the description of work for J.D. Kline WSP is presented in detail.

Table 2.2 J.D. Kline WSP Rapid Mixer Comparison to Guidelines

Section	Description	Requirement	Actual	Compliance
4.3.2.3 a)	Mixing Intensity, G	600 - 1000s^{-1}	395s^{-1}	Non-compliant
4.3.2.3 b)	Retention Time, t	10 – 60s	90s	Non-compliant
4.3.2.3 c)	Gt	6,000 – 25,000	32,850	Non-compliant

Table 2.3 J.D. Kline WSP Flocculation Tanks Comparison to Guidelines

Section	Description	Requirement	Actual	Compliance
4.3.3.1.5	Total Retention time	>30 min	30 min	compliant
4.3.3.1.6	Flow-through velocity	0.15 – 0.45 m/s	0.016 m/s	Non-compliant
4.3.3.1.7	Velocity for interconnecting piping and conduits	0.15 – 0.45 m/s	Varies (at inlet of pipe 2.3 m/s)	varies
4.3.3.1	Mixing intensity of hydraulic flocculators	5 – 50s-1	Varies	varies

Table 2.4 J.D. Kline WSP Filtration Comparison to Guidelines

Section	Description	Requirement	Actual	Compliance
4.5.1.2	Rate of Filtration	<9.0 m/hr	8.2 m/hr	compliant
4.5.1.6.1	Filter Media Total depth of media	600 mm – 750 mm	900 mm	Non-compliant
4.5.1.6.2	Effective size of smallest media	0.45 mm to 0.55 mm	0.55 mm	compliant
Dual media specifications				
4.5.1.6.5	**Anthracite** Depth(mm) Effective Size(mm) Uniformity Coefficient	300 – 600 0.8 – 2.0 1.3 – 1.8	600 mm 1.0 mm unknown	compliant compliant
	Silica Sand Depth(mm) Effective Size(mm) Uniformity Coefficient	150 – 300 0.45 – 0.55 <1.7	300 mm 0.55 mm unknown	compliant compliant

During the filter ripening stage, the flow of water is reduced in the ripening filter; hence, the other filters will dilute the ripening water.

2.3.6 Observations on Compliance with Design Guidelines

Note: Reference calculations for the following section are available in Appendix E. Calculations assume the design capacity of 220MLD.

Rapid Mix

The mixing intensity (g-value) of the rapid mix tank (395s^{-1}) is lower than the design guidelines (600 – 1000s^{-1} in Section 4.3.2.3a). To increase the g-value to within the range of the design guidelines the power of the mix would have to increase between 106,000 – 296,000W or the volume of the tank decreased to between 27 to 74m^3.

The retention time of one rapid mix tank at Pockwock is currently 90 seconds; this is above the design guidelines between the ranges of 10 to 60 seconds in Section 4.3.2.3b). To achieve a retention time within the design guidelines the flow rate through the WSP would have to be between 328 MLD to 1952 MLD. This range is above the WSP's design capacity and withdrawal permits.

Flocculation Tanks

Assuming equal flow into the four (4) flocculation trains, the velocity in the 0.6 m diameter pipe into each flocculation tanks is 2.3m/s. The design guidelines require a flow through velocity of 0.15 – 0.45m/s in Section 4.3.3.1.6. The flow rate of the plant would have to be in the range of 15 to 44MLD.

A hydraulic study using computation fluid dynamics was done on the flocculation tanks and it was discover that there are very low g-values and short circuiting occurring. (Yadasarukkai, Y.A. Assessment of the Hydraulic Performance of Flocculation Processes using Computational Fluid Dynamic (CFD) MASc thesis, Dalhousie, March 2010)

Filtration

The total depth of filter media is 900 mm, which is greater than the design guidelines of 750 mm in Section 4.5.1.6.1. In addition the effective size of the smallest media at 0.55 mm is on the higher range from the design guidelines at 0.45 to 0.55 mm in Section 4.5.1.6.2.

2.3.7 Known Issues

Known issues regarding the J.D. Kline WSP brought on by preview research studies are as follows:

- A computational fluid dynamics model done at Dalhousie University of the flocculation tanks has determined that the performance of the direct filtration system could be improved with the installations of mechanical mixers within the flocculation tanks. HDT Engineering is investigating the best approach to upgrade the flocculators.
- As indicated in the Water Quality Master Plan (Version 2), the pre chlorination before filtration for microbial control is leading to more disinfectant by-products (DBPs) being produced. There is a greater concentration of natural organic matter (NOM) in the water before filtration. The greater concentration of NOM will react with chlorine to produce a greater concentration of DBPs.
- There are high levels of aluminum in the process wastewater from J.D. Kline WSP. A concept level study was completed. The study determines that an engineered wetland or mechanical separation technology would be best suited to reduce aluminum levels. A pre design study is in progress.
- The chlorination system is original to the construction of the J. D. Kline WSP in the 1970s. A proposal is in place to install a new chlorination system which will meet current safety standards.

2.3.8 Planned Improvements

In the Halifax Water Five (5) Year Business Plan, HRWC had budgeted for the following:

- Design of mechanical mixers in mixing tanks (mechanical flocculators)
- Flow splitting improvement in pre-mix
- Upgrade to the chlorination system

- Replacement valve actuators at pumping station
- Replacement program for filter valve actuators
- Removal of aluminum in the process wastewater
- General renovations, such as lobby upgrades, and road paving renewal, and parking lot resurfacing
- Industrial Process pump upgrade
- Raw water supply pump energy study
- Wind energy development within the Pockwock Watershed

In the Water Quality Master Plan (WQMP) Version 2, the following projects are included for the implementation at the J.D. Kline WSP.

- Flocculation Mechanical Mixing Studies
- Alum Coagulation/Coagulant Aid Optimization
- Chemistry Assessment and Finalization of Pilot Plant
- Filter Operational Strategy and Flow Control of Pilot Plant
- Pre-chlorination evaluation (DBP reduction through eliminating pre chlorination), investigation will include bio-filtration

2.4 LAKE MAJOR WSP

2.4.1 Permitting and Approvals

The Lake Major Water Supply System obtains its primary source of water through the Lake Major WSP, with a backup system operated at the Lake Lamont WSP. Figure 2.3 shows an aerial view of the Lake Major Water Supply Plant. Figure 2.4 shows an aerial view of the Lake Lamont Water Supply Plant used for emergencies.

Figure 2.3 Lake Major Water Supply Plant - Aerial View

Figure 2.4 Lake Lamont Water Supply Plant (Emergency Supply) - Aerial View

The Lake Major WSP produces potable water to service the former City of Dartmouth, Eastern Passage and Forrest Hills/Colby Village. The Lake Major WSP currently operates under NSE Approval to Operate #2009-067618, which expires on March 22, 2018. The Lake Major WSP currently operates with one (1) Withdrawal Permit, #2006-055292, which expires on December 31, 2018. The Withdrawal Permit limits water taking to an average daily flow of 64.58 MLD (30 day average), a maximum daily flow of 105 MLD (three (3) day average) and a total annual water taking of 23.6 billion litres.

The Lake Lamont WSP is a backup system to be used only when there is a supply problem from the Lake Major WSP. The Lake Lamont WSP provides only chlorination and hence does not produce potable water. The Lake Lamont WSP operates with one (1) Withdrawal Permit, #2009-067056, which expires on September 11, 2019. The Withdrawal Permit permits the distribution of an average daily flow of 40 MLD in an emergency.

2.4.2 Source Water

The Lake Major Watershed Protected Area is approximately 6,997 hectares, of which 6,197 hectares is forested land, and 800 hectares is water. Percentage wise, the watershed consists of 41% crown land, 41% HRWC land, and 18% private land. When available, Halifax Water purchases land in the vicinity of the Lake Major Watershed to protect the water supply. Portions of five communities are located with the watershed area (Montagues, Cherry Brook, Lake Major, East Preston, and North Preston). Lake Major is a large deep lake, with depths over 40 meters.

The safe watershed yield of Lake Major is 65.9MLD. Furthermore, according to the System Assessment Report by CBCL, the yield can be increased to 104.4 MLD by raising current lake level by 1.8 m. The Lake Major Watershed is designated a protected water area as defined in Nova Scotia's Environment Act, subsection 106(5).

Table 2.5 and Figure 2.5 Lake Major WSP Flow summarize the flows of raw and treated water at the Lake Major Water Supply Plant.

Table 2.5 Lake Major Water Supply Plant Flow Production

Year	Rated Capacity	Withdrawal Permit	Average Daily Flow	Maximum Daily Flow
2008	90.8MLD	65.8 MLD	43.8 MLD	59.6 MLD
2009			44.9 MLD	56.3 MLD
2010			40.1MLD	57.9 MLD
2011			41.9 MLD	52.5 MLD
Note: Historic flows from Halifax Water Annual Water Reports				

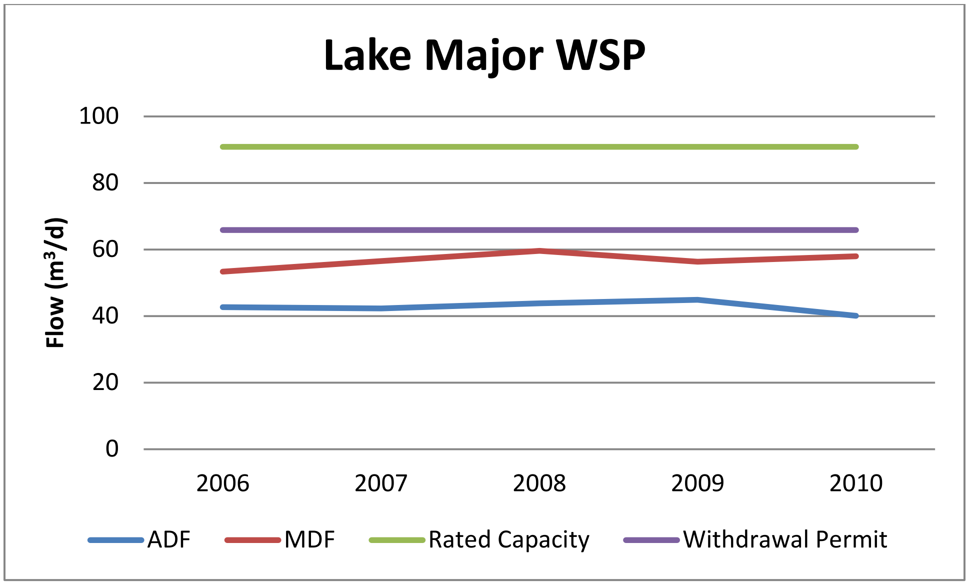


Figure 2.5 Lake Major WSP Flow

2.4.3 Treated Water Quality

The treated water quality is shown in Appendix F. The annual average treated water quality is exception, in comparison to the Canadian Drinking Water Quality Standards. Although chlorinated disinfection by-products are lower than the requirements of the Canadian Drinking Water Quality Standards they are just under the concentration of attaining the Halifax Water objectives.

According to the Guidelines for Canadian Drinking Water Quality (GCDWQ) the Lake Major WSP for 2010 had no Maximum Acceptable Concentration (MAC) or Interim Maximum Acceptable Concentration (IMAC) exceedances.

2.4.4 Description

The Lake Major WSP is a conventional filtration plant as described below.

Raw water from Lake Major is brought in through two (2) parallel concrete chambers with screens to a wet well. From the wet well, the raw water is pumped through a 484 m long raw water transmission main to the water supply plant. In the two rapid mix tank for coagulation, potassium permanganate, carbon dioxide, and alum are added to the raw water.

For flocculation and sedimentation, an up flow sludge blanket clarifier is used. For filtration, four (4) parallel multimedia filters made of anthracite, sand and garnet are used. The water then enters a clear well for storage. Polyphosphate, sodium hydroxide and chlorine are added for corrosion control, pH, and disinfection.

Appendix D provides the process schematic of the Lake Major WSP.

2.4.5 Capacity Evaluation

The terms of reference for the assessment were provided by Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems (September 2004 prepared by CBCL) available at http://www.gov.ns.ca/nse/water/docs/WaterSystemGuidelines.pdf)

In Appendix B, the description of works for Lake Major WSP is presented in detail.

Table 2.6 Lake Major WSP Rapid Mixer Comparison to Guidelines

Section	Description	Requirement	Actual	Compliance
4.3.2.3 a)	Mixing Intensity, G	600 - 1000s^{-1}	250s^{-1}	Non-compliant
4.3.2.3 b)	Retention Time, t	10 – 60s	240s	Non-compliant
4.3.2.3 c)	Gt	6,000 – 25,000	60,000	Non-compliant

Table 2.7 Lake Major WSP Upflow Sludge Blanket Clarifiers to Guidelines

Section	Description	Requirement	Actual	Compliance
4.4.1.5.3	Flocculation time	Minimum 30 min in a separate tank	Only two rapid mix tanks	Non-compliant
4.4.1.5.4	Surface overflow rates	Should not exceed 2.4 m/hr	6.3 m/h	Non-compliant
4.4.1.5.6	Retention Time	One(1) to two(2) hours	42 min at max flow	Non-compliant

Table 2.8 Lake Major WSP Filtration Comparison to Guidelines Rapid Rate Gravity Filtration

Section	Description	Requirement	Actual	Compliance
4.5.1.2	Rate of Filtration	<9.0 m/hr	11.6 m/hr	Non-compliant
4.5.1.6.1	Filter Media Total depth of media	600 mm – 750 mm	860 mm	Non-compliant
4.5.1.6.2	Effective size of smallest media	0.45 mm to 0.55 mm	0.2 mm to 0.32 mm Garnet, 0.45 to 0.55 mm sand	compliant
Multi-media Specifications				
4.5.1.6	Anthracite Depth(mm) Effective Size (mm) Uniformity Coefficient	 500 – 600 0.8 – 2.0 1.3 – 1.8	 560 mm 1.0 mm unknown	 compliant compliant
	Silica Sand Depth(mm) Effective Size (mm) Uniformity Coefficient	 150 – 300 0.45 – 0.55 <1.7	 225 mm 0.45 – 0.55 mm unknown	 compliant compliant
	Garnet Depth(mm) Effective Size (mm) Uniformity Coefficient	 50 – 100 0.15 – 0.35 <1.7	 75 mm 0.2 – 0.32 mm unknown	 compliant compliant
4.5.1.7	Filter Under drain Supporting media	ES 2.5 to 5 mm Depth 50 mm to 75 mm	ES1.5 mm depth of 125 mm	Non-compliant Non-compliant

2.4.6 Observations on Compliance with Design Guidelines

Reference calculations for the observations on compliance with design guidelines are in Appendix E.

Rapid Mix

In section 4.3.2.3, the requirement for the g-value is between 600 – 1000s^{-1}. The actual value is 250s^{-1}. To increase the G-value to within the guidelines the power of the mixer can be increase to between 100,000 – 280,000W or the volume of fluid can decrease from 213 m^3 to the range of 10 to 28 m^3.

In addition, Section 4.3.2.3 requires the retention time in the rapid mix tank to be between 10 and 60s. The retention time is currently 240s. To achieve a retention time between 10 and 60s, the flow rate through the WSP would have to be between 307 to 1,840MLD (over design capacity and withdraw permits).

Upflow Sludge Blanket Clarifier

In Section 4.4.1.5.3, a flocculation time of 30 min is required in a separate tank. The Lake Major does not have a separate flocculation tank, only two rapid mix tanks that have a HRT of 4.0 min each.

The surface overflow rate of 6.3 m/hr does exceed the design guidelines of 2.4 m/hr (Section 4.4.1.2). A flow rate through the WSP of 72.6MLD will reduce the surface overflow rate to the design guidelines.

Filtration

In section 4.5.1.2, the design guideline for the rate of filtration is less than 9.0 m/hr. Currently at the Lake Major WSP, the rate of filtration is 11.6 m/hr at the design capacity of 90MLD. To achieve a rate of filtration of 9.0 m/hr the flow rate through the WSP would have to be 72.6MLD.

The total depth of filter media is larger at 860 mm than the recommend depth between 600 – 750 mm in Section 4.5.4.6.1. The effective size of the current garnet media of garnet sand (ES 0.2 – 0.32 mm) is smaller than the requirement in section 4.5.1.6.2 (ES 0.45 – 0.55 mm).

In addition the supporting media (filter under drain) the effective size of 1.5 mm is low compared to the requirement in Section 4.5.1.7 of ES 2.5 – 5 mm. The depth of this media is 125 mm; this is greater than the required depth between 50 – 75 mm for the design standards in Section 4.5.1.7.

2.4.7 Known Issues

At the Lake Major WSP, there is no flocculation time before the up flow clarification assessment. The Atlantic Canada Guidelines for Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems require that there be a flocculation time of at least 30 min in a separate tank or in a baffled chamber (Section 4.4.1.5).

2.4.8 Planned Improvements

In the Halifax Water Five (5) year Business Plan, HRWC had budgeted for the following:

- Control Room Renovations
- Lime System Upgrade
- Ventilation in Motor Control Room
- New Diesel Generator
- Wind Energy Development in the Lake Major Watershed

In the Water Quality Master Plan (WQMP) Version 2, the following projects are included for the implementation at the Lake Major WSP:

- Coagulation and Upflow Clarification Assessment
- Residuals Handling Optimization (sludge)

2.5 BENNERY LAKE WSP

2.5.1 Permitting and Approvals

The Aerotech Water Supply system obtains its source of water through the Bennery Lake WSP. In the 1960s the Province of Nova Scotia gave permission to the Halifax International Airport to use Bennery Lake as the water supply. In the 1980s the Bennery lake WSP was constructed to treat water for the increasing demands of the Halifax International Airport and Aerotech Business Park. Figure 2.6 shows an aerial view of the Bennery Lake Water Supply Plant.

Figure 2.6 Bennery Lake Water Supply Plant - Aerial View

The Bennery Lake WSP currently operates with one (1) Withdrawal Permit, #2009-068230, which expires on March 11, 2020. The Withdrawal Permit limits the taking of water from Bennery Lake to an average daily flow of 2.3 MLD.

The Bennery Lake WSP was issued an Approval to Operate (#2009-067617), from NSE, which expires on March 22, 2018.

2.5.2 Source

The watershed for Bennery Lake is approximately 6.44 km^2. The watershed contains, clear-cut areas, natural tree stands, bogs, wetland, two gravel pits and a number of small lakes. Bennery Lake is a shallow small lake. Due to the natural soil and geological characteristics approximately of Bennery Lake, there are higher than normal concentration of aluminum, iron, and manganese.

The Bennery Lake is designated a protected water area as defined in Nova Scotia's Environment Act, subsection 106(6). When available, Halifax Water purchases land near the Bennery Lake Watershed to protect the water supply. Currently Halifax Water owns 10% and the Crown owns 30% of the watershed. The safe yield of Bennery Lake is 2.3MLD.

Appendix F shows the raw water quality of the Bennery Lake WSP. The raw water quality is outstanding, in comparison to the Canadian Drinking Water Quality Standards, with the exception of elevated colour, turbidity, and manganese. There are often high manganese levels, above the aesthetic objective of 0.05mg/L.

Figure 2.7 summarize the flows of raw and treated water at the Bennery Lake Water Supply Plant. In the past, the maximum daily flow has exceeded the withdrawal permit. For the past two years the average daily flow and maximum daily flow is less than the withdrawal permit. If existing users require more water use in the service area or grow, consideration for increasing the Withdrawal Permit flow allowance needs to be addressed.

The original design capacity of the Bennery Water Supply plant was 7.95ML/d. In 2002, provincial treatment standards indicated that a plant's capacity must be based on having one (1) filter out of service. The Bennery Lake WSP has two (2) filters; with one (1) filter down, the design capacity reduced by half to 3.98 ML/d.

Table 2.9 Bennery Lake WSP Raw Water Withdrawal and Treated Water Production

Year	Rated Capacity	Withdrawal Permit	Average Daily Flow	Maximum Daily Flow
2008	7.95MLD	2.3 MLD	1.2MLD	2.7MLD
2009			1.2 MLD	1.9MLD
2010			1.0MLD	1.8MLD
2011			1.0MLD	2.1MLD

Note:
Historic flows from Halifax Water Annual Water Reports

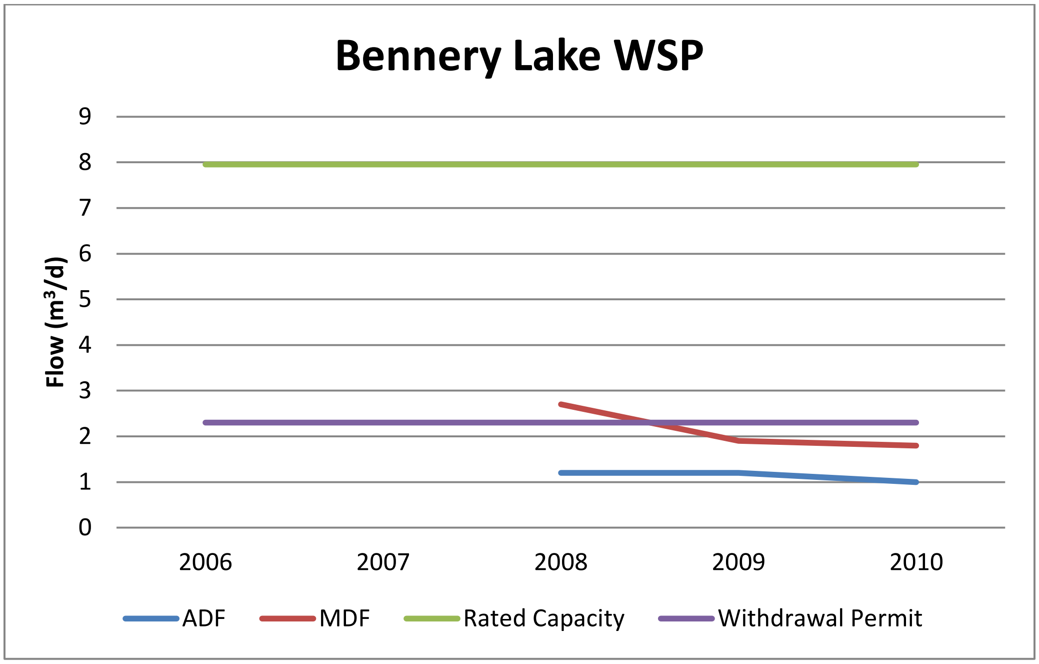


Figure 2.7 Bennery Lake WSP Flow

2.5.3 Alternate or Additional Source Water Supply for Bennery Lake WSP

The level of Bennery Lake will decrease during drought conditions (Aerotech Servicing Study by CBCL May 2008). Since the commissioning of the WSP in 1986, the water supply has been concerned that Bennery Lake alone will not be able to supply more water as the demand increase at the HIAA and Aerotech. Three options to combat this issue are:

1. **Impounded storage of Bennery Lake by a dam**. Currently there is no control structure/dam at the outlet of Bennery Lake. A dam can increase the safe yield of the lake. There are design plans (from Interprovincial Engineering, Bennery Lake Dam and Outlet Structure, Design Drawings (not constructed), 1988 Halifax County Industrial commission) for a 2.0 m high earth filled dam.
2. **Transfer water from Grand Lake** – Additional raw water could be obtained from nearby Grand Lake. In the IRP, there is money allocated for the pump station between the years of 2022 to 2026.
3. **Connect to J.D. Kline or Lake Major water system** – Currently the J.D. Kline and Lake Major WSPs have additional capacity that could be used for the HIAA and the Aerotech Business Park. However, this solution is very expensive.

2.5.4 Treated Water Quality

The treated water quality is shown in Appendix F. The annual average treated water quality is exception, in comparison to the Canadian Drinking Water Quality Standards. Although chlorinated disinfection by-products are lower than the requirements of the Canadian Drinking Water Quality Standards they slightly higher than the Halifax Water objectives. Halifax Water has several research projects investigating on the best approach to minimize the formation of THMs and HAAs within their drinking water supply plants.

High manganese reading at the Bennery Lake WSP is a persistent problem.

2.5.5 Description

Raw water is drawn from Bennery Lake and pumped to the WSP. Once raw water is at the WSP, lime and carbon dioxide are added to adjust the pH and reduce corrosive tendency. For coagulated, alum (aluminum sulphate) is added to two (2) rapid mix tanks. Flocculation takes place in three (3) trains, each consisting of three (3) baffled chambers per train.

Following flocculation, sedimentation takes place in two (2) clarifiers. This allows the heavier flocs to settle. Filtration is done using two (2) parallel filter beds that use anthracite, sand, and gravel. Chlorine in added to the filtered water before entering the clear well. The clear well consists of two (2) chambers separated by a concrete wall. From the clear well, water is pumped to the Aerotech reservoir to be used in the distribution system.

The process schematic of the Bennery Lake WSP is provided in Appendix D.

2.5.6 Capacity Evaluation

The terms of reference for the assessment were provided by Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems (September 2004 prepared by CBCL) available at http://www.gov.ns.ca/nse/water/docs/WaterSystemGuidelines.pdf)

In Appendix C, the description of work for Bennery Lake WSP is presented in detail.

Table 2.10 Bennery Lake WSP Rapid Mixer Comparison to Atlantic Canada Guidelines

Section	Description	Requirement	Actual	Compliance
4.3.2.3 a)	Mixing Intensity, G	600 - 1000s^{-1}	220s^{-1}	Non-compliant
4.3.2.3 b)	Retention Time, t	10 – 60s	300s	Non-compliant
4.3.2.3 c)	Gt	6,000 – 25,000	66,000	Non-compliant

Table 2.11 Bennery Lake WSP Flocculation Tanks Comparison to Guidelines (3 trains with 3 cells each)

Section	Description	Requirement	Actual	Compliance
4.3.3.1.5	Total Retention time	>30 min	33 min	Compliant
4.3.3.1.6	Flow-through velocity	0.15 – 0.45 m/s	1.7 m/s at design capacity	Non-compliant
4.3.3.1.7	Velocity for interconnecting piping and conduits	0.15 – 0.45 m/s	Coming into Chamber 1 (150 mm pipe) =1.7 m/s Chamber 2 (250 mm pipe) =0.63 m/s Chamber 3 (350 mm pipe) =0.32 m/s	Non-compliant
4.3.3.1	Mixing intensity of hydraulic flocculators	5 – 50s^{-1}	Chamber 1=0.08 s^{-1} Chamber 2=0.07 s^{-1} Chamber 3=0 s^{-1}	Non-compliant

Table 2.12 Bennery Lake WSP Clarification Tanks Comparison to Guidelines (Conventional Sedimentation)

Section	Description	Requirement	Actual	Compliance
4.4.1.2.3	Surface overflow rate	Not exceed 1.2 m/hr	5.17 m/hr	Non-compliant
4.4.1.2.4	Flow through basin	Not exceed 0.15 m/min	0.69 m/min	Non-compliant
4.4.1.2.5	Water depth	3.0 – 5.0 m	5.0 m	compliant
4.4.1.2.6	Minimum length: width ratio	4:1	8:4 – 2:1	Non-compliant
4.4.1.2.7	Inlet/outlet weir loading rates	As high as 360 m^3/day/m		

Table 2.13 Bennery Lake WSP Filtration Comparison to Guidelines

Section	Description	Requirement	Actual	Compliance
4.5.1.2	Rate of Filtration	<9.0 m/hr	6.2 m/hr(design)	compliant
4.5.1.6.1	Filter Media Total depth of media	600 mm – 750 mm	975 mm(600 mm anthracite, 375 mm sand)	non-compliant
4.5.1.6.2	Effective size of smallest media	0.45 mm to 0.55 mm	Sand 0.354 mm to 1.41 mm	compliant

Table 2.13 Bennery Lake WSP Filtration Comparison to Guidelines

Section	Description	Requirement	Actual	Compliance
Dual media specifications				
4.5.1.6.5	Anthracite	Depth(mm) - 300 -600 Effective Size(mm) – 0.8 – 2.0 Uniformity Coefficient 1.3 – 1.8	600 0.5 – 3.36 unknown	compliant compliant
	Silica Sand	Depth(mm) - 150 - 300 Effective Size(mm) 0.45 – 0.55 Uniformity Coefficient <1.7	300 0.354 - 1.41 unknown	compliant compliant
4.5.1.7	Filter Under drains Gravel	ES(2.5 mm to 5 mm) Depth (50 mm to 75 mm) ES(5 mm to 12 mm) Depth 50 mm – 75 mm ES(12 mm to 19 mm) Depth 75 mm – 125 mm	#3: ES 3.36 to 6.35 mm (75 mm depth) #2: ES 6.35 to 12.7 mm (75 mm depth) #1: ES12.7 to 19 mm (100 mm depth)	compliant compliant compliant

2.5.7 Observations on Compliance with Design Guidelines

Reference calculations for the observations on compliance with design guidelines are found in Appendix E.

Rapid Mixer

At the design capacity of the WSP, the mixing intensity (g-value of $220s^{-1}$) is low compared to the required range of 600 – $1000s^{-1}$ (Section 4.3.2.3). To increase the mixing intensity (g-value) to compliance, the power of mixer can be increase to between 14,000 - 38,000W, or the volume of the tank (keeping the power of the mixer the same) can decrease between 1.4 - 3.8 m^3. The concern with a lower g-value in the rapid mix is not all particles are being captured by the coagulant to later form floc that can be filtered out. Smaller particles such as virus/crypto may be small enough to make it through the filtration stage.

Retention time in the rapid mix tanks is greater than the design guidelines in Section 4.3.2.4. At design capacity of 7.95MLD the retention time in the rapid mix tanks is 300s compared to the design guidelines between 10 and 60s. To obtain a retention time between 10 and 60s, changing only the flow rate of the WSP (maintaining the volume at 29 m^3) the flow rate of the plant would have to be between 41 to 250MLD. This is above the plant's capacity and withdrawn permit.

Flocculation Tanks

The design guidelines in section 4.3.3.1.6 recommend the velocity into the flocculation tanks is between 0.15 – 0.45 m/s, this is lower than the 1.7 m/s calculated. To obtain a velocity between 0.15 – 0.45 m/s, the flow rate through the WSP would be between 0.67 to 2.05MLD.

The design guidelines in section 4.3.3.1 for hydraulic flocculation, the mixing intensity (g-values) should be within the range of 5 - 50s^{-1}. Based on design calculation for hydraulically mixed flocculation chambers, the g-values in all three (3) tanks are less than 1s^{-1}. Low mixing gradient the flocculation chambers have the potential to limit the flocculation of particles resulting in smaller particles. Smaller particles are more difficult to remove as the smaller particles will not settle in the clarification stage and be brought to the filters. This can increase the particulate loading in the filters resulting in a shorter filter run time and requires more backwashing.

Assuming the retention time stays the same at 670s for each chamber (associated with the design flow rate of 7.95MLD) in the flocculation tanks, the head loss between the tanks would have to be in the range of 104 to 10400 m, which is not practical.

Clarification

The surface overflow rate of 5.17 m/hr at the design capacity exceeds the guidelines of 1.2 m/hr. To obtain a surface overflow rate of 1.2 m/hr, the flow rate through the WSP would have to be 1.84MLD. However if plate settlers are installed, then the design guidelines state that the surface overflow rate must not exceed 4.8 m/hr. To obtain this overflow rate, the flow rate through the WSP would be 7.37MLD (assuming the area of the tube settlers cover the area of the sedimentation tanks)

The design guidelines in Section 4.4.1.2.6 (conventional sedimentation) required a 4:1 length to wide ratio for the clarification tank. Since the clarification tank was designed to use plate settlers, it has a 2:1 length to width ratio. Using plate settlers would have section 4.4.1.2, not be applicable. Since the current clarifier has a lower length to width ratio, there is potential that some flocs are not settling and being brought to the filtration stage. Large flocs at the filtration stage will reduce the filter run time.

Filtration

The filter media total depth is greater than the design guideline. The greater filter media depth has the potential to create voids that could lead to the short-circuiting of the filters. The effective size of the smallest media has a larger range (0.354 to 1.41 mm), which is greater than what is requires in Section 4.5.1.6.2 of the design guidelines (0.45 – 0.55 mm).

2.5.8 Known Issues

The operators at the plant had identified the following concerns (from the 2008 Aerotech servicing study by CBCL 2008):

1. Issues with manganese (large fluctuations in raw water concentration)
2. Flow balancing to floc tank feeds result in uneven flow distribution
3. Channel between floc tank and sedimentation tank cannot be drained for cleaning purposes.
4. Sludge is removed from the system manually with no instrumentation to determine how much is being removed.
5. If pumping rate (which is still within the hydraulic capacity of the WSP) is increased beyond a certain value the wet well can be pumped empty. The low wet well levels are due to head loss in the intake, most likely due to the intake screens at intake being clogged at the bottom of the lake.
6. The level of Bennery Lake is drawn down during drought conditions

2.5.9 Planned Improvements

In the Halifax Water Five (5) year Business Plan, HRWC had budgeted for the following:

- Bennery Lake WSP – Future Process Improvements from the 2008 Aerotech Servicing Study
- Raw Water Supply From Grand Lake
- Bennery WSP Upgrades (non-specific) over the next five (5) years

In the Water Quality Master Plan (WQMP) Version 2, the following projects are included for the implementation at the Bennery Lake WSP:

- Process Optimization Study – Challenges to be addressed are floc carry over due to poor settling, unbalanced hydraulics, undesirably short filter run times, consistent manganese removal to meet regulatory objectives, achieving HAA regulatory requirements, secondary turbidity spikes, and quality issues associated with start-up/shut down of plant.

2.6 SMALL SYSTEMS

HRWC operate six (6) small water supply plants within the HRM area. Collins Park, Middle Musquodoboit, and Bomont use surface water. Five Island Lake, Sliver Sands, and Miller Lake use ground water. All three (3) well water sources are considered non-GUDI, meaning ground water that is not under the direct influence of surface water. The six (6) small watersheds are not as well protected compared to the watersheds of the three (3) large WSP. The small WSPs account for roughly 0.1% of customers for the HRWC. The small WSPs service tiny rural and suburban areas. A summary of the small systems production rates are provided in Table 2.14.

The small WSP are visited at least twice a week to undertake process checks, carry out minor maintenance, refill chemical tanks, and sample for water quality parameters. Most water quality parameters are measured with hand-held portable devices. Other testing required is sent out to an independent lab to be sampled.

For the surface water treatment facilities currently commissioned by Halifax Water (Five Island Lake, Sliver Sands, and Miller Lake) Giardia and Crypotosporidium are tested twice a year (in May and November) according to the Water Sampling Manuel by Halifax Water (March 2011). In Appendix D of the 2010 Annual Drinking Water Systems Report, Giardia and Crypotosporidium data from Water Trax indicate no positive results for Giardia and Crypotosporidium.

Table 2.14 Summary of Small WSP

System	Approval to Withdrawal Water (Average Rate)	Average Production*	Design Capacity
Five Island Lake	None <23 m^3/day	6 m^3/day	27 m^3/day
Collins Park	105 m^3/day	73 m^3/day	160 m^3/day
Middle Musquodoboit	150 m^3/day	60 m^3/day	260 m^3/day
Silver Sands	28 m^3/day	21 m^3/day	144 m^3/day
Miller Lake	None<23 m^3/day**	26 m^3/day	55 m^3/day
Bomont	None <23 m^3/day	15m^3/day (expected)	20 m^3/day

*2010 Annual Drinking Water System Reports to NSE from Halifax Water (March 31, 2011),

**The two (2) wells at Miller Lake are under producing, thus providing less than <23 m^3/day.

Note: An Approval to withdrawal water is not required by the NSE when the withdrawal rate is less than 23 m^3/day.

2.6.1 Five Island Lake

Figure 2.8 Five Island Lake Water Supply Plant - Aerial View

The system was constructed and commissioned in 1994 due to a PCB in the area affecting surrounding resident's wells. [i]The Halifax Regional Municipality managed the system from 1994 to 1996. In 1996, Halifax Water assumed operation.

The Five Island Lake WSP consists of one (1) 15.2 cm diameter drilled non-GUDI well at an elevation of 97 m and is 50 m deep. Figure 2.8 shows an aerial view of the Five Island Water Supply Plant. In November 2009, a plastic well casing was installed to prevent surface water intrusion.

The WSP is located off of St. Margaret's Bay Road near Hubley. The Halifax Regional Municipality County managed the system from 1994 to 1996, but then HRWC assumed operation. The former Halifax County constructed and commissioned the WSP in 1994 due to a PCB spill contamination event in the area. PCB testing is done twice a year.

The well system serves 12 customers for an average daily flow of 8 m^3/day.

The treatment processes consists of disinfection with ultraviolet (Trojan Aqua UV 505) and chlorine (sodium hypochlorite). The typical UV dose for the system is 16mJ/cm^2 at a UV transmittance of 90%. An aeration system is in place for the removal of radionuclides. The design capacity of the well pumps is 11 – 15Lpm (15.8 to 21.6 m^3/day) and 18.9Lpm (27 m^3/day) for the UV disinfection system.

For water storage, there are three (3) above-ground 4,545 L polyethylene tanks. The distribution system delivers the treated water to customers via a 100 mm diameter PVC piping. The HRWC does not own any land within the watershed.

The Five Island Lake Water Treatment Facility was issued an Approval to Operate (#2010-074268-A01) from NSE, which expires on May 31, 2019.

From the Source Water Protection report (Halifax Water March 2011) the wells at Five Island Lake have the highest quality water from all the groundwater system. The geological characteristics in the region favour ground water quality. The well head is far from highways and other negative human activity. There are no provincial regulations restricting any housing or business constructed in the wellhead protection area.

As described in the 2011 Halifax Water Annual Drinking Water Report (March 31, 2012) Five Island lake had a drastic increase due to leaks and suspected increased from a commercial property.

2.6.2 Collins Park

Figure 2.9 Collins Park Water Supply Plant - Aerial View

The source water for the Collins Park WSP is Lake Fletcher, part of the Shubenacadie River/Canal system. The watershed covers approximately 16,000 hectares. Halifax County constructed the WSP in the 1985 in response to the high levels of arsenic in local wells. In 2010, the WSP was upgraded and taken over by HRWC. The WSP was upgraded to membrane filtration (ultra-filtration followed by nano-filtration), and disinfection with ultraviolet and sodium hypochlorite. Ortho-polyphosphate is used for corrosion control. Figure 2.9 shows an aerial view of the Collins Park WSP.

The greatest risk to the public is the private septic system around Lake Fletcher. There were higher concentrations of E.Coli, phosphorus, and turbidity that suggests the septic system along with other human activity could be contributing to the nutrient loading of the lake. The high arsenic and manganese level in the lake water are indicative of the natural geological characteristic of the reign. There is no provincial legislation to protection the water supply for Collins Park. In the 2011-2012 capital budget, there is $22,000 budgeted for upgrades to the water intake.

The average production is 64 m^3/day. It serves approximately 200 customers in the Collins Park and Kendlemark subdivisions in the Wellington area. The current WSP design capacity is a production rate of potable water at 160 m^3/day with one (1) UF membrane train down. The clear well can store 160 m^3 in a concrete chamber.

The Collins Park Water Treatment Facility was issued an Approval to Operate (2009-069294) from NSE, which expires on December 14, 2019. From Lake Fletcher, the average rate of withdrawal (averages over 30 days) is 105,000 litres/day and the maximum rate of withdrawal is 160,000 litres/day.

2.6.3 Middle Musquodoboit

Figure 2.10 Middle Musquodoboit Water Supply Plant - Aerial View

The Musquodoboit River is the source water for the community of Middle Musquodoboit. The water supply area encompasses approximately 33,330 hectares; the length of the main channel is over 25 km long. Halifax County commissioned the WSP in 1989, in response to the water quality and quantity issues in Middle Musquodoboit. In 2010 the system was upgrade to the new membrane system (ultra-filtration followed by Nano-filtration), and disinfection with ultraviolet and sodium hypochlorite. Figure 6.3 shows an aerial view of the Middle Musquodoboit Water Supply Plant.

The average production is 61 m^3/day. The WSP serves 96 customers through 150 mm diameter piping in the community of Middle Musquodoboit. The design capacity of the

Middle Musquodoboit facility is 260 m^3/day with one UF membrane train out of service. The clear well chamber located beneath the WSP can store 23 m^3 of treated water.

The Middle Musquodoboit Water Treatment Facility was issued an Approval to Operate (2009-065892) from NSE, which expires on August 21, 2019. From the Musquodoboit River the daily average rate is 150,000L/day (averaged over 30 days). The three (3) day maximum withdrawal rate is 260,000 L/day.

2.6.4 Silver Sands

Figure 2.11 Silver Sand Water Supply Plant - Aerial View

Silver Sands is a mini-home park in Cow Bay, located east of Dartmouth. The area that is serviced includes Spruce Drive, Cow Bay Road, and Dogwood Road. The source water for this system is two (2) wells. The wells are drawing ground water from a fractured rock aquifer formation. There are approximately 300 ha of well head protection. Figure 2.11 shows an aerial view of the Silver Sand Water Supply Plant.

The system was originally constructed in the 1970s and operated by the Silver Sands Water Utility. In 1999, it was upgraded and acquired by Halifax Water after complaints about poor water quality from system customers to the NSUARB[ii]. The average production is 27m^3/day. The system serves forty-five (45) customers.

The treatment process consist of the addition of potassium permanganate to oxidize iron and manganese, green-sand pressure filtration, pH adjustment with caustic soda, polyphosphate addition for sequestering, and chlorine disinfection with sodium hypochlorite. There is a secondary pumping system which provides water to the distribution system. There is an underground 18,900 L fibreglass water storage tank. The distribution system is made of a 100 mm diameter PVC pipe along spruce drive and a 38 mm polyethylene along Cow Bay Road and Dogwood Road.

The raw water pumps have a total rated pumping capacity of 83.7 Lpm (120m^3/day) but are set at 61 Lpm (88m^3/day) (in 2003). The filtration system is rated to provide 100Lpm (144m^3/day) at peak demand.

There is no back up water supply for Silver Sands. Treated water will be brought to the storage tank in the event of an emergency. Also there is no backup power for the water supply system. If there is a prolonged power outage, a mobile generator could be provided.

In 2008 Annual Water System Report there is occasional shortages that require supplementary water in Silver Sands due to groundwater levels. To address this problem, well # 2 was rehabilitated as part of a GUDI study.

Well #1 was decommissioned and another well was constructed. In the NSE well log, the well was drilled on August 31, 2009 at a depth of 405ft (123m) the well yield is estimated to be 7igm(well log record #090596). The company that drilled the well for commercial use is Bluenose Well Drilling Ltd.

The Silver Sands Water Treatment Facility was issued an Approval to Operate (2011-077957) from NSE, which expires on May 31, 2019.

The Silver Sands Water Treatment Facility well #2 was issued an Approval to Operate (2009-065889) from NSE, which expires on April 15, 2019. The average rate of withdrawal is 28,000 litres per day (averaged over 30 days). The maximum rate of withdrawal is 78,600 litres per day (averaged over 3 days). The maximum total annual volume is 10,220,000 litres. Well #2 has a NSE well log of 880721. The total depth of the well is 86 m. The PVC liner casing depth is 20.7 m. The diameter of the well is 152 mm.

2.6.5 Miller Lake

Figure 2.12 Miller Lake Water Supply Facility - Street View

The source water has come from three (3) wells in a fractured bedrock aquifer formation that serves the Miller Lake subdivision (including homes on Miller Lake Road and Oakes Road) near Fall River, NS. Figure 2.12 shows the street view of the Miller Lake Water Supply Plant. The well head protection area encompasses approximately 232 hectares. The concentration of arsenic is ten (10) times greater than the minimal acceptable limits; this is due to the natural geological characteristics of the region.

The WSP was first commissioned in the early 1960s. Due to the homeowners association being unable to operate the system HRWC upgraded the WSP and acquired it in 2002. In the 1960s well #1 and #3 were constructed. Well #3 had high levels of arsenic, so in the early 1980s well #2 was drilled and #3 was only used for emergencies. Well #2 had a low flow and a storage reservoir was needed. In 1998, well #3 was deepened and put back online due to water quality issues.

In 2009 a candidate area for a well exploration program was done. Approval for withdrawal is depending. Well #3 was determined to be GUDI and have been permanently discontinued. Also In 2009 well #1 was decommissioned and another well was constructed.

The treatment process consist of the addition of sulphuric acid to lower the pH, arsenic removal with G2 media, addition of sodium hydroxide to increase the pH, and disinfection with chlorine as sodium hypochlorite. The average production is 24m^3/day. There is a 37,270L concrete water storage tank. The secondary pumping system consists of alternating duty and standby pumps and pressure tanks to the distribution system. The distribution system consists of 25 mm to 50 mm polyethylene pipe along Miller Lake Road and Oakes Road and in line pressure boosting station at Miller Lake Road.

The well raw water pumps limit the capacity at 36Lpm (52m^3/day). The arsenic removal treatment system is designed to handle a peak flow of 38Lpm (55m^3/day).

There is no back up water supply for Miler Lake. Treated water will be brought to the storage tank in the event of an emergency. Also there is no backup power for the water supply system. If there is a prolonged power outage, a mobile generator could be provided.

There is an ongoing problem with the sufficient supply of water in the wells of the Miller Lake system, water has been brought in from the larger WSP to supplementary the shortage. Therefore, In the Capital Budget for 2011/12, there is a budget for the Miller Lake Wellhead, watershed land acquisition. In addition there is budget for the extension of the well supply line for 2012-2013.

The Miller Lake Water Treatment Facility was issued an Approval to Operate (2008-061211-DIR-0901001-A) from NSE.

2.6.6 Bomont

The Bomont subdivision located in Elmsdale was developed in the mid-1970s. The source water for the Bomont subdivision is the Shubenacadie River. The existing system consisted of basic filtration with chlorination and was operated by a private company. HRWC assumed operation on a cost-recovery, fee-for-service basis. Due to the existing system not meeting requirements, the WSP is currently being upgraded before HRWC will take over operation.

A new treatment train is currently being built in 2011. The new treatment train will consist of ultra-filtration in triplicate, redundant carbon scavenger ion exchange resins, pH adjustment with calcite media, and redundant disinfection with UV (Trojan UV PRO 10). Chemical disinfection is done with sodium hypochlorite. The use of resins at Bomont is the first time the HRWC will use this technology for water treatment.

The WSP will service fourteen (14) homes. The design capacity of the system is 20m^3/day; the current demand is expected to be 15m^3/day. There is a 20,000L treated water storage tank, made of fibre-reinforced plastic, located beneath the floor of the WSP.

Bomont does not have a withdrawal permit from NSE as it uses less than 23,000 litres/day of water.

3. DAMS

Halifax Water owns and operates five (5) dams; Pockwock Dam, Bayers Lake Dam, Chain Lake Dam, Lake Lamont Dam, Lake Major Dam, and East Lake Dam. Dams are established to control the depth of the lake for drinking water supply plants.

A formal Dam Safety Review was done in 2004 and was performed in accordance with the 1999 Dam Safety Guidelines published by the Canadian Dam Association (CDA, 1999). The Dam Safety Guidelines by the CDA have since been updated in 2007.

Table 3.13.1 is a summary of the five (5) dams that are owned by the HRWC. The dams are regulated under the Water Withdrawal Approvals issued by NSE. The Department of Fisheries of Oceans into the approval application and requirements for operating the dams and maintaining fisheries bases on flows.

Recommendations by the HRWC Dam Safety review from AMEC in 2005 recommend that each dam performs a topographic field survey and geotechnical investigation to confirm information shown in design drawings and to determine if there is any frost damage.

The next Dam Safety Review will be completed in 2012.

Work has been done on the Pockwock Lake dam recently; major repair for the Lake Major will need to be done soon.

Table 3.1 List of Dams for Drinking Water Supply

Dam Name	Type of Dam	Type of Spillway	Year built	Location	Remedial works	Other
Pockwock Lake Dam	Earth fill with clay core	Concrete free overflow	1974	Between Pockwock lake and little Pockwock lake	2002-work done to spillway to raise crest	Auxiliary dam (rock fill) for emergency overflow
Bayers Lake Dam	Granular Fill with HDPE Core	-	Late 1980s	Upstream of Chain Lake		Built to divert potential contaminate from business back
Chain Lake Dam	Gravel and loam with concrete core wall	Stop log-controlled sluice	1894	Between Long Lake and Chain Lake	1980 spillway was pressure grouted to reduce leakage	First used in 1848
Lake Lamont Dam	Earth fill (Till)	Inlet sluiceway to 600 mm pipe	1890's	South end of Lake Lamont, adjacent to Main Street in Dartmouth		Back up supply for Dartmouth
Lake Major Dam	Rocked filled Timber Crib	Timber crib	1940s	South end of Lake major immediately adjacent to lake Major Road	1999 removal and replacement of totted timber and replacement of riprap	Also include a fish way
East Lake Dam	Concrete	Stop-controlled concrete	Mid 1970s			

4. WATER QUALITY

Halifax Water has a commitment to ensuring high quality drinking water. Halifax Water meets all current water distribution and treatment compliance. The explanation of exceedances and challenges are summarised in Table 4.14.1. A more detailed summary of the water quality is located in Appendix F.

Table 4.1 Summary of Water Quality of the WSP (2011 Halifax Water Annual Drinking Water Report, March 31, 2012)

	J.D. Kline	Lake Major	Bennery Lake	Small Systems
MAC and IMAC from GCDWQ*	No exceedances	No exceedances	No exceedances (manganese exceeded aesthetic objective)	No exceedances
THMs	LRAA below 100ug/L	LRAA below 100ug/L	LRAA below 100ug/L	LRAA below 100ug/L
HAA	LRAA below 80ug/L	LRAA below 80ug/L	LRAA below 80ug/L	LRAA below 80ug/L
Bacteriological Sampling	99.81% absent sample results	100% absent sample results	100% absent sample results	99.92% absent sample results
Filter Turbidity	>1.0NTU were investigated, attributed to errors in instruments	Never exceeded 1.0NTU	>1.0NTU were investigated, attributed to errors in measurement	> 1.0NTU attributed to instrument maintenance and calibration
Finished Turbidity	95% within range	Below 0.2NTU 95% of the time	Challenged meeting 0.2NTU, 5 out of 12 months	> 1.0NTU attributed to instrument maintenance and calibration

*Guidelines for Canadian Drinking Water Quality (GCDWQ) all MAC and IMAC are tested twice a year for the large WSP (J.D. Kline, Lake Major, and Bennery Lake), once a year for the small systems (Five Island Lake, Collins Park, Middle Musquodoboit, Silver Sands, Miller Lake, and Bomont)

4.1 FUTURE WATER QUALITY

Short Term

There have been a number of recent consultations since 2010 to identify new and revised drinking water quality guidelines. Of interest to Halifax Water are proposed guidelines for dichloromethane and N-nitrosodimethylamine (NDMA), shown in Table 4.24.2.

Dichloromethane is classified as a probable human carcinogen. NDMA is highly likely to be carcinogenic, and may be occurring in Nova Scotia sources that have naturally-occurring colour and/or humic substances present.

Table 4.2 Recent Health Canada consultations on Drinking Water Quality Guidelines

Parameter Description	Type	Current Guideline	Proposed Guideline
Dichloromethane	Existing	0.05 mg/L	0.015 mg/L

N-nitrosodimethylamine (NDMA)	New	–	0.04 µg/L

There have been recent consultations on a number of parameters for which no change in MAC was proposed. In addition, the Federal-Provincial-Territorial Committee has identified parameters for which the committee is in the process of preparing guideline technical documents, which may or may not contain proposals for revised MACs (Table 4.3).

Table 4.3 Parameter with Reaffirmed Drinking Water Quality Guidelines and Pending Consultations

Proposed Guideline Same as Existing Guideline		Guideline Technical Documents Pending	
• Carbon Tetrachloride	• Heterotrophic Plate Count	• Ammonia	• Selenium
• E. coli	• Protozoa	• Chromium	• Tetrachloroethylene
• Enteric Viruses	• Total Coliforms	• 1,2-dichloroethane	• Turbidity
• Fluoride		• Nitrate / Nitrite	• Vinyl chloride

Long Term

Over the long term the following regulating can reasonably be expected to occur. Disinfection by-products – Trihalomethanes (THMs) and Haloacetic acids (HAAs). There is a continued emphasis on reducing the MAC for DBPs such as THMs and HAAs. The current standard in Canada is 80ug/L and 100ug/L for HAAs and THMS respectively. While in the US it is 60ug/L and 100ug/L for HAAs and THMs respectively. Canada is expected to evenly follow the US leads in sticker DBP concentrations.

Quantitative Microbial Risk Assessment (QMRA)

The use of QMRA could be part of the multi-barrier approach to drinking water management. QMRA uses mathematical modeling for the risk assessment of pathogens in drinking water.

New Parameter and Low MAC for current parameters

Over the long term is it reasonable to expect that existing parameters and new parameters will be reviewed and changes done due to new information

5. OPERATING COSTS FOR IRP

In the financial plan water supply plant operating costs were accounted for by incremental costs. Incremental costs were calculated for the three (3) large water supply plants (J.D. Kline, Lake Major, and Bennery Lake), as no growth is predicted for the six (6) small WSPs.

Operating costs were provided by Halifax Water from the past five years (2006-07 to 2010-11). The operating costs from Halifax Water were broken down into the following categories: Electricity and Chemicals, Salaries & Benefits, Training & Development, Contract Services, Materials & Supplies, Professional Services, Fleet Services, Other Operating Expenses, and Non-Operating Expenses. All categories were considered to be a fixed cost except for Electricity and Chemicals. Electricity and Chemicals were considered as variable costs. Furthermore, 20% of the Electrical costs were considered to be fixed due to the heating load, while the other 80% was assumed to be variable costs.

The average yearly inflation factor was calculated from the past five (5) years of operating costs. For the fixed costs, the average inflation factor was applied in on top of the 2010-2011 cost for each year of the IRP.

For variable costs, 80% of electrical load and chemicals, the amount of growth was taken into account. A different growth rate was used for each of the three (3) large WSP due to different growth rates predicted for each service area. Growth rates of 1.012617, 1.01426, and 1.0483 were associated with the J.D. Kline WSP (Pockwock), Lake Major, and Bennery Lake (Aerotech/Airport) respectively.

6. LEAKAGE REDUCTION

Halifax Water has a strong leak detection and repair program which has reduced unaccounted for water (non-revenue). Halifax Water leak detection program started in 1999. Often the only way to detect a leak is when water starts to surface. However, in Halifax, water often drains away to the bedrock and then to the ocean, thus never reaching the surface. Halifax Water adopted the International Water Association's integrated approach to water loss control. The leak detection program is based on dividing the service area into discrete section and methodically tracking water flows (using meters) to determine where leaks are. Water use is lowest at night, so when a service area water use is higher one night then it has been for days, there is a high probability there is a leak there. When leaks are suspected in certain sections crews go out to find specifically where leaks are. To pin point a leak Halifax Water crews will use stethoscope-like devices to listen of leaks. When leaks are found, they are fixed shortly after.

Halifax has saved between $600,000 and $650,000 per year in water loss prevention. Other benefits for water loss control are reduced energy (pumping), and chemicals to treat the water. Energy consumption is a large cost driver for Halifax Water. In addition, leakage reduction can assist in preventing sinkholes from forming. Halifax Water has recognized by the Federation of Canadian Municipalities and awarded the 2005 FCM-CH2M Hill Sustainable Community Award for its leak reduction program.

Leak detection work has been carried out by Pure Technologies and Halifax Water using Smart Ball methodology. SmartBall is a free swimming foam ball with an instrument designed for in line leak detection technology to be operated live within the pipeline. The technology was used in the fall of 2011 with key section of water transmission mains extending from Northwest Arm Drive to Quinpool Road. Furthermore Halifax Water has additional used PipeDiver from Pure Technologies to inspect the Halifax to

Bedford connector. The PipeDiver is a free swimming instrument used to survey the pipelines under live operating conditions.

7. WATER TRANSMISSION SYSTEMS

In the Halifax Regional Municipality, there are three primary water systems and 7 small systems which collectively provide potable water and fire protection service to approximately 85,000 service connections. The three primary treatment systems are the Lake Major Water Supply Plant (WSP), which generally services the communities east of Halifax Harbour, the J.D. Kline WSP (Pockwock Lake) which services the communities north, west, and south of the harbour and the Bennery Lake WSP which services the Aerotech Business Park and Halifax Stanfield International Airport.

The primary water network servicing Metro Halifax, Bedford, Sackville, Dartmouth, Cole Harbour and Eastern Passage is divided into three operating regions, West, Central and East. The West and Central Regions are supplied by the J.D. Kline WSP while the East Region is supplied from the Lake Major WSP. These regions are further subdivided into 67 pressure zones (16 East, 30 Central, and 21 West) reflecting the elevation differences throughout the city. The network and its pressure zones are shown in Exhibit 1 – Halifax Regional Water Commission Regional Pressure Zone Map.

In addition there are five re-chlorination stations within the transmission/distribution system to increase the chorine residual. Re-chlorination occurs at: Cowie Hill, Timberlea, Waverly, North Preston, and Akerley. There is no re-chlorination at Aerotech/Airport or the small systems.

7.1 J. DOUGLAS KLINE (POCKWOCK LAKE) WATER SUPPLY PLANT

The J. Douglas Kline Water Supply Plant provides treated water to the communities of Halifax, Bedford, Sackville, Spryfield, Herring Cove, Fall River, Waverley, and Timberlea. The treatment facility has a design capacity of 227MLD. The J. Douglas Kline WSP is supplied from Pockwock Lake which has a watershed area of 5,661 Ha and a safe yield of 145.5MLD.

7.1.1 Western Region (Halifax / Herring Cove / BLT)

The Western Region of the Halifax Water System is supplied from the J. Douglas Kline Water Supply Plant. Pockwock Lake is located at 113 metres HGL. The J. Douglas Kline WSP clearwell is located at approximately 170 metres HGL. Treated water is distributed to the network by gravity from the clearwell in a 1,500 mm diameter Hyprescon watermain.

Water transmission piping is split near the intersection of Hammonds Plains Road and Kearney Lake Road for distribution to either the Central or Western regions. Water Transmission to the Western Region continues through a 1,200 mm diameter water main on Kearney Lake Road. Near the Highway 102 ramps to Kearney Lake Road, the water transmission main is split again into a 1,200 mm diameter main which continues on Dunbrack Street and a 750 mm diameter main which continues along a service

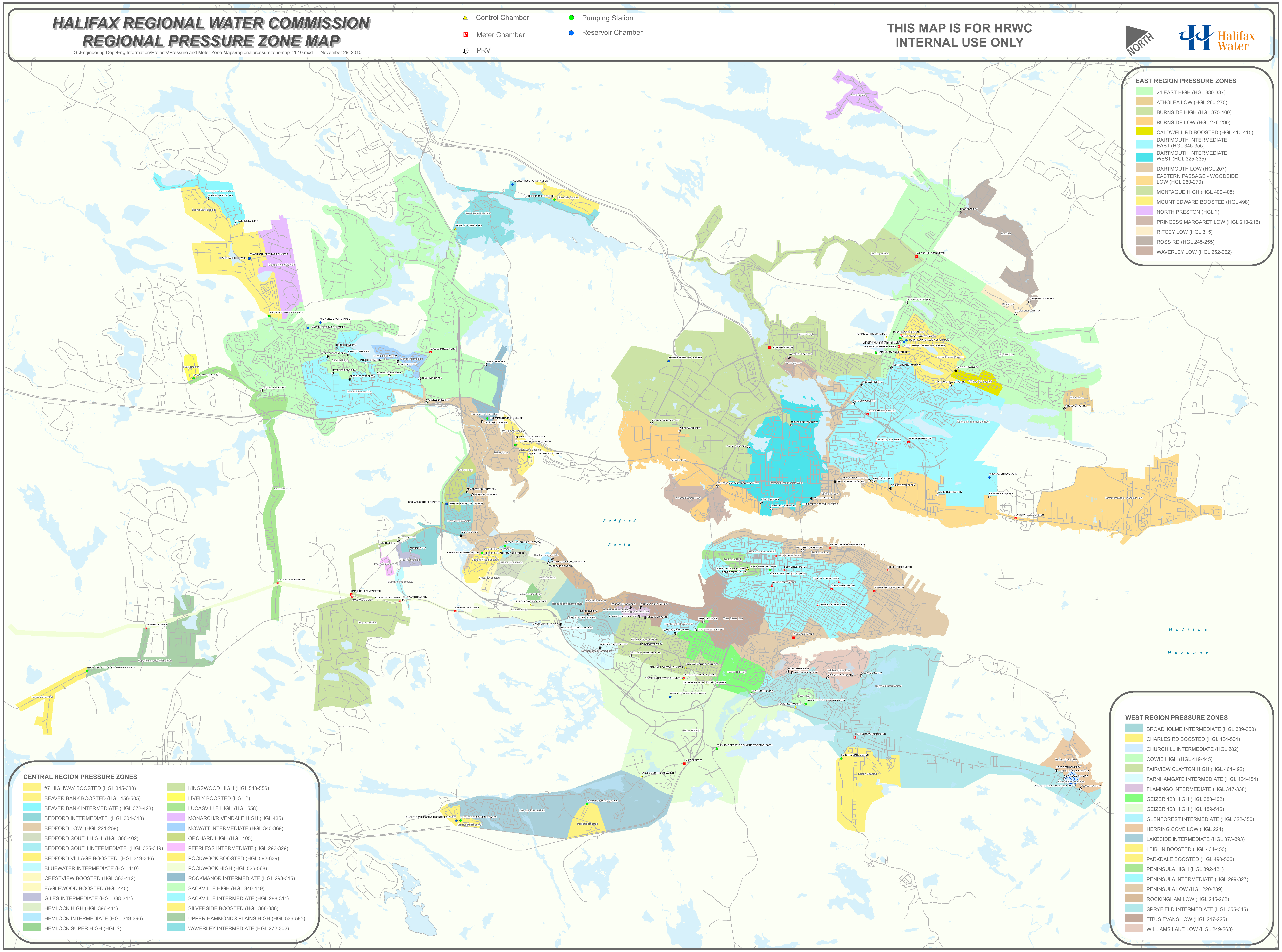

HALIFAX REGIONAL WATER COMMISSION
REGIONAL PRESSURE ZONE MAP
G:\Engineering Dept\Eng Information\Projects\Pressure and Meter Zone Maps\regionalpressurezonemap_2010.mxd November 29, 2010
Control Chamber
Meter Chamber
PRV
Pumping Station
Reservoir Chamber
THIS MAP IS FOR HRWC INTERNAL USE ONLY
NORTH
Halifax Water
EAST REGION PRESSURE ZONES
24 EAST HIGH (HGL 380-387)
ATHOLEA LOW (HGL 260-270)
BURNSIDE HIGH (HGL 375-400)
BURNSIDE LOW (HGL 276-290)
CALDWELL RD BOOSTED (HGL 410-415)
DARTMOUTH INTERMEDIATE EAST (HGL 345-355)
DARTMOUTH INTERMEDIATE WEST (HGL 325-335)
DARTMOUTH LOW (HGL 207)
EASTERN PASSAGE - WOODSIDE LOW (HGL 260-270)
MONTAGUE HIGH (HGL 400-405)
MOUNT EDWARD BOOSTED (HGL 498)
NORTH PRESTON (HGL ?)
PRINCESS MARGARET LOW (HGL 210-215)
RITCEY LOW (HGL 315)
ROSS RD (HGL 245-255)
WAVERLEY LOW (HGL 252-262)
Bedford Basin
Halifax Harbour
CENTRAL REGION PRESSURE ZONES
#7 HIGHWAY BOOSTED (HGL 345-388)
BEAVER BANK BOOSTED (HGL 456-505)
BEAVER BANK INTERMEDIATE (HGL 372-423)
BEDFORD INTERMEDIATE (HGL 304-313)
BEDFORD LOW (HGL 221-259)
BEDFORD SOUTH HIGH (HGL 380-402)
BEDFORD SOUTH INTERMEDIATE (HGL 325-349)
BEDFORD VILLAGE BOOSTED (HGL 319-346)
BLUEWATER INTERMEDIATE (HGL 410)
CRESTVIEW BOOSTED (HGL 363-412)
EAGLEWOOD BOOSTED (HGL 440)
GILES INTERMEDIATE (HGL 338-341)
HEMLOCK HIGH (HGL 396-411)
HEMLOCK INTERMEDIATE (HGL 349-396)
HEMLOCK SUPER HIGH (HGL ?)
KINGSWOOD HIGH (HGL 543-556)
LIVELY BOOSTED (HGL ?)
LUCASVILLE HIGH (HGL 558)
MONARCH/RIVENDALE HIGH (HGL 435)
MOWATT INTERMEDIATE (HGL 340-369)
ORCHARD HIGH (HGL 405)
PEERLESS INTERMEDIATE (HGL 293-329)
POCKWOCK BOOSTED (HGL 592-639)
POCKWOCK HIGH (HGL 526-568)
ROCKMANOR INTERMEDIATE (HGL 293-315)
SACKVILLE HIGH (HGL 340-419)
SACKVILLE INTERMEDIATE (HGL 288-311)
SILVERSIDE BOOSTED (HGL 368-386)
UPPER HAMMONDS PLAINS HIGH (HGL 536-585)
WAVERLEY INTERMEDIATE (HGL 272-302)
WEST REGION PRESSURE ZONES
BROADHOLME INTERMEDIATE (HGL 339-350)
CHARLES RD BOOSTED (HGL 424-504)
CHURCHILL INTERMEDIATE (HGL 282)
COWIE HIGH (HGL 419-445)
FAIRVIEW CLAYTON HIGH (HGL 464-492)
FARNHAMGATE INTERMEDIATE (HGL 424-454)
FLAMINGO INTERMEDIATE (HGL 317-338)
GEIZER 123 HIGH (HGL 383-402)
GEIZER 158 HIGH (HGL 489-516)
GLENFOREST INTERMEDIATE (HGL 322-350)
HERRING COVE LOW (HGL 224)
LAKESIDE INTERMEDIATE (HGL 373-393)
LEIBLIN BOOSTED (HGL 434-450)
PARKDALE BOOSTED (HGL 490-506)
PENINSULA HIGH (HGL 392-421)
PENINSULA INTERMEDIATE (HGL 299-327)
PENINSULA LOW (HGL 220-239)
ROCKINGHAM LOW (HGL 245-262)
SPRYFIELD INTERMEDIATE (HGL 355-345)
TITUS EVANS LOW (HGL 217-225)
WILLIAMS LAKE LOW (HGL 249-263)

EXHIBIT 1

easement between Dunbrack Street and Parkland Drive. The 750 mm transmission main is primarily used to feed the Geizer Hill Water Reservoirs located near the top of Main Street. The 1,200 mm diameter transmission main feeds several pressure zones through PRVs along Dunbrack Street. The 1,200 mm diameter transmission main can be used to fill the Geizer Hill Reservoirs and the 750 mm diameter transmission main can be used to supply Dunbrack Street through a valving arrangement if required.

Two (2) water reservoirs are located at Geizer Hill, known as Geizer 158 and Geizer 123. The Geizer 158 water reservoir floats on the Pockwock High HGL to a top water level of 158.5 metres. The Geizer 123 reservoir is filled through a dump valve to a maximum HGL of 123.4 metres. Treated water from the Geizer 158 tank generally continues to fill the water reservoirs at Cowie Hill, Charles Road and supplies the communities of Timberlea, Cowie Hill, Spryfield, and Herring Cove. Treated water from the Geizer 123 Reservoir generally flows to the Halifax Peninsula where it fills the Robie Street reservoir.

The Western Region is currently subdivided into 21 pressure zones. One pressure zone at Brunello is under construction. The following four zones are boosted; Charles Road Boosted, Brunello Boosted, Parkdale Boosted and Lieblin Boosted. The remaining pressure zones are fed by gravity, through PRVs, from the Pockwock Water Supply Plant.

Table 7.1 Pressure Zones with HGL for West

Pressure Zone Name	HGL Range (m)
Broadholme Intermediate	339-350
**Brunello Boosted	To be determine
Charles Road Boosted	424-504
Churchill Intermediate	282
Cowie High	419-445
Fairview Clayton High	464-492
Farnhamgate Intermediate	424-454
Flamingo Intermediate	317-338
Geizer 123 High	383-402
Geizer 158 High	489-516
Glenforest intermediate	322-350
Herring Cove Low	224
Lakeside Intermediate	373-393
Leiblin Boosted	434-450
Parkdale Boosted	490-506
Peninsula High	392-421
Peninsula Intermediate	299-327

Table 7.1 Pressure Zones with HGL for West

Pressure Zone Name	HGL Range (m)
Peninsula Low	220-239
Rockingham Low	245-262
Spryfield Intermediate	355-345
Titus Evans Low	217-225
Williams Lake Low	249-263

**Under Construction

The distribution system of the West Region is made of cast iron, ductile iron, PVC and some asbestos cement. Downtown Halifax distribution pipe were installed in the late 1800s to early 1900s. General the distribution pipe is laid out in a grid like pattering servicing all of the West Region.

7.1.2 Central Region (Bedford / Sackville)

The Central Region of the Halifax Water System is supplied from the J. Douglas Kline Water Supply Plant. The Central Region is subdivided into 30 pressure zones, 8 of which are boosted. A number of zones are fed through PRVs directly from the Pockwock Hyprescon transmission main. These include Kingswood High, Upper Hammonds Plains High, Hemlock High, Hemlock Intermediate, Bluewater Intermediate, Peerless Intermediate and Giles Intermediate. A 400 mm diameter transmission main connects Pockwock Hyprescon transmission main to Middle Sackville.

A 750 mm diameter transmission main connects to the Pockwock transmission main near the intersection of Kearney Lake Road and Hammonds Plains Road with the Meadowbrook Reservoir in Bedford. At the Meadowbrook Reservoir, the transmission watermain is split with some of the flow going through a PRV to the Meadowbrook Reservoir and the remainder of the water passing through another PRV and continuing to Sackville through another 750 mm diameter transmission main. Treated water from the Meadowbrook Reservoir is supplied to the community of Bedford. The other treated water continues to the Sampson and Stokil Reservoirs located in the Sackville High pressure zone. Water from these tanks supplies the community of Sackville and also supplies water to the Waverley Reservoir by gravity and the Beaverbank Reservoir through the Beaverbank Booster Station.

The water distribution is made of cast iron, ductile iron, PVC, and some asbestos cement. Ductile iron has been the material of choice since the 1980s. The distribution system in the Central region is made of a wide range of pipe sizes. The distribution system for Bedford was installed in the early 1900s, Sackville in the early 1960s, and BLT in the early 1970s. There is fire protection everywhere in the Central Region, expect for Waverly.

Table 7.2 Pressure Zone and HGL Range for Central Region

Pressure Zone Name	HGL Range (m)
# 7 Highway Boosted	345-388
Beaverbank Boosted	456-505
Beaverbank Intermediate	372-423
Bedford Intermediate	304-313
Bedford Low	221-259
Bedford South High	360-402
Bedford South Intermediate	325-349
Bedford Village Boosted	319-346
Bluewater Intermediate	410
Crestview Boosted	363-412
Eaglewood Boosted	440
Giles Intermediate	338-341
Hemlock High	396-411
Hemlock Intermediate	349-396
Hemlock Super High	?
Kingswood High	543-556
Lively Boosted	?
Lucasville High	558
Monarch/Rivendale High	435
Mowatt Intermediate	340-369
Orchard High	405
Peerless Intermediate	293-329
Pockwock Boosted	592-639
Pockwock Intermediate	526-568
Rockmanor Intermediate	293-315
Sackville High	340-419
Sackville Intermediate	288-311
Silverside Boosted	368-386
Upper Hammonds Plains High	536-585
Waverley Intermediate	272-302

7.2 LAKE MAJOR WATER SUPPLY PLANT

The Lake Major Water Supply Plant provides treated water to the communities of Dartmouth, Cole Harbour, Eastern Passage, Burnside, and North Preston. The treatment facility has a design capacity of 90 MLD. The Lake Major WSP is supplied from Lake Major which has a watershed area of 6,944 Ha and a safe yield of 65.9MLD.

7.2.1 Eastern Region (Dartmouth / Cole Harbour / Eastern Passage)

The Eastern Region of the Halifax Water System is supplied from the Lake Major Water Supply Plant. Lake Major is located at approximately 18.9 metres HGL. The Lake Major Water Treatment Clearwell is located at approximately 62.52 metres HGL. Treated water is pumped from the Clear Well to an HGL of approximately 126.5 metres where it is distributed to the network via a 1,050 mm diameter transmission pipeline. Treated water is split at the Topsail Control Valve. During the Average Daily Flow, treated water flows through a PRV to fill twin tanks located at Mount Edward Road to a top level of 118.9 metres HGL. The remainder of the treated water continues through transmission pipes of mainly 600 mm diameter to fill the Akerley Tank, located in Burnside, to a top level of 118.9 metres HGL and to feed several pressure zones.

The Eastern Region is subdivided into 16 pressure zones. With the exception of the booster pumps located at the Lake Major Water Supply Plant, the Eastern Region has three boosted pressure zones: Mount Edward Boosted, Caldwell Road Boosted and North Preston. The boosted zones are supplied through two booster pumping stations and a PRV control chamber. The remainder of the pressure zones are fed from the Mount Edward and Akerley Tanks through a series of PRVs. The eastern region contains 25 PRV stations.

The distribution consists of mainly 300 mm, 200 mm, and 150 mm diameter mains throughout the East system. The pipes are a mix of ductile iron, cast iron, PVC, and some asbestos cement. The oldest pipe is located in downtown Dartmouth. The pipes form a grid like patters that services Dartmouth, Eastern Passage, and Forrest Hills/Colby Village.

Table 7.3 Pressure Zone and HGL Range for the East Region

Pressure Zone Name	HGL Range (m)
24 East High	380-387
Atholea Low	260-270
Burnside High	375-400
Burnside Low	276-290
Caldwell Road Boosted	410-415
Dartmouth Intermediate East	345-355
Dartmouth Intermediate West	325-335
Dartmouth Low	207
Eastern Passage – Woodside Low	260-270
Montague High	400-405
Mount Edward Boosted	498
North Preston	?
Princess Margaret Low	210-215
Ritcey Low	315
Ross Road	245-255
Waverley Low	252-262

7.3 BENNERY LAKE WSP

The Bennery Lake WSP supplies water to the Halifax Stanfield International Airport (HSIA) and the nearby Aerotech Business Park. The majority of the water distribution infrastructure within the SIA was constructed in the 1960s and 1970s to service the Air Terminal Building. The Aerotech Business Park was developed in 1986 with water distribution piping installed along Aerotech Drive and Pratt and Whitney Drive. The current water supply plant, reservoir and transmission piping was constructed at this time. The original raw water pumping station and transmission main was decommissioned.

A 350mm diameter transmission main connects the clearwell at the water supply plan to the Aerotech Reservoir, located to the North of Highway 102. The transmission main is ductile iron and is approximately 2,400 metres in length.

The Aerotech reservoir was constructed in 1987 as a steel reservoir with an epoxy coated interior. The tank was constructed with a single inflow/outflow pipe without the ability to bypass the tank for inspection/cleaning. As a result the reservoir was not inspected or cleaned between commissioning and 2009 when a project was completed to allow temporary bypassing of the reservoir.

Table 7.4 Water Tank Volumes at Airport/Aerotech

Tank	Year of Construction	Base (m amsl)	High Level (HGL)	Volume (m^3)
Bennery WSP Clearwell	1986	75.85-75.9	~83.4	985
Aerotech Reservoir	1987	160.2	174.5	4,085
Airport Terminal Reservoir	1960s		133.6	910

A 400 mm diameter transmission main connects the reservoir to the Aerotech Business Park, to the south of Highway 102. The transmission main is ductile iron and is approximately 1,480 meters in length. The transmission main crosses Highway 102 through dual 350 mm diameter ductile iron mains. Both 350 mm diameter transmission mains are located within 1,050 mm diameter casings, one under the northbound lane of Highway 102 (20 metres long) and the other under the southbound lane of Highway 102 (17 metres long). The transmission mains are packed in sand within the casings. A Pressure Reducing Valve is located to the south of Highway 102 near Pratt and Whitney Drive and reduces pressure from the reservoir when the Aerotech fire pump is operating.

In addition to the Aerotech Reservoir, the HSIA maintains a reservoir located near the Airport Terminal to provide additional storage for firefighting and emergency potable water for the airport terminal building. The airport reservoir is an in-ground concrete storage tank used primarily to provide fire flow storage. The elevation of the storage tank requires that pumping is required to provide water back to the distribution network. Supplementary chlorination is manually provided at the airport reservoir by hypo-chlorination. A 50 mm Grunfos pump is used to circulate the water in the reservoir during re-chlorination. The chlorine solution is injected into the discharge of the recirculation pump.

During normal operation, domestic water flows by gravity from the Aerotech Reservoir to supply potable water demands at the Airport Terminal and in the Aerotech Business Park. The distribution piping consists of 150 mm to 300 mm diameter piping of various materials. The piping in the Aerotech Business Park was generally installed in 1986/87 and consists of ductile iron piping. The piping at the Stanfield International Airport was installed between 1960 and present day and consist of a combination of cast iron, ductile iron. One section of distribution piping near the maintenance building at the airport consists of a mixture of unknown materials, including schedule 40 PVC not to AWWA standards, installed during repairs to the original cast iron piping.

During normal operations, there is one pressure zone for the airport and the Aerotech Business Park which is controlled by the elevation of water in the Aerotech Reservoir. However, when the airport reservoir fire pumps are in operation, a second pressure zone is developed at the Stanfield International Airport. High pressure at the Airport created by the airport reservoir fire pumps cause the check valves located at Barnes

Drive and Bell Boulevard to close isolating the Airport network from the Aerotech Business Park network. Each service connection within the Stanfield Airport system is equipped with a pressure reducing valve to protect the domestic piping from damage during fire pump operation.

The Aerotech Reservoir Fire Pump is activated if the water level in the Airport Reservoir is drawn below 131.1 m. This pressurizes the Aerotech zone and forces water back into the Airport Zone, re-establishing a single pressure zone.

A surge relief valve is located near the Aerotech sewage treatment facility discharges water should pressure in the system exceed 1,100 kPa (160 psi).

The Aerotech/Airport distribution systems are generally looped on Pratt and Whitney Drive and Barnes Drive. Check-valves are located on Barnes Drive and Bell Boulevard to prevent water from the airport returning to the Aerotech distribution network. The check valves are typically open during normal operating conditions as the pressure in the Aerotech distribution network is typically higher than at the airport.

A diesel drivel fire pump provides additional fire flow between the Aerotech Reservoir and the airport reservoir during fire conditions. The Aerotech Fire Pump is rated to produce between 18,900 Lpm and 28,350 Lpm at 79 metres and 25 metres of head respectively. The fire pump is activated with the airport reservoir is drawn down to 131.1 metres or the pressure switch located in the Airport Terminal Building is at or below 200 kPa (29psi). The pump can also be activated manually at the control panel in the Provincial Airlines Hanger. Once activated, the pump can only be shut-off manually.

Two fire pumps and a jockey pump are located at the airport reservoir. The jockey pump can be operated manually to supply domestic water to the terminal in the event that the transmission main from the Aerotech Reservoir is off-line. The two fire pumps, one primary pump and one standby, with rated capacities of 7,600 Lpm (out of service) and 3,800 Lpm respectively. A waste cone on the discharge of the pumps limits the pressure at the pump to a maximum of 690 kPa (100psi). The pumps are automatically activated should the airport system pressure drop below 338Kpa (49 psi). The fire pumps can also be activated manually from one of three alarm panels located in the air terminal building, the maintenance garage or the fire hall. The pumps will continue to operate until manually shut-down.

The distribution system of the HSIA and Aerotech business park is fed by gravity from the Aerotech reservoir through 150 mm to 300 mm diameter piping of various materials. The majority of the system is not owned by Halifax Water, only operated by Halifax Water. The original distribution system from the 1960/70s is made of cast iron and ductile iron. The distribution system that was constructed in 1987 consists of ductile iron pipe with Hyprotec exterior coating. Additional work was done on the system in 2002/2003 and consisted of D.I. pipe with Hyprotec coating.

7.4 SMALL SATELLITE SYSTEMS

A summary of the small satellite distribution systems is shown in Table 7.5. In general, the satellite systems do not have any in-distribution storage, expect for Middle Musquodoboit. The clear well provides the water storage for the small satellite systems. Furthermore, there are no supplementary chlorination stations in the satellite distribution systems.

There is no back-up water supply for the small system. In the event that water demand cannot be met, treated water will be brought in from the larger WSP and put into the clearwell.

Table 7.5 Summary of Small Satellite Distribution Systems

System	Year	# of service connections	Distribution System	Pumps (from clearwell to distribution system)	Pressure Zone	Storage
Five Island Lake[iii]	1993	12 customers	100mm dia PVC piping	Two (2) 3hp centrifugal pumps	One (1) pressure zone at 15 to 30psi with distribution system	Clearwell – three (3) 4,540L polyethylene storage tanks
Collins Park[iv]	1984/85	200 customers through 79 service connections[v]	100mm dia ductile iron with 18mm di copper service laterals	Two (2)centrifugal, 10hp VFD, 350L/min	One (1) pressure zone at 50 -0100psi	Clearwell – concrete chamber 160, 000L
Middle Musquodoboit	1989[vi]	90 customers	3,353m of 150mm and 100mm dia Class 52 Ductile iron piping	Two(2) end suction, centrifugal, 7.5hp 415L/min[vii]	One (1) pressure zone at 30 to 70 psi controlled by storage reservoir	Clearwell – concrete chamber 27,270L, *Storage Reservoir* on distribution system – 275,000L
Silver Sands[viii]	Early 1970's	40 connections	38mm dia polyethylene (early 1970s), 100mm PVC piping (1998)	5hp, 190Lpm Jacuzzi pump	One, pressure tanks operating between 40 and 55psi	Clearwell – 18,900L fiberglass storage tank
Miller Lake[ix]	Early 1960's	44 homes	25mm to 50mm copper and/or polyethylene pipe	Two centrifugal pumps at 156Lpm	Two pressure zones 1. Finished water pumps (50 to 60 psi), 2. 3.5HP Jacuzzi booster pump (40 to 55psi)	Clearwell- concrete chamber 37,270L
Bomont[x]	Mid 1970s	16 homes	50mm to 75mm dia	Two (2) centrifugal – 76.5L/min	One pressure zone: 30 – 50psi	Clearwell - Fiber-reinforced plastic tank, 20,000L

8. WATER MODEL

This report summarizes the work completed by GENIVAR in the update and development of the System-Wide Integrated Hydraulic Network Model (Integrated Network Model) of the water distribution systems across the urban core of HRM as part of the Integrated Resource Plan (IRP) for the Halifax Water. The Integrated Network Model is intended to serve as the prime hydraulic network analytical tool for the whole of the Pockwock and Lake Major water supply and distribution systems. As Halifax Water moves toward greater integration of the two regional water supply and transmission systems, this Integrated Network Model will become more significant as a tool to predict the dynamic operation of the system under a wide range of operational scenarios including the long-term planning horizon of 30-years currently being considered in the IRP.

8.1 BACKGROUND

The Integrated Network Model incorporates three pre-existing network models prepared for the pre-existing constituent municipalities of the Halifax Regional Municipality (HRM), including distribution systems in the City of Dartmouth, the City of Halifax and portions of the County of Halifax. As part of the IRP, GENIVAR has assembled one integrated network model from the three pre-existing models and expanded the system to include the majority of the remaining serviced parts of the urban core of the HRM. In addition to including the majority of the water distribution piping, storage reservoirs, booster pumping stations and control valve systems within the serviced core, the Integrated Network Model has been configured to represent two distinct conditions of demand regime within the model:

1. Existing Conditions Model (2010 Demands) – The Existing Conditions Model is intended to represent the average and peak water consumption patterns across the existing water distribution system within the serviced portion of the Urban Core. The water demands within the Existing Conditions Model are based on metered water consumption collected by Halifax Water in 2010 using their extensive master metering system and stored in the Utility's PI database.
2. Future Conditions Model (2046 Demands) – The Future Conditions Model is intended to represent the average and peak water consumption patterns across the future water distribution system within the Urban Core. The water distribution network in the Existing Conditions Model has been extended to include anticipated new developments across the Urban Core to 2046, as determined by HRM Planning. The water demands within the Future Conditions Model have been based on the 2010 demand regime scaled up to represent the future population projections, with additional block demands added at new suburban development locations.

8.2 INTEGRATED NETWORK MODEL DEVELOPMENT AND APPLICATION

As part of the IRP, the Existing and Future Conditions Models have been utilized to evaluate the existing and long-term future capacity requirements for each of the Priority Water Transmission Main projects listed in Exhibit 2. Since Halifax Water is currently considering Priority Water Transmission Main Projects intended to address population growth, asset renewal, and system security issues, the Integrated Network Model have been useful to help Halifax Water to gain an understanding of the existing and future hydraulic requirements and the size of infrastructure required to meet the average and peak demands across the distribution system. The models have been used to determine the preliminary diameter and configuration of each of the Priority Transmission Main systems under existing (2010) demand conditions and under future (2046) demands.

In recognition of the potential future requirements for meeting limited demands across the City under emergency conditions, the Future Conditions Model has also been used to study the transmission main sizes required to deliver limited amounts of water from the Pockwock WSP to the Dartmouth distribution system and from the Lake Major WSP to the Communities of Bedford and Sackville. The results of this analysis has shown that the proposed water transmission mains incorporated into an integrated regional water transmission system will have the capacity to meet future average day demands through most of the Urban Core when one of the major water supply plants (WSP) is out of service. In fact, the only part of the system that cannot be provided with average day demand from the Lake Major WSP is the Halifax Peninsula and the west part of the system serviced from the Geizer Hill Storage Reservoirs. During a protracted loss of service from the Pockwock WSP, these areas of the system will receive unfiltered, disinfected water from the Chain Lakes backup source.

8.3 INTEGRATED NETWORK MODEL DEVELOPMENT

8.3.1 Selection of Hydraulic Model

The Integrated Network Model has been constructed in the WaterCAD (Ver 8i) modeling environment, supplied by Bentley Corporation, a leader in the development of hydraulic analysis software products for the engineering and utility industry. Halifax Water has adopted WaterCAD as their preferred water distribution network analysis tool. The Integrated Network Model, which was constructed based on three pre-existing partial models of the distribution system in the HRM Urban Core, was extended to include all available information on existing water transmission and distribution piping infrastructure across the system. The integration of the previous models into one integrated model was intended to provide a unified tool to allow GENIVAR to complete an overall assessment of the existing and future water transmission system and to determine the preliminary configuration of a number of Priority Water Transmission Main projects intended to serve new development over the coming decades and to

EXHIBIT 2

Priority Water Transmission Main Projects - Revised Cost Sharing - June 12, 2012																
		Base Pipe Diameter		IRP 2046 Pipe Diameter				Base Cost		IRP 2046 Cost		Cost Attribution				
Project	Length (m)	Diameter (in)	Diameter (mm)	Diameter (in)	Diameter (mm)	Project Type and Nature of Cost Sharing	Short Description	Unit Cost[1] (HRWC Cost)	Preliminary Total Cost (2012 $)	Unit Cost[1] (HRWC Cost)	Preliminary Total Cost (2012 $)	Local - Growth	Utility - Regional Growth (RDC [4])	Utility - AR & SS	In-Service Date	Comments
East Region																
E1	1,390	12	300	16	400	Incremental Cost Shared - Utility Led	Windmill Road Transmission Main Replacement - Phase 1	$1,494	$2,076,660	$1,635	$2,272,650	$195,990	$0	$2,076,660	2022	
E2	1,540	12	300	16	400	Incremental Cost Shared - Utility Led	Windmill Road Transmission Main Replacement - Phase 2	$1,494	$2,300,760	$1,635	$2,517,900	$217,140	$0	$2,300,760	2022	
E3	3,610	16	400	36	900	Incremental Cost Shared - Development Led	Port Wallace Transmission Main - Phase 1	$1,635	$5,902,350	$2,784	$10,050,240	$5,902,350	$974,700	$3,173,190	2016	Base need for local development is 400mm; Regional oversizing to 600mm; system security to 900mm
E4	820	24	600	24	600	Asset Renewal/System Security - Utility Replacement	Gaston Road Transmission Main Replacement - Phase 2	$1,905	$1,562,100	$1,905	$1,562,100	$0	$0	$1,562,100	2027	
E5	1,280	16	400	16	400	Asset Renewal/System Security - Utility Replacement	Eastern Passage Transmission Main Replacement	$1,635	$2,092,800	$1,635	$2,092,800	$0	$0	$2,092,800	2027	
E6	2,605	16	400	36	900	Incremental Cost Shared - Development Led	Port Wallace Transmission Main - Phase 2	$1,635	$4,259,175	$2,784	$7,252,320	$4,259,175	$703,350	$2,289,795	2027	Base need for local development is 400mm; Regional oversizing to 600mm; system security to 900mm
E7	1					Asset Renewal/System Security - Utility Replacement	Burnside - Bedford Booster Pumping Station	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$0	$0	$1,000,000	2042	Bi-Directional Booster Pumping Station
E8	5,740	16	400	30	750	Incremental Cost Shared - Development Led	Burnside - Bedford Connector Transmission Main	$1,635	$9,384,900	$2,528	$14,510,720	$9,384,900	$1,549,800	$3,576,020	2037	Base need for local development is 400mm; Regional oversizing to 600mm; system security to 750mm
E9	1,350	12	300	24	600	Incremental Cost Shared - Development Led	Burnside - Bedford Connector Transmission Main Extension of 600mm Main on Glendale Dr. to HWY 102	$1,494	$2,016,900	$1,905	$2,571,750	$2,016,900	$190,350	$364,500	2017	Project Proposed by GENIVAR Team Base need for local development is 300mm; Regional oversizing to 400mm; system security to 600mm
							Sub-Total East Region		**$30,595,645**		**$43,830,480**	**$21,976,455**	**$3,418,200**	**$18,435,825**		
Central Region																
C1	980	30	750	30	750	Asset Renewal/System Security - Utility Replacement	Bedford Connector 30" Replacement - Phase 3	$2,528	$2,477,440	$2,528	$2,477,440	$0	$0	$2,477,440	2017	
C2	1,515	12	300	24	600	Incremental Cost Shared - Development Led	Windgate Drive Transmission Main	$1,494	$2,263,410	$1,905	$2,886,075	$2,263,410	$213,615	$409,050	2027	Project Partially Completed by HW. Cost Currently Assumes that No Previous Work has Been Completed. Does Constructed Portion Extend to Rivendale Dr? Base need for local development is 300mm; Regional oversizing to 400mm; system security to 600mm
C3	620			24	600	Asset Renewal/System Security - Utility Replacement	Stokil Tank Connection to Windgate Drive	$1,905	$1,181,100	$1,905	$1,181,100	$0	$0	$1,181,100	2032	Project Proposed by GENIVAR Team
C4	5,470	16	400	30	750	Incremental Cost Shared - Development Led	Lucasville Road Transmission Main - Phase 1 (includes beaverbank Reinforcement)	$1,635	$8,943,450	$2,528	$13,828,160	$8,943,450	$1,476,900	$3,407,810	2017	Base need for local development is 400mm; Regional oversizing to 600mm; system security to 750mm
C5	5,515	16	400	30	750	Incremental Cost Shared - Development Led	Lucasville Road Transmission Main - Phase 2	$1,635	$9,017,025	$2,528	$13,941,920	$9,017,025	$1,489,050	$3,435,845	2022	Base need for local development is 400mm; Regional oversizing to 600mm; system security to 750mm
C6	1,000	24	600	24	600	Asset Renewal/System Security - Utility Replacement	Nordic Crescent Upgrading	$1,905	$1,905,000	$1,905	$1,905,000	$0	$0	$1,905,000	2032	Project Proposed by GENIVAR Team
							Sub-Total Central Region		**$25,787,425**		**$36,219,695**	**$20,223,885**	**$3,179,565**	**$12,816,245**		
West Region																
W1	1,485	48	1200	48	1200	Asset Renewal/System Security - Utility Replacement	Pockwock Transmission Main Replacement Kearney Lake Road (Twin Culverts to Bluewater Road)	$3,774	$5,604,390	$3,774	$5,604,390	$0	$0	$5,604,390	2014	
W2	1,620	48	1200	48	1200	Asset Renewal/System Security - Utility Replacement	Pockwock Transmission Main Replacement Kearney Lake Road (Bluewater Road to Ham-Kearney Connector)	$3,774	$6,113,880	$3,774	$6,113,880	$0	$0	$6,113,880	2017	
W3	1,050	36	900	36	900	Asset Renewal/System Security - Utility Replacement	North End Feeder Tunnel 36" Transmission Main Rehab	$2,784	$2,923,200	$2,784	$2,923,200	$0	$0	$2,923,200	2017	
W4	4,035	24	600	24	600	Asset Renewal/System Security - Utility Replacement	Peninsula Low 24" Transmission Main Sliplining	$1,905	$7,686,675	$1,905	$7,686,675	$0	$0	$7,686,675	2027	
W5	4,035	15	375	15	375	Asset Renewal/System Security - Utility Replacement	Peninsula Intermediate 15" Transmission Main Sliplining	$1,635	$6,597,225	$1,635	$6,597,225	$0	$0	$6,597,225	2022	
W6	6,120	27	675	27	675	Asset Renewal/System Security - Utility Replacement	Peninsula Low 27" Transmission Main Sliplining	$2,390	$14,626,800	$2,390	$14,626,800	$0	$0	$14,626,800	2032	
W7	2,610	16	400	16	400	Asset Renewal/System Security - Utility Replacement	Herring Cove Transmission Main Replacement	$1,635	$4,267,350	$1,635	$4,267,350	$0	$0	$4,267,350	2022	
W8	1					100% Development Funded	Mainland North Booster Pumping Station to Fill Geizer 158	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$0	$1,000,000	$0	2037	Project is entirely growth driven
W9	5,100	16	400	30	750	Incremental Cost Shared - Development Led	Susie Lake Transmission Main	$1,635	$8,338,500	$2,528	$12,892,800	$8,338,500	$1,377,000	$3,177,300	2027	Base need for local development is 400mm; Regional oversizing to 600mm; system security to 750mm
							Sub-Total West Region		**$57,158,020**		**$61,712,320**	**$8,338,500**	**$2,377,000**	**$50,996,820**		
							Total Cost		**$113,541,090**		**$141,762,495**	**$ 50,538,840**	**$ 8,974,765**	**$ 82,248,890**		
							% of 2046 Total Cost					**35.7%**	**6.3%**	**58.0%**		

Notes:
1: Unit Costs are Based on HRWC Unit Rates incl. On-Costs, Risk, HST and Overhead
2: Unit Costs Do Not Differentiate Between New,Replacement or Sliplining
3: Unit Cost for Project E7 and Project W9 are for in-line booster pumping stations intended to provide limited boosting of transmission main pressures.
4. RDC = Regional Development Charge (policy currently under revision)

provide enhanced system security in the event of a significant loss of supply from one of the two major Water Supply Plants (WSP).

8.3.2 Data Collection and Model Development

From the start of the IRP, the intent was to use the Integrated Network Model to evaluate system performance under various demand/flow forecast scenarios including existing conditions (2010 demand data) and future conditions (2046 demand projections) based on population projections supplied by HRM Planning. The Integrated Network Model (INM) was constructed from three (3) independent hydraulic network models (Central – Bedford area, West –Halifax, East – Dartmouth) prepared by others and provided by Halifax Water at the outset of the IRP. The original Central and West models, which were constructed in 1999 by Halifax Water, were primarily skeleton models with larger pipe (greater than 300 mm diameter), but lacked the finer detail of the smaller distribution piping. The East model (City of Dartmouth and area) was completed in the early 1994 by Dillon Consultants using the Waterworks modeling environment and converted to the Cybernet environment CBCL Ltd in the early 2000's.

As part of the IRP, GENIVAR joined the three (3) previous network models into a single Integrated Network Model and added significant detail to the model using information from record drawing files provide from a number of sources, including the distribution systems in the Beechville-Lakeside-Timberlea (BLT) and North Preston communities, which were added from GENIVAR project record files. In addition, the existing models were reviewed to identify any gaps in information, functionality, required updates or improvements, and additions. Certain parts of the Integrated Network Model continue to contain only the skeletonized version of the network, but do not yet include the smaller diameter pipes that are considered insignificant to the hydraulics of the overall system. The Integrated Network Model was also updated to include water storage tanks, booster pumping systems, pressure control and pressure reducing valve (PRV) systems, based on detailed information provided by Halifax water. The logic and set points for the pumps and control valve systems were established in the model based on information provided by Halifax Water.

8.3.3 Existing Conditions Model Calibration

Halifax Water currently monitors water demands in approximately 65 areas of the distribution system using master meters that feed data into the PI database system. The water demand regime within the Integrated Network Model was based on the 2010 water consumption database for the master meters, provided by Halifax water. Existing demand conditions in the model, including average day and peak day demands, were adjusted in each metered zone to match the 2010 data provided by Halifax Water. While this approach to model calibration does not represent the fine detail of water consumption across each of the meter zones, it is considered adequate to support the analysis of the water transmission system required by the IRP.

In addition to calibration of the water demands, pressure settings at various pressure reducing valve (PRV) stations were adjusted to correspond to information on valve set points provided by Halifax Water from their Pi water information database system. The demand regime within each of the water service areas was calibrated against one year (2010) of master meter flow data supplied by Halifax Water.

8.3.4 Model Assumptions and Limitations

For the purposes of the IRP, the Integrated Network Model has been operated as a steady state model representing the hydraulic operation of the system under either average day or peak day demand conditions, with the storage tanks, pumping system and control valves functioning without variation. No diurnal variation in demands across the system has been implemented in the model since the intent of the analysis has been primarily to observe the performance of the water transmission system under extreme water demand conditions only. Future versions of the Integrated Network Model may include diurnal demand patterns for residential, commercial, industrial, and institutional consumption to support extended time analyses of the system, including analysis of the behaviour of the pumping systems and storage reservoirs and pressure regimes at critical areas of the network.

Due to the lack of smaller diameter distribution piping in the existing Integrated Network Model and the lack of calibration within the various meter zones, the existing model is less reliable as a tool to analyse pressures and flows at the micro level in the network. The existing real pressure and flow time data collected through the SCADA system and presented in the PI database are a better source of information concerning the local network and its potential performance with new development. The Integrated Network Model is best suited as a tool to examine the long-term, future performance of the water transmission and storage systems under a wide range of population and demand scenarios.

8.3.5 Long Term Water Demands and Modeling

Water demands within the Existing Conditions Model (2010) and the Future Conditions Model (2046) are based on a unit per capita demand of 410 Litres per person per day, as required by the current version of Halifax water's Design and Construction Specifications (2012 Edition). Recent per capita demands across the network have been falling at the rate of approximately 3% per year, while the overall serviced population of the City has been increasing at the rate of 0.8% to 1% per year. The net effect of these two trends has been that the overall consumption of potable water across the urban core of HRM has been declining at approximately 2% per year. This decline in per capita water consumption, which is consistent with other utilities across the region, may be the result of increased cost and public awareness to the importance of water conservation. While it is expected that the recent trend of declining per capita water consumption may continue indefinitely, it is also anticipated that the rate of decline will diminish as customers reach some lower limit of demand associated with the practical amount of water required to support human existence in a modern urban environment. It is recognized that the unit demand for potable water in HRM has a considerable way to go before it reaches this long-term lower demand limit.

8.3.6 Future Model Updates

The recent decline in long-term per capita water consumption is expected to continue for the foreseeable future, although the rate of decline may diminish as the unit demand approaches the amount necessary for human health. Future demands in the Integrated Network Model, which have been structured based on the current design unit rate of 410 L/capita/day, may be adjusted in future analyses to reflect the latest data on per capita consumption. The net effect of this anticipated decline in unit water demand will be to extend the capacity and useful life of existing water treatment, transmission and storage systems and delay the time when these systems will need to be expanded or replaced. The net impact of declining water consumption rates across HRM on the future capital and operating expenditures on the water systems has been examined in sensitivity analyses completed during the IRP.

8.4 HYDRAULIC ANALYSIS FUTURE DEMAND CONDITIONS

8.4.1 Population Growth and System Security

Halifax Water is currently developing a long-term plan to expand and upgrade the trunk water transmission main system across the Urban Core to meet the demands of a growing population; to enhance overall system security; and to strengthen the capacity of the system to provide water under emergency conditions between the Pockwock System and the Lake Major System. In addition to extending the water demands within the model to represent the 2046 population, the Future Conditions Model has also been extended to include Halifax Water's list of Priority Water Transmission Main projects (see Exhibit 2). Many of these Priority Water Transmission Main projects are intended to strengthen the capacity of the existing water transmission system to deliver water to the expanded serviced population within the service area, while also enhancing the capacity to deliver water during emergencies from one source of supply to the whole Urban Core.

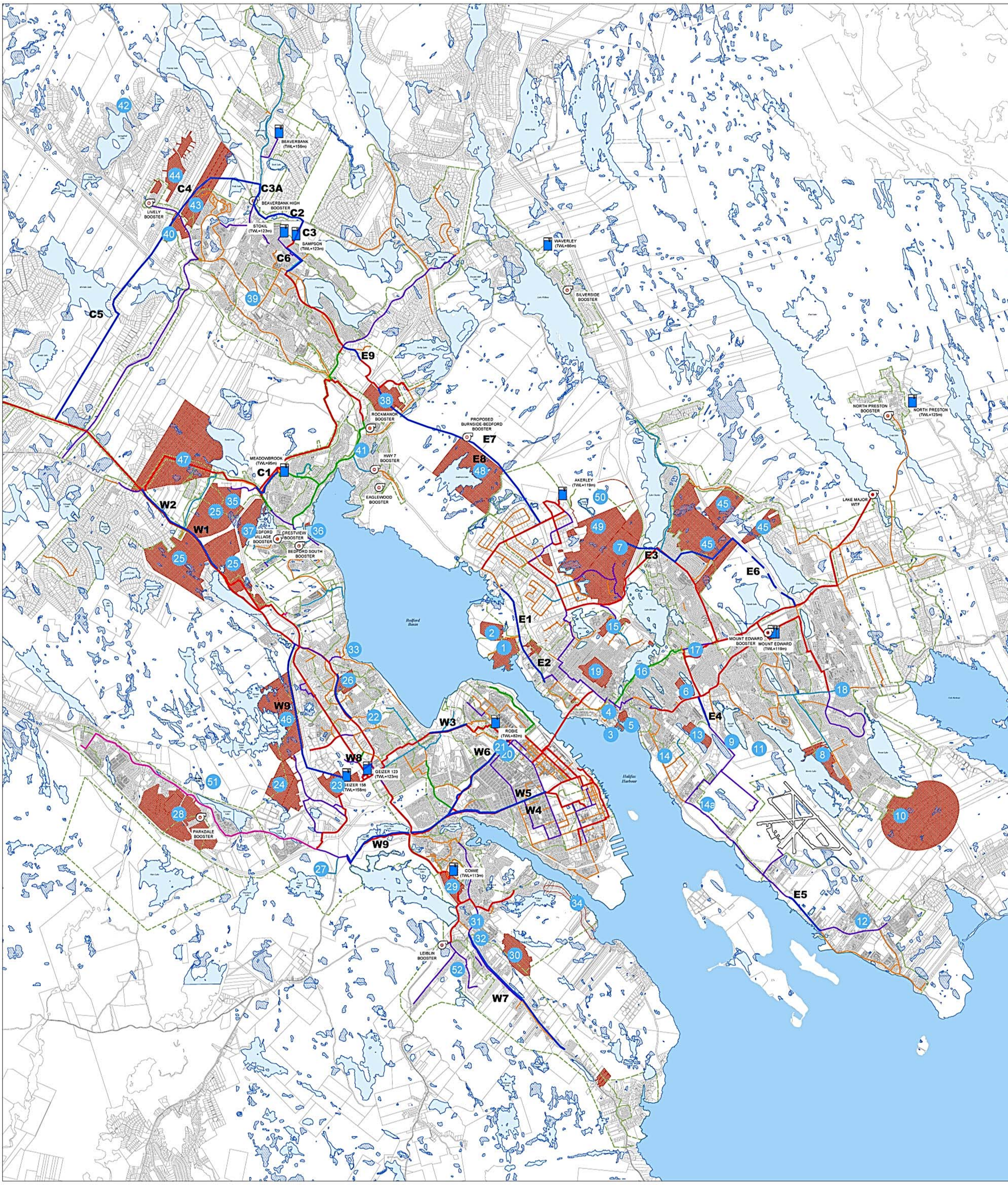
8.4.2 Priority Water Transmission Main Projects

As part of their long-term planning process, Halifax Water has prepared a list of Priority Water Transmission Main projects that are anticipated for construction over the coming decades to strengthen the hydraulic capacity of the system to deliver water under normal and extreme conditions within the Urban Core. . The list of Priority Water Transmission mains has been considered under four distinct categories based on the driver that will trigger the construction of the project and on the sources of funding required to pay for these capital projects. While some of the projects will be triggered by Halifax Water's ongoing requirements for renewal of existing water transmission assets of as part of the long-term plan to strengthen the security of the transmission system, other projects will be triggered primarily by the growth of serviced population associated with new residential, commercial, and industrial developments across the system. The list of Priority Water Transmission Main projects has been considered under the following four (4) categories as presented in Exhibit 2.

1. Case 1 – Incremental Cost Shared – Utility Led (red colour) – These projects involve the renewal of existing water transmission mains that have reached the limit of their capacity to serve an ever growing population within specific areas of the Urban Core. While the requirements for these projects will be the result of a growing serviced population, the timing and configuration of these asset renewal projects will be led by Halifax Water, who will determine their long-term capacity requirements based on long-term population and water demand projections within the serviced area. The capital cost of these projects will be shared between the Utility and the Developers based on the benefits that will accrue to each party.
2. Case 2 – Incremental Cost Shared – Development Led (green colour) – The timing of the construction of these projects will be triggered by the water demand requirements of new developments, with their capacity and configuration the result of cooperation between the Developers and the Utility. During the planning and design of these new developments, Halifax Water will cooperate with the Developers to determine the capacity and configuration of the transmission mains required to serve the requirements of the new developments and of the greater overall water distribution system. The construction of these water transmission main projects will be integrated into the construction of the new developments with Halifax water contributing to the capital cost based on the incremental share of the system capacity benefiting the community at large.
3. Case 3 – Asset Renewal/System Security – Utility Replacement (blue colour)– These projects have been identified by the Utility as requiring the renewal of existing water transmission systems that have reached the end of their useful life and presenting an opportunity to enhance the security of the overall water transmission system. The capital cost of these projects will be borne by Halifax Water, with the cost attributed to Asset Renewal (30%) and System Security (70%).
4. Case 4 - 100% Development Funded (yellow colour) – These projects are regional in character and are driven entirely by increased water demands associated with ongoing population growth. The capital cost of these projects will be charged against regional capital cost agreement.

Table 8.1 provides a summary of these Priority Water Transmission Main projects complete with the project type and nature of their funding and a brief description of the main reason for each project. Exhibit 3 illustrates the location and preliminary configuration of the Priority Water Transmission Main projects laid against the backdrop of the population growth areas as defined by HRM Planning.

EXHIBIT 3



LEGEND:

PRIORITY WATER TRANSMISSION MAIN PROJECTS	300mm TRANSMISSION MAIN
PROPERTY BOUNDARY	350mm TRANSMISSION MAIN
52 FUTURE GROWTH AREA (HRM PLANNING)	400mm TRANSMISSION MAIN
E2 PRIORITY TRANSMISSION MAIN PROJECT	450mm TRANSMISSION MAIN
	500mm TRANSMISSION MAIN
	GREATER THAN 500mm TRANSMISSION MAIN

FOR INTERNAL USE

HALIFAX WATER
TRANSMISSION NETWORK

2 1.5 1 0.5 0 1 2 3 4 km
1 : 35,000

JUNE 12, 2012
Priority Water Transmission Main Projects from Halifax Water, Feb. 2010
K:\DARTMOUTH\2011\DA11325 IRP - HALIFAX WATER\DWG\ENG\DA11325_TRANSMISSION.DWG

Table 8.1 Priority Water Transmission Main Projects

#	Project	Project Type/Nature of Cost Sharing	Explanation
East Region			
E1	Windmill Road Transmission Main Replacement - Phase 1	Incremental Cost Shared - Utility Led	Support growth at Shannon Park and area
E2	Windmill Road Transmission Main Replacement - Phase 2	Incremental Cost Shared - Utility Led	Support growth at Shannon Park and area
E3	Port Wallace Transmission Main - Phase 1	Incremental Cost Shared - Development Led	Support local growth with oversizing for regional purposes.
E4	Gaston Road Transmission Main Replacement - Phase 2	Asset Renewal/System Security - Utility Replacement	Reinforce transmission system to Shearwater and Eastern Passage Area
E5	Eastern Passage Transmission Main Replacement	Asset Renewal/System Security - Utility Replacement	Replace existing transmission main to increase system security
E6	Port Wallace Transmission Main - Phase 2	Incremental Cost Shared - Development Led	Support local growth with oversizing for regional purposes.
E7	Burnside - Bedford Booster Pumping Station	Asset Renewal/System Security - Utility Replacement	Reinforce transmission main capacity between Bedford and Dartmouth Systems.
E8	Burnside - Bedford Connector Transmission Main	Incremental Cost Shared - Development Led	Supply Local Development and increase transmission system capacity between Bedford and Dartmouth
E9	Burnside - Bedford Connector Main - Extension of 600mm Main - Glendale Dr. to Highway 102	Incremental Cost Shared - Development Led	Reinforce transmission capacity in Bedford
Central Region			
C1	Bedford Connector 30" Replacement - Phase 3	Asset Renewal/System Security - Utility Replacement	Reinforce supply to Meadowbrook Storage Reservoir
C2	Windgate Drive Transmission Main	Incremental Cost Shared - Development Led	Reinforce supply to Sackville Storage Reservoirs
C3	Stokil Tank Connection to Windgate Drive	Asset Renewal/System Security - Utility Replacement	Reinforce supply to Lower Sackville & Dartmouth System
C4	Lucasville Road Transmission Main - Phase 1 (incl. Beaverbank Reinforcement)	Incremental Cost Shared - Development Led	Reinforce supply to Beaverbank Tank/Middle Sackville
C5	Lucasville Road Transmission Main - Phase 2	Incremental Cost Shared - Development Led	Reinforce supply to Sackville and Fall River Areas
C6	Nordic Crescent Upgrading	Asset Renewal/System Security - Utility Replacement	Reinforce supply to Sackville Storage Reservoirs
West Region			
W1	Pockwock Transmission Main	Asset Renewal/System Security -	Replacement/Twinning of Original

Table 8.1 Priority Water Transmission Main Projects

#	Project	Project Type/Nature of Cost Sharing	Explanation
	Replacement Kearney Lake Road (Twin Culverts to Bluewater Road)	Utility Replacement	Pockwock Transmission Main
W2	Pockwock Transmission Main Replacement Kearney Lake Road (Bluewater Road to Ham-Kearney Connector)	Asset Renewal/System Security - Utility Replacement	Replacement/Twinning of Original Pockwock Transmission Main
W3	North End Feeder Tunnel 36" Transmission Main Rehab	Asset Renewal/System Security - Utility Replacement	Replacement/Twinning of major feeder main to Peninsula North End.
W4	Peninsula Low 24" Transmission Main Sliplining	Asset Renewal/System Security - Utility Replacement	Rehabilitation of major feeder to Peninsula Low Zone
W5	Peninsula Intermediate 15" Transmission Main Sliplining	Asset Renewal/System Security - Utility Replacement	Rehabilitation of major feeder to Peninsula Intermediate Zone
W6	Peninsula Low 27" Transmission Main Sliplining	Asset Renewal/System Security - Utility Replacement	Rehabilitation of major feeder to Peninsula Low Zone
W7	Herring Cove Transmission Main Replacement	Asset Renewal/System Security - Utility Replacement	Extension of transmission main toward Herring Cove.
W8	Mainland North Booster Pumping Station to Fill Geizer 158	100% Development Funded	Raise hydraulic grade line to fill Geizer 156 Tank.
W9	Susie Lake Transmission Main	Incremental Cost Shared - Development Led	Reinforce supply to developments in Susie Lake/Quarry Lake area.

8.4.3 Impact of Projected Population Growth

The projected population growth within HRM over the coming 30 years has been estimated at approximately 160,000 additional citizens based on the medium growth scenario provided by HRM Planning. HRM Planning has identified population growth within the development areas shown on Exhibit 3. The water treatment, transmission and distribution systems must be able to meet the increased demands associated with this increased demand, while also providing adequate domestic water pressures across the system and meeting the fire protection requirements associated with the various structures in each service area.

A preliminary evaluation of water pressures across the Future Conditions Model (2046) under average and peak demand conditions indicates that the future configuration of the water transmission and distribution systems, including the Priority Water Transmission Main projects presented above will be adequate to meet the domestic water supply requirements of the future serviced population, including both continued build-out within the Urban Core and development of greenfield suburban lands at the edge of the water distribution system.

In addition to analysing the capacity requirements of the proposed Priority Water Transmission Main projects to meet current (2010) water demand requirement, the Future Conditions (2046) version of the Integrated Network Model has also been used to analyse the capacity requirements of the Priority Water Transmission Main projects to meet the long-term transmission requirements during extreme conditions including fire flows and emergency supply conditions when all or a portion of one of the water supply plants (WSP) is out of service. In addition to showing the location of the various future growth areas in HRM, Exhibit 3 also illustrates the configuration of the Priority Water Transmission Main projects intended to strengthen the regional water transmission system.

The water consumption growth projections associated with the various growth areas identified in Exhibit 3 have been loaded into the Future Conditions Model (2046) to assess their potential impacts on the water transmission and storage systems. The results of our analysis of existing and future water storage reservoir capacities is presented in the next section entitled “Water Storage Report”.

Exhibit 2 provides a summary of the transmission main pipe diameters required to meet the current (2010) and future (2046) water demands across the system. In addition to meeting peak water demands in the present, certain of the Priority Water Transmission Main projects will require larger diameter pipes to meet future population growth and to provide enhanced security of supply during extreme conditions, such as loss of supply from one of the major WSPs.

8.4.4 Timing of Priority Water Transmission Main Projects

The proposed construction of the Priority Water Transmission Main Projects represents a significant capital expenditure for Halifax Water that must be spread over the next few decades. While certain of the ‘Incremental Cost Shared - Development Led’ projects will be constructed in association with the developments that require them, other ‘Incremental Cost Shared - Utility Led’ projects will be scheduled by Halifax water based on Utility priorities. In general, the most urgent projects will be those associated with the renewal of the original Pockwock Water Transmission Main system, high pressure concrete-lined cylinder pipe that has reached the end of its useful life and needs replacement or relining. Exhibit 2 provides an estimated ‘in-service date’ for each of the projects. These dates are preliminary and useful for the IRP and are subject to change as Halifax Water continues to develop their list of Priority Water Transmission Main projects.

8.5 MODELING OF POTENTIAL EMERGENCY SITUATIONS

The Pockwock Water Supply System and the Lake Major Water Supply System are currently independent systems with the exception of the 600 mm diameter water transmission main located on the MacDonald Bridge. Over the past century, Halifax water's treatment, transmission and distribution systems have proven to be reliable and capable of providing uninterrupted, high quality potable water service to the customer base. As an example, when the Halifax area was hit by a major hurricane, Juan, and the electrical system was out of service for two weeks or more, the one system that continued to function without interruption was the water system.

Halifax Water has recognized the need for greater integration of the two systems to address the growing need for enhanced system security, especially under a range of emergency scenarios. Halifax Water is currently developing a long-term plan aimed at strengthening the regional water treatment and transmission system to form a more integrated transmission system that will address these emergency situations. Emergency water supply scenarios can range from short duration, local interruptions to the delivery of water associated with failure of local infrastructure, to longer duration, regional loss of water supply associated with the failure of larger infrastructure that may have more extensive impact on the City. Some of the typical emergency conditions that may be expected to occur that could have an impact on the operation of the water supply system are presented in the following.

8.5.1 Type and Scale of Emergency

The duration of a water supply disruption, can vary from a few hours, such as a distribution main, to several weeks or months, typically associated with the failure of a water supply plant or a major contamination event, may be categorized as short, medium and long duration.

Short Duration Emergency (less than 24 hours) – Typically, Halifax Water has available in reservoir storage within each service area enough water to meet the average day demand for a period of approximately 24 hours or enough water to fight a major fire within the service area. Short-term emergencies are typically associated with the failure of a water transmission main or booster pumping system, events that can be repaired or remediated within the 24 hour period. Should the emergency require somewhat longer to repair then the Utility may choose to advise the public and to enact water conservation measures such as restricted use beyond the most necessary uses.

Medium Duration Emergency (less than 2 weeks) – Emergencies that extend beyond the capacity of the reservoir storage will typically require the use of the back-up water supply systems at Chain Lakes and at Lake Lamont/Topsail Lake. Halifax Water continues to maintain these two raw water sources as unfiltered but disinfected back-up water supplies for the City. Both of these sources are reputed to have a capacity of at least two (2) weeks, however, the duration of their use may extend beyond that amount depending on the climatic conditions and the extent of the network that requires access to the supply. The use of this disinfected, unfiltered water would be acceptable in an emergency; however it would also likely include the institution of a boil order that could take many weeks to clear.

Emergencies that might fall into this category could include a contamination event in the water transmission or storage system, an extended loss of raw or finished water pumping (possibly due to an electrical fire), or an outbreak of a water-borne sickness associated with a portion of the distribution system. Should the yield at the back-up sources be insufficient to meet the demands for the duration of the event, it is possible that the yield at each lake system could be augmented by pumping raw water from Long Lake into the Chain Lakes or from Lake Major into the Lamont/Topsail Lake System. Both of these options have the potential to greatly extend the capacity and duration of the back-up sources.

Long Duration Emergency (greater than two weeks) – When the duration of an emergency extends beyond the capacity of the back-up water sources, then the City must have in place an emergency supply plan that involves severe restrictions on water consumption and usage, replenishment of back-up raw water supplies, and other emergency measures. Long duration emergencies might involve a protracted loss of service from one of the major water supply plants, possibly requiring extensive reconstruction of the pumping, process, and electrical and control systems. It is during one of these long duration scenarios that the integration of the regional water transmission, storage, and distribution system may have the greatest value. When the Priority Water Transmission Main projects have been completed and the Pockwock and Lake Major systems are more strongly interconnected, it will be possible for Halifax Water to supply part or all of one system from the other side of the Harbour. For example, the Integrated Network Model has shown that, in the future, the whole of Halifax water's Distribution System (both sides of the Harbour) can be supplied with average day demand from the Pockwock WSP provided that the Burnside-Bedford Transmission Main (E8) and Booster Pumping Station (E9), as well as the Lucasville Transmission Main System (C4 and C5) are in service. The model also indicates that the communities of Bedford and Sackville may be serviced from the Lake Major System using the same infrastructure.

8.6 CAPITAL COST ESTIMATES

As part of the IRP, GENIVAR has prepared concept level capital cost estimates for each of the Priority water Transmission Main Projects based on prevalent unit rates for the construction or rehabilitation of the various piping and pumping systems proposed in Exhibit 2. These unit construction costs have been utilized within the IRP and the RWWFP to estimate the cost to construct each project. The capital cost estimates for each of the Priority Water Transmission Main projects, presented in Exhibit 2, are based on these unit rates for construction plus the allowance for 'on-costs'.

8.7 CONCLUSION

The Integrated Network Model of the water supply, transmission, and distribution system, prepared during the IRP, has been used to evaluate the existing (2010) and future (2046) capacity requirements for the list of Priority Water Transmission Main projects and for the water storage reservoirs across the City (HRM). The construction and commissioning of these projects transmission main projects and water storage reservoirs will significantly increase the security of supply across the system and the overall capacity of the system to support anticipated growth across the system.

9. WATER STORAGE RESERVOIR

9.1 INTRODUCTION

This section is intended as a summary of the current and future water storage requirements within the serviced core of the City, with preliminary capacity and capital cost estimates for new water storage reservoirs that will be required in the future to meet the needs of the growing population.

9.2 BACKGROUND

Raw water supply and water treatment facilities are usually located at a distance from the areas of largest water demand and require a large diameter water transmission system to deliver the water to the customers. Due to the wide variation in water demands throughout the day and the seasons, and the potential for failure of the water transmission system, the distribution system is usually equipped with water storage reservoirs located on higher ground within the various service districts. In the event of a transmission main failure or a major fire requiring large flows for fire protection, water stored in a local storage reservoir would be available to maintain uninterrupted service within the system.

Typically, water storage reservoirs are designed to meet three specific requirements within a water service district with the total volume of active storage being the sum of the individual volumes required for each of the three elements.

1. Peak Balancing – Water transmission systems are designed to deliver the highest average daily demand across the network. When instantaneous demands in the network exceed the capacity of the transmission system, water is drawn from the peak balancing component of the reservoir to meet the short duration peaks that typically occur during the high demand periods including breakfast and supper times. The volume of the peak balancing storage is a function of the diurnal demand fluctuations in a community or service area and is commonly estimated at 25% of the total maximum day demand.

2. Fire Storage – Ideally, fire protection requirements within a service area, typically established by the Insurers Advisory Organization (IAO), are typically provided from the fire storage component within the local water storage reservoir. The volume of fire storage required within a particular service area is typically based on the rate and duration of the highest fire flow within the service area, as recommended by IAO or other regulatory body.
3. Emergency Storage – In the event of a loss of water supply or transmission system capacity to the City, the water demands within the service area may be satisfied for a short period of time from the emergency storage component within the storage reservoir. Loss of water supply may be the result of failure of the treatment plant, a transmission main, the electrical system, or a natural disaster. The volume of emergency storage required within a storage reservoir is typically based an assessment of risk and the degree of system dependability required by the client. For the purposes of the IRP, we have assumed an emergency storage requirement of 25% of the sum of peak balancing plus fire flow.

For our analysis, we have assumed that the total volume of storage required in each service area will be the sum of each of the three storage elements described above.

9.3 EXISTING WATER STORAGE RESERVOIR CAPACITY

Typically water storage reservoirs are located at natural 'high' points within the areas being served to take advantage of delivery into the network by gravity. If a storage structure is of a type that only allows the upper portion of the stored water to provide a useful function, such as providing adequate water pressure, the remaining lower portion of the stored water is termed 'dead storage'. For the purposes of this analysis, it has been assumed that all existing and future storage will be available to serve the community and that no dead storage exists in the existing storage reservoirs.

Halifax Water currently owns and maintains 18 water storage reservoirs across HRM, with a total storage volume of 266.15 Million Litres (ML) or 58.62 Million Imperial Gallons. Of this total volume, 167.9 ML of storage is located on the Pockwock Transmission System (West and Central Areas) and 93.93 ML of storage is located on the Lake Major Water Transmission System. An additional 4.36 ML of storage is also located on two satellite systems (Middle Musquodoboit & Aerotech). Table 9.1 provides a summary of the high and low water levels, total volume, material of construction, and date of construction of each of the existing water storage reservoirs within HRM.

Table 9.1 Halifax Water System Existing Water Storage Reservoir

Storage Reservoir Name	Low Water Level (m)	High Water Level (m)	Volume (m^3)	Volume (MIgal)	Material of Construction	Year Constructed
West & Central Areas						
Pockwock Clearwell		170	13,600	3.0	Concrete	1977
Sampson Reservoir	103.9	123	12,273	2.7	Steel	1970

Table 9.1 Halifax Water System Existing Water Storage Reservoir

Storage Reservoir Name	Low Water Level (m)	High Water Level (m)	Volume (m^3)	Volume (MIgal)	Material of Construction	Year Constructed
Stokil Reservoir	97.8	123	23,636	5.2	Steel	1991
Beaverbank Reservoir	121.5	156	6,937	1.5	Steel	2007
Waverly Reservoir	78.6	86	1,364	0.3	Steel	1982
Meadowbrook Reservoir	86	95	9,091	2.0	Gunnite	1971
Geizer 158 Reservoir	148.6	158	36,400	8.0	Steel	1986
Geizer 123 Reservoir	109.7	123	31,800	7.0	Gunnite	1975
Robie St. Reservoir	73.8	82	15,900	3.5	Concrete	1913
Cowie Hill Reservoir	100.4	113	11,400	2.5	Gunnite	1972
Charles Rd. (Lakeside Timberlea)	108.8	119	5,455	1.20	Gunnite	1982
Hemlock Reservoir (Future)			Nil	Nil	Steel	
Herring Cove Reservoir (Future)			Nil	Nil	Steel	
Total Current Volume (Central Area):			167,856	37.0		
East Areas						
Lake Major Treatment Plant Clearwell		60	9,092	2.0	Concrete	1999
Mount Edward #1	109.7	119	22,728	5.0	Gunnite	1979
Mount Edward #2			22,728	5.0	Steel	1998
Akerley Boulevard	100	119	37,727	8.3	Steel	1986
North Preston		125	1,659	0.4	Steel	1988
Eastern Passage (Future)			Nil	Nil	Steel	
Total Current Volume (East Area):			93,934	20.7		
Satellite Systems						
Middle Musquodoboit Reservoir		81	275	0.06	Gunnite	1989
Aerotech Reservoir		174	4,085	0.90	Steel	1986
Total Current Volume (Satellite Areas):			4,360	0.96		

9.4 PROJECTED 2046 WATER STORAGE RESERVOIR CAPACITY REQUIREMENTS

As the serviced population of HRM increases over the coming decades, there potentially may be a requirement for new water storage reservoirs in areas not currently served by a storage reservoir and for increased volume of storage within service areas where a reservoir currently exists. As part of the IRP, GENIVAR has analyzed the future (2046) storage requirements within each of the existing and future major service areas. It is noted that certain of the smaller service areas located primarily at the tops of hills may not be provided with a dedicated storage reservoir, but will depend on a local booster pumping station equipped with domestic duty pumps and a fire pump capable of meeting the normal and emergency water demands within the zone.

The volume of active storage required within a service area is a function of the serviced population, the definitive fire flow rate and duration required to protect the largest structures in the zone, and the decree of risk that the Utility wishes to assume when the transmission system is out of service. For the purposes of the IRP and the RWWFP, HRM Planning has provided projections of the anticipated population growth within specific service areas across the City Core, which totals approximately 160,000 more persons by the Year 2046. They have also provided estimates of the additional population equivalents associated with commercial growth across the City. The medium growth scenario contained in these population growth projections has been used to estimate future (2046) average and peak water consumption rates within each of the service areas.

Table 9.2 provides a summary of the projected total volume of reservoir storage required within each of the major service areas in HRM by the Year 2046 based on the population projections. This table includes an estimate of the percentage of the total volume available currently that will be utilized in the Year 2046. In most instances it is apparent that there is sufficient storage available in the existing water storage reservoir to meet the long-term (2046) storage requirements. In other instances, the existing storage reservoir is marginal or inadequate to meet the future (2046) storage requirements within the service area.

Table 9.2 Projected 2046 Storage Tank Requirements

Name	2012 Volume Available (m^3)	2012 Volume Available (M.Imp.Gal.)	2046 Volume Required (m^3)	2046 Volume Required (Imp. Gal.)	2046 Capacity Utilized (%)
West & Central Areas					
Pockwock Clearwell	13,600	3.0	7,567	1,666,630	55.6%
Sampson/Stokil Reservoir	35,909	7,909,471	15,237	3,356,057	42.4%
Beaverbank Reservoir	6,937	1,527,974	3,381	744,714	48.7%
Waverly Reservoir	1,364	300,441	1,395	307,365	102.3%

Table 9.2 Projected 2046 Storage Tank Requirements

Name	2012 Volume Available (m³)	2012 Volume Available (M.Imp.Gal.)	2046 Volume Required (m³)	2046 Volume Required (Imp. Gal.)	2046 Capacity Utilized (%)
Meadowbrook Reservoir	9,091	2,002,423	11,005	2,424,029	121.1%
Geizer 158 Reservoir	36,400	8,017,621	15,196	3,347,137	41.7%
Geizer 123 Reservoir	31,800	7,004,405	22,788	5,019,383	71.7%
Robie St. Reservoir	15,900	3,502,203	9,794	2,157,159	61.6%
Cowie Hill Reservoir	11,400	2,511,013	10,586	2,331,718	92.9%
Charles Rd. (Lakeside Timberlea)	5,455	1.2	1,243	273,733	22.8%
Bedford South (Future) (Note 6)	Nil	nil	19,885	4,380,000	nil
Herring Cove Reservoir (Future) (Note 5)	Nil	nil	7,718	1,700,000	nil
Total Volume (West & Central):	167,856	.97	98,191	21,627,925	58.5%
East Areas					
Lake Major WSP Clearwell	9092	2.0	0	0	0.0%
Mount Edward #1 & #2	45,456	10.0	39,380	8,674,009	86.6%
Akerley Boulevard	37,727	8.3	17,795	3,919,604	47.2%
Eastern Passage (Proposed) (Note 7)	Nil	nil	6,263	1,379,515	N/A
North Preston	1,659	0.37	1,113	245,154	67.1%
Total Volume (East Area):	93,934	20.7	64,551	14,218,282	68.7%
Satellite Systems					
Middle Musquodoboit Reservoir	275	0.06			
Aerotech Reservoir	4085	0.9			
Total Volume (Satellite Areas):	4,360	0.96			

Assumptions:

1 - Total Volume of Tank is Available for Use

2 - Fire Flow Assumed to be 3,000 USGPM for 3.0 hrs. Unless Otherwise Noted

3 - Residential Fire Flow Assumed to be 1,440 USGPM for 2.0 hrs. based on R-2 Wood Frame Duplex

4 - Total Serviced Population = 467,527 Persons (vs. Target = 477,444 in 2010)

219,655 Persons between 2010 and 2046

164,455	Total increase in Residential serviced Population
5,215	excess population

5 - Herring Cove Tank Volume (Herring Cove Water and Sewer Services Study - CBCL (May 2004))

6 - Bedford South Tank Volume recommended by CBCL

7 - Eastern Passage Tank Volume based on ultimate pop. of 14,400 persons (GENIVAR 2011)

9.5 ANALYSIS OF FUTURE WATER STORAGE REQUIREMENTS

As part of the IRP, GENIVAR has investigated the future water storage requirements of the long-term (2046) populations within each of the service areas across HRM. The long-term (2046) capacity requirements of each existing storage reservoir and several new reservoirs have been estimated based on population growth projections provided by HRM Planning and regional fire flow requirements within suburban areas with significant new developments.

9.5.1 New Storage Reservoir

Currently, Halifax Water has plans to construct new water storage reservoirs to meet the future storage requirements within the communities of Bedford South, Herring Cove and Eastern Passage, which are not currently provided with reservoir storage.

Bedford South Reservoir (Future) – The Bedford South Service Area is one of the fastest growing residential and commercial communities in HRM, providing future water services to more than 60,000 persons from the adjacent Pockwock Water Transmission Main system. Based on a water servicing study completed by CBCL Ltd, the volume of reservoir storage required to service the Bedford West distribution network is 19.885 ML (4.38 Million imperial gallons) to be located adjacent the Larry Uteck Interchange.

Herring Cove Reservoir (Future) – The community of Herring Cove, located near the entrance to Halifax Harbour is a fast growing suburban fishing community that is provided with potable water by a single water transmission main located in the Herring Cove Road. Due to the risk associated with the single transmission main serving the community and the anticipated residential growth anticipated, a water storage reservoir has been recommended for construction in the near future. Based on the Herring Cove Water and Sewer Services Study completed in 2004 by CBCL Ltd., the recommended volume of the proposed water storage reservoir is 7.718 ML (1.7 million imperial gallons) to be located on a hill within the community of Herring Cove.

Eastern Passage Reservoir (Future) – The community of Eastern Passage, located along the eastern shore of Halifax Harbour near Dartmouth, is serviced with potable water through a single 400 mm water transmission main located in Pleasant Street and extending from the Dartmouth supply. While the community is largely developed, there is still room for additional development and Halifax Water has a plan to construct a new water storage reservoir to serve the community. The volume of storage required to serve the long-term (2046) population is estimated at 6.26 ML (1.38 million imperial gallons). The location for this new reservoir has yet to be finalized.

9.5.2 Marginal Storage Requirements

The provision of an adequate volume of reservoir storage within a community is essential to the operation of the water distribution system throughout a wide range of operational conditions, including normal daily variations in peak demand, and extraordinary conditions such as fire flow and emergency conditions such as loss of water treatment and transmission capacity. Calculation of reservoir storage volume within a service area is complicated by the interconnectivity of the overall water distribution system, since water may be drawn from neighbouring areas or from the water transmission system to reinforce the supply in a particular situation. As shown in Table 9.2, Halifax Water has been rigorous in their efforts to provide an adequate volume of reservoir storage within every service area, with many of the reservoirs having double the volume required in the future (2046). In fact, nearly all of the existing storage reservoirs have more than adequate volume to meet the long-term future (2046) storage requirements, with the following minor exceptions.

Waverley Reservoir – The Waverley water supply system was originally designed to serve a limited suburban residential population located within the watershed of the sensitive Shubenacadie Lake System. Due to concerns regarding the potential impact of urban development on water quality in this precious natural fresh water system, over the past thirty (30) years or more, the City has deliberately restricted development within the Shubenacadie Lakes Watershed. To this end, the capacity of the Waverley water distribution system was limited to the provision of potable water for domestic consumption, but without capacity for fire protection.

The current Waverley Water Storage Reservoir has sufficient capacity to meet the requirements of the future (2046) serviced population with fire protection required for single family residential development only. It is recognized that the existing distribution system is not intended to provide fire protection, however, limited capacity does existing in the existing reservoir to provide this limited fire flow.

Meadowbrook Reservoir – The Meadowbrook Storage Reservoir, which serves the community of Bedford, as well as acting as a backup supply to the communities of Lower and Middle Sackville, appears to have inadequate volume to meet the long-term (2046) storage requirements of the service area, however, the future construction of a new large diameter water transmission system adjacent the Lucasville Road will provide a second supply into Lower and Middle Sackville and the Fall River Service Area. In addition, the proposed new Bedford South Storage Reservoir, located at the Larry Uteck Interchange, will reduce the storage requirements from the Meadowbrook Storage Reservoir.

Cowie Hill Reservoir – The Cowie Hill Reservoir, which serves the communities located in Mainland South from Spryfield to Herring Cove, has adequate capacity to serve the future (2046) population within the current service area. The proposed construction of the water storage reservoir in Herring Cove will relieve the Cowie Hill Reservoir of a portion of its direct service area. Therefore, there will be no need to expand the Cowie Hill Reservoir in the foreseeable future.

Mount Edward Reservoirs (#1 and #2) – The two Mount Edward Water Storage Reservoirs (#1 & #2) are the centrepiece of the Mount Edward Water System, with the majority of the water consumed in the Lake Major System being delivered to their location. The capacity of these two reservoirs is adequate to meet the long-term (2046) requirements of the service area. Halifax Water currently plans to replace the older Gunnite storage tank with a new steel tank in the near future. Considering the long lifespan of a storage reservoir (more than 75 years), Halifax Water may wish to revisit the storage capacity requirements of the Mount Edward Storage System before the tank is replaced to ensure that there will adequate capacity for the longer term.

9.5.3 System Security and Regional Storage Requirements

The history of the water supply systems in the Greater Halifax Area May be characterized as a continual expansion from small independent local water supplies toward a fully integrated regional water supply system. Currently, the Pockwock Water Supply System (West and Central Areas) and the Lake Major Water Supply System (East Area) are largely independent with the exception of their limited capacity to deliver water across the Harbour on the MacDonald Bridge. In the interest of enhanced system security, Halifax Water is currently developing a long-term plan to construct a series of Priority Water Transmission Main projects that will reinforce the capacity of the transmission system to deliver limited supply from one system to the other. Preliminary analysis of the potential capacity of these transmission main projects to meet normal (average day) demands within the whole of HRM have indicated that these projects will significantly increase the security of supply across the system. Subsequent to the completion of the completion of the Integrated Resource Plan (IRP), it is recommended that Halifax Water continue to work toward the preparation of a Regional Water System Functional Plan that will define a path forward toward a more integrated regional system capable of meeting water demands during major emergencies that restrict the capacity of one of the two major water treatment or transmission main systems. The availability of the Integrated Network Model prepared during the IRP (GENIVAR 2012) will allow Halifax Water to investigate the dynamics of the integrated water transmission system operating under a variety of emergency scenarios to meet the water demands across the system.

10. REFERENCES

10.1 REPORTS

2006-2010 Annual Water Systems Reports, by Halifax Water

Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems (September 2004 prepared by CBCL) available at http://www.gov.ns.ca/nse/water/docs/WaterSystemGuidelines.pdf

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Halifax Water Two year Business Plan 2010/11 and 2011/12 Appendix B.1 Water Services Approved by Halifax Water Board February 18, 2010

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IRP Overview of Water System Drivers Presentation on August 25, August 2011

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Middle Musquodoboit Surface Water Small System Upgrade issued for Approval Design Brief by CBCL Limited July 2008

Miller Lake System Assessment Report for Water Works by CBCL Limited March 2004

Pockwock System Assessment Report for Water Works by CBCL Limited April 2004

Silver Sands System Assessment Report for Water Works by CBCL Limited March 2004

10.2 DRAWINGS

As-Built CAD drawing by THE TAP GROUP, The Atlantic to Pacific Water Group, April 1997 for the Lake Major Water Supply Plant

Halifax County Industrial Commission AEROTECH BUINESS PARK WATER TREATMENT PLANT As build drawings, UMA Engineering LTD and Gore & Storrie Limited, November 1985

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10.3 WEBSITES

Five island Small System Source Water protection Plan, November 2010, Halifax Water, http://www.halifax.ca/hrwc/documents/FiveIslandSWPPWebsite.pdf

Item No. 9.1 Halifax Regional Municipality, Subject Hillside Water Utility Upgrade (Local improvement Charge), Beaumont Subdivision, Elmsdale, http://www.halifax.ca/council/agendasc/documents/090428ca91.pdf

Water Treatment Facilities Small systems http://www.halifax.ca/hrwc/TreatmentFacilities1.html#five

Appendix A – J. Douglas Kline Water Supply Plant – Description of Works

Table A.1 – Intake Structure Properties (A concrete abutment adjacent to Pockwock Lake)

Materials of Construction	Concrete, steel screen
Dimensions	3 openings at 2.744m wide by 3.280m high
Capacity	It is an opening
HRT	It is an opening
Flow Control	Lake, gravity, sluice gates
Inlet	Pockwock Lake
Outlet	2.5m wide, 10.5m high, and 7.8m long channel to wet well
Elevation	113m
Make/Model	
UTM co-ordinates	433208.768E, 4958979.750N
Date of Const./Modification	1975-1977

Table A.2 – Intake Line to Wet Well (3 lines)

Materials of Construction	Concrete
Dimensions	2.5m wide, 10.5m high, and 7.8m each
Capacity	205m^3 each line
HRT	1.3min at plant capacity
Flow Control	Sluice gates, gravity
Inlet	Sluice gate between intake structure
Outlet	Sluice gate before wet well
Elevation	Same as Pockwock Lake
Make/Model	
UTM co-ordinates	Same as intake structure
Date of Const./Modification	1975-1977

Table A.3 – (Wet Well) Low Lift Chamber/Raw Well Properties

Materials of Construction	concrete
Dimensions	5.4m wide, by 14.5m long
Capacity	Varies from 315,500L to 811,200L depending of water level (wet well top water elevation of 170.08m)
HRT	Plant Capacity(220MLD) – 2.0 min – 5.1 min Daily Average (110MLD)– 4.1min – 10.6min
Flow Control	Sluice gate
Inlet	2.5m wide, 10.5m high, and 7.8m long channel
Outlet	6 lift pumps to processing plant
UTM co-ordinates	Same as intake structure
Date of Const./Modification	1975-1977, Inspected in 2003 was found to be in good condition

Table A.4 – Low Lift Pump Properties (6 pumps)

Capacity	With all 6 pumps operating – 254.5MLD
Power	Pumps No. 1, 3, 6: 526L/s at 74.7m TDH, 520kW, 1775 rpm Pumps No. 2, 4, 6: 190L/s at 76.2m TDH, 186kW, 1775 rpm Vertical Turbine by Peerless
Flow Control	Continuous, set by operator
Inlet	Wet well 5.4m wide, by 14.5m long
Outlet	Transmission main to water supply plant, 1000m of 1200mm(48”) diameter Hyprescon pressure pipe
Make/Model	Pumps 1, 2: U.S. Motor, all other pumps: Tamper/Canron
UTM co-ordinates	Same as intake structure

Table A.5 – Rapid-Mix Tank Properties (3 Tanks)

Materials of Construction	Concrete
Dimensions	4.3m by 4.3m by 12.2m each tank
Capacity	226m^3 for each tank,
HRT	1.5min per tank at 227MLD
Flow Control	Pumps at pump house
Inlet	60”x48”(1.5mx1.2m)concentric reducer from transmission line from pump house(60in diameter pipe)
Outlet	Over a weir to a 48’(1.2m) diameter pipe, where there is 4 opening for each floc train
Top Water Elevation	175m
Mixer Make/Model	
UTM co-ordinates	WSP – 433765.778E, 4958311.177N
Date of Const./Modification	1975-1977

Table A.6 – Flocculation Tank Properties (4 trains)

Materials of Construction	concrete
Dimensions	5mx5mx7.8m for each cell
Capacity	1,170 m^3 per train (195 m^3 per cell)
HRT	30min per train at 227MLD
Flow Control	24’ (0.6m)motorized butterfly valve
Inlet	24‘(0.6m)diameter concrete pipe
Outlet	36‘ by 48‘ (0.9m by 1.2m)slide plate
Top Water Elevation	174m
Make/Model	
UTM co-ordinates	Same as WSP
Date of Const./Modification	1975-1977

Table A.7 – Filter Tank Properties (Rapid Sand Filter)

	Filters (8)
Materials of Construction	Concrete walls and floor
Dimensions	28ft by 56ft (8.5m by 17m)
Capacity	1,193m^3/hr(at 227 MLD)
Velocity	8.2m/hr at 227 MLD (surface loading rate)
HRT	1 hr at 227MLD
Flow Control	Motorized value(set by operator)
Inlet	36‘ by 36‘ (0.9m by 0.9m) sluice gate
Outlet to Drain	Trough to 20”(0.50m) diameter pipe
Outlet to Clear Well	60’x72’(1.5m by 1.8m) sluice gate
Make/Model	Backwash pump: Split Case Centrifugal, by Worthington (Tamper/Canron) Rating at 920L/s at 12.2 TDH
UTM co-ordinates	Same as WSP
Date of Const./Modification	1975-1977

Table A.8 – Filter Bed Properties

	Filters
Surface Area	143.1m^2 per filter
Anthracite depth	609.7mm
Sand depth	304.8mm
Support media	Gravel(75mm of ES3.36 – 6.35mm, 75mm of ES 6.35 – 12.7, 100mm of ES 12.7 – 19mm)
Effective Openings	Not specified
Strainer system	Leopold SuperBlock II

Table A.9 – Backwash Cycle

Steps	Description	Duration
1 - surface wash	Leopold agitators, 8 arms per filter, 32 nozzles per arm	Varies
2 - backwash low	Backwash pump 1 (200hp) at 60%	Varies
3 - backwash high	Backwash pump 1(200hp) turns up to 100%, backwash pump 2 turns on to 100%	Varies
4 - backwash low	Backwash water pump 1 turns off, backwash pump 2 goes to 60%	Varies
5 - drain	Water drains	Varies
	Total Time	8-10min
Filter ripping	Takes 1hr to prime the filter (depending on turbidity) before it is ready to use again	

Table A.10 – Clear Well Properties

Materials of Construction	Concrete (dual compartment, west and east compartment – west clear well receives filtered water from the "west bank" of filters, east clear well receives filtered water from the "east bank" of filters)
Dimensions	
Capacity	4,545 m^3(for both clear wells)
HRT	30min based on plant capacity of 220MLD(based on total volume of both clear wells)
Flow Control	Filtration rate
Inlet	30inh(0.762m) diameter pipe off of filters
Outlet	1.8m by 1.5m sluice gate
Overflow Elevation	167m
Make/Model	
UTM CO-ORDINATES	Same as WSP
Date of Const./Modification	1975-1977

Table A.11 – Service Water Pumps High Lift Pump Properties

Materials of Construction	
Dimensions	
Capacity	
HRT	
Flow Control	
Inlet	
Outlet	
Elevation	
Make/Model	
UTM co-ordinates	Same as WSP
Date of Const./Modification	1975-1977

Appendix B – Lake Major Water Supply Plant – Description of Works

Table B.1 – Intake Structure Properties

Materials of Construction	Concrete chambers with screens
Dimensions	Two parallel concrete chambers, 4m high, 1.7 wide, 4.7 m long each
Capacity	$32m^3$ each ($64m^3$ total)
HRT	1min based on the plant capacity of $90,800m^3$/day
Flow Control	sluice gate
Inlet	Lake Major
Outlet	Sluice gate, Wet well
Elevation	15.15m
Make/Model	
UTM co-ordinates	462093.2E, 4952103.8N
Date of Const./Modification	()1999

Table B.2 – Low Lift Chamber/Raw Well Properties (Wet Well)

Materials of Construction	concrete
Dimensions	2.1m wide, 14.8m long, 4.5m high
Capacity	$140m^3$
HRT	2.24min based on the plant capacity of $90,000m^3$/day
Flow Control	butterfly valve
Inlet	Two parallel concrete chambers from Lake Major
Outlet	Low lift pumps
UTM co-ordinates	Same as intake structure
Date of Const./Modification	()1999

Table B.3 – Low Lift Pump Properties (4 pumps)

Capacity	
Power	3 pumps at 22,222Lpm(32MLD)vertical turbine, 1 pump 11,111Lpm(16)
Flow Control	operator
Inlet	Wet well
Outlet	600mm diameter header then to a 1050mm diameter, 484m long raw water main to WSP,
Make/Model	Same as intake structure
UTM co-ordinates	

Table B.4 – Rapid-Mix Tank Properties (2 basins)

Materials of Construction	Concrete
Dimensions	6.4m by 6.4m by 5.2m
Capacity	$214m^3$ per basin (Design G-Value – $250s^{-1}$)
HRT	4.02min per basin at designed flow
Flow Control	raw water value(butterfly valve), control by the low-level lift tanks
Inlet	1050mm diameter raw water main
Outlet	0.91m diameter pipe
Top Water Elevation	
Mixer Make/Model	
UTM co-ordinates	461745.8E, 4951639.2N (WSP)
Date of Const./Modification	1999

Table B.5 – Upflow Sludge Blanket Clarification (2 parallel trains)

Materials of Construction	
Dimensions	20.1m length, 14.9m width, 4.85m deep per train
Capacity	$1,452m^3$ per train
HRT	42 min at the max flow of
Flow Control	Effluent weirs and control values
Inlet	0.91m diameter pipe
Outlet	At the bottom of the clarifier, the effluent discharger to a header which leads to an open effluent channel that splits off into four (4) for the filters
Top Water Elevation	
Make/Model	Degremont UltraPulsators
UTM co-ordinates	Same as WSP
Date of Construction/ Modification	1999
Surface Area	$233m^2$ per train
Water Depth	4.85m
Settling area	$247.6m^2$

Table B.6 – Filter Tank Properties (Tri-media)

	Filter (4 parallel beds)
Materials of Construction	concrete
Dimensions	6.3m by 13.5m by 4.6m
Capacity	391m^3
Velocity	11.6m/hr (surface loading rate)
HRT	980.2m^3/hr (max flow rate per train)
Flow Control	Filter effluent valve (at each filter)
Inlet	Open effluent channel from up flow sludge blanket clarifier
Outlet to Drain	valve
Outlet to Clear Well	filter plenum
Make/Model	
UTM co-ordinates	Same as WSP
Date of Const./Modification	1999

Table B.7 – Filter Bed Properties

	Filter
Surface Area	84m^2 per filter
(ES 1.0mm) Anthracite Depth	560mm
0.45mm to 0.55mm Sand Depth	225mm
0.2 to 0.32mm Garnet Depth	75mm
1.5mm Garnet (support) Depth	125mm
Support media	1.5mm Garnet support
Effective Openings	
Strainer system	Media strainers on poured concrete plenum

Table B.8 – Backwash Cycle (Upflow water washing and air scour)

Steps	Description	Duration
1 - surface wash (air scour)	Start air blower, air meter is at 95% and 7lbs of pressure	2 – 5min 1 – 2min for air bubbles to purge
2 - backwash low	Backwash pump one at 36m^3 when valve is completely open	
3 - backwash high	Start backwash pump two, once fully open the yield of the two backwash pumps is 56m^3.	Approximately 5min
4 - backwash low	Stop pump two, start closing the backwash rate control valve to 30%, stop pump one when pump two has stopped completely.	Approximately 1.5min to shut down pumps
5 - drain	Close backwash rate control valve, filter backwash valve, backwash drain valve.	

Table B.9 – Clear Well Properties (two underground clear wells contacted by a 900mm butterfly valve with the invert 100mm above the floor of the clear well)

Materials of Construction	concrete
Dimensions (for each clear well)	17.65m wide, 50m long, max water depth of 5m
Capacity	4,412.5m^3 (each clear well)
HRT	141.2min for both clear wells based on plant capacity of 90,800m^3/day
Flow Control	filtration
Inlet	900mm diameter stainless steel pipe
Outlet	Two of three 1,372mmx1,372mm sluice gates to high lift pump wet well
Overflow Elevation	5m to a collection manhole
Make/Model	
UTM CO-ORDINATES	Same as WSP
Date of Const./Modification	1999

Table B.10 – High Lift Pump Properties

Materials of Construction	
Dimensions	5.5m by 6.4m by 20m – 880m^3
Capacity	1 pump at 10,555 Lpm (15.2MLD), 3 pumps at 21,042 Lpm (30.3MLD) (all pumps operating, total design peak flow is 62,500Lpm(90MLD)))
HRT	11min
Flow Control	Sluice gate/pumps
Inlet	Two of three 1, 372mm x 1,372mm sluice gates from clear well
Outlet	900mm diameter pipe to distribution system
Elevation	68.00m
Make/Model	
UTM co-ordinates	Same as WSP
Date of Const./Modification	1999

Appendix C – Bennery Lake Water Supply Plant – Description of Works

Table C.1 – Intake Structure Properties (cylindrical coarse intake screen)
Intake at the bottom of the lake, 13m below water level, and 100m off shore

Materials of Construction	
Dimensions	
Capacity	
HRT	
Flow Control	Manuel , on/off operation
Inlet	Bottom of Bennery Lake
Outlet	Wet well for low level lift pumps
Elevation	Intake at the bottom of the late at 50.54m above sea level (Lake level is 63.76m)
Make/Model	
UTM co-ordinates	Bennery Lake 455207.4E, 4971051.5.6N
Date of Const./Modification	

Table C.2 – Intake Line to Wet Well (dual chamber wet well)

Materials of Construction	Polyethylene pipe
Dimensions	355mm, and approximately 100m from shore
Capacity	
HRT	
Flow Control	
Inlet	Bennery Lake
Outlet	Wet Well
Elevation	
Make/Model	
UTM co-ordinates	
Date of Const./Modification	

Table C.3 – Wet Well (two raw water wet wells that are parallel)

Materials of Construction	
Dimensions	
Capacity	
HRT	
Flow Control	Manuel , on/off operation
Inlet	Bottom of Bennery Lake
Outlet	Wet well for low level lift pumps
Elevation	Bottom of pump chamber is 58m
Make/Model	
UTM co-ordinates	
Date of Const./Modification	

Table C.4 – Low Lift Pump Properties

Power	Each raw water wet well (two pumps in total) has a 30hp (2,160m^3/day), one (1) wet well has a second pump with a capacity of 4,300m^3/day (this pump is used most often)
Flow Control	Operator, on or off
Inlet	Bottom of Bennery Lake
Outlet	200mm diameter raw water transmission pump
Make/Model	
UTM co-ordinates	Same as Bennery Lake

Table C.5 – Rapid-Mix Tank Properties

Materials of Construction	Concrete
Dimensions	2.4m x 2.4m x 5m
Capacity	29m^3
HRT	5min per tank at design flow(7,950m^3)
Flow Control	300mm diameter butterfly value
Inlet	300mm diameter pipe(there is a reducer 300x200mm from the raw water transmission pipe)
Outlet	300mm pipe that splits into three (3) 150mm diameter pipes for the floc tanks
Top Water Elevation	84.51m
Mixer Make/Model	
UTM co-ordinates	455264.5E, 7970712.6N (WSP)
Date of Const./Modification	Commissioned: 1987

Table C.6 – Flocculation Tank Properties (3 trains with 3 chambers each) Hydraulic Flocculation

Materials of Construction	Concrete
Dimensions	2.1m x 2.1mx 4.5m per chamber
Capacity	20m^3 per chamber
HRT	33min at plant capacity
Flow Control	operator
Inlet	150mm diameter pipe (for each train)
Outlet	Sluice gate
Top Water Elevation	84.30m
Make/Model	
UTM co-ordinates	Same as WSP
Date of Const./Modification	Commissioned: 1987

Table C.7 – Clarification Design Values (2 clarifiers)

Type	Plate Settling
Dimensions(each)	8m by 4m by 5m
Capacity(each)	100m^3
Sludge hopper depth	2.8m
Maximum Flow (each)	3.8MLD
Overflow rate	8.3m/hr
Flow Control	operator
Inlet	Sluice gate
Outlet	400mm diameter effluent pipe
Top Water Elevation	85.1m
Make/Model	
UTM co-ordinates	Same as WSP
Date of Const./Modification	Commissioned: 1987

Table C.8 – Filter Tank Properties (2 filters)

Materials of Construction	Concrete walls
Dimensions	3.65mx7.3mx4.2m each filter
Capacity	204m^3
Velocity	6.2m/hr based on design rate
HRT	37min based on design rate of 7,950m^3/day
Flow Control	400mm diameter motorized butterfly value
Inlet	400mm diameter pipe
Outlet to Drain	300mm diameter pipe
Outlet to Clear Well	150mm stainless steel orifice tubes to 500mm diameter stainless steel pipe
Make/Model	Backwash pump: two vertical turbine pumps at 9,600Lpm from each clear well chamber
UTM co-ordinates	Same as WSP
Date of Const./Modification	Commissioned: 1987

Table C.9 – Filter Bed Properties

	Filters
Surface Area	27m^2 each filter
Anthracite effective grain size	0.5 to 3.36mm
Anthracite depth	600mm
Sand effective grain size	#2 – 0.354 to 1.41mm #1 – 1.19 to 2.38mm
Sand depth	#2 – 300mm #1 – 75mm
Support media Gravel Effective grain size	#3 – 3.36 to 6.35mm #2 – 6.35 to 12.7mm #1 – 12.7 to 19mm
Support media Gravel depth	#3 – 75mm #2 – 75mm #1 – 100mm
Strainer system	Leopold title
Water Height Above media	1.65m

Table C.10 – Backwash Cycle

Steps	Description	Duration
1 - surface wash	2 arms spray treated water to top of media	5-10min varies depends on season
2 - backwash low	Low rate pump turns on at 15MLD	2-3min, until air is out of the filter
3 - backwash high	Surface wash is shut off, high rate pump is turn on at 30MLD	~3min until water clears up
4 - backwash low	Low rate pump at 15MLD and then stepped down to 9MLD	3-4min
5 - drain	Water to drains	2-3min

Table C.11 – Clear Well Properties (2 clear wells)

Materials of Construction	concrete
Dimensions	1. 3.0m x 20.7m x 6.1m, 2. 3.9m x 20.7m x 7.5m* (*height is approximation due to the bottom being at a 0.5% slope
Capacity	381m^3 2. 604m^3
HRT	1.70min, 2. 110min (based on a design capacity of 7950m3/d)
Flow Control	The two clearwells are connected hydraulically with a 300mm gate valve
Inlet	500mm diameter stainless steel pipe
Outlet	High lift pumps (directly done from clear well)
Overflow Elevation	80.30m
Make/Model	
UTM CO-ORDINATES	Same as Aerotech water supply plant
Date of Const./Modification	Commissioned: 1987

Table C.12 – High Lift Pump Properties (clearwell to Aerotech reservoir)

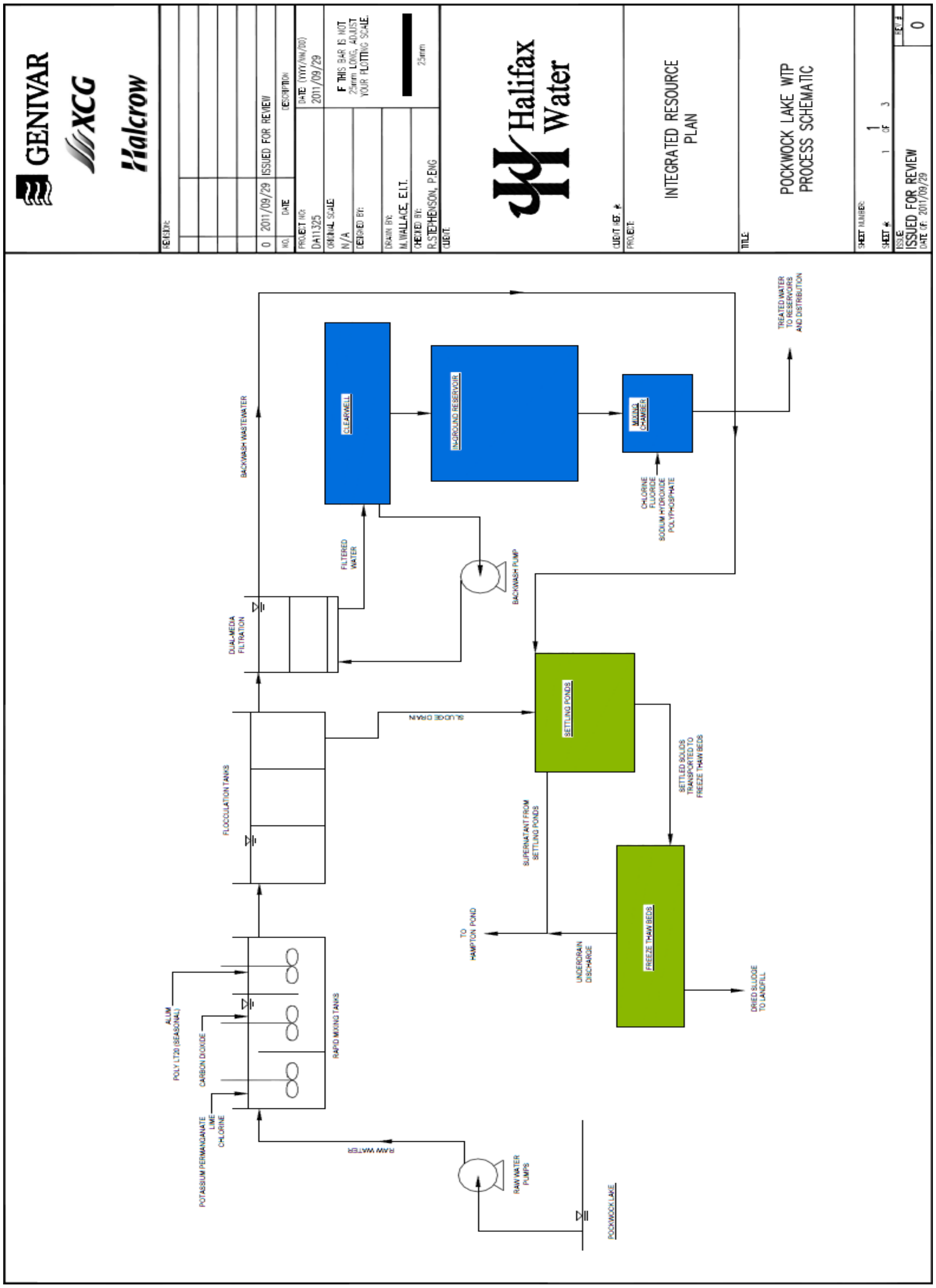
Materials of Construction	n/a
Dimensions	n/a
Capacity	Chamber 1. 832Lpm and a 5,270Lpm pump, chamber 2. 3,122Lpm
HRT	Distribution demand
Flow Control	Distribution demand
Inlet	Clear well
Outlet	350mm diameter transmission line that is 2,400m long to the Aerotech Reservoir
Elevation	80.90m
Make/Model	
UTM co-ordinates	Same as Aerotech water supply plant
Date of Const./Modification	Commissioned: 1987

Table C.13 - Aerotech Reservoir

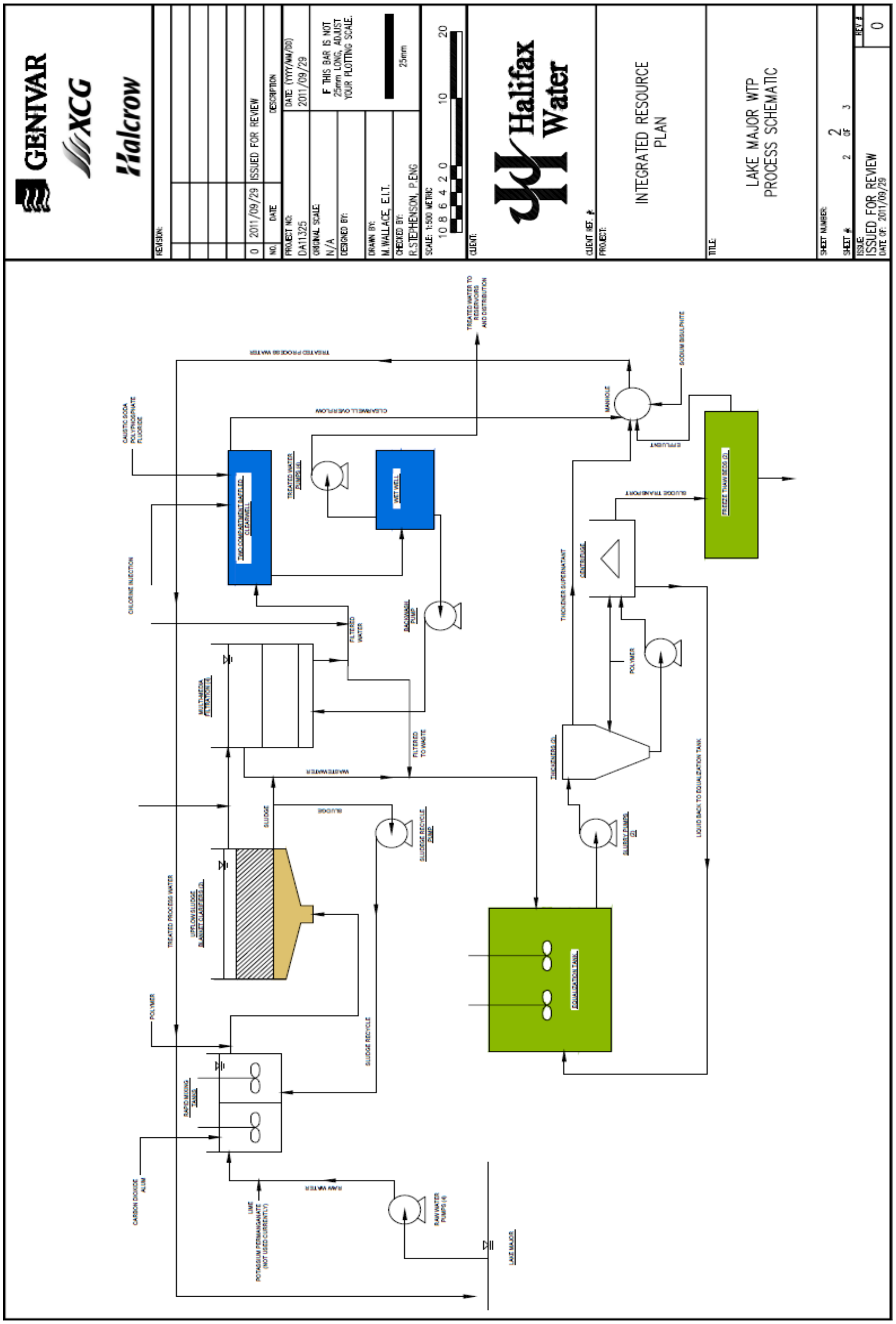
Materials of Construction	G.40.21-44 W Steel
Dimensions	19.5m diameter, 14m height
Capacity	4.085m^3
HRT	Distribution demand
Flow Control	Distribution demand
Inlet	350mm diameter transmission line that is 2,400m long to the Aerotech Reservoir ()
Outlet	Distribution system
Elevation	175m
Make/Model	
UTM co-ordinates	456233.5E, 4968452.9N
Date of Const./Modification	Constructed 1986, 2009 new exterior isolation valves on inlet/outlet lines, 2010 new security system

Appendix D – Process Flow Schematics

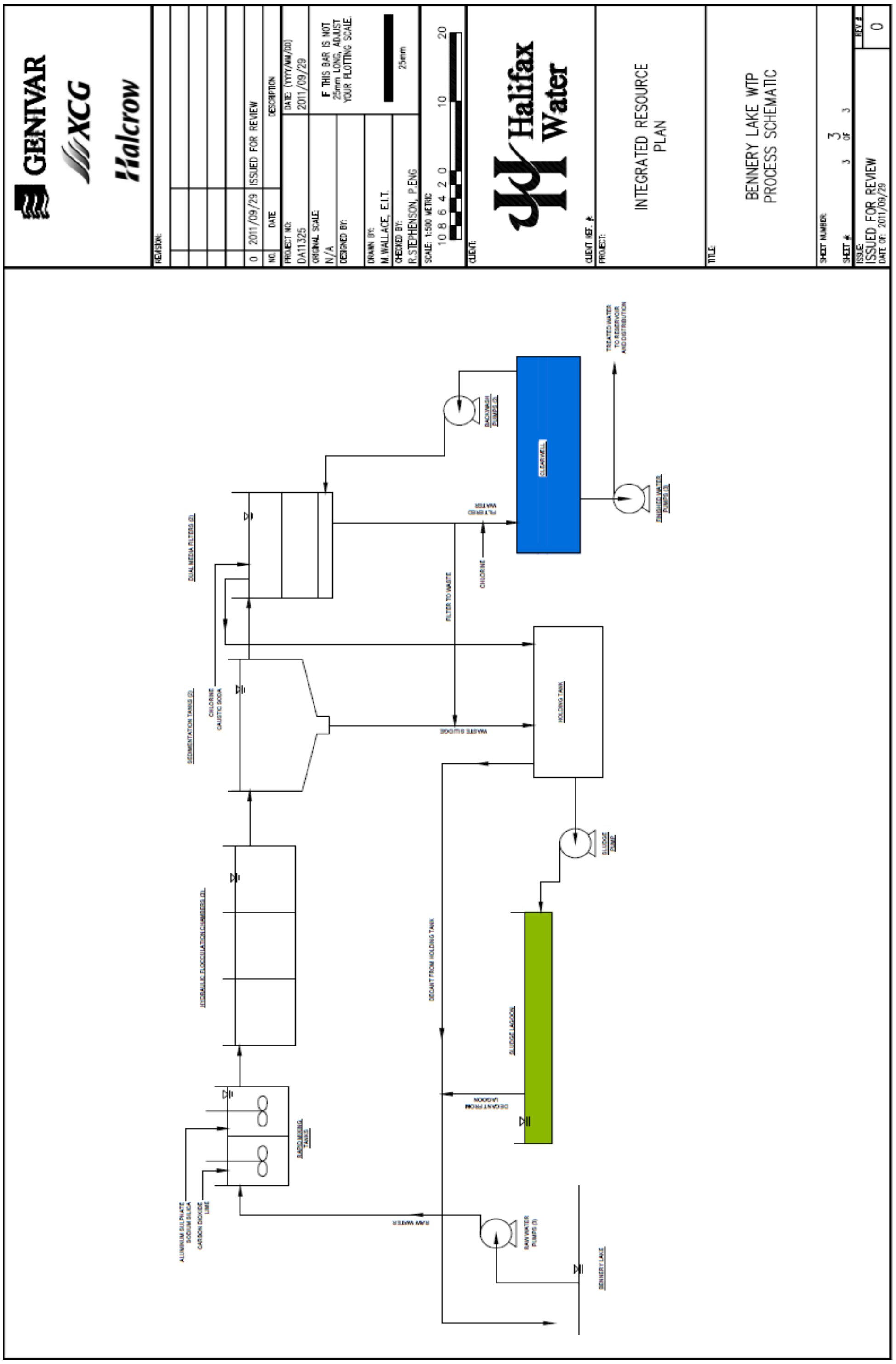
PROCESS DIAGRAM OF THE J.D. KLINE WSP



PROCESS DIAGRAM OF THE LAKE MAJOR WSP



PROCESS DIAGRAM OF THE BENNERY LAKE WSP



Appendix E – Reference Calculations

Reference Calculations
J.D. Kline WSP
Interconnecting Piping – Raw Water Transmission Line

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{2.6m^3/_s}{(1.2m)^2}\right) = 2.3m/s$$

Where
v=velocity (m/s),
q=volume flow at design capacity is 227MLD (2.6m^3/s)
d=diameter of pipe which is 1.2m

Interconnecting Piping – Rapid Mix to Flocculation
Note: there are four (4) trains for flocculation, (assuming equal flow to each)

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{2.6\frac{m^3}{s}/4}{(0.6m)^2}\right) = 2.3m/s$$

Where
v=velocity (m/s),
q=volume flow at design capacity is 227MLD – 2.6m^3/s / 4 filter trains,
d=diameter of pipe which is 0.6m

Flocculation Tanks Reference Calculations
Reference calculations
Flow through velocity

$$v = \frac{q}{A} = \frac{2.6\frac{m^3}{s}/4}{5m*7.8m} = 0.016m/s$$

Where
V= velocity
q= flow rate per flocculation train
A= area of flow through in floc tank (5m by 7.8m)

Interconnecting Piping – Slide Gate from Flocculation
Flocculation slide gate (coming out of flocculation train)

$$v = \frac{q}{A} = \frac{2.6\frac{m^3}{s}/4}{.9*1.2} = 0.6m/s$$

Where
V= velocity
q= flow rate per flocculation train
A= area of slide gate (.9m by 1.2m)

Interconnecting Piping – Sluice Gate going into Filters

$$v = \frac{q}{A} = \frac{\frac{2.6\frac{m^3}{s}}{8}}{.9*.9} = 0.4m/s$$

Where
V= velocity
q= flow rate per filter (8)
A= area of sluice gate (0.9m by 0.9m)

Interconnecting Piping – Intake to Clearwell Velocity Limitations

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{2.6m^3/_s}{(0.762m)^2}\right) = 5.70m/s$$

Where
v=velocity (m/s),
q=volume flow=@design capacity is 227MLD – 2.6m^3/s,
d=diameter of pipe which is 0.762m (30inh)

Lake Major WSP
Interconnecting Piping – Raw Water Transmission Line

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{1.05m^3/_s}{(1.05m)^2}\right) = 1.2m/s$$

Where
v=velocity (m/s),
q=volume flow at the design capacity is 90.8MLD – 1.05m^3/s,
d=diameter of pipe which is 1.05m

Reference calculation
250s^{-1} is from the design g- value in the assessment report and Water Quality Master Plan.
Interconnecting Piping – Velocity into Clarifier Trains

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{(1.05\frac{m^3}{s})/2trains}{(0.91m)^2}\right) = 0.81m/s$$

Where
v=velocity (m/s),
q=volume flow=@design capacity is 90.8MLD – 1.05m^3/s/2 clarifier trains,
d=diameter of pipe which is 0.91m

Interconnecting Piping – Inlet to Clear well

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{(1.05\frac{m^3}{s})}{(0.90m)^2}\right) = 1.65m/s$$

Where
v=velocity (m/s),
q=volume flow at design capacity is 90.8MLD – 1.05m^3/s
d=diameter of pipe which is 0.9m

Bennery Lake WSP
Interconnecting Piping – Velocity in Raw Water Transmission Line

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{0.092m^3/s}{(0.3m)^2}\right) = 1.3m/s$$

Where
v=velocity (m/s),
q=volume flow=@design capacity is 7950MLD – 0.092m^3/s,
d=diameter of pipe which is 0.3m

Reference Calculation

$$G = \sqrt{\frac{P}{uV}} = \sqrt{\frac{1800W}{(.001308)(29m^3)}} = 220s^{-1}$$

Where P = power of mixture in water (3hp (2235W) mixer assuming 80% efficiency, is 1800W in water)
u=dynamic viscosity (0.001308Pa·s @ 10 degrees C),
V = volume of the tank (29m^3)

Note= Design Value is 250s^{-1} in the HRWC Bennery Lake – System Assessment Report for Water

Interconnecting Piping – Velocity from Rapid Mix to Flocculation Trains
Note: there are three (3) trains for flocculation, assuming equal flow to each

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{0.092\frac{m^3}{s}/3}{(0.15m)^2}\right) = 1.7m/s$$

Where
v=velocity (m/s),
q=volume flow at design capacity is 7950MLD – 0.092m^3/s / 3 filter trains,
d=diameter of pipe into each floc train is 0.150m

Reference calculations

Interconnecting Piping – Velocity Limitations in Floc Train
Chamber 1

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{0.031\frac{m^3}{s}}{(0.15m)^2}\right) = 1.7m/s$$

Where
v=velocity (m/s),
q=volume flow at design capacity of7.95MLD – 0.092m^3/s / 3 filter trains,(0.031m^3/s)
d=diameter of pipe into chamber 1 for floc train is 0.150m

Chamber 2

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{0.031\frac{m^3}{s}}{(0.25m)^2}\right) = 0.63m/s$$

Where
v=velocity (m/s),
q=volume flow at design capacity of7.95MLD – 0.092m^3/s / 3 filter trains,(0.031m^3/s)
d=diameter of pipe into chamber 2 for floc train is 0.250m

Chamber 3

$$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{0.031\frac{m^3}{s}}{(0.35m)^2}\right) = 0.32m/s$$

Where
v=velocity (m/s),
q=volume flow at design capacity of7.95MLD – 0.092m^3/s / 3 filter trains,(0.031m^3/s)
d=diameter of pipe into chamber 3 for floc train is 0.350m

Flocculation (sluice gate) to Clarification

$$v = \frac{q}{A} = \frac{\frac{0.092\frac{m^3}{s}}{3trains}}{.45m * .9m} = 0.76m/s$$

Reference Calculations for G-value
Chamber 1
H= head loss = 84.30-84.27=0.03m
T=V/q=20m^3/0.03m^3/s=670s

$$G = 12.7\sqrt{\frac{H}{t}} = 12.7\sqrt{\frac{0.03}{670}} = 0.08s^{-1}$$

Chamber 2
H= head loss = 84.27-84.250=0.02m
T=V/q=20m^3/0.03m^3/s=670s

$G = 12.7\sqrt{\frac{H}{t}} = 12.7\sqrt{\frac{0.02m}{670s}} = 0.07s^{-1}$

Chamber 3

H= head loss = 84.250-84.250=0m

T=V/q=20m^3/0.03m^3/s=670s

$G = 12.7\sqrt{\frac{H}{t}} = 12.7\sqrt{\frac{0}{670}} = 0s^{-1}$

Reference Calculation (surface overflow rate)

Design flow for WSP is 7.95MLD (with 2 clarifiers, the flow is 3.975MLD in each)

Area of application = length x width = 8m x 4m = 32m^2

Application rate = 165.6m^3/hr / 32m^2 = 5.17m/hr

Flow through basin

Area of application = length x width = 8m x 4m = 32m^2

Flow through basin = 7.95MLD/ (2*24*60) =2.76m^3/min

Flow through basin = 2.76m^3/min / 32m^2=0.069m/min

Interconnecting Piping – Velocity Limitations

Velocity out of clarification and into filtration

Note: there are two (2) trains for clarification,

$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{0.046\frac{m^3}{s}/2}{(0.4m)^2}\right) = 0.36m/s$

Where

v=velocity (m/s),

q=volume flow=@design capacity is 7950MLD – 0.092m^3/s / 2 clarification trains,

d=diameter of pipe which is 0.4m

Interconnecting Piping – Velocity Limitations

Filters to Clearwell

Note: there are two (2) filters,

$v = 1.274\frac{q}{d^2} = 1.274\left(\frac{0.092\frac{m^3}{s}/2}{(0.15m)^2}\right) = 2.0m/s$

Where

v=velocity (m/s),

q=volume flow=@design capacity is 7950MLD – 0.092m^3/s /2 filters,

d=diameter of pipe which is 0.150m (steel orifice tube)

Appendix F – Raw and Treated Water Quality Parameters from 2010

TYPICAL ANALYSIS OF THE THREE (3) LARGE WATER SUPPLY PLANT IN 2010/2011 (All data is in mg/L unless otherwise stated)								
	Bennery Lake WSP		**J.D. Kline WSP**		**Lake Major WSP**		**GCDWQ**	
Parameter	Raw	Treated	Raw	Treated	Raw	Treated	MAC	OC
Alkalinity (as $CaCO_3$)	<5	33.5	<1.0	19.0	<1.0	14.5	-	-
Aluminum	.130	0.05	0.147	0.066	0.222	0.054	-	*0.20/0.10
Ammonia (N)	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	-	-
Arsenic	<0.002	<.002	<0.001	<0.001	<0.001	<0.001	0.010	-
Calcium	2.5	9.2	1.1	4.2	1.0	6.6	-	-
Chloride	8	11.5	6.5	9.0	6.0	8.0	-	<250
Chlorate	0.7	0.2	<0.1	<0.1	<0.1	<0.1	1.0	-
Chlorite	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.0	-
Colour (TCU)	29	<5	1530	3.0	40.0	3.0	-	≤15.0
Conductivity (µmho/cm)	46	130	42	81.5	35.0	98.5	-	-
Copper (total)	0.56	0.024	0.043	0.002	0.145	<0.002	-	≤1.0
Fluoride	<0.1	<0.1	<0.1	0.60	<0.1	0.70	1.5	0.7-0.8
Hardness (as $CaCO_3$)	9	25	4.0	12.5	4.0	18.0	-	-
Hardness (grains)	-	-	0.3	0.9	0.3	1.3	-	-
HAA5 (avg.)	-	0.034	<0.005	0.062	<0.005	0.061	0.080	-
Iron (Total)	0.707	<0.05	<0.063	<0.050	0.164	<0.020	-	≤0.3
Langelier Index - @5°C	-	-	-4.8	-2.5	-5.4	-2.3	-	-
Langelier Index @60°C	-	-	-4.4	-2.2	-4.4	-2.0	-	-
Lead (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	10.0	-
Magnesium	0.6	0.55	0.4	0.46	0.42	0.42	-	-
Manganese (Total)	0.038	0.029	0.056	0.008	0.094	0.019	-	≤0.05
Mercury(µg/L)	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	1.0	-
Nitrate (as N)	0.075	0.06	0.06	0.06	0.06	0.06	10.0	-
Nitrite (as N)	<0.01		<0.01	<0.01	<0.01	<0.01	3.2	-
pH (pH units)	6.1	7.4	5.6	7.4	5.4	7.4	-	6.5-8.5
Potassium	0.3	0.41	0.3	0.4	0.4	0.4	-	-
Sodium	5	17	4.8	13.1	4.1	11.8	-	≤200
TDS	24	78	19.0	50.5	23.0	55.0	-	≤500
Sulphate	4	<0.02	4.0	9	3.0	16.0	-	≤500
Turbidity (NTU)	1.140	0.154	0.36	<0.1	0.35	<0.1	**0.02/0.5	≤5

TYPICAL ANALYSIS OF THE THREE (3) LARGE WATER SUPPLY PLANT IN 2010/2011 (All data is in mg/L unless otherwise stated)								
	Bennery Lake WSP		J.D. Kline WSP		Lake Major WSP		GCDWQ	
TOC	4.2	2.2	2.7	1.9	4.0	1.5	-	-
THMs (avg)	-	0.05	-	0.073	-	0.89	0.100	-
Uranium (µg/L)	<0.001	<0.001	<0.1	<0.1	<0.1	<0.1	20.0	-
Zinc (total)	0.016	0.114	0.009	0.102	0.006	0.078	-	≤5.0

*Aluminum objective relies on the type of plant filtration, for direct filtration (J.D.Kline WSP and Bennery Lake WSP) it is <0.20mg/L, conventional filtration (Lake Major WSP) it is 0.10mg/L

**0.2/0.5 means that the WSP must have water with a turbidity of <0.2NTU 90% of the and <0.5NTU 100% of the time (required by Provincial Permit)

GCDWQ- Guidelines for Canadian Drinking Water Quality
HAA5 – Haloacetic Acids
MAC – Maximum Acceptable Concentration
OC – Objective Concentrations
TDS – Total Dissolved Solids
THMs - Trihalomethanes
TOC – Total organic Carbon
WSP-Water Supply Plant

Data for Bennery Lake WSP from Appendix B of the 2010 Annual Drinking Water Systems Reports, and data for J.D. Kline WSP and Lake Major WSP from Halifax Water Typical Analysis (http://www.halifax.ca/hrwc/documents/20102011Pockwock-LakeMajor.pdf)

Data from Appendix B of the 2010 Annual Drinking Water Systems Reports,

*A new membrane WSP was commission in 2010 for Middle Musquodoboit and Collins Park, the average for the treated water test included data from both the old and new treatment systems

[i] Five Island Lake System Assessment Report for Water Works (March 2004) for Halifax Water from CBCL
[ii] Silver Sand System Assessment Report for Water Works. (March 2004) for Halifax Water from CBCL
[iii] Five Island Lake system Assessment Report for Water Works March 2004 for HRWC by CBCL
[iv] Collins Park System Assessment Report for Water Works march 2004 for HRWC by CBCL
[v] Collins Park Surface Water Small System Upgrade issued for Approval Design Brief July 2008 for Halifax Water by CBCL
[vi] Middle Musquodoboit system Assessment Report for Water Works March 2004 for HRWC by CBCL
[vii] Middle Musquodoboit Surface Water Small system Upgrade issued for Approval Design Brief July 2008 for Halifax Water by CBCL
[viii] Silver Sands System Assessment Report for Water Works march 2004 for HRWC by CBCL
[ix] Miller Lake system Assessment Report for Water Works March 2004 for HRWC by CBCL
[x] BoMont WTP issued for Review Documents June 2009, for Halifax Water by CBCL

VOLUME 3 – APPENDIX B

Wastewater Treatment Facility Review

VOLUME 3 – APPENDIX B-1

WP1.3: Wastewater Systems – Treatment Overview

WP1.3: WASTEWATER SYSTEMS – TREATMENT OVERVIEW
HALIFAX WATER INTEGRATED RESOURCE PLAN

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Tables

List of Acronyms

ADF	Average Day Flow
BOD	Biochemical Oxygen Demand
cBOD	Carbonaceous Biochemical Oxygen Demand
DO	Dissolved Oxygen
HHS	Halifax Harbour Solutions
HW	Halifax Water
NPS	National Performance Standards
NSE	Nova Scotia Environment
PTO	Permit to Operate
SBR	Sequencing Batch Reactor
TAN	Total Ammonia Nitrogen
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TRC	Total Residual Chlorine
TSS	Total Suspended Solids
UV	Ultra-Violet
UVT	Ultra-Violet Transmittance
WSER	Wastewater Systems Effluent Regulations
WWTF	Wastewater Treatment Facility

1. WP1.3: WASTEWATER SYSTEMS – TREATMENT

1.1 Background

This Working Paper summarizes a review of the existing conditions, historic performance and treatment capacity of fourteen wastewater treatment facilities (WWTFs) operated by Halifax Water (HW) in the Greater Halifax Region, namely:

- Halifax WWTF
- Dartmouth WWTF
- Herring Cove WWTF
- Lockview/MacPherson (Fall River) WWTF
- Middle Musquodoboit WWTF
- North Preston WWTF
- Uplands Park WWTF
- Steeves Subdivision (Wellington) WWTF
- Frame Subdivision (Waverley) WWTF
- Springfield Lake WWTF
- Mill Cove WWTF
- Eastern Passage WWTF
- Lakeside/Timberlea WWTF
- Aerotech WWTF

The overall objectives of the wastewater treatment review were as follows:

- Compile, review and summarize relevant information available regarding the design and current performance of each WWTF;
- Review capability of WWTF to meet the recently promulgated Wastewater Systems Effluent Regulations (WSER) requirements[1];
- Assess current operating performance for each WWTF in terms of meeting the existing required level of service and identify any existing capacity and performance limiting factors; and
- Identify the current hauled waste and biosolids handling practices and evaluate their potential impact on the overall performance of the wastewater treatment system.

Detailed information regarding the assessment of individual WWTFs can be found in Volume 3 Appendices B2 to B15. The following sections of this Working Paper summarize the results of the wastewater treatment review.

[1] "Wastewater Systems Effluent Regulations", Canada Gazette, Vol. 146 No. 15, June 2012

1.2 Existing Wastewater Treatment Facilities

1.2.1 Historic Performance and Compliance

Historic performances of the WWTFs were evaluated based on effluent quality data, as recorded in WaterTrax, and current Nova Scotia Environment (NSE) compliance requirements.

To determine current NSE compliance requirements for each WWTF, treatment requirements listed under the WWTFs Permit to Operate (PTO) were assumed. If no PTO requirements were listed or available, the current treatment requirements were based on Halifax Water treatment standards, as recorded in WaterTrax. If no treatment requirements were identified either in the PTO or WaterTrax, the Atlantic Canada Wastewater Guidelines (Environment Canada, 2006) values were used. A summary of the current compliance requirements for each WWTF is presented in Table 1.1.

Compliance with respect to the effluent requirements was evaluated based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data, as recorded in WaterTrax, was conducted for each WWTF to determine compliance with respect to the current effluent requirements. The results of this analysis are presented in Table 1.2.

Table 1.1 Summary of Current NSE WWTF Effluent Requirements

Parameter		Quarterly Effluent Requirements (Individual Sample Effluent Requirements)													
		Halifax WWTF	Dartmouth WWTF	Herring Cove WWTF	Lockview MacPherson WWTF	Middle Musquodoboit WWTF	North Preston WWTF	Uplands Park WWTF	Wellington WWTF	Frame WWTF	Springfield Lake WWTF	Mill Cove WWTF	Eastern Passage WWTF	Lakeside/ Timberlea WWTF	Aerotech WWTF
$cBOD_5$ (mg/L)		50 (100)	50 (100)	50 (100)	5 (10)	20 (40)	10 (20)	20 (40)	20 (40)	20 (40)	5 (10)	30 (60)	-	15 (30)	10 (20)
TSS (mg/L)		40 (80)	40 (80)	40 (80)	5 (10)	20 (40)	10 (20)	20 (40)	20 (40)	20 (40)	5 (10)	30 (60)	-	15 (30)	10 (20)
TP (mg/L)	Summer	-	-	-	-	-	1.5 (3.0)	-	-	-	-	-	-	1 (2)	2 (4)
	Winter													3 (6)	
PO_4-P (mg/L)	Summer	-	-	-	1.5 (3.0)	-	1.5 (3.0)	-	-	-	-	-	-	1 (2)	-
	Winter													3 (6)	
TAN (mg/L)	Summer	-	-	-	-	-	3 (6)	-	-	-	-	-	-	3 (6)	3 (6)
	Winter													5 (10)	
BOD_5 removal (%)		-	-	-	-	-	-	-	-	-	90	-	40	90	-
TSS removal (%)		-	-	-	-	-	-	-	-	-	90	-	50	-	-
Fecal coliforms (cfu/100 mL)		5,000 (10,000)	5,000 (10,000)	5,000 (10,000)	200 (400)	1,000 (2,000)	200 (400)	2,000 (4,000)	1,000 (2,000)	1,000 (2,000)	200 (400)	2,000 (4,000)	2,000 (4,000)	200 (400)	200 (400)
Fecal coliforms (quarterly geomean, cfu/100 mL)		10,000	10,000	10,000	400	2,000	-	-	2,000	2,000	-	4,000	4,000	-	400
pH		-	-	-	-	-	6.5 to 9	-	-	-	-	-	-	-	6.5 to 9
DO		-	-	-	-	-	-	-	-	-	-	-	-	> 5 (> 5)	-

Notes:
n/a – not applicable
$cBOD_5$ – five-day carbonaceous biochemical oxygen demand
TSS – total suspended solids
TP – total phosphorus
TAN – total ammonia nitrogen
DO – dissolved oxygen

Table 1.2 Summary of Historic WWTF Compliance with NSE Treatment Requirements

Parameter	No. of Quarters/Samples in Compliance/Total No. of Quarters/Samples in the Review Period													
	Halifax WWTF	Dartmouth WWTF	Herring Cove WWTF	Lockview MacPherson WWTF	Middle Musquodoboit WWTF	North Preston WWTF	Uplands Park WWTF	Wellington WWTF	Frame WWTF	Springfield Lake WWTF	Mill Cove WWTF	Eastern Passage WWTF	Lakeside/ Timberlea WWTF	Aerotech WWTF
Quarterly Treatment Requirements														
$cBOD_5$	0/2	3/4	3/3	6/10	10/10	10/10	6/6	8/10	4/6	6/10	6/6	-	6/6	6/6
TSS	2/2	2/4	3/3	1/10	8/10	4/10	6/6	1/10	5/10	4/10	5/6	-	2/6	0/6
TP	-	-	-	-	-	3/3	-	-	-	-	-	-	2/4	6/6
PO4-P	-	-	-	-	-	10/10	-	-	-	-	-	-	5/6	-
TAN	-	-	-	10/10	-	8/10	-	-	-	-	-	-	0/6	0/6
BOD_5 removal	-	-	-	-	-	-	-	-	-	9/10	-	3/6	6/6	-
TSS removal	-	-	-	-	-	-	-	-	-	7/10	-	5/6	-	-
Fecal coliforms	2/2	0/4	3/3	9/10	10/10	10/10	5/6	7/10	4/10	5/9	6/6	3/4	4/6	5/6
Fecal coliforms (geomean)	2/2	4/4	3/3	10/10	10/10	-	-	9/10	6/10	-	6/6	6/6	-	6/6
pH	-	-	-	-	-	0/10	-	-	-	-	-	-	-	6/6
DO	-	-	-	-	-	-	-	-	-	-	-	-	6/6	-
Individual Sample Treatment Requirements														
$cBOD_5$	117/125	223/234	177/177	230/248	124/124	120/120	35/35	55/55	32/33	103/123	347/347	-	214/216	214/215
TSS	124/125	176/238	176/178	136/244	118/120	108/112	35/35	28/55	47/55	93/125	375/376	-	227/228	198/236
TP	-	-	-	-	-	39/39	-	-	-	-	-	-	96/114	228/237
PO4-P	-	-	-	246/246	-	119/119	-	-	-	-	-	-	224/227	-
TAN	-	-	-	-	-	117/117	-	-	-	-	-	-	138/216	32/204
Fecal coliforms	129/129	229/234	174/178	229/245	122/122	123/123	31/34	47/54	34/55	76/104	354/371	168/211	193/222	216/230
pH	-	-	-	-	-	34/115	-	-	-	-	-	-	-	210/210
DO	-	-	-	-	-	-	-	-	-	-	-	-	221/227	-

Notes:

Results shown with a yellow background met treatment requirements for between 80% and 99% of quarters/samples; results with an orange background met treatment requirements for between 64% and 79% of quarters/samples; results shown with a red background met treatment requirements for less than 64% of quarters/samples.

Based on the detailed evaluation of historic performance of the WWTFs presented in Volume 3 Appendices B2 to B15, the following observations are made:

- Halifax WWTF:
  - The Halifax WWTF has consistently met the quarterly effluent requirements for TSS and fecal coliforms.
  - Effluent has consistently exceeded quarterly effluent requirements for $cBOD_5$.
  - The raw wastewater has historically been high in soluble cBOD, which cannot be removed using the DensaDeg process. According to HW's Compliance Plan, Oland's Brewery, which has been contributing significant soluble BOD loadings to the collection system, has indicated their intention to become compliant with the 300 mg/L BOD limit for sewer discharges, possibly reducing the influent soluble cBOD loading to the Halifax WWTF.
- Dartmouth WWTF:
  - The Dartmouth WWTF has consistently met the quarterly effluent requirements for fecal coliform geometric mean.
  - Effluent has consistently exceeded quarterly effluent requirements for TSS, fecal coliforms. Effluent $cBOD_5$ also occasionally exceeds effluent requirements.
  - Operations staff indicates that there are many industrial contributors and there have been spikes in influent pH and conductivity. In addition, the WWTF experiences reduced performance during wet weather flows, impairing solids separation. These may have contributed to the poor performance in terms of meeting effluent requirements.
- Herring Cove WWTF:
  - The Herring Cove WWTF has consistently met the quarterly effluent requirements for cBOD5, TSS, and fecal coliforms.
- Lockview/MacPherson WWTF:
  - The Lockview/MacPherson WWTF has consistently met quarterly effluent requirements for TAN and fecal coliforms.
  - Effluent has consistently exceeded quarterly effluent requirements for $cBOD_5$ and TSS.
  - Factors likely contributing to the poor effluent quality include the current configuration and operation of the equalization tank pumps, the design of the secondary clarifiers, and limited filtration capacity. See Section 1.2.3 for more information.

- Middle Musquodoboit WWTF:
  - The Middle Musquodoboit WWTF has consistently met effluent requirements in terms of $cBOD_5$ and fecal coliforms.
  - Effluent has occasionally exceeded quarterly effluent requirements for TSS, with the facility being in compliance 8 out of 10 quarters over the review period.
- North Preston WWTF:
  - Mechanical plant effluent samples are collected for compliance purposes for the North Preston WWTF, since no autosampler is currently installed to collect samples at the effluent of the engineered wetland.
  - The North Preston WWTF has consistently met quarterly effluent requirements in terms of $cBOD_5$, TP, PO_4-P and fecal coliforms.
  - Effluent has occasionally exceeded quarterly effluent requirements for TAN, with the facility being in compliance 8 out of 10 quarters over the review period.
  - Effluent has consistently exceeded quarterly effluent requirements for TSS and pH.
  - Low alkalinity in the raw wastewater has contributed to exceedances of effluent requirements with respect to pH and, occasionally, TAN. High influent flows into the treatment facility also negatively impact process performance, likely contributing to the exceedances of effluent requirements with respect to TSS. See Section 1.2.3 for more information regarding current operational and design issues.
- Uplands Park WWTF:
  - The Uplands Park WWTF has consistently met quarterly effluent requirements for $cBOD_5$ and TSS.
  - Effluent has occasionally exceeded quarterly effluent requirements for fecal coliforms, with the facility being in compliance 5 out of 6 quarters over the review period.
- Wellington WWTF:
  - Effluent has occasionally exceeded quarterly effluent requirements for $cBOD_5$ and fecal coliforms, with the facility being in compliance 8 out of 10 quarters for $cBOD_5$ and 7 out of 10 quarters for fecal coliforms over the review period.
  - Effluent has consistently exceeded quarterly effluent TSS requirements.
  - The existing facility is being decommissioned and replaced with a new extended aeration facility with UV disinfection. The new facility will be designed to meet NSE effluent requirements specific to the receiver.

- Frame WWTF:
  - Effluent has consistently exceeded quarterly effluent requirements for $cBOD_5$, TSS and fecal coliforms.
  - The poor performance is due to high peak flows impairing secondary clarifier performance, resulting solids washout and loss of biological treatment activity. Based on the operational issues at the Frame WWTF, it is likely that effluent requirements have periodically been met due to the diluted nature of the raw wastewater, and not due to any significant treatment being achieved through the package plant. Section 1.2.3 for more information regarding current operational and design issues.
- Springfield Lake WWTF:
  - Effluent has occasionally exceeded quarterly effluent requirements with respect to $cBOD_5$ removal and TSS removal, with 9 out of 10 and 7 out of 10 quarters in compliance over the review period for $cBOD_5$ removal and TSS removal, respectively.
  - Effluent has consistently exceeded quarterly effluent requirements for $cBOD_5$, TSS and fecal coliforms.
  - The current NSE effluent requirements are typical of those for a tertiary treatment facility; however, the existing facility provides only secondary level treatment. In addition, the existing chlorination is undersized to provide adequate disinfection. Section 1.2.3 for more information regarding current operational and design issues.
- Mill Cove WWTF:
  - The Mill Cove WWTF has consistently met quarterly effluent requirements for $cBOD_5$ and fecal coliforms.
  - Effluent has occasionally exceeded quarterly effluent requirements for TSS, with 5 out of 6 quarters in compliance over the review period.
  - The South Plant secondary clarifiers were recently upgraded, which has improved effluent quality, namely in terms of TSS.
- Eastern Passage WWTF:
  - Effluent has occasionally exceeded quarterly effluent requirements for TSS removal, with 5 out of 6 quarters in compliance over the review period.
  - Effluent has consistently exceeded quarterly effluent requirements for BOD_5 removal and fecal coliforms. The effluent has, however, consistently met the less stringent fecal coliform geometric mean requirements.
  - A project is currently underway to convert this facility from a primary treatment plant to a secondary treatment facility with UV disinfection. The new facility will be designed to meet NSE effluent requirements specific to the receiver.

- Lakeside/Timberlea WWTF:
  - The Lakeside/Timberlea WWTF has consistently met quarterly effluent requirements for $cBOD_5$, BOD_5 removal, and DO.
  - Effluent has occasionally exceeded quarterly effluent requirements in terms of PO_4-P and fecal coliforms, with 5 out of 6 quarters in compliance for PO_4-P and 4 out of 6 quarters in compliance for fecal coliforms over the review period.
  - Effluent has consistently exceeded quarterly effluent requirements in terms of TSS, TP and TAN.
  - A project is currently underway to upgrade this secondary treatment facility to a tertiary treatment facility with UV disinfection. The new facility will be designed to meet NSE effluent requirements specific to the receiver.
- Aerotech WWTF:
  - The Aerotech WWTF consistently met quarterly effluent requirements for $cBOD_5$, TP and pH.
  - Effluent has occasionally exceeded quarterly effluent requirements in terms of fecal coliforms with 5 out of 6 quarters in compliance over the review period. The effluent has, however, consistently met the less stringent fecal coliform geometric mean requirements.
  - Effluent has consistently exceeded effluent requirements in terms of TSS and TAN.
  - High influent TKN loadings due to contributions from on-site sludge handling processes and the N-Viro facility, combined with limited biological treatment capacity, are likely contributing to effluent TAN exceedances. According to the Compliance Plan, various methods of reducing TKN loadings to the Aerotech WWTF are being evaluated, including diverting a portion of the sludge generated at the Mill Cove WWTF to the Herring Cove WWTF for dewatering, and the implementation of pre-treatment at the N-Viro facility. High wet weather flows and peak flow capacity limitations are also likely contributing to effluent TSS exceedances. See Section 1.2.3 for more information regarding current operational and design issues

1.2.2 WSER Compliance Requirements

Environment Canada published the final Wastewater Systems Effluent Regulations (WSER) in June 2012. The regulations are intended to phase out the release of untreated and undertreated wastewater. The regulations will apply to wastewater systems that treat, or are designed to treat, an average daily volume of 100 cubic metres per day (m^3/d). The National Performance Standards (NPS) that wastewater systems will be expected to meet are shown in Table 1.3.

Table 1.3 WSER National Performance Standards (NPS)

Parameter	Concentration
$CBOD_5$	Average ≤ 25 mg/L
TSS	Average ≤ 25 mg/L
TRC	Average ≤ 0.02 mg/L
Un-ionized ammonia as N at $15^oC \pm 1^oC$	Maximum < 1.25 mg/L

The average concentrations shown in Table 1.3 are typically achievable with secondary level of treatment.

For each WWTF, the existing quarterly NSE effluent requirements and historic annual average effluent quality were evaluated to determine if they currently comply with the WSER NPS. The results of this analysis are summarized in Table 1.4. Halifax Water has developed a Compliance Plan (dated November 2011) which outlines the upgrades required for facilities that do not currently meet the WSER NPS.

Table 1.4 Current Compliance with WSER NPS

WWTF	Current Effluent Requirements		Historic Effluent Quality	
	Parameter	Meets NPS	Parameter	Meets NPS
Halifax WWTF	**$cBOD_5$** **TSS** TRC Un-ionized ammonia	**No** **No** N/A N/A	**$cBOD_5$** **TSS** TRC Un-ionized ammonia	**No** **No** Yes Yes
Dartmouth WWTF	**cBOD5** **TSS** TRC Un-ionized ammonia	**No** **No** N/A N/A	**cBOD5** **TSS** TRC Un-ionized ammonia	**No** **No** Yes Yes
Herring Cove WWTF	**cBOD5** **TSS** TRC Un-ionized ammonia	**No** **No** N/A N/A	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes Yes Yes
Lockview/Macpherson WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A N/A	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes Yes Yes
Middle Musquodoboit WWTF	$cBOD_5$ TSS	Yes Yes	$cBOD_5$ TSS	Yes Yes

Table 1.4 Current Compliance with WSER NPS

WWTF	Current Effluent Requirements		Historic Effluent Quality	
	Parameter	Meets NPS	Parameter	Meets NPS
	TRC Un-ionized ammonia	N/A N/A	TRC Un-ionized ammonia	Yes Yes
North Preston WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A Yes	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes Yes Yes
Uplands Park WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A N/A	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes Yes Yes
Wellington WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A N/A	$cBOD_5$ **TSS** **TRC** Un-ionized ammonia	Yes **No** **No** Yes
Frame Subdivision WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A N/A	$cBOD_5$ TSS **TRC** Un-ionized ammonia	Yes Yes **No** Yes
Springfield Lake WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A N/A	$cBOD_5$ TSS **TRC** Un-ionized ammonia	Yes Yes **No** Yes
Mill Cove WWTF	**cBOD5** **TSS** TRC Un-ionized ammonia	**No** **No** N/A N/A	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes Yes Yes
Eastern Passage WWTF	**cBOD5** **TSS** TRC Un-ionized ammonia	**No** **No** N/A N/A	**cBOD5** **TSS** **TRC** Un-ionized ammonia	**No** **No** **No** Yes

Table 1.4 Current Compliance with WSER NPS

WWTF	Current Effluent Requirements		Historic Effluent Quality	
	Parameter	Meets NPS	Parameter	Meets NPS
Lakeside/Timberlea WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A Yes	$cBOD_5$ TSS **TRC** Un-ionized ammonia	Yes Yes **No** Yes
Aerotech WWTF	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes N/A Yes	$cBOD_5$ TSS TRC Un-ionized ammonia	Yes Yes Yes Yes

In summary, the following facilities have existing treatment requirements and/or effluent quality that do not meet the WSER NPS:

- Halifax WWTF:
  - The current effluent requirements do not meet the WSER NPS requirements for $cBOD_5$ and TSS.
  - Historic effluent quality did not meet the WSER NPS requirements in terms of $cBOD_5$ and TSS.
  - Upgrades to full secondary treatment would be required to meet WSER NPS requirements. According to the Compliance Plan, an upgrade to full secondary treatment would be required within 30 years.
- Dartmouth WWTF:
  - The current effluent requirements do not meet the WSER NPS requirements for $cBOD_5$ and TSS.
  - Historic effluent quality did not meet the WSER NPS requirements in terms of $cBOD_5$ and TSS.
  - Upgrades to full secondary treatment would be required to meet WSER NPS requirements. According to the Compliance Plan, an upgrade to full secondary treatment would be required within 20 years.
- Herring Cove WWTF:
  - The current effluent requirements do not meet the WSER NPS requirements for $cBOD_5$ and TSS.
  - Upgrades to full secondary treatment would be required to meet WSER NPS requirements. According to the Compliance Plan, an upgrade to full secondary treatment would be required within 30 years.

- Wellington WWTF:
  - Historic effluent quality did not meet the WSER NPS requirements in terms of TSS and TRC.
  - The existing facility is being decommissioned and replaced with a new extended aeration facility with UV disinfection. The new facility will be designed to be compliant with the WSER NPS.
- Frame WWTF:
  - Historic effluent quality did not meet the WSER NPS requirements in terms of TRC.
  - The Compliance Plan indicates that short-term upgrades to the Frame WWTF will include conversion to UV disinfection, brining the facility into compliance with the WSER NPS.
- Springfield Lake
  - Historic effluent quality did not meet the WSER NPS requirements in terms of TRC.
  - The Compliance Plan indicates that a UV disinfection system will be installed, brining the facility into compliance with the WSER NPS.
- Mill Cove WWTF:
  - The current effluent requirements do not meet the WSER NPS requirements for $cBOD_5$ and TSS.
  - Historic effluent quality has met the WSER NPS for all parameters. Therefore, no upgrades to the existing treatment system are required to meet the WSER NPS.
- Eastern Passage:
  - The current effluent requirements do not meet the WSER NPS requirements for $cBOD_5$ and TSS.
  - Historic effluent quality did not meet the WSER NPS requirements in terms of $cBOD_5$, TSS and TRC.
  - A project is currently underway to convert this facility from a primary treatment plant to a secondary treatment facility with UV disinfection. The new facility will be designed to be compliant with the WSER NPS. Based on the Compliance Plan, construction is scheduled for completion by the end of 2013.
- Lakeside/Timberlea WWWTF:
  - Historic effluent quality did not meet the WSER NPS requirements in terms of TRC.
  - A project is currently underway to upgrade this secondary treatment facility to a tertiary treatment facility with UV disinfection. The new facility will be designed to be compliant with the WSER NPS.

It should be noted that, based on an analysis annual average of effluent quality data as recorded in WaterTrax, the Aerotech WWTF was found to be in compliance with the WSER NPS for all parameters. However, the Compliance Plan notes that the Aerotech WWTF has not met the WSER NPS values of 25 mg/L for $cBOD_5$ and 25 mg/L for TSS.

1.2.3 Design and Operational Issues Impacting Performance

Information regarding design and operational issues that impact performance of the WWTFs was obtained from operations staff during the site visits to the various treatment facilities. Additional information was also provided by HW staff during the WWTF Baseline Review Workshop held on August 23, 2011.

Table 1.5 provides a summary of the key design and operational issues identified for the WWTFs reviewed. Detailed information regarding each WWTF can be found in Volume 3 Appendices B2 to B15.

1.2.4 Existing Treatment Capacity

Preliminary desk-top capacity assessments were completed to estimate the existing treatment capacities of each WWTF. These assessments were based on data available, including design briefs and drawings where available, and focussed on:

- Process tankage volumes and dimensions (equalization tanks, primary clarifiers, bioreactors, secondary clarifiers);
- Historic raw wastewater quality, if available;
- Typical raw wastewater quality if no historic data were available;
- Typical design guideline values for the various unit processes (Atlantic Canada Wastewater Guidelines (Environment Canada, 2006), Metcalf & Eddy (2003));
- Recorded performance of the facility at historic flows and loadings;
- Discussions with operations staff regarding observed treatment capacity and operational issues; and
- Compliance with existing treatment requirements unless otherwise noted.

For the purposes of these treatment capacity analyses, it was assumed that the following parameters were not capacity limiting: sludge handling processes, preliminary treatment systems (screening, comminution and/or degritting), disinfection processes, and hydraulic capacities of existing channels.

The average day and peak flow capacities of the facilities were evaluated. The results of the treatment capacity assessment are presented in Table 1.6. The design capacities of the WWTFs, where available, were included for comparison purposes. In addition, the historic average day and maximum day flows, as a percent of the estimated average day and peak flow capacities, are also shown.

Table 1.5 Design and Operational Issues Impacting WWTF Performance

Facility	Design/Operational Issues	Issues Related to Wet Weather Flows
Halifax WWTF	• Raw wastewater may have high soluble BOD_5 concentration. Existing enhanced primary treatment system (DensaDeg) cannot remove soluble BOD_5. • DensaDeg effluent prone to foaming, negatively impacting the performance of the downstream ultrasonic level detector associated with the downstream effluent v-notch weir flow meter.	• Peak flows have resulted in washout of the sedimentation zone in the DensaDeg process at peak flows of approximately 200,000 m^3/d, resulting in poor effluent quality. • Effects of wet weather flows mitigated by controlling the upstream pumping stations to limit influent flow to the Halifax WWTF during high flow periods, resulting in upstream overflows at the collection system pumping stations.
Dartmouth WWTF	• Level sensors to measure coarse screen differential head do not work properly, resulting in frequent bypassing of the coarse screen although flows do not exceed the screen's capacity. • The configuration of the grit removal system may be resulting in short-circuiting. • DensaDeg effluent prone to foaming, negatively impacting the performance of the downstream ultrasonic level detectors associated with the downstream effluent v-notch weir flow meters. A spray bar has been installed, however this has not eliminated the issue. • The current control system does not provide adequate rotation of mechanical equipment (pumps, blowers, etc.). Operations staff must manually alternate the lead/lag settings to ensure equal run-times.	• Peak flows have resulted in washout of the sedimentation zone in the DensaDeg process at peak flows of approximately 216,000 m^3/d, resulting in poor effluent quality. • Effects of wet weather flows mitigated by closing the main inlet gate to the Dartmouth WWTF during high flow periods, resulting in upstream overflows at the collection system pumping stations.
Herring Cove WWTF	• The existing fine screens allow a significant amount of hair and other particles to pass through, resulting in clogging of downstream pipes. • Backflow preventers are not installed on the potable water lines to the WWTF. • DensaDeg effluent prone to foaming, negatively impacting the performance of the downstream ultrasonic level detectors associated with the downstream effluent v-notch weir flow meters	• Peak flows have resulted in washout of the sedimentation zone in the DensaDeg process at peak flows of approximately 50,000 m^3/d, resulting in poor effluent quality.
Lockview/MacPherson WWTF	• Operations staff indicates that all influent flows to the Lockview/MacPherson WWTF are routed through one pumping station in the collection system. When the pumping station turns on, the magnitude of the flow results in partial bypasses of the comminutor. • The flow split between the two aeration tanks and the flow split between the two secondary clarifiers are uneven. • The continuous backwash filter does not have sufficient capacity to handle the peak flows through the process, resulting in frequent partial filter bypasses. • Operations staff noted that the intermittent nature and magnitude of the EQ tank effluent flows result in frequent instances of short-duration, high intensity peak flows. These result in poor performance of the secondary clarifiers and partial tertiary filter bypasses, in spite of the facility operating well below its average day capacity. • According to operations staff, short circuiting within the secondary clarifiers results in poor clarifier performance. • Due to the configuration of WAS draw off via a plunger valve at the bottom of the RAS tank, operations staff noted that they lose the ability to waste solids if there are no influent flows to the WWTF. As a result, operators need to manually waste several small volumes of sludge after each EQ tank pumping cycle. This is labour intensive, taking 1.5 to 2 manhours of effort per day. In addition, the siphons from the secondary clarifiers to the RAS tank are prone to clogging. • The suction piping for the RAS pumps lacks an air release valve. Operators noted that the couplings on the suction lines tend to leak, causing the RAS pumps to lose prime. • The aerated sludge holding tank is prone to developing septic conditions; operators indicated that this may be due to a lack of oxygenation capacity.	• Historic maximum day flows to the WWTF exceed the estimated peak flow capacity of the treatment system.

Table 1.5 Design and Operational Issues Impacting WWTF Performance

Facility	Design/Operational Issues	Issues Related to Wet Weather Flows
Middle Musquodoboit WWTF	• Algae blooms occur in the polishing pond every spring, impacting effluent quality. • Muskrats have undermined the berm of the polishing pond, and have made nests in the secondary clarifiers. • The raw wastewater has high concentrations of FOG, resulting in FOG accumulation in the EQ tank resulting in operational difficulties. • The bearings on the RBC units need to be replaced frequently (approximately every two years). • The WWTF also has some issues with regards to power outages and lack of back-up power. The influent flow is electronically stored on a SCADA system; however, if the power is lost, than that one day of data will be lost. There is no back-up power for any of the processes or electronic systems.	• According to operations staff, the flow equalization tank is undersized, and high flows seen during wet weather events cause a wash out of the fats, oils and grease (FOG) from the oil trap compartment where they are directed into the process, resulting in a treatment process upset. • A vacuum truck is required after every sizeable rain event to pump out the process tanks. • Historic maximum day flows to the WWTF exceed the estimated peak flow capacity of the mechanical treatment plant. Polishing pond has likely allowed the facility to operate at peak flows greatly exceeding the estimated peak flow capacity of the mechanical plant while not impacting effluent quality.
North Preston WWTF	• The North Preston WWTF is at the end of the power grid, and as a result it is prone to frequent power outages. • Operations staff noted that fats, oils, and grease (FOG) accumulation in the equalization tank/pumping station wet well is an issue. • The raw wastewater has very low alkalinity, which can negatively impact nitrification performance in the biological treatment system and effluent pH. Operations staff noted that the use of caustic soda is limited due to its negative impact on biological treatment when added in large dosages. As a result, low effluent pH has been an ongoing operational issue.	• According to operations staff, during wet weather events the influent flows exceed the capacity of the mechanical plant, resulting in raw wastewater being discharged into the first cell of the engineered wetland. • Operations staff also indicated that high influent flows result in preliminary treatment bypass, whereby influent flows bypass grit removal and screening and discharge directly into the equalization tank. Operations staff attributes this to a hydraulic bottleneck in the influent pipe to the screen.
Uplands Park WWTF	• Uneven flow splitting between the various treatment trains (primary clarifiers, trickling filters, secondary clarifiers) impacts process performance. • The dividing wall between the primary clarifiers, and the wall between the secondary clarifiers, does not extend to the end of the tank, and there are no gates available to isolate one clarifier from the other. • The pipes on the two distribution arms in trickling filter are routinely blocked with solids that have carried through the pre-treatment system. These need to be unblocked on a regular basis by an operator. • The trickling filter splitter box and manual bar screen require manual cleaning at least three times per week, making the process labour intensive. • The two rotating distribution arms are also in need of repair. The wastewater will bypass the rotating arms. This results in a majority of the wastewater discharging at the centre of the distribution arms, resulting in localized high loading of the trickling filter. • Operations staff note that the manual bar screen does not provide adequate treatment and is undersized for the amount of large solids in the raw wastewater. • There is no back-up power for the facility.	• During wet weather events, hydraulic limitations have been observed in the plant and high flows negatively impact process performance
Wellington WWTF	• A new Wellington WWTF will be constructed, and the existing facility decommissioned. No summary of issues related to the existing system is presented.	
Frame WWTF	• The configuration of the secondary clarifier may result in poor in-tank hydraulics (such as short-circuiting), potentially resulting in poor performance even during low flow conditions. • The existing package plant is over 40 years old and is reaching the end of its useful life. The metal tank walls and bars visible above the water level show signs of corrosion. • There is currently no backup power for the facility. • Based on the operational issues at the Frame Subdivision WWTF, it is likely that effluent requirements have periodically been met due to the diluted nature of the raw wastewater, and not due to any significant treatment being achieved through the package plant.	• Historic maximum day flows to the WWTF exceed the estimated peak flow capacity of the treatment system. • Operations staff indicates that the existing facility has been hydraulically overloaded during extreme wet weather events, leading to package plant process tankage overflowing. • The existing secondary clarifier is undersized for current wet weather flows. This results in solids washout during high flow periods. Operations staff noted that this is common for the facility to operate with no observable mixed liquor in the aeration tank, and that biological activity does not generally appear until after approximately two weeks of dry weather flows

Table 1.5 Design and Operational Issues Impacting WWTF Performance

Facility	Design/Operational Issues	Issues Related to Wet Weather Flows
Springfield Lake WWTF	• The WWTF has only one treatment train, and for this reason, the operators are not able to take any process off-line for maintenance without bypassing the entire plant. For this reason, the plant has not been taken off-line for maintenance for over 10 years. • Due to the configuration of the aeration tank and the supporting beams and columns for the mechanical aerators, the RAS system is not performing adequately, resulting in an accumulation of solids in the clarifier. Operations staff has installed PVC air piping in an attempt to enhance RAS flow through the addition of an air-lift to improve RAS flow. In spite of this, solids accumulation in the secondary clarifier is still an operational issue. • In addition, the existing mechanical aerators do not provide sufficient oxygen transfer to maintain an adequate dissolve oxygen concentration in the aeration tank. As a result, operations staff has temporarily installed a Biolac® aeration header to provide additional oxygenation to the bioreactor. • The gates to the screen bypass channel are seized and cannot be operated. This limits the operators' ability to bypass the automatic screen. • The Springfield Lake WWTF is unable to maintain an adequate chlorine residual in the effluent under peak flow conditions, as the disinfection system is undersized. • There is no back-up power for any of the processes or electronic systems.	• Historic maximum day flows to the WWTF exceed the estimated peak flow capacity of the treatment system. • Historic wet weather flows have led to a deterioration in the performance of the secondary treatment and disinfection systems.
Mill Cove WWTF	• Plant staff indicated that flows splits in the primary splitter box are not well balanced. With all gates open, flow will preferentially go to the South Plant primary clarifiers. As a result, the sluice gates are throttled to provide some flow split control. • The influent Bedford PS was constructed over 40 years ago, and the pumps, valves and piping are in need of replacement. In addition, the dry pit area of the PS is very small, limiting the ability to retrofit the existing PS. • Plant operations staff indicated that Nocardia filaments are a recurring operational issue, resulting in the accumulation of foam in the bioreactors, channels, and flow splitter boxes, as well as sludge bulking and deterioration in effluent quality. This is mitigated by running the bioreactors at a target MLSS concentration of 1,000 mg/L.	• Operations staff indicated during the site visit that overflows from the Bedford PS wet well have occurred during extreme wet weather conditions. • Effects of wet weather flows on liquid stream treatment performance mitigated by diverting influent flow to the surge tank, leading to overflows of the surge tank. The surge tank effluent is not disinfected prior to being discharged into the Bedford Basin
Eastern Passage WWTF	• The plant is designed to be able to bypass the automatic coarse bar screen with gates; however, these gates have seized and are no longer operable. • Operations staff indicates that flow splits between the five primary clarifiers are uneven. The inlet gates to each primary clarifier have been adjusted to try to equalize flows, however operations staff indicates that the first two tanks still have more scum and sludge accumulation than the other three primary clarification tanks, due to unequal flows. • Operations staff indicates that high levels of H2S are an issue in the headworks building. It is understood that Bioxide may be added to the upstream pumping stations to try to reduce the H2S in the raw wastewater. • Three small portable generators are available to operate the lights and power outlets in the headworks building; however, this power is not enough to operate any of the main process equipment, such as digester mixing, pumping, sludge collection mechanisms, and disinfection.	• The Eastern Passage WWTF bypasses the primary clarifiers on a frequent basis due to wet weather flows, usually having at least one bypass event occur each month. • Operations staff noted that hydraulic limitations of the bypass channels have led to back-ups through the treatment process, resulting in flooding of tanks and the grassy area around the chlorine contact tanks.

Table 1.5 Design and Operational Issues Impacting WWTF Performance

Facility	Design/Operational Issues	Issues Related to Wet Weather Flows
Lakeside/Timberlea WWTF	• Flow splitting between the two trains, particularly between the primary clarifiers and RBC trains, is uneven and negatively impacts process performance. A lack of control weirs/gates limits the operators' ability to control flow splits. • There are cracks in the concrete walls of the primary clarifiers, and there are also significant cracks in the headworks building foundation. During the site visit, it was noted that repairs to these known cracks are scheduled; however the condition of these exposed tank walls highlights the need for an inspection of the other tanks/concrete structures. • Operations staff indicated that the flare needs to be upgraded and/or replaced. • Operations staff noted a concern regarding the lack of back-up power for the main processes. Three small portable generators are available to operate the lights and power outlets in the office areas and digester building; however, none of the treatment processes are able to run during a power outage.	• Historic maximum day flows to the WWTF exceed the estimated peak flow capacity of the treatment system.
Aerotech WWTF	• Operators indicated that the N-Viro facility is not operated on a 24-hour basis, potentially resulting in large diurnal variations in influent quality. In addition, the overflows from the lagoon are high in TAN (average concentration of 200 mg/L) resulting in high TAN loadings to the liquid treatment train and, during wet weather, slug loads. These influent quality issues are believed to have contributed to poor historical effluent quality with respect to TAN. • Because the effluent flow rate from the post-equalization tank is limited by the capacity of the downstream filters, if several SBR reactors begin decanting simultaneously, the liquid level in the post-equalization tank will rise, ultimately leading to an overflow of the post-equalization tank. • There is currently no means available to bypass the liquid treatment train downstream of the pre-equalization tank. According to plant staff, this has historically resulted in overflows of process tankage in the liquid treatment train. • Operations staff indicates that, although the mixed liquor in the SBRs settles well, the effluent from the SBR reactors is often high in TSS. Operators were unsure why or when this is occurring during the decant cycle. • Due to the high solids concentration of the SBR effluent, operations staff does not currently aerate the post-equalization tank; rather, they operate the post-equalization tank without aeration to allow solids to settle out to prevent high influent solids concentrations to the downstream filters to avoid filter blinding. • Elevated concentrations of solids in the effluent from the SBR reactors combined with the design of the post-equalization tank (flat bottom, location of effluent hopper) results in an accumulation of solids in the bottom of the post-equalization tank. Operators need to frequently clean out the post-equalization tank to remove the solids (approximately every two weeks). This process is very labour intensive, and can only be done during dry weather periods. • The existing back-up power generator, located on-site, only provides power for lights and the influent pumping station.	• Historic maximum day flows to the WWTF exceed the estimated peak flow capacity of the treatment system. • During wet weather, precipitation into the lagoon will cause it to overflow, further increasing the flow and influent loadings, namely in terms of TKN/TAN, to the WWTF. • There are no means available to plant staff to limit influent flow into the Aerotech WWTF from either the collection system or lagoon. • During wet weather events, operators indicated that the pre-equalization tank, surge tank and post-equalization tank will fill and overflow.

Table 1.6 Preliminary WWTF Capacity Assessment Results

Facility	Capacity Assessment					Historic Flows as % of Estimated Capacity	
	Design ADF Capacity (m^3/d)	Estimated ADF Capacity (m^3/d)	Estimated Peak Capacity (m^3/d)	Capacity Based on Providing Year-Round Nitrification?	Notes	ADF	Peak Day
Halifax WWTF	133,920	133,920	< 200,000	No	• Estimated ADF capacity based on supplier rated capacity of the DensaDeg system • Estimated Peak capacity based on operations staff observations of treatment performance at high flows	73%	121%
Dartmouth WWTF	83,808	83,808	< 216,000	No	• Estimated ADF capacity based on supplier rated capacity of the DensaDeg system • Estimated Peak capacity based on operations staff observations of treatment performance at high flows	65%	81%
Herring Cove WWTF	28,512	28,512	< 50,000	No	• Estimated ADF capacity based on supplier rated capacity of the DensaDeg system • Estimated Peak capacity based on operations staff observations of treatment performance at high flows	44%	105%
Lockview/MacPherson WWTF	454	454	< 840	Yes	• Current treatment requirements do not require nitrification, however HW noted it is likely that nitrification will be required in the future due to the sensitive nature of the receiver • Peak flow capacity may be limited to less than 840 m^3/d due to capacity of filter	41%	104%
Middle Musquodoboit WWTF	114	275	300	No	• Capacities shown are for the mechanical plant. No analysis of the capacity of the polishing pond was conducted. • Peak capacity limited by secondary clarifier surface area and pre-equalization volume. The result is a facility with a very small peaking factor (1.1). • Polishing pond has likely allowed the facility to operate at peak flows greatly exceeding the estimated peak flow capacity of the mechanical plant while not impacting effluent quality	57%	187%
North Preston WWTF	680	850	1,475	Yes	• Capacities shown are for the mechanical plant. No analysis of the capacity of the engineered wetland was conducted.	68%	250%
Uplands Park WWTF	91	119	Insufficient data available	Yes	• Estimated ADF capacity based on historic flows and performance. No information regarding tank dimensions was available.	100%	-
Wellington WWTF	45	See notes	See notes	Yes	• Design capacity shown is for the new, proposed Wellington WWTF to replace the existing package extended aeration facility. • New facility to have maximum day and peak instantaneous design flows of 85 m^3/d and 260 m^3/d, respectively.	-	-
Frame WWTF	80	80	315	No	• Estimated capacities of existing package extended aeration facility based on meeting current treatment requirements	138%	370%
Springfield Lake WWTF	545	550	1,308	Yes	• Treatment capacities based on providing effluent quality typical of that from a secondary treatment facility. The current effluent requirements for this facility are, however, consistent with those for a tertiary treatment system. • Current treatment requirements do not require nitrification, however the receiver has limited assimilative capacity and, as a result, is likely that nitrification will be required in the future. • Peak capacity may be limited to less than 1,308 m^3/d based on secondary clarifier hydraulics.	85%	147%
Mill Cove WWTF	28,400	28,400	70,000	No	• Estimated capacities of existing treatment facility based on meeting current treatment requirements.	78%	70%
Eastern Passage WWTF	17,730	17,700	60,000	No	• Estimated average and peak capacities based on providing coagulant and/or polymer addition upstream of the existing primary clarifiers	86%	89%
Lakeside/Timberlea WWTF	4,540	2,860	9,295	Yes	• Average day capacity limited by the biological treatment capacity of the RBCs to provide year-round nitrification.	133%	153%
Aerotech WWTF	1,400	700	1,710	Yes	• Average day capacity limited by providing year-round nitrification. High influent TKN loadings contributed to the low estimated average day capacity.	167%	197%

Notes:
ADF – Average day flow

Based on the detailed information regarding the capacity assessments of the individual WWTFs (presented in Volume 3 Appendices B2 to B15) and the summary presented in Table 1.6, the following observations are made:

- Due to the proprietary nature of the DensaDeg treatment process, a desktop assessment of treatment capacity of the Halifax Harbour Solutions Facilities was not possible. However, historic operating conditions and information from operations staff were used to estimate the peak flow capacities of each WWTF.
- The estimated ADF capacity of each facility was taken to be the design ADF capacity, or 133,920 m^3/d, 83,808 m^3/d and 28,512 m^3/d for the Halifax, Dartmouth and Herring Cove WWTFs, respectively.
- Based on discussions with plant operations staff, the estimated peak flow capacity of the Halifax WWTF is < 200,000 m^3/d. Historically, peak day flows to the WWTF have exceeded the estimated peak flow capacity by as much as 21%.
- Based on discussions with plant operations staff, the estimated peak flow capacity of the Dartmouth WWTF is < 216,000 m^3/d. Historically, peak day flows to the WWTF have not exceeded the estimated peak flow capacity, although peak instantaneous flows in excess of 216,000 m^3/d have been recorded.
- Based on discussions with plant operations staff, the estimated peak flow capacity of the Herring Cove WWTF is < 50,000 m^3/d. Historically, peak day flows to the WWTF have exceeded the estimated peak flow capacity by as much as 5%.
- The Lockview/MacPherson WWTF has an estimated ADF treatment capacity equivalent to its design capacity of 454 m^3/d. The estimated peak flow capacity is 840 m^3/d, however this may be further limited by the capacity of the existing filter. Historically, the facility has operated at 41% of its estimated ADF treatment capacity. Peak day flows to the WWTF have exceeded the estimated peak flow capacity by as much as 4%.
- The Middle Musquodoboit WWTF mechanical treatment plant has an estimated ADF treatment capacity of 275 m^3/d, which is higher than the design capacity of 114 m^3/d. The peak flow capacity of the mechanical plant is limited by the secondary clarifiers, and is estimated to be 300 m^3/d. This results in a very small peaking factor (1.1). Historically, the facility has operated at 57% of its estimated ADF treatment capacity. Peak day flows have exceeded the estimated peak flow capacity by as much as 87%. The polishing pond has likely allowed the facility to operate at peak flows exceeding the estimated peak flow capacity of the mechanical plant while not impacting effluent quality.
- The North Preston WWTF mechanical treatment plant has an estimated ADF treatment capacity of 850 m^3/d, which is higher than the design capacity of 680 m^3/d. The peak flow capacity of the mechanical plant was estimated to be 1,475

m^3/d. Historically, the facility has operated at 57% of its estimated ADF capacity. Peak day flows have exceeded the estimated peak flow capacity by as much as 87%.

- The Uplands Park WWTF has an estimated ADF treatment capacity of 119 m^3/d, which is higher than the design capacity of 91 m^3/d. No data were available regarding tank/tricking filter dimensions, as a result the capacity assessment was based on historic average flows and historic plant performance. Insufficient data were available to develop an estimated peak flow capacity.
- A capacity of assessment of the existing Wellington WWTF was not conducted, as a project is currently underway to replace the existing plant with a new, extended aeration facility. The new facility has a design ADF capacity of 45 m^3/d.
- The Frame WWTF has an estimated ADF treatment capacity equivalent to its design capacity of of 80 m^3/d. The estimated peak flow capacity is limited by the existing secondary clarifier surface area, and is 315 m^3/d. Historically, the facility has operated at 138% of its estimated ADF capacity. Peak day flows have exceeded the estimated peak flow capacity by as much as 270%.
- The Springfield Lake WWTF has an estimated ADF treatment capacity of 550 m^3/d, which is slightly above the design rated capacity of 545 m^3/d. The estimated peak flow capacity is limited by the existing secondary clarifier surface area, and is 1,308 m^3/d. Historically, the facility has operated at 85% of its estimated ADF capacity. Peak day flows have exceeded the estimated peak flow capacity by as much as 47%. The estimated treatment capacities were based on providing effluent quality typical of that from a secondary treatment facility. The current effluent requirements for this facility are, however, consistent with those for a tertiary treatment system.
- The Mill Cove WWTF has an estimated ADF treatment capacity equivalent to its design capacity of 28,400 m^3/d. The estimated peak flow capacity is 70,000 m^3/d. Historically, the facility has operated at 78% of its estimated ADF capacity, and peak day flows have been as high as 70% of the estimated peak flow capacity.
- The Eastern Passage WWTF has an estimated ADF capacity of 17,700 m^3/d, which is consistent with its design capacity of 17,730 m^3/d. The estimated peak flow capacity is 60,000 m^3/d. Estimated capacities were developed based on providing coagulant and/or polymer addition upstream of the existing primary clarifiers. Historically, the facility has operated at 86% of its estimated ADF capacity, and peak day flows have been as high as 89% of the estimated peak flow capacity.

- The Lakeside/Timberlea WWTF has an estimated ADF capacity of 2,860 m^3/d, which is less than the design capacity of 4,540 m^3/d. The estimated peak flow capacity is 9,295 m^3/d. Historically, the facility has operated at 133% of its estimated ADF capacity. Peak day flows have exceeded the estimated peak flow capacity by as much as 53%.
- The Aerotech WWTF has an estimated ADF capacity of 700 m^3/d, which is less than the design capacity of 1,400 m^3/d. The estimated peak flow capacity is 1,710 m^3/d. The ADF capacity is limited by the capability of the biological treatment process to meet year-round nitrification requirements in conjunction with high influent TKN loadings. The peak flow capacity is limited by available equalization volume. Historically, the facility has operated at 133% of its estimated ADF capacity. Peak day flows have exceeded the estimated peak flow capacity by as much as 97%.

In summary, current flows exceed the estimated ADF capacity of three treatment facilities, namely the Frame, Lakeside/Timberlea, and Aerotech WWTFs. Historic peak day flows have also exceeded the estimated peak flow capacity for these facilities. The collection system for the Frame WWTF is currently being replaced, and it is expected that this will reduce average flows to the treatment facility. Long-term plans also include the decommissioning of the Frame WWTF and construction of a new treatment facility. An expansion is planned for the Lakeside/Timberlea WWTF, and studies are currently underway to develop plans to address capacity limitations at the Aerotech WWTF.

Historic peak day flows have exceeded the peak flow capacity of five other facilities, namely the Halifax, Herring Cove, Lockview/MacPherson, Middle Musquodoboit, and North Preston WWTFs.

1.3 Sludge and Hauled Waste Handling Practices

The following sections summarize the current sludge and hauled waste handling practices at the HW operated facilities.

1.3.1 Sludge/Biosolids Handling

Currently, sludge/biosolids dewatering is provided at the following facilities:

- Halifax WWTF;
- Dartmouth WWTF;
- Herring Cove WWTF; and
- Aerotech WWTF.

The Harbour Solutions facilities (Halifax, Dartmouth, Herring Cove) provide dewatering for sludge generated in their respective treatment processes. The Aerotech WWTF provides centralized dewatering for undigested sludge and anaerobically digested biosolids from the other HW WWTFs.

Liquid, undigested sludge is hauled to Aerotech WWTF from the following facilities:

- Lockview/MacPherson WWTF;
- Middle Musquodoboit WWTF;
- North Preston WWTF;
- Uplands Park WWTF;
- Wellington WWTF;
- Frame WWTF; and
- Springfield Lake WWTF.

Liquid, anaerobically digested sludge is hauled to Aerotech WWTF from the following facilities:

- Mill Cove WWTF;
- Eastern Passage WWTF; and
- Lakeside/Timberlea WWTF.

The total volumes of sludge/biosolids accepted at the Aerotech WWTF were 2,300 m^3, 2,265 m^3, and 2,280 m^3 in 2008, 2009 and 2010, respectively (volumes include a small contribution from hauled waste, including septage; see Section 1.3.2). All dewatered cake from the Aerotech WWTF is hauled to the N-Viro facility, located in the Aerotech business park.

The current sludge/biosolids handling practices have a significant impact on the operation and performance of the Aerotech WWTF due to increased influent loads, namely in terms of TKN/TAN, impacting process performance and limiting available biological treatment capacity. HW is currently undertaking a trial program to reduce ammonia loadings to the Aerotech WWTF, which includes sending half of the sludge generated at the Mill Cove WWTF to the Herring Cove WWTF for dewatering. HW does not expected that the additional load associated with filtrate from the Mill Cove sludge will negatively impact the effluent quality from the Herring Cove WWTF.

The N-Viro facility provides alkaline stabilization of the sludge cake produced at the Harbour Solutions and Aerotech WWTFs. The waste stream from the N-Viro process discharges to the Aerotech WWTF collection system, increasing loadings to the Aerotech WWTF. In addition, operator staff indicated that the N-Viro facility is not operated on a 24-hour basis, potentially resulting in large diurnal variations in influent quality to the Aerotech WWTF.

All liquid sludge hauled to the Aerotech WWTF is dewatered via Fournier presses. Rotary press filtrate is collected in a filtrate tank, along with WAS from the Aerotech SBRs, and is pumped to the lagoon. Other hauled wastes which cannot be dewatered, such as storm sewer catch-basin cleanout waste, is discharged directly into the lagoon. Overflow from the lagoon is directed to the head of the Aerotech WWTF liquid treatment train.

Lagoon effluent is high in TAN concentrations (average recorded concentration of 200 mg/L), increasing loadings to the Aerotech WWTF. In addition, during wet weather, precipitation into the lagoon will cause it to overflow, further increasing the flow to the WWTF. There are no means available to plant staff to limit influent flow into the Aerotech WWTF from either the collection system or lagoon.

The impact of the dewatering waste streams should be taken into account when evaluating the upgrade requirements for the Aerotech WWTF to ensure that the liquid treatment train is designed to adequately treat the high influent TKN/TAN loadings.

1.3.2 Hauled Waste

Hauled waste, including septage, is received at the Aerotech WWTF. Those wastes that can be dewatered are directed to the solids handling treatment train, where they are mixed with sludge and biosolids hauled from other treatment facilities, before being dewatered and ultimately hauled to the N-Viro facility for further treatment.

Other hauled wastes which cannot be dewatered, such as storm sewer catch-basin cleanout waste, are discharged directly into the Aerotech lagoon.

According to operations staff, the volume of hauled waste accepted at the Aerotech WWTF has declined over the past several years, and comprises only a small fraction of the total volume accepted at the Aerotech WWTF solids handling process.

1.4 Findings and Recommendations

The following section summarizes findings and recommendations for each WWTF developed based on the baseline review of the WWTFs, HW's Compliance Plan (dated November 2011), and a review of ongoing studies.

- Halifax WWTF:
  - The existing facility has been consistently non-compliant with respect to NSE $cBOD_5$ effluent requirements. A treatability study is recommended to determine the ability of the existing treatment process to meet the existing NSE treatment requirements, and opportunities for process optimization be investigated and implemented.
  - Should it be determined that the existing treatment facility will cannot meet existing NSE treatment requirements, an upgrade to the existing treatment system may be required. This could involve constructing a secondary treatment process to treat a portion of the influent flow to the Halifax WWTF. The resulting blended effluent from the primary and secondary treatment processes would be capable of meeting the existing NSE treatment requirements.
  - Upgrades to full secondary treatment would be required to meet WSER requirements. According to the Compliance Plan, an upgrade to full secondary treatment would be required within 30 years.

- Dartmouth WWTF:
  - The existing facility has been non-compliant with respect to NSE fecal coliform requirements. It is recommended that the UVT of the treated effluent be monitored, and the treatment capacity of the existing UV disinfection system be evaluated. If the capacity of the existing UV disinfection system is found to be insufficient, it is recommended that the UV system be upgraded.
  - The Compliance Plan noted that the WWTF is still covered by a performance and equipment warranty, and that deficiencies continue to be addressed.
  - Once all deficiencies have been addressed, a treatability study is recommended to determine the ability of the existing treatment process to meet the existing NSE treatment requirements, and opportunities for process optimization be investigated and implemented.
  - Should it be determined that the existing treatment facility will cannot meet existing NSE treatment requirements, an upgrade to the existing treatment system may be required. This could involve constructing a secondary treatment process to treat a portion of the influent flow to the Dartmouth WWTF. The resulting blended effluent from the primary and secondary treatment processes would be capable of meeting the existing NSE treatment requirements.
  - Upgrades to full secondary treatment would be required to meet WSER requirements. According to the Compliance Plan, an upgrade to full secondary treatment would be required within 20 years.
- Herring Cove WWTF:
  - The existing raw wastewater concentrations for all parameters are considered to be very low. It is therefore recommended that the influent be monitored closely, since an increase in the raw wastewater strength due to growth in the service area and/or a reduction in I/I may negatively impact the effluent quality from the DensaDeg process.
  - Upgrades to full secondary treatment would be required to meet WSER requirements. According to HW's Compliance Plan, an upgrade to full secondary treatment would be required within 30 years.
  - According to the Compliance Plan, it is planned that half of the sludge generated at the Mill Cove WWTF will be sent to the Herring Cove WWTF for dewatering as part of a trial program to reduce ammonia loadings on the Aerotech WWTF. It is not expected that this additional load will negatively impact the effluent quality from the Herring Cove WWTF.
- Lockview/MacPherson WWTF:
  - Effluent has consistently exceeded NSE quarterly effluent requirements for $cBOD_5$ and TSS. Several factors are likely contributing to the poor performance.

- The current configuration and operation of the equalization tank pumps results in influent flows of high intensity but short duration, negatively impacting process performance. It is recommended that modifications be made to the equalization tank pumping configuration and/or that additional equalization volume be provided. The Compliance Plan notes that installing VFDs on the pumps is being considered.
- The configuration of the existing secondary clarifiers results in poor hydraulics and scum carry-over, negatively impacting downstream filter performance and effluent quality. It is recommended that upgrades to the existing clarifiers (such as the installation of baffles and a new scum collection system) be implemented to improve clarifier performance.
- The existing tertiary filter is undersized for the peak flows experienced at the WWTF, resulting in frequent partial tertiary bypasses which negatively impacts effluent quality. HW is planning to install additional filtration capacity at the Lockview/MacPherson WWTF to address these limitations.

- Middle Musquodoboit WWTF:
  - The peak flow capacity of the mechanical treatment plant has been exceeded, however the polishing pond has likely allowed the final effluent to meet existing treatment requirements in spite of the high peak flows. To ensure continued compliance in the future, it is recommended that additional equalization storage volume be provided to attenuate peak flows to the downstream treatment process and/or a bypass line be provided around the mechanical plant discharging to the polishing pond to protect the treatment process.
  - There are several asset renewal items which need to be addressed, including restoring the berm integrity of the polishing pond, and addressing RBC system maintenance requirements. This facility also requires back-up power for key processes.
- North Preston WWTF:
  - Low alkalinity in the raw wastewater has contributed to exceedances of NSE effluent limits with respect to pH and, occasionally, TAN. Operations staff has noted that the existing caustic soda addition system is problematic due to the current dosing location. It is recommended that alternative chemicals be evaluated for alkalinity adjustment and/or the caustic soda addition injection point be relocated. The Compliance Plan notes this as a project that will be undertaken to bring the facility into compliance with effluent pH requirements.
  - Currently, no autosampler is installed to collect samples at the effluent of the engineered wetland. Consistent with the Compliance Plant, it is recommended that an autosampler be installed in this location to collect samples for compliance purposes.

- Uplands Park WWTF:
  - To ensure continued compliance with existing NSE treatment requirements, and to improve performance, it is recommended that flow splitter boxes be constructed and trickling filter and secondary clarifier influent piping be reconfigured to improve flow splits.
  - There are several asset renewal items which need to be addressed, including replacing the mechanical equipment associated with the existing trickling filters, including distribution arms and effluent collection system. This facility also requires back-up power for key processes.
- Wellington WWTF:
  - The existing facility is being decommissioned and replaced with a new extended aeration facility with UV disinfection. The new facility will be designed to meet NSE treatment requirements specific to the receiver, and will be compliant with WSER NPS.
- Frame WWTF:
  - The existing facility has aged beyond its useful life and requires replacement. Historically, the facility has frequently exceeded NSE requirements for cBOD, TSS and fecal coliforms. In addition the existing facility is non-compliant with the WSER requirement for chlorine residual.
  - It is recommended that the existing treatment facility be decommissioned and replaced with a new treatment facility with UV disinfection to meet receiver specific effluent requirements and WSER NPS. Since the existing collection system is being replaced, it is recommended that raw wastewater flows and characteristics be recorded after upgrades to the collection system are complete. This will provide an opportunity to develop a design basis for the new facility that will be representative of raw wastewater flows and loadings associated with the new collection system.
  - The Compliance Plan outlines short-term upgrades for the Frame WWTF, including relocating the outfall to Lake William and installing a new UV disinfection system. The long-term plan for this facility is to replace the existing WWTF with a new treatment plant. The new facility will be designed to meet NSE treatment requirements specific to the receiver, and will be compliant with WSER NPS.
- Springfield Lake WWTF:
  - The existing facility does not meet NSE treatment requirements for $cBOD_5$, TSS and fecal coliforms. It should be noted that the effluent requirements are typical of a tertiary treatment system; the Springfield Lake WWTF, however, provides only secondary level treatment.

  - The existing facility does not meet the WSER requirement for chlorine residual. According to the Compliance Plan, a UV disinfection system will be installed, bringing this facility into compliance with the WSER NPS.
  - The configuration of the bioreactors and clarifiers negatively impact process performance. In addition, the peak flow capacity of the facility is limited by the secondary clarifier capacity. It is recommended that new clarifiers be constructed to improve effluent quality, namely in terms of TSS and $cBOD_5$. In addition, installation of tertiary filters may be required to meet current NSE treatment requirements.
- Mill Cove WWTF:
  - This facility is currently in compliance with both the current NSE requirements as well as WSER NPS.
  - There are several asset renewal items which need to be addressed, including replacing the Bedford PS.
  - According to the Compliance Plan, the long-term plan for this facility includes an expansion of treatment capacity.
- Eastern Passage WWTF:
  - A project is currently underway to convert this facility from a primary treatment plant to a secondary treatment facility with UV disinfection. The new facility will be designed to meet NSE effluent requirements specific to the receiver, and will be compliant with WSER NPS. The upgraded facility will also be designed to accommodate growth within the collection system. Based on the Compliance Plan, the upgrades and expansion are expected to be completed by the end of 2013.
- Lakeside/Timberlea WWTF:
  - The existing facility is non-compliant with respect to NSE effluent requirements for TSS, TP, TAN and fecal coliforms. The facility is also non-compliant with respect to the WSER requirement for chlorine residual.
  - A project is currently underway to upgrade this secondary treatment facility to a tertiary treatment facility with UV disinfection. The new facility will be designed to meet NSE effluent requirements specific to the receiver, and will be compliant with WSER NPS. The upgraded facility will also be designed to accommodate growth within the collection system. According to the Compliance Plan, diverting flow from the Lakeside/Timberlea sewershed to the Halifax WWTF is also being considered.
  - There are several asset renewal items which need to be addressed, including repairing cracks in concrete tankage/foundations, and replacing and upgrading the biogas flare.

- Aerotech WWTF:
  - The existing facility is consistently non-compliant with respect to NSE effluent requirements for TSS and TAN. Historic effluent quality has been in compliance with the WSER NPS.
  - The performance of the existing treatment facility is limited by both the biological treatment capacity and available peak flow capacity.
  - Influent TKN loadings are very high due to the contributions from on-site sludge handling processes as well as the N-Viro facility. Upgrades to the biological treatment system, including providing additional SBR capacity, are required to meet current NSE requirements for ammonia. In addition, it is recommended that an operational control strategy be implemented to slowly add the Aerotech lagoon effluent to the mechanical treatment plant to avoid slug loads of high TKN/TAN influent during wet weather events.
  - It is recommended that additional peak flow capacity be provided, either through additional equalization volume and/or filtration capacity, to address peak flow limitations and improve effluent quality, namely in terms of TSS. According to the Compliance Plan, utilizing the existing Aerotech lagoon for off-line storage is also being investigated as an option to mitigate wet weather flow impacts.
  - According to the Compliance Plan, various methods of reducing TKN loadings to the Aerotech WWTF are being evaluated, including a trial involving diverting half of the sludge generated at the Mill Cove WWTF to the Herring Cove WWTF for dewatering. In addition, the N-Viro facility is now utilizing pre-treatment of its waste streams prior to discharging to the collection system.

1.5 References

Environment Canada (2006), Atlantic Canada Wastewater Guidelines.

Metcalf & Eddy (2003). Wastewater Engineering Treatment and Reuse, 4th ed.

VOLUME 3 – APPENDIX B-2

Dartmouth WWTF

APPENDIX - WORKING PAPER NO. 1.3
DARTMOUTH WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

Table of Contents

1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Dartmouth WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Dartmouth Wastewater Treatment Facility (WWTF);
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection;
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were in this baseline review:

- A site visit completed on July 6, 2011;
- Permit to Operate for the Dartmouth Sewage Collection & Treatment Plant, Nova Scotia Department of the Environment, 2010 (see Appendix A);
- Dartmouth WWTF Design Basis, Degremont, 2006; and
- Operating data from WaterTrax over the period January 2010 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Dartmouth WWTF was commissioned around 2008, and consists of coarse and fine screening, grit removal, enhanced primary clarification (Densadeg®), and an ultra violet (UV) disinfection system. The enhanced primary treatment plant was designed to treat a design ADF of 83,808 m^3/d and a peak wet weather flow (WWF) of 222,912 m^3/d. Currently, the ADF is approximately 54,650 m^3/d and peak flows have reached up to 175,500 m^3/d. The effluent from the plant discharges to Halifax Harbour.

Waste sludge is collected and removed from the Densadeg® process. Some of the sludge is recycled to the head of the Densadeg® process, and the remainder of the sludge is pumped out to the two sludge holding tanks. The raw waste sludge is then dewatered by two rotary presses. Following dewatering, the cake is hauled to the biosolids processing facility located in the AeroTech business park.

An odour control system, consisting of two wet scrubbers and a activated carbon system, provides odour control for the entire plant.

The WWTF serves approximately 85,000 people and has a geographical coverage from the Burnside Industrial Park to the Imperial Oil Refinery and East to Cole Harbour. The Dartmouth WWTF is the number one receiver of industrial flows in the Halifax region. The Dartmouth WWTF receives flow from 12 upstream pumping stations, and has the ability to shut off the main gate and in turn, the 12 upstream pumping stations will also shut down and flow will bypass directly into Halifax Harbour.

Figure 2.1 shows an aerial view of the Dartmouth WWTF site.

Figure 2.1 Dartmouth WWTF - Aerial View

2.2 Existing Facilities

Wastewater from the collection system is pumped from the 12 pumping stations to the treatment facility headworks. Influent flows to the WWTF are controlled by a main inlet gate. From the inlet gate, wastewater flows, by gravity, to an automatic coarse bar screen to remove any objects larger than the 25 mm opening size. In the event of a failure or planned maintenance, the wastewater is re-directed to flow through the manual back-up coarse bar screen (30 mm opening size).

The wastewater then flows to an influent wet well and the raw wastewater is pumped up to three fine screens (two fine screens in service and one fine screen on standby).

Raw wastewater flows are recorded via magnetic flowmeters which are connected to the SCADA system.

The screened wastewater then flows to two aerated grit removal units, which operate in parallel. In the event of maintenance or failure, the wastewater can bypass the grit tanks.

The degritted wastewater then combines into one channel before being split between two Densadeg® processes operating in parallel. In the event of maintenance or failure, the wastewater can bypass the Densadeg® treatment trains.

The wastewater enters each Densadeg® system through two flocculation zones, where alum is added in a rapid mix zone, with polymer added downstream. Sludge recycle from the sedimentation zone is also added to further enhance the flocculation process. Each Densadeg® system has one sedimentation zone, where the floc produced in the flocculation zone is settled. Lamella tube settlers are utilized in the sedimentation zone to enhance sedimentation.

Settled sludge from each Densadeg® system is removed from the sedimentation zone using a rotating scraper mechanism. A small amount of this sludge is recycled to the flocculation zone and the remainder is pumped to the sludge holding tanks. Scum is collected off of the top of the sedimentation zone and sent to an oil and grease separator. Subnatant from the oil and grease separator is discharged to the influent wet well, and collected fats, oil and grease (FOG) are pumped to the sludge holding tanks. Sludge is dewatered via two Fournier rotary presses. The cake is then trucked to the biosolids processing facility located in the AeroTech business park.

The Densadeg® system effluent is disinfected via a UV disinfection system.

Following disinfection, the wastewater flow combines before being divided amongst three separate channels, each equipped with v-notch weir flow meters. The effluent then recombines and flows by gravity to the outfall and into Halifax Harbour.

Figure 2.2 presents a process flow diagram of the Dartmouth WWTF.

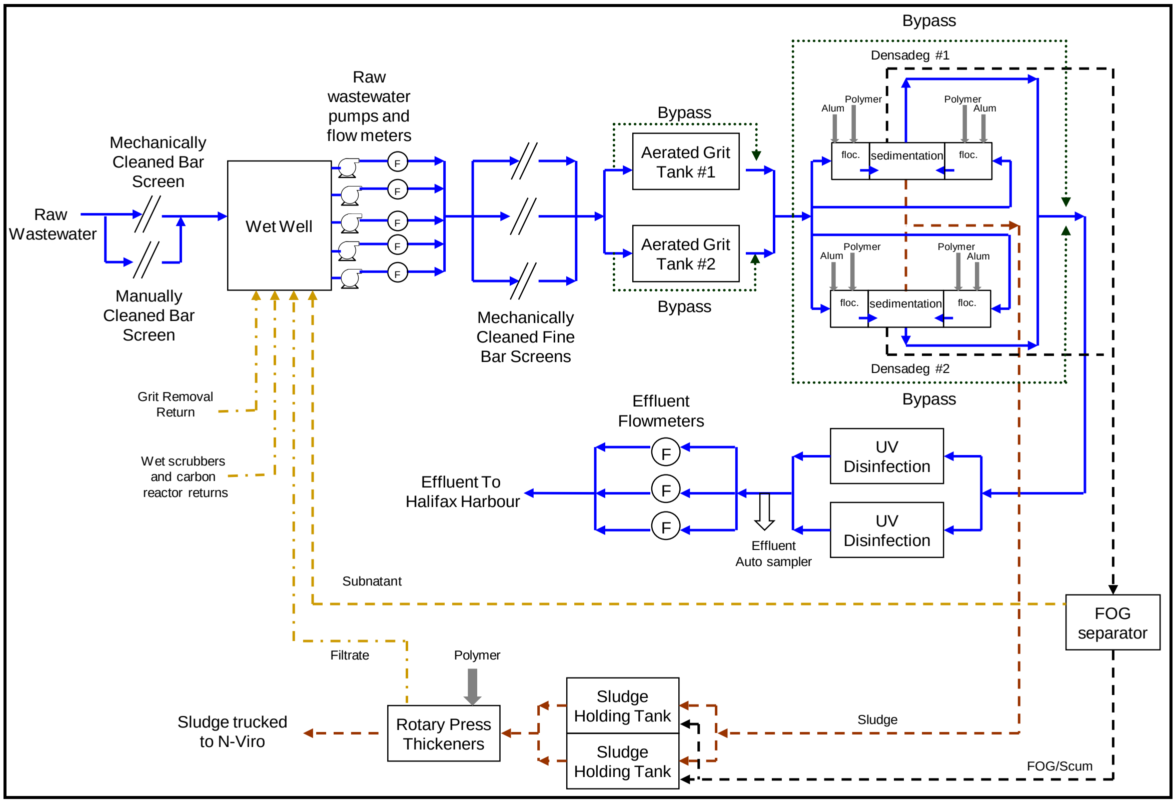


Figure 2.2 Process Flow Diagram of Dartmouth WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Dartmouth WWTF is regulated by the Nova Scotia Environment (NSE) under Permit to Operate (PTO) Approval No. 2010-070605-A01.

Table 2.1 presents the effluent requirements based on the Permit to Operate, effluent requirements as recorded in WaterTrax, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). Because the PTO defines treatment requirements, the current effluent requirements for the Dartmouth WWTF are based on PTO requirements.

Table 2.1 Dartmouth WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service
$cBOD_5$ (mg/L)	50	50	25	50
TSS (mg/L)	40	40	25	40
Fecal coliforms (MPN/100 mL) (2)	5,000	5,000	200	5,000
Fecal coliforms (geomean, MPN/100 mL) (3)	10,000	10,000	-	10,000

Notes:

n/a – not applicable

$cBOD_5$ – carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception fecal coliform individual samples and geomean).
2. Based on individual sample results.
3. Based on a geometric mean of all samples in the quarterly monitoring period.

The current treatment requirements for the Dartmouth WWTF are consistent with those for an enhanced primary treatment facility.

3. Historic Plant Performance

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2010 to July 2011) are summarized in Table 3.1. Raw wastewater quality data are based on composite samples from the influent wastewater prior to fine screening.

Table 3.1 Dartmouth WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	126 (2)	170	110 (low) 190 (med) 350 (high)
TSS	130	200	120 (low) 210 (med) 400 (high)
TP	n/d	7	4 (low) 7 (med) 12 (high)
TKN	n/d	25	20 (low) 40 (med) 70 (high)

Notes:

n/d - data not available

n/a – not applicable

BOD_5 - 5-day biochemical oxygen demand

TSS - total suspended solids

TP - total phosphorus

TKN – total Kjeldahl nitrogen

1. The "low", "med", and "high" refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. Historic values recorded as $cBOD_5$ concentrations. Sampling and testing protocol for raw wastewater should be confirmed with plant operators.

The raw wastewater quality is low to medium strength with respect to BOD_5 and TSS. In addition, operations staff noted that there are many industrial contributors and there have been spikes in raw wastewater pH and conductivity.

The raw wastewater is not currently monitored for TP or TKN. It is recommended that these parameters be added to the normal compliance sampling protocol.

3.2 Historic Flows and Effluent Quality

The flow and effluent quality data for the review period (July 2010 to July 2011) are summarized in Table 3.2. Effluent quality data are based on composite and grab samples from the effluent downstream of UV disinfection.

Table 3.2 Dartmouth WWTF Effluent Flow and Quality Data

Parameter	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 4)	48,641	64,315	-
MDF (m^3/d) (1)	175,506	152,622	-
$cBOD_5$ (mg/L)	35.5	33.6	50
TSS (mg/L)	29.2	31.8	40
TP (mg/L) (2)	0.6	0.7	-
TAN (mg/L) (2)	8.1	9.9	-
Fecal coliforms (MPN/100 mL) (3)	1,519	3,872	10,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data for 2011 were only available over the period January to May.
2. Results were only available over the period from November 2010 to July 2011.
3. Average fecal coliform values reported are annual arithmetic means.
4. Rated ADF capacity is 83,808 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80 percent of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Dartmouth WWTF Compliance with Treatment Requirements (July 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	3 in compliance / 4 total	233 in compliance / 234 total
TSS	2 in compliance / 4 total	176 in compliance / 238 total
Fecal coliforms	0 in compliance / 4 total	229 in compliance / 234 total
Fecal coliforms (geomean)	4 in compliance / 4 total	n/a

Historically, the Dartmouth WWTF has met effluent requirements in terms of the quarterly requirements for $cBOD_5$ and fecal coliform geomean, which were met for 75 and 100 percent of the quarters, respectively.

Effluent TSS and fecal coliforms frequently exceeded the PTO compliance limits with only 50 and 0 percent of the quarterly samples in compliance, respectively.

Individual samples for $cBOD_5$, TSS, and fecal coliforms were in compliance for the majority of the time with 99, 74, and 98 percent of the individual samples meeting compliancy requirements, respectively.

Currently, there are no TP effluent limits for the Dartmouth WWTF, but the historical effluent TP concentration averaged about 0.70 mg/L.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Dartmouth WWTF has the ability to bypass the aerated grit removal tanks in the event of a failure or if maintenance is needed to be performed on the process. The bypass is located directly before the grit removal tank, and the bypass lines discharge into the grit removal effluent channel. The Dartmouth WWTF also has the ability to bypass the entire Densadeg® system, in which case the wastewater flows directly to UV disinfection.

Power outages, limitations in on-line treatment capacity, communication issues between the pumping stations and the WWTF, and computer system issues have led to the automatic closing of the main gate inlet gate, which causes the upstream pumping stations to overflow into the Halifax Harbour.

Peak flows due to inflow and infiltration (I/I) are a major hydraulic issue. The Dartmouth WWTF receives a dry weather average day flow of about 48,000 m^3/d; during wet weather events, peak instantaneous flows have been as high as 216,000 m^3/d. Operations staff have noted that peak flows have resulted in washout of the sedimentation zones of the Densadeg® systems, resulting in poor effluent quality.

3.4 Design, Operational and Condition Issues

Operations staff indicate that the level sensors that determine differential liquid levels upstream and downstream of the coarse screen do not work properly, resulting in the frequent operation of the manual bar screen although the flows did not exceed the capacity of the automatic bar screen.

Plant operations staff indicate that there may be short-circuiting within the grit removal systems due to modifications made to the effluent channel of the grit tank. An accumulation of grit has been found in the inlet channel to the Densadeg® systems, indicating inadequate upstream grit removal.

The effluent from the Densadeg® systems is prone to foaming. Although this does not negatively impact effluent quality, it has affected the downstream v-notch weir flow meters that utilize ultrasonic level detectors. A spray bar has been installed directly before the effluent flow is measured; however, this has not fully rectified effluent flow metering problem.

One of three main motor control centres (MCCs) is located in the basement of the WWTF, which may be an issue should flooding occur. According to operations staff, a flood occurred in February 2011, and the water level rose to within an inch of the bottom of the MCC.

According to operations staff, many pieces of equipment (pumps, blowers, etc.) are not set to rotate lead/lag operation, and therefore operations staff manually run the equipment to have equal run-times.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Dartmouth WWTF is 83,808 m^3/d. The historic January 2010 to May 2011 average day flow to the Dartmouth WWTF was 54,655 m^3/d, or approximately 65 percent of the design rated capacity.

The design peak wet weather flow capacity of the Dartmouth WWTF is 222,912 m^3/d. The Dartmouth WWTF has reached maximum day flows as high as 175,506 m^3/d, or approximately 79 percent of the design rated capacity.

The design capacity values from the Degremont Design Basis (Degremont, 2006) were used in order to establish the existing treatment capacity of the Dartmouth WWTF. The minimum flow the plant is designed to treat is 16,416 m^3/d. The channels in the plant are designed to hydraulically handle flows up to four times the average dry weather flow, equivalent to 264,384 m^3/d.

Due to the proprietary nature of the Densadeg treatment process, a desktop assessment of treatment capacity was not possible. However, according to input from operations staff, the effluent quality from the Densadeg systems has been impaired at peak instantaneous flows around 216,000 m^3/d.

4. FUTURE CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver is Halifax Harbour on the Atlantic Ocean. The effluent is discharged approximately 800 metres off-shore. An assimilative capacity study of the effluent receiver would be required to determine future treatment requirements.

4.2 Site Constraints

The Halifax Regional Municipality owns land southeast of the existing Dartmouth WWTF, on a grassy flat area, that is available for expansion.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Dartmouth WWTF:

- Historically, the Dartmouth WWTF has produced good quality effluent with respect to $cBOD_5$ and fecal coliforms (geomean). Effluent requirements for these parameters have been consistently met.
- Effluent TSS and fecal coliforms exceeded the PTO quarterly compliance limits the majority of the time.
- Currently, there are no TP effluent limits for the Dartmouth WWTF, but the historical effluent TP concentration averaged about 0.70 mg/L.
- The Dartmouth WWTF receives low strength raw wastewater; however, there are many industrial contributors and there have been spikes in influent pH and conductivity.
- The WWTF experiences reduced performance during high wet weather flows, when solids separation is impaired.
- The Dartmouth WWTF experiences short circuiting issues in their grit removal process, as well as uneven flow splits between fine screens.
- The WWTF experiences a number of communications and SCADA system related issues that cause the main gate to close at the WWTF, resulting in pumping stations overflowing directly into the Halifax Harbour.
- Based on the Degremont Design Basis, the existing Dartmouth WWTF has design capacities as follows:
  - Average day flow capacity: 83,808 m^3/d; and
  - Peak WWF capacity: 222,912 m^3/d.
- According to operations staff, deterioration in effluent quality is seen at peak instantaneous flows of approximately 216,000 m^3/d.
- An assimilative capacity study of the effluent receiver, Halifax Harbour, would be required to determine future treatment requirements.
- Halifax Regional Municipality owns land located southeast of the existing Dartmouth WWTF, which is available for expansion.

6. REFERENCES

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA
Environment
Environmental Monitoring and Compliance

30 Damascus Road
Suite 115
Bedford, NS
Canada B4A 0C1

902 424-7773 T
902 424-0597 F
www.gov.ns.ca

Our File Number: 94300-30BED-070605

Mr. Tony Blouin, PhD
Halifax Regional Water Commission
200 Bluewater Road
Bedford, NS
B4B 1G9

HALIFAX WATER
ENGINEERING DEPARTMENT
RECEIVED
SEP 1 4 2010
Noted
File

Dear Mr. Blouin:

RE: Approval to Operate - Dartmouth Sewage Collection & Treatment Plant
Approval No. 2010-070605-A01

Enclosed please find Approval # 2010-070605-A01 to operate the Dartmouth Sewage Collection & Treatment Plant at 12 Mawiomi Place, Dartmouth Halifax Regional Municipality, Nova Scotia.

Strict adherence to the attached terms and conditions is imperative in order to validate this approval.

Despite the issuance of this Approval, the Approval Holder is still responsible for obtaining any other authorization which may be required to carry out the activity, including those which may be necessary under provincial, federal or municipal law.

Should you have any questions, please contact Steve Westhaver, Central Region, Bedford Office at (902) 424-8183.

Yours Truly

Stephen Westhaver

Steve Westhaver, PEng
District Manager

NOVA SCOTIA
Environment

APPROVAL

Province of Nova Scotia
***Environment Act*, S.N.S. 1994-95, c.1**

APPROVAL HOLDER: **Halifax Regional Water Commission**

APPROVAL NO: **2010-070605-A01**

EXPIRY DATE: **June 30, 2013**

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Operation of the Dartmouth Sewage Collection & Treatment Plant, and associated works, at or near 12 Mawiomi Place, Dartmouth, Halifax Regional Municipality in the Province of Nova Scotia.

Administrator Stephen Westhaver

Effective Date September 13, 2010

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Environment

Approval Holder: Halifax Regional Water Commission
Project: Dartmouth Sewage Collection & Treatment Plant
Site: 12 Mawiomi Place,
Dartmouth, Halifax Regional Municipality
PID # 41127069

Approval No: 2010-070605-A01

File No: 94300-30BED-070605

Reference Documents:

- Application dated January 10, 2010 and attachments.
- Dexter Harbour Solutions Submission dated Nov 12/08
- Dartmouth STP Performance Test Report dated December 9, 2009
- Halifax Water Substantial Completion Letter dated August 3, 2010

1. **Definitions**

a) "Act" means the *Environment Act* S.N.S. 1994-1995, c.1, and includes all regulations made pursuant to the Act.

b) "Composite Sample" means a representative sample which is taken from the combination of individual samples that are collected over a 24 hour period with at least one sample of 100 ml taken at two hour intervals.

c) "Department" means the Central Region, Bedford Office, of Nova Scotia Environment located at the following address:

Nova Scotia Environment
Environmental Monitoring and Compliance Division
Central Region, Bedford Office,
Suite 115, 30 Damascus Road
Bedford, Nova Scotia, B4A 0C1

Phone: (902) 424-7773
Fax: (902) 424-0597

d) "Facility" means the Dartmouth Sewage Collection & Treatment Plant and associated works related to the Halifax Solutions Project.

e) "Grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled.

f) "Minister" means the Minister of Nova Scotia Environment.

g) "NSE" means Nova Scotia Environment.

h) "Sewage Collection System" means the piping, equipment and all auxiliaries for the Halifax Solutions collection, CSO stations, and storage of sewage from the source of the sewage to the Sewage Treatment Plant for the Dartmouth location.

i) "Sewage Treatment Plant"(STP) means the equipment and all the auxiliaries associated with the treatment of sewage including the plant effluent outfall.

2. **Scope of Approval**

a) This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to operate the Facility with the sewage collection & treatment plant, situated at or near 12 Mawiomi Place, Dartmouth, Halifax Regional Municipality (the "Site"). **This replaces the previous approval #2010-070605 which is now null & void.**

b) The Facility shall be operated as outlined in the application for approval dated January 10, 2010 and supporting documentation.

c) The Site shall not exceed the area as outlined in the application and supporting documentation.

3. **General Terms and Conditions**

a) The Approval Holder shall operate and reclaim its Facility in accordance with provisions of the:

i) *Environment Act* S.N.S. 1994-1995, c.1, as amended from time to time;
ii) Regulations, as amended from time to time, pursuant to the above Act;

b) The Approval Holder is responsible for ensuring that they operate the Facility on lands which they own or have a lease or written agreement with the landowner or occupier. Breach of this condition may result in cancellation or suspension of the Approval.

c) If there is a discrepancy between the reference documents and the terms and conditions of this Approval, the terms and conditions of this Approval shall apply.

d) Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

e) The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

f) This Approval is not transferable without the consent of the Minister or Administrator.

g) (i) If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(2)(b) and 58(4) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

(ii) Despite a cancellation or suspension of this Approval, the Approval Holder remains subject to the penalty provisions of the Act and regulations.

h) The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the sewage treatment plant, including process changes or waste disposal practices which are not granted under this Approval. Extensions or modifications to the sewage treatment plant may be subject to the Environmental Assessment Regulations. An amendment to this Approval will be required before implementing any change.

i) Pursuant to Section 60 of the *Act*, the Approval Holder shall submit to the Administrator any new and relevant information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval.

j) The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

k) The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

l) Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

m) Unless written approval is received otherwise from the Administrator, all samples required by this Approval shall be analysed by a laboratory that meets the requirements of the Department's "Policy on Acceptable Certification of Laboratories" as amended from time to time.

n) The Approval Holder shall submit any monitoring results or reports required by this Approval to the Department. Unless specified otherwise in this Approval, all monitoring results shall be submitted within 30 days following the last month of the monitoring period.

o) The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel directly involved in the Facility operation are made fully aware of the terms and conditions which pertain to this Approval.

4. **Spills or Releases**

a) All spills or releases shall be reported in accordance with the *Act* (Part VI) and the *Emergency Spill Regulations*.

b) Spills or releases shall be cleaned up immediately in accordance with the *Act*.

c) A quantity of spill/release response material is to be maintained on Site at all times.

5. **Sludge Disposal**

a) All sludge generated at the Facility shall be treated and disposed of by a method acceptable to the Department.

6. **Operation**

a) The Approval Holder shall designate in writing, to the Department, any change in the contact person for this Approval.

b) The Facility must be operated and maintained in a manner that will prevent erosion, chemical spills or any other incidents that may be detrimental to the environment and public health.

c) The Approval Holder shall ensure that the Facility is operated, maintained and has appropriate backup facilities to protect against failures of the power supply, treatment process, equipment, or structure. Security measures shall assure the safety of the sewage treatment processes, storage facilities, and the discharge system.

d) The Approval Holder shall ensure the development and implementation of a contingency/emergency response plan for the Facility in accordance with the requirements of the Nova Scotia Environment "Contingency Planning Guidelines" as amended from time to time. A copy of the contingency/emergency response plan is to be maintained on Site at all times. The plan should include:

   i) General procedures for routine (equipment break-down, upset conditions, maintenance, etc.) or major emergencies within the facility system; and

   ii) A plan for equipment becoming inoperable in a major emergency.

   iii) A plan for dealing with spills or releases.

e) When it is necessary to use an approved by-pass related to a Facility issue, the Approval Holder shall notify the Department immediately.

f) The Approval Holder shall take immediate preventive or corrective action when results of an inspection or sampling results indicate conditions which are currently or may become a detriment to the STP operations, and/or result in adverse impact to the environment or public health.

g) The Facility has been classified as a **Class III sewage treatment plant and Class III sewage collection system**. The day-to-day operations of the sewage treatment plant and collection system shall be supervised directly by certified operators who hold the appropriate certification.

h) The Approval Holder shall establish and submit to NSE upon request notification procedures to be used to contact the Medical Officer of Health, NSE, other relevant authorities and the general public in the case of an emergency situation.

i) The Approval Holder shall prepare a comprehensive operations manual for the STP within three months of commencement of operation of the sewage treatment plant and keep it up to date. The manual shall be subject to review by NSE upon request.

j) The Approval Holder shall establish procedures for receiving and responding to complaints including a reporting system which records what steps were taken to determine the cause of complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

7. Performance And Limits

7.1 Treated Effluent

The sewage treatment plant shall be managed and operated in such a manner that the effluent being discharged to the receiving waters satisfies the following criteria:

a) $CBOD_5$, shall not exceed 50 mg/l.

b) Total Suspended Solids, shall not exceed 40 mg/l

c) Fecal coliform shall not exceed 5000/100 mls or the geometric mean of all samples in the quarterly monitoring period shall be less than or equal to 10,000 counts per 100 mls.

d) Disinfection of the effluent from the sewage treatment plant shall be continuous.

e) The sewage treatment plant shall be considered in compliance with the effluent limitations if 80% of the sample test results, at the frequency and location specified in table 1 meet the specified effluent limits. No single result can be greater than two times the limits except for the fecal limit as noted.

7.2 Odour Control

a) The Approval Holder shall operate the Facility in a manner which will not result in the generation of offensive or hazardous odours/vapours.

b) The Approval Holder shall be required to implement control measures if odour generation is deemed excessive by the Department.

8. Monitoring and Recording

a) The Approval Holder shall conduct all monitoring and analysis required in this section according to the latest edition of "Standard Methods for the Examination of Water and Waste Water".

b) All equipment must be installed, maintained and calibrated as specified by the manufacturer's instructions.

c) Following a review of any of the analytical results required by this Approval, NSE may alter the frequencies, location, and parameters for analyses required for this Approval.

TABLE 1		
PARAMETER	**MINIMUM FREQUENCY**	**STP LOCATION**
$CBOD_5$	5/week	effluent discharge
Suspended Solids	5/week	effluent discharge
Fecal Coliform	5/week(grab sample)	effluent discharge
pH	5/week	effluent discharge
Plant Volumes	continuous	entering or leaving stp
Total Ammonia	1/month	effluent discharge

* All samples shall be composite unless stated otherwise.

9. Reporting

9.1 Quarterly Reporting

a) The Approval Holder shall prepare and submit to the Department on a quarterly basis, the results of the sampling conducted at the locations indicated in table 1.

b) The Approval Holder shall prepare and submit to the Department, a quarterly performance report for the Facility. The report shall contain the following information in a format acceptable to the District Manager.

i) a summary and discussion of the quantity of sewage treated during the reporting period compared to the design values for the sewage treatment plant, including peak flow rates, maximum daily flows and monthly average daily flows;

ii) a summary and interpretation of analytical results obtained in accordance with Section 8 (Monitoring and Recording) of this Approval;

iv) a tabulation and description of any emergency or upset conditions which occurred during the period being reported upon and action taken to correct them;

v) any complaints that were received and the Approval Holders response.

vi) the monitoring results associated with the CSO overflow events(ie. times, volumes, quality)

9.2 **Emergency Reporting on Operation**

a) The Approval Holder shall notify the Department forthwith in the event that untreated sewage is directed to the environment as a result of malfunction, upset, or equipment failure.

b) The Approval Holder shall immediately notify the Department of any incidents of exceedence of the compliance requirement indicated in section 7.1.

10. **Records**

a) The Approval Holder shall keep the following records and wastewater effluent quality analyses:

i) $CBOD_5$, Suspended Solids, and Bacteriological analyses shall be kept for five years;

ii) Flow meter readings shall be kept for 10 years.

b) The Approval Holder shall also retain the following information for a period of three years:

i) calibration and maintenance record

ii) continuous monitoring data

iii) records of any violations of the conditions of this Approval and actions taken by the Approval Holder to correct those violations.

c) A complete set of the as-built drawings, incorporating any amendments made from time to time, shall be kept by the Approval Holder at the Site for as long as the sewage treatment plant is kept in operation.

11. **Site Specific Conditions**

a) On or before September 30, 2010 a proposed monitoring protocol for the combined sewer overflow(CSO) stations associated with the Dartmouth Sewage Collection System is to be submitted to NSE for review and authorization. The proposed monitoring protocol is to include testing for $CBOD_5$, SS, and fecal coliform as well as the times and volumes of the overflow events.

b) The Approval Holder upon request by the Department may be required to modify the monitoring locations, parameters and frequency; evaluate impact of the overflow event or conduct remedial measures depending on the information obtained from the authorized CSO monitoring program.

APPENDIX B

SITE VISIT PHOTOS

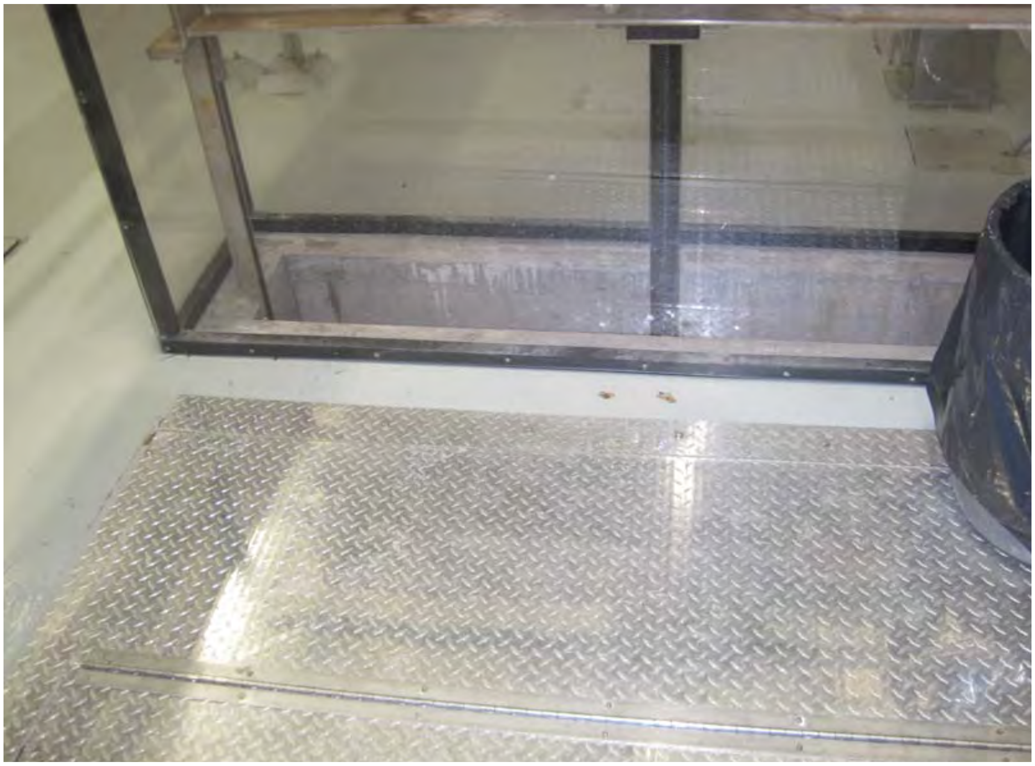
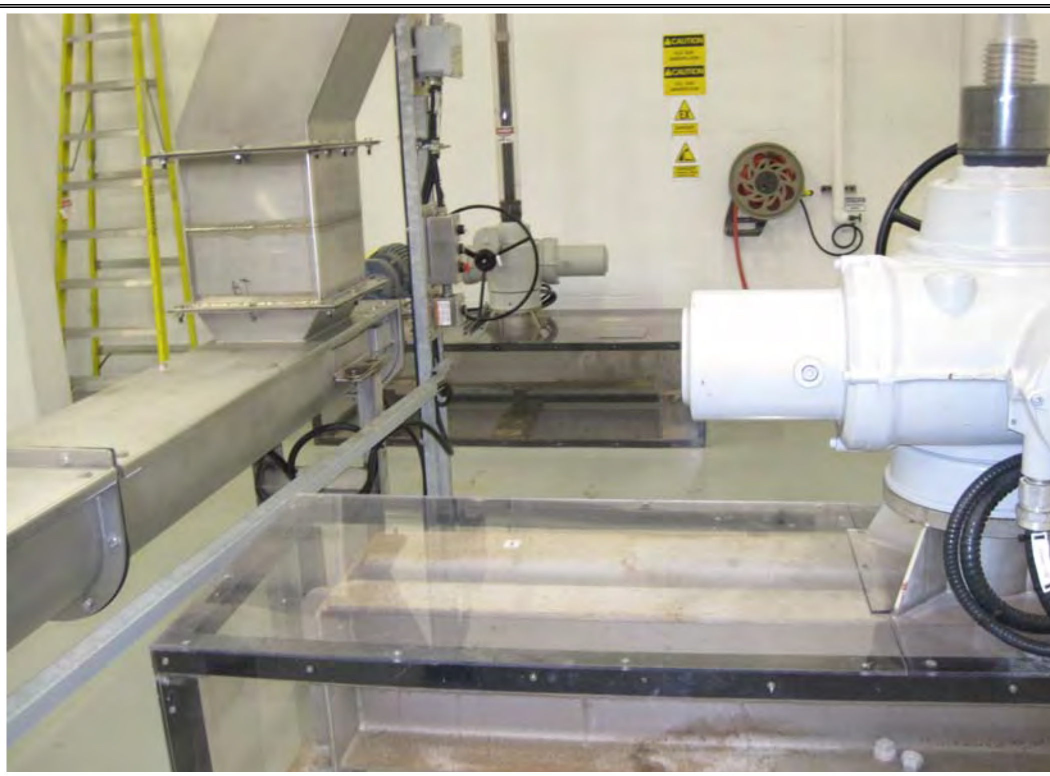


Photo 1 Dartmouth Influent Weir Gate



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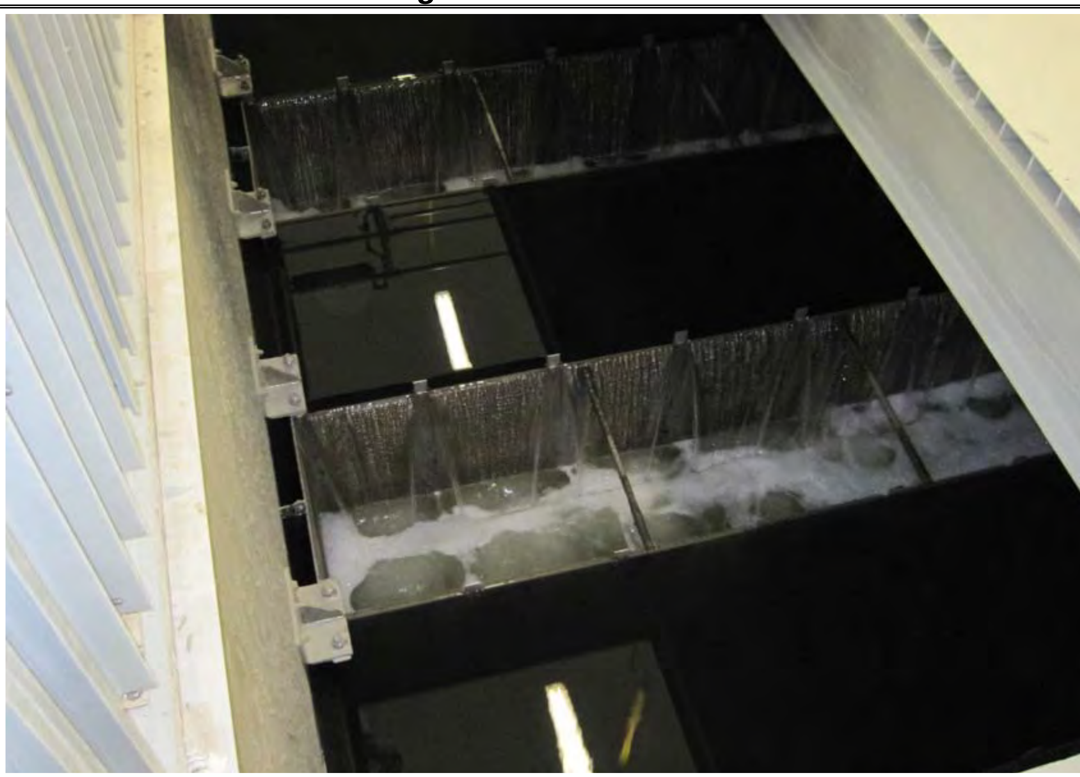

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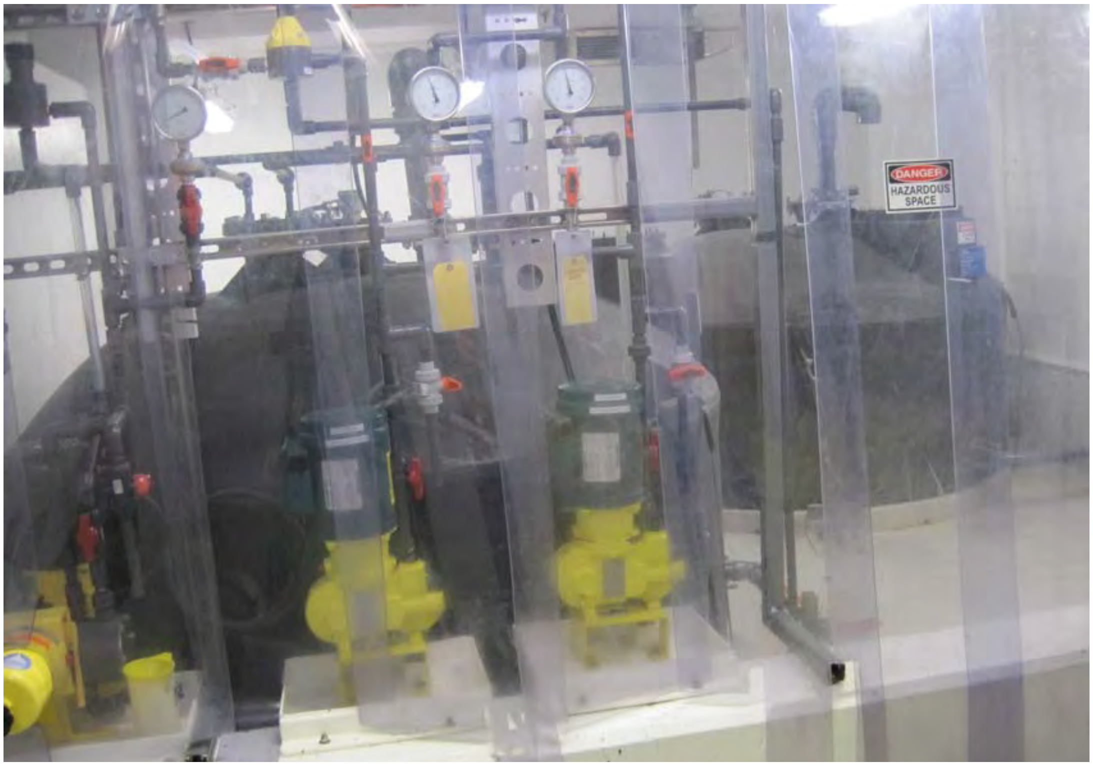

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VOLUME 3 – APPENDIX B-3

Aerotech WWTF

APPENDIX - WORKING PAPER NO. 1.3
AEROTECH WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the AeroTech WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the AeroTech Wastewater Treatment Facility (WWTF);
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection;
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- Permit to Operate, AeroTech WWTF, Approval No. 2004-042134, effective September 10, 2004 and expiring September 10, 2014 (see Appendix A);
- Permit to Operate, AeroTech Sludge Treatment Facility, Approval No. 20042010-070726, dated February 10, 2010 and expiring December 1, 2016;
- A site visit conducted on July 4, 2011;
- Final AeroTech Report, CBCL Limited Consulting Engineers, 2008;
- Operating data from WaterTrax over the period January 2010 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The AeroTech WWTF is a tertiary treatment facility that services the Halifax Stanfield International Airport (HSIA) and AeroTech Business Park. It was upgraded in 2006 and has a design capacity of 1,400 m^3/d. The AeroTech WWTF also provides sludge dewatering for other HRM wastewater treatment facilities. The liquid treatment train consists of screening, grit removal, sequencing batch reactors (SBRs) with pre- and post-equalization, granular media filtration, and UV disinfection. The solids handling process consists of sludge polymer conditioning and dewatering via rotary press filters. The dewatered sludge cake is sent to the nearby biosolids processing facility for further processing. Filtrate from the dewatering process is sent to a lagoon for storage prior to be returned to the AeroTech WWTF for treatment. Overflows from the filtrate storage lagoon are also directed to the AeroTech WWTF.

Effluent is discharged to the Johnson River, a sensitive receiver. As such, the AeroTech WWTF is required to provide year-round nitrification.

Figure 2.1 shows an aerial view of the AeroTech WWTF and the AeroTech Lagoon.

Figure 2.1 AeroTech WWTF and Lagoon - Aerial View

2.2 Existing Facilities

Liquid Treatment Train

Wastewater from the AeroTech Business Park collection system and the filtrate storage lagoon flow to an onsite pumping station equipped with four pumps and a magnetic flowmeter on the raw sewage forcemain to record influent flows to the WWTF. From there, the wastewater passes through preliminary treatment consisting of screening and vortex grit removal. A bypass is provided around the mechanical bar screen (equipped with a manual bar screen) and around grit removal.

The screened and degritted wastewater is directed to a pre-equalization tank. The tank is equipped with online pH and temperature sensors. An equalization surge tank provides additional storage in the case of high flows to the AeroTech WWTF. Prior to the latest plant expansion, which converted the facility from a rotating biological contactor (RBC) treatment process to SBRs, the pre-equalization and surge tanks were the primary and secondary clarifier tanks, respectively. These tanks were retrofitted as part of the expansion.

The screened and degritted wastewater is then pumped to the four SBR reactors. Alum for phosphorus removal, and caustic soda for alkalinity addition, are added upstream of the SBR reactors. The SBR reactors are operated batch-wise, with the treatment cycles controlled based on a timer system. During normal (dry weather) flows, the react time is set to 180 minutes. During higher flows, the react time is automatically adjusted via the SCADA system to 110 min or, during extreme wet weather events, down to 60 min. The settling phase of the cycle is set to 60 min. Historically, waste activated sludge (WAS) from the SBRs is mixed with the rotary press filtrate prior to being discharged to the lagoon, however it is understood that this operational practice has recently been modified. WAS is now directed to the solids treatment train for dewatering.

The decant from the SBR reactors is directed to the post-equalization tank. The secondary effluent is pumped from the post-equalization tank to the two continuous backwash granular media filters, which operate in parallel. Backwash flow rates are adjusted manually based on a visual assessment of the backwash quality.

The filter effluent is then directed to UV disinfection prior to being discharged to the outfall.

Figure 2.2 presents a process flow diagram of the AeroTech WWTF liquid treatment train.

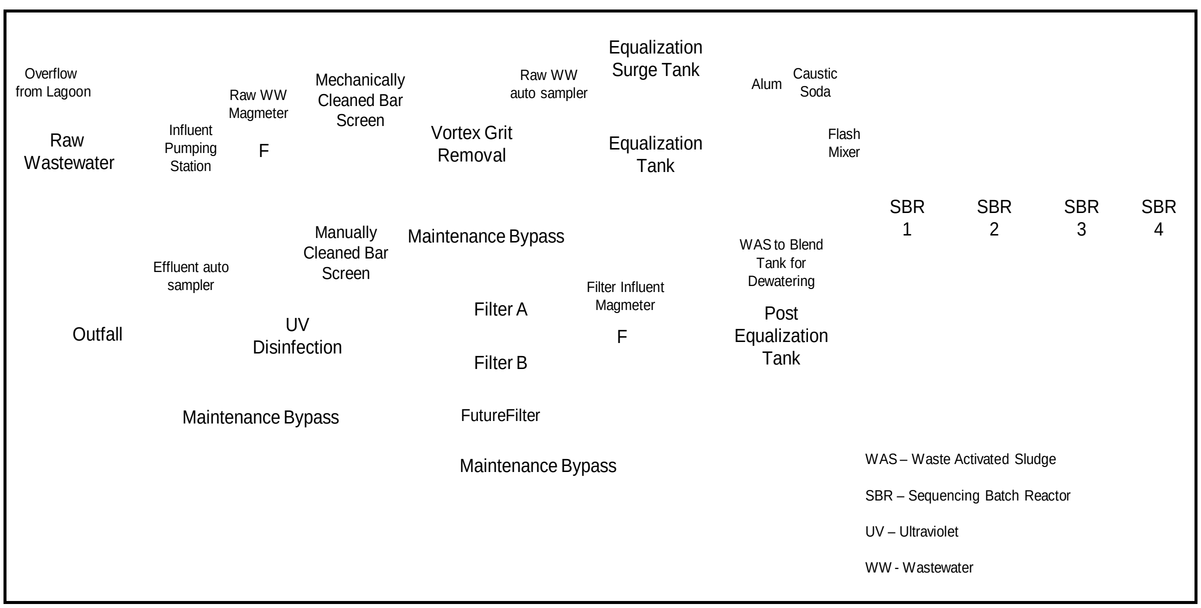

Figure 2.2 Process Flow Diagram of the AeroTech WWTF Liquid Treatment Train

Sludge Handling

The AeroTech WWTF provides sludge dewatering for all HRM wastewater treatment facilities that do not have their own onsite dewatering treatment processes, namely the Mill Cove, Eastern Passage, Timberlea/Lakeside, North Preston, Lockview (Fall River), Springfield Lake, Middle Musquodoboit, Uplands Park, Wellington, and Frame WWTFs. Septage and other hauled wastes are also accepted at the AeroTech WWTF.

The sludge handling process consists of screening, short-term storage in a sludge blend tank, and two dewatering units consisting of four Fournier rotary presses in each unit. The sludge is conditioned with polymer, and allowed to flocculate, prior to dewatering. The dewatered sludge cake is directly discharged into a truck, and hauled off-site to the nearby biosolids processing facility for further processing.

Rotary press filtrate is collected in a filtrate tank, along with WAS from the AeroTech SBRs, and is pumped to the lagoon. Other hauled wastes which cannot be dewatered, such as storm sewer catch-basin cleanout waste, is discharged directly into the lagoon. Overflow from the lagoon is directed to the head of the AeroTech WWTF liquid treatment train.

Figure 2.3 presents a process flow diagram of the AeroTech WWTF sludge handling and treatment train.

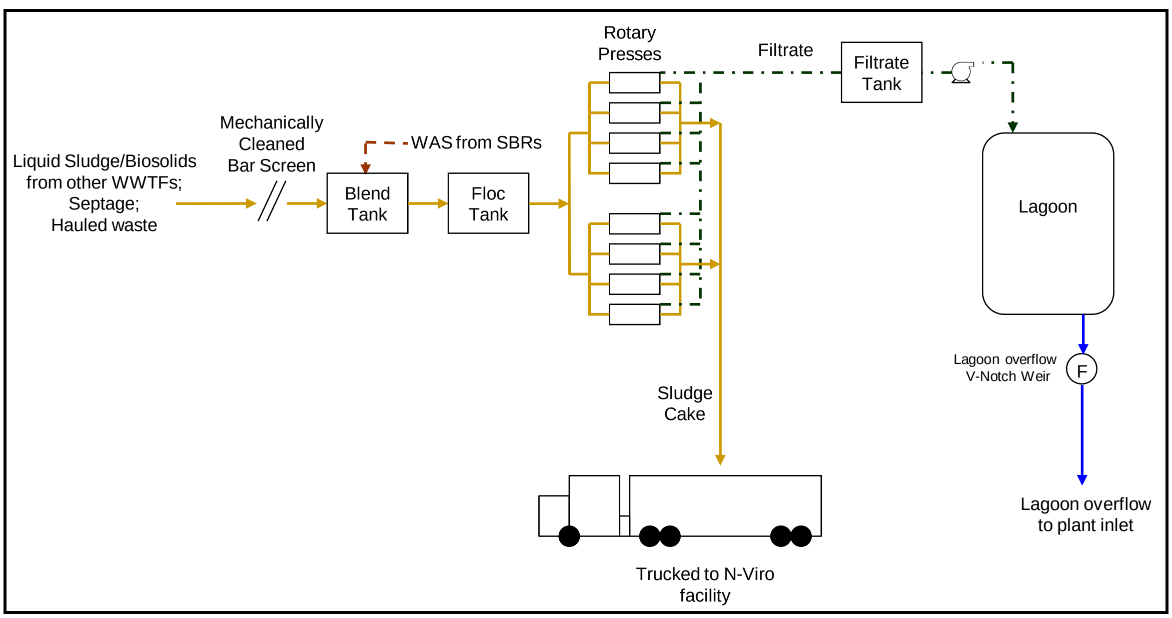

Figure 2.3 **Process Flow Diagram of the AeroTech WWTF Sludge Handling and Treatment Train**

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Dartmouth WWTF is regulated by Nova Scotia Environment (NSE) under Approval No. 2004-042134, effective September 10, 2004 and expiring September 10, 2014.

Table 2.1 presents the effluent requirements based on the Permit to Operate (PTO), effluent requirements as recorded in WaterTrax, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). Because the PTO defines treatment requirements, the current effluent requirements for the Dartmouth WWTF are based on PTO requirements, with an additional effluent requirement for fecal coliform geomean, as recorded in WaterTrax.

Table 2.1 AeroTech WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	HW Treatment Standards	Atlantic Canada Guidelines	Current Required Level of Service (1)
$cBOD_5$ (mg/L)	10	10	20	10
TSS (mg/L)	10	10	20	10
TP (mg/L)	2	2	-	2
TAN (mg/L)	3	3	-	3
Fecal coliforms (cfu/100 mL) (2)	200	200	200	200
Fecal coliforms (geomean, cfu/100 mL) (3)	-	400	-	400
pH	Between 6.5 and 9	Between 6.5 and 9	-	Between 6.5 and 9

Notes:

n/a – not applicable

$cBOD_5$ – five-day carbonaceous biochemical oxygen demand

TSS – total suspended solids

TP – total phosphorus

TAN – total ammonia nitrogen

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception pH, and fecal coliform individual samples and geomean).
2. Based on individual sample results.
3. Based on a geometric mean of all samples in the quarterly monitoring period.

The current treatment requirements for the AeroTech WWTF are consistent with those for a nitrifying tertiary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2010 to July 2011) are summarized in Table 3.1.

Table 3.1 AeroTech WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	140	170	110 (low) 190 (med) 350 (high)
TSS	154	200	120 (low) 210 (med) 400 (high)
TP	4.6	7	4 (low) 7 (med) 12 (high)
TKN	63 (2)	25	20 (low) 40 (med) 70 (high)

Notes:

n/d - data not available

n/a – not applicable

TKN – total Kjeldahl nitrogen

1. The “low”, “med”, and “high” refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. The raw wastewater TKN was estimated based on the historic raw wastewater TAN concentration of 50 mg/L, and assuming a TAN:TKN ratio of 0.80.

The raw wastewater quality is low to medium strength with respect to BOD_5, TSS and TP, and medium to high strength with respect to TKN.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2010 to July 2011) are summarized in Table 3.2.

Table 3.2 AeroTech WWTF Effluent Flow and Quality Data

Parameter	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1)	1,191	1,147	-
MDF (m^3/d)	3,365	2,967	-
$cBOD_5$ (mg/L)	5.7	5.9	10
TSS (mg/L)	13.3	13.3	10
TP (mg/L)	0.39	0.41	2
TAN (mg/L)	26.6	47.7	3
E. coli (MPN/100 mL) (2)	6.2	13	200

Notes:

ADF – average day flow

MDF – maximum day flow

1. Design ADF capacity is 1,400 m^3/d.
2. Average fecal coliform values reported are annual geometric means.

Compliance with respect to the current effluent requirements is determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 AeroTech WWTF Compliance with Treatment Requirements (January 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	6 in compliance/6 total	214 in compliance/215 total
TSS	0 in compliance/6 total	198 in compliance/236 total
TP	6 in compliance/6 total	228 in compliance/237 total
TAN	0 in compliance/6 total	32 in compliance/204 total
Fecal coliforms	5 in compliance/6 total	216 in compliance/230 total
Fecal coliforms (geomean)	6 in compliance/6 total	n/a
pH	6 in compliance/6 total	210 in compliance/210 total

The AeroTech WWTF has historically been in compliance with the effluent $cBOD_5$, TP, fecal coliform, and pH effluent requirements. Although effluent TSS has exceeded the quarterly treatment requirements for all quarters over the review period, over 80% of the individual samples met the individual sample requirement of 20 mg/L (twice the target limit). The AeroTech WWTF has consistently been non-compliant with the effluent TAN requirements both on a quarterly and individual sample basis.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The collection system shows evidence of high inflow/infiltration, resulting in high flows to the AeroTech WWTF. In addition, during wet weather, precipitation into the lagoon will cause it to overflow, further increasing the flow to the WWTF. There are no means available to plant staff to limit influent flow into the AeroTech WWTF from either the collection system or lagoon.

No hydraulic issues were reported regarding the influent pumping station or headworks.

During wet weather events, operators indicated that both the pre-equalization tank and surge tank will fill and overflow. This is due to limited capacity available in the SBRs and limited equalization storage volume.

Operators also indicated that the post-equalization tank has overflowed during wet weather events. Because the effluent flow rate from the post-equalization tank is limited by the capacity of the downstream filters, if several SBR reactors begin decanting simultaneously, the liquid level in the post-equalization tank will rise, ultimately leading to an overflow.

3.4 Design, Operational and Condition Issues

Operators indicated that the biosolids processing facility located in the AeroTech business park, which discharages to the AeroTech WWTF collection system, is not operated on a 24-hour basis, potentially resulting in large diurnal variations in influent quality. In addition, the overflows from the AeroTech lagoon are high in TAN (average concentration of 200 mg/L) resulting in high TAN loadings to the liquid treatment train and, during wet weather, slug loads. These influent quality issues are believed to have contributed to poor historical effluent quality with respect to TAN.

There is currently no means available to bypass the liquid treatment train downstream of the pre-equalization tank. According to plant staff, this has historically resulted in overflows of process tankage in the liquid treatment train.

Operations staff indicate that, although the mixed liquor in the SBRs settles well, the effluent from the SBR reactors is often high in TSS. Operators were unsure why or when this is occurring during the decant cycle. In addition, due to the high solids concentration of the SBR effluent, operations staff do not currently aerate the post-equalization tank; rather, they operate the post-equalization tank without aeration to allow solids to settle out to prevent high influent solids concentrations to the downstream filters to avoid filter blinding.

Elevated concentrations of solids in the effluent from the SBR reactors combined with the design of the post-equalization tank (flat bottom, location of effluent hopper) results in an accumulation of solids in the bottom of the post-equalization tank. Operators need to frequently clean out the post-equalization tank to remove the solids (approximately every two weeks). This process is very labour intensive, and can only be done during dry weather periods.

The existing back-up power generator, located on-site, only provides power for lights and the influent pumping station.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the AeroTech WWTF is 1,400 m^3/d. The historic January 2010 to April 2011 average day flow to the AeroTech WWTF was 1,182 m^3/d, or approximately 84% of the design rated capacity. In spite of operating at average flows below the design capacity, the AeroTech WWTF has been unable to achieve the effluent requirements, namely in terms of TSS and TAN.

A preliminary desktop capacity assessment was completed to estimate the existing treatment capacity of the AeroTech WWTF liquid treatment train. Based on four SBR cells providing a total volume of 1,424 m^3, a post-equalization tank with a volume of 411 m^3 (CBCL, 2008), maintaining a minimum dissolved oxygen (DO) concentration in the SBR tanks of 2.0 mg/L, historic raw wastewater quality, and providing year-round nitrification, the estimated average day capacity of the AeroTech WWTF is 700 m^3/d (required react cycle duration of 10 hours). The maximum day biological treatment capacity was estimated to be 1,210 m^3/d (minimum required react cycle duration of 5.5 hours).

Limited data were available regarding existing pre-equalization tank sizes. As a result, an evaluation of the existing peak flow capacity of the AeroTech WWTF could not be completed. However, based on the downstream biological treatment capacity and estimated pre-equalization tank volumes, the peak flow capacity of the AeroTech WWTF is estimated to be approximately 1,710 m^3/d.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver, Johnson River, has low flow periods and would be a dry ditch for several months a year without plant effluent. As a result, the existing assimilative capacity of the Johnson River is very limited. Given the zero dilution ratio available during dry months, the effluent from the AeroTech WWTF may need to meet Canadian Water Quality Guideline values, requiring the application of best available technology (BAT).

The Johnson River discharges to Soldier Lake, which has assimilative capacity available. According to the Final AeroTech Report (CBCL, 2008), if the outfall were extended to discharge directly into Soldier Lake, the existing effluent limits as outlined in the PTO, could be maintained. An assimilative capacity assessment of Soldier Lake would need to be completed to confirm future treatment requirements.

4.2 Site Constraints

There is room available for expansion within the existing fenced area of the AeroTech WWTF. Two or three additional SBR tanks could be constructed adjacent to the existing SBR tanks, and additional influent equalization volume could be constructed adjacent to the existing equalization tankage.

The properties located adjacent to the AeroTech WWTF, on the south side of AeroTech Drive, are wooded. Expansion of the treatment facility onto these adjacent properties may be possible.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the AeroTech WWTF:

- The raw wastewater quality is low to medium strength with respect to BOD_5, TSS and TP, and medium to high strength with respect to TKN.
- Historically, the AeroTech WWTF has produced effluent of high quality with respect to $cBOD_5$, TP and fecal coliforms. Effluent requirements for these parameters have been consistently met.
- Although effluent TSS has exceeded the quarterly treatment requirements for all quarters over the review period, over 80% of the individual samples met the individual sample requirement of 20 mg/L.
- The AeroTech WWTF has consistently been non-compliant with the effluent TAN requirements both on a quarterly and individual sample basis.
- The high TAN concentrations in the lagoon overflow have contributed to the high influent TKN loadings at the AeroTech WWTF. In addition, there is the potential for significant diurnal variations in influent quality due to discharges into the collection system from the biosolids processing facility as well as slug loads from the lagoon overflow during wet weather events.
- According to operations staff, the hydraulic capacity of the AeroTech WWTF has been exceeded, resulting in overflows of the pre- and post-equalization tanks.
- High TSS concentrations in the SBR effluent, combined with the physical configuration of the post-equalization tank, result in the need for operators to frequently drain and clean out the tank.
- The existing back-up power generator only provides power for lights and the influent pumping station.
- Based on the results of a desk-top preliminary capacity assessment, the existing AeroTech WWTF has estimated capacities as follows:
  - Average day flow capacity: 700 m^3/d;
  - Maximum day flow capacity: 1,210 m^3/d; and
  - Peak flow capacity: 1,710 m^3/d.

- The existing receiver, Johnson River, is a sensitive receiver which provides zero dilution of plant effluent over several months per year. Expansion of the AeroTech WWTF may require the application of best available technology. Extending the outfall to Soldier Lake may allow the existing effluent requirements to be retained after expansion.
- There is limited room available for expansion within the existing fenced area of the AeroTech WWTF. Expansion of the treatment facility onto adjacent wooded lots may be possible.

6. REFERENCES

CBCL Limited Consulting Engineers (2008). Final AeroTech Report.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

APPENDIX A
PERMIT TO OPERATE

NOVA SCOTIA
Department of Environment and Labour

APPROVAL

Province of Nova Scotia
***Environment Act*, S.N.S. 1994-95, c.1**

APPROVAL HOLDER: **Halifax Regional Municipality**

APPROVAL NO: **2004-042134**

EFFECTIVE DATE: **September 10, 2004**

EXPIRY DATE: **September 10, 2014**

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Construction and operation of a Sewage Treatment Plant/Sludge Dewatering Facility,and associated works, at or near Aerotech Park, Halifax, Halifax Regional Municipality in the Province of Nova Scotia.

Administrator Darby J[signature]
Date Signed Sept. 8 '04

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Department of Environment and Labour

Project: Halifax Regional Municipality
Sewage Treatment Plant/ Sludge Dewatering
Aerotech Park
Halifax, Halifax Regional Municipality

Approval No: 2004-042134

File No: 94200-30BED-042134

Reference Documents:

- Application dated August 4, 2004 and attachments.
- Dillon Project Drawings# 04-282 dated Aug 4/04
- Facility Design Report dated April/04
- Maritime Testing Geotechnical Report dated May/04
- HRM Tender Document dated Aug 5/04
- Dillon Response Memo dated Sept 2/04

1. **Definitions**

a) "Act" means the *Environment Act* S.N.S. 1994-1995, c.1, and includes all regulations made pursuant to the Act.

b) "Composite Sample" means a representative sample which is taken from the combination of individual samples that are collected over a 24 hour period with at least one sample of 100 ml taken at two hour intervals.

c) "Department" means the Central Region, Bedford Office, of the Nova Scotia Department of Environment and Labour located at the following address:

Nova Scotia Department of Environment and Labour
Environmental Monitoring and Compliance Division
Central Region, Bedford Office,
Suite 224, 1595 Bedford Highway,
Bedford, Nova Scotia, B4A 3Y4.

Phone: (902) 424-7773
Fax: (902) 424-0597

d) "Facility" means the Sewage Treatment Plant and associated works.

e) "Grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled.

f) "Minister" means the Minister of the Nova Scotia Department of Environment and Labour.

g) "NSDEL" means the Nova Scotia Department of Environment and Labour.

h) "Sewage Collection System" means the Facility and all auxiliaries for the collection, treatment, storage and discharge of sewage from the source of the sewage to the final discharge point.

2. **Scope of Approval**

a) This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to construct and operate the Facility, situated at or near Aerotech Park, Halifax, Halifax Regional Municipality (the "Site").

b) The Facility shall be constructed and operated as outlined in the application for approval dated August 4, 2004 and supporting documentation.

c) The Site shall not exceed the area as outlined in the application and supporting documentation.

d) This Approval is restricted to the installation and operation of the Facility only. No alteration or infill of a watercourse or water resource is permitted by this Approval. Works associated with the alteration or infill of a watercourse or water resource will require separate approval from the Nova Scotia Department of Environment and Labour.

e) This Approval does not apply to the electrical, roadways, and structural components of the project.

f) Should the work authorized by this Approval not be commenced within a year, this Approval shall automatically be null and void, unless extended in writing by an Administrator.

3. **General Terms and Conditions**

a) The Approval Holder shall construct, operate and reclaim its Facility in accordance with provisions of the:

i) *Environment Act* S.N.S. 1994-1995, c.1;
ii) Regulations pursuant to the above Act;
iii) Any future amendments to the Act and regulations

b) No authority is granted by this Approval to enable the Approval Holder to construct the Facility on lands which are not in the control or ownership of the Approval Holder. It is the responsibility of the Approval Holder to ensure that such a contravention does not occur. Upon request, the Approval Holder shall provide, to the Department, proof of such control or ownership.

c) If there is a discrepancy between the reference documents and the terms and conditions of this Approval, the terms and conditions of this Approval shall apply.

d) Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

e) The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

f) This Approval is not transferable without the consent of the Minister or Administrator.

g) (i) If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(2)(b) and 58(4) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

(ii) Despite a cancellation or suspension of this Approval, the Approval Holder remains subject to the penalty provisions of the Act and regulations.

h) The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the Facility, including process changes or waste disposal practices which are not granted under this Approval. Extensions or modifications to the Facility may be subject to the Environmental Assessment Regulations. An amendment to this Approval will be required before implementing any change.

i) Pursuant to Section 60 of the *Act*, the Approval Holder shall submit to the Administrator any new and relevant information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval.

j) The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

k) The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

l) Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

m) All samples required by this Approval shall be analysed by a laboratory that is:

   i) Accredited by the Standards Council of Canada; or

   ii) Accredited by another agency recognised by the Nova Scotia Department of Environment and Labour to be equivalent to the Standards Council of Canada; or

   iii) Maintaining an acceptable standard in a proficiency testing program conducted by the Canadian Association for Environmental Analytical Laboratories for all parameters being reported; or

   iv) Maintaining an acceptable standard in a proficiency or performance testing in another program considered acceptable to the Nova Scotia Department of Environment and Labour for all parameters being reported

n) The Approval Holder shall submit any monitoring results or reports required by this Approval to the Department. Unless specified otherwise in this Approval, all monitoring results shall be submitted within 30 days following the month of monitoring.

o) The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel directly involved in the Facility operation are made fully aware of the terms and conditions which pertain to this Approval.

4. **Construction of Facility**

a) All erosion and sedimentation controls are to be in place prior to construction at this Facility. The Nova Scotia Department of the Environment " Erosion and Sedimentation Control Handbook For Construction Sites" shall serve as the reference document for all erosion control measures. These measures are minimum requirements and additional controls shall be implemented if Site runoff exceeds the discharge limits contained herein.

b) All erosion and sedimentation controls are to be maintained and remain in place until the disturbed areas are stabilized.

c) The Approval Holder shall sample for the parameters and at the frequency indicated to ensure the following liquid effluent levels from any discharge from the Site are met:

Liquid Effluent Discharge Limits During Construction

Parameters	**Maximum in a Grab Sample**	**Monthly Arithmetic Mean**	**Monitoring Frequency**
Total Suspended Solids	50 mg/l	25 mg/l	weekly/rain event
pH	5 - 9	5 - 9	weekly/rain event

d) Non-compliance of the effluent discharge limits noted in clause (c) shall be immediately reported to the Department.

e) (i) The monitoring station(s) for the liquid effluent shall be the discharge from any location on Site, including the settling ponds.

(ii) Monitoring station locations shall be constantly reviewed by the Approval Holder and the locations revised as construction progresses and as approved by the Department.

(iii) The Department reserves the right to modify the monitoring locations, parameters and frequency, and to require remedial measures depending on the information obtained.

f) The Approval Holder shall submit a monthly report summarizing the above sampling results to the Department.

g) All areas exposed during construction and temporary diversion, or control structures such as berms, ditches, etc., shall be stabilized immediately.

h) When dewatering of construction areas is required, the water must not be discharged directly to a watercourse or water resource, nor to a conveyance (a ditch, culvert, manhole) that may lead to a watercourse or water resource without prior treatment to meet limits established in condition 4(c).

i) Grubbings and excavated material shall be stored or disposed of in a manner that will not result in sedimentation of adjacent and downstream watercourses or water resources.

j) Temporary erosion and sedimentation controls are to remain in place until Site stability is established. Approval for the removal of such controls must be obtained from the Department. All erosion and sedimentation control measures shall be monitored daily throughout the construction period and maintained as necessary.

k) Chemical flocculants are to be approved by the Department prior to their use. Requests for approval must be submitted at least 15 days prior to the use of the flocculants.

l) All phases of construction shall be overseen by a qualified professional engineer, licensed to practice in the Province of Nova Scotia, or technologist who works under the supervision of an engineer.

m) (i) Written certification by a professional engineer is required stating that all construction or installation has been conducted in accordance with and has met the minimum requirements of the approved drawings and specifications.

(ii) This certification must be provided to NSDEL, within 6 weeks of project completion.

(iii) The certification must include a complete set of as built drawings (if different than the approved drawings) and information on any major changes from the referenced drawings or specifications made during construction.

(iv) The certification must confirm that all as-built drawings and any other relevant documentation have been turned over to the Approval Holder by the engineer.

(v) The certification must include the result of the performance testing conducted on the sewage treatment plant during commissioning and the

confirmation that the Facility meets the requirements of this Approval prior to placement in service.

(vi) The Approval Holder must be complete the "Completion of the Approved Work" form and it shall be included with the certification submission.

n) It is an offence under Section 50(1) and (2) of the Act to proceed with construction or operation of the Facility in advance of receiving this Approval.

5. **Spills or Releases**

a) All spills or releases of dangerous goods, waste dangerous goods, or petroleum hydrocarbon shall be reported to the Department in accordance with the Act (Part VI) and the *Emergency Spill Regulations*.)

b) Spills or releases shall be cleaned up immediately.

c) An adequate quantity of spill/release response material is to be maintained on Site at all times.

6. **Sludge Disposal**

a) All sludge generated at the Facility shall be treated and disposed of by a method approved by the Department.

7. **Operation**

a) The Approval Holder shall designate in writing, to the Department, a contact for this Approval, prior to the startup and operation of the Facility.

b) The Facility must be constructed, operated and maintained in a manner that will prevent erosion, chemical spills or any other incidents that may be detrimental to the environment and public health.

c) The Approval Holder should ensure that the system is operated, maintained and has appropriate backup facilities to protect against failures of the power supply, treatment process, equipment, or structure. Security measures should assure the safety of the sewage treatment processes, storage facilities, and the discharge system.

d) The Approval Holder shall ensure the development and implementation of an emergency response plan as part of the operations program. This plan is to

meet the requirements of the Nova Scotia Department of Environment and Labour contingency Plan for Releases of Dangerous Goods and Hazardous Wastes. The plan is to be made available to NSDEL upon request and should include:

i) General procedures for routine (equipment break-down, upset conditions, maintenance, etc.) or major emergencies within the sewage works system; and

ii) A plan for equipment becoming inoperable in a major emergency.

iii) A plan for dealing with spills or releases.

e) The Approval Holder shall not establish nor maintain a bypass to divert sewage around the Facility or any feature of the Facility treatment process unless the bypass has been approved by the Department. When it is necessary to use an approved by-pass, the Approval Holder shall notify the Department.

f) The Approval Holder shall take immediate preventive or corrective action ,when results of an inspection or sampling results indicate conditions which are currently or may become a detriment to system operations, and/or result in adverse impact to the environment or public health.

g) The Facility has been classified as a **Class III Wastewater Treatment Plant** The day-to-day operations of the wastewater treatment plant shall be supervised directly by certified operators who hold the appropriate certification

h) The Approval Holder shall establish and make available upon request, notification procedures to be used to contact the Medical Officer of Health, NSDEL, other relevant authorities and the general public in the case of an emergency situation.

i) The Approval Holder shall prepare a comprehensive operations manual within three months of commencement of operation of the Facility and keep it up to date. The manual shall be subject to review by NSDEL upon request.

j) A complete set of the drawings, incorporating any amendments made from time to time, shall be kept by the Approval Holder at the Facility for as long as the Facility is kept in operation.

k) The Approval Holder shall establish procedures for receiving and responding to complaints including a reporting system which records what steps were taken to determine the cause of complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

8. Performance And Limits

8.1 Treated Effluent

The Facility and associated sewage collection system shall be managed and operated in such a manner that the effluent being discharged to the receiving waters satisfies the following criteria:

a) Biological oxygen demand, BOD_5, shall not exceed 10 mg/l.

b) Suspended Solids, shall not exceed 10 mg/l

c) Fecal coliform shall not exceed 200/100 count/mls

d) Disinfection of the effluent from the Facility shall be continuous.

e) pH - 6.5 to 9.

f) Nutrient levels shall not exceed the following:

Total Phosphorus	2 mg/l
Ammonia	3 mg/l

8.2 Odour Control

a) The Approval Holder shall operate the Facility in a manner which will not result in the generation of offensive or hazardous odours/vapours.

b) The Approval Holder shall be required to implement additional control measures if odour generation is deemed excessive by the Department.

9. Monitoring and Recording

a) The Approval Holder shall conduct all monitoring and analysis required in this section according to the latest edition of "Standard Methods for the Examination of Water and Waste Water".

b) All equipment must be installed, maintained and calibrated as specified by the manufacturer's instructions.

c) Following a review of any of the analytical results required by this Approval, NSDEL may alter the frequencies, location, and parameters for analyses required for this Approval.

TABLE 1		
PARAMETER	**MINIMUM FREQUENCY**	**LOCATION**
BOD_5	3/week	treated effluent discharge
Suspended Solids	3/week	treated effluent discharge
Fecal Coliform	3/week	treated effluent discharge
NH3	3/week	treated effluent discharge
Total Phosphorus	3/week	treated effluent discharge
pH	3/week	treated effluent discharge
Plant Volumes	continuous	plant inlet

d). The Facility shall be considered in compliance with the effluent limitations if 80% of the sample test results, at the frequency and number specified in table 1 meet the specified limit in section 8.1. No single result can be greater than two times the limits in section 8.1.

10. Reporting

10.1 Quarterly Reporting

a) The Approval Holder shall prepare and submit to the Department on a quarterly basis, the results of the sampling conducted at the locations indicated in table 1 above.

a) The Approval Holder shall prepare and submit to the Department, a quarterly performance report for the facility. The report shall contain the following information in a format acceptable to NSDEL.

i) a summary and discussion of the quantity of wastewater treated during the reporting period compared to the design values for the facility, including peak flow rates, maximum daily flows and monthly average daily flows;

ii) a summary and interpretation of analytical results obtained in accordance with Section 9 (monitoring and recording) of this Approval;

iv) a tabulation and description of any emergency or upset conditions which occurred during the period being reported upon and action taken to correct them;

v) Any complaints that were received and the Approval Holders response.

10.2 Emergency Reporting on Operation

a) The Approval Holder shall notify the Department forthwith in the event that untreated wastewater is directed to the receiving waters.

b) The Approval Holder shall immediately notify the Department of any incidents of exceedence of the compliance requirement indicated in section 9(d).

11. Records

a) The Approval Holder shall keep the following records and wastewater effluent quality analyses:

i) BOD_5, Suspended Solids, Ammonia, Phosphorus and Bacteriological analyses shall be kept for five years;

ii) Flow meter readings shall be kept for 10 years.

b) The Approval Holder shall also retain the following information for a period of three years:

i) calibration and maintenance records;

ii) continuous monitoring data;

iii) records of any violations of the conditions of this Approval and actions taken by the Approval Holder to correct those violations.

c) A copy of this Approval, project reports, construction documents and drawings, inspection reports, shall be kept for the life of the facility.

APPENDIX B
SITE VISIT PHOTOS

Photo 1 AeroTech Influent Pumping Station

Photo 2 AeroTech Headworks Building and Equalization Tanks

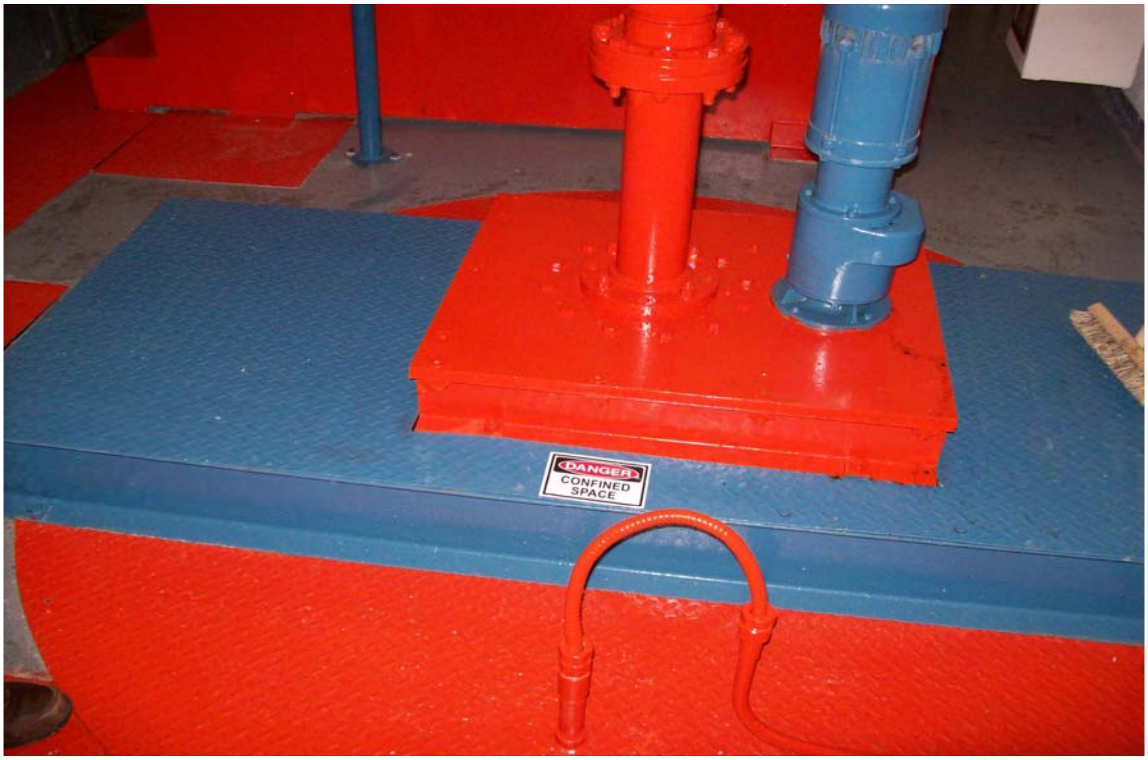

Photo 3 AeroTech Grit Tank

Photo 4 AeroTech Manual Grit Collection

Photo 5 AeroTech Manual Grit Collection 2

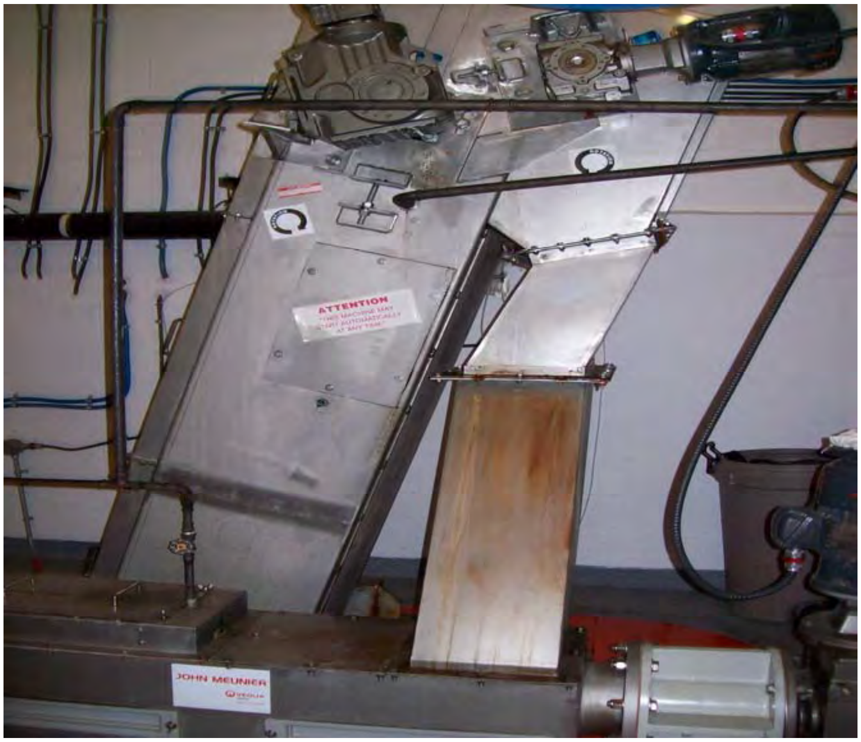

Photo 6 AeroTech Mechanical Screen

Photo 7 AeroTech Screenings Bin

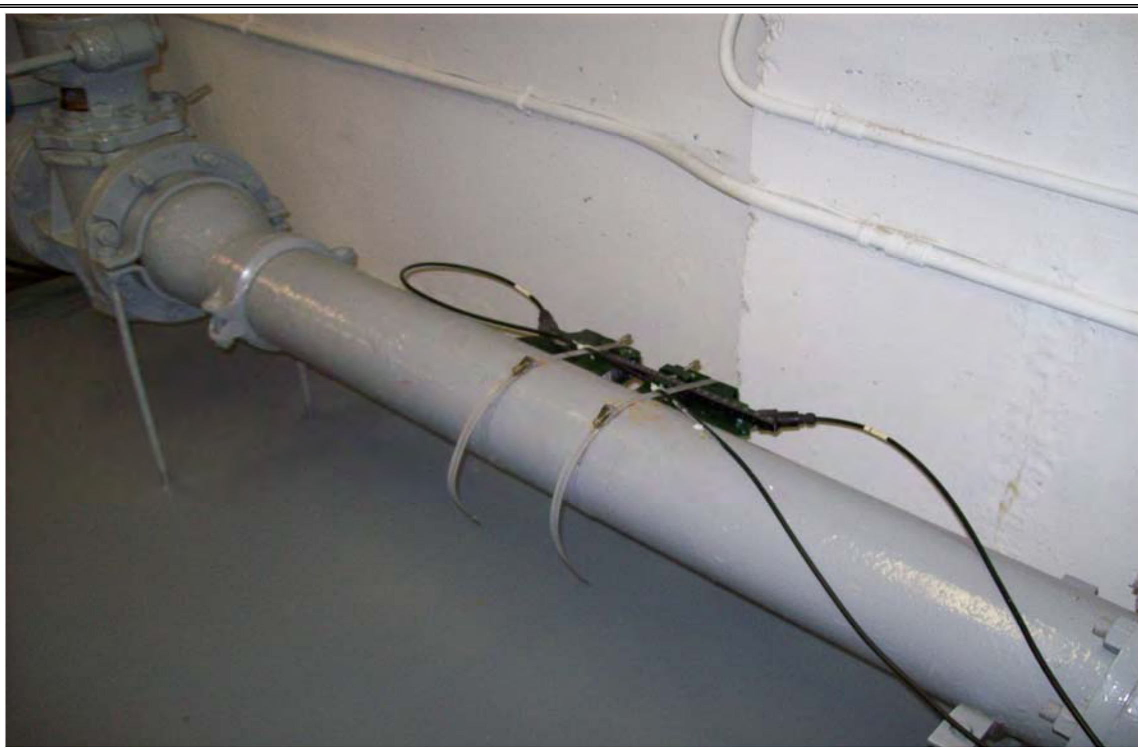

Photo 8 AeroTech Influent Wastewater Clamp on Ultrasonic Flow Meter

Photo 9 AeroTech Influent Wastewater Magmeter

Photo 10 AeroTech Influent Wastewater Magmeter Control Panel

Photo 11 AeroTech Raw Wastewater Autosampler

Photo 12 AeroTech Equalization Tank 1

Photo 13 AeroTech Equalization Tank 1 Online Temperature and pH

Photo 14 AeroTech Equalization Tank 1 Overflow to Equalization Tank 2

Photo 15 AeroTech Equalization Tank 2

Photo 16 AeroTech post Equalization Tank

Photo 17 AeroTech Post Equalization Tank with Emergency Overflow

Photo 18 AeroTech Equalization Tank Effluent and Alum Injection Point

Photo 19 AeroTech Caustic Injection Point and Flash Mixer

Photo 20 AeroTech Blowers

Photo 21 AeroTech Blowers 2

Photo 22 AeroTech SBR Feed Pumps

Photo 23 AeroTech SBR

Photo 24 AeroTech SBR Decant Mechanism

Photo 25 AeroTech SBR WAS Lines and Pump

Photo 26 AeroTech SBR Online Analyzer Control Panel

Photo 27 AeroTech Filter Feed Pumps

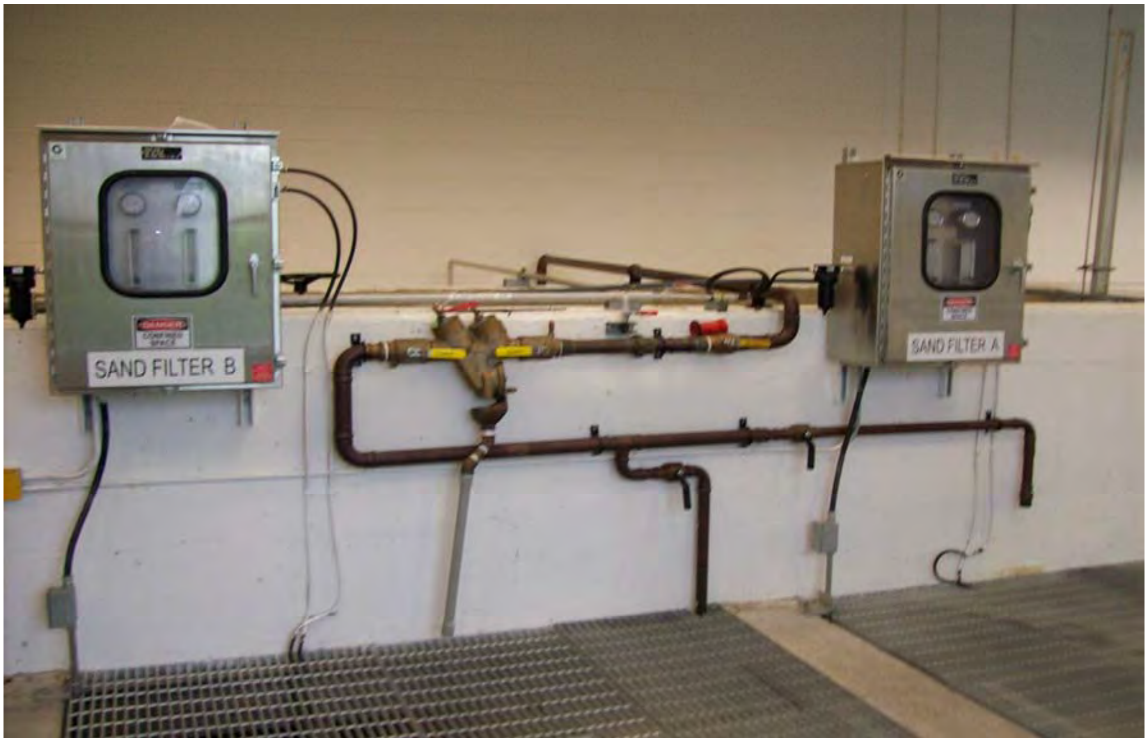

Photo 28 AeroTech Sand Filters

Photo 29 AeroTech Filter Backwash Channel

Photo 30 AeroTech UV System

Photo 31 AeroTech UV System and Effluent

Photo 32 AeroTech Effluent Sample Location

Photo 33 AeroTech Effluent Autosampler

Photo 34 AeroTech Sludge Floc Tank

Photo 35 AeroTech Sludge Handling Polymer

Photo 36 AeroTech Sludge Dewatering Presses

Photo 37 AeroTech Sludge Loading

Photo 38 AeroTech Sludge Building

VOLUME 3 – APPENDIX B-4

Frame Subdivision WWTF

APPENDIX - WORKING PAPER NO. 1.3
FRAME SUBDIVISION WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

Table of Contents

1. INTRODUCTION

1.1 Background

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Frame Subdivision WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Frame Subdivision WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used to develop this TM:

- A site visit conducted on July 5, 2011;
- Frame Subdivision WWTF Assessment and Pre-Design, Genivar, 2011;
- HRM Wastewater Treatment Upgrade Study - Final Report, Dillon Consulting Limited, September 2003; and
- Operating data from WaterTrax over the period January 2009 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Frame Subdivision WWTF, located at 63 Pembrooke St in Waverley, is a package extended aeration facility manufactured by Chicago Pump and installed in the 1960's. Its design rated capacity is 80 m^3/d (Dillon, 2003), and it services 45 lots or approximately 158 people (Genivar, 2011).

Treatment consists of comminution, biological treatment in an aerated bioreactor, secondary clarification, and chlorine disinfection. Treated effluent is discharged to a culvert and ditch system which passes through private yards prior to discharging into Lake William.

The Frame Subdivision WWTF treats domestic wastewater from the Frame Subdivision area. No additional service connections are anticipated within the Frame Subdivision collection system.

2.2 Existing Facilities

Liquid Treatment Train

Wastewater from the collection system flows to the inlet structure which consists of a comminutor. The wastewater flows into an aeration tank and then into a secondary clarifier. The clarifier is equipped with two air-lift return activated sludge (RAS) lines. Clarified effluent flows to a below grade chlorine contact tank, located under the blower/chemical building. Sodium hypochlorite is dosed in the contact tank. The effluent then flows over a V-notch weir used for flow metering, and is discharged via a 150 mm outfall to a ditch which flows to Lake William.

A plant bypass line allows flow to bypass the package plant, with the bypass controlled by a manual sluice gate. Bypass flows enter the chlorine contact tank for disinfection prior to discharge through the outfall.

Waste sludge is removed directly from the aeration tank and hauled to AeroTech WWTF for dewatering.

Figure 2.1 presents a process flow diagram of the Frame Subdivision WWTF.

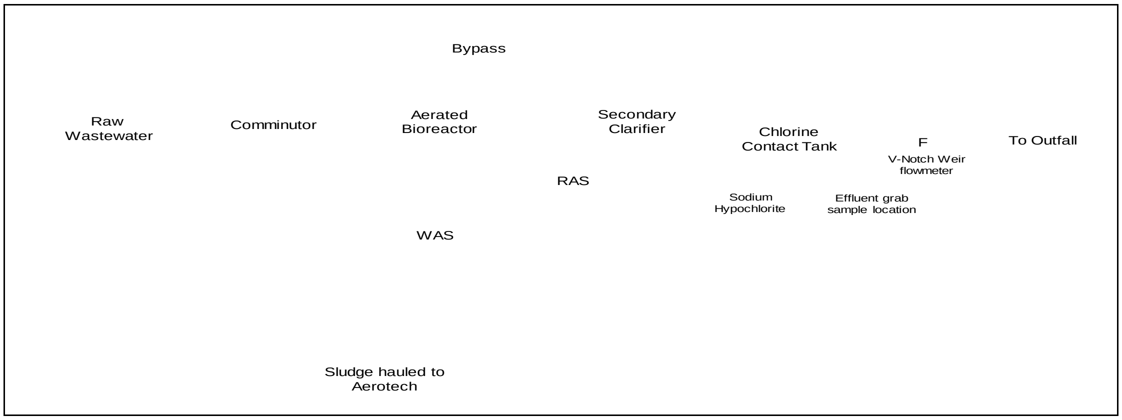

Figure 2.1 Process Flow Diagram of the Frame Subdivision WWTF

2.3 Current Compliance Requirements

Table 2.1 presents the effluent requirements for the Frame Subdivision WWTF. The quality and quantity of effluent discharged is regulated by effluent criteria as recorded in WaterTrax. The Permit to Operate (PTO) does not identify any treatment requirements.

Table 2.1 Frame Subdivision WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service (2)
$cBOD_5$ (mg/L)	-	20	20	20
TSS (mg/L)	-	20	20	20
Fecal coliforms (cfu/100 mL)	-	1,000	200	1,000
Fecal coliforms (geomean, cfu/100 mL) (1)	-	2,000	-	2,000

Notes:

n/a – not applicable

$cBOD_5$ –five-day carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. Based on a geometric mean of all samples in the quarterly monitoring period.
2. For the purposes of this assessment compliance with the effluent requirements will be taken to be based on the compliance criteria outlined in more recent PTO's, namely: The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits and no single result can be greater than two times the effluent limit for that parameter (with the exception of the fecal coliform geomean).

The current treatment requirements for the AeroTech WWTF are consistent with those for a nitrifying tertiary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

No raw wastewater samples are collected at the Frame Subdivision WWTF. As a result it was not possible to evaluate the historic raw wastewater characteristics.

It is recommended that raw wastewater samples be collected and analyzed for, at a minimum, BOD_5, TSS, TKN, TP, and pH.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2009 to July 2011) are summarized in Table 3.1. Effluent quality data are based on grab samples of the plant effluent.

Table 3.1 Frame Subdivision WWTF Effluent Flow and Quality Data

Parameter	2009	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 4)	118	94	147	-
MDF (m^3/d) (1)	537	1,071	1,164	-
$cBOD_5$ (mg/L) (2)	17.9	14.3	6.5	20
TSS (mg/L)	22.2	30.5	10.3	20
TAN (mg/L)	-	1.5	1.0	-
Fecal coliforms (MPN/100 mL) (3)	18	3,348	6,851	1,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data for 2009 were only available over the period September to December; flow data for 2011 were only available over the period January to March.
2. Effluent BOD_5 was reported in 2009. Effluent $cBOD_5$ was reported from 2010 to present.
3. Average fecal coliform values reported are annual geometric means.

Design ADF capacity is 80 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration in at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.2.

In general, the Frame Subdivision WWTF has had minor exceedances of effluent cBOD5 on a quarterly basis; however, nearly all individual samples met the individual sample requirement of 40 mg/L (twice the target concentration). Effluent TSS and coliforms have frequently exceeded the quarterly treatment requirements.

Table 3.2 Frame Subdivision WWTF Compliance with Treatment Requirements (January 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$ (1)	4 in compliance/6 total	32 in compliance/33 total
TSS	5 in compliance/10 total	47 in compliance/55 total
Fecal coliforms	4 in compliance/10 total	34 in compliance/55 total
Fecal coliforms (geomean)	6 in compliance/10 total	n/a

Notes:
1. ADF – Includes only effluent data reported as $cBOD_5$. Effluent $cBOD_5$ was reported from 2010 to present.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The collection system is prone to high levels of infiltration/inflow (I/I). In 2010, the recorded ADF was 94 m^3/d, with a maximum day flow of 1,071 m^3/d, equivalent to a maximum day peak flow factor of 11.4. Typical peaking factors for similarly sized treatment facilities are on the order of four to six. At the time of the site visit, work was underway to install a new sanitary collection system in an attempt to reduce I/I within the collection system.

Operations staff indicate that the existing facility has been hydraulically overloaded during extreme wet weather events, leading to package plant process tankage overflowing.

3.4 Design, Operational and Condition Issues

The existing secondary clarifier is undersized for current flows. This results in solids washout during high flow periods. During the site visit, there was no observable mixed liquor in the aeration tank. Operations staff noted that this is common, and that biological activity does not generally appear until after approximately two weeks of dry weather flows. In addition, the configuration of the secondary clarifier may result in poor in-tank hydraulics (such as short-circuiting), potentially resulting in poor performance even during low flow conditions.

The existing package plant is over 40 years old and is reaching the end of its useful life. The metal tank walls and bars visible above the water level show signs of corrosion.

There is currently no backup power available at the Frame Subdivision WWTF.

Based on the operational issues at the Frame Subdivision WWTF, it is likely that effluent requirements have periodically been met due to the diluted nature of the raw wastewater, and not due to any significant treatment being achieved through the package plant.

3.5 Preliminary Assessment of Existing Treatment Capacity

The existing Frame Subdivision WWTF has a design average day flow capacity of 80 m^3/d. No information was available regarding the design peak flow capacity.

A preliminary capacity assessment was completed based on the dimensions of the existing bioreactor and secondary clarifier. Assuming no nitrification is required, the existing Frame Subdivision WWTF has average day and peak flow capacities of 80 m^3/d and 315 m^3/d, respectively.

Historically, the Frame Subdivision WWTF has operated at approximately 138% of its estimated ADF capacity, and 370% of its estimated peak capacity. This has likely contributed to the operational issues and poor effluent quality experienced at the Frame WWTF.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

The existing receiver, a ditch and culvert system which discharges to Lake William, has low flow upstream of the WWTF outfall and provides little dilution of the treated effluent. In addition, there are several residential properties with direct access to the receiver. It is likely that the existing receiver has very limited assimilative capacity.

It has been recommended that the outfall be extended so that it discharges directly into Lake William (Genivar, 2011), which has more assimilative capacity than the existing receiver. Should the outfall be relocated, an assimilative capacity assessment of Lake William would need to be completed to confirm future treatment requirements.

4.1 Site Constraints

There is very limited space available for expansion within the existing fenced area of the Frame Subdivision WWTF.

Lands adjacent to the existing Frame Subdivision WWTF are owned by Halifax Water. If needed, expansion and/or construction of a new treatment facility on these adjacent properties may be possible.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Frame Wastewater WWTF:

- No data regarding raw wastewater characteristics were available. It is recommended that raw wastewater samples be collected and analyzed for, at a minimum, BOD_5, TSS, TKN, TP, and pH.
- Historically, the Frame Subdivision WWTF has produced effluent of good quality with respect to $cBOD_5$. Effluent quality has frequently exceeded the quarterly treatment requirements for TSS and coliforms.
- The collection system is prone to high levels of I/I, resulting in high peak flows to the Frame Subdivision WWTF. Work is currently underway to install a new sanitary collection system in an attempt to reduce I/I within the collection system.
- The facility is prone to solids washout from the secondary clarifier, and operations staff indicate it is not uncommon for there to be no biological activity in the bioreactor.
- The existing package plant is 40 years old and reaching the end of its useful life.
- Based on the operational issues and configuration of the facility, it is likely that effluent requirements have periodically been met due to the diluted nature of the raw wastewater, and not due to any significant treatment being achieved through the package plant.
- Based on the results of a desk-top preliminary capacity assessment, the existing Frame Subdivision WWTF has estimated capacities as follows:
  - Average day flow capacity (without nitrification): 80 m^3/d; and
  - Peak flow capacity (without nitrification): 315 m^3/d.
- The existing receiver, a ditch and culvert system which discharges to Lake William, provides little dilution and likely has very little assimilative capacity. Consideration is being given to extend the outfall so that it discharges directly into Lake William, which has more assimilative capacity that the existing receiver.
- There is limited space available within the existing fenced area of the Frame Subdivision WWTF. If needed, expansion and/or construction of a new treatment facility on adjacent lands, owned by Halifax Water, may be possible.

6. REFERENCES

Dillon (2003). HRM Wastewater Treatment Upgrade Study - Final Report.

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

Genivar (2011). Frame Subdivision WWTF Assessment and Pre-Design Report.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA
Department of Environment and Labour

APPROVAL

Province of Nova Scotia
Environment Act, S.N.S. 1994-95, c.1

APPROVAL HOLDER: Halifax Regional Municipality

APPROVAL NO: 2004-042134

EFFECTIVE DATE: September 10, 2004

EXPIRY DATE: September 10, 2014

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Construction and operation of a Sewage Treatment Plant/Sludge Dewatering Facility,and associated works, at or near Aerotech Park, Halifax, Halifax Regional Municipality in the Province of Nova Scotia.

Administrator Darby [signature]
Date Signed Sept. 8 '04

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Department of Environment and Labour

Project: Halifax Regional Municipality
Sewage Treatment Plant/ Sludge Dewatering
Aerotech Park
Halifax, Halifax Regional Municipality

Approval No: 2004-042134

File No: 94200-30BED-042134

Reference Documents:

- Application dated August 4, 2004 and attachments.
- Dillon Project Drawings# 04-282 dated Aug 4/04
- Facility Design Report dated April/04
- Maritime Testing Geotechnical Report dated May/04
- HRM Tender Document dated Aug 5/04
- Dillon Response Memo dated Sept 2/04

1. **Definitions**

a) "Act" means the *Environment Act* S.N.S. 1994-1995, c.1, and includes all regulations made pursuant to the Act.

b) "Composite Sample" means a representative sample which is taken from the combination of individual samples that are collected over a 24 hour period with at least one sample of 100 ml taken at two hour intervals.

c) "Department" means the Central Region, Bedford Office, of the Nova Scotia Department of Environment and Labour located at the following address:

Nova Scotia Department of Environment and Labour
Environmental Monitoring and Compliance Division
Central Region, Bedford Office,
Suite 224, 1595 Bedford Highway,
Bedford, Nova Scotia, B4A 3Y4.

Phone: (902) 424-7773
Fax: (902) 424-0597

d) "Facility" means the Sewage Treatment Plant and associated works.

e) "Grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled.

f) "Minister" means the Minister of the Nova Scotia Department of Environment and Labour.

g) "NSDEL" means the Nova Scotia Department of Environment and Labour.

h) "Sewage Collection System" means the Facility and all auxiliaries for the collection, treatment, storage and discharge of sewage from the source of the sewage to the final discharge point.

2. **Scope of Approval**

a) This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to construct and operate the Facility, situated at or near Aerotech Park, Halifax, Halifax Regional Municipality (the "Site").

b) The Facility shall be constructed and operated as outlined in the application for approval dated August 4, 2004 and supporting documentation.

c) The Site shall not exceed the area as outlined in the application and supporting documentation.

d) This Approval is restricted to the installation and operation of the Facility only. No alteration or infill of a watercourse or water resource is permitted by this Approval. Works associated with the alteration or infill of a watercourse or water resource will require separate approval from the Nova Scotia Department of Environment and Labour.

e) This Approval does not apply to the electrical, roadways, and structural components of the project.

f) Should the work authorized by this Approval not be commenced within a year, this Approval shall automatically be null and void, unless extended in writing by an Administrator.

3. **General Terms and Conditions**

a) The Approval Holder shall construct, operate and reclaim its Facility in accordance with provisions of the:

i) *Environment Act* S.N.S. 1994-1995, c.1;
ii) Regulations pursuant to the above Act;
iii) Any future amendments to the Act and regulations

b) No authority is granted by this Approval to enable the Approval Holder to construct the Facility on lands which are not in the control or ownership of the Approval Holder. It is the responsibility of the Approval Holder to ensure that such a contravention does not occur. Upon request, the Approval Holder shall provide, to the Department, proof of such control or ownership.

c) If there is a discrepancy between the reference documents and the terms and conditions of this Approval, the terms and conditions of this Approval shall apply.

d) Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

e) The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

f) This Approval is not transferable without the consent of the Minister or Administrator.

g) (i) If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(2)(b) and 58(4) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

(ii) Despite a cancellation or suspension of this Approval, the Approval Holder remains subject to the penalty provisions of the Act and regulations.

h) The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the Facility, including process changes or waste disposal practices which are not granted under this Approval. Extensions or modifications to the Facility may be subject to the Environmental Assessment Regulations. An amendment to this Approval will be required before implementing any change.

i) Pursuant to Section 60 of the *Act*, the Approval Holder shall submit to the Administrator any new and relevant information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval.

j) The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

k) The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

l) Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

m) All samples required by this Approval shall be analysed by a laboratory that is:

  i) Accredited by the Standards Council of Canada; or

  ii) Accredited by another agency recognised by the Nova Scotia Department of Environment and Labour to be equivalent to the Standards Council of Canada; or

  iii) Maintaining an acceptable standard in a proficiency testing program conducted by the Canadian Association for Environmental Analytical Laboratories for all parameters being reported; or

  iv) Maintaining an acceptable standard in a proficiency or performance testing in another program considered acceptable to the Nova Scotia Department of Environment and Labour for all parameters being reported

n) The Approval Holder shall submit any monitoring results or reports required by this Approval to the Department. Unless specified otherwise in this Approval, all monitoring results shall be submitted within 30 days following the month of monitoring.

o) The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel directly involved in the Facility operation are made fully aware of the terms and conditions which pertain to this Approval.

4. **Construction of Facility**

a) All erosion and sedimentation controls are to be in place prior to construction at this Facility. The Nova Scotia Department of the Environment " Erosion and Sedimentation Control Handbook For Construction Sites" shall serve as the reference document for all erosion control measures. These measures are minimum requirements and additional controls shall be implemented if Site runoff exceeds the discharge limits contained herein.

b) All erosion and sedimentation controls are to be maintained and remain in place until the disturbed areas are stabilized.

c) The Approval Holder shall sample for the parameters and at the frequency indicated to ensure the following liquid effluent levels from any discharge from the Site are met:

Liquid Effluent Discharge Limits During Construction

Parameters	Maximum in a Grab Sample	Monthly Arithmetic Mean	Monitoring Frequency
Total Suspended Solids	50 mg/l	25 mg/l	weekly/rain event
pH	5 - 9	5 - 9	weekly/rain event

d) Non-compliance of the effluent discharge limits noted in clause (c) shall be immediately reported to the Department.

e) (i) The monitoring station(s) for the liquid effluent shall be the discharge from any location on Site, including the settling ponds.

(ii) Monitoring station locations shall be constantly reviewed by the Approval Holder and the locations revised as construction progresses and as approved by the Department.

(iii) The Department reserves the right to modify the monitoring locations, parameters and frequency, and to require remedial measures depending on the information obtained.

f) The Approval Holder shall submit a monthly report summarizing the above sampling results to the Department.

g) All areas exposed during construction and temporary diversion, or control structures such as berms, ditches, etc., shall be stabilized immediately.

h) When dewatering of construction areas is required, the water must not be discharged directly to a watercourse or water resource, nor to a conveyance (a ditch, culvert, manhole) that may lead to a watercourse or water resource without prior treatment to meet limits established in condition 4(c).

i) Grubbings and excavated material shall be stored or disposed of in a manner that will not result in sedimentation of adjacent and downstream watercourses or water resources.

j) Temporary erosion and sedimentation controls are to remain in place until Site stability is established. Approval for the removal of such controls must be obtained from the Department. All erosion and sedimentation control measures shall be monitored daily throughout the construction period and maintained as necessary.

k) Chemical flocculants are to be approved by the Department prior to their use. Requests for approval must be submitted at least 15 days prior to the use of the flocculants.

l) All phases of construction shall be overseen by a qualified professional engineer, licensed to practice in the Province of Nova Scotia, or technologist who works under the supervision of an engineer.

m) (i) Written certification by a professional engineer is required stating that all construction or installation has been conducted in accordance with and has met the minimum requirements of the approved drawings and specifications.

(ii) This certification must be provided to NSDEL, within 6 weeks of project completion.

(iii) The certification must include a complete set of as built drawings (if different than the approved drawings) and information on any major changes from the referenced drawings or specifications made during construction.

(iv) The certification must confirm that all as-built drawings and any other relevant documentation have been turned over to the Approval Holder by the engineer.

(v) The certification must include the result of the performance testing conducted on the sewage treatment plant during commissioning and the

confirmation that the Facility meets the requirements of this Approval prior to placement in service.

(vi) The Approval Holder must be complete the "Completion of the Approved Work" form and it shall be included with the certification submission.

n) It is an offence under Section 50(1) and (2) of the Act to proceed with construction or operation of the Facility in advance of receiving this Approval.

5. **Spills or Releases**

a) All spills or releases of dangerous goods, waste dangerous goods, or petroleum hydrocarbon shall be reported to the Department in accordance with the Act (Part VI) and the *Emergency Spill Regulations*.)

b) Spills or releases shall be cleaned up immediately.

c) An adequate quantity of spill/release response material is to be maintained on Site at all times.

6. **Sludge Disposal**

a) All sludge generated at the Facility shall be treated and disposed of by a method approved by the Department.

7. **Operation**

a) The Approval Holder shall designate in writing, to the Department, a contact for this Approval, prior to the startup and operation of the Facility.

b) The Facility must be constructed, operated and maintained in a manner that will prevent erosion, chemical spills or any other incidents that may be detrimental to the environment and public health.

c) The Approval Holder should ensure that the system is operated, maintained and has appropriate backup facilities to protect against failures of the power supply, treatment process, equipment, or structure. Security measures should assure the safety of the sewage treatment processes, storage facilities, and the discharge system.

d) The Approval Holder shall ensure the development and implementation of an emergency response plan as part of the operations program. This plan is to

meet the requirements of the Nova Scotia Department of Environment and Labour contingency Plan for Releases of Dangerous Goods and Hazardous Wastes. The plan is to be made available to NSDEL upon request and should include:

i) General procedures for routine (equipment break-down, upset conditions, maintenance, etc.) or major emergencies within the sewage works system; and

ii) A plan for equipment becoming inoperable in a major emergency.

iii) A plan for dealing with spills or releases.

e) The Approval Holder shall not establish nor maintain a bypass to divert sewage around the Facility or any feature of the Facility treatment process unless the bypass has been approved by the Department. When it is necessary to use an approved by-pass, the Approval Holder shall notify the Department.

f) The Approval Holder shall take immediate preventive or corrective action ,when results of an inspection or sampling results indicate conditions which are currently or may become a detriment to system operations, and/or result in adverse impact to the environment or public health.

g) The Facility has been classified as a **Class III Wastewater Treatment Plant** The day-to-day operations of the wastewater treatment plant shall be supervised directly by certified operators who hold the appropriate certification

h) The Approval Holder shall establish and make available upon request, notification procedures to be used to contact the Medical Officer of Health, NSDEL, other relevant authorities and the general public in the case of an emergency situation.

i) The Approval Holder shall prepare a comprehensive operations manual within three months of commencement of operation of the Facility and keep it up to date. The manual shall be subject to review by NSDEL upon request.

j) A complete set of the drawings, incorporating any amendments made from time to time, shall be kept by the Approval Holder at the Facility for as long as the Facility is kept in operation.

k) The Approval Holder shall establish procedures for receiving and responding to complaints including a reporting system which records what steps were taken to determine the cause of complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

8. Performance And Limits

8.1 Treated Effluent

The Facility and associated sewage collection system shall be managed and operated in such a manner that the effluent being discharged to the receiving waters satisfies the following criteria:

a) Biological oxygen demand, BOD_5, shall not exceed 10 mg/l.

b) Suspended Solids, shall not exceed 10 mg/l

c) Fecal coliform shall not exceed 200/100 count/mls

d) Disinfection of the effluent from the Facility shall be continuous.

e) pH - 6.5 to 9.

f) Nutrient levels shall not exceed the following:

Total Phosphorus	2 mg/l
Ammonia	3 mg/l

8.2 Odour Control

a) The Approval Holder shall operate the Facility in a manner which will not result in the generation of offensive or hazardous odours/vapours.

b) The Approval Holder shall be required to implement additional control measures if odour generation is deemed excessive by the Department.

9. Monitoring and Recording

a) The Approval Holder shall conduct all monitoring and analysis required in this section according to the latest edition of "Standard Methods for the Examination of Water and Waste Water".

b) All equipment must be installed, maintained and calibrated as specified by the manufacturer's instructions.

c) Following a review of any of the analytical results required by this Approval, NSDEL may alter the frequencies, location, and parameters for analyses required for this Approval.

TABLE 1		
PARAMETER	**MINIMUM FREQUENCY**	**LOCATION**
BOD_5	3/week	treated effluent discharge
Suspended Solids	3/week	treated effluent discharge
Fecal Coliform	3/week	treated effluent discharge
NH3	3/week	treated effluent discharge
Total Phosphorus	3/week	treated effluent discharge
pH	3/week	treated effluent discharge
Plant Volumes	continuous	plant inlet

d). The Facility shall be considered in compliance with the effluent limitations if 80% of the sample test results, at the frequency and number specified in table 1 meet the specified limit in section 8.1. No single result can be greater than two times the limits in section 8.1.

10. Reporting

10.1 Quarterly Reporting

a) The Approval Holder shall prepare and submit to the Department on a quarterly basis, the results of the sampling conducted at the locations indicated in table 1 above.

a) The Approval Holder shall prepare and submit to the Department, a quarterly performance report for the facility. The report shall contain the following information in a format acceptable to NSDEL.

i) a summary and discussion of the quantity of wastewater treated during the reporting period compared to the design values for the facility, including peak flow rates, maximum daily flows and monthly average daily flows;

ii) a summary and interpretation of analytical results obtained in accordance with Section 9 (monitoring and recording) of this Approval;

iv) a tabulation and description of any emergency or upset conditions which occurred during the period being reported upon and action taken to correct them;

v) Any complaints that were received and the Approval Holders response.

10.2 Emergency Reporting on Operation

a) The Approval Holder shall notify the Department forthwith in the event that untreated wastewater is directed to the receiving waters.

b) The Approval Holder shall immediately notify the Department of any incidents of exceedence of the compliance requirement indicated in section 9(d).

11. Records

a) The Approval Holder shall keep the following records and wastewater effluent quality analyses:

i) BOD_5, Suspended Solids, Ammonia, Phosphorus and Bacteriological analyses shall be kept for five years;

ii) Flow meter readings shall be kept for 10 years.

b) The Approval Holder shall also retain the following information for a period of three years:

i) calibration and maintenance records;

ii) continuous monitoring data;

iii) records of any violations of the conditions of this Approval and actions taken by the Approval Holder to correct those violations.

c) A copy of this Approval, project reports, construction documents and drawings, inspection reports, shall be kept for the life of the facility.

APPENDIX B
SITE VISIT PHOTOS

Photo 1 AeroTech Influent Pumping Station

Photo 2 AeroTech Headworks Building and Equalization Tanks

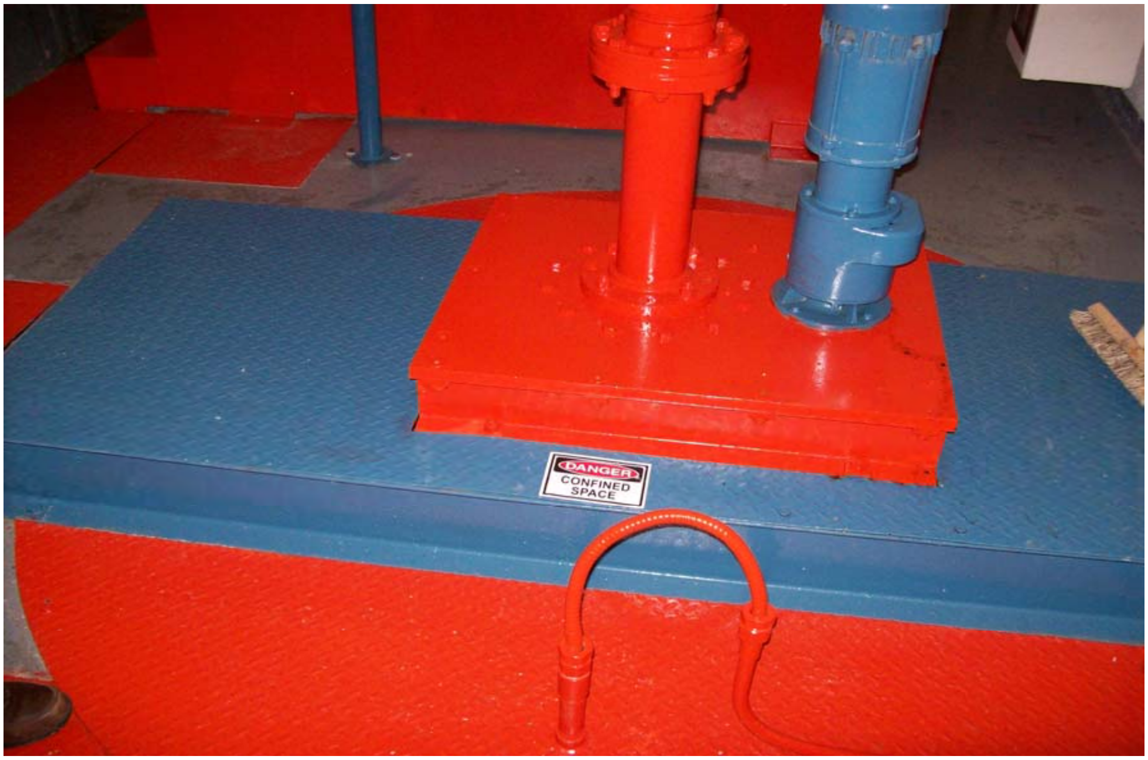

Photo 3 AeroTech Grit Tank

Photo 4 AeroTech Manual Grit Collection

Photo 5 AeroTech Manual Grit Collection 2

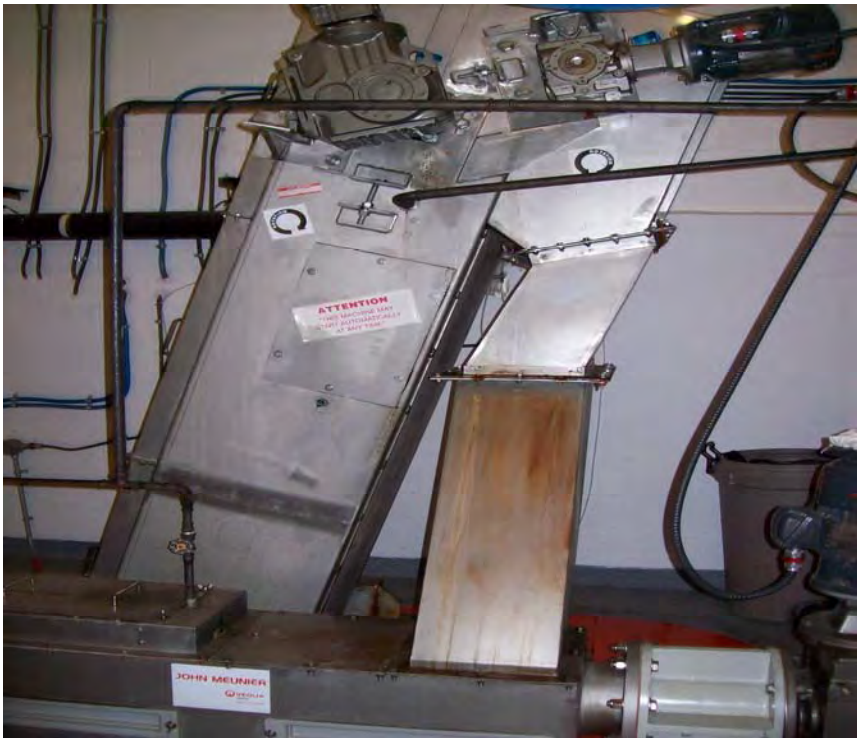

Photo 6 AeroTech Mechanical Screen

Photo 7 AeroTech Screenings Bin

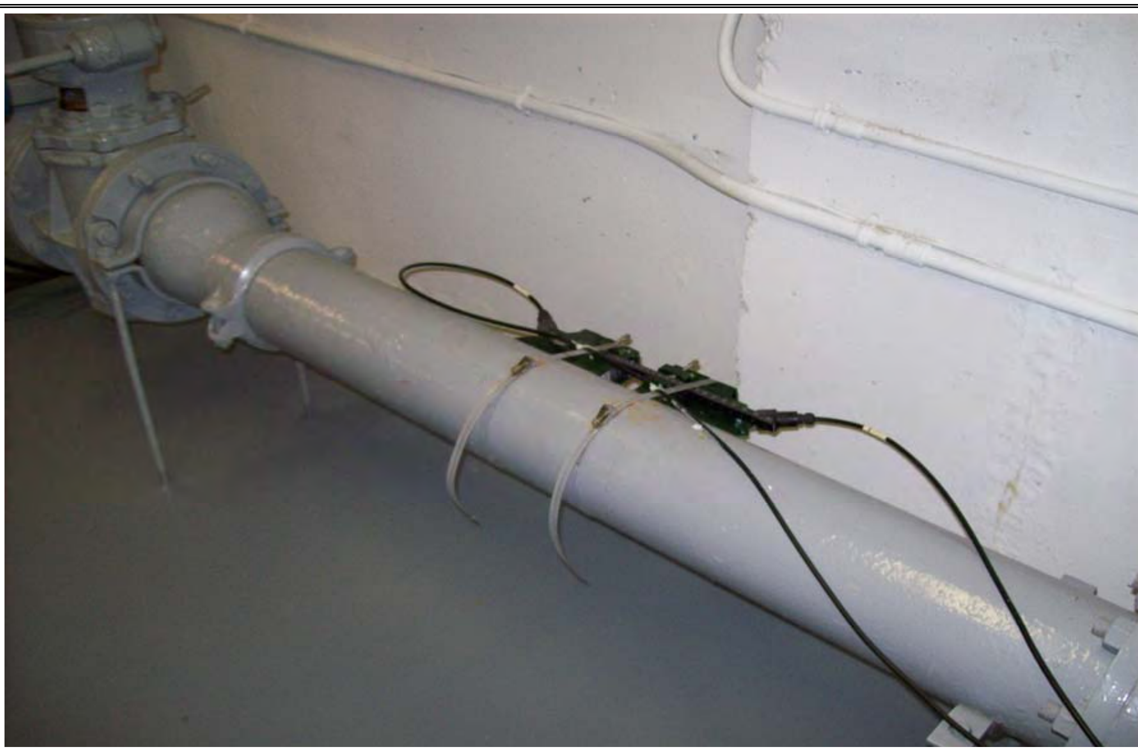

Photo 8 AeroTech Influent Wastewater Clamp on Ultrasonic Flow Meter

Photo 9 AeroTech Influent Wastewater Magmeter

Photo 10 AeroTech Influent Wastewater Magmeter Control Panel

Photo 11 AeroTech Raw Wastewater Autosampler

Photo 12 AeroTech Equalization Tank 1

Photo 13 AeroTech Equalization Tank 1 Online Temperature and pH

Photo 14 AeroTech Equalization Tank 1 Overflow to Equalization Tank 2

Photo 15 AeroTech Equalization Tank 2

Photo 16 AeroTech post Equalization Tank

Photo 17 AeroTech Post Equalization Tank with Emergency Overflow

Photo 18 AeroTech Equalization Tank Effluent and Alum Injection Point

Photo 19 AeroTech Caustic Injection Point and Flash Mixer

Photo 20 AeroTech Blowers

Photo 21 AeroTech Blowers 2

Photo 22 AeroTech SBR Feed Pumps

Photo 23 AeroTech SBR

Photo 24 AeroTech SBR Decant Mechanism

Photo 25 AeroTech SBR WAS Lines and Pump

Photo 26 AeroTech SBR Online Analyzer Control Panel

Photo 27 AeroTech Filter Feed Pumps

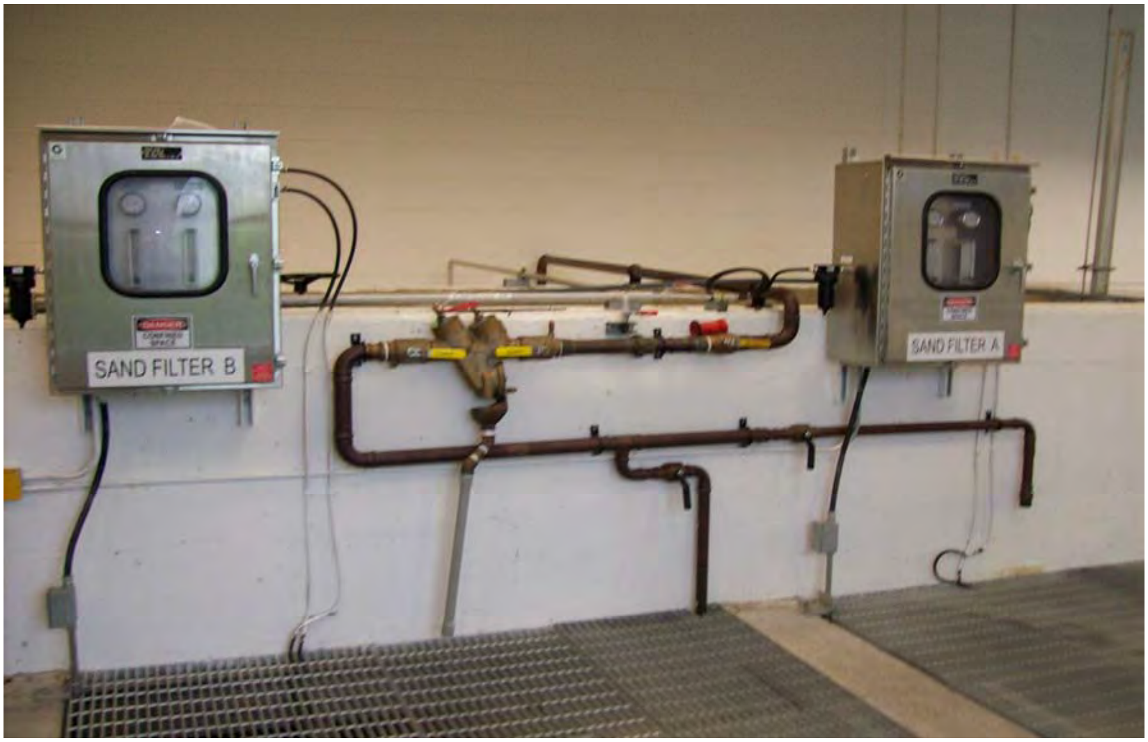

Photo 28 AeroTech Sand Filters

Photo 29 AeroTech Filter Backwash Channel

Photo 30 AeroTech UV System

Photo 31 AeroTech UV System and Effluent

Photo 32 AeroTech Effluent Sample Location

Photo 33 AeroTech Effluent Autosampler

Photo 34 AeroTech Sludge Floc Tank

Photo 35 AeroTech Sludge Handling Polymer

Photo 36 AeroTech Sludge Dewatering Presses

Photo 37 AeroTech Sludge Loading

Photo 38 AeroTech Sludge Building

VOLUME 3 – APPENDIX B-5

Lakeside Timberlea WWTF

APPENDIX - WORKING PAPER NO. 1.3
LAKESIDE TIMBERLEA WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

Table of Contents

1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Lakeside Timberlea WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Lakeside Timberlea Wastewater Treatment Facility (WWTF);
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection;
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- A site visit completed on July 5, 2011;
- Lakeside and Timberlea Area Pollution Control Plant Drawings, CBCL Ltd., 1981;
- Lakeside Sewage Treatment Plant Upgrade Drawings, CBCL Ltd., 1993;
- Joint Certificate of Approval for the Lakeside Timberlea Area Pollution Control Plant, Nova Scotia Department of the Environment, 1982 (see Appendix A); and
- Operating data from WaterTrax over the period January 2010 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Lakeside Timberlea WWTF was commissioned in 1984, and consists of screening, grit removal, primary clarification, rotating biological contactors (RBCs), secondary settling, chlorine contact tanks, and post aeration tankage. The enhanced secondary treatment plant was designed to treat an average day flow (ADF) of 4,545 m^3/d, and the average daily flow is quickly approaching this design ADF value. The effluent from the plant discharges to the Nine Mile River.

Waste sludge is collected and removed from the primary and secondary clarification tanks, and this sludge is then sent to the on-site anaerobic digester. Supernatant is removed from the digester and returned to the head of the plant, and the digested biosolids are trucked to the AeroTech WWTF for dewatering.

The WWTF serves the communities of Beechville, Lakeside and Timberlea. The system collects flow from the Lakeside Business Park and surrounding residential area, and two pumping stations pump all of the flow to the Lakeside/Timberlea WWTF.

Figure 2.1 shows an aerial view of the Lakeside Timberlea WWTF site.

Figure 2.1 Lakeside Timberlea WWTF - Aerial View

2.2 Existing Facilities

Wastewater from the communities of Beechville, Lakeside and Timberlea is pumped from two separate pumping stations to the plant headworks. The headworks treatment consists of automatic coarse bar screening, and an aerated grit chamber which removes inorganic solids from the incoming raw wastewater. One manual coarse bar screen, placed in parallel with the automatic coarse bar screen, is used in the event of a breakdown of the automatic bar screen. Lime is added at the head of the aerated grit chamber for alkalinity addition.

Following grit removal, the wastewater enters the primary clarifiers. Chain and flight mechanisms remove grease and scum off the top of the clarifier, and push settled sludge along the bottom of the clarifier to a collection system. This scum and sludge is then transferred to the anaerobic digester for stabilization.

The wastewater then flows to the RBCs for further treatment. There are two parallel RBC trains, each train consisting of four RBC units. The total RBC media surface area is on the order of 2,200 m^2. Based on the original design of the RBC system, the first two RBC units in each train are designed for BOD removal; the final two RBC units are designed for nitrification.

Following the RBCs, the wastewater flows to the secondary clarifiers. Alum is dosed to the channel entering the secondary clarifiers for phosphorus removal. Flash mixing is provided.

Secondary effluent flows to two chlorine contact tanks/re-aeration tanks which operate in parallel. Sodium hypochlorite is added upstream of the chlorine contact tanks. The re-aeration portion of each tank provides aeration to meet the effluent dissolved oxygen (DO) requirement of a minimum of 5 mg/L.

Following aeration, the treated effluent flows by gravity through the outfall which discharges to the Nine Mile River.

Figure 2.2 presents a process flow diagram of the Lakeside Timberlea WWTF.

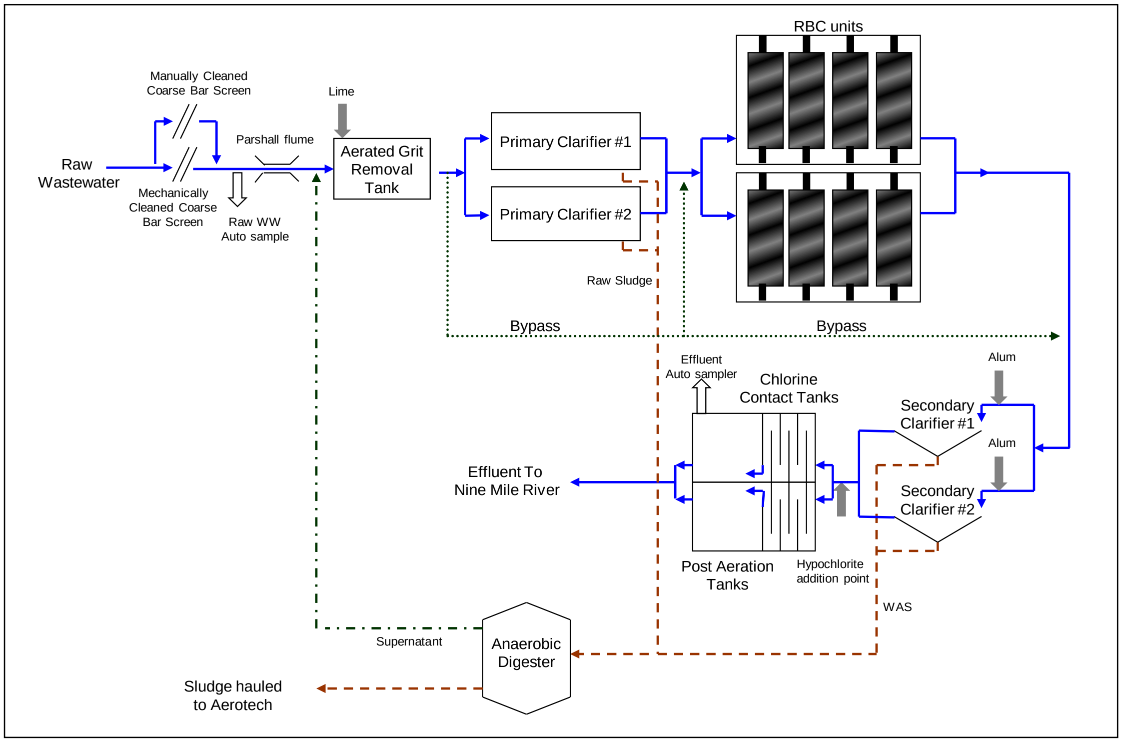

Figure 2.2 Process Flow Diagram of Lakeside Timberlea WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Lakeside Timberlea WWTF is regulated by effluent criteria as recorded in WaterTrax.

Table 2.1 presents the effluent requirements based on the Permit to Operate (PTO), WaterTrax requirements, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). Because the PTO includes no effluent requirements, the current treatment requirements were based on the most stringent of the treatment standards as recorded in WaterTrax and those identified in Atlantic Canada Guidelines.

Table 2.1 Lakeside Timberlea WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service
$cBOD_5$ (mg/L)	-	15	20	15
TSS (mg/L)	-	15	20	15
TP (mg/L)	-	Summer = 1 Winter = 3	-	Summer = 1 Winter = 3
Ortho-phosphate (mg/L as P)	-	Summer = 1 Winter = 3	-	Summer = 1 Winter = 3
TAN (mg/L)	-	Summer = 3 Winter = 5	-	Summer = 3 Winter = 5
Fecal coliforms (MPN/100 mL)	-	200	200	200
DO (mg/L)	-	> 5	-	> 5
$cBOD_5$ Removal (%)	-	90	-	90

Notes:

n/a – not applicable

$cBOD_5$ – carbonaceous biochemical oxygen demand

TSS – total suspended solids

TAN - total ammonia nitrogen

TP - total phosphorus

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception of $cBOD_5$ removal and DO concentration, for which the required level of service values shown are minimum concentration values).

The current treatment requirements for the Lakeside Timberlea WWTF are consistent with those for a nitrifying secondary treatment facility.

3. Historic Plant Performance

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2010 to June 2011) are summarized in Table 3.1. Raw wastewater quality data are based on grab samples from the influent wastewater following coarse bar screening.

Table 3.1 Lakeside Timberlea WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	155	170	110 (low) 190 (med) 350 (high)
TSS	153	200	120 (low) 210 (med) 400 (high)
TP	n/a	7	4 (low) 7 (med) 12 (high)
Ortho-phosphate as P	4.1 (2)	n/a	n/a
TKN	n/a	25	20 (low) 40 (med) 70 (high)
TAN	22.3 (3)	n/a	n/a

Notes:

n/a – not applicable/data not available

TKN – total Kjeldahl nitrogen

1. The "low", "med", and "high" refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. Historical raw wastewater phosphorus values recorded as ortho-phosphate as P. No raw wastewater TP values were available.
3. Historical raw wastewater TAN recorded; no raw wastewater TKN values were available.

The raw wastewater quality is low to medium strength with respect to BOD_5 and TSS. The raw wastewater is low strength with respect to phosphorus, based on the ortho-phosphate concentration, and nitrogen, based on the TAN concentration.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2010 to July 2011) are summarized in Table 3.2.

Table 3.2 Lakeside Timberlea WWTF Effluent Flow and Quality Data

Parameter	2010	2011 (1)	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (2, 4)	3,593	-	-
MDF (m^3/d) (2)	14,205	-	-
$cBOD_5$ (mg/L)	7.1	5.9	15
TSS (mg/L)	14.1	14.6	15
TP (mg/L)	1.9	2.0	Summer = 1 Winter = 3
TAN (mg/L)	8.1	7.6	Summer = 3 Winter = 5
Fecal coliforms (MPN/100 mL) (3)	28.5	4.6	-

Notes:
ADF – average day flow
MDF – maximum day flow
1. Effluent quality data were only available over the period from January to July.
2. Flow data were not available for 2011.
3. Average fecal coliform values reported are annual geometric means.
4. Rated ADF capacity is 4,540 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Lakeside Timberlea WWTF Compliance with Treatment Requirements (January 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	6 in compliance/6 total	214 in compliance/216 total
TSS	2 in compliance/6 total	227 in compliance/228 total
TP	2 in compliance/4 total	96 in compliance/114 total
Ortho-phosphate	5 in compliance/6 total	224 in compliance/227 total
TAN	0 in compliance/6 total	138 in compliance/216 total
Fecal coliforms	4 in compliance/6 total	193 in compliance/222 total
DO	6 in compliance/6 total	221 in compliance/227 total
BOD_5 Removal	6 in compliance/6 total	n/a

Historically, the Lakeside Timberlea WWTF has performed well in terms of BOD_5 removal and effluent $cBOD_5$, ortho-phosphate, and DO concentrations meeting quarterly treatment targets for each of these parameters in 100, 100, 83, and 100% of quarters, respectively.

Effluent TSS, TP, TAN and fecal coliforms frequently exceeded the effluent requirements with only 33, 50, 0, and 67% of the quarterly samples in compliance, respectively.

Individual sample results for TAN were frequently out of compliance with only 64% of the samples meeting individual sample treatment requirements. The individual sample results for $cBOD_5$, TSS, TP, ortho-phosphate, fecal coliforms and DO were generally in compliance.

As can be seen in Table 3.2, the historical TSS average values are nearing the HW compliance limit of 15 mg/L. It can also be seen that the historical TAN average values are consistently over the HW compliance limits. The effluent TAN concentration values are quite variable, indicating unstable nitrification performance.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Lakeside Timberlea WWTF has the ability bypass the entire treatment facility; however, this bypass has never been used.

The Lakeside Timberlea WWTF can also bypass the primary clarifiers, or both the primary clarifiers and RBCs; however, according to operations staff, these bypasses have never been used.

Flow splitting between the two trains, particularly between the primary clarifiers and RBC trains, is uneven and negatively impacts process performance. A lack of control weirs/gates limits the operators' ability to control flow splits.

High levels of inflow and infiltration (I/I) in the collection system impact peak wet weather flows to the Lakeside Timberlea WWTF. The WWTF receives an ADF of approximately 3,600 m^3/d during dry weather conditions; during wet weather events, the plant has received flows as high as 14,205 m^3/d.

3.4 Design, Operational and Condition Issues

The digestion system was originally designed to have both both a primary and secondary digester; however, funding limitations allowed the construction of the secondary digester only. This secondary digester is now operated as an unmixed primary digester. Digester maintenance is difficult since it must be emptied completely, and there is no other onsite sludge storage available.

There are cracks in the concrete walls of the primary clarifiers, and there are also significant cracks in the headworks building foundation. During the site visit, it was noted that repairs to these known cracks are scheduled; however the condition of these exposed tank walls highlights the need for an inspection of the other tanks/concrete structures.

The flare stack, for methane gas produced as a by-product of the digestion process, was non-functional during the site visit. Operations staff indicated that the flare needs to be upgraded and/or replaced.

According to the plant supervisor, there are plans to upgrade the pumps with variable frequency drives (VFDs) at each of the pumping stations that discharge to the WWTF. There are also plans in the capital budget to upgrade the lime addition system at the plant.

Operations staff noted a concern regarding the lack of back-up power for the main processes. Three small portable generators are available to operate the lights and power outlets in the office areas and digester building; however, none of the treatment processes are able to run during a power outage.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Lakeside Timberlea WWTF is 4,540 m^3/d. The historic January 2009 to December 2010 average day flow to the Lakeside Timberlea WWTF was 3,812 m^3/d, or approximately 84% of the design rated capacity. In spite of operating at average flows below the design capacity, the Lakeside Timberlea WWTF has not been able to achieve the effluent requirements, primarily in terms of TAN and TSS.

A preliminary desktop capacity assessment was completed to estimate the existing treatment capacity of the Lakeside Timberlea WWTF liquid treatment train. Based on primary clarifiers with a total surface area of 298 m^2, RBC units with approximately 36,000 m^2 of surface area per train, secondary clarifiers with a total surface area of 298 m^2, typical raw wastewater quality, and providing year-round nitrification, the estimated average day capacity of the Lakeside WWTF is 2,860 m^3/d. The peak flow capacity of the Lakeside Timberlea WWTF is estimated to be 9,295 m^3/d.

Based on the estimated capacities, the Lakeside Timberlea WWTF has historically operated at 133% and 153% of these average and peak flow capacities, respectively.

4. FUTURE CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver, the Nine Mile River, has low flow periods throughout the year, and the Nine Mile River ecosystem has been identified as sensitive. It is understood than an Environmental Risk Assessment (ERA) for the receiver has been completed, however no data were available regarding the assimilative capacity of the receiver and/or future effluent requiremnets.

4.2 Site Constraints

The HRM owns land adjacent to the existing Lakeside Timberlea WWTF that is available for expansion. It is understood that design of an upgrade and expansion of the Lakeside Timberlea WWTP is currently underway.

5. Summary and Conclusions

Based on the above review, the following conclusions can be made regarding the Lakeside Timberlea WWTF:

- Historically, the Lakeside Timberlea WWTF has produced good quality effluent with respect to $cBOD_5$, ortho-phosphate, DO, and BOD_5 removal. Effluent requirements for these parameters have been consistently met.
- Effluent TSS, TP, TAN and fecal coliforms frequently exceeded the compliance requirements.
- The Lakeside Timberlea WWTF has had a great deal of difficulty meeting effluent TAN limits due to capacity limitations of the RBCs.
- Based on the results of a desk-top preliminary capacity assessment, the existing Lakeside Timberlea WWTF has estimated capacities as follows:
  - Average day flow capacity: 2,860 m^3/d, with nitrification; and
  - Peak flow capacity: 9,295 m^3/d, with nitrification.
- The Lakeside Timberlea WWTF experience uneven flow splitting conditions between treatment trains.
- Many pieces of equipment are reaching the end of their useful life, and civil works require inspection and repair. Upgrades to the existing system are required to maintain system functionality.
- The existing receiver, the Nine Mile River, has low flow periods throughout the year, and the Nine Mile River ecosystem has been identified as sensitive. It is understood that an ERA of the receiver has been completed, however information regarding future effluent requirements was not available.
- The HRM owns land directly on the existing Lakeside Timberlea WWTF that is available for expansion. Upgrades and expansion are planned for this WWTF.

6. References

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

Halifax Regional Municipality (2010). Lakeside/Timberlea WWTF. Halifax Water website (http://www.halifax.ca/hrwc/wastewaterTreatmentPlantsLakesideTimberlea.html)

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

APPENDIX A
PERMIT TO OPERATE

... OF THE ENVIRONMENT

AND

DEPARTMENT OF PUBLIC HEALTH

Joint Certificate of Approval

for

Municipal Water and Sewage Services

MUNICIPALITY OF THE COUNTY OF HALIFAX
(Municipality or Owner)

File No.: 1900-HAL-H190

Approval No.: 81-215

Project Description: County of Halifax, Lakeside Timberlea area, pollution control plant. Design by CBCL Ltd. Drawings No. G1 to G6, L1 to L2, A1 to A24, S1 to S23, M1 to M24, E1 to E30, I1 to I12, dated November, 1981.

Total Estimated Cost: $5,400,000.00

Stipulation:

Riverview Drive

RECOMMENDED

REGISTERED PROFESSIONAL ENGINEER D. S. GIFFIN

Department of the Environment

APPROVED

Minister of the Environment

Feb 12/82

Date Approved

Department of the Environment

REGISTERED PROFESSIONAL ENGINEER

Department of Public Health

Minister of Public Health

Feb 23/82

1. Name of applicant ...... Municipality of the County of Halifax
(municipality or owner)

P.O. Box 300 - Armdale, Halifax, Nova Scotia
(postal address) (county)

2. Location of project ... Lakeside/Timberlea Area
(number, street, or road)

(municipality, county)

3. Brief description of and reasons for the project .... Pollution Control Plant to service the Timberlea/Lakeside area.

4. Number of persons served ..... 6,000 (now) ..... 10,000 (future)

5. Number of units served –

		NOW	FUTURE
Houses	residential units		
Mobile Homes		1,100	2,500
Classrooms			
Motel Units			
Other (specify)		Industrial Park	Industrial Park

6. Water Supply –

Source .... Maximum yield ....

Demand ....

Available yield .... (72-hour test for a well)

Treatment given ....

Bacteriological condition ....

Chemical and physical condition ....

Storage available ....

Estimated line pressure .... No. of hydrants ....

Type of pipe ....

Item	Number or Length Required	Estimated Cost Installed
	(Total)	
Engineering Charges		
	(Total Capital Cost)	
Estimate of annual operating and maintenance costs		

SUBMIT EXTRA SHEET IF MORE SPACE REQUIRED)

Received Time Jul. 2. 2009 5:02PM No 7410

Item	Number or Length Required	Estimated Cost Installed
	(Total)	
Engineering Charges		
	(Total Capital Cost)	
Estimated annual operation and maintenance costs		

(SUBMIT EXTRA SHEET IF MORE SPACE REQUIRED)

8. Sewage Treatment Plant–

Type Secondary (RBC), Nitrification, & Nutrient Reduction

Size 1.0 IMGD ~~gpd~~ Size criteria .... gpd

Estimated hydraulic load 1.0 IMGD (avg.) 3.15 IMGD (peak) ~~gpd~~

Estimated biological load 1,700 pounds/day BOD_5

Number of persons served 6,000 (now) 10,000 (future)

Estimated degree of treatment 90 % removal of BOD_5

Type of chlorinator One (1) duty and one (1) standby gas chlorinators, 500 lb/day capacity, flow paced

Chlorine contact time 20 min. at peak flow

Type, quantity and quality of industrial load if included Lakeside Industrial Park, no process

Special problems ....

Location of outfall sewer (if watercourse give name) Nine Mile River

The distance from treatment plant to the nearest

(a) surface watercourse is 200 feet

(b) private well is .... feet central system being provided

(c) municipal well is .... feet water supply from regional system

(d) dwelling or built up area is 1,000 feet

Received Time Jul. 2. 2009 5:02PM No 7410

Item	Number or Length Required	Estimated Cost Installed
Treatment Plant		$4,600,000
	(Total)	
Engineering Charges		800,000
	(Total Capital Cost)	$5,400,000

Estimated annual operation and maintenace costs

(SUBMIT EXTRA SHEET IF MORE SPACE REQUIRED)

9. Storm Sewers-

Area serviced

Design flow

Design storm

Has this been a problem area?

Is the project separating a combined sewer?

Describe the receiving brook or stream and where it flows?

Item	Number or Length Required	Estimated Cost Installed
	(Total)	
Engineering Charges		
	(Total Capital Cost)	

Estimated annual operation and maintenance costs

(SUBMIT EXTRA SHEET IF MORE SPACE REQUIRED)

10. Proposed starting date of proposed project 1st quarter 1982

Proposed completion date of proposed project 3rd quarter 1983

Received Time Jul. 2. 2009 5:02PM No. 7410

Item	Number or Length Required	Estimated Cost Installed
Treatment Plant		$4,600,000
	(Total)	
Engineering Charges		800,000
	(Total Capital Cost)	$5,400,000

Estimated annual operation and maintenace costs

(SUBMIT EXTRA SHEET IF MORE SPACE REQUIRED)

9. Storm Sewers–

Area serviced

Design flow

Design storm

Has this been a problem area?

Is the project separating a combined sewer?

Describe the receiving brook or stream and where it flows?

Item	Number or Length Required	Estimated Cost Installed
	(Total)	
Engineering Charges		
	(Total Capital Cost)	

Estimated annual operation and maintenance costs

(SUBMIT EXTRA SHEET IF MORE SPACE REQUIRED)

10. Proposed starting date of proposed project 1st quarter 1982

Proposed completion date of proposed project 3rd quarter 1983

Received Time Jul 2. 2009 5:02PM No 7410

APPENDIX B

SITE VISIT PHOTOS

Photo 1 Aerial View of Site Layout

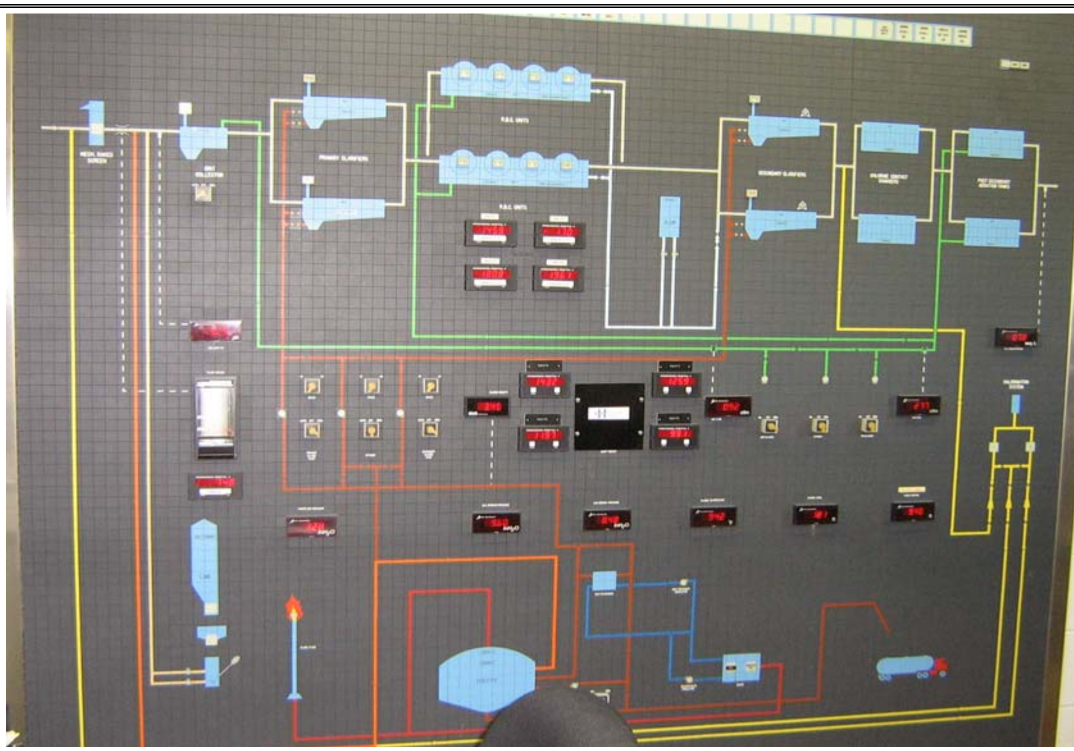

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Photo 16 Primary Clarifier Effluent Weirs

Photo 17 Primary Clarifier Effluent Wiers

Photo 18 Rotating Biological Contactors (RBCs) – 2 Trains of 4 RBCs

Photo 19 Influent to RBCs

Photo 20 RBC Drives

Photo 21 RBC media – First Stage

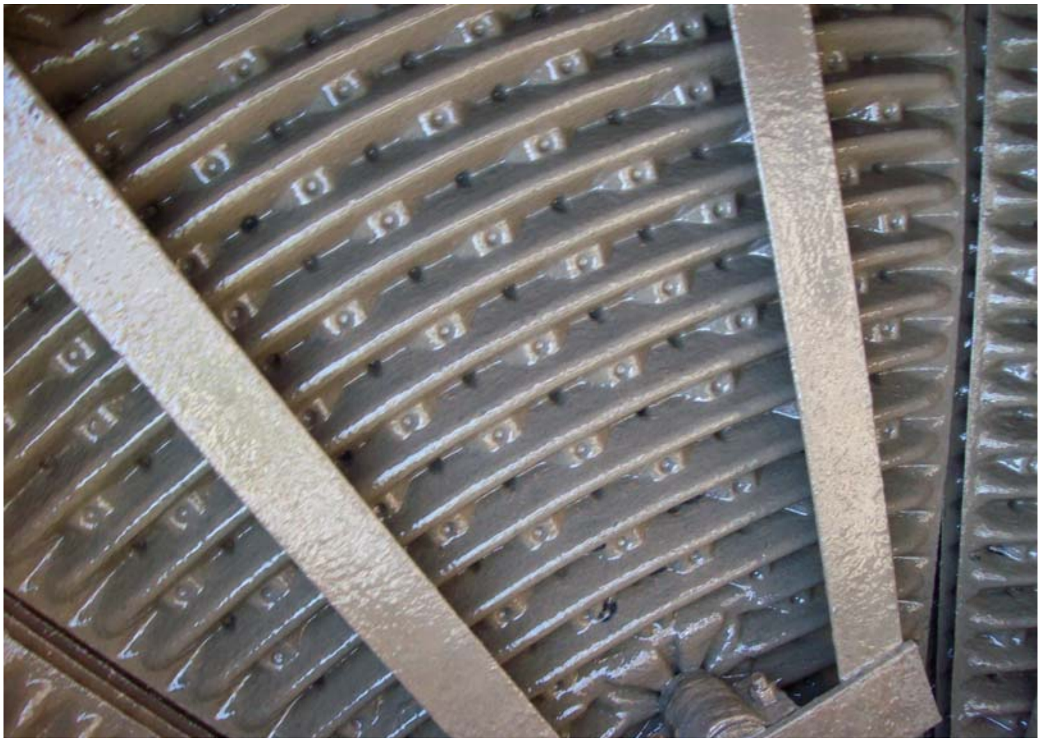

Photo 22 RBC media –First Stage

Photo 23 RBC Media – Second Stage

Photo 24 RBC Drive and Bearing Box Connected to RBC Shaft

Photo 25 RBC Effluent

Photo 26 RBC Effluent

Photo 27 RBC Effluent to Secondary Clarification

Photo 28 Channel from RBCs to Secondary Clarification

Photo 29 Alum Dosage Point and Flash Mixing

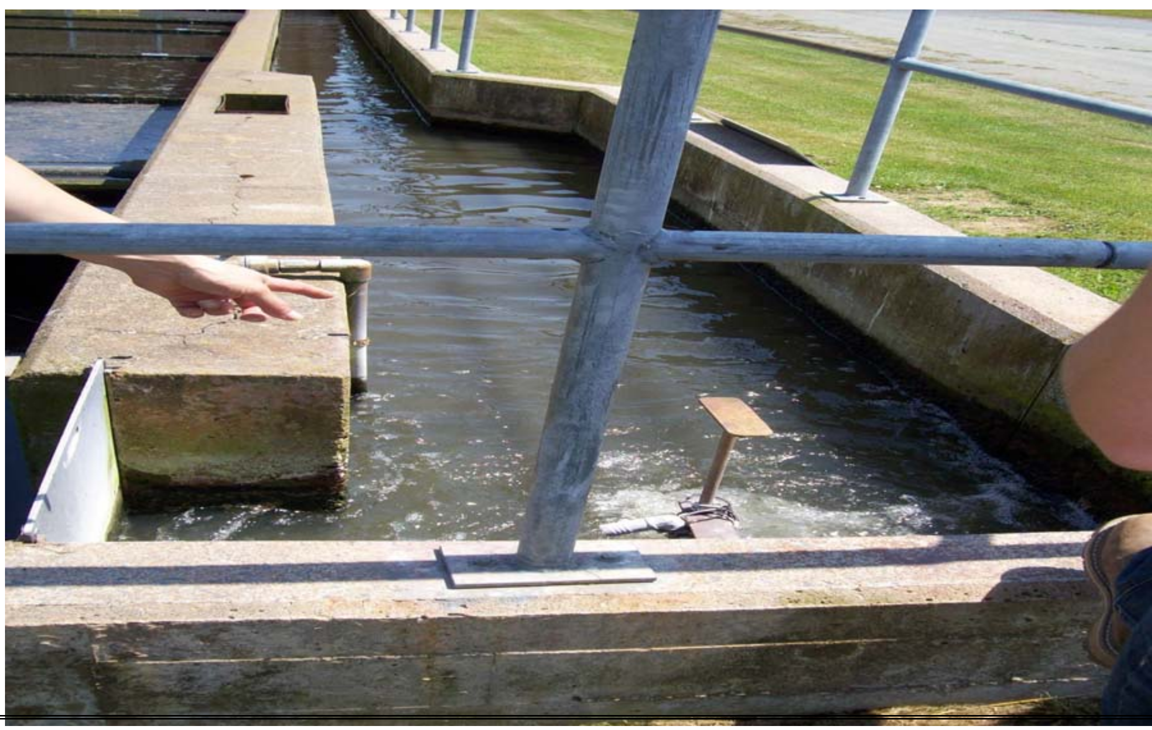

Photo 30 Alum Dosage Point and Flash Mixing

Photo 31 Bypass Slide Gate Around Secondary Clarification

Photo 32 Secondary Clarifiers

Photo 33 Secondary Clarifier Weirs and Effluent

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Photo 61 Sludge Recirculation through Heat Exchanger

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VOLUME 3 – APPENDIX B-6

Mill Cove WWTF

APPENDIX - WORKING PAPER NO. 1.3
MILL COVE WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Mill Cove WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Mill Cove WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- Permit to Operate, Mill Cove WWTF, Approval No. 95-77, dated August 31, 1995 (see Appendix A);
- A site visit conducted on July 4, 2011;
- Mill Cove WWTF South Side Secondary Clarifers Assessment, CBCL Limited Consulting Engineers, 2008;
- HRM Wastewater Treatment Upgrade Study - Final Report, Dillon Consulting Limited, September 2003; and
- Operating data from WaterTrax over the period January 2010 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Mill Cove WWTF is a secondary treatment facility that has a design average day flow capacity of 28,400 m^3/d. The plant was originally built in the 1970's, and has undergone several expansions, the last of which occurred in 1996 when the plant was converted from a conventional activated sludge process to a pure oxygen process.

The liquid treatment train consists of screening, grit removal, primary clarification, biological treatment in pure-oxygen reactors, secondary clarification and UV disinfection. Treated effluent is discharged to the Bedford Basin. An underground surge tank provides some equalization storage during high flow events. The solids handling process consists of anaerobic digestion. Liquid biosolids are hauled off-site to the AeroTech WWTF for further processing.

The Mill Cove WWTF treats mainly domestic wastewater, however there are several industries that discharge into the collection system including pre-treated effluent from a dairy. Landfill leachate and compost leachate are also accepted at the Mill Cove WWTF, with the latter contributing significant influent loadings.

Figure 2.1 shows an aerial view of the Mill Cove WWTF.

Figure 2.1 Mill Cove WWTF - Aerial View

2.2 Existing Facilities

Wastewater from the collection system flows to the onsite Bedford Pumping Station (PS), a dry well/wet well PS equipped with three raw wastewater pumps. Wastewater is conveyed to preliminary treatment which consists of two mechanically cleaned coarse bar screens and two vortex grit separators. A bypass is provided around the mechanical bar screens (equipped with a manual bar screen) and around grit removal.

The screened and degritted wastewater then passes through a Parshall flume to record influent flow to the Mill Cove WWTF. From there, the wastewater flows to the primary flow splitter box, which is used to control flow splits to the North Plant and South Plant primary clarifiers and bioreactors, as well as the 650,000 USgal (2,460 m^3) surge tank.

The screened and degritted wastewater flows to four primary clarifiers in the North Plant, and three primary clarifiers in the South Plant. The North Plant primary effluent is directed to Pure Oxygen Reactor 1, while the South Plant primary effluent is directed to Pure Oxygen Reactor 2. Both 2-celled bioreactors are equipped with paddle mixers and a hydrocarbon detection system. Oxygen flow rates are controlled based on off-gas quality.

The effluent from the bioreactors flows to the secondary flow splitter box where the flow is directed to two rectangular secondary clarifiers in the North Plant or four circular secondary clarifiers in the South Plant. The effluent flows from the North Plant secondary clarifiers and South Plant secondary clarifiers are recorded using two velocity-area meters; these meters are used to control the flow splits between the North and South Plant secondary clarifiers. Secondary effluent from both sets of clarifiers recombines prior to passing through UV disinfection (Trojan 4000, two banks each with 36 high-pressure bulbs). Disinfected effluent is discharged via an outfall to the Bedford Basin.

Return activated sludge (RAS) from the North Plant secondary clarifiers is directed to Pure Oxygen Reactor 1, and RAS from the South Plant secondary clarifiers is directed to Pure Oxygen Reactor 2. Waste activated sludge (WAS) from both the North and South Plants is discharged to the primary flow splitter box, where it is co-thickened with raw sludge in the primary clarifiers. Co-thickened sludge pumping from both the North and South Plant primary clarifiers is controlled based on a timer system, which is manually adjusted based on the sludge blanket level.

Sludge digestion consists of one anaerobic primary digester, equipped with draft tube mixers, and two smaller secondary digesters complete with floating covers for biogas storage. Supernatant from the secondary digesters is directed to a supernatant pumping station, which discharges into the primary splitter box. The biogas collected is used to run the boilers for building and digester heating. Liquid biosolids are hauled off-site via tanker truck to the AeroTech WWTF for further processing.

Foul air from the headworks and primary clarifiers is collected and treated through a wet scrubber/activated carbon odour control system.

Figure 2.2 presents a process flow diagram of the Mill Cove WWTF liquid treatment train.

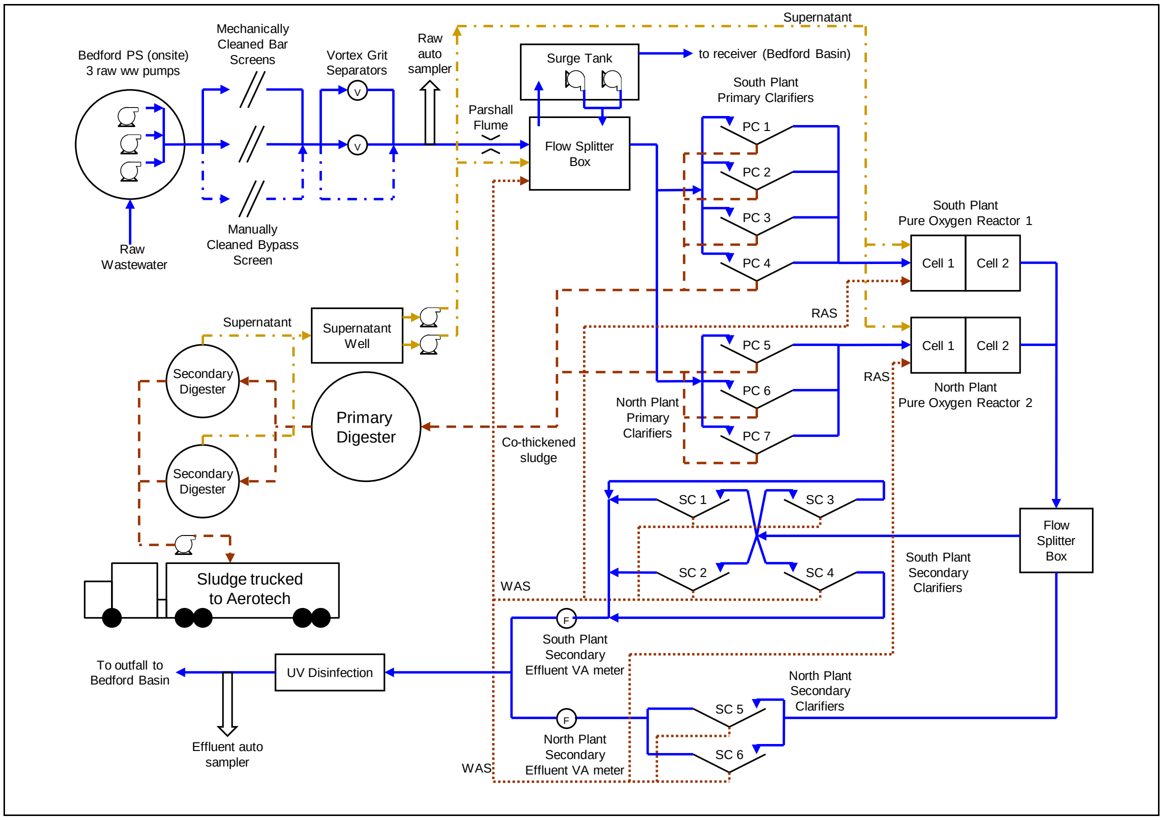

Figure 2.2 Process Flow Diagram of the Mill Cove WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Mill Cove WWTF is regulated by effluent criteria as recorded in WaterTrax.

Table 2.1 presents the effluent requirements based on the Permit to Operate (PTO), WaterTrax requirements, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). Because no PTO requirements are listed or available, the current treatment requirements were based on the treatment standards as recorded in WaterTrax.

Table 2.1 Mill Cove WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	HW Treatment Standards	Atlantic Canada Guidelines	Current Required Level of Service
cBOD5 (mg/L)	-	30	20	30
TSS (mg/L)	-	30	20	30
Fecal coliforms (cfu/100 mL)	-	2,000	200	2,000
Fecal coliforms (geomean, cfu/100 mL) (1)	-	4,000	-	4,000

Notes:

n/a – not applicable

$cBOD_5$ – carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. Based on a geometric mean of all samples in the quarterly monitoring period.

The current treatment requirements for the Mill Cove WWTF are consistent with those for a secondary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2010 to July 2011) are summarized in Table 3.1.

Table 3.1 Mill Cove WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 [1]
BOD_5	168	170	110 (low) 190 (med) 350 (high)
TSS	174	200	120 (low) 210 (med) 400 (high)
TP	-	7	4 (low) 7 (med) 12 (high)
TKN	-	25	20 (low) 40 (med) 70 (high)

Notes:

n/d - data not available

n/a – not applicable

TKN – total Kjeldahl nitrogen

1. The “low”, “med”, and “high” refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. The raw wastewater TKN was estimated based on the historic raw wastewater TAN concentration of 50 mg/L, and assuming a TAN:TKN ratio of 0.80.

The raw wastewater quality is low to medium strength with respect to BOD_5 and TSS. No raw wastewater concentrations of TP or TKN were recorded in WaterTrax. Raw wastewater samples should be analyzed for these parameters if this is not currently being done.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2010 to July 2011) are summarized in Table 3.2.

Table 3.2 Mill Cove WWTF Effluent Flow and Quality Data

Parameter	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1)	23,227	21,252	-
MDF (m^3/d)	48,320	41,974	-
$cBOD_5$ (mg/L)	10.6	18.1	30
TSS (mg/L)	13.9	20.3	30
TP (mg/L)	2.2	3.1	-
TAN (mg/L)	15.3	22.9	-
Fecal coliforms (MPN/100 mL) (2)	51	78	2,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Design ADF capacity is 28,400 m^3/d.
2. Average fecal coliform values reported are annual geometric means.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Mill Cove WWTF Compliance with Treatment Requirements (January 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	6 in compliance/6 total	347 in compliance/347 total
TSS	5 in compliance/6 total	375 in compliance/376 total
Fecal coliforms	6 in compliance/6 total	354 in compliance/371 total
Fecal coliforms (geomean)	6 in compliance/6 total	n/a

Historically, the Mill Cove WWTF effluent quality has met the quarterly treatment requirements for $cBOD_5$, TSS, and fecal coliforms, with the exception of one quarterly TSS result. Effluent was in compliance for $cBOD_5$, TSS and fecal coliform individual sample requirements for 100%, 99% and 95% of samples, respectively.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

Operations staff indicated during the site visit that overflows from the Bedford PS wet well have occurred during extreme wet weather conditions. In addition, the surge tank overflows during wet weather events. The surge tank effluent is not disinfected prior to being discharged into the Bedford Basin.

Plant staff indicated that flows splits in the primary splitter box are not well balanced. With all gates open, flow will preferentially go to the South Plant primary clarifiers. As a result, the sluice gates are throttled to provide some flow split control.

The Mill Cove WWTF is equipped with a secondary treatment bypass channel. However, plant operations staff indicate that this bypass has never been used.

3.4 Design, Operational and Condition Issues

The influent Bedford PS was constructed over 40 years ago, and the pumps, valves and piping are in need of replacement. In addition, the dry pit area of the PS is very small, limiting the ability to retrofit the existing PS.

Plant operations staff indicated that Nocardia filaments are a recurring operational issue, resulting in the accumulation of foam in the bioreactors, channels, and flow splitter boxes, as well as sludge bulking and deterioration in effluent quality. Evidence of Nocardia foam was observed during the site visit. Operations staff indicate that Nocardia has historically been observed from June/July through to December. During periods with severe foaming, vacuum trucks are used to remove foam from the covered bioreactors, the bioreactor effluent channels and secondary flow splitter box. Plant staff indicate that Nocardia tends to appear at MLSS concentrations greater than 1,200 mg/L; therefore, the target operational MLSS concentration is approximately 1,000 mg/L. A RAS chlorination system is available, but is not used.

Pin floc has also occasionally been observed in the secondary effluent.

The South Plant secondary clarifiers are very shallow (2.7 m SWD) and have historically performed poorly. Upgrades to the clarifiers were completed over the winter of 2010/2011, including the installation of in-tank baffles, new sludge collection systems, and RAS flow metering. These upgrades have improved clarifier performance, and allowed plant staff to operate with a near 50/50 flow split between the South Plant and North Plant secondary clarifiers.

3.5 Preliminary Assessment of Existing Treatment Capacity

The existing Mill Cove WWTF has a design average day flow (ADF) capacity of 28,400 m^3/d.

A desk-top capacity assessment of the Mill Cove WWTF was conducted based on the dimensions of the existing primary clarifiers, bioreactors, and secondary clarifiers. Assuming no nitrification is required, which is consistent with the current treatment requirements, the existing Mill Cove WWTF has average day and peak flow capacities of 28,400 m^3/d and 70,000 m^3/d, respectively.

Historically, the Mill Cove WWTF has operated at approximately 78% of its estimated ADF capacity, and 70% of its estimated peak flow capacity.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver, the Bedford Basin, is a salt water receiver and may have additional assimilative capacity available. An assimilative capacity assessment of Bedford Basin would need to be completed to confirm future treatment requirements.

4.2 Site Constraints

There is limited room available for expansion within the existing fenced area of the Mill Cove WWTF. According to Dillon (2008), the existing facility has been designed to accommodate two additional primary clarifiers (one in the North Plant and one in the South Plant), one new bioreactor, and one new secondary clarifier.

The properties located adjacent and to the north, east and south of Mill Cove WWTF are built-up. The property located to the west of the facility is wooded. Expansion of the treatment facility onto the wooded area to the west may be possible; however, it would reduce the buffer zone to the neighbouring residential lots.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Mill Cove WWTF:

- The raw wastewater quality is low to medium strength with respect to BOD_5 and TSS. No raw wastewater concentrations of TP or TKN were recorded in WaterTrax. Raw wastewater samples should be analyzed for these parameters if this is not currently being done.
- Historically, the Mill Cove WWTF effluent quality has met the quarterly treatment requirements for $cBOD_5$, TSS, and fecal coliforms, with the exception of one quarterly TSS result.
- Operations staff indicated that overflows from the Bedford PS wet well have occurred during extreme wet weather conditions. In addition, the surge tank overflows during wet weather events.
- The influent Bedford PS was constructed over 40 years ago, and the pumps, valves and piping are in need of replacement. In addition, the dry pit area of the PS is very small, limiting the ability to retrofit the existing PS.
- Plant operations staff indicated that Nocardia filaments are a recurring operational issue, resulting in the accumulation of foam in the bioreactors, channels, and flow splitter boxes, as well as sludge bulking and deterioration in effluent quality.
- Based on the results of a desk-top preliminary capacity assessment, the existing Mill Cove WWTF has estimated capacities as follows:
  - Average day flow capacity (without nitrification): 28,400 m^3/d; and
  - Peak flow capacity (without nitrification): 70,000 m^3/d.
- The existing receiver, the Bedford Basin, is a salt water receiver and may have additional assimilative capacity available. An assimilative capacity assessment of Bedford Basin would need to be completed to confirm future treatment requirements.
- There is limited room available for expansion within the existing fenced area of the Mill Cove WWTF. Expansion beyond the existing fence line may not be possible due to the proximity of adjacent residential lots.

6. REFERENCES

Dillon (2008). HRM Wastewater Treatment Upgrade Study - Final Report, Dillon Consulting Limited, September 2003.

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

APPROVAL TO CONSTRUCT AND OPERATE SEWAGE WORKS

Pursuant to Section 56 of the Environment Act and subject to the terms and conditions contained in Schedule "A" of this approval, this approval is granted to the Municipality of the County of Halifax to construct and operate ***Mill Cove Sewage Treatment Plant Expansion, Phase 1, Package 2, Aeration and Digestion Systems, Bedford*** *in the County of* ***Halifax,*** *Province of Nova Scotia.*

Granted at Halifax, in the County of Halifax, Province of Nova Scotia, this 31 day of August A.D. 1995.

95-77
Approval Number

Minister of the Environment

SCHEDULE "A"

Project: Mill Cove Sewage Treatment Plant, Second Expansion, Phase 1, Installation/Construction of new headworks, new primary clarifiers, new secondary clarifiers, control building upgrade, ultraviolet disinfection and yard piping. Design by Porter Dillon Limited, Package 2, Contract No. 332-W-91C:

- Halifax County Municipality, Town of Bedford, Mill Cove STP 2nd Expansion, General Construction Package No. 2, Tender and Contract Documents , Contract No.332-W-91C, dated July 1995, Prepared by Porter Dillon Limited.
- Drawing Package 2 for Contract No. 332-W-91C, dated July 1995, received by N.S.D.O.E. July 20, 1995.
- Halifax County Municipality, 2nd Expansion-Phase 1, Preliminary Design Brief, dated April 1992, Prepared by Porter Dillon.
- Letter of September 30, 1995, from P.J.Wright, P.Eng. to M.T. Grant, P.Eng.

File: 12-95-0127

Permit No: 95-77

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1. The above noted drawings and plans, including drawings and plans having design specifications and installation measures, form part of this authorization.
2. All phases of construction shall be overseen by a qualified professional engineer or technologist. Certification by a professional engineer is required stating that all construction/installations have been conducted in accordance with the approved plans and specifications. This certification must be provided to the Regional Manager, Central Regional Office, Nova Scotia Department of the

Environment within three weeks of project completion.

3. It is an offence under the Environment Act to proceed with construction in advance of receiving this approval in writing.

4. The Department shall advise the approval holder in writing of any breach or defect on behalf of the approval holder to comply with the requirements of the design and construction of the sewage system. The approval holder shall have 7 working days to remedy the defects or breaches, or such other time frame as may be agreed upon in writing by the Department.

5. Should the work approved under this approval not be commenced within a year, this approval shall automatically be null and void.

6. Any changes in approved plans and specifications must be authorized in writing by the Regional Manager, Central Regional Office, Nova Scotia Department of the Environment prior to construction/implementation.

7. This approval does not negate the requirement for compliance with other existing municipal, provincial and federal laws and regulations.

8. A copy of the post construction report must be provided to the Regional Manager, Central Regional Office, Nova Scotia Department of the Environment. The "Post-Construction Report" must contain all information regarding major changes from the approved plans or specifications made during construction. These major changes include any deviations which affect capacity, flow or operation of units. The "Post-Construction Report" must also include all commission or start-up of equipment tests and any other test results produced during construction. The "Post Construction Report" must also guarantee that all as-built drawings, operation and maintenance manuals, and any other relevant documentation have been turned over to the owner/operator by the engineer.

<u>Erosion Control During Construction</u>

9. All work is to be carried out in accordance with the <u>Nova Scotia Watercourse Alteration Specifications (1993)</u>. Particular attention is to be given to the <u>General Specifications</u> and those for <u>Pipelines</u>.

10. The Nova Scotia Department of the Environment's "Erosion and Sedimentation Control Handbook for Construction Sites" will serve as a reference document for construction/erosion control measures.

11. All off-site drainage shall be limited to a maximum suspended

solids level of 25 mg/l monthly arithmetic mean and 50 mg/l in any single grab sample. Turbid water from excavation dewatering activities shall be adequately clarified/settled before being discharged to downstream watercourse(s). The proponent shall provide sampling of site effluent if requested by the Nova Scotia Department of the Environment.

12. If chemical flocculants are to be used, approval by the Bedford Regional Office of the Nova Scotia Department of the Environment is required prior to their use.

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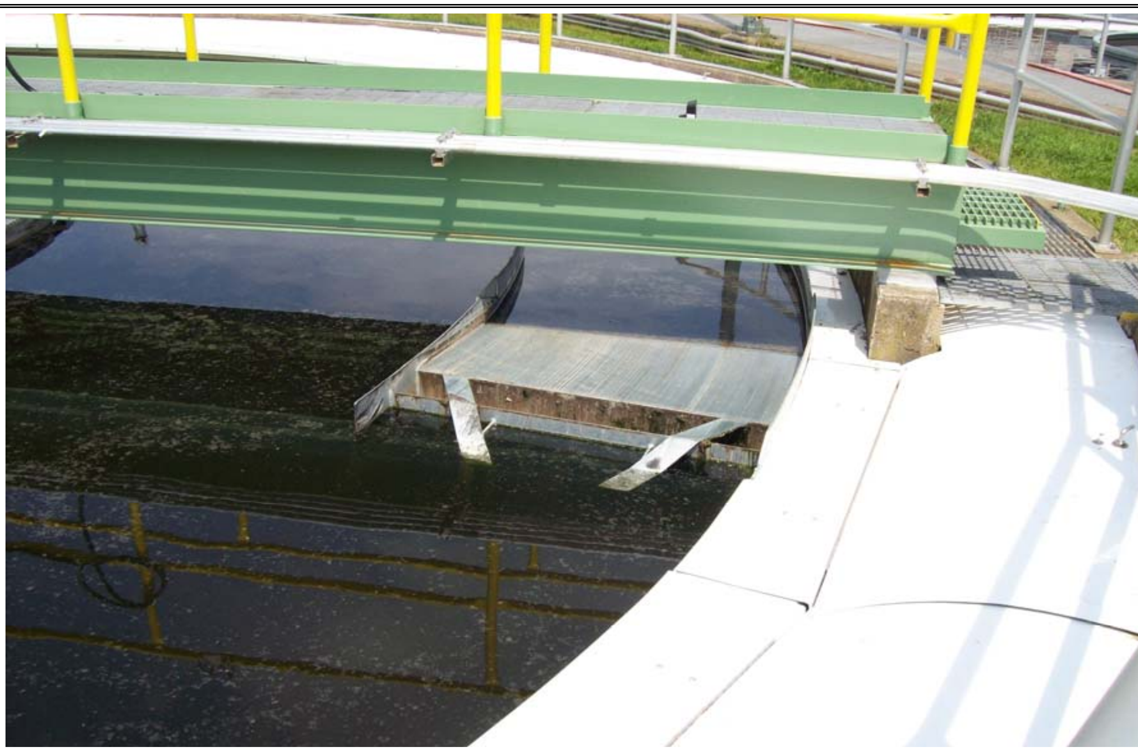

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VOLUME 3 – APPENDIX B-7

North Preton WWTF

APPENDIX - WORKING PAPER NO. 1.3
NORTH PRESTON WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the North Preston WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the North Preston WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used to develop this TM:

- Permit to Operate, North Preston WWTF, Approval No. 2005-048309, dated January 31, 2006 (see Appendix A);
- A site visit conducted on July 5, 2011;
- North Preston Sewage Treatment Plant Upgrade Drawings, prepared by CBCL Limited, record drawings dated November 2007; and
- Operating data from WaterTrax over the period January 2009 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The North Preston WWTF is a sequencing batch reactor (SBR) treatment facility with a two-celled engineered wetland for effluent polishing. According to Halifax Water staff, it has a design average day flow capacity of 680 m^3/d. The plant, which was originally constructed as a rotating biological contactor (RBC) facility, was converted into an SBR treatment system with effluent polishing around 2006.

The liquid treatment train consists of grit removal, screening, equalization, biological treatment in continuous-fill SBRs, UV disinfection, and effluent polishing in a horizontal flow-through engineered wetland system. Treated effluent is discharged to Whynder Lake. The solids handling process consists of an aerobic storage tank. Liquid sludge is hauled off-site to the AeroTech WWTF for further processing.

The North Preston WWTF treats mainly domestic wastewater.

Figure 2.1 shows an aerial view of the North Preston WWTF, including the engineered wetlands.

Figure 2.1 North Preston WWTF - Aerial View

2.2 Existing Facilities

Wastewater from the collection system flows to preliminary treatment, which consists of grit removal and one mechanically cleaned bar screen. Preliminary treated wastewater is then discharged into the raw wastewater pumping station wet well, which also acts as the influent equalization tank. A bypass around preliminary treatment allows influent wastewater to discharge directly into the raw wastewater wet well.

The raw wastewater pumping station/equalization tank is equipped with two submersible pumps which direct the flow to the SBRs. An emergency overflow in the equalization tank diverts excess flows directly to the engineered wetland in the case of high flows.

The SBR influent line is equipped with a magnetic flowmeter to record influent flows. Alum, for phosphorus removal, and caustic soda, for alkalinity control, are added downstream of the flowmeter. The flow is then split between the two continuous-fill SBR tanks.

The SBR tank cycle times are controlled via a timer system, with cycle times adjusted based on influent flows. During typical flows, the react cycle is set to 3.0 hrs; during high flow events, the react cycle duration is reduced to as low as 30 minutes. Oxygenation is provided by two Aerzen blowers (one duty, one standby). There is currently no means to control air flow based on dissolved oxygen (DO) concentrations in the SBR tanks.

Waste activated sludge (WAS) is withdrawn from the SBR tanks, with a timer system for control of pumping. WAS is sent to an aerated sludge holding tank. Supernatant from the sludge holding tank is directed to the equalization tank. Sludge holding tank contents are pumped out approximately three times per week, with the liquid sludge hauled off-site to the AeroTech WWTF for further processing.

SBR effluent from both tanks is combined prior to passing through UV disinfection. The disinfected effluent then flows to a two-celled, horizontal flow through, planted reed engineered wetland. The effluent passes through the two cells in series prior to being discharged via an outfall to Whynder Lake.

Figure 2.2 presents a process flow diagram of the North Preston WWTF liquid treatment train.

2.3 Current Compliance Requirements

Table 2.1 presents the effluent requirements based on the Permit to Operate (PTO), effluent requirements as recorded in WaterTrax, and the Altantic Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). To determine the current required level of service, treatment requirements listed under the WWTF's PTO were assumed. If no PTO requirements were listed or available for a particular parameter, the current treatment requirements were based on Halifax Water treatment standards, as recorded in WaterTrax.

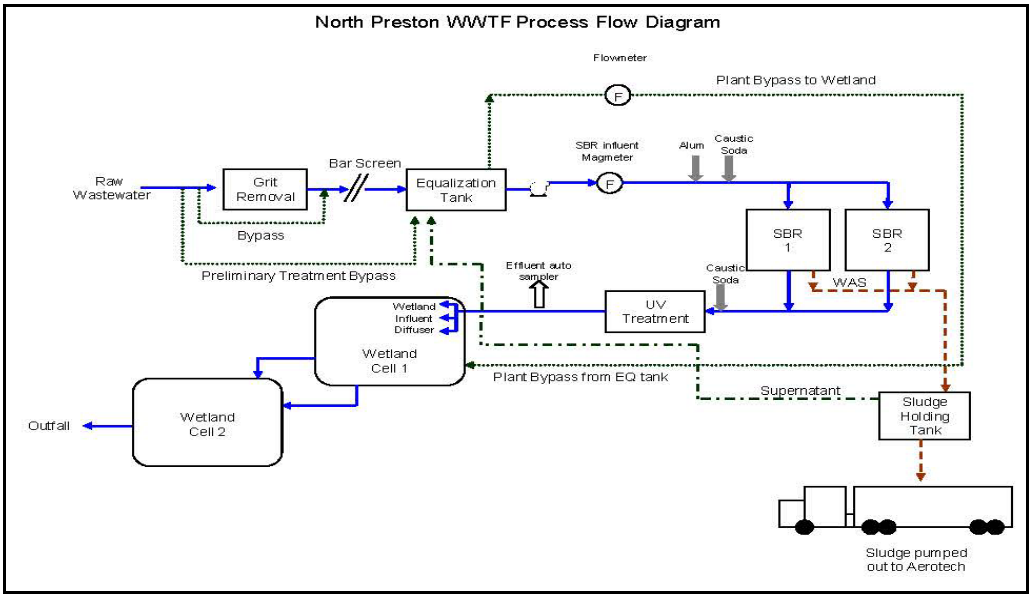

Figure 2.2 Process Flow Diagram of the North Preston WWTF

Table 2.1 North Preston WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	HW Treatment Standards	Atlantic Canada Guidelines	Current Required Level of Service (1)
cBOD5 (mg/L)	10	10	20	10
TSS (mg/L)	10	10	20	10
TAN (mg/L)	3	3	-	3
Ortho-phosphate (mg/L as P)	-	1.5	-	1.5
TP (mg/L)	1.5	-	-	1.5
E. coli (cfu/100 mL)	200	-	-	200
Fecal coliforms (cfu/100 mL)	-	200	200	200
pH	6.5 to 9	6.5 to 9	-	6.5 to 9

Notes:

n/a – not applicable
$cBOD_5$ – carbonaceous biochemical oxygen demand
TSS – total suspended solids
TAN - total ammonia nitrogen

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception of pH).

The current treatment requirements for the North Preston WWTF are consistent with those for a tertiary treatment facility providing year-round nitrification.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2009 to July 2011) are summarized in Table 3.1.

Table 3.1 AeroTech WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	67.7	170	110 (low) 190 (med) 350 (high)
TSS	53.2	200	120 (low) 210 (med) 400 (high)
TP	-	7	4 (low) 7 (med) 12 (high)
TKN (2)	13.0	25	20 (low) 40 (med) 70 (high)

Notes:
n/d - data not available
n/a – not applicable
TKN – total Kjeldahl nitrogen
1. The “low”, “med”, and “high” refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. The raw wastewater TKN was estimated based on the historic raw wastewater TAN concentration of 10.4 mg/L, and assuming a TAN:TKN ratio of 0.80.

The raw wastewater quality is very low strength with respect to BOD_5, TSS and TKN. No raw wastewater TKN concentrations were recorded in WaterTrax, and only one raw wastewater TP value was recorded over the review period. Raw wastewater samples should be analyzed for these parameters if this is not currently being done.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2009 to July 2011) are summarized in Table 3.2. It should be noted that the effluent quality data are based on samples collected downstream of UV disinfection, but upstream of the engineered wetland. Thus, the effluent quality presented is that of the mechanical plant effluent.

Table 3.2 North Preston WWTF Effluent Flow and Quality Data

Parameter	2009	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 4)	559	549	977	-
MDF (m^3/d)	3,694	2,804	3,668	-
$cBOD_5$ (mg/L)	3.8 (3)	4.8	4.2	10
TSS (mg/L)	5.4	8.7	6.9	10
PO4-P (mg/L)	0.65	0.23	0.02	1.5
TP (mg/L)	n/a	0.27	0.23	1.5
TAN (mg/L)	1.6	1.5	2.0	3
Fecal coliforms (MPN/100 mL) (2)	11	1.7	1.4	200

Notes:
ADF – average day flow
MDF – maximum day flow
1. Flow data for 2011 were only available from January 1 to March 31.
2. Average fecal coliform and E. coli values reported are annual geometric means.
3. Effluent BOD_5 recorded in 2009. $cBOD_5$ values were recorded in 2010 and 2011.
4. Design ADF capacity is 680 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Historically, the North Preston WWTF mechanical plant has produced effluent that meets the treatment requirements with respect to $cBOD_5$, PO_4-P, TP and fecal coliforms, based on both the quarterly and individual sample treatment requirements.

Mechanical plant effluent TAN exceeded the quarterly treatment requirement (i.e. - 80% of the sample results with a TAN concentration of 3 mg/L or less) on two occasions; however, no samples exceeded the individual sample requirement of less than 6 mg/L. As a result, the TAN exceedances were minor in nature.

Mechanical plant effluent TSS has exceeded the quarterly treatment requirements (i.e. - 80% of the sample results with a TSS concentration of 10 mg/L or less) in six of the ten quarters evaluated. In addition, there were four samples that exceeded the individual sample treatment requirement of 20 mg/L. In spite of these exceedances, the average annual effluent TSS concentrations from the North Preston WWTF over the review period were less than the treatment requirement of 10 mg/L.

Effluent pH was consistently non-compliant on a quarterly basis, and less than 30% of the individual samples were within the range of 6.5 to 9.0. Effluent pH was consistently low, with an average pH of 6.3.

Table 3.3 North Preston WWTF Compliance with Treatment Requirements (January 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$ (1)	10 in compliance/10 total	120 in compliance/120 total
TSS	4 in compliance/10 total	108 in compliance/112 total
PO4-P	10 in compliance/10 total	119 in compliance/119 total
TP	3 in compliance/3 total	39 in compliance/39 total
TAN	8 in compliance/10 total	117 in compliance/117 total
Fecal coliforms	10 in compliance/10 total	123 in compliance/123 total
pH (2)	0 in compliance/10 total	34 in compliance/115 total

Notes:

Analysis of compliance based on the recorded mechanical plant effluent quality. The wetland effluent is not currently collected or analyzed.
Effluent quality marked as "compliance" data in WaterTrax were used for this analysis. Quarters were taken to be January to March, April to June, July to September, and October to December of each calendar year. Quarterly results were based on quarters that had a minimum of three samples values recorded.

1. Effluent BOD5 recorded to January 2010. Effluent cBOD5 recorded from February 1, 2010 on. Compliance with respect to the cBOD5 treatment requirement was assessed based on effluent BOD5 concentrations up to and including January 2010, and based on effluent cBOD5 concentrations from February 1, 2010 on.
2. Individual sample results for pH based on individual samples being between 6.5 to 9.0.

As noted previously, the wetland effluent is not sampled. It is recommended that samples of the wetland effluent be collected and analyzed for compliance purposes, as this will be representative of the effluent being discharged to the receiver.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

According to operations staff, during wet weather events the influent flows exceed the capacity of the mechanical plant, resulting in raw wastewater being discharged into the first cell of the engineered wetland.

Operations staff also indicated that high influent flows result in preliminary treatment bypass, whereby influent flows bypass grit removal and screening and discharge directly into the equalization tank. Operations staff attribute this to a hydraulic bottleneck in the influent pipe to the screen.

Finally, operations staff noted that there may be high levels of both inflow and infiltration (I/I) in the collection system.

3.4 Design, Operational and Condition Issues

The North Preston WWTF is at the end of the power grid, and as a result it is prone to frequent power outages.

Operations staff noted that fats, oils, and grease (FOG) accumulation in the equalization tank/pumping station wet well is an issue.

The design mixed liquor suspended solids (MLSS) concentration in the SBRs was approximately 3,500 mg/L, however operations staff noted that a target range of 2,700 to 3,000 mg/L is used to avoid process upset and decreased effluent quality which occurs when operating at higher MLSS concentrations.

The raw wastewater has very low alkalinity, which can negatively impact nitrification performance in the biological treatment system and effluent pH. Operations staff noted that the use of caustic soda for alkalinity addition has historically been limited due to its negative impact on biological treatment when added in large dosages. As a result, low effluent pH from the mechanical plant has been an ongoing operational issue.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the North Preston WWTF is 680 m^3/d. Historic average flows to the WWTF were approximately 85% of the rated capacity over the years 2009 to 2011; however, in 2011, the ADF has averaged 977 m^3/d or about 144% of rated the capacity. Operations staff indicated that the facility frequently experiences bypasses of the mechanical treatment system during wet weather events.

A preliminary desk-top capacity assessment of the mechanical treatment plant was completed to estimate the existing treatment capacity of the North Preston WWTF liquid treatment train. Based on two continuous fill SBRs providing a total volume of 826 m^3, an influent equalization tank with a usable storage volume of 76 m^3, historic raw wastewater characteristics, and providing year-round nitrification, the estimated average day capacity of the North Preston WWTF is 850 m^3/d. The maximum day treatment capacity was estimated to be 1,475 m^3/d.

Based on the estimated treatment capacities, the North Preston WWTF has historically operated at approximately 68% and 250% of its average and maximum day treatment capacities, respectively.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

No data were available regarding the existing receiver, Whynder Lake. An assimilative capacity assessment of Whynder Lake would need to be completed to confirm future treatment requirements.

4.2 Site Constraints

There is room available for expansion within the existing fenced area of the North Preston WWTF. One or two additional SBR tanks could be constructed adjacent to the existing tanks, and additional room for expansion is available directly adjacent and to the west of wetland Cell No. 1.

The property located to the north of the WWTF is a tipping ground. The area to the south of the WWTF is wooded. Expansion on to the adjacent wooded property may be possible.

5. Summary and Conclusions

Based on the above review, the following conclusions can be made regarding the North Preston WWTF:

- The raw wastewater quality is very low strength with respect to BOD_5, TSS and TKN.
- No raw wastewater TKN concentrations were recorded in WaterTrax, and only one raw wastewater TP value was recorded over the review period. Raw wastewater samples should be analyzed for these parameters if this is not currently being done.
- Historically, the North Preston WWTF mechanical plant has produced effluent that meets the treatment requirements with respect to $cBOD_5$, PO_4-P, TP and fecal coliforms, based on both the quarterly and individual sample treatment requirements.
- Mechanical plant effluent TAN and TSS have exceeded the quarterly treatment requirements in two and six of ten quarters, respectively. Effluent pH was consistently non-compliant on quarterly and individual sample bases.
- It is recommended that samples of the wetland effluent be collected and analyzed for compliance purposes, as this will be representative of the effluent being discharged to the receiver.
- According to operations staff, during wet weather events the influent flows exceed the capacity of the mechanical plant, resulting in raw wastewater being discharged into the first cell of the engineered wetland.
- The North Preston WWTF is at the end of the power grid, and as a result it is prone to frequent power outages.
- Based on the results of a desk-top preliminary capacity assessment, the existing North Preston WWTF has estimated capacities as follows:
  - Average day flow capacity: 850 m^3/d; and
  - Maximum day flow capacity: 1,475 m^3/d.
- No data were available regarding the existing receiver, Whynder Lake. An assimilative capacity assessment of Whynder Lake would need to be completed to confirm future treatment requirements.
- There is room available for expansion within the existing fenced area of the North Preston WWTF. One or two additional SBR tanks could be constructed adjacent to the existing tanks, and additional room for expansion is available directly adjacent and to the west of wetland Cell No. 1.

6. References

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA
Department of Environment and Labour

Suite 224, Sunnyside Mall
1595 Bedford Highway
Bedford, NS B4A 3Y4

Tel: (902) 424-7773
Fax: (902) 424-0597

Our File Number: 94300-30-/BED-048309

January 31, 2006

Mr. Alan Brady
Halifax Regional Municipality
PO Box 1749
Halifax, NS
B3J 3A5

Dear Mr. Brady:

RE: Approval to Construct and Operate - Sewage Treatment Upgrade
Approval No. 2005-048309

Enclosed please find Approval # 2005-048309 to construct and operate the Sewage Treatment Upgrade at North Preston, Halifax Regional Municipality, Nova Scotia. The operating conditions contained in this approval apply to the upgraded stp once commissioned.

Strict adherence to the attached terms and conditions is imperative in order to validate this approval

Despite the issuance of this Approval, the Approval Holder is still responsible for obtaining any other authorization which may be required to carry out the activity, including those which may be necessary under provincial, federal or municipal law.

Should you have any questions, please contact Frank C MacNeil, Central Region, Bedford Office at (902) 424-2531

Yours Truly

Frank C MacNeil, PEng
Regional Engineer

cc M. Abbott

Eimas #: 2005-048309

NOVA SCOTIA
Department of Environment and Labour

APPROVAL

Province of Nova Scotia
***Environment Act*, S.N.S. 1994-95, c.1**

APPROVAL HOLDER: **Halifax Regional Municipality**

APPROVAL NO: **2005-048309**

EFFECTIVE DATE: **January 31, 2006**

EXPIRY DATE: **January 31, 2016**

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Construction and operation of a Sewage Treatment Upgrade, and associated works, at or near North Preston, Halifax Regional Municipality in the Province of Nova Scotia.

Administrator Stephen Westhaver
Date Signed January 30, 2006

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Department of Environment and Labour

Project: Halifax Regional Municipality
Sewage Treatment Upgrade
North Preston, Halifax Regional Municipality

Approval No: 2005-048309

Reference Documents:

- Application dated August 15, 2005 and attachments.
- Revised Engineeing Drawings# 05-355 dated Jan23/06
- CBCL Design Brief dated Jan/06
- CBCL Submissions dated Jan 18 & 23/06

1. **Definitions**

a) "Act" means the *Environment Act* S.N.S. 1994-1995, c.1, and includes all regulations made pursuant to the Act.

b) "Composite Sample" means a representative sample which is taken from the combination of individual samples that are collected over a 24 hour period with at least one sample of 100 ml taken at two hour intervals.

c) "Department" means the Central Region, Bedford Office, of the Nova Scotia Department of Environment and Labour located at the following address:

Nova Scotia Department of Environment and Labour
Environmental Monitoring and Compliance Division
Central Region, Bedford Office,
Suite 224, 1595 Bedford Highway,
Bedford, Nova Scotia, B4A 3Y4.

Phone: (902) 424-7773
Fax: (902) 424-0597

d) "Facility" means the Sewage Treatment Upgrade and associated works.

e) "Grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled.

f) "Minister" means the Minister of the Nova Scotia Department of Environment and Labour.

g) "NSDEL" means the Nova Scotia Department of Environment and Labour.

h) "Sewage Collection System" means the Facility and all auxiliaries for the collection, treatment, storage and discharge of sewage from the source of the sewage to the final discharge point.

2. **Scope of Approval**

a) This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to construct and operate the Facility, situated at or near North Preston, Halifax Regional Municipality (the "Site").

b) This approval(#2005-048309) authorizes the construction upgrading for the existing stp and this approval also cancels & replaces the existing operating approval(JCA 88-54) upon acceptance by the department of the Completion of Approved Work form as required under section 4(m).

c) The Facility shall be constructed and operated as outlined in the application for minicipal approval dated August 15, 2005 and supporting documentation.

d) The Site shall not exceed the area as outlined in the application and supporting documentation.

e) This Approval is restricted to the installation and operation of the Facility only. No alteration or infill of a watercourse or water resource is permitted by this Approval. Works associated with the alteration or infill of a watercourse or water resource will require separate approval from the Nova Scotia Department of Environment and Labour.

f) This Approval does not apply to the electrical, roadways, and structural components of the project.

g) Should the work authorized by this Approval not be commenced within a year, this Approval shall automatically be null and void, unless extended in writing by an Administrator

3. **General Terms and Conditions**

a) The Approval Holder shall construct, operate and reclaim its Facility in accordance with provisions of the:

   i) *Environment Act* S.N.S. 1994-1995, c 1;
   ii) Regulations pursuant to the above Act;
   iii) Any future amendments to the Act and regulations

b) No authority is granted by this Approval to enable the Approval Holder to construct the Facility on lands which are not in the control or ownership of the Approval Holder. It is the responsibility of the Approval Holder to ensure that such a contravention does not occur. Upon request, the Approval Holder shall provide, to the Department, proof of such control or ownership.

c) If there is a discrepancy between the reference documents and the terms and conditions of this Approval, the terms and conditions of this Approval shall apply.

d) Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

e) The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

f) This Approval is not transferable without the consent of the Minister or Administrator.

g) (i) If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(2)(b) and 58(4) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

   (ii) Despite a cancellation or suspension of this Approval, the Approval Holder remains subject to the penalty provisions of the Act and regulations

h) The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the Facility, including process changes or waste disposal practices which are not granted under this Approval. Extensions or modifications to the Facility may be subject to the Environmental Assessment Regulations. An amendment to this Approval will be required before implementing any change.

i) Pursuant to Section 60 of the *Act*, the Approval Holder shall submit to the Administrator any new and relevant information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval

j) The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

k) The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

l) Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

m) All samples required by this Approval shall be analysed by a laboratory that is:

   i) Accredited by the Standards Council of Canada; or

   ii) Accredited by another agency recognised by the Nova Scotia Department of Environment and Labour to be equivalent to the Standards Council of Canada; or

   iii) Maintaining an acceptable standard in a proficiency testing program conducted by the Canadian Association for Environmental Analytical Laboratories for all parameters being reported; or

   iv) Maintaining an acceptable standard in a proficiency or performance testing in another program considered acceptable to the Nova Scotia Department of Environment and Labour for all parameters being reported

n) The Approval Holder shall submit any monitoring results or reports required by this Approval to the Department. Unless specified otherwise in this Approval, all monitoring results shall be submitted within 30 days following the month of monitoring.

o) The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel directly involved in the Facility operation are made fully aware of the terms and conditions which pertain to this Approval.

4. **Construction of Facility**

a) All erosion and sedimentation controls are to be in place prior to construction at this Facility. The Nova Scotia Department of the Environment " Erosion and Sedimentation Control Handbook For Construction Sites" shall serve as the reference document for all erosion control measures. These measures are minimum requirements and additional controls shall be implemented if Site runoff exceeds the discharge limits contained herein.

b) All erosion and sedimentation controls are to be maintained and remain in place until the disturbed areas are stabilized

c) The Approval Holder shall sample for the parameters and at the frequency indicated to ensure the following liquid effluent levels from any discharge from the Site are met:

Liquid Effluent Discharge Limits During Construction

Parameters	Maximum in a Grab Sample	Monthly Arithmetic Mean	Monitoring Frequency
Total Suspended Solids	50 mg/l	25 mg/l	All Rain Events
pH	5 - 9	5 - 9	All Rain Events

d) Non-compliance of the effluent discharge limits noted in clause (c) shall be immediately reported to the Department

e) (i) The monitoring station(s) for the liquid effluent shall be the discharge from any location on Site, including the settling ponds.

(ii) Monitoring station locations shall be constantly reviewed by the Approval Holder and the locations revised as construction progresses and as approved by the Department.

(iii) The Department reserves the right to modify the monitoring locations, parameters and frequency, and to require remedial measures depending on the information obtained.

f) The Approval Holder shall submit a monthly report summarizing the above sampling results to the Department.

g) All areas exposed during construction and temporary diversion, or control structures such as berms, ditches, etc., shall be stabilized immediately.

h) When dewatering of construction areas is required, the water must not be discharged directly to a watercourse or water resource, nor to a conveyance (a ditch, culvert, manhole) that may lead to a watercourse or water resource without prior treatment to meet limits established in condition 4(c).

i) Grubbings and excavated material shall be stored or disposed of in a manner that will not result in sedimentation of adjacent and downstream watercourses or water resources.

j) Temporary erosion and sedimentation controls are to remain in place until Site stability is established. Approval for the removal of such controls must be obtained from the Department. All erosion and sedimentation control measures shall be monitored daily throughout the construction period and maintained as necessary.

k) Chemical flocculants are to be approved by the Department prior to their use. Requests for approval must be submitted at least 15 days prior to the use of the flocculants.

l) All phases of construction shall be overseen by a qualified professional engineer, licensed to practice in the Province of Nova Scotia, or technologist who works under the supervision of an engineer.

m) (i) Written certification by a professional engineer is required stating that all construction or installation has been conducted in accordance with and has met the minimum requirements of the approved drawings and specifications.

(ii) This certification must be provided to the Regional Manager, within 6 weeks of project completion.

(iii) The certification must include a complete set of as build drawings (if different than the approved drawings) and information on any major changes from the referenced drawings or specifications made during construction.

(iv) The certification must confirm that all as-built drawings and any other relevant documentation have been turned over to the Approval Holder by the engineer.

(v) The certification must include the result of the performance testing conducted on the sewage treatment plant during commissioning and the

confirmation that the Facility meets the requirements of this Approval prior to placement in service.

(vi) The Approval Holder must be complete the "Completion of the Approved Work" form and it shall be included with the certification submission.

n) It is an offence under Section 50(1) and (2) of the Act to proceed with construction or operation of the Facility in advance of receiving this Approval.

5 **Spills or Releases**

a) All spills or releases of dangerous goods, waste dangerous goods, or petroleum hydrocarbon shall be reported to the Department in accordance with the Act (Part VI) and the *Emergency Spill Regulations.*)

b) Spills or releases shall be cleaned up immediately.

c) An adequate quantity of spill/release response material is to be maintained on Site at all times.

6 **Sludge Disposal**

a) All sludge generated at the Facility shall be treated and disposed of by a method approved by the Department.

7. **Operation**

a) The Approval Holder shall designate in writing, to the Department, a contact for this Approval, prior to the startup and operation of the Facility.

b) The Facility must be constructed, operated and maintained in a manner that will prevent erosion, chemical spills or any other incidents that may be detrimental to the environment and public health.

c) The Approval Holder should ensure that the system is operated, maintained and has appropriate backup facilities to protect against failures of the power supply, treatment process, equipment, or structure. Security measures should assure the safety of the sewage treatment processes, storage facilities, and the discharge system

d) The Approval Holder shall ensure the development and implementation of an emergency response plan as part of the operations program. This plan is to

meet the requirements of the Nova Scotia Department of Environment and Labour contingency Plan for Releases of Dangerous Goods and Hazardous Wastes. The plan should include:

i) General procedures for routine (equipment break-down, upset conditions, maintenance, etc.) or major emergencies within the sewage works system; and

ii) A plan for equipment becoming inoperable in a major emergency.

iii) A plan for dealing with spills or releases.

e) The Approval Holder shall not establish nor maintain a bypass to divert sewage around the Facility or any feature of the Facility treatment process unless the bypass has been approved by the Department. When it is necessary to use an approved by-pass, the Approval Holder shall notify the Department.

f) The Approval Holder shall take immediate preventive or corrective action ,when results of an inspection or sampling results indicate conditions which are currently or may become a detriment to system operations, and/or result in adverse impact to the environment or public health.

g) The Facility has been classified as a **Class 2** treatment plant. The day-to-day operations of the wastewater treatment plant shall be supervised directly by certified operators who hold the appropriate certification.

h) The Approval Holder shall establish and submit to NSDEL upon request notification procedures to be used to contact the Medical Officer of Health, NSDEL, other relevant authorities and the general public in the case of an emergency situation.

i) The Approval Holder shall prepare a comprehensive operations manual within three months of commencement of operation of the Facility and keep it up to date. The manual shall be subject to review by NSDEL upon request.

j) A complete set of the drawings, incorporating any amendments made from time to time, shall be kept by the Approval Holder at the Facility for as long as the Facility is kept in operation.

k) The Approval Holder shall establish procedures for receiving and responding to complaints including a reporting system which records what steps were taken to determine the cause of complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

8. **Performance And Limits**

8.1 **Treated Effluent**

The Facility and associated sewage collection system shall be managed and operated in such a manner that the effluent being discharged to the receiving waters satisfies the following criteria:

a) Biological oxygen demand, BOD_5, shall not exceed 10 mg/l.

b) Suspended Solids, shall not exceed 10 mg/l

c) Ecoli shall not exceed 200/100 count/mls

d) Disinfection of the effluent from the Facility shall be continuous.

e) pH - 6.5 to 9.

f) Nutrient levels shall not exceed the following: Ammonia 3 mg/l and Phosphorous 1.5 mg/l

8.2 **Odour Control**

a) The Approval Holder shall operate the Facility in a manner which will not result in the generation of offensive or hazardous odours/vapours.

b) The Approval Holder shall be required to implement control measures if odour generation is deemed excessive by the Department.

9. **Monitoring and Recording**

a) The Approval Holder shall conduct all monitoring and analysis required in this section according to the latest edition of "Standard Methods for the Examination of Water and Waste Water".

b) All equipment must be installed, maintained and calibrated as specified by the manufacturer's instructions.

c) Following a review of any of the analytical results required by this Approval, NSDEL may alter the frequencies, location, and parameters for analyses required for this Approval.

TABLE 1		
PARAMETER	MINIMUM FREQUENCY	LOCATION
BOD_5	5/month	treated effluent discharge
Suspended Solids	5/month	treated effluent discharge
Ecoli	5/month	treated effluent discharge
pH	5/month	treated effluent discharge
NH3	5/month	treated effluent discharge
Phosphorous	5/month	treated effluent discharge
Plant Volumes	continuous	entering and leaving plant

* All samples shall be grab unless stated otherwise.

d). The Facility shall be considered in compliance with the effluent limitations if 80% of the sample test results, at the frequency and number specified in table 1 meet the specified limit in section 8.1. No single result can be greater than two times the limits in section 8.1.

10. Reporting

10 1 Quarterly Reporting

a) The Approval Holder shall prepare and submit to the Department on a quarterly basis, the results of the sampling conducted at the locations indicated in table 1 above.

a) The Approval Holder shall prepare and submit to the Department, a quarterly performance report for the facility. The report shall contain the following information in a format acceptable to the Regional Manager.

i) a summary and discussion of the quantity of wastewater treated during the reporting period compared to the design values for the facility, including peak flow rates, maximum daily flows and monthly average daily flows;

ii) a summary and interpretation of analytical results obtained in accordance with Section 9 (monitoring and recording) of this Approval;

iv) a tabulation and description of any emergency or upset conditions which occurred during the period being reported upon and action taken to correct them;

v) Any complaints that were received and the Approval Holders response.

10.2 Emergency Reporting on Operation

a) The Approval Holder shall notify the Department forthwith in the event that untreated wastewater is directed to the receiving waters.

b) The Approval Holder shall immediately notify the Department of any incidents of exceedence of the compliance requirement indicated in section 9(d).

11 Records

a) The Approval Holder shall keep the following records and wastewater effluent quality analyses:

   i) BOD_5, Suspended Solids, and Bacteriological analyses shall be kept for five years;

   ii) Flow meter readings shall be kept for 10 years.

b) The Approval Holder shall also retain the following information for a period of three years:

   i) calibration and maintenance records;

   ii) continuous monitoring data;

   iii) records of any violations of the conditions of this Approval and actions taken by the Approval Holder to correct those violations.

c) A copy of this Approval, project reports, construction documents and drawings, inspection reports, shall be kept for the life of the facility.

File No: 94300-30-/BED-048309

NOVA SCOTIA
Department of Environment and Labour

COMPLETION OF THE APPROVED WORK

A condition of this Approval requires that the Approval Holder notify the Department of Environment and Labour that the work authorized is complete.

Please enter the information on this sheet and return it to the Nova Scotia Department of Environment and Labour at the following address:

Nova Scotia Department of Environment and Labour
Environmental Monitoring and Compliance Division
Central Region, Bedford Office,
Suite 224, 1595 Bedford Highway,
Bedford, Nova Scotia, B4A 3Y4.

Phone: (902) 424-7773
Fax: (902) 424-0597
NSDEL Contact: Frank C MacNeil

APPROVAL NUMBER: 2005-048309

NAME OF APPROVAL HOLDER: Halifax Regional Municipality

TYPE OF WORK: Sewage Treatment Upgrade

WORK AUTHORIZED: ______________________

NAME OF CONTRACTOR: ______________________

DATE WORK WAS COMPLETED: ______________________

COMMENTS: ______________________

____

____

____

____

____

SIGNATURE ______________________ Date ______________________

APPENDIX B

SITE VISIT PHOTOS

Photo 1 EQ Tank Below Checker Plate

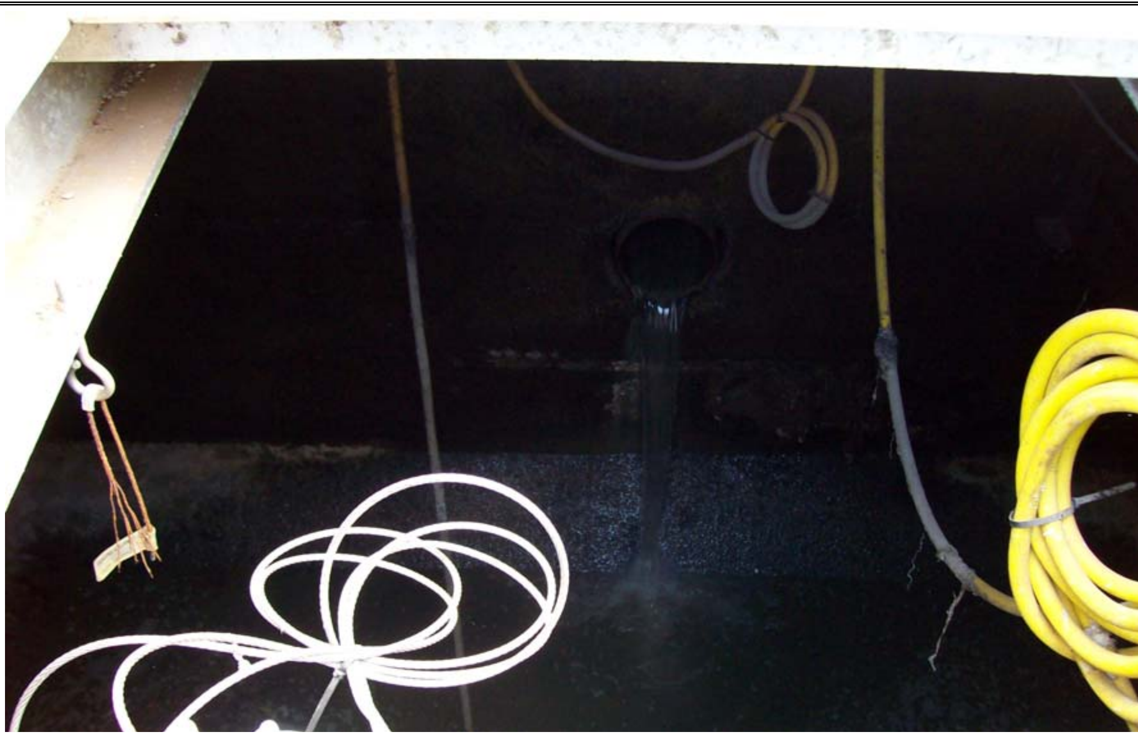

Photo 2 EQ Tank Influent Line

Photo 3 EQ Tank with Evidence of Grease Balls

Photo 4 Grit Removal and Influent Line to Screen

Photo 5 Grit Tank Overflow Weir

Photo 6 Mechanical Screen

Photo 7 Odour Control

Photo 8 Screen and Screenings Bin

Photo 9 SBR Influent Flowmeter

Photo 10 Lime Feed System

Photo 11 Lime Injection Point

Photo 12 SBR Tank

Photo 13 SBR Decant Mechanism (typ)

Photo 14 SBR Tanks in Decant Mode (left) and Fill Mode (right)

Photo 15 SBR Tanks in React Mode

Photo 16 Blower (typ.)

Photo 17 UV Disinfection

Photo 18 Engineered Wetland Cell No. 1 - Inlet

Photo 19 Engineered Wetland Cell No. 1 - Outlet

Photo 20 Engineered Wetland Cell No. 2 - Outlet

Photo 21 Receiver – Whynder Lake

VOLUME 3 – APPENDIX B-8

Springfield Lake WWTF

APPENDIX - WORKING PAPER NO. 1.3
SPRINGFIELD LAKE WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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APPENDICES

1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Springfield Lake WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Springfield Lake WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection;
- Assess current operating performance in terms of meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- A site visit completed on July 4, 2011;
- Joint Certificate of Approval for the Springfield Lake Sewage Treatment Plant, Nova Scotia Department of the Environment, 1988 (see Appendix A);
- Springfield Lake Sewerage System drawing set, Porter Dillon, 1988; and
- Operating data from WaterTrax over the period January 2009 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Springfield Lake WWTF is an extended aeration facility that was constructed in 1987, and consists of grit removal, screening, biological treatment in an aerated bioreactor, secondary clarification, and chlorine disinfection. The WWTF was designed to treat an average day flow (ADF) of 545 m^3/d and a peak flow of 2,100 m^3/d. The facility is operating at 88% of its average rated capacity. The effluent from the plant discharges into a small brook flowing to Lisle Lake.

Waste sludge is collected and removed from the secondary clarification tank, and this sludge is stored in an on-site sludge holding tank. Supernatant is decanted from the sludge storage tank and returned to the extended aeration tank. The settled sludge is then removed and trucked to the AeroTech WWTF for dewatering and further treatment and disposal.

The WWTF serves the Springfield Lake community, and receives wastewater from three separate collection systems. The first collection system serves Fenerty Road, including Lake Crest Drive to Ashley Drive. The second collection system serves Springfield Lake Road, including Falcon Crest Court and North Brook Court. The third collection system serves Lakeview Road, including First Avenue, Dyllys Drive, Megan Crescent and Andrea Lori Drive. The Springfield Lake Road subdivision uses grinder pumps at each household; the other two collection systems are conventional gravity systems. All three collection systems discharge to the WWTF via dedicated forcemains.

2.2 Existing Facilities

Wastewater is pumped to the treatment facility headworks. The headworks consist of grit removal, and an automatic coarse bar screen with a 12 mm opening size.

Following screening, the wastewater enters the aerated bioreactor. The wastewater is aerated and mixed by two mechanical surface aerators. Due to low dissolved oxygen concentrations in the bioreactor, the operators have temporarily installed a Biolac® aeration header to provide additional oxygenation to the bioreactor.

Following aeration, the wastewater flows to the secondary clarifier. The secondary clarifier is a rectangular tank attached to the aeration tank by a common wall with the bottom sloping back to the aeration basin. Return activated sludge (RAS) is returned to the bioreactor passively via tank hydraulics and convective currents created by the surface aerators in the bioreactor.

A skimmer/scraper mechanism keeps the clarifier free of settled sludge and floating debris. Scum is skimmed from the top of the clarifier and collected in a trough that is sent to the sludge holding tank, and a portion of the settled sludge is wasted and sent to the sludge holding tank. Supernatant from the sludge holding tank is returned to the bioreactor. The thickened sludge is hauled to the AeroTech WWTF for dewatering (Refer to TM_3-10118833).

The secondary effluent flows to the chlorine contact tank. Sodium hypochlorite is added at the head of the chlorine contact tank, and flow paced to maintain a residual of between 0.5 mg/L to 1.0 mg/L in the contact tank effluent. The disinfected effluent flows by gravity via the outfall to a brook leading to Lisle Lake.

Figure 2.1 presents a process flow diagram of the Springfield Lake WWTF.

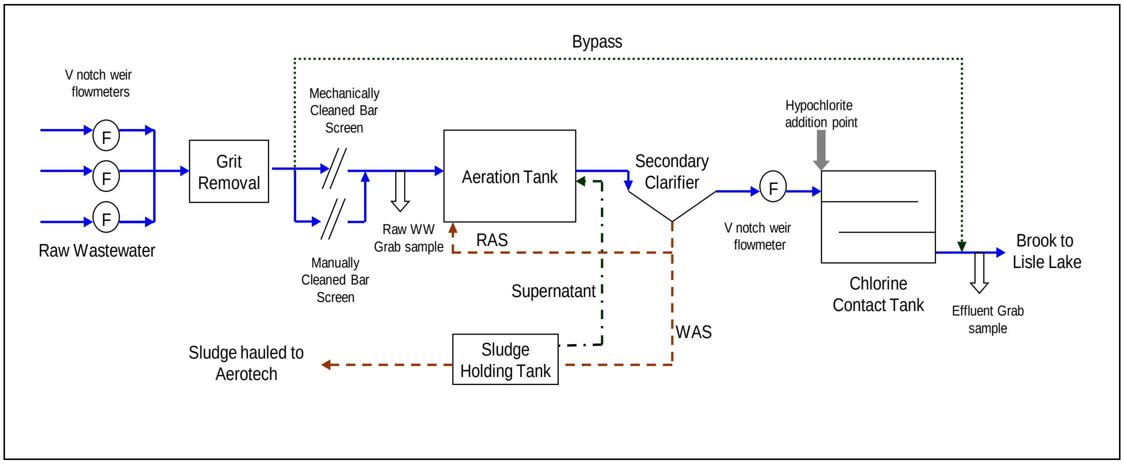

Figure 2.1 Process Flow Diagram of Springfield Lake WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Springfield Lake WWTF is regulated by effluent criteria as recorded in WaterTrax.

Table 2.1 presents the effluent requirements based on the Permit to Operate (PTO), WaterTrax requirements, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). Because the PTO includes no effluent requirements, the current treatment requirements were based on the most stringent of the treatment standards as recorded in WaterTrax and those identified in Atlantic Canada Guidelines.

Table 2.1 Springfield Lake WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	HW Treatment Standards	Atlantic Canada Guidelines	Current Required Level of Service
$cBOD_5$ (mg/L)	-	5	25	5
TSS (mg/L)	-	5	25	5
BOD_5 Removal (%)	-	90	-	90
TSS Removal (%)	-	90	-	90
Fecal coliforms (MPN/100 mL)	-	200	200	200

Notes:

n/a – not applicable

$cBOD_5$ – carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception of BOD_5 removal and TSS removal, for which the required level of service values shown are minimum values).

The current treatment requirements for the Springfield Lake WWTF are consistent with those for a tertiary treatment facility, in spite of it providing secondary level treatment only.

3. Historic Plant Performance

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2009 to July 2011) are summarized in Table 3.1. Raw wastewater quality data are based on grab samples from the influent wastewater at the bar screen.

Table 3.1 Springfield Lake WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	130	170	110 (low) 190 (med) 350 (high)
TSS	156	200	120 (low) 210 (med) 400 (high)
TP	n/d	7	4 (low) 7 (med) 12 (high)
TKN	40 (2)	25	20 (low) 40 (med) 70 (high)

Notes:

n/d - data not available

n/a – not applicable

TKN – total Kjeldahl nitrogen

1. The “low”, “med”, and “high” refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. The raw wastewater TKN was estimated based on the historic raw wastewater TAN concentration of 32 mg/L, and assuming a TAN:TKN ratio of 0.80.

The raw wastewater quality is low to medium strength with respect to BOD_5 and TSS. The raw wastewater quality is medium strength with respect to TKN. Raw wastewater TP data were not available; it is recommended that raw wastewater samples be analyzed for this parameter.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2009 to July 2011) are summarized in Table 3.2. Effluent quality data are based on grab samples from the effluent following chlorination.

Table 3.2 Springfield Lake WWTF Effluent Flow and Quality Data

Parameter	2009	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 5)	475	468	585	-
MDF (m^3/d) (1)	1,455	1,932	1,425	-
$cBOD_5$ (mg/L)	4.5(2)	6.6	15.6	5
TSS (mg/L)	5.8	10.2	36.3	5
TP (mg/L) (3)	-	1.1	1.6	-
TAN (mg/L) (3)	-	1.1	10.3	-
Fecal coliforms (MPN/100 mL) (4)	1.5	43.7	316.5	-

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data for 2011 were only available over the period January to February.
2. 2009 BOD value is reported as BOD_5. All values from 2010 to the present are reported as $cBOD_5$.
3. Effluent TP and TAN results were only available over the period from November 2010 to July 2011.
4. Average fecal coliform values reported are annual geometric means.
5. Design ADF capacity is 545 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80%of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Springfield Lake WWTF Compliance with Treatment Requirements (January 2009 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	6 in compliance/10 total	103 in compliance/123 total
TSS	4 in compliance/10 total	93 in compliance/125 total
BOD_5 Removal	9 in compliance/10 total	n/a
TSS Removal	7 in compliance/10 total	n/a
Fecal coliforms	5 in compliance/9 total	76 in compliance/104 total

Notes:

Compliance results for $cBOD_5$ include four quarters (January to December, 2009) for which effluent BOD_5 concentrations were measured.

Historically, the Springfield Lake WWTF has performed well in terms of effluent BOD_5 and TSS removal, meeting quarterly treatment targets for each of these parameters in 90% and 70%of quarters, respectively.

Effluent $cBOD_5$, TSS, and fecal coliforms concentrations frequently exceeded the Halifax Water compliance requirements with only 60%, 40% and 55%of the quarterly samples in compliance, respectively. Individual samples for $cBOD_5$, TSS, and fecal coliforms were in compliance for the majority of the time with 84%, 74%, and 73% of the individual samples meeting compliance requirements, respectively.

Despite the majority of the individual samples for $cBOD_5$, TSS, and fecal coliforms meeting the individual sample compliance requirements, the overall annual averages of these parameters were still above the quarterly compliance requirements.

Currently, there are no established TP effluent limits for the Springfield Lake WWTF, and the historical TP concentration values average about 1.4 mg/L. As well, there are currently no established TAN effluent limits for the Springfield Lake WWTF. The historical TAN concentration values are variable, with the plant achieving nitrification on a seasonal basis.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Springfield Lake WWTF has the ability to bypass from the grit chamber directly to the outfall; however, this bypass has not been used for over 10 years. The Springfield Lake WWTF can also bypass the automatic bar screen; however, this is also not usually practised at the WWTF. Due to the configuration of the tankage, the operators are unable to isolate any other part of the system for maintenance. Should a shut-down of a particular unit process be required, a full plant by-pass would be required. The plant bypass would result in the discharge of raw wastewater directly to the brook that feeds Lisle Lake. This brook runs directly through the back yard of a residential property.

High levels of inflow and infiltration (I/I) in the collection system impact peak wet weather flows to the Springfield Lake WWTF. The WWTF receives an ADF of approximately 490 m^3/d during dry weather conditions; during wet weather events, the plant has received flows as high as 1,940 m^3/d. Although the WWTF was designed to handle peak flows as high as 2,100 m^3/d, historic wet weather flows have led to deterioration in the performance of the secondary treatment and disinfection systems.

3.4 Design, Operational and Condition Issues

The Springfield Lake WWTF has only one treatment train and, for this reason, the operators are not able to take any process off-line for maintenance without bypassing the entire plant. For this reason, the plant has not been taken off-line for maintenance for over 10 years.

Return activated sludge (RAS) is returned to the bioreactor passively via tank hydraulics and convective currents created by the surface aerators in the bioreactor. Due to the configuration of the aeration tank and the supporting beams and columns for the mechanical aerators, the RAS system is not performing adequately, resulting in an accumulation of solids in the clarifier. Operations staff have installed PVC air piping in an attempt to enhance RAS flow through the addition of an air-lift system. In spite of this, solids accumulation in the secondary clarifier is still an operational issue.

In addition, the existing mechanical aerators do not provide sufficient oxygen transfer to maintain an adequate dissolved oxygen concentration in the aeration tank. As a result, operations staff have temporarily installed a Biolac® aeration header to provide additional oxygenation to the bioreactor.

The gates to the screen bypass channel are seized and cannot be operated. This limits the operators' ability to bypass the automatic screen.

The Springfield Lake WWTF is unable to maintain an adequate chlorine residual in the effluent under peak flow conditions, as the disinfection system is undersized.

There is no back-up power for any of the processes or electronic systems.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Springfield Lake WWTF is 545 m^3/d. The historic January 2009 to February 2011 average day flow to the Springfield Lake WWTF was 480 m^3/d, or approximately 88% of the design rated capacity. In spite of operating at average flows below the design capacity, the Springfield Lake WWTF has struggled to achieve the effluent requirements.

A preliminary desktop capacity assessment was completed to estimate the existing treatment capacity of the Springfield Lake WWTF liquid treatment train. Based on an extended aeration tank with a volume of 468 m^3, a secondary clarifier with a surface area of 54.5 m^2, and typical raw wastewater quality, the estimated average day capacity of the Springfield Lake WWTF is 1,376 m^3/d, without nitrification. The peak capacity of the Springfield Lake WWTF is estimated to be 2,180 m^3/d, without nitrification, however this peak capacity may be limited by the hydraulics of the secondary clarifier.

If the Springfield Lake WWTF capacity is calculated assuming nitrification is required, the estimated average day capacity of the WWTF is 550 m^3/d, with a peak capacity of 1,308 m^3/d, however this peak capacity may be limited by the hydraulics of the secondary clarifier.

It should be noted that the above treatment capacities are based on providing effluent quality typical of that for a secondary treatment process (i.e. – 20 mg/L $cBOD_5$, 20 mg/L TSS). The current effluent limits for the Springfield Lake WWTF are consistent with those for a tertiary treatment facility; therefore, the existing processes at the Springfield Lake WWTF cannot meet the current effluent requirements at current flows. However, should the facility be required to meet effluent requirements typical of a secondary treatment system, the estimated treatment capacities identified above would be applicable.

4. FUTURE CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing outfall discharges the effluent into a small stream that is fed by Springfield Lake. This small brook discharges into Lisle Lake. Depending on the season and corresponding water level, the outfall pipe is occasionally submerged in the brook.

The small brook flows directly behind and through the backyard area of several residential properties. The small brook is sometimes reduced to very limited flow, if any, depending on the season. For this reason, the brook has fairly limited assimilative capacity. Lisle Lake may have more assimilative capacity; extending the outfall to Lisle Lake could be considered if the Springfield Lake WWTF is upgraded and/or expanded.

An assimilative capacity assessment of the small brook and Lisle Lake would need to be completed to confirm future treatment requirements.

4.2 Site Constraints

There is very limited space available for expansion within the existing fence line of the Springfield Lake WWTF. The adjacent properties are wooded or residential. Expansion onto the adjacent wooded properties may be possible.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Springfield Lake WWTF:

- Historically, the Springfield Lake WWTF met effluent requirements with respect to BOD_5, and TSS removal; however, the WWTF is frequently out of compliance with respect to $cBOD_5$, TSS, and fecal coliform quarterly effluent concentration requirements.
- Historically, the facility has only been able to meet effluent requirements during dry weather flow conditions. During high flows, the system cannot maintain effluent quality and results are out of compliance.
- Currently, there are no established TP effluent limits for the Springfield Lake WWTF, and the historical TP concentration values average about 1.4 mg/L.
- The current effluent requirements are typical of those for a tertiary treatment facility, however the existing Springfield Lake WWTF provides only secondary level treatment.
- Based on the results of a desk-top preliminary capacity assessment, and assuming that the facility is required to meet effluent requirements consistent with those for a secondary treatment facility, the existing Springfield Lake WWTF has estimated capacities as follows:
  - Average day flow capacity: 1,376 m^3/d, without nitrification;
  - Peak flow capacity: 2,180 m^3/d, without nitrification.
  - Average day flow capacity: 550 m^3/d, with nitrification; and
  - Peak flow capacity: 1,308 m^3/d, with nitrification.
  - It should be noted that the peak flow capacities identified above may be further limited by the hydraulics of the secondary clarifier.
- There is only one treatment train at the Springfield Lake WWTF. As a result, if a unit process needs to be taken off-line for maintenance, this would result in a plant by-pass.
- The structural design of the aeration tank and clarifier impacts RAS flows, causing a build-up of sludge in the clarifier.
- The existing mechanical aerators do not provide sufficient oxygen transfer to maintain an adequate dissolved oxygen concentration in the aeration tank. As a

result, operations staff have temporarily installed a Biolac® aeration header to provide additional oxygenation to the bioreactor.

- The Springfield Lake WWTF is unable to maintain a good chlorine residual in the effluent, as the disinfection system is undersized for peak flows.
- There is very limited capacity for expansion within the existing fenced area of the Springfield Lake WWTF. Expansion onto the adjacent wooded properties may be possible.
- The existing receiver, the small brook leading Lisle Lake, requires an assimilative capacity assessment to be completed in order to confirm future treatment requirements.

6. REFERENCES

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

AND

NOVA SCOTIA DEPARTMENT OF HEALTH AND FITNESS

Joint Certificate of Approval

for

Municipal Water and Sewage Services

Halifax County Municipality
(Municipality or Owner)

File No.: 12-88-0192-02.2

Approval No.: 88-103

Project Description: Halifax County Municipality Springfield Lake Sewage System - Sewage Treatment Plant design by Porter Dillon - Project no. 2185, sheets 1 to 8 dated June, 1988.

Total Estimated Cost: $672,000

Stipulation: (1) Additional treatment to be added if the estimated degree of treatment of 90% removal of BOD5 and suspended solids is not being achieved.

(2) Reduced pressure principle backflow preventors should be installed on domestic water supply system, especially at taps.

(3) Sewage treatment plant should have available a self-contained or air-supplied type of respiratory protective equipment which works on pressure demand or constant flow principle. Staff are to be trained in its use.

RECOMMENDED — Registered Professional Engineers, Province of Nova Scotia; DATE; R. S. GIFFIN; 1483

Department of the Environment

APPROVED

Minister of the Environment

SEP 8 1988

APPENDIX B

SITE VISIT PHOTOS

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Photo 11 Aeration Tank and Wall of Clarifier Building

Photo 12 Secondary Clarifier and Blower

Photo 13 Secondary Clarifier

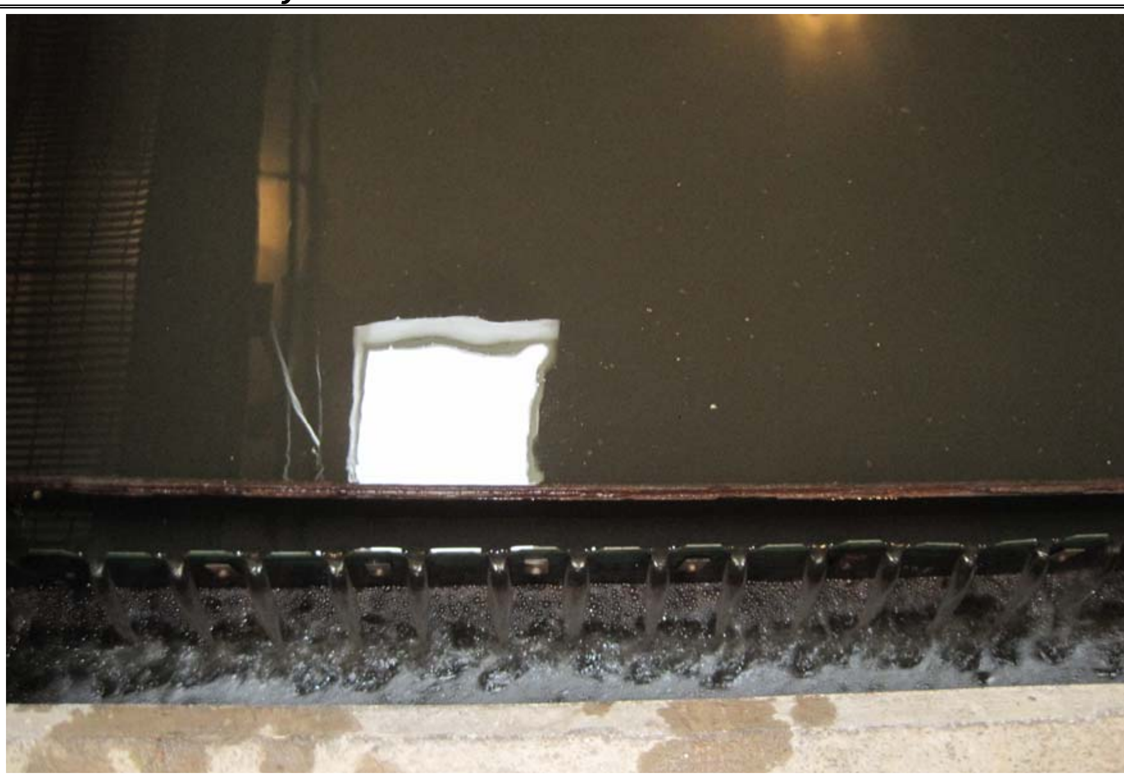

Photo 14 Secondary Clarifier Effluent Weir

Photo 15 Secondary Clarifier Influent from Aeration Tank

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Photo 17 Chlorine Contact Tank

Photo 18 Chlorine Contact Tank

Photo 19 Effluent V-Notch Weir and Ultrasonic

Photo 20 Effluent V-Notch Weir

Photo 21 Outfall to Brook to Lisle Lake

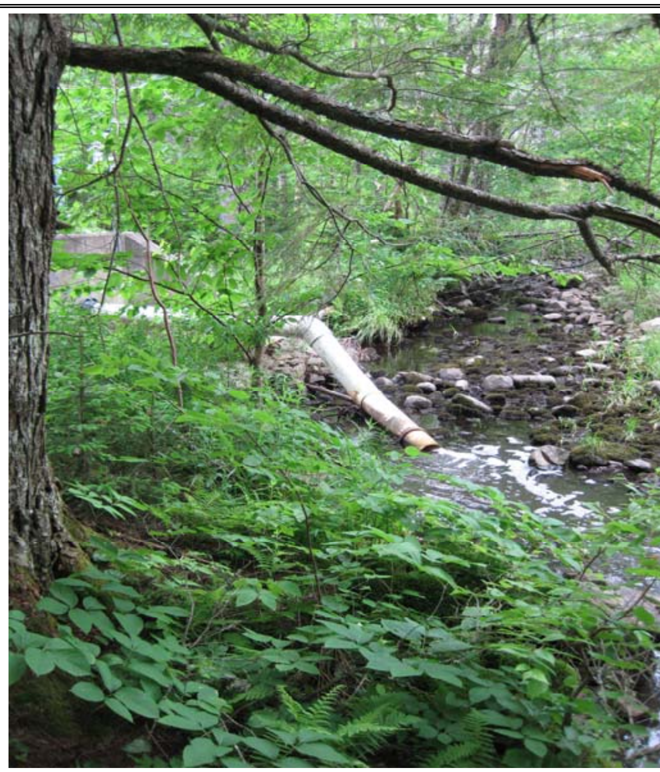

Photo 22 Outfall to Brook to Lisle Lake

Photo 23 Flow Meters for Three Influent Forcemains

Photo 24 Blower

Photo 25 Waste Sludge Tank

Photo 26 Waste Sludge Tank and Supernatant Line

Photo 27 Chemical Storage and Metering

Photo 28 Effluent Flow Meter

VOLUME 3 – APPENDIX B-9

Uplands Park WWTF

APPENDIX - WORKING PAPER NO. 1.3
UPLANDS PARK WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Uplands Park WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Uplands Park Wastewater Treatment Facility (WWTF);
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms of meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- A site visit completed on July 4, 2011;
- Joint Certificate of Approval for the Uplands Park Subdivision Sewage Treatment Plant, Nova Scotia Department of the Environment, 1980 (see Appendix A); and
- Operating data from WaterTrax over the period January 2010 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Uplands Park WWTF consists of screening, primary clarification, fixed film trickling filter technology, secondary clarification, and ultra violet (UV) disinfection. The secondary treatment plant was designed to treat an average flow of 91 m^3/d, and the historic average daily flows (ADF) have been recorded at approximately 119 m^3/d. based on historic operating data, peak wet weather flows have reached flows as high as 2,900 m^3/d. The effluent from the plant discharges to a natural marsh area which drains to Sandy Lake.

Waste sludge is collected and removed from the primary and secondary clarification tanks, and this is sent directly to Aerotech WWTF for further processing as there are no sludge holding tank on site.

The Uplands Park WWTF serves approximately 182 people from the Uplands Park region. The WWTF receives no flow from industry; wastewater flows are almost entirely from residential users through a domestic sanitary sewer system.

Figure 2.1 shows an aerial view of the Uplands Park WWTF.

Figure 2.1 Uplands Park WWTF - Aerial View

2.2 Existing Facilities

Wastewater from the Uplands Park community is gravity fed to the head of the treatment facility. The wastewater flows by gravity through a manually cleaned coarse bar screen. This screen was recently installed (in the past few years) to address a large amount of solid material coming to the plant.

Following screening, the wastewater enters the primary clarifiers prior to entering secondary treatment. There are two separate rotating distribution arms that distribute the wastewater on the rock media, which then trickles through the rocks and is collected and flows out to the secondary clarifiers by gravity. A sludge seed line, using settled sludge from the secondary clarifier, is returned to the trickling filter flow splitter box. The sludge from the primary and secondary clarifiers is pumped out of the tanks on a weekly basis and hauled to the AeroTech WWTF.

From the secondary clarifiers, the wastewater flows to the chlorine contact tank. The chlorine contact tank is now used as an emergency alternative to a new ultra violet (UV) disinfection system. The wastewater still travels through the baffled tank; however, hypochlorite is no longer dosed at this point. Following the chlorine contact tank, the wastewater flows to the recently commissioned UV disinfection system. The UV system is comprised of four separate units of four bulbs each.

Following disinfection, the water flows by gravity to the outfall, and the effluent is discharge to a natural marsh area which drains to Sandy Lake.

Figure 2.2 presents a process flow diagram of the Uplands Park WWTF

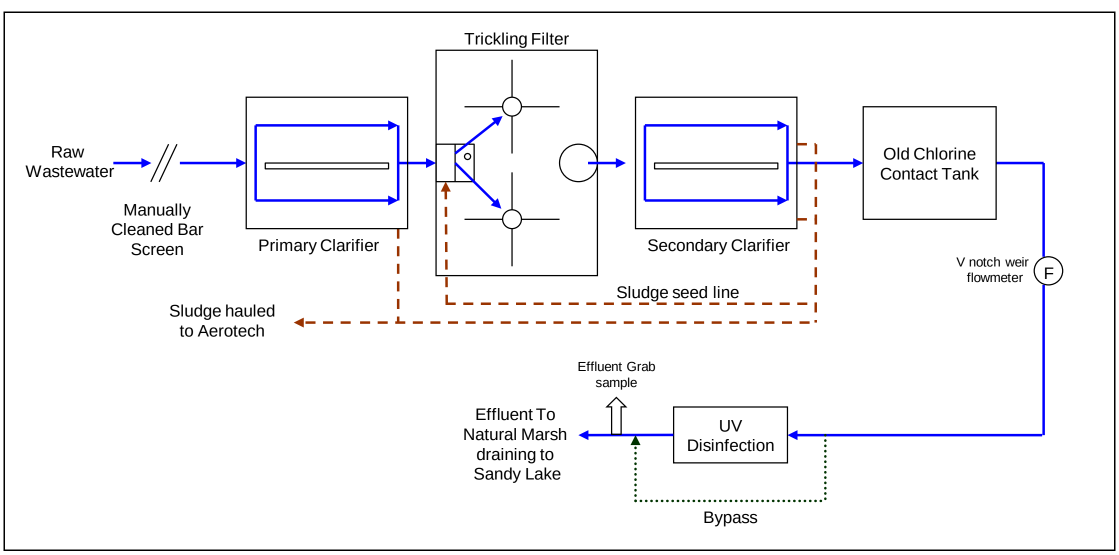

Figure 2.2 Process Flow Diagram of Uplands Park WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Uplands Park WWTF is regulated by effluent criteria as recorded in WaterTrax.

Table 2.1 presents the effluent requirements based on the Permit to Operate (PTO), WaterTrax requirements, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). Because the PTO includes no effluent requirements, the current treatment requirements were based on the most stringent of the treatment standards as recorded in WaterTrax and those identified in Atlantic Canada Guidelines.

Table 2.1 Uplands Park WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service (1)
$cBOD_5$ (mg/L)	-	20	20	20
TSS (mg/L)	-	20	20	20
Fecal coliforms (cfu/100 mL)	-	2,000	200	2,000

Notes:

n/a – not applicable

$cBOD_5$ – carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. For the purposes of this assessment compliance with the effluent requirements will be taken to be based on the compliance criteria outlined in more recent PTO's, namely: The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits and no single result can be greater than two times the effluent limit for that parameter.

The current treatment requirements for the Uplands Park WWTF are consistent with those for a secondary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

No raw wastewater samples are collected at the Uplands Park WWTF. As a result, it was not possible to evaluate the historic raw wastewater characteristics.

It is recommended that raw wastewater samples be collected and analyzed for, at a minimum, BOD_5, TSS, TKN, TP, and pH.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2010 to July 2011) are summarized in Table 3.1. Effluent quality data are based on grab samples from the effluent at the outfall.

Table 3.1 Uplands Park WWTF Effluent Flow and Quality Data

Parameter	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 4)	103	186	-
MDF (m^3/d) (1)	1,514	1,363	-
$cBOD_5$ (mg/L)	5.3	6.2	20
TSS (mg/L)	10.4	8.7	20
TP (mg/L) (2)	1.7	2.1	-
TAN (mg/L) (2)	1.5	4.0	-
Fecal coliforms (MPN/100 mL) (3)	4.4	51.8	2,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data for 2011 were only available over the period January to March.
2. Results only available over the period from November 2010 to June 2011.
3. Average fecal coliform values reported are annual geometric means.
4. Design ADF capacity is 91 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.2

Table 3.2 Uplands Park WWTF Compliance with Treatment Requirements (January 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	6 in compliance / 6 total	35 in compliance / 35 total
TSS	6 in compliance / 6 total	35 in compliance / 35 total
Fecal coliforms	5 in compliance / 5 total	31 in compliance / 34 total

Historically, the Uplands Park WWTF has performed well and is in compliance with all of the Halifax Water in-house treatment standards. In terms of effluent $cBOD_5$, TSS, and fecal coliforms, the quarterly treatment targets were met for all of these parameters for all quarters in the review period.

The individual sample results also met treatment requirements 100% of the time for both the $cBOD_5$ and TSS parameters, and 91% for fecal coliforms.

Currently, there are no established TP effluent limits for the Uplands Park WWTF, and the historical TP concentration values average about 1.9 mg/L. As well, there are currently no established TAN effluent limits for the Uplands Park WWTF, although the facility is nitrifying. The historical TAN concentration values are fairly stable year-round, with annual average concentrations ranging from 1.5 to 4.0 mg/L.

Overall, this plant is in compliance with the Halifax Water in-house treatment standards the majority of the time. It is recommended that samples of the wetland effluent be collected and analyzed for compliance purposes, in order to determine the quality of the effluent being discharged into Sandy Lake.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Uplands Park WWTF only has the ability to bypass the UV disinfection system. There is other bypassing capability at the facility, including no bypass at the head of the plant. The bypass line around the recently installed UV disinfection unit has not yet been used; however, the operations staff are concerned regarding the elevation and position of the bypass weir and its ability to function as intended during high flow events. There are no means to measure bypass flows around the UV disinfection system.

Flow splitting between the two treatment trains in the primary and secondary clarifiers and the trickling filter distribution arms is a major hydraulic issue for the Uplands Park WWTF. During typical ADF flows, the flow takes the most direct hydraulic passage, resulting in unequal loading and flow to the two trains. Although there are two of each primary and secondary clarifiers, there is no means available to isolate the individual clarifiers. The dividing wall between the primary clarifiers, and the wall between the secondary clarifiers, does not extend to the end of the tank, and there are no gates available to isolate one clarifier from the other. This, along with the configuration of the inlet pipe, leads to uneven hydraulic loading on the clarifiers.

Figure 3.1 Flow splitting issues in clarifiers

High levels of inflow and infiltration (I/I) in the collection system impact peak wet weather flows to the Uplands Park WWTF. The Uplands Park WWTF receives an ADF of about 119 m^3/d during dry weather conditions; during wet weather events, the plant has received flows as high as 2,900 m^3/d. Hydraulic limitations have been observed in the plant and high flows negatively impact process performance.

3.4 Design, Operational and Condition Issues

Due to the age of the Uplands Park WWTF, the facility has a variety of operational and condition issues.

Overall, the plant is operationally very demanding due to the trickling filter process. The pipes on the two distribution arms in trickling filter are routinely blocked with solids that have carried through the pre-treatment system. These need to be unblocked on a regular basis by an operator. As well, the inlet splitter box to the trickling filter and the cylindrical screen need to be cleaned at least three times a week. The manual bar screen also requires raking and a clean out at least three times a week.

The two rotating distribution arms are also in need of repair. The wastewater will bypass the rotating arms. This results in a majority of the wastewater discharging at the center of the distribution arms, resulting in localized high loading of the trickling filter. During the site visit, a gear box that rotates one of the distribution arms was non-functional, and as a result the distribution arm was not rotating.

Operations staff also indicate that the preliminary treatment (manual bar screen) does not provide adequate treatment and is undersized for the amount of large solids in the raw wastewater.

Operations staff indicated that during the winter, ice builds up around the door of the trickling filter building, presenting a falling hazard for the operators. This ice build-up may be due to insufficient insulation between the entrance doors and inside the trickling filter building.

There is no back-up power for any of the processes or electronic systems; however, there is a built in connection for a generator to power the whole treatment plant although no generator has been installed. According to operations staff, no portable generators are available for the Uplands Park WWTF.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Uplands Park WWTF is 91 m^3/d. The historic January 2010 to March 2011 average day flow to the Uplands Park WWTF was 119 m^3/d, or approximately 130% of the design rated capacity. In spite of operating at average flows above the design capacity, the Uplands Park WWTF has been able to produce an effluent of excellent quality.

A preliminary desktop capacity assessment could not be completed as no information regarding process tankage / trickling filter sizing was available and there are no raw wastewater concentration data. However, based on historic performance, the Uplands Park WWTF has been capable of treating average day flows as high as 119 m^3/d.

4. FUTURE CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing outfall discharges into a small ditch that flows into a natural marsh area. This marsh wetland travels approximately 2.7 kilometres and drains into Sandy Lake. The small ditch has limited to no flow throughout the year and, without the plant effluent flow, it would be a dry ditch for several months of the year. As a result, the existing assimilative capacity of this receiver is very limited.

It is likely that Sandy Lake would have more assimilative capacity than the existing receiver. As a result, extending the outfall to discharge to Sandy Lake could be considered for the Uplands Park WWTF.

An assimilative capacity assessment of the existing receiver, as well as Sandy Lake, would need to be completed to confirm future treatment requirements.

4.2 Site Constraints

There is very limited space available for expansion within the existing fence line of the Uplands Park WWTF.

Lands adjacent to the existing Uplands Park WWTF are marshland and wooded lots. Expansion onto the adjacent wooded lots may be possible.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Uplands Park WWTF:

- Historically, the Uplands Park WWTF has produced effluent which met the treatment requirements with respect to $cBOD_5$, TSS and fecal coliforms.
- Currently, there are no established effluent TP limits for the Uplands Park WWTF. Historical effluent TP concentration values average approximately 1.9 mg/L.
- Although the Uplands Park WWTF has no effluent TAN requirements, the facility has historically provided year-round nitrification.
- There is significant I/I in the collection system and this is reflected in the magnitude of peak flows during wet weather flow events.
- Poor tank hydraulics results in uneven flow splitting between the treatment trains.
- The Uplands Park WWTF is operationally very demanding with the trickling filter technology. Examples of this include: distribution arms are old and become frequently blocked (causing solids carry over), the inlet splitter box and cylindrical screen are required to be cleaned at least three times per week, and the manual bar screen at the head of the plant requires cleaning at least three times per week.
- The existing receiver, a small ditch and marsh wetland, requires an assimilative capacity assessment to be completed in order to confirm future treatment requirements. Consideration could be given to relocating the outfall to discharge into Sandy Lake.
- There is no room for expansion within the existing fenced area of the Uplands Park WWTF. Expansion of the treatment facility onto adjacent wooded lots may be possible.
- It is recommended that raw wastewater samples be collected and analyzed for, at a minimum, BOD_5, TSS, TP, TKN and pH.

6. REFERENCES

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

AND

DEPARTMENT OF PUBLIC HEALTH

Joint Certificate of Approval

for

Municipal Water and Sewage Services

MUNICIPALITY OF THE COUNTY OF HALIFAX
(Municipality or Owner)

File No.: 1935-HAL-U5

Approval No.: 80-65

Project Description: Hammonds Plains, Halifax County, Uplands Park Subdivision - Improvement and Reconditioning of existing sewage treatment plant. Proposal by County of Halifax.

Total Estimated Cost: $6,500.00

Stipulation:

RECOMMENDED

R. S. GIFFIN

Department of the Environment

APPROVED

Minister of the Environment

APPENDIX B

SITE VISIT PHOTOS

Photo 1 Uplands Park Head of Plant

Photo 2 Uplands Park Bar Screening and Primary Clarification

Photo 3 Uplands Park Manual Bar Screen

Photo 4 Uplands Park Manual Bar Screen

Photo 5 Uplands Park Primary Clarification

Photo 6 Uplands Park Primary Influent

Photo 7 Uplands Park Uneven Primary Flow Split

Photo 8 Uplands Park Trickling Filter Building

Photo 9 Uplands Park Trickling Filter

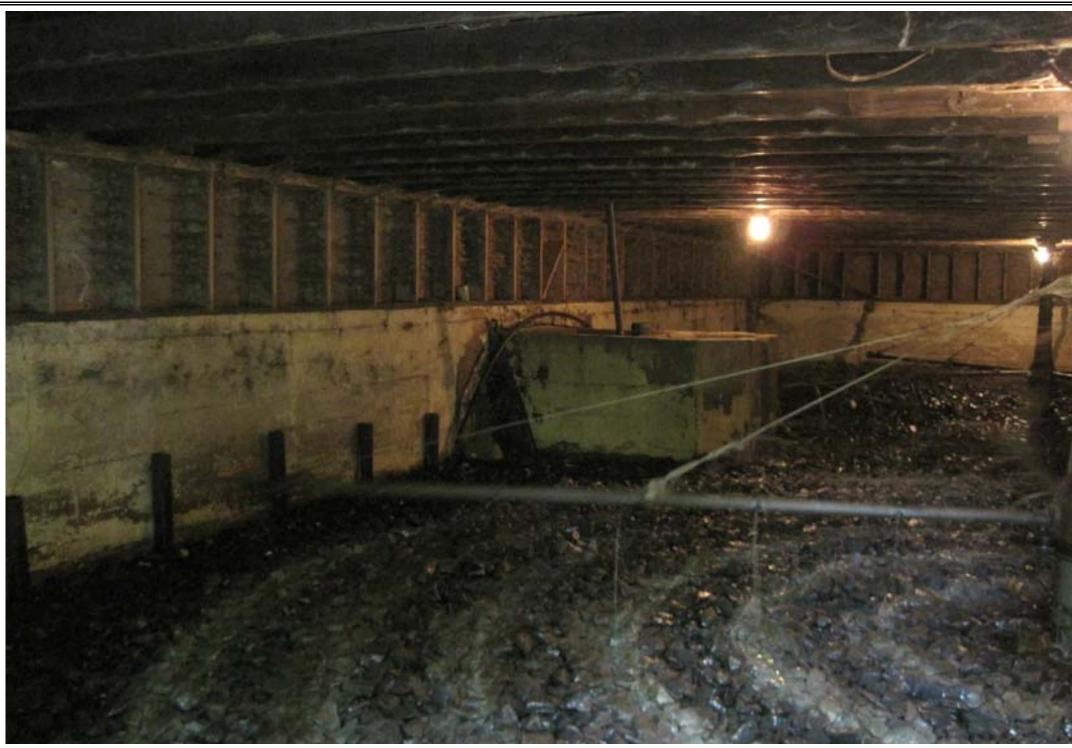

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Photo 16 Uplands Park Secondary Clarifier and Chlorination Building

Photo 17 Uplands Park Secondary Clarifier Influent

Photo 18 Uplands Park Secondary Clarification Uneven Flow Splitting

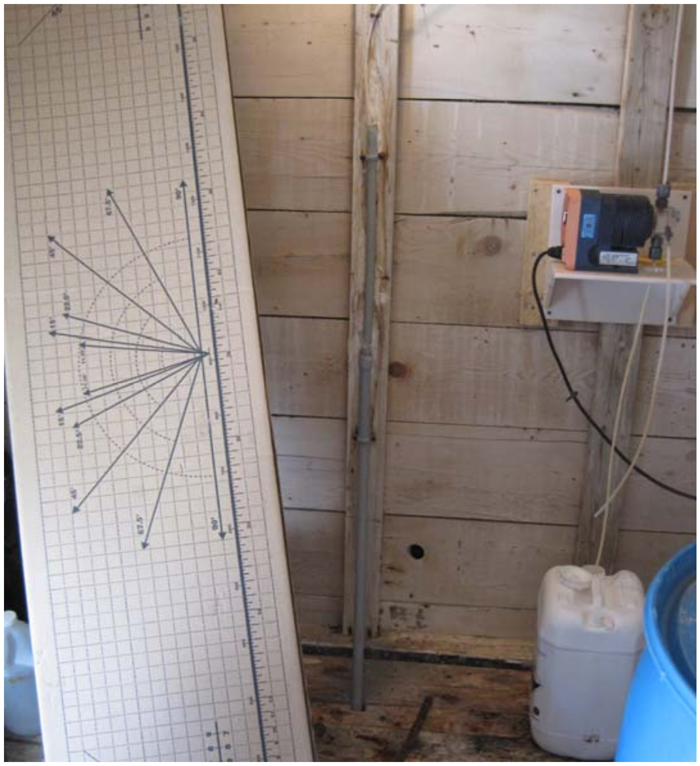

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Photo 25 Uplands Park Bypass Line with Groundwater entering the Channel

Photo 26 Uplands Park UV Disinfection & Bypass Line

Photo 27 Uplands Park UV Disinfection – 4 Tubes x 4 Bulbs

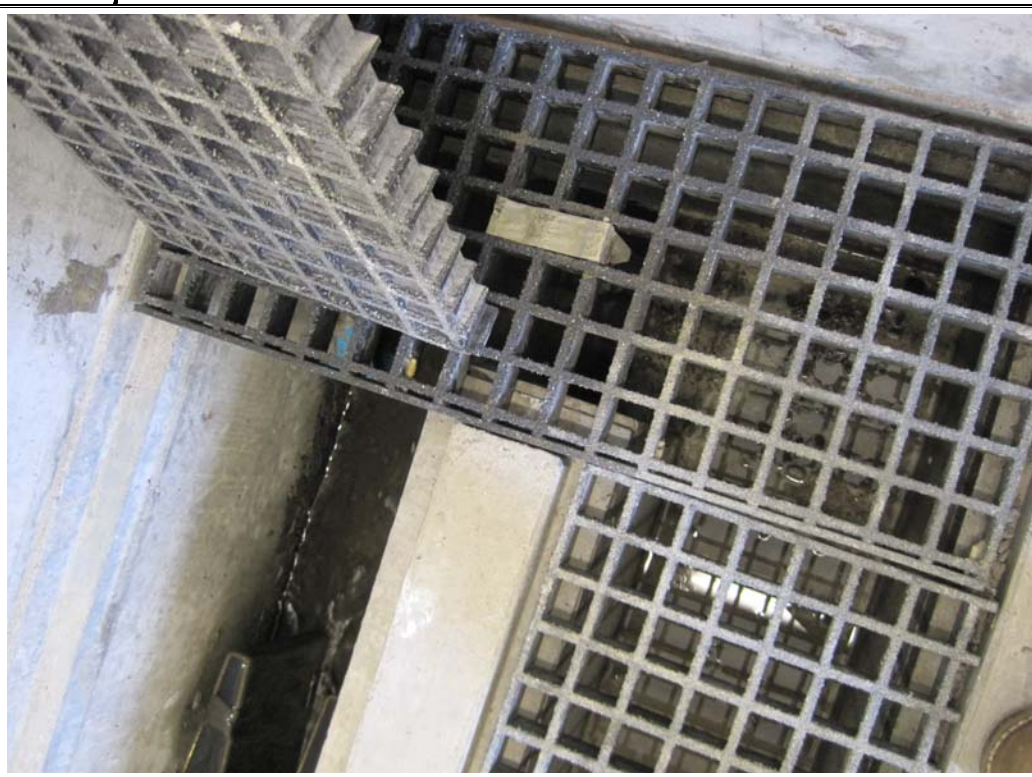

Photo 28 Uplands Park Bypass Line Meeting UV Disinfection Effluent

Photo 29 Uplands Park Outfall to Marsh

Photo 30 Uplands Park Natural Marsh Area Fenced in

VOLUME 3 – APPENDIX B-10

Wellington WWTF

APPENDIX - WORKING PAPER NO. 1.3
WELLINGTON WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. INTRODUCTION

1.1 Background and Objectives

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The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Wellington WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- A site visit conducted on July 5, 2011;
- Wellington WWTF Replacement Receiving Water Study Report, ABL Environmental Consultants Limited, January 5, 2011;
- Wellington WWTF Replacement Predesign Report, ABL Environmental Consultants Limited, May 2, 2011;
- HRM Wastewater Treatment Upgrade Study - Final Report, Dillon Consulting Limited, September 2003; and
- Operating data from WaterTrax over the period January 2009 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Wellington WWTF, located at 12 Wellington Dr in Wellington, is a package extended aeration facility manufactured by Chicago Pump and installed in 1976. Its design rated capacity is 68 m^3/d (Dillon, 2003), and it services 27 lots, or approximately 100 people, and a bakery and restaurant (ABL Environmental, 2011b).

Treatment consists of comminution, biological treatment in an aerated bioreactor, secondary clarification, and chlorine disinfection. Treated effluent is discharged to Fletcher's Run, a one kilometer long river that connects Fletcher's Lake and Grand Lake.

The Wellington WWTF treats primarily domestic wastewater from the Wellington/Steeves subdivision. No additional service connections are anticipated within the Wellington collection system.

The existing Wellington WWTF is scheduled for decommissioning, with a new treatment facility to be constructed adjacent to the existing package treatment plant.

2.2 Existing Facilities

Wastewater from the collection system flows to the influent pumping station. Raw wastewater is then pumped to the inlet structure which consists of a comminutor. The wastewater flows into an aeration tank and then into a secondary clarifier. The clarifier is equipped with two air-lift return activated sludge (RAS) lines. Clarified effluent flows to an effluent channel, where sodium hypochlorite is added with retention time provided in the effluent channel. The effluent then flows over a V-notch weir used for flow metering, and is discharged via an outfall to Fletcher's Run.

Figure 2.1 presents a process flow diagram of the Wellington WWTF.

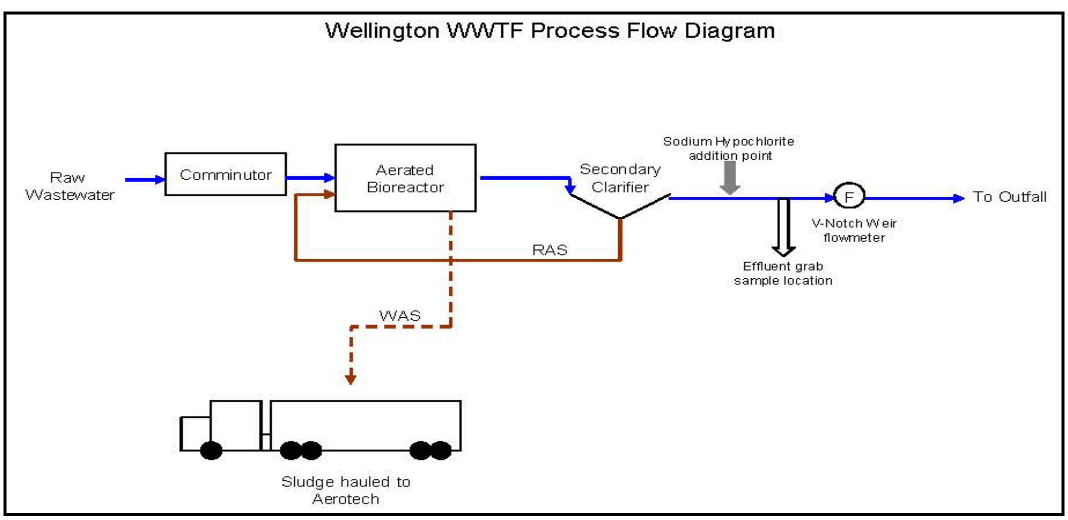

Figure 2.1 Process Flow Diagram of the Welllington WWTF

2.3 Current Compliance Requirements

Table 2.1 presents the effluent requirements based on the Permit to Operate (if available), effluent requirements as outlined in WaterTrax, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). To determine the current required level of service, since no treatment requirements are listed under the WWTF's Permit to Operate (PTO), current treatment requirements were based on those recorded in WaterTrax.

Table 2.1 Wellington WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service [(2)]
$cBOD_5$ (mg/L)	-	20	20	20
TSS (mg/L)	-	20	20	20
Fecal coliforms (cfu/100 mL)	-	1,000	200	1,000
Fecal coliforms (geomean, cfu/100 mL) [(1)]	-	2,000	-	2,000

Notes:

n/a – not applicable

$cBOD_5$ – five-day carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. Based on a geometric mean of all samples in the quarterly monitoring period.
2. For the purposes of this assessment compliance with the effluent requirements will be taken to be based on the compliance criteria outlined in more recent PTO's, namely: The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits and no single result can be greater than two times the effluent limit for that parameter (with the exception of the fecal coliform geomean).

The current treatment requirements for the Wellington WWTF are consistent with those for a secondary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

No raw wastewater samples are collected at the Wellington WWTF. As a result it was not possible to evaluate the historic raw wastewater characteristics.

It is recommended that raw wastewater samples be collected and analyzed for, at a minimum, BOD_5, TSS, TKN, TP, and pH.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2009 to July 2011) are summarized in Table 3.2. Effluent quality data are based on grab samples of the plant effluent.

Table 3.1 Wellington WWTF Effluent Flow and Quality Data

Parameter	2009	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 3)	57	39	34	-
MDF (m^3/d) (1)	364	113	88	-
$cBOD_5$ (mg/L)	12.0	12.5	9.1	20
TSS (mg/L)	26.7	50.7	35.6	20
TP (mg/L)	-	5.1	4.9	-
Fecal coliforms (MPN/100 mL) (2)	-	159	19.5	1,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data for 2011 were only available over the period January to March.
2. Average fecal coliform values reported are annual geometric means.
3. Design ADF capacity is 68 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.2 Wellington WWTF Compliance with Treatment Requirements (January 2009 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	8 in compliance / 10 total	55 in compliance / 55 total
TSS	1 in compliance / 10 total	28 in compliance / 55 total
Fecal coliforms	7 in compliance / 10 total	47 in compliance / 54 total
Fecal coliforms (geomean)	9 in compliance / 10 total	n/a

Notes:

Compliance results for $cBOD_5$ include four quarters (January to December, 2009) for which effluent BOD_5 concentrations were measured rather than $cBOD_5$.

Historically, the Wellington WWTF has performed well in terms of effluent $cBOD_5$ and fecal coliforms, meeting quarterly treatment targets for each of these parameters in 80 and 70% of quarters, respectively. Individual sample results met treatment requirements 100% of the time for $cBOD_5$ and 87% of the time for fecal coliforms. Quarterly geomean targets for fecal coliforms were met in 90% of quarters.

Exceedances in effluent TSS limits occurred frequently, with only 10% of quarterly results and 51% of individual sample results meeting effluent limits.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The collection system was prone to high levels of infiltration/inflow (I/I) and, as a result, a new collection system was installed in 2009 significantly reducing I/I. Operations staff indicated that, since the installation of the new collection system, it is not uncommon for there to be periods of two hours or more between influent pumping station pumping cycles. This has resulted in inconsistent influent flows to the treatment process.

3.4 Design, Operational and Condition Issues

The existing package plant is almost 40 years old and is reaching the end of its useful life. It is understood that a new Wellington WWTF will be constructed within a year to replace the existing facility, which will be decommissioned.

Operations staff have indicated that fats, oils and grease (FOG) in the raw wastewater have caused the accumulation of grease balls in the process tankage.

3.5 Preliminary Assessment of Existing Treatment Capacity

The existing Wellington WWTF will be decommissioned and replaced with a new extended aeration facility. As a result, a capacity evaluation of the existing treatment process was not conducted.

The new Wellington WWTF will have design capacities as follows: 45 m^3/d average day flow, 85 m^3/d maximum day flow, and 260 m^3/d peak flow (ABL Environmental, 2011).

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

Based on the receiving water study and design brief, both dated 2011 and prepared by ABL Environmental, the new Wellington WWTF will use the existing outfall and will be required to meet the following effluent requirements, developed in consultation with NSE:

- $cBOD_5$ 15 mg/L
- TSS 15mg/L
- TAN 3 mg/L
- TP 1.0 mg/L and 85% reduction
- Aluminum 1.0 mg/L

4.2 Site Constraints

The new Wellington WWTF will be constructed on the land adjacent to the existing facility. The existing playground adjacent to the proposed new WWTF may have to be relocated.

The existing service area is built-out and no additional service connections are anticipated. As a result, it is not anticipated that the new Wellington WWTF will require expansion. Therefore, no future site constraints are anticipated.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Wellington WWTF:

- No data are available regarding raw wastewater quality. It is recommended that raw wastewater samples be collected and analyzed for, at a minimum, BOD_5, TSS, TKN, TP and pH.
- Historically, the Wellington WWTF has produced effluent that typically meets effluent requirements in terms of BOD_5 and fecal coliforms. Effluent has frequently exceeded effluent TSS requirements on both a quarterly and individual sample basis.
- Since construction of the new collection system in 2009, maximum day flows experienced at the Wellington WWTF have been reduced significantly in magnitude. Flows have decreased to the point that it is now not uncommon for there to be periods of two hours or more between influent pumping stations pumping cycles, resulting in inconsistent flows to the treatment process.
- A new Wellington WWTF will be constructed, and the existing facility will be decommissioned. As a result, an evaluation of the capacity of the existing facility was not completed. The new WWTF will have design capacities as follows: 45 m^3/d average day flow, 85 m^3/d maximum day flow, and 260 m^3/d peak flow.
- The new Wellington WWTF liquid treatment train will consist of extended aeration with alum for phosphorus removal and UV disinfection. The new facility will have effluent requirements of 15 mg/L, 15 mg/L, 3 mg/L, 1.0 mg/L and 1.0 mg/L for $cBOD_5$, TSS, TAN, TP and aluminum, respectively.
- The existing service area is built-out and no additional service connections are anticipated. As a result, it is not anticipated that the new Wellington WWTF will require expansion; therefore, no future site constraints are anticipated.

6. REFERENCES

ABL Environmental Consultants Limited (2011a). Replacement Receiving Water Study Report, ABL Environmental Consultants Limited, January 5, 2011.

ABL Environmental Consultants Limited (2011b). Replacement Predesign Report, ABL Environmental Consultants Limited, May 2, 2011.

Dillon (2003). HRM Wastewater Treatment Upgrade Study - Final Report.

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A
PERMIT TO OPERATE

NOVA SCOTIA WATER RESOURCES COMMISSION

AND

DEPARTMENT OF PUBLIC HEALTH

Joint Certificate of Approval

for

Municipal Water and Sewage Services

MUNICIPALITY OF THE COUNTY OF HALIFAX
(Municipality or Owner)

File No: OP80-65S

Approval No: 73-141

Project Description: Steeves Subdivision, Wellington, Halifax County - sewer services and sewage treatment plant - plans and specifications by Canplan Consultants Limited Plans 1-11.

Total Estimated Cost: $79,420.00

Stipulation:

RECOMMENDED

R. S. GIFFIN

Water Resources Commission

APPROVED

Minister Under The Water Act

Aug. 3/73

Date Approved

Water Resources Commission

D. A. GRANTHAM

Department of Public Health

Minister of Public Health

Aug ... /73

Date Approved

APPENDIX B
SITE VISIT PHOTOS

Photo 1 Wellington Package Plant Overview

Photo 2 Wellington Influent Pumping Station & Site for New Facility

Photo 3 Wellington Influent Pumping Station & Site for New Facility

Photo 4 Wellington Influent Channel

Photo 5 Wellington Comminutor

Photo 6 Wellington Bioreactor

Photo 7 Wellington Foam on Bioreactor

Photo 8 Wellington Secondary Clarifier and RAS Lines

Photo 9 Wellington Effluent Channel and Sodium Hypochlorite Addition Point

Photo 10 Wellington Effluent Channel and Sodium Hypochlorite Addition Point

Photo 11 Wellington Effluent Channel Chlorine Contact Area

Photo 12 Wellington Effluent V-Notch Weir Flow Meter

Photo 13 Wellington Effluent Manhole

Photo 14 Wellington Receiver

Photo 15 Wellington Blower and Chlorine Solution Storage

Photo 16 Wellington Blower Building

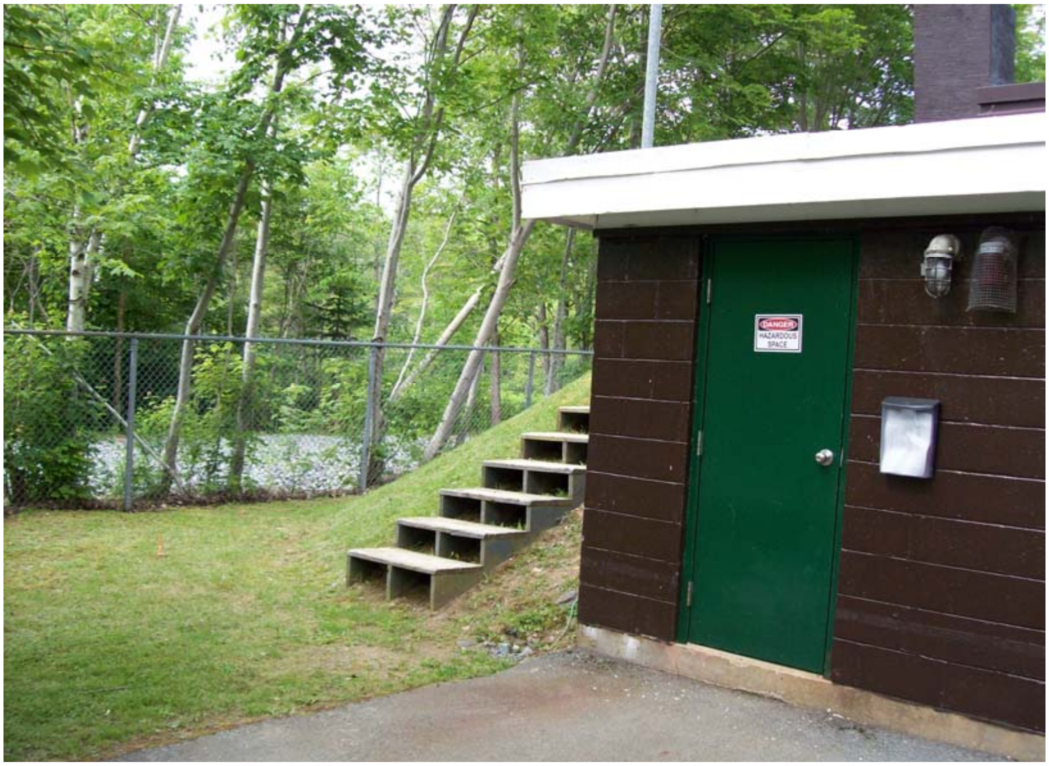

Photo 17 Wellington Blower Building and Stairs to Package Treatment Plant

Photo 18 Wellington Chlorine Metering Pump

VOLUME 3 – APPENDIX B-11

Halifax WWTF

APPENDIX - WORKING PAPER NO. 1.3
HALIFAX WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Halifax WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Halifax WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- Permit to Operate, Halifax WWTF, Approval No. 2010-075214, expiring June 30, 2013 (see Appendix A);
- A site visit conducted on July 6, 2011;
- Halifax Sewage Treatment Plant Basis of Design by Degremont, dated November 3, 2003; and
- Operating data from WaterTrax over the period January 2010 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Halifax WWTF treatment process consists of coarse and fine screening, grit removal, enhanced primary treatment (Densadeg®), and ultra violet (UV) disinfection. The enhanced primary treatment plant was designed to treat an average day flow (ADF) of 133,920 m^3/d.

Waste sludge is collected and removed from the sedimentation zone of the Densadeg® process. Some of the sludge is recycled to the head of the Densadeg® process, and the remainder of the sludge is pumped out to the two sludge holding tanks. The raw waste sludge then dewatered on-site by rotary presses. Following dewatering, the cake is hauled to the biosolids processing facility located in the AeroTech business park.

The WWTF serves a mixture of residential and industrial/commercial/institutional (ICI) users. Two major pumping stations in the collection system discharge to the head of the Halifax WWTF.

Figure 2.1 shows an aerial view of the Halifax WWTF.

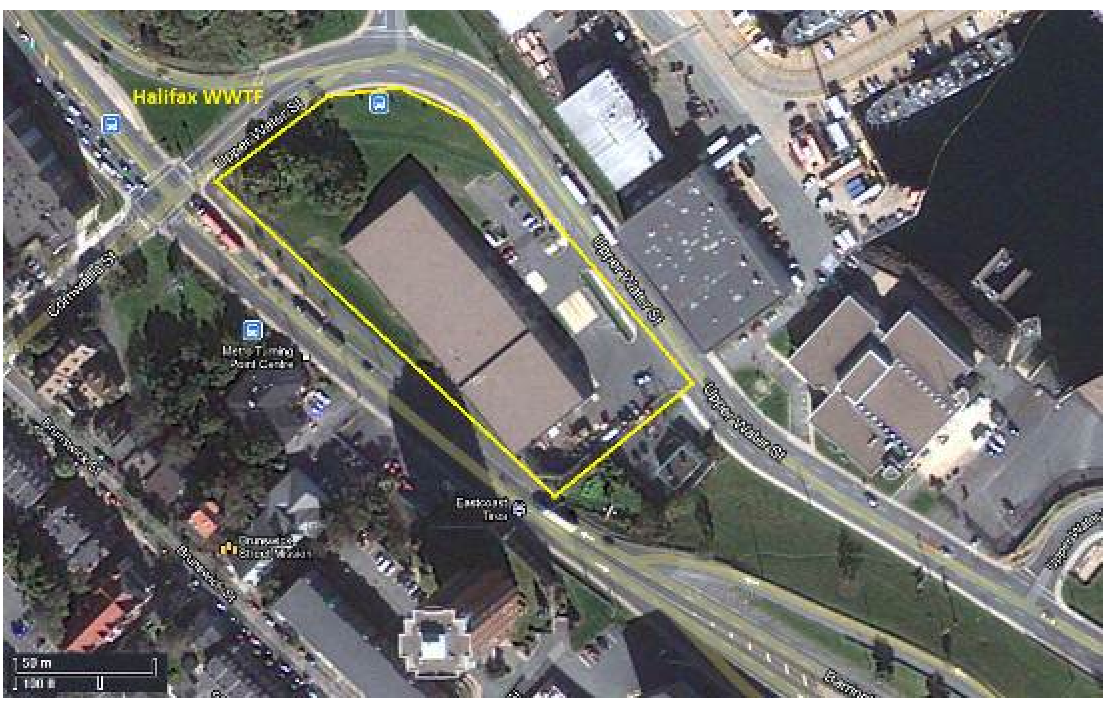

Figure 2.1 Halifax WWTF - Aerial View

2.2 Existing Facilities

Wastewater from the collection system is pumped from the pumping stations to the treatment facility headworks. Influent flows to the WWTF can be throttled by manipulating the set point of the main inlet gate; however, operations staff indicate that influent flows to the WWTF are controlled by modifying the operation of the upstream pumping stations. From the inlet chamber, wastewater flows, by gravity, to two automatic coarse bar screens that operate in parallel. In the event of a failure or planned maintenance, the wastewater can be re-directed to flow through the manual back-up coarse bar screen.

The wastewater then flows to an influent wet well and the raw wastewater is pumped up to three fine screens (two fine screens in service and one fine screen on standby). Raw wastewater flows are recorded via magnetic flowmeters which are connected to the SCADA system.

The screened wastewater then flows to two aerated grit removal trains, which operate in parallel. In the event of maintenance or failure, the wastewater can bypass the grit tanks.

The degritted wastewater then combines into one channel before being split between two Densadeg® processes operating in parallel. In the event of maintenance or failure, the wastewater can bypass the Densadeg® treatment trains.

The wastewater enters each Densadeg® system through two flocculation zones, where alum is added in a rapid mix zone, with polymer added downstream. Sludge recycle from the sedimentation zone is also added to further enhance the flocculation process. Each Densadeg® system has one sedimentation zone, where the floc produced in the flocculation zone is settled. Lamella tube settlers are utilized in the sedimentation zone to enhance settling.

Settled sludge from each Densadeg® system is removed from the sedimentation zone using a rotating scraper mechanism. A small amount of this sludge is recycled to the flocculation zone and the remainder is pumped to the sludge holding tanks. Scum is collected off of the top of the sedimentation zone and sent to an Oil and Grease separator. Subnatant from the oil and grease separator is discharged to the influent wet well, and collected fats, oil and grease (FOG) are pumped to the sludge holding tanks. Sludge from the sludge dewatered via two Fournier rotary presses. The cake is then trucked to the biosolids processing facility located in the AeroTech business park.

The effluent from each Densadeg® system is disinfected in two parallel UV disinfection units. A v-notch weir is located downstream of each UV disinfection unit to measure effluent flows from each treatment train. The effluent then flows by gravity to Halifax Harbour.

Figure 2.2 presents a process flow diagram of the Halifax WWTF

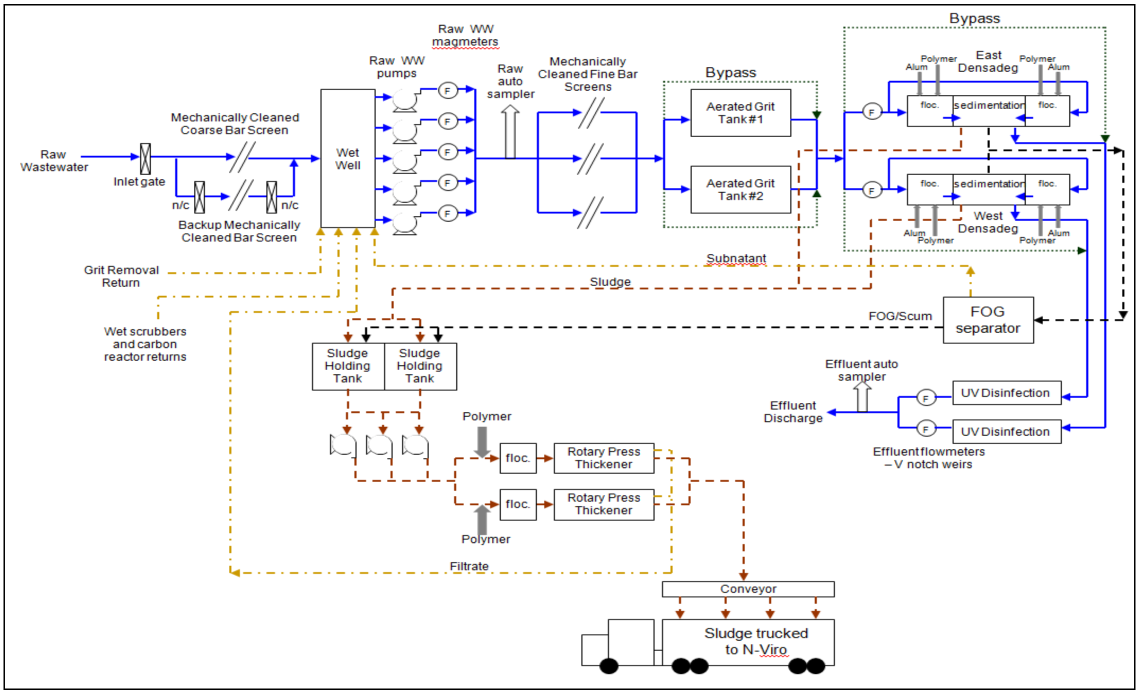

Figure 2.2 Process Flow Diagram of the Halifax WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Halifax WWTF is regulated by Nova Scotia Environment (NSE) under Permit to Operate (PTO) Approval No. 2010-075214, expiring June 30, 2013. Table 2.1 presents the effluent requirements based on the PTO. For reference purposes, effluent requirements as recorded in WaterTrax and those included in the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006) are also shown.

Table 2.1 Halifax WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service [1]
$cBOD_5$ (mg/L)	50	50	25	50
TSS (mg/L)	40	40	25	40
Fecal coliforms (individual samples, MPN/100 mL) [2]	5,000	5,000	200	5,000
Fecal coliforms (geomean, MPN/100 mL) [3]	10,000	10,000	-	10,000

Notes:

n/a – not applicable

$cBOD_5$ – five-day carbonaceous biochemical oxygen demand

TSS – total suspended solids

TP – total phosphorus

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception fecal coliform individual samples and geomean).
2. Based on individual sample results.
3. Based on a geometric mean of all samples in the quarterly monitoring period.

The current treatment requirements for the Halifax WWTF are consistent with those for an enhanced primary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (June 2010 to July 2011) are summarized in Table 3.1.

Table 3.1 Halifax WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	174 (2)	170	110 (low) 190 (med) 350 (high)
$cBOD_5$	139	n/a	n/a
TSS	143	200	120 (low) 210 (med) 400 (high)
Soluble c BOD_5	39	n/a	n/a

Notes:

n/d - data not available

n/a – not applicable

c BOD_5 – 5-day carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. The "low", "med", and "high" refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. Raw wastewater BOD_5 was estimated based on the historic recorded $cBOD_5$ and assuming a $cBOD_5$ to BOD_5 ratio of 0.80.

The raw wastewater quality is low to medium strength with respect to $cBOD_5$ and TSS. Raw wastewater is not analyzed for BOD_5, TKN or TP. It is recommended that samples be analyzed for these parameters.

3.2 Historic Flows and Effluent Quality

The flow and effluent quality data for the review period (June 2010 to July 2011) are summarized in Table 3.2. Effluent samples for compliance purposes were only collected in 2011.

Table 3.2 Halifax WWTF Flow and Effluent Quality Data

Parameter	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1)	92,478	107,420	-
MDF (m^3/d)	239,150	242,800	-
$cBOD_5$ (mg/L)	-	57	50
TSS (mg/L)	-	28	40
Fecal coliforms (MPN/100 mL) (2)	-	101	10,000

Notes:
ADF – average day flow
MDF – maximum day flow
1. Design ADF capacity is 133,920 m^3/d.
2. Average fecal coliform values reported are annual geometric means.

Compliance with respect to the current effluent requirements is determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding target twice the parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Halifax WWTF Compliance with Treatment Requirements (January 2011 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	0 in compliance / 2 total	117 in compliance / 125 total
TSS	2 in compliance / 2 total	124 in compliance / 125 total
Fecal coliforms	2 in compliance / 2 total	129 in compliance / 129 total
Fecal coliforms (geomean)	2 in compliance / 2 total	n/a

The Halifax WWTF has historically been in compliance with the effluent TSS and fecal coliform requirements on both the quarterly and individual sample bases. Effluent $cBOD_5$ has exceeded the quarterly compliance requirements, although it has met the individual sample requirements for 94% of samples. Operations staff indicate that raw wastewater soluble $cBOD_5$ concentrations are consistently high, possibly due to the wastewater contributions from a brewery connected to the collection system. This likely contributes to the poor performance in terms of effluent $cBOD_5$ as soluble $cBOD_5$ will not be removed by the enhanced primary treatment process.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Halifax WWTF has the ability to bypass the aerated grit removal tanks in the event of a failure or if maintenance is needed to be performed on the process. The bypass is located directly before the grit removal tank, and the bypass discharges to the grit removal effluent channel. The entire Densadeg® system can also be bypassed, in which event the wastewater flows directly to UV disinfection

The collection system shows evidence of high inflow / infiltration (I/I), resulting in high flows to the Halifax WWTF. Operations staff have noted that peak flows have resulted in washout of the sedimentation zones of the Densadeg® systems, resulting in poor effluent quality.

To avoid hydraulically overloading the Halifax WWTF, influent flows to the facility are controlled by modifying the operation of the upstream pumping stations during high flow periods. This has resulted in upstream overflows in the collection system.

3.4 Design, Operational and Condition Issues

The effluent from the Densadeg® systems is prone to foaming. Although this does not negatively impact effluent quality, it has affected the downstream v-notch weir flow meters that utilize ultrasonic level detectors.

The electronic equipment associated with the raw wastewater pumps, and other sensitive equipment, has been moved from directly above the influent wet well to the upper level of the Halifax WWTF to protect them from potential flooding.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Halifax WWTF is 133,920 m^3/d. The historic June 2010 to July 2011 average day flow to the Halifax WWTF was 98,346 m^3/d, or approximately 73% of the design rated capacity.

Due to the proprietary nature of the Densadeg treatment process, a desktop assessment of treatment capacity was not possible. However, according to input from operations staff, the effluent quality from the Densadeg systems was impaired at daily flows around 200,000 m^3/d.

The Halifax WWTF has been able to consistently meet effluent requirements in terms of TSS and fecal coliforms while operating at the historic ADF of 98,346 m^3/d. It is possible that the non-compliance with respect to $cBOD_5$ is as a result of the composition of the raw wastewater (i.e. – high soluble $cBOD_5$ concentrations). As a result, the Densadeg process may not be capable of meeting existing effluent $cBOD_5$ requirements due to limitations of the process itself. For the purposes of this capacity assessment, it is assumed that the existing treatment process has an ADF capacity equivalent to the design capacity of 133,920 m^3/d; however it is recommended that raw wastewater and effluent characterization be conducted to determine the potential cause of non-compliance with respect to effluent $cBOD_5$.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver is Halifax Harbour on the Atlantic Ocean. An assimilative capacity study of the effluent receiver would be required to determine future treatment requirements.

4.2 Site Constraints

There is limited room available for expansion within the existing fenced area. Due to the location of the Halifax WWTF, expansion onto adjacent properties does not appear to be feasible.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Halifax WWTF:

- The raw wastewater quality is low to medium strength with respect to BOD_5 (estimated based on recorded $cBOD_5$ concentrations) and TSS.
- Raw wastewater is not analyzed for BOD_5, TKN, or TP. It is recommended that samples be analyzed for these parameters.
- The Halifax WWTF has historically been in compliance with the effluent TSS and fecal coliform requirements on both the quarterly and individual sample bases.
- Effluent $cBOD_5$ has exceeded the quarterly compliance requirements, although it has met the individual sample requirements for 94% of samples.
- It is possible that the non-compliance with respect to $cBOD_5$ is as a result of the composition of the raw wastewater (i.e. – high soluble $cBOD_5$ concentrations). As a result, the Densadeg process may not be capable of meeting existing effluent $cBOD_5$ requirements due to limitations of the process itself.
- The collection system shows evidence of high inflow / infiltration, resulting in high flows to the Halifax WWTF. Operations staff have noted that peak flows have resulted in washout of the sedimentation zones of the Densadeg® systems, resulting in poor effluent quality.
- Although the Halifax WWTF has not met effluent requirements in terms of $cBOD_5$ at an average day flow of 98,346 m^3/d, for the purposes of this capacity assessment, it is assumed that this was not capacity limiting; however it is recommended that raw wastewater and effluent characterization be conducted to determine the potential cause of non-compliance with respect to effluent $cBOD_5$.
- Based on the design capacities, and historic performance with respect to effluent TSS and fecal coliforms, the existing Halifax WWTF has estimated capacities as follows:
  - Average day flow capacity: 133,920 m^3/d;
  - Maximum day flow capacity: <200,000 m^3/d; and
- The existing receiver is Halifax Harbour on the Atlantic Ocean. An assimilative capacity study of the effluent receiver would be required to determine future treatment requirements.
- There is limited room available for expansion within the existing fenced area. Due to the location of the Halifax WWTF, expansion onto adjacent properties does not appear to be feasible.

6. REFERENCES

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A
PERMIT TO OPERATE

NOVA SCOTIA
Environment

APPROVAL

Province of Nova Scotia
Environment Act, S.N.S. 1994-95, c.1

APPROVAL HOLDER: **Halifax Regional Water Commission**

APPROVAL NO: **2010-075214**

EXPIRY DATE: **June 30, 2013**

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Operation of the Halifax Sewage Collection & Treatment Plant, and associated works,(PID# 41020363) at or near, Upper Water Street, Halifax Regional Municipality in the Province of Nova Scotia.

Administrator Stephen Westhaver

Effective Date December 22, 2010

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Environment

Approval Holder:	Halifax Regional Water Commission
Project:	Halifax Sewage Collection & Treatment Plant
Site:	Upper Water Street Halifax, Halifax Regional Municipality PID # 41020363
Approval No:	2010-075214
File No:	94300-30BED-075214

Reference Documents:

- Application dated December 16/10 and attachments.
- HRWC Email Submission with Monitoring Results dated Dec 16/10
- HRM Letters of Authorization dated Nov 19/09 & Sept 28/10

1. **Definitions**

a) "Act" means the *Environment Act* S.N.S. 1994-1995, c.1, and includes all regulations made pursuant to the Act.

b) "Composite Sample" means a representative sample which is taken from the combination of individual samples that are collected over a 24 hour period with at least one sample of 100 ml taken at two hour intervals.

c) "Department" means the Central Region, Bedford Office, of Nova Scotia Environment located at the following address:

Nova Scotia Environment
Environmental Monitoring and Compliance Division
Central Region, Bedford Office,
Suite 115, 30 Damascus Road
Bedford, Nova Scotia, B4A 0C1

Phone: (902) 424-7773
Fax: (902) 424-0597

d) “Facility” means the Halifax Sewage Collection & Treatment Plant and associated works.

e) “Grab sample” means an individual sample collected in less than 30 minutes and which is representative of the substance sampled.

f) "Minister" means the Minister of Nova Scotia Environment.

g) “NSE” means Nova Scotia Environment.

h) “Sewage Collection System” means the piping, equipment and all auxiliaries for the Halifax collection, CSO stations, and storage of sewage from the source of the sewage to the Sewage Treatment Plant for the Halifax location.

i) “Sewage Treatment Plant”(STP) means the equipment and all the auxiliaries associated with the treatment of sewage including the plant effluent outfall.

2. **Scope of Approval**

a) This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to operate the Facility with the sewage collection & treatment plant, situated at or near Upper Water Street , Halifax Regional Municipality (the "Site"). **This replaces the previous commissioning approval #2009-070101(Appendix 1B) which is now null & void.**

b) The Facility shall be operated as outlined in the application for approval dated December 16, 2010 and supporting documentation.

c) The Site shall not exceed the area as outlined in the application and supporting documentation.

3. **General Terms and Conditions**

a) The Approval Holder shall operate and reclaim its Facility in accordance with provisions of the:

   i) *Environment Act* S.N.S. 1994-1995, c.1, as amended from time to time;
   ii) Regulations, as amended from time to time, pursuant to the above Act;

b) The Approval Holder is responsible for ensuring that they operate the Facility on lands which they own or have a lease or written agreement with the landowner or occupier. Breach of this condition may result in cancellation or suspension of the Approval.

c) If there is a discrepancy between the reference documents and the terms and conditions of this Approval, the terms and conditions of this Approval shall apply.

d) Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

e) The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

f) This Approval is not transferable without the consent of the Minister or Administrator.

g) (i) If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(2)(b) and 58(4) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

   (ii) Despite a cancellation or suspension of this Approval, the Approval Holder remains subject to the penalty provisions of the Act and regulations.

h) The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the sewage treatment plant, including process changes or waste disposal practices which are not granted under this Approval. Extensions or modifications to the sewage treatment plant may be subject to the Environmental Assessment Regulations. An amendment to this Approval will be required before implementing any change.

i) Pursuant to Section 60 of the *Act*, the Approval Holder shall submit to the Administrator any new and relevant information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval.

j) The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

k) The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

l) Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

m) Unless written approval is received otherwise from the Administrator, all samples required by this Approval shall be analysed by a laboratory that meets the requirements of the Department's "Policy on Acceptable Certification of Laboratories" as amended from time to time.

n) The Approval Holder shall submit any monitoring results or reports required by this Approval to the Department. Unless specified otherwise in this Approval, all monitoring results shall be submitted within 30 days following the last month of the monitoring period.

o) The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel directly involved in the Facility operation are made fully aware of the terms and conditions which pertain to this Approval.

4. **Spills or Releases**

a) All spills or releases shall be reported in accordance with the *Act* (Part VI) and the *Emergency Spill Regulations*.

b) Spills or releases shall be cleaned up immediately in accordance with the *Act*.

c) A quantity of spill/release response material is to be maintained on Site at all times.

5. **Sludge Disposal**

a) All sludge generated at the Facility shall be treated and disposed of by a method acceptable to the Department.

6. **Operation**

a) The Approval Holder shall designate in writing, to the Department, any change in the contact person for this Approval.

b) The Facility must be operated and maintained in a manner that will prevent erosion, chemical spills or any other incidents that may be detrimental to the environment and public health.

c) The Approval Holder shall ensure that the Facility is operated, maintained and has appropriate backup facilities to protect against failures of the power supply, treatment process, equipment, or structure. Security measures shall assure the safety of the sewage treatment processes, storage facilities, and the discharge system.

d) The Approval Holder shall ensure the development and implementation of a contingency/emergency response plan for the Facility in accordance with the requirements of the Nova Scotia Environment "Contingency Planning Guidelines" as amended from time to time. A copy of the contingency/emergency response plan is to be maintained on Site at all times. The plan should include:

  i) General procedures for routine (equipment break-down, upset conditions, maintenance, etc.) or major emergencies within the facility system; and

  ii) A plan for equipment becoming inoperable in a major emergency.

  iii) A plan for dealing with spills or releases.

e) When it is necessary to use an approved by-pass related to a Facility issue, the Approval Holder shall notify the Department immediately.

f) The Approval Holder shall take immediate preventive or corrective action ,when results of an inspection or sampling results indicate conditions which are currently or may become a detriment to the STP operations, and/or result in adverse impact to the environment or public health.

g) The Facility has been classified as a **Class III sewage treatment plant and Class III sewage collection system**. The day-to-day operations of the sewage treatment plant and collection system shall be supervised directly by certified operators who hold the appropriate certification.

h) The Approval Holder shall establish and submit to NSE upon request notification procedures to be used to contact the Medical Officer of Health, NSE, other relevant authorities and the general public in the case of an emergency situation.

i) The Approval Holder shall prepare a comprehensive operations manual for the STP within three months of commencement of operation of the sewage treatment plant and keep it up to date. The manual shall be subject to review by NSE upon request.

j) The Approval Holder shall establish procedures for receiving and responding to complaints including a reporting system which records what steps were taken to determine the cause of complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

7. Performance And Limits

7.1 Treated Effluent

The sewage treatment plant shall be managed and operated in such a manner that the effluent being discharged to the receiving waters satisfies the following criteria:

a) $CBOD_5$, shall not exceed 50 mg/l.

b) Total Suspended Solids, shall not exceed 40 mg/l

c) Fecal coliform shall not exceed 5000/100 mls or the geometric mean of all samples in the quarterly monitoring period shall be less than or equal to 10,000 counts per 100 mls.

d) Disinfection of the effluent from the sewage treatment plant shall be continuous.

e) The sewage treatment plant shall be considered in compliance with the effluent limitations if 80% of the sample test results, at the frequency and location specified in table 1 meet the specified effluent limits. No single result can be greater than two times the limits except for the fecal limit as noted.

7.2 Odour Control

a) The Approval Holder shall operate the Facility in a manner which will not result in the generation of offensive or hazardous odours/vapours.

b) The Approval Holder shall be required to implement control measures if odour generation is deemed excessive by the Department.

8. **Monitoring and Recording**

a) The Approval Holder shall conduct all monitoring and analysis required in this section according to the latest edition of "Standard Methods for the Examination of Water and Waste Water".

b) All equipment must be installed, maintained and calibrated as specified by the manufacturer's instructions.

c) Following a review of any of the analytical results required by this Approval, NSE may alter the frequencies, location, and parameters for analyses required for this Approval.

TABLE 1		
PARAMETER	**MINIMUM FREQUENCY**	**STP LOCATION**
$CBOD_5$	5/week	effluent discharge
Suspended Solids	5/week	effluent discharge
Fecal Coliform	5/week(grab sample)	effluent discharge
pH	5/week(grab sample)	effluent discharge
Plant Volumes	continuous	entering or leaving stp
Total Ammonia	1/month	effluent discharge

* All samples shall be composite unless stated otherwise.

9. **Reporting**

9.1 **Quarterly Reporting**

a) The Approval Holder shall prepare and submit to the Department on a quarterly basis, the results of the sampling conducted at the locations indicated in table 1.

b) The Approval Holder shall prepare and submit to the Department, a quarterly performance report for the Facility. The report shall contain the following information in a format acceptable to the District Manager.

i) a summary and discussion of the quantity of sewage treated during the reporting period compared to the design values for the sewage treatment plant, including peak flow rates, maximum daily flows and monthly average daily flows;

ii) a summary and interpretation of analytical results obtained in accordance with Section 8 (Monitoring and Recording) of this Approval;

iv) a tabulation and description of any emergency or upset conditions which occurred during the period being reported upon and action taken to correct them;

v) any complaints that were received and the Approval Holders response.

vi) the monitoring results associated with the CSO overflow events(ie. times, volumes, quality)

9.2 Emergency Reporting on Operation

a) The Approval Holder shall notify the Department forthwith in the event that untreated sewage is directed to the environment as a result of malfunction, upset, or equipment failure.

b) The Approval Holder shall immediately notify the Department of any incidents of exceedence of the compliance requirement indicated in section 7.1.

10. Records

a) The Approval Holder shall keep the following records and wastewater effluent quality analyses:

i) $CBOD_5$, Suspended Solids, and Bacteriological analyses shall be kept for five years;

ii) Flow meter readings shall be kept for 10 years.

b) The Approval Holder shall also retain the following information for a period of three years:

i) calibration and maintenance records;

ii) continuous monitoring data;

iii) records of any violations of the conditions of this Approval and actions taken by the Approval Holder to correct those violations.

c) A complete set of the as-built drawings, incorporating any amendments made from time to time, shall be kept by the Approval Holder at the Site for as long as the sewage treatment plant is kept in operation.

11. **Site Specific Conditions**

a) On or before March 31, 2011 a proposed monitoring protocol for the combined sewer overflow(CSO) stations associated with the Halifax Sewage Collection System is to be submitted to NSE for review and authorization. The proposed monitoring protocol is to include testing for CBOD, SS, and fecal coliform as well as the times and volumes of the overflow events.

b) The Approval Holder upon request by the Department may be required to modify the monitoring locations, parameters and frequency; evaluate impact of the overflow event or conduct remedial measures depending on the information obtained from the authorized CSO monitoring program.

APPENDIX B

SITE VISIT PHOTOS

Photo 1 Halifax Main Influent Control Gate

Photo 2 Halifax Influent Wet Well Below Slab and Pump Discharge Lines

Photo 3 Halifax Control Panels for Raw Wastewater Pumps

Photo 4 Halifax Mechanical Screen

Photo 5 Halifax Mechanical Screen and Back-Up Mechanical Screen

Photo 6 Halifax Back-Up Bar Screen

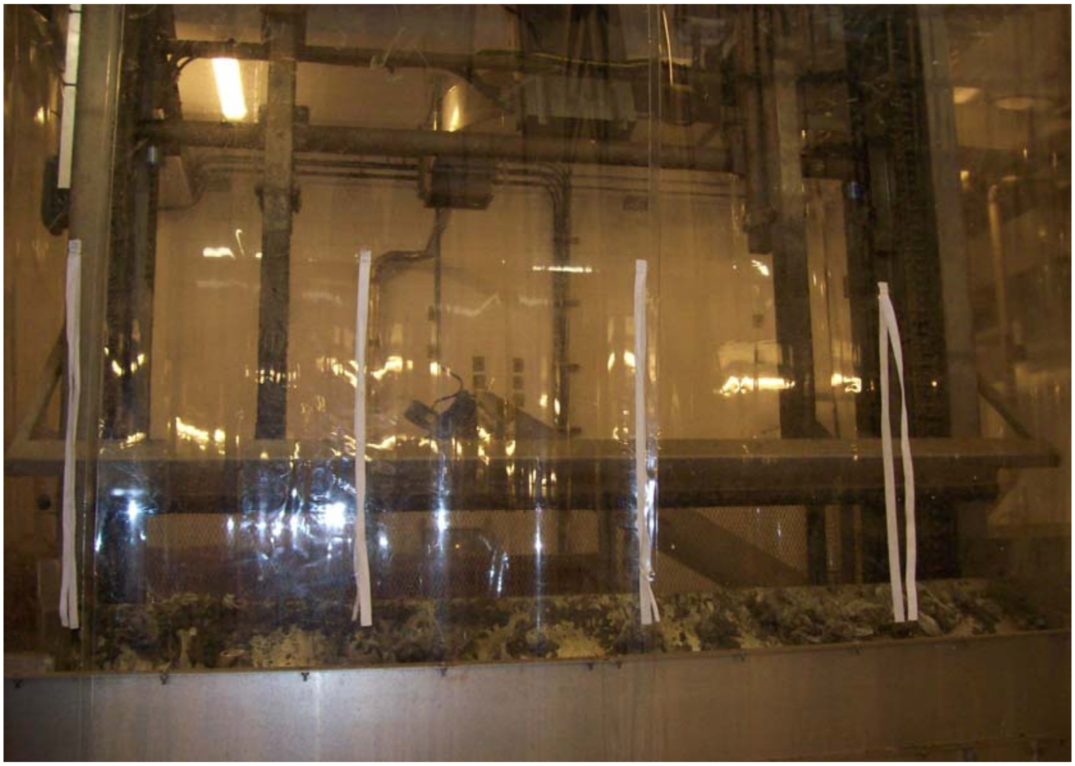

Photo 7 Halifax Main Screen Screenings Collection

Photo 8 Halifax Back-Up Bar Screen Screenings Bin

Photo 9 Halifax Influent PS Gas Detectors

Photo 10 Halifax Raw Wastewater Magmeter on Raw Pump Discharge Line (typ)

Photo 11 Halifax Fine screen (typ)

Photo 12 Halifax Fine Screens and Screenings Conveyor

Photo 13 Halifax Grit Conveyor

Photo 14 Halifax Grit Bin

Photo 15 Halifax Densadeg Flocculation Tank Below Slab

Photo 16 Halifax Densadeg Flocculation Tank

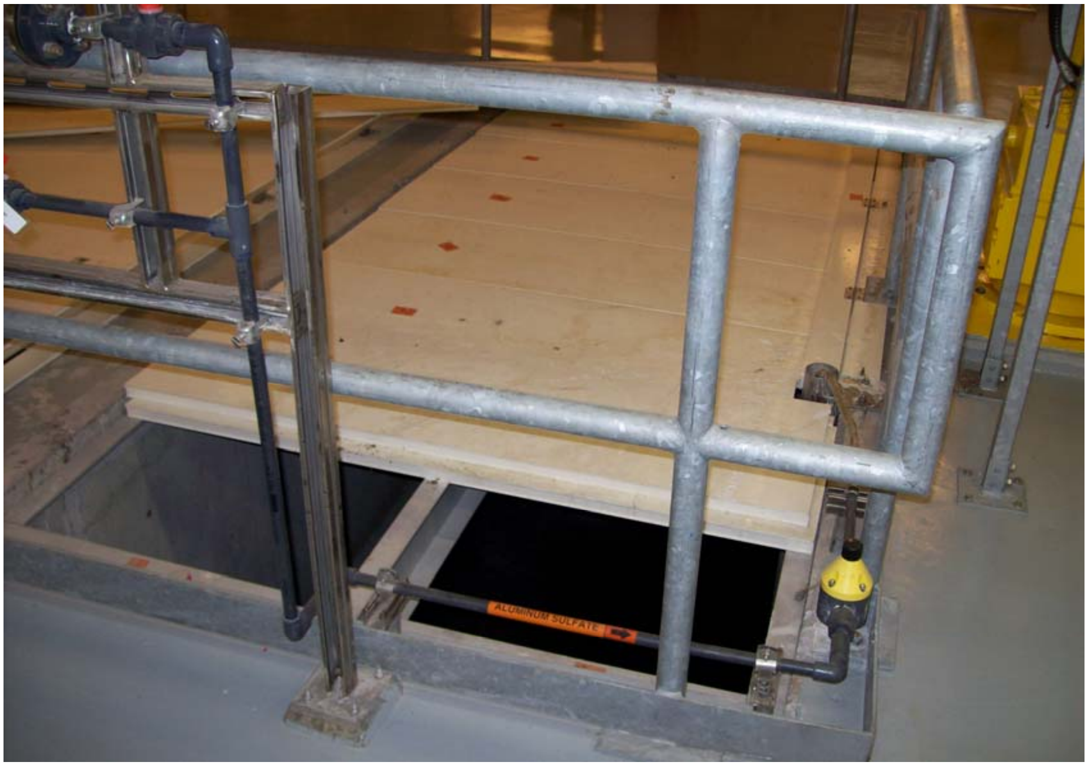

Photo 17 Halifax Densadeg Alum Dosing Line

Photo 18 Halifax Densadeg Effluent Trough

Photo 19 Halifax Densadeg Effluent Troughs

Photo 20 Halifax Blowers

Photo 21 Halifax Densadeg Sludge Pumps

Photo 22 Halifax West UV Disinfection System

Photo 23 Halifax East UV Disinfection System

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Photo 34 Halifax Fournier Rotary Presses

Photo 35 Halifax Sludge Cake Loading Bay and Truck

Photo 36 Halifax Odour Control Foul Air Fan

Photo 37 Halifax Odour Control Wet Scrubber Solution Pumps & Wet Scrubber

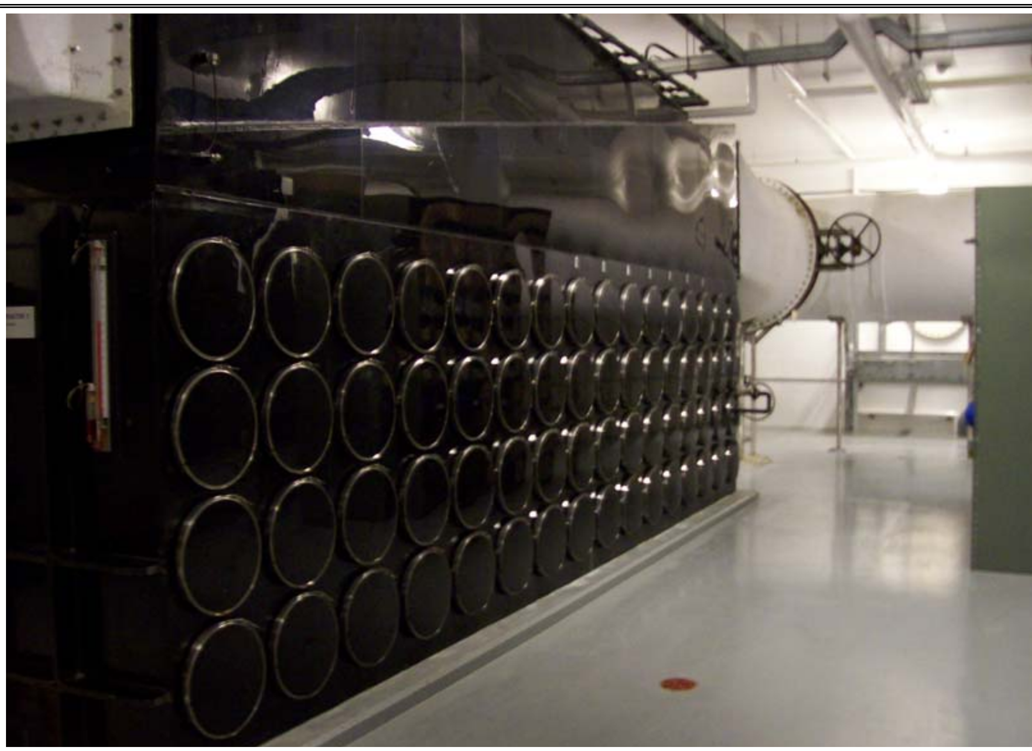

Photo 38 Halifax Odour Control Carbon Scrubber

Photo 39 Halifax Generator for Back-Up Power

Photo 40 Halifax Treed Area Available for Expansion

Photo 41 Halifax Treed Area Available for Expansion

VOLUME 3 – APPENDIX B-12

Herring Cove WWTF

APPENDIX - WORKING PAPER NO. 1.3
HERRING COVE WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Herring Cove WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Herring Cove WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- A site visit completed on July 5, 2011;
- Permit to Operate for the Herring Cove Sewage Collection & Treatment Plant, Nova Scotia Department of the Environment, 2010 (see Appendix A);
- Herring Cove WWTF Design Basis, Degremont, 2007; and
- Operating data from WaterTrax over the period October 2010 to July 2011..

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Herring Cove WWTF was commissioned in December 2009, and consists of coarse and fine screening, grit removal, enhanced primary treatment (Densadeg®), and an ultra violet (UV) disinfection system. The enhanced primary treatment plant was designed to treat a design ADF of 28,512 m^3/d and a peak wet weather flow (WWF) of 76,032 m^3/d. Currently, the ADF is about 12,685 m^3/d and the WWTF receives peak flows about four or five times the average flows. The effluent from the plant discharges to Herring Cove.

Waste sludge is collected and removed from the Densadeg® process. Some of the sludge is recycled to the head of the Densadeg® process, and the remainder of the sludge is pumped to the two sludge holding tanks. The raw waste sludge then dewatered by two rotary presses. Following dewatering, the cake is hauled to the biosolids processing facility in the AeroTech business park on a weekly basis.

The WWTF serves over 7,000 connections from the Spryfield area, which is mainly residential but includes some fast food restaurants and commercial users. The influent wastewater to the Herring Cove WWTF is consistent in composition with no spikes in pH or significant changes in conductivity. The WWTF receives very little wastewater by gravity flow, and mainly receives flow from pumping stations.

Figure 2.1 shows an aerial view of the Herring Cove WWTF site while it was under construction.

Figure 2.1 Herring Cove WWTF under Construction - Aerial View

2.2 Existing Facilities

Wastewater from the collection system is pumped from the pumping stations to the treatment facility headworks. Influent flows to the WWTF are controlled by a main gate. From the inlet chamber, wastewater flows, by gravity, to an automatic coarse bar screen to remove any objects larger than the 25 mm opening size. In the event of a failure or planned maintenance, the wastewater is re-directed to flow through the manual back-up coarse bar screen. The wastewater then flows to the three fine screens (two online at all times, and one standby).

Following screening, the wastewater is directed through two parallel Parshall flume flowmeters, in order to measure and report the raw wastewater flows into the WWTF. The wastewater then proceeds to two aerated grit tanks that operate in parallel. In the event of maintenance or failure, the wastewater can bypass the grit tanks

The degritted wastewater then combines into one channel before being split between two Densadeg® processes operating in parallel. In the event of maintenance or failure, the wastewater can bypass the Densadeg® treatment trains. Operations staff generally only operate one Densadeg® treatment train when flows are below approximately 8,000 m^3/d. The second Densadeg® treatment train is brought online in the event of increase flows, such as during a wet weather event.

The wastewater enters each Densadeg® system in one flocculation zone, where alum is added in a rapid mix zone, with polymer added downstream. Sludge recycle from the sedimentation zone is also added to further enhance the flocculation process. Each Densadeg® system has one sedimentation zone, where the floc produced in the flocculation zone is settled. Lamella tube settlers are utilized in the sedimentation zone to enhance settling.

Settled sludge from each Densadeg® system is removed from the sedimentation zone using a rotating scraper mechanism. A small amount of this sludge is recycled to the flocculation zone and the remainder is pumped to the sludge holding tanks. Scum is collected off of the top of the sedimentation zone and sent to an Oil and Grease separator. Subnatant from the oil and grease separator is discharged to the influent wet well, and collected fats, oil and grease (FOG) are pumped to the sludge holding tanks. Sludge from the sludge dewatered via two Fournier rotary presses. The cake is then trucked to the biosolids processing facility located in the AeroTech business park.

The clarified wastewater from the Densadeg® system flows out and recombines prior to splitting between two parallel UV disinfection systems operating in parallel.

Following disinfection, the effluent wastewater flow is measured by a v-notch wier, and the effluent flows by gravity to the outfall and into Herring Cove.

Figure 2.2 presents a process flow diagram of the Herring Cove WWTF.

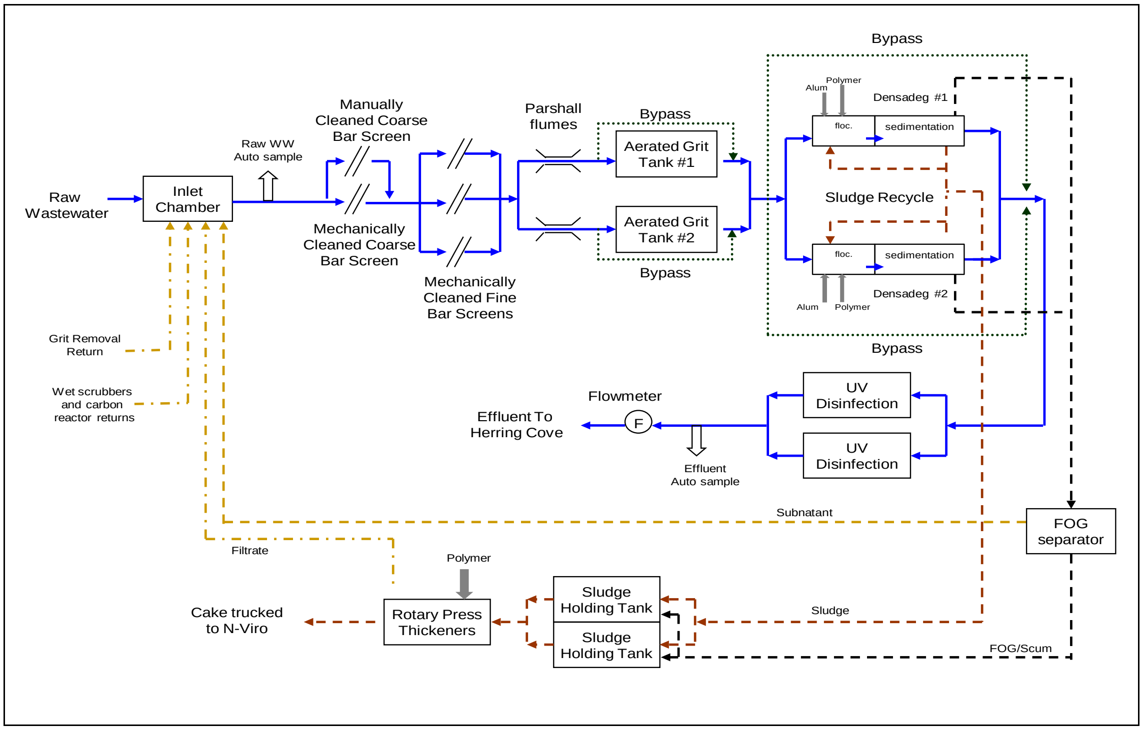

Figure 2.2 Process Flow Diagram of Herring Cove WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Herring Cove WWTF is regulated by Nova Scotia Environment (NSE) under Permit to Operate (PTO) Approval No. 2010-074148. Table 2.1 presents the effluent requirements based on the PTO. For reference purposes, effluent requirements as recorded in WaterTrax and those included in the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006) are also shown.

Table 2.1 Herring Cove WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	**WaterTrax Criteria**	**Atlantic Canada Guidelines**	**Current Required Level of Service (1)**
$cBOD_5$ (mg/L)	50	50	25	50
TSS (mg/L)	40	40	25	40
Fecal coliforms (individual sample, MPN/100 mL) (2)	5,000	5,000	200	5,000
Fecal coliforms (geomean, MPN/100 mL) (3)	10,000	10,000	-	10,000

Notes:

n/a – not applicable

$cBOD_5$ – carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception fecal coliform individual samples and geomean).
2. Based on individual sample results.
3. Based on a geometric mean of all samples in the quarterly monitoring period.

The current treatment requirements for the Herring Cove WWTF are consistent with those for an enhanced primary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (October 2010 to June 2011) are summarized in Table 3.1. Raw wastewater quality data are based on composite samples from the influent wastewater prior to coarse bar screening.

Table 3.1 Herring Cove WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	80 (2)	170	110 (low) 190 (med) 350 (high)
TSS	79	200	120 (low) 210 (med) 400 (high)
TP	n/d	7	4 (low) 7 (med) 12 (high)
TKN	n/d	25	20 (low) 40 (med) 70 (high)

Notes:

n/d - data not available

n/a – not applicable

TKN – total Kjeldahl nitrogen

1. The “low”, “med”, and “high” refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. Historic values recorded as $cBOD_5$ concentrations. Sampling and testing protocol for raw wastewater should be confirmed with plant operators

Raw wastewater is not analyzed for BOD_5, TKN or TP. It is recommended that samples be analyzed for these parameters. Historic raw wastewater BOD_5 concentrations were estimated based on recorded $cBOD_5$ concentrations.

The raw wastewater quality is low strength with respect to BOD_5 and TSS.

3.2 Historic Flows and Effluent Quality

The effluent flow and quality data for the review period (October 2010 to July 2011) are summarized in Table 3.2. Effluent quality data are based on composite and grab samples from the effluent following UV disinfection.

Table 3.2 Herring Cove WWTF Effluent Flow and Quality Data

Parameter	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 4)	12,159	13,400	-
MDF (m^3/d) (1)	52,541	43,982	-
$cBOD_5$ (mg/L)	16.3	22.5	50
TSS (mg/L)	12.5	19.6	40
TP (mg/L) (2)	0.3	0.6	-
TAN (mg/L) (2)	7.7	9.2	-
Fecal coliforms (MPN/100 mL) (3)	29	202	10,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data for 2010 were only available over the period January to April and October to December. Flow data for 2011 were only available over the period January to May.
2. Results were only available over the period from November 2010 to July 2011.
3. Average fecal coliform values reported are annual geometric means.
4. Design ADF capacity is 28,512 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Herring Cove WWTF Compliance with Treatment Requirements (October 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	3 in compliance / 3 total	177 in compliance / 177 total
TSS	3 in compliance / 3 total	176 in compliance / 178 total
Fecal coliforms	3 in compliance / 3 total	174 in compliance / 178 total
Fecal coliforms (geomean)	3 in compliance / 3 total	n/a

Historically, the Herring Cove WWTF has performed well and is generally in compliance with all of the Permit to Operate treatment standards. In terms of all effluent parameters, $cBOD_5$, TSS, fecal coliforms and fecal coliform geomean, the quarterly treatment targets were met for each of these parameters for 100% of the quarters.

The individual sample results for $cBOD_5$, TSS, and fecal coliforms also met treatment requirements 100, 99, and 98% of the time for each of these parameters.

Currently, there are no TP effluent limits for the Herring Cove WWTF, but the historical effluent TP concentration averaged about 0.55 mg/L.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Herring Cove WWTF has the ability to bypass the aerated grit removal tanks in the event of a failure or if maintenance is needed to be performed on the process. The bypass is located directly before the grit removal tank, and the bypass lines discharge to the grit removal effluent channel. The Herring Cove WWTF also has the ability to bypass the entire Densadeg® system and have the wastewater flow directly to UV disinfection.

Peak flows due to inflow and infiltration (I/I) are a major hydraulic issue. The Herring Cove WWTF receives a dry weather average day flow of about 7,000 m^3/d. Depending on the rainfall event, operators reported that peak instantaneous flows can reach as high as 50,000 m^3/d. Operations staff have noted that peak flows have resulted in washout of the sedimentation zones of the Densadeg® systems, resulting in poor effluent quality.

3.4 Design, Operational and Condition Issues

The Herring Cove WWTF is the third enhanced primary treatment plant to be designed, following the design of both the Halifax and Dartmouth WWTFs. For this reason, the majority of the bottleneck and operational issues were dealt with prior to the design and construction of the Herring Cove facility. However, operations staff indicated that there are several design and operational issues at the Herring Cove WWTF.

Operations staff indicate that the existing fine screens allow a significant amount of hair and other particles to pass through, resulting in clogging of various pipes due to large accumulations of hair.

The effluent from the Densadeg® systems is prone to foaming. Although this does not negatively impact effluent quality, it has affected the downstream v-notch weir flow meters that utilize ultrasonic level detectors.

The high air flow rate for the odour control system results in a large volume of fresh air being brought into the WWTF building. Operations staff noted that, during the winter months, this results in high costs for heating the WWTF building.

Operations staff also indicated that backflow preventers are not installed on the potable water lines to the WWTF. Backflow preventers should be installed to avoid contamination of the potable water system.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Herring Cove WWTF is 28,512 m^3/d. The historic January 2010 to May 2011 (excluding May to October 2010) average day flow to the Herring Cove WWTF was 12,685 m^3/d, or approximately 44% of the design rated capacity.

The design peak wet weather flow capacity of the Herring Cove WWTF is 76,032 m^3/d. The Herring Cove WWTF has reached maximum day flows as high as 52,541 m^3/d, or approximately 69% of the design rated capacity.

The design capacity values from the Degremont Design Basis were used in order to establish the existing treatment capacity of the Herring Cove WWTF. The minimum flow the plant is designed to treat is 5,184 m^3/d. The channels in the plant are designed to hydraulically handle flows up to four times the average dry weather flow, equivalent to 76,932 m^3/d and the peak wet weather flow.

Due to the proprietary nature of the Densadeg treatment process, a desktop assessment of treatment capacity was not possible. However, according to input from operations staff, the effluent quality from the Densadeg systems was impaired at peak instantaneous flows around 50,000 m^3/d.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver is Halifax Harbour on the Atlantic Ocean. The effluent is discharged approximately 100 metres off-shore. An assimilative capacity assessment of Herring Cove would need to be completed to confirm future treatment requirements.

4.2 Site Constraints

The Halifax Regional Municipality owns land directly adjacent to the existing Herring Cove WWTF that is available for expansion.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Herring Cove WWTF:

- Historically, the Herring Cove WWTF has produced good quality effluent with respect to $cBOD_5$, TSS and fecal coliforms. Effluent requirements for these parameters have been consistently met.
- Currently, there are no TP effluent limits for the Herring Cove WWTF, but the historical effluent TP concentration averaged about 0.55 mg/L.
- The Herring Cove WWTF receives low strength raw wastewater that has very little variation in its influent characteristics.
- The WWTF experiences reduced performance during peak wet weather flows, when solids separation is impaired.
- Operations staff note that the existing fine screens allow hair and other solids to pass through the headworks.
- Based on the Degremont Design Basis, the existing Herring Cove WWTF has design capacities as follows:
  - Average day flow capacity: 28,512 m^3/d; and
  - Peak WWF capacity: 76,032 m^3/d.
- According to operations staff, deterioration in effluent quality is seen at peak instantaneous flows of approximately 50,000 m^3/d.
- Halifax Regional Municipality owns land located southeast of the existing Herring Cove WWTF, which is available for expansion.

6. REFERENCES

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA
Environment
Environmental Monitoring and Compliance

30 Damascus Road
Suite 115
Bedford, NS
Canada B4A 0C1

902 424-7773 T
902 424-0597 F
www.gov.ns.ca

SEP. 30 2010

Our File Number: 94300-30BED-074148

Mr. Tony Blouin, PhD
Halifax Regional Water Commission
200 Bluewater Road
Bedford, NS
B4B 1G9

Dear Mr. Blouin:

RE: Approval to Operate - Herring Cove Sewage Collection & Treatment Plant Approval No. 2010-074148

Enclosed please find Approval # 2010-074148 to operate the Herring Cove Sewage Collection & Treatment Plant at 59 Village Road, Herring Cove, Halifax Regional Municipality, Nova Scotia.

Strict adherence to the attached terms and conditions is imperative in order to validate this approval.

Despite the issuance of this Approval, the Approval Holder is still responsible for obtaining any other authorization which may be required to carry out the activity, including those which may be necessary under provincial, federal or municipal law.

Should you have any questions, please contact Steve Westhaver, Central Region, Bedford Office at (902) 424-8183.

Yours Truly

Stephen Westhaver

Steve Westhaver, PEng
District Manager

NOVA SCOTIA
Environment

APPROVAL

Province of Nova Scotia
Environment Act, S.N.S. 1994-95, c.1

APPROVAL HOLDER: **Halifax Regional Water Commission**

APPROVAL NO: **2010-074148**

EXPIRY DATE: **June 30, 2013**

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Operation of the Herring Cove Sewage Collection & Treatment Plant, and associated works, at or near 59 Village Road, Herring Cove, Halifax Regional Municipality in the Province of Nova Scotia.

Administrator Stephen Westhaver

Effective Date September 30, 2010

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Environment

Approval Holder:	Halifax Regional Water Commission
Project:	Herring Cove Sewage Collection & Treatment Plant
Site:	59 Village Road Herring Cove, Halifax Regional Municipality PID # 41117631
Approval No:	2010-074148
File No:	94300-30BED-074148

Reference Documents:

- Application dated September 8, 2010 and attachments.
- Degremount Submission dated Nov 30/09
- Herring Cove STP Performance Test Report dated May 13/10
- Halifax Water Substantial Completion Submission dated Sept 9/10
- HRM Letter of Authorization dated Sept 28/10

1. **Definitions**

a) "Act" means the *Environment Act* S.N.S. 1994-1995, c.1, and includes all regulations made pursuant to the Act.

b) "Composite Sample" means a representative sample which is taken from the combination of individual samples that are collected over a 24 hour period with at least one sample of 100 ml taken at two hour intervals.

c) "Department" means the Central Region, Bedford Office, of Nova Scotia Environment located at the following address:

Nova Scotia Environment
Environmental Monitoring and Compliance Division
Central Region, Bedford Office,
Suite 115, 30 Damascus Road
Bedford, Nova Scotia, B4A 0C1

Phone: (902) 424-7773

d) "Facility" means the Herring Cove Sewage Collection System & Sewage Treatment Plant and associated works related to the Halifax Solutions Project.

e) "Grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled.

f) "Minister" means the Minister of Nova Scotia Environment.

g) "NSE" means Nova Scotia Environment.

h) "Sewage Collection System" means the piping, equipment and all auxiliaries for the collection, and storage of sewage from the source of the sewage to the Sewage Treatment Plant for the Herring Cove location.

i) "Sewage Treatment Plant"(STP) means the equipment and all the auxiliaries associated with the treatment of sewage including the plant effluent outfall.

2. **Scope of Approval**

a) This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to operate the Facility wit h the sewage collection & treatment plant, situated at or near 59 Village Road, Herring Cove, Halifax Regional Municipality (the "Site").

b) The Facility shall be operated as outlined in the application for approval dated September 8, 2010 and supporting documentation.

c) The Site shall not exceed the area as outlined in the application and supporting documentation.

3. **General Terms and Conditions**

a) The Approval Holder shall operate and reclaim its Facility in accordance with provisions of the:

   i) *Environment Act* S.N.S. 1994-1995, c.1, as amended from time to time;
   ii) Regulations, as amended from time to time, pursuant to the above Act;

b) The Approval Holder is responsible for ensuring that they operate the Facility on lands which they own or have a lease or written agreement with the landowner or occupier. Breach of this condition may result in cancellation or suspension of the Approval.

c) If there is a discrepancy between the reference documents and the terms and conditions of this Approval, the terms and conditions of this Approval shall apply.

d) Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

e) The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

f) This Approval is not transferable without the consent of the Minister or Administrator.

g) (i) If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(2)(b) and 58(4) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

(ii) Despite a cancellation or suspension of this Approval, the Approval Holder remains subject to the penalty provisions of the Act and regulations.

h) The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the sewage treatment plant, including process changes or waste disposal practices which are not granted under this Approval. Extensions or modifications to the sewage treatment plant may be subject to the Environmental Assessment Regulations. An amendment to this Approval will be required before implementing any change.

i) Pursuant to Section 60 of the *Act*, the Approval Holder shall submit to the Administrator any new and relevant information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval.

j) The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

k) The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

l) Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

m) Unless written approval is received otherwise from the Administrator, all samples required by this Approval shall be analysed by a laboratory that meets the requirements of the Department's "Policy on Acceptable Certification of Laboratories" as amended from time to time.

n) The Approval Holder shall submit any monitoring results or reports required by this Approval to the Department. Unless specified otherwise in this Approval, all monitoring results shall be submitted within 30 days following the last month of the monitoring period.

o) The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel directly involved in the Facility operation are made fully aware of the terms and conditions which pertain to this Approval.

4. **Spills or Releases**

a) All spills or releases shall be reported in accordance with the *Act* (Part VI) and the *Emergency Spill Regulations*.

b) Spills or releases shall be cleaned up immediately in accordance with the *Act*.

c) A quantity of spill/release response material is to be maintained on Site at all times.

5. **Sludge Disposal**

a) All sludge generated at the Facility shall be treated and disposed of by a method acceptable to the Department.

6. **Operation**

a) The Approval Holder shall designate in writing, to the Department, any change in the contact person for this Approval.

b) The Facility must be operated and maintained in a manner that will prevent erosion, chemical spills or any other incidents that may be detrimental to the environment and public health.

c) The Approval Holder shall ensure that the Facility is operated, maintained and has appropriate backup facilities to protect against failures of the power supply, treatment process, equipment, or structure. Security measures shall assure the safety of the sewage treatment processes, storage facilities, and the discharge system.

d) The Approval Holder shall ensure the development and implementation of a contingency/emergency response plan for the Facility in accordance with the requirements of the Nova Scotia Environment "Contingency Planning Guidelines" as amended from time to time. A copy of the contingency/emergency response plan is to be maintained on Site at all times. The plan should include:

   i) General procedures for routine (equipment break-down, upset conditions, maintenance, etc.) or major emergencies within the facility system; and

   ii) A plan for equipment becoming inoperable in a major emergency.

   iii) A plan for dealing with spills or releases.

e) When it is necessary to use an approved by-pass related to a Facility issue, the Approval Holder shall notify the Department immediately.

f) The Approval Holder shall take immediate preventive or corrective action when results of an inspection or sampling results indicate conditions which are currently or may become a detriment to the STP operations, and/or result in adverse impact to the environment or public health.

g) The Facility has been classified as a **Class III sewage treatment plant and Class III sewage collection system**. The day-to-day operations of the sewage treatment plant and collection system shall be supervised directly by certified operators who hold the appropriate certification.

h) The Approval Holder shall establish and submit to NSE upon request notification procedures to be used to contact the Medical Officer of Health, NSE, other relevant authorities and the general public in the case of an emergency situation.

i) The Approval Holder shall prepare a comprehensive operations manual for the STP within three months of commencement of operation of the sewage treatment plant and keep it up to date. The manual shall be subject to review by NSE upon request.

j) The Approval Holder shall establish procedures for receiving and responding to complaints including a reporting system which records what steps were taken to determine the cause of complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

7. Performance And Limits

7.1 Treated Effluent

The sewage treatment plant shall be managed and operated in such a manner that the effluent being discharged to the receiving waters satisfies the following criteria:

a) $CBOD_5$, shall not exceed 50 mg/l.

b) Total Suspended Solids, shall not exceed 40 mg/l

c) Fecal coliform shall not exceed 5000/100 mls or the geometric mean of all samples in the quarterly monitoring period shall be less than or equal to 10,000 counts per 100 mls.

d) Disinfection of the effluent from the sewage treatment plant shall be continuous.

e) The sewage treatment plant shall be considered in compliance with the effluent limitations if 80% of the sample test results, at the frequency and location specified in table 1 meet the specified effluent limits. No single result can be greater than two times the limits except for the fecal limit as noted.

7.2 Odour Control

a) The Approval Holder shall operate the Facility in a manner which will not result in the generation of offensive or hazardous odours/vapours.

b) The Approval Holder shall be required to implement control measures if odour generation is deemed excessive by the Department.

8. Monitoring and Recording

a) The Approval Holder shall conduct all monitoring and analysis required in this section according to the latest edition of "Standard Methods for the Examination of Water and Waste Water".

b) All equipment must be installed, maintained and calibrated as specified by the manufacturer's instructions.

c) Following a review of any of the analytical results required by this Approval, NSE may alter the frequencies, location, and parameters for analyses required for this Approval.

TABLE 1

PARAMETER	MINIMUM FREQUENCY	STP LOCATION
$CBOD_5$	5/week	effluent discharge
Suspended Solids	5/week	effluent discharge
Fecal Coliform	5/week(grab sample)	effluent discharge
pH	5/week(grab sample)	effluent discharge
Plant Volumes	continuous	entering or leaving stp
Total Ammonia	1/month	effluent discharge

* All samples shall be composite unless stated otherwise.

9. Reporting

9.1 Quarterly Reporting

a) The Approval Holder shall prepare and submit to the Department on a quarterly basis, the results of the sampling conducted at the locations indicated in table 1.

b) The Approval Holder shall prepare and submit to the Department, a quarterly performance report for the Facility. The report shall contain the following information in a format acceptable to the District Manager.

i) a summary and discussion of the quantity of sewage treated during the reporting period compared to the design values for the sewage treatment plant, including peak flow rates, maximum daily flows and monthly average daily flows;

ii) a summary and interpretation of analytical results obtained in accordance with Section 8 (Monitoring and Recording) of this Approval;

iv) a tabulation and description of any emergency or upset conditions which occurred during the period being reported upon and action taken to correct them;

v) any complaints that were received and the Approval Holders response.

9.2 **Emergency Reporting on Operation**

a) The Approval Holder shall notify the Department forthwith in the event that untreated sewage is directed to the environment as a result of malfunction, upset, or equipment failure.

b) The Approval Holder shall immediately notify the Department of any incidents of exceedence of the compliance requirement indicated in section 7.1.

10. **Records**

a) The Approval Holder shall keep the following records and wastewater effluent quality analyses:

i) $CBOD_5$, Suspended Solids, and Bacteriological analyses shall be kept for five years;

ii) Flow meter readings shall be kept for 10 years.

b) The Approval Holder shall also retain the following information for a period of three years:

i) calibration and maintenance record

ii) continuous monitoring data

iii) records of any violations of the conditions of this Approval and actions taken by the Approval Holder to correct those violations.

c) A complete set of the as-built drawings, incorporating any amendments made from time to time, shall be kept by the Approval Holder at the Site for as long as the sewage treatment plant is kept in operation.

APPENDIX B
SITE VISIT PHOTOS

Photo 1 Herring Cove Inlet Chamber and Shut Off Valve

Photo 2 Herring Cove Weir Gate

Photo 3 Herring Cove Weir Gate and Manual Coarse Bar Screen

Photo 4 Herring Cove Automatic Coarse Bar Screen

Photo 5 Herring Cove Influent Sampling Point

Photo 6 Herring Cove Screenings Conveyor

Photo 7 Herring Cove Screenings Conveyed to Grit Bin

Photo 8 Herring Cove Screenings Waste

Photo 9 Herring Cove Fine Bar Screens

Photo 10 Herring Cove Automatic Fine Bar Screen

Photo 11 Herring Cove Two Trains of Grit Removal & Parshall Flumes Below Floor

Photo 12 Herring Cove Screenings and Grit Disposal Bin

Photo 13 Herring Cove Headworks MCC Room

Photo 14 Herring Cove Densadeg Enhanced Primary Treatment

Photo 15 Herring Cove Rapid Mixer for Flocculation Tank

Photo 16 Herring Cove Densadeg Flocculation Tanks Below Slab

Photo 17 Herring Cove Inclined Tube Settlers Placed in Settling Zone of Densadeg

Photo 18 Herring Cove Effluent from Enhanced Primary Treatment

Photo 19 Herring Cove Foaming in Densadeg Effluent Trough

Photo 20 Herring Cove Densadeg Sedimentation Zone Sludge Blanket Sampling Sink

Photo 21 Herring Cove UV Disinfection Control Panel

Photo 22 Herring Cove UV Disinfection Channels

Photo 23 Herring Cove Effluent Sampling

Photo 24 Herring Cove Effluent Sampling

Photo 25 Herring Cove Final Effluent from UV Disinfection

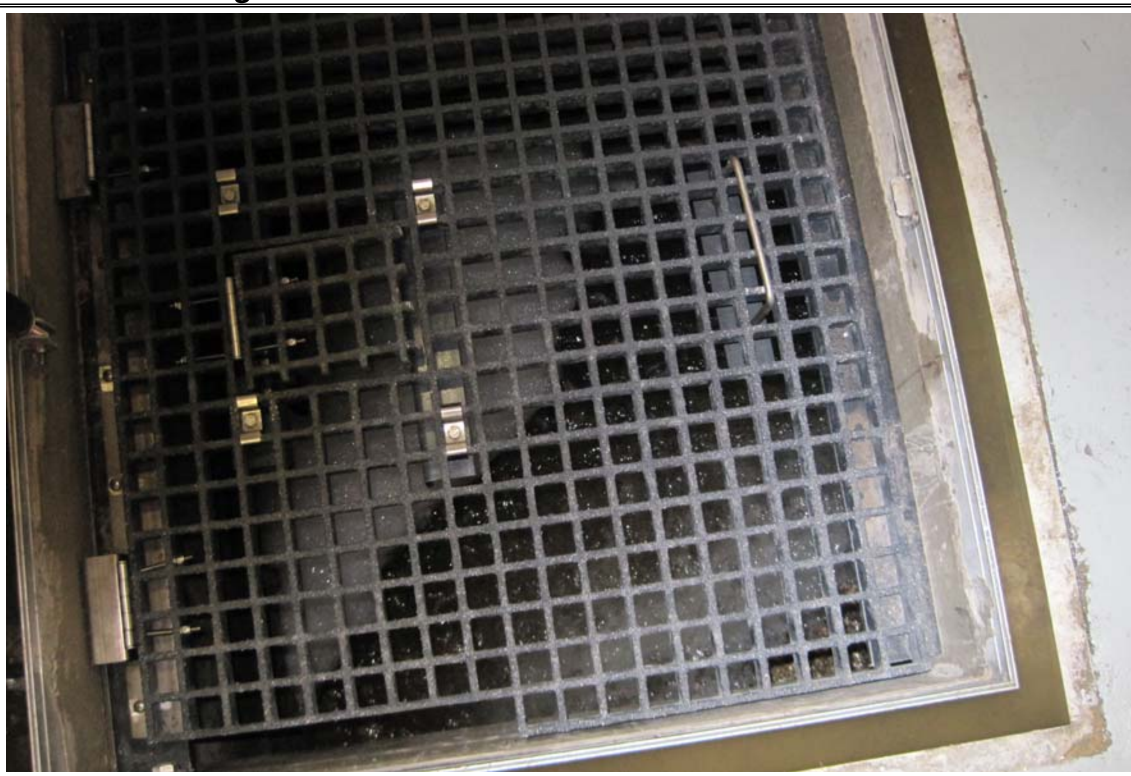

Photo 26 Herring Cove Final Effluent with Visible Foam

Photo 27 Herring Cove Polymer Pumps for Densadeg

Photo 28 Herring Cove Polymer Pump Metering System

Photo 29 Herring Cove Polymer Storage Containers for Densadeg Polymer

Photo 30 Herring Cove Polymer Storage Containers for Rotary Press Polymer

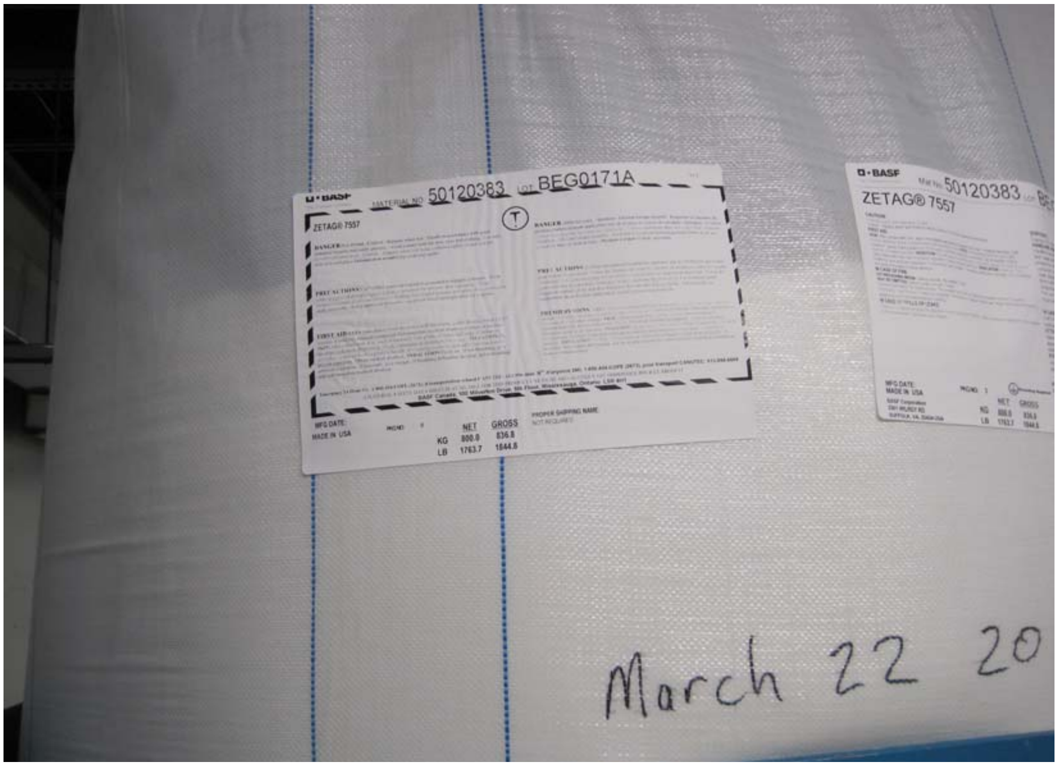

Photo 31 Herring Cove Polymer Dry Powder for Rotary Press

Photo 32 Herring Cove Chemical Metering

Photo 33 Herring Cove Chemicals: Sodium Hypochlorite, Caustic Soda & Alum

Photo 34 Herring Cove Caustic Chemical Storage

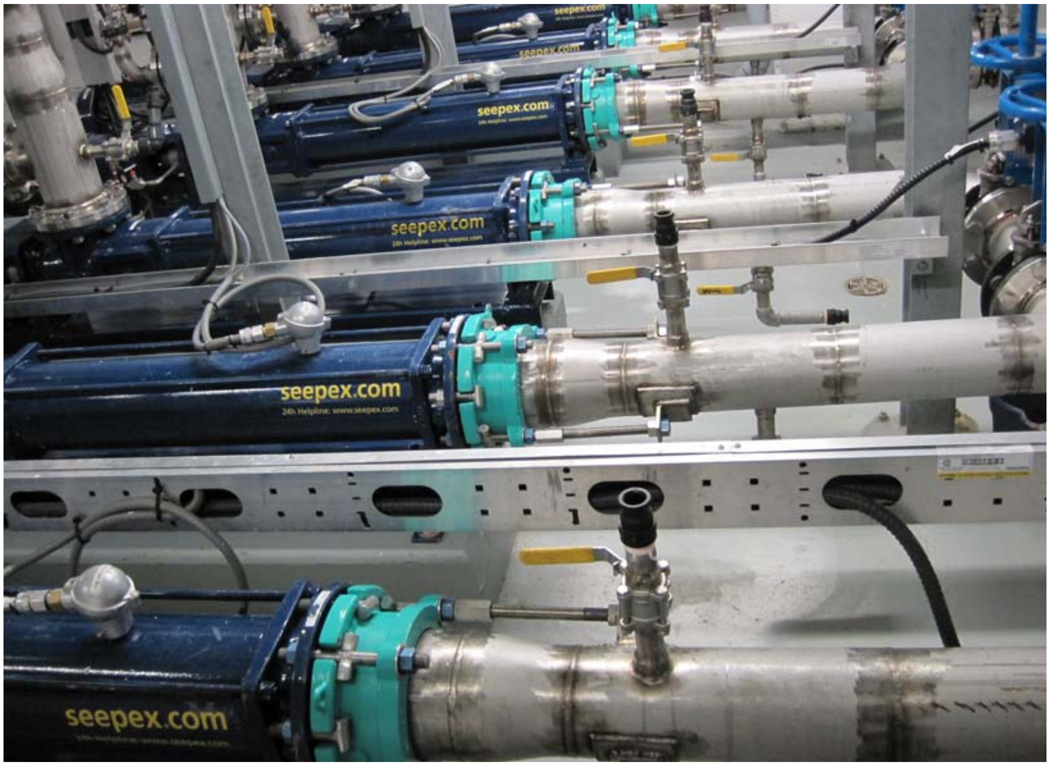

Photo 35 Herring Cove Densadeg Sludge Transfer & Recirculation Pumps

Photo 36 Herring Cove Extraction and Recirculation Pump Metering

Photo 37 Herring Cove Sludge Pumps

Photo 38 Herring Cove Solids Handling Pumps

Photo 39 Herring Cove Sludge Flocculation Tank

Photo 40 Herring Cove Rotary Press

Photo 41 Herring Cove Fournier Rotary Presses

Photo 42 Herring Cove Sludge Cake

Photo 43 Herring Cove Return Flows to Headworks

Photo 44 Herring Cove Odour Control Carbon Scrubber

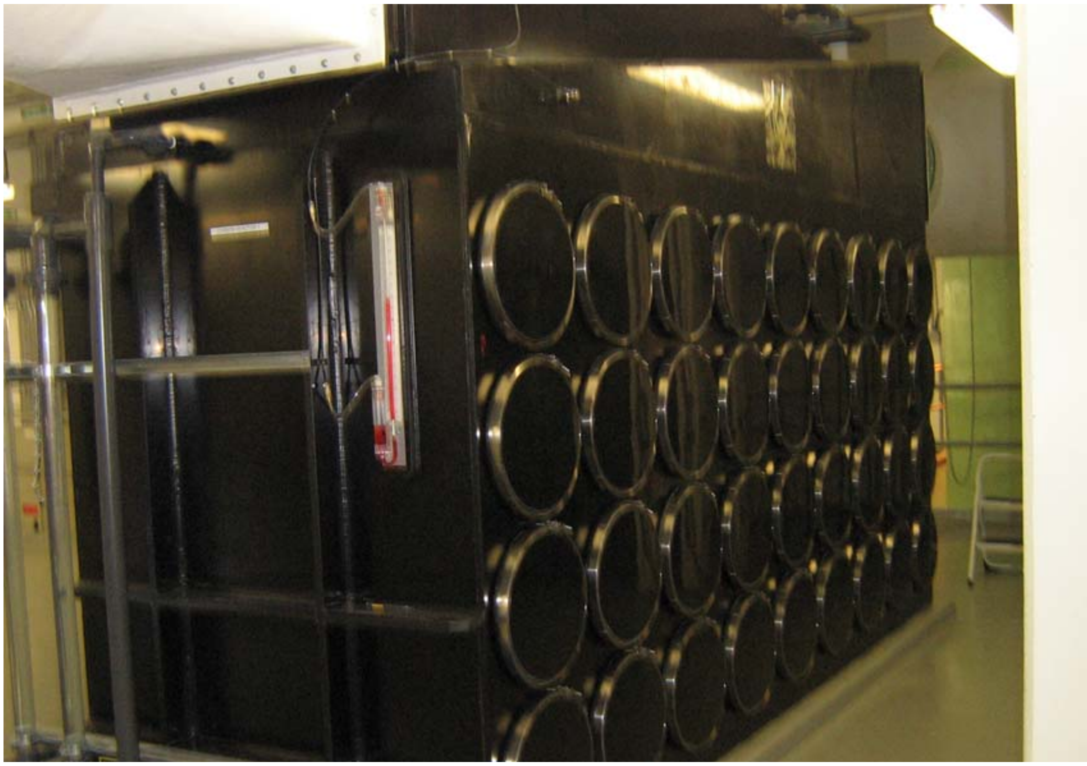

Photo 45 Herring Cove Odour Control Carbon Scrubber

Photo 46 Herring Cove Odour Control Wet Scrubber

Photo 47 Herring Cove Wet Scrubber Solution Pumps

Photo 48 Herring Cove Odour Control Wet Scrubber Media

Photo 49 Herring Cove Rotary Screw Pump Compressors

Photo 50 Herring Cove Back-up Generator

Photo 51 Herring Cove In House Laboratory

Photo 52 Herring Cove WWTP & Diesel Storage for Back-up Power

Photo 53 Herring Cove and Outfall

VOLUME 3 – APPENDIX B-13

Lockview MacPherson WWTF

Halifax Water
Halifax Regional Water Commission

APPENDIX - WORKING PAPER NO. 1.3
LOCKVIEW/MACPHERSON WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

Table of Contents

1. INTRODUCTION

1.1 Background

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Lockview/MacPherson (Fall River) WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Lockview/MacPherson (Fall River) WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection;
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used to develop this TM:

- Permit to Operate, Halifax WWTF, Approval No. 93-35, dated August 31, 1993 (see Appendix A);
- A site visit conducted on July 5, 2011;
- Fall River Sewage Treatment Plant drawings prepared by UMA Engineering Ltd., dated April 1993; and
- Operating data from WaterTrax over the period January 2009 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Lockview/MacPherson WWTF, which was commissioned in 1994, is a tertiary treatment facility consisting of flow equalization, preliminary treatment, an extended aeration activated sludge process, tertiary granular media filtration, and UV disinfection. The facility has an average day flow (ADF) design capacity of 454 m^3/d.

The WWTF serves approximately 454 residential users, five restaurants, three schools and the Sobey's Mall. The service area extends from Lockview Road, east across the Shubie Canal system and the Number 2 highway to the Sobey's Mall.

2.2 Existing Facilities

Raw wastewater receives preliminary treatment via a comminutor installed in the influent channel. Should influent flows exceed the capacity of the comminutor, flows are automatically diverted to a bypass channel equipped with a manually cleaned bar screen.

The preliminary treated wastewater is then discharged to the influent equalization (EQ) tank. Wastewater is pumped from the EQ tank via two variable-speed submersible pumps, which operate in duty/standby mode. The pumps operate automatically based on float level switches.

The wastewater is discharged from the EQ tank into the aeration tank influent channel. Return activated sludge (RAS) and caustic soda, for alkalinity addition, are also added to the aeration tank influent channel. The resulting mixed liquor then flows to two aeration tanks, which operate in parallel (East Tank, and West Tank). Effluent from the aeration tanks recombine in a common channel before being split between two secondary clarifiers, which operate in parallel (East Clarifier and West Clarifier).

Inverted siphons are used to draw RAS from the bottom of each clarifier into the RAS tank. Two RAS pumps are then used to pump the sludge from the RAS tank to the aeration tank inlet channel. Waste activated sludge (WAS) is drawn off the RAS tank via a plunger valve. WAS is stored in the aerated sludge holding tank, which is located below the RAS tank. Supernatant from the sludge holding tank is returned to the head of the plant. Thickened sludge is hauled to the AeroTech WWTF for further processing.

Secondary effluent then flows to a Dynasand continuous backwash filter for tertiary treatment. Flows which exceed the capacity of the filter automatically bypass the filter. Backwash flows are collected in a backwash holding tank, and returned to the EQ tank.

The tertiary effluent is then disinfected via an ultraviolet (UV) disinfection system. Effluent is then discharged to an effluent pumping station, from where it is pumped to Lake Fletcher.

Figure 2.1 presents a process flow diagram of the Lockview/MacPherson WWTF.

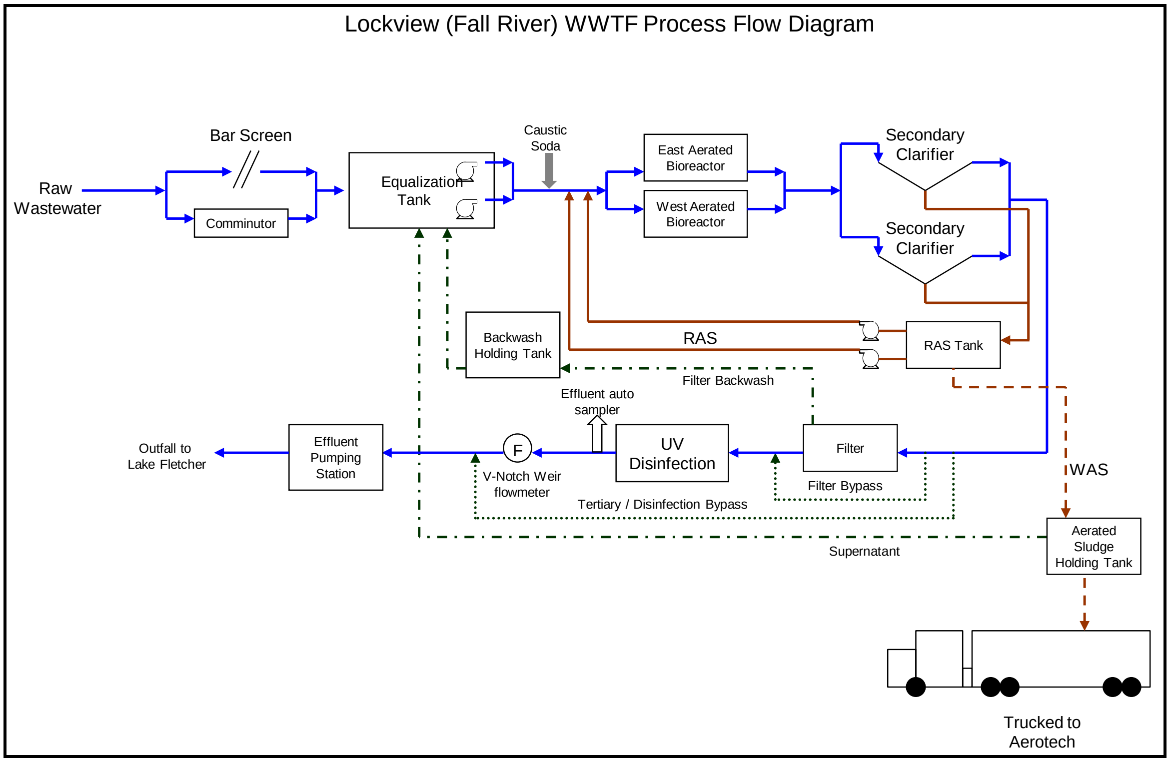

Figure 2.1 Process Flow Diagram of the Lockview/MacPherson WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Lockview/MacPherson WWTF is regulated by Nova Scotia Environment (NSE) under Permit to Operate (PTO) Approval No. 93-35, dated August 31, 1993. Table 2.1 presents the effluent requirements based on the PTO. For reference purposes, effluent requirements as recorded in WaterTrax and those included in the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006) are also shown.

Table 2.1 Lockview/MacPherson WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service
$cBOD_5$ (mg/L)	5	5	25	5
TSS (mg/L)	5	5	25	5
Ortho-phosphate (mg/L as P)	1.5	1.5	-	1.5
Fecal coliforms (individual sample, MPN/100 mL)	200	200	200	200
Fecal coliforms (geomean, MPN/100 mL) (1)	-	400	-	400

Notes:

n/a – not applicable

$cBOD_5$ – five-day carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. Based on a geometric mean of all samples in the quarterly monitoring period.
2. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter.

The current treatment requirements for the Lockview/MacPherson WWTF are consistent with those for a tertiary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2009 to July 2011) are summarized in Table 3.1.

Table 3.1 Lockview /MacPherson WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 [(1)]
BOD_5 [(2)]	202	170	110 (low) 190 (med) 350 (high)
TSS	176	200	120 (low) 210 (med) 400 (high)
TAN	23.9	n/a	n/a
Ortho-phosphate (as P)	15.2	n/a	n/a

Notes:

n/d - data not available

n/a – not applicable

TAN – total ammonia nitrogen

1. The "low", "med", and "high" refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.
2. Raw wastewater BOD5 was estimated based on the historic recorded c BOD5 and assuming a c BOD5 to BOD5 ratio of 0.80.

The raw wastewater quality is medium strength with respect to BOD_5 and TSS. Raw wastewater is not analyzed for TKN or TP. It is recommended that samples be analyzed for these parameters.

Although no raw wastewater TKN concentrations are available, the raw wastewater TAN is consistent with a medium strength wastewater. In addition, the recorded ortho-phosphate concentration of 15.2 mg/L as P is very high compared to typical domestic wastewater.

3.2 Historic Flows and Effluent Quality

The flow and effluent quality data for the review period (June 2010 to July 2011) are summarized in Table 3.2. Effluent samples for compliance purposes were only collected in 2011.

Table 3.2 Lockview/MacPherson WWTF Flow and Effluent Quality Data

Parameter	2009	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1)	183	176	204	-
MDF (m^3/d)	552	873	626	-
$cBOD_5$ (mg/L)	-	9.9	7.8	5
TSS (mg/L)	5.3	11.4	35.1	5
Ortho-phosphate	0.72	0.08	0.07	1.5
TP	-	0.14	1.0	-
Fecal coliforms (MPN/100 mL) (2)	12	2.6	3.1	400

Notes:

ADF – average day flow

MDF – maximum day flow

3. Design ADF capacity is 454 m^3/d.
4. Average fecal coliform values reported are annual geometric means.

Compliance with respect to the current effluent requirements is determined based on meeting the target parameter concentration on at least 80 percent of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Lockview/MacPherson WWTF Compliance with Treatment Requirements (January 2009 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	6 in compliance/10 total	230 in compliance/248 total
TSS	1 in compliance/10 total	136 in compliance/244 total
Ortho-Phosphate	10 in compliance/10 total	246 in compliance/246 total
Fecal coliforms	9 in compliance/10 total	229 in compliance/245 total
Fecal coliforms (geomean)	10 in compliance/10 total	n/a

The Lockview/MacPherson WWTF has historically been in compliance with the effluent ortho-phosphate and fecal coliform requirements on both the quarterly and individual sample bases.

Effluent $cBOD_5$ and TSS results have frequently exceeded the quarterly compliance requirements. Effluent TSS results also often exceed the individual sample requirements. Operations staff indicate peak flows result in frequent partial tertiary filter bypass events, which contribute to the poor effluent performance in terms of $cBOD_5$ and TSS.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

Operations staff indicate that all influent flows to the Lockview/MacPherson WWTF are routed through one pumping station in the collection system. When the pumping station turns on, the magnitude of the flow results in partial bypasses of the comminutor.

It was also noted that the flow split between the two aeration tanks and the flow split between the two secondary clarifiers are uneven.

The continuous backwash filter does not have sufficient capacity to handle the peak flows through the process, resulting in frequent partial filter bypasses. Due to the current mode of operation of the EQ tank, high magnitude flows of short duration are frequent occurrences through the liquid treatment train.

A bypass around the filter and UV system was installed in the late 1990's/early 2000's. There is provision to chlorinate these bypass flows. This allows relief of hydraulic bottlenecks associated with the filter/UV disinfection systems to avoid hydraulic backups in secondary treatment.

3.4 Design, Operational and Condition Issues

According to operations staff, short circuiting within the secondary clarifiers results in poor clarifier performance.

Due to the configuration of WAS draw off via a plunger valve at the bottom of the RAS tank, operations staff noted that they lose the ability to waste solids if there are no influent flows to the WWTF. As a result, operators need to manually waste several small volumes of sludge after each EQ tank pumping cycle. This is labour intensive, taking 1.5 to 2 manhours of effort per day. In addition, the siphons from the secondary clarifiers to the RAS tank are prone to clogging.

The suction piping for the RAS pumps lacks an air release valve. Operators noted that the couplings on the suction lines tend to leak, causing the RAS pumps to lose prime.

The aerated sludge holding tank is prone to developing septic conditions; operators indicated that this may be due to a lack of oxygenation capacity.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Lockview/MacPherson WWTF is 454 m^3/d. The historic average day flow was approximately 185 m^3/d, or approximately 41 percent of the design rated capacity. In spite of operating at flows below the design rated capacity, the Lockview/MacPherson WWTF has often been non-compliant with respect to $cBOD_5$ and TSS.

A preliminary desktop capacity assessment was completed to estimate the existing treatment capacity of the Lockview/MacPherson WWTF liquid treatment train. Based on an EQ tank with an effective storage volume of 36 m^3, two aeration tanks providing a total volume of 366 m^3, two secondary clarifiers providing a total surface area of 27.4 m^3, and providing year-round nitrification, the estimated average day capacity of the Lockview/MacPherson WWTF is 454 m^3/d. In addition, it is estimated that the Lockview/MacPherson WWTF has a peak flow capacity of 840 m^3/d. Although the current treatment requirements do not include effluent total ammonia nitrogen (TAN) limits, HW indicated that it is likely that nitrification will be required in the future due to the sensitive nature of the receiver.

It should be noted that no sizing information was available for the filter. Based on information from operating staff, the frequent bypassing of the filter, and the poor performance in terms of effluent TSS concentrations, the peak flow capacity of the Lockview/MacPherson WWTF is likely limited to less than 840 m^3/d by the filter capacity. Historically, the Lockview/MacPherson WWTF has operated at a maximum day flow of 873 m^3/d, or 104% of the estimated peak flow capacity. However, operations staff noted that the intermittent nature and magnitude of the EQ tank effluent flows result in frequent instances of short-duration, high intensity peak flows. These result in poor performance of the secondary clarifiers and partial tertiary filter bypasses, in spite of the facility operating well below its average day capacity.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver is Lake Fletcher, part of the Shubie Canal System, and a sensitive receiver. An assimilative capacity study of the effluent receiver would be required to determine future treatment requirements.

4.2 Site Constraints

There is limited room available for expansion within the existing fenced area. There may be the possibility to expand onto adjacent, wooded lots.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Lockview/MacPherson WWTF:

- The raw wastewater quality is medium strength with respect to BOD_5 and TSS.
- Although no raw wastewater TKN concentrations are available, the raw wastewater TAN is consistent with a medium strength wastewater. The recorded ortho-phosphate concentration of 15.2 mg/L as P is very high compared to typical domestic wastewater.
- It is recommended that raw wastewater samples be analyzed for TKN and TP.
- The Lockview/MacPherson WWTF has historically been in compliance with the effluent ortho-phosphate and fecal coliform requirements on both the quarterly and individual sample bases.
- Effluent $cBOD_5$ and TSS results have frequently exceeded the quarterly compliance requirements. Effluent TSS results also often exceed the individual sample requirements.
- The continuous backwash filter does not have sufficient capacity to handle the peak flows through the process, resulting in frequent partial filter bypasses. Due to the operation of the EQ tank, high magnitude flows of short duration are frequent occurrences. This may have contributed to poor effluent quality in terms of $cBOD_5$ and TSS
- According to operations staff, short circuiting within the secondary clarifiers results in poor clarifier performance.
- The existing system for wasting sludge from the process is labour intensive, taking 1.5 to 2 manhours of effort per day.
- Based on a preliminary desktop capacity assessment, the Lockview/MacPherson WWTF has estimated capacities as follows:
  - Average day flow capacity: 454 m^3/d (with nitrification); and
  - Peak flow capacity: 840 m^3/d (with nitrification).
- No sizing information was available for the filter. Based on information from operating staff, the frequent bypassing of the filter, and the poor performance in terms of effluent TSS concentrations, the peak flow capacity of the Lockview/MacPherson WWTF is likely limited to less than 840 m^3/d by the filter capacity.

- Operations staff noted that the intermittent nature and magnitude of the EQ tank effluent flows result in frequent instances of short-duration, high intensity peak flows. These result in poor performance of the secondary clarifiers and partial tertiary filter bypasses, in spite of the facility operating well below its average day capacity.
- The existing receiver is Lake Fletcher, part of the Shubie Canal System, and a sensitive receiver. An assimilative capacity study of the effluent receiver would be required to determine future treatment requirements.
- There is limited room available for expansion within the existing fenced area. There may be the possibility to expand onto adjacent, wooded lots.

6. REFERENCES

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A
PERMIT TO OPERATE

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

PERMIT TO CONSTRUCT AND OPERATE SEWAGE WORKS

Pursuant to Section 13 of the Water Act and Section 23 of the Environmental Protection Act and subject to the terms and conditions contained in Schedule "A" of this permit, this permit is granted to ***Municipality of the County of Halifax****, to construct and operate a* ***sewage treatment plant, at Lockview Road and MacPherson Road in Fall River*** *in the County of Halifax, Province of Nova Scotia.*

Granted at ***Halifax****, in the County of* ***Halifax****, Province of Nova Scotia, this 31st day of August, A.D.* ***1993****.*

93-35
Permit Number

Minister of the Environment

UMA Engineering Ltd.
Planners, Engineers & Project Managers

Suite 616, Royal Bank Building, 5161 George Street, Halifax, N.S., Canada B3J 1M7
Telephone (902) 421-1065; FAX (902) 429-3525

FACSIMILE TRANSMISSION

TO: MAXIM CONSTRUCTION
ATTENTION: Mr. Allan MacIntosh

FAX NO.: 468-7715
PROJECT NO.: 5707 001 05 04H

DATE: September 2, 1993

Page: 1 of 17

COPY TO: Solveig Madsen, N.S.D.O.E. (Pages 1 & 2 only)
M.T. Grant, N.S.D.O.E. (Pages 1 & 2 only)
→ Ted Tam, Halifax County
Peter Corkum/Brian Green, UMA

RE: FALL RIVER SEWAGE TREATMENT PLANT

We are in receipt of your letter dated September 1, which describes your Erosion and Sedimentation Control Plan for the above referenced project. We understand that your plan will be identical to the Erosion and Sedimentation Control Plan prepared by UMA, with the exception that the erosion control facilities will be installed as the the site is developed and as required to prevent contaminated runoff from leaving the site, rather than installing all of the erosion control facilities at the outset of construction. N.S.D.O.E. staff stated that a phased approach for installation of the erosion control facilities would be acceptable, as long as the facilities indicated on the erosion plan are provided in the affected areas prior to construction in those areas.

We have received the Permit to Construct, enclosed, for this project from the N.S.D.O.E. This approval is based on the UMA Erosion and Sedimentation Plan. You may begin construction, provided you take the following precautions:

* Ensure the work is carried out in strict accordance with the approved (UMA) Erosion and Sedimentation Control Plan and the noted specifications in the Permit to Construct.

* Protect the site and water courses against oil spills or other contaminants.

* Provide adequate stockpile of environmental protection materials on site for accidents or contigencies.

Please note that we had previously instructed you to provide adequate erosion control facilities, such as check dams and silt fences, around the disturbed areas at the site. As of yesterday, this was not done. However, you indicated in our telephone conversation today that you are presently installing the erosion control facilities. Please be advised that this construction is in a relatively sensitive area, and uncontrolled runoff to the water courses will not be tolerated.

As we requested previously, we need your proposed construction schedule as soon as possible so that we can determine staff requirements (inspector and surveyor) at the site. In the interim, please contact Peter Corkum at the UMA site office, telephone no. 860-0856, or the undersigned at 421-1065.

Regards,
UMA ENGINEERING LTD.

John C. Lam, P. Eng.
Senior Environmental Engineer

Nova Scotia

Department of the Environment

PO Box 2107
Halifax, Nova Scotia
B3J 3B7

Our file no:

12-93-0069

September 1, 1993

UMA Engineering Ltd.
Suite 616
5161 George Street
Halifax, Nova Scotia
B3J 1M7

Gentlemen:

Enclosed please find your Permit to Construct and Operate Sewage Works Application No. PTC-93-35 covering Sewage Treatment Plant, Lockview Road and MacPherson Road, Fall River.

Yours truly,

M T Grant

M.T. Grant, P. Eng.
Environmental Engineer

MTG/den
enclosure

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

PERMIT TO CONSTRUCT AND OPERATE SEWAGE WORKS

Pursuant to Section 13 of the Water Act and Section 23 of the Environmental Protection Act and subject to the terms and conditions contained in Schedule "A" of this permit, this permit is granted to ***Municipality of the County of Halifax****, to construct and operate a* ***sewage treatment plant, at Lockview Road and MacPherson Road in Fall River*** *in the County of Halifax, Province of Nova Scotia.*

Granted at ***Halifax****, in the County of* ***Halifax****, Province of Nova Scotia, this 31st day of August, A.D.* ***1993****.*

93-35
Permit Number

Minister of the Environment

SCHEDULE "A"

Project: Lockview / MacPherson Sewage Treatment Facility, Fall River, Municipality of the County of Halifax, Design by U.M.A. Engineering Limited, Project No. 5707-001-05-03: Drawings G1 to G4, S1 to S6, M1 to M6, Revision 0, dated 06/07/93; E1 to E13, Revision 0, dated 7/7/93; Erosion & Sediment Control Plan, Dwg. 1, dated April 1993, stamped, signed and dated June 25, 1993, by J.C.Y. Lam P.Eng.; "General Project Statement", dated June 25, 1993; Tender documents dated April 1993, Addendum No. 1, dated July 13, 1993 & Addendum No.2, dated July 23, 1993; Predesign Report dated July 1992, Addendum No.1, dated December 1992; Letter of July 26, 1993 from J.C.Lam, P.Eng. to M.T. Grant, P.Eng.

File: 12-93-0069

Permit No: 93-35

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1. The above noted drawings and plans, including drawings and plans having design specifications and installation measures, will form part of this authorization.

2. All phases of construction must be overseen by a qualified professional engineer or technologist. Certification by a professional engineer is required stating that all construction/installations have been conducted in accordance with the approved plans and specifications.

3. It is an offence under Section 13 of the Water Act and/or Regulation 7 of the Water License and Permit Regulations to proceed with Construction without a permit or in advance of receiving this approval.

4. Failure, in the opinion of the Department, of the permit holder to comply with any and all stipulations pertaining to this approval will render this permit null and void. The permit holder shall have seven (7) days to remedy any breaches or defects and failing this, this permit shall be null and void. Permit holder to comply with all legislation (Acts/Regulations) with respect to this project.

5. Should the work approved under this permit not be commenced within a year this permit is considered to be null and void.

6. Any changes in approved plans and specifications must be authorized prior to construction/implementation by the Nova Scotia Department of the Environment.

7. Approvals granted under this permit do not negate the requirement for compliance with other existing municipal, provincial and federal laws and regulations.

8. A post construction report must be provided. The "Post-Construction Report" must contain all information regarding major changes from the approved plans or specifications made during construction. These major changes include any deviations which affect capacity, flow or operation of units. The "Post-Construction Report" must also include all commission or start-up of equipment tests and any other test results produced during construction. The "Construction Report" must also guarantee that all as-built drawings, operation and maintenance manuals, and any other relevant documentation have been turned over to the owner/operator by the engineer.

9. Effluent compliance requirements are as follows:

BOD_5	< 5 mg/l
Suspended Solids	< 5 mg/l
Fecal Coliform	< 200/100mls
Phosphorus, as Phosphate	< 1.5 mg/l

10. An application for wastewater facilities classification must be registered before commencement of operations of new sewage treatment facility. The required level of operator certification will be determined at that time. The operator must be certified at the required level of certification under the Atlantic Canada Water and Wastewater Voluntary Certification Program.

11. An influent (grab) and effluent (24 hour composite) sample must be collected five (5) times each yearly quarter, from the sewage treatment facility, and sent to a certified lab for analysis. Samples must be analyzed for the following parameters:

(A) influent
- BOD_5
- TSS
- Ammonia

(B) effluent - BOD_5
- TSS
- Ammonia
- Fecal Coliform
- Phosphate

All sampling and analysis operations, including sample collection, preservation and submission, laboratory requirements and analysis results reporting shall be performed in accordance with standard laboratory procedures.

A copy of the sample results plus a record of daily flows for the period must be submitted on a monthly basis to the N.S.D.O.E. Central Region Office, Bedford.

General Construction Requirements:

12. The concentration of suspended solids in water runoff must not exceed 25 mg/l, in any grab sample, upon entering any watercourses.

13. All erosion and sedimentation control measures must be inspected as required. All control measures must be maintained in good working condition for as long as they are required.

14. If measures that have been employed are not sufficient to reduce the concentration of suspended solids to 25 mg/l in water runoff, the permit holder is responsible to have further measures implemented immediately.

15. Sedimentation control measures must not be installed in watercourses. All sediment must be arrested prior to it entering any watercourse.

16. The construction of and implementation of any sedimentation and erosion control measures must be in accordance with the "Erosion and Sedimentation Control Handbook for Construction Sites".

17. All exposed areas in sensitive locations must be stabilized in 48 hours. All other exposed areas must be stabilized in 72 hours.

18. All work must proceed in accordance with the "Guidelines for Development of Slates in Nova Scotia, April 1991".

Bank Protection of Watercourse Between Site
Access Road and Culvert at Lockview Road:

19. *The bank stabilization must be completed in accordance with applicable conditions in the "Nova Scotia Watercourse Alteration Specifications (1993) - Bank Stabilization".*

Installation of Box Culvert in
Watercourse at Site Access Road:

20. *The installation must be completed in accordance with the conditions in the "Nova Scotia Watercourse Alteration Specifications (1993) Culverts".*

APPENDIX B
SITE VISIT PHOTOS

Photo 1 Lockview Inlet Screen and Comminutor

Photo 2 Lockview Comminutor

Photo 3 Lockview Covered Equalization Tank

Photo 4 Lockview Equalization Tank and Ultrasonic

Photo 5 Lockview Caustic Metering Pumps

Photo 6 Lockview Caustic Storage Tanks

Photo 7 Lockview Aeration Tanks

Photo 8 Lockview Aeration Tank

Photo 9 Lockview Aeration Tank Outlet and Clarifier Inlet

Photo 10 Lockview Blower Motor Nameplate

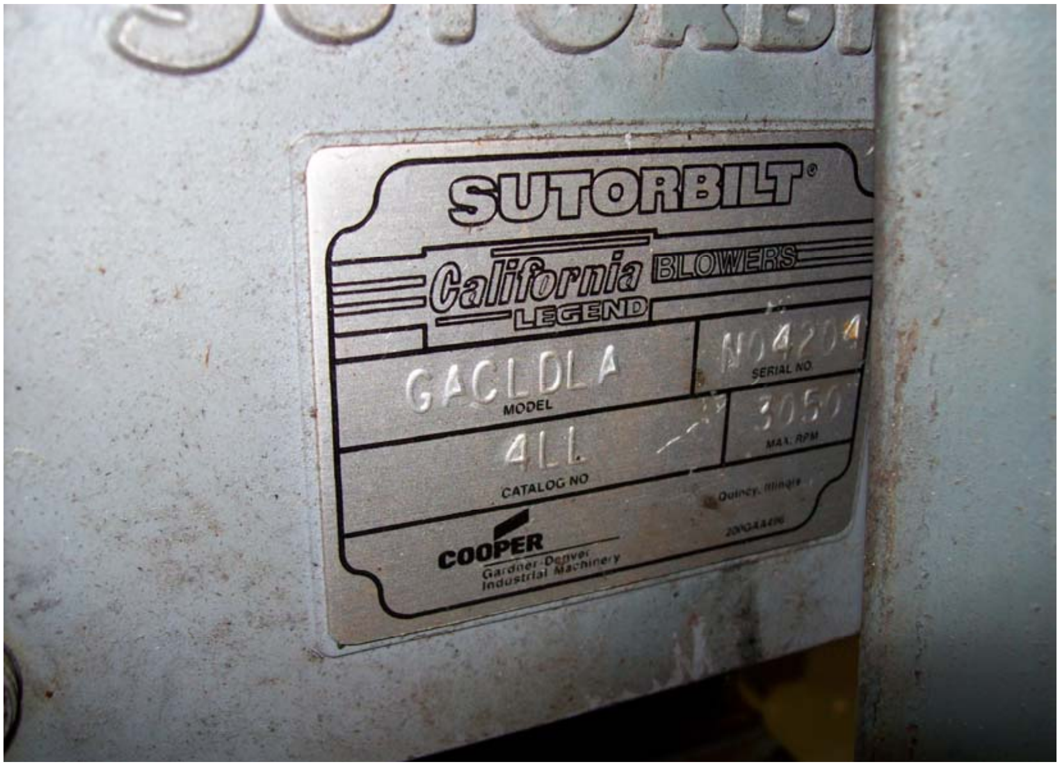

Photo 11 Lockview Blower Nameplate

Photo 12 Lockview Blowers

Photo 13 Lockview Clarifier Influent Weirs

Photo 14 Lockview Manual Skimming of Secondary Clarifier

Photo 15 Lockview Clarifier Effluent Weir

Photo 16 Lockview Clarifier Effluent Weir

Photo 17 Lockview RAS Tank

Photo 18 Lockview RAS Tank with WAS Valve 0pen

Photo 19 Lockview Hatch to RAS Tank

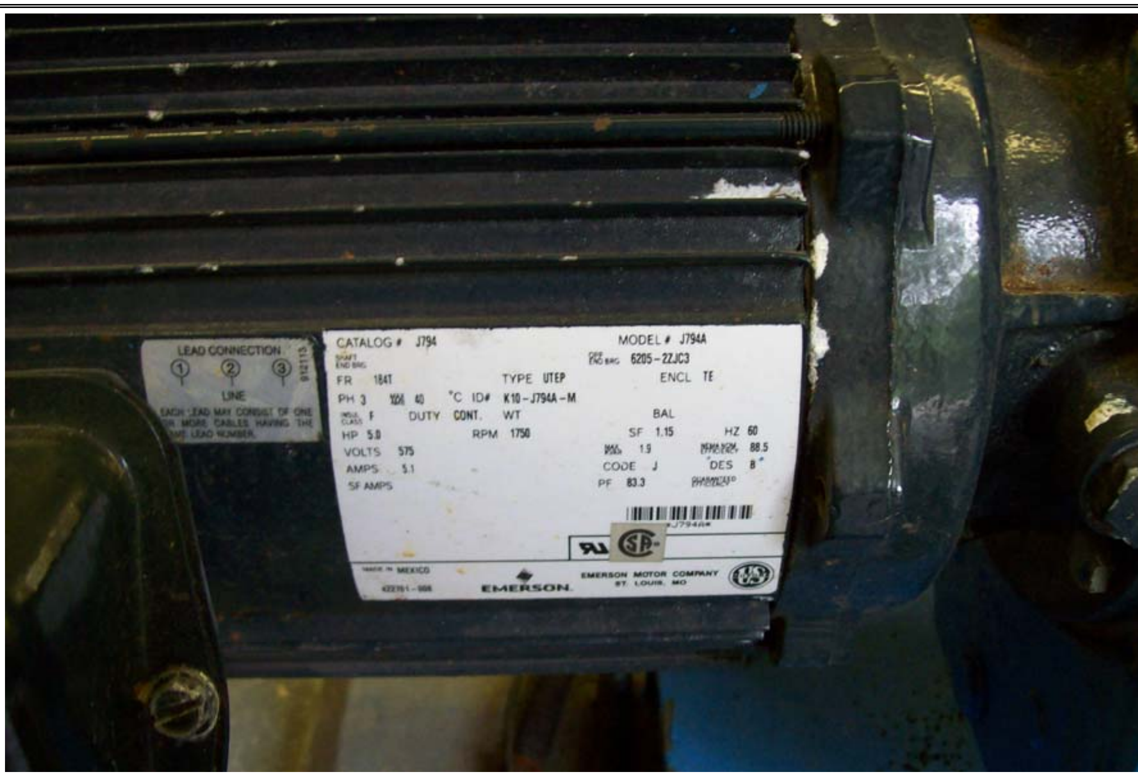

Photo 20 Lockview RAS Pump Motor Nameplate

Photo 21 Lockview RAS Pump Nameplate

Photo 22 Lockview RAS Pumps

Photo 23 Lockview Tertiary Filer Below Grating

Photo 24 Lockview Filter Effluent Piping and Sightglass

Photo 25 Lockview UV Disinfection System

Photo 26 Lockview Effluent Autosampler

Photo 27 Lockview Effluent V-notch Weir Flow Meter & Effluent Sample Tubing

Photo 28 Lockview Effluent Pumping Station

Photo 29 Lockview MCC

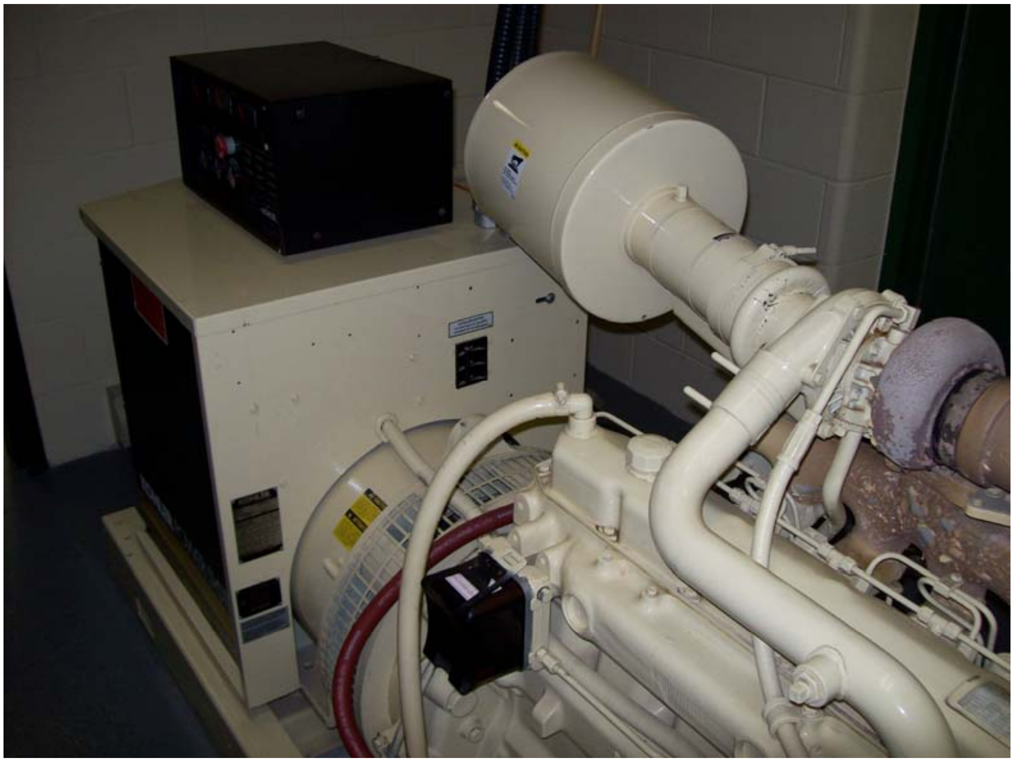

Photo 30 Lockview Genset

Photo 31 Lockview Diesel Tank for Genset

Photo 32 Lockview Valve Stems for Bypass Lines

VOLUME 3 – APPENDIX B-14

Middle Musquodoloit WWTF

APPENDIX - WORKING PAPER NO. 1.3
MIDDLE MUSQUODOBOIT WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. Introduction

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Middle Musquodoboit WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Middle Musquodoboit Wastewater Treatment Facility (WWTF);
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection; and
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- A site visit completed on July 4, 2011;
- Middle Musquodoboit drawing set, Alderney Consultants Ltd., 1988; and
- Operating data from WaterTrax over the period January 2009 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Middle Musquodoboit WWTF was commissioned in 1986, and consists of flow equalization, primary clarification, rotating biological contactors (RBCs), secondary settling, a polishing pond, and ultraviolet (UV) disinfection. The secondary treatment plant was designed to treat an average day flow (ADF) of 114 m^3/d; however, historic average daily flows (ADF) have recently approached 160 m^3/d. The effluent from the plant discharges into the Musquodoboit River.

Waste sludge is collected and removed from the primary and secondary clarification tanks, and this is sent directly to Aerotech WWTF for further processing as there is no sludge holding tank on site. The polishing pond is cleaned out at a minimum once every four years and more frequently if necessary.

The WWTF serves the community of Middle Musquodoboit, including the Middle Musquodoboit Hospital and Extended Care facility, one restaurant, and the community retirement home.

2.2 Existing Facilities

Wastewater from the community of Middle Musquodoboit is gravity fed to the treatment facility lift station, which is equipped with two Flygt pumps with a duplex float switch controlled system. The pumping station wet well provides equalization volume. Separation of fats, oils and greases (FOG) takes place in the wet well. The wastewater is pumped from the influent pumping station to grit removal.

Following grit removal, the wastewater enters the primary clarifier, and the primary effluent receives some aeration from fine bubble diffusers prior to entering the RBC tank. The RBC tank effluent then flows to the secondary clarifier, and the clarified effluent is discharged to the aerated polishing pond.

The polishing pond contains four trains of fine bubble diffusers on the influent side of the pond, and it contains an aeration pod with three diffusers in the middle of the pond to keep the ice to a minimum in winter temperatures. The flow then continues through the outlet of the polishing pond, and is directed through UV disinfection. The UV system is comprised of two separate units.

Following disinfection, the effluent flows by gravity to the outfall and is discharged to the Musquodoboit River.

Figure 2.1 presents a process flow diagram of the Middle Musquodoboit WWTF.

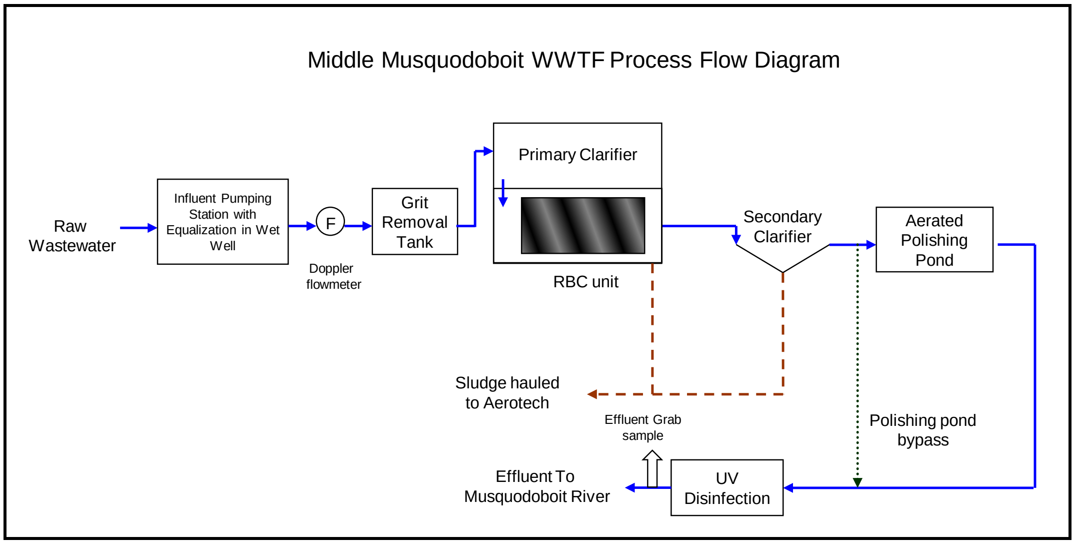

Figure 2.1 Process Flow Diagram of Middle Musquodoboit WWTF

2.3 Current Compliance Requirements

Table 2.1 presents the effluent requirements based on requirements as recorded in WaterTrax. Effluent requirements as outlined in the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006) are also shown for reference.

Table 2.1 Middle Musquodoboit WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service (1)
$cBOD_5$ (mg/L)	-	20	20	20
TSS (mg/L)	-	20	20	20
Fecal coliforms (individual sample, cfu/100 mL)	-	1,000	200	1,000
Fecal coliforms (geomean, cfu/100 mL)	-	2,000	-	2,000 (2)

Notes:

n/a – not applicable

$cBOD_5$ – carbonaceous biochemical oxygen demand

TSS – total suspended solids

1. The sewage treatment plant shall be considered in compliance with the effluent limitation if 80% of the sample test results meet the specified effluent limits. No single result can be greater than two times the specified limit for that parameter (with the exception of pH and the fecal coliform geomean).
2. Based on a geometric mean of all samples in the quarterly monitoring period.

The current treatment requirements for the Middle Musquodoboit WWTF are consistent with those for a secondary treatment facility.

3. HISTORIC PLANT PERFORMANCE

No raw wastewater samples are collected at the Middle Musquodoboit WWTF. As a result, it was not possible to evaluate the historic raw wastewater characteristics.

It is recommended that raw wastewater samples be collected and analyzed for, at a minimum, BOD_5, TSS, TKN, TP, and pH.

3.1 Historic Flows and Effluent Quality

The flow and effluent quality data for the review period (January 2009 to July 2011) are summarized in Table 3.1. Effluent quality data are based on grab samples collected downstream of the UV disinfection system.

The raw wastewater quality is low to medium strength with respect to BOD_5, TSS and TP, and medium to high strength with respect to TKN.

3.2 Historic Effluent Flows and Quality

The effluent flow and quality data for the review period (January 2009 to July 2011) are summarized in Table 3.2.

Table 3.1 Middle Musquodoboit WWTF Flow and Effluent Quality Data

Parameter	2009	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 5)	145	159	200	-
MDF (m^3/d) (1)	561	488	535	-
$cBOD_5$ (mg/L)	7.0 (2)	6.5	9.4	20
TSS (mg/L)	9.2	11.2	16.0	20
TP (mg/L) (3)	-	2.4	2.7	-
TAN (mg/L) (3)	-	4.3	6.1	-
Fecal coliforms (MPN/100 mL) (4)	27.6	37.2	62.2	2,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data for 2011 were only available over the period January to March.
2. 2009 BOD value is reported as BOD_5. All values from 2010 to the present are reported as $cBOD_5$.
3. Results were only available over the period from November 2010 to July 2011.
4. Average fecal coliform values reported are annual geometric means.
5. Design ADF capacity is 114 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration on at least 80% of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.2.

Table 3.2 Middle Musquodoboit WWTF Compliance with Treatment Requirements (January 2009 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
$cBOD_5$	10 in compliance / 10 total	124 in compliance / 124 total
TSS	8 in compliance / 10 total	118 in compliance / 120 total
Fecal coliforms	10 in compliance / 10 total	122 in compliance / 122 total
Fecal coliforms (geomean)	10 in compliance / 10 total	n/a

Notes:

Compliance results for $cBOD_5$ include four quarters (January to December, 2009) for which effluent BOD_5 concentrations were measured.

Historically, the Middle Musquodoboit WWTF has performed well and is generally in compliance with the effluent treatment requirements. In terms of effluent $cBOD_5$ and fecal coliforms, the quarterly treatment targets were met for both of these parameters for 100% of the quarters. The individual sample results also met treatment requirements 100% of the time for both of these parameters.

Quarterly effluent TSS limits were met 80% of the time, and 98% of the individual sample results met effluent limits.

Currently, there are no TP effluent limits for the Middle Musquodoboit WWTF, but the historical effluent TP concentration averaged about 2.6 mg/L. As well, there are currently no established TAN effluent limits for the Middle Musquodoboit WWTF. The historical TAN concentration values are quite variable within the limited sampling period, and indicate that the facility is nitrifying seasonally.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Middle Musquodoboit WWTF has the ability to bypass the entire plant and the WWTF is also designed to be able to bypass the polishing pond. The bypass line for the entire plant has not been used, to the supervisor’s knowledge, for over 15 years. If this bypass line was utilized, raw sewage would be sent to the Musquodoboit River.

The bypass line around the aerated polishing pond is used about every four years when sludge is removed from the polishing pond. At this time, the pond is drained, the sludge is pumped out, and hauled off-site to the Aerotech WWTP. While the pond is being cleaned, the wastewater flows directly from the secondary clarifier to a flow splitter box that directs the flow to UV disinfection.

According to operations staff, the flow equalization tank is undersized, and high flows seen during wet weather events cause a wash out of the fats, oils and grease (FOG) from the oil trap compartment over the wet well separation wall weir and into the operating compartment. The FOG is then pumped, with the wastewater, through the entire operating process instead of being collected in the oil trap compartment. There has never been an overflow of the tank itself; however, every rain event causes an upset of the treatment process due to the excess solids and FOG. As well, a Vacuum truck is required after every sizeable rain event to pump the additional sludge out of the process tanks. Typically, the sludge is pumped out of the clarifiers and equalization tank and hauled to the AeroTech WWTP on a weekly basis with a vacuum truck; however, this frequency is increased in the event of wet weather and increased flows.

3.4 Design, Operational and Condition Issues

Due to the age and different components of the Middle Musquodoboit WWTF, the facility has a variety of operational and condition issues.

The polishing pond presents a variety of operational difficulties. Algae blooms occur every spring, and the site supervisor indicated that a variety of approaches have been tried to address this issue, such as dosing with hypochlorite, however none have eliminated the algae blooms. The polishing pond is also home to a variety of wildlife, including muskrats. The muskrats have undermined the berm in some areas. The site supervisor stated that they are due to place riprap around the base of the pond to control erosion.

In addition, muskrats have progressed from the polishing pond into the secondary clarifier, and they have made nests in the clarifier (housing up to 10 muskrats) and chewed wires.

The raw wastewater has high concentrations of FOG, resulting in FOG accumulation in the EQ tank resulting in operational difficulties.

The bearings on the RBC units need to be replaced frequently (approximately every two years).

The facility has had odour complaints in the past due to its operations; however, there have been no complaints received in the last three years.

The WWTF also has some issues with regards to power outages and lack of back-up power. The influent flow is electronically stored on a SCADA system; however, if the power is lost, then that one day of data will be lost. There is no back-up power for any of the processes or electronic systems.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated capacity of the Middle Musquodoboit WWTF is 114 m^3/d. The historic January 2009 to March 2011 average day flow to the Middle Musquodoboit WWTF was 158 m^3/d, or approximately 139% of the design rated capacity. In spite of operating at average flows above the design capacity, the Middle Musquodoboit WWTF has been able to achieve the effluent requirements the majority of the time.

A preliminary desktop capacity assessment was completed to estimate the existing treatment capacity of the Middle Musquodoboit WWTF liquid treatment train. Based on a pre-equalization tank with a volume of 24 m^3, a primary clarification tank with a surface area of 26.5 m^2, an RBC performing BOD removal only with a surface area of 7,350 m^2, a secondary clarification tank with a surface area of 7.0 m^2, and typical raw wastewater quality, the estimated average day capacity of the Middle Musquodoboit WWTF is 275 m^3/d. Based on the secondary clarifier capacity and the pre-equalization tank capacity, the Middle Musquodoboit WWTF has an estimated peak flow capacity of 300 m^3/d.

4. FUTURE SITE-SPECIFIC CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing outfall discharges to the Musquodoboit River. The outfall's path crosses Highway 357 and a farmer's field to the receiver.

The Musquodoboit River discharges into Musquodoboit Harbour, a bay located on the Atlantic Ocean. The Musquodoboit River is a popular recreational destination for fishing, canoeing and kayaking. As well, there are several farming and residential properties with direct access to the receiver.

An assimilative capacity assessment of the Musquodoboit River would need to be completed to confirm future treatment requirements.

4.2 Site Constraints

There is very limited space available for expansion within the existing fence line of the Middle Musquodoboit WWTF; however, a small expansion may be possible.

Lands adjacent to the existing Middle Musquodoboit WWTF are mainly farming properties and wooded areas. Expansion and/or construction of a new treatment facility onto these adjacent properties may be possible.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Middle Musquodoboit WWTF:

- Historically, the Middle Musquodoboit WWTF has produced good quality effluent with respect to $cBOD_5$, TSS and fecal coliforms. Effluent requirements for these parameters have been consistently met.
- Currently, there are no TP effluent limits for the Middle Musquodoboit WWTF, but the historical effluent TP concentration averaged about 2.6 mg/L.
- Based on the results of a desk-top preliminary capacity assessment, the existing Middle Musquodoboit WWTF has estimated capacities as follows:
  - Average day flow capacity: 275 m3/d; and
  - Peak flow capacity: 300 m3/d.
- According to operations staff, the flow equalization tank is undersized for the WWTF. Resulting high influent flows from wet weather events cause a wash out of the FOG from the oil trap compartment over the wet well separation wall weir and into the operating compartment, transferring additional solids throughout the entire plant.
- Algae blooms develop in the polishing pond every spring, impacting effluent quality.
- Muskrats have undermined the polishing pond berms and have made nests in the secondary clarifiers.
- There is limited room available for a small expansion within the existing fenced area of the Middle Musquodoboit WWTF. Expansion of the treatment facility onto adjacent wooded lots and farming properties may be possible.
- The existing receiver, the Musquodoboit River, requires an assimilative capacity assessment to be completed in order to confirm future treatment requirements.

6. REFERENCES

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

APPENDIX A

SITE VISIT PHOTOS

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Photo 13 Trojan UV Disinfection System

Photo 14 Middle Musquodoboit Overflow Pipe

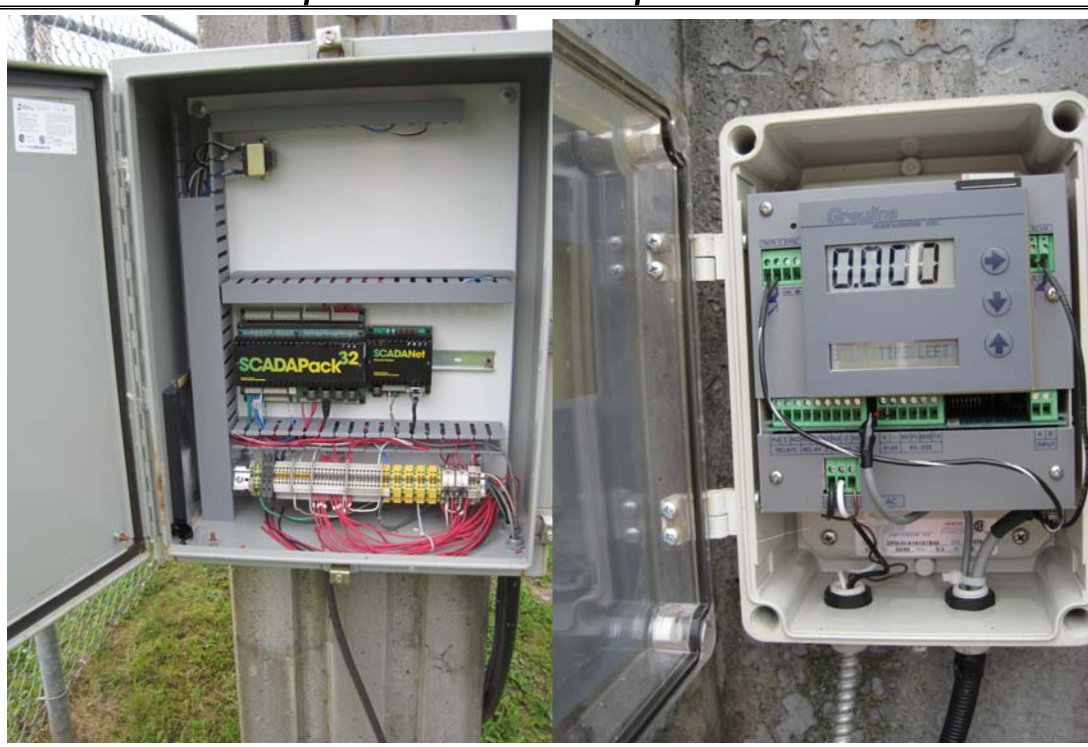

Photo 15 SCADA System panels

VOLUME 3 – APPENDIX B-15

Eastern Passage WWTF

APPENDIX - WORKING PAPER NO. 1.3
EASTERN PASSAGE WWTF
HALIFAX WATER INTEGRATED RESOURCE PLAN - BASELINE REVIEW

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1. INTRODUCTION

1.1 Background and Objectives

Halifax Water presently owns and operates fifteen wastewater treatment facilities (WWTFs). This appendix to Working Paper No. 1.3 is one of a series of baseline reports documenting the current status of the Eastern Passage WWTF.

The specific objectives of this Working Paper appendix are to:

- Compile, review and summarize relevant information available regarding the design and current performance of the Eastern Passage WWTF;
- Identify any data gaps and, where applicable, recommend additional monitoring and/or data collection;
- Assess current operating performance in terms meeting the existing required level of service and identify any existing capacity and performance limiting factors.

1.2 Data Sources

The following data sources were used in the baseline review:

- A site visit completed on July 6, 2011;
- Google Earth images and tools to determine estimates of existing tank dimensions;
- Joint Certificate of Approval for the Eastern Passage Pollution Control Plant, Nova Scotia Department of the Environment, 1987 (see Appendix A); and
- Operating data from WaterTrax over the period January 2010 to July 2011.

2. EXISTING CONDITIONS

2.1 Treatment and Service Area Overview

The Eastern Passage WWTF was constructed in 1974 and expanded in 1987, and consists of coarse screening, grit removal, primary clarification, and chlorination. The existing WWTF is due for replacement in 2011 or 2012, and will incorporate retrofitting and/or replacing many of the processes. The primary treatment plant was designed to treat a design average day flow (ADF) of 17,730 m^3/d and a peak flow of 45,500 m^3/d. Currently, the ADF is about 15,200 m^3/d. The effluent from the plant discharges to Halifax Harbour.

Waste sludge is collected and removed, using chain and flight mechanisms from the primary clarification tanks, and this sludge is then pumped to the on-site primary digester. The digested biosolids are then sent to the secondary digester for storage, and supernatant is removed from the secondary digester and returned downstream of the Parshall flume. Every week, approximately 55 m^3 of biosolids from the anaerobic digesters are trucked to the AeroTech WWTF for dewatering and further treatment.

The WWTF serves the geographical area of Cole Harbour, Eastern Passage, and Shearwater. The Eastern Passage WWTF receives wastewater from a variety of different sources including: residential sources, a fire station, a defense airport, an autoport, automotive garages, a salvage yard and several restaurants.

Figure 2.1 shows an aerial view of the Eastern Passage WWTF site.

Figure 2.1 Eastern Passage WWTF - Aerial View

2.2 Existing Facilities

Wastewater from the Cole Harbour, Eastern Passage, and Shearwater communities is gravity fed to the Eastern Passage WWTF where it is pumped to the headworks. The wastewater then passes through an automatic coarse bar screen. Following screening, the wastewater flows to the aerated grit removal system.

Following preliminary treatment, the screened and degritted wastewater is directed to five primary clarifiers that operate in parallel. Primary sludge and scum removed from the primary clarifiers is wasted to the primary digester located on-site. The primary digested biosolids are then sent to the secondary digester for thickening and storage. The supernatant from the secondary digester is returned downstream of the Parshall flume. The biosolids from the anaerobic digesters are then trucked to the AeroTech WWTF facility for further processing.

From the primary clarifiers, the primary effluent flows to a chlorine contact tank. Chlorine gas is used as a disinfectant. The WWTF currently has a two stage chlorine disinfection process involving a circular and a rectangular chlorine contact chamber that operate in series.

Following chlorine disinfection, the wastewater gravity flows to the outfall, and the effluent is discharged into Halifax Harbour.

Figure 2.2 presents a process flow diagram of the Eastern Passage WWTF.

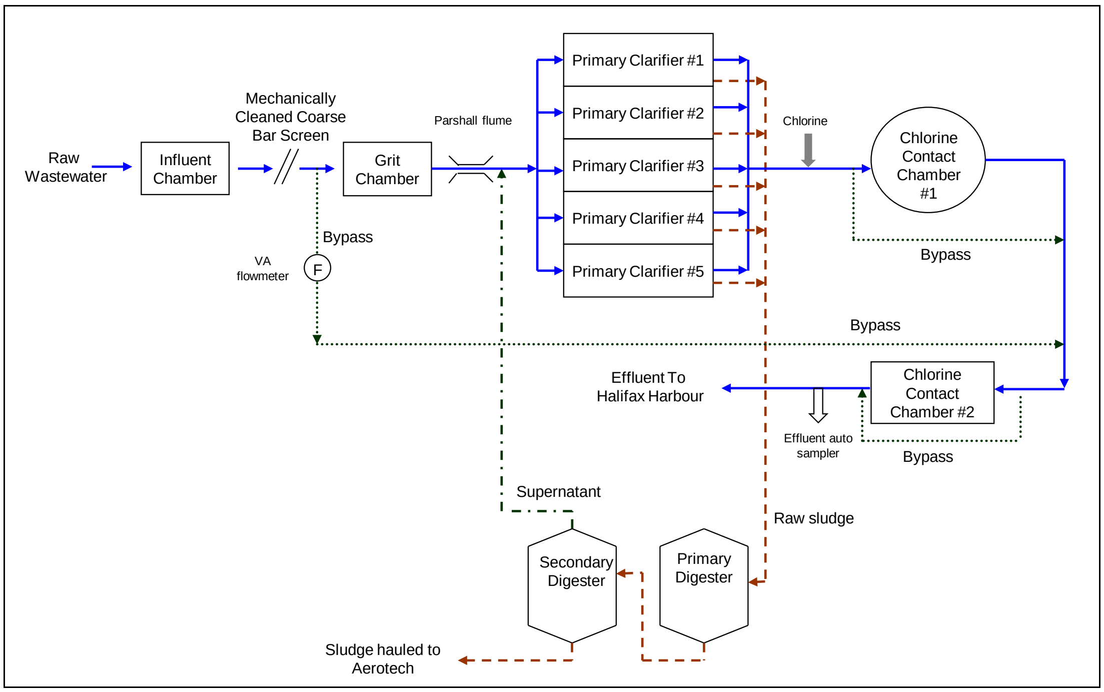

Figure 2.2 Process Flow Diagram of Eastern Passage WWTF

2.3 Current Compliance Requirements

The quality and quantity of effluent discharged by the Eastern Passage WWTF is regulated by effluent criteria as recorded in WaterTrax.

Table 2.1 presents the effluent requirements based on the Permit to Operate (PTO), WaterTrax requirements, and the Atlantic Canada Wastewater Guidelines Manual (Environment Canada, 2006). Because the PTO includes no effluent requirements, the current treatment requirements were based on the the treatment standards as recorded in WaterTrax.

Table 2.1 Eastern Passage WWTF Effluent Requirements

Parameter	Effluent Requirements			
	Permit to Operate	WaterTrax Criteria	Atlantic Canada Guidelines	Current Required Level of Service
BOD_5 Removal (%)	-	40	-	40
TSS Removal (%)	-	50	-	50
Fecal coliforms (individual sample, MPN/100 mL)	-	2,000	200	2,000
Fecal coliforms (geomean, MPN/100 mL) (1)	-	4,000	-	4,000

Notes:

n/a – not applicable

BOD_5 –biochemical oxygen demand

TSS – total suspended solids

1. Based on a geometric mean of all samples in the quarterly monitoring period.

The current treatment requirements for the Eastern Passage WWTF are consistent with those for a primary treatment facility.

3. HISTORIC PLANT PERFORMANCE

3.1 Historic Raw Wastewater Characteristics

Historic raw wastewater characteristics over the review period (January 2010 to July 2011) are summarized in Table 3.1. Raw wastewater quality data are based on composite samples from the influent wastewater following coarse bar screening.

Table 3.1 Eastern Passage WWTF Raw Wastewater Characteristics

Parameters	Average Concentration (mg/L)	Typical Raw Domestic Wastewater Concentrations (mg/L)	
		Environment Canada, 2006	Metcalf & Eddy, 2003 (1)
BOD_5	119	170	110 (low) 190 (med) 350 (high)
TSS	191	200	120 (low) 210 (med) 400 (high)
TP	n/d	7	4 (low) 7 (med) 12 (high)
TKN	n/d	25	20 (low) 40 (med) 70 (high)

Notes:

n/d - data not available

n/a – not applicable

TKN – total Kjeldahl nitrogen

1. The "low", "med", and "high" refer to low, medium, and high strength wastewaters. Low strength wastewaters based on approximate flowrate of 750 L/capita/d, medium strength on 460 L/capita/d, and high strength on 240 L/capita/d.

The raw wastewater quality is low strength with respect to BOD_5 and medium strength with respect to TSS. Raw wastewater is not analyzed for TKN or TP. It is recommended that samples be analyzed for these parameters.

3.2 Historic Flows and Effluent Quality

The flow and effluent quality data for the review period (January 2010 to July 2011) are summarized in Table 3.2. Effluent quality data are based on composite and grab samples from the effluent following chlorination.

Table 3.2 Eastern Passage WWTF Effluent Flow and Quality Data

Parameter	2010	2011	Current Effluent Requirements (Level of Service)
ADF (m^3/d) (1, 3)	13,633	12,550	-
MDF (m^3/d) (1)	44,547	37,173	-
$cBOD_5$ (mg/L)	82.7	77.0	-
TSS (mg/L)	58.6	59.7	-
TP (mg/L)	3.1	3.6	-
TAN (mg/L)	16.0	19.1	-
Fecal coliforms (MPN/100 mL) (2)	262.9	474.5	4,000

Notes:

ADF – average day flow

MDF – maximum day flow

1. Flow data were only available over the period from January 2010 to March 2011.
2. Average fecal coliform values reported are annual geometric means.
3. Design ADF capacity is 17,730 m^3/d.

Compliance with respect to the current effluent requirements was determined based on meeting the target parameter concentration / removal rate on at least 80 percent of quarterly sample results (for quarterly treatment requirements) and not exceeding twice the target parameter concentrations in any individual grab sample (for individual sample treatment requirements). An analysis of the effluent quality data was conducted to determine compliance with respect to the current effluent requirements, and the results are presented in Table 3.3.

Table 3.3 Eastern Passage WWTF Compliance with Treatment Requirements (January 2010 to July 2011)

Parameter	Quarterly Treatment Requirements - Compliance Frequency Achieved	Individual Sample Requirements - Compliance Frequency Achieved
BOD_5 Removal	3 in compliance / 6 total	n/a
TSS Removal	5 in compliance / 6 total	n/a
Fecal coliforms	3 in compliance / 4 total	168 in compliance / 211 total
Fecal coliforms (geomean)	6 in compliance / 6 total	n/a

Historically, the Eastern Passage WWTF has performed well in terms of TSS removal, fecal coliforms and fecal coliform geomean, meeting quarterly treatment targets for each of these parameters in 83, 75 and 100 percent of quarters, respectively. Individual samples for fecal coliforms were compliant 80 percent of the time.

Effluent BOD_5 removal frequently did not meet the set HW compliance limits with only 50 percent of the quarterly samples in compliance, respectively.

3.3 Hydraulic Bottlenecks and Historic Plant Bypass Events

The Eastern Passage WWTF can be bypassed in the event of a failure or if maintenance is required. The main bypass is located following the automatic coarse bar screen, and flows to the inlet channel of the second chlorine contact chamber. The flow can then be bypassed further around the second chlorine contact tank and directly to the outfall to the Halifax Harbour. The plant is also designed to be able to bypass the automatic coarse bar screen with gates; however, these gates have seized and are no longer operable. The facility also has the ability to bypass the first chlorine contact chamber, if needed.

The Eastern Passage WWTF bypasses the primary clarifiers on a frequent basis, usually having at least one bypass event occur each month. From January to October 2010, 46 bypass events occurred. From January to July 2011, 35 bypass events occurred. These events ranged from very small bypass volumes (<1,000 m^3), to large bypass volumes (>20,000 m^3).

Operations staff noted that hydraulic limitations of the bypass channels have led to back-ups through the treatment process, resulting in flooding of tanks and the grassy area around the chlorine contact tanks.

Operations staff also indicate that flow splits between the five primary clarifiers are uneven. The inlet gates to each primary clarifier have been adjusted to try to equalize flows, however operations staff indicate that the first two tanks still have more scum and sludge accumulation than the other three primary clarification tanks, due to unequal flows.

3.4 Design, Operational and Condition Issues

Due to the age of the Eastern Passage WWTF, and the fact that flows are nearing the design capacity of the plant, the facility has a variety of operational and condition issues. An upgrade and expansion to the Eastern Passage WWTF is planned for the near future. As a result, only a few key concerns are summarized below.

Operations staff indicate that high levels of H_2S are an issue in the headworks building. It is understood that Bioxide may be added to the upstream pumping stations to try to reduce the H_2S in the raw wastewater.

Three small portable generators are available to operate the lights and power outlets in the headworks building; however, this power is not enough to operate any of the main process equipment, such as digester mixing, pumping, sludge collection mechanisms, and disinfection.

Despite the best efforts of the operational staff, the effluent from the WWTF has difficulty meeting the 40 percent BOD reduction compliance target. Plant operators take a sample every day to analyze the BOD reduction, and these results vary significantly from day to day. On some days, effluent BOD concentrations are higher than influent concentrations (negative reduction), while on other days the percent removals are higher than 50 percent.

Cracks were noted in the basement of the main headworks building, and a structural repair company has repaired the wall. All of the existing infrastructure should be closely examined prior to design and construction of the replacement facility, in order to determine if any of the infrastructure can be retrofitted or re-used, and if any of the infrastructure will need to be decommissioned.

3.5 Preliminary Assessment of Existing Treatment Capacity

The design rated average capacity of the Eastern Passage WWTF is 17,730 m^3/d. The historic January 2009 to March 2011 average day flow to the Eastern Passage WWTF was 15,144 m^3/d, or approximately 85 percent of the design rated capacity. The design rated peak capacity of the Eastern Passage WWTF is 45,500 m^3/d. The Eastern Passage WWTF has reached maximum day flows as high as 53,636 m^3/d, or approximately 118 percent of the design rated capacity.

The Eastern Passage WWTF is quickly approaching its average design rated capacity, and has already exceeded its peak design rated capacity. It is struggling to achieve some of the HW in-house treatment standards, particularly BOD_5 removal.

A preliminary desktop capacity assessment was completed to estimate the potential treatment capacity of the Eastern Passage WWTF liquid treatment train. Based on primary clarifiers with a total surface area of approximately 600 m^2, typical raw wastewater quality and process optimization through the addition of a coagulant and/or polymer upstream of the primary clarifiers, the estimated average day capacity of the Eastern Passage WWTF is 17,700 m^3/d. The peak capacity of the Eastern Passage WWTF is estimated to be 60,000 m^3/d. It should be noted that the Eastern Passage WWTF does not currently operate with chemical addition upstream of the clarifiers and, as such, the capacities of the existing, un-optimized process are less than the estimated capacities noted above.

4. FUTURE CONSTRAINTS

4.1 Assimilative Capacity Requirements

The existing receiver is Halifax Harbour on the Atlantic Ocean. The effluent is discharged approximately 200 metres off-shore. An assimilative capacity study of the effluent receiver would be required to determine future treatment requirements.

4.2 Site Constraints

There is room available for expansion within the existing fenced area of the Eastern Passage WWTF . The Halifax Regional Municipality (HRM) recently acquired property adjacent to the existing WWTF to accommodate the planned expansion of the Eastern Passage WWTF.

5. SUMMARY AND CONCLUSIONS

Based on the above review, the following conclusions can be made regarding the Eastern Passage WWTF:

- Historically, the Eastern Passage WWTF has performed well in terms of effluent TSS removal, fecal coliforms and fecal coliform geomean, consistently meeting the HW compliance limits.
- Effluent BOD_5 removal has not consistently met effluent requirements.
- The Eastern Passage WWTF receives raw wastewater from a variety of contributors including: an airport, garages, restaurants, a salvage yard and domestic wastewater.
- The facility operators report hydraulic capacity limitations in bypass piping, resulting in overflow of process tankage.
- The Eastern Passage WWTF experiences uneven flow splitting conditions to the primary tanks.
- Based on the results of a desk-top preliminary capacity assessment, the Eastern Passage WWTF, if optimized to provide chemical addition upstream of the primary clarifiers, has estimated capacities as follows:
  - Average day flow capacity: 17,700 m^3/d; and
  - Peak flow capacity: 60,000 m^3/d.
- There is room available for expansion within the existing fenced area of the Eastern Passage WWTF. The Halifax Regional Municipality (HRM) recently acquired property adjacent to the existing WWTF to accommodate the planned expansion of the Eastern Passage WWTF.

6. REFERENCES

Environment Canada (2006). Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal.

Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse. 4th Ed.

APPENDIX A

PERMIT TO OPERATE

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

AND

DEPARTMENT OF PUBLIC HEALTH

Joint Certificate of Approval

for

Municipal Water and Sewage Services

MUNICIPALITY OF THE COUNTY OF HALIFAX

(Municipality or Owner)

File No.: 12-87-0008-02.2

Approval No.: 87-6

Project Description: County of Halifax, Eastern Passage Pollution Control Pla expansion. Design by Porter Dillon Ltd. Project No. 2126, drawing Nc P1 to P17, S1 to S16, A1 to A8, I1 to I20, R1 to R-8 dated Jan., 1987.

Total Estimated Cost: $3,329,000.00

Stipulation: Secondary treatment to be added when required, to improve receiving water quality.

RECOMMENDED

REGISTERED PROVINCIAL ENGINEER
R. GRIFFIN
PROVINCE OF NOVA SCOTIA

Department of the Environment

APPROVED

Minister of the Environment

APPENDIX B
SITE VISIT PHOTOS

Photo 1 Eastern Passage Site Layout – Aerial View

Photo 2 Eastern Passage Site

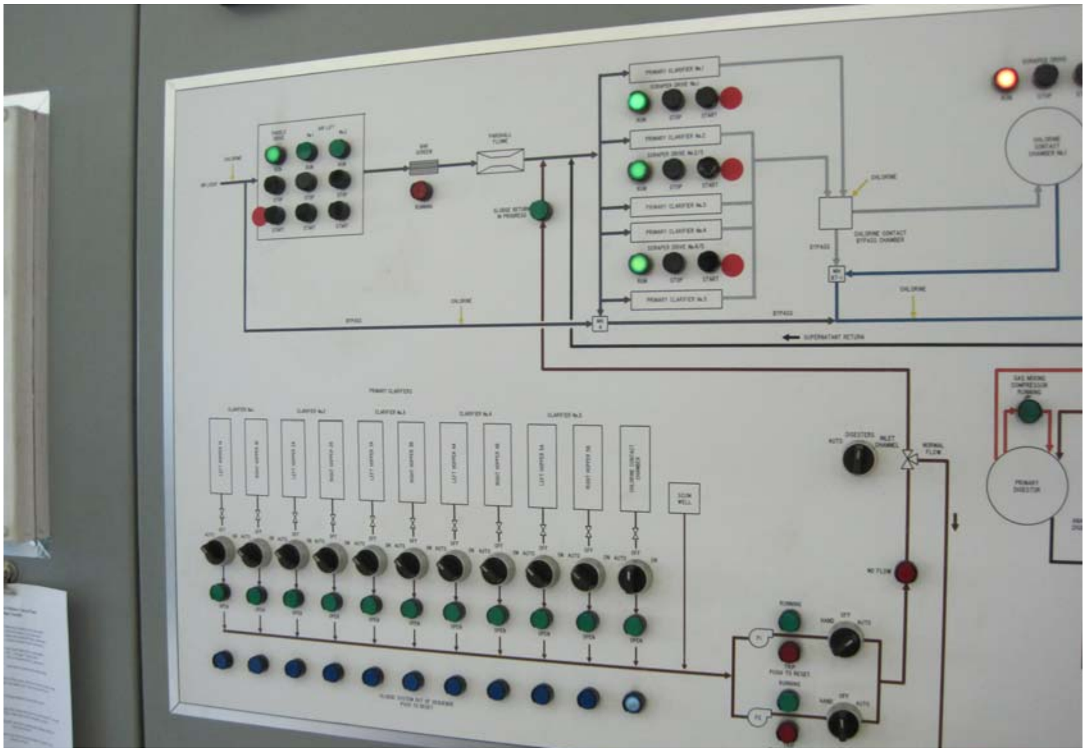

Photo 3 Eastern Passage Site Operating Control Board

Photo 4 Eastern Passage Flow Tracking Panel

Photo 5 Eastern Passage Operator Control Panel

Photo 6 Eastern Passage Flow Meter Display

Photo 7 Eastern Passage H_2S Monitor

Photo 8 Eastern Passage H_2S Meter

Photo 9 Eastern Passage Coarse Bar Screen

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Photo 15 Eastern Passage Flow Covered Primary Clarifier Influent Channel

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Photo 21 Eastern Passage Circular Chlorine Contact Chamber

Photo 22 Eastern Passage Effluent from 1st Stage of Chlorination

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Photo 38 Eastern Passage Sludge Pumps

Photo 39 Eastern Passage Area Available for Expansion in Existing Fenced Area

Photo 4 Receiver – Halifax Harbour

VOLUME 3 – APPENDIX B-16

WWTF Growth and Expansion Costs

XCG CONSULTANTS LTD.
T 905 829 8880 F 905 829 8890 | toronto@xcg.com
2620 Bristol Circle, Suite 300, Oakville, Ontario, Canada L6H 6Z7

Date: May 9, 2012 **XCG File No.: 3-026-42-01**

To: Val Williams, Halifax Water

From: Melody Johnson and George Zukovs

Re: Summary of Methodology Used to Develop Capacity Increase Requirements and WWTF Expansion Costs as Part of the IRP

This memorandum summarizes the approach used for the development of capacity increase requirements and wastewater treatment facility (WWTF) expansion costs as part of the Halifax Water Integrated Resource Plan (IRP).

1. *PROJECTED CAPACITY INCREASES REQUIRED DUE TO GROWTH*

The collection system model developed and calibrated as part of the Regional Wastewater Functional Plan (RWWFP) was used to estimate both existing (historic, based on 2003 operating data) and model predicted future (2046) average flows to each facility. The difference between these flow values was then used as an estimate of the increase in flows anticipated in each WWTF's service area due to growth ("Modelled RWWFP Flow Increase").

The projected increases in flows, based on the RWWFP model, were then added to the baseline flows developed as part of the IRP ("Existing Observed Flows"), which were based on historic average raw wastewater flow data recorded at each WWTF over the period January 2010 to July 2011, yielding an estimate of future (2046) flows at each WWTF.

This estimated future (2046) flow value was then compared to the existing Permit to Operate (PtO) rated capacity for each facility. If the future (2046) projected flow was higher than the existing PtO rated capacity, it was determined that expansion of the existing WWTF would be required to bring the facility's capacity up to the projected future (2046) average flow value.

A summary of the growth expansion requirements for various WWTFs is presented in Table 1. For those WWTFs not shown in Table 1, it was determined that no expansion would be required to accommodate growth in the service area.

Table 1 Summary of WWTF Expansion Requirements

WWTF	PTO Capacity (ML/d)	Existing Observed Flow (ML/d)	Modelled RWWFP Flow Increase (ML/d)	Future (2046) Design Flow (ML/d)	Capacity Increase Required (ML/d)
Halifax	133.92	97.7	19.48	117.18	No Expansion
Dartmouth	83.8	54.5	45.36	99.86	16.06
Eastern Passage	25	15.2	5.3	20.5	No Expansion
Herring Cove	28.5	12.5	69.55	82.05	53.55
Mill Cove	28.4	22.2	2.0	24.2	No Expansion
AeroTech	1.4	1.17	6.48	7.65	6.25

2. DEVELOPMENT OF WWTF EXPANSION COSTS

The IRP utilized cost curves developed from recent studies to estimate construction costs. These cost curves are based on providing standard primary treatment (screening, degritting, primary sedimentation, disinfection) and secondary treatment (screening, degritting, primary sedimentation, biological treatment, secondary clarification, and disinfection).

A cost curve to add nitrification to a secondary treatment system was also included where appropriate. Modifications to the cost curves for small treatment facilities (up to 1 ML/D capacity) were made based on experience elsewhere. Allowances, based on experience elsewhere, were also made for the cost associated with sludge storage (estimated to be 5 percent of the equivalent secondary WWTF construction cost) and sludge digestion (estimated to be 15 percent of the equivalent secondary WWTF construction cost). In addition, if the cost curves included a built-in project multiplier, a separate "adjustment factor" was applied to result in a predicted construction cost (not project cost). Engineering News-Record (ENR) construction cost index (CCI) values were used to develop a "CCI Factor" scale these cost curve estimates to 2012 dollars.

Table 2 presents a summary of the cost curves utilized in the IRP.

Table 2 Cost Curves Utilized in the IRP

Cost Curve	Equation (where "x" is the capacity in m^3/d)	Adjustment Factor	CCI Factor	Comments
Primary WWTF without sludge handling	$3414.6x^{0.8529}$	1	1.24	-
Secondary WWTF without sludge handling	$-0.0009x^2+1391.2x+3e+06$	1	1.24	Facilities > 1 ML/D
	$0.75(-0.0009x^2+1391.2x+3e+06)$	1	1.24	Facilities 0.5 to 1.0 ML/D
	$0.6(-0.034x^2+1789.35x+2551843.5)$	0.7519	1.319	Facilities up to 0.5 ML/D
Addition of Nitrification to a Secondary WWTF	$-0.0000052x^2+67.66x+94324$	0.7519	1.319	-

References / Notes:

Construction costs, in 2012 dollars, were developed by computing:

Construction Cost = (the cost as per the applicable equation)*(adjustment factor)*(CCI Factor)

Construction costs associated with sludge storage / sludge digestion were developed by computing:

Sludge Storage Cost = (Construction Cost for Secondary WWTF of equivalent ADF treatment capacity)*1.05

Sludge Digestion Cost = (Construction Cost for Secondary WWTF of equivalent ADF treatment capacity)*1.15

Project costs were then computed as follows:

Project Cost = (Total Construction Cost)*1.6

Primary WWTF and secondary WWTF > 1 ML/D cost curves from Burnside (2005). Secondary WWTF cost curve for facilities from 0.5 to 1.0 ML/D modified from Burnside (2005).

Secondary WWTF cost curve for facilities up to 0.5 ML/D modified from Hydromantis et al. (2004). Addition of nitrification to a secondary WWTF cost curve from Hydromantis et al. (2004).

Burnside (2005). Water and Wastewater Asset Cost Study - Ministry of Public Infrastructure Renewal.

Hydromantis, XCG and Enviromega (2004). Available Technology and Implementation Costs to Meet Selected Effluent Criteria for Municipal Sewage Treatment Plants.

The cost curves presented in Table 2 result in unit cost ranges as follows:

- For Primary WWTFs:
  - From $1,197/ML/D (for a 10 ML/D plant) to $813K/ML/D (for a 150 ML/D plant) for plants providing sludge storage only; and
  - From $1,406K/ML/D (for a 10 ML/D plant) to $971K/ML/D (for a 150 ML/D plant) for plants providing sludge digestion.
- For Secondary WWTFs:
  - From $17,060K/ML/D (for a 0.1 ML/D plant) to $1,662K/ML/D (for a 150 ML/D plant) for plants providing sludge storage only; and
  - From $19,690K/ML/D (for a 0.1 ML/D plant) to $1,887K/ML/D (for a 150 ML/D plant) for plants providing sludge digestion.

The cost curves presented in Table 2 were utilized to develop cost estimates for the construction of new treatment facilities (primary and secondary) over a range of treatment plant capacities. These estimates were construction costs only (ie - no project multiplier was applied to any construction cost estimate developed), and are presented graphically in Figures 1 to 3.

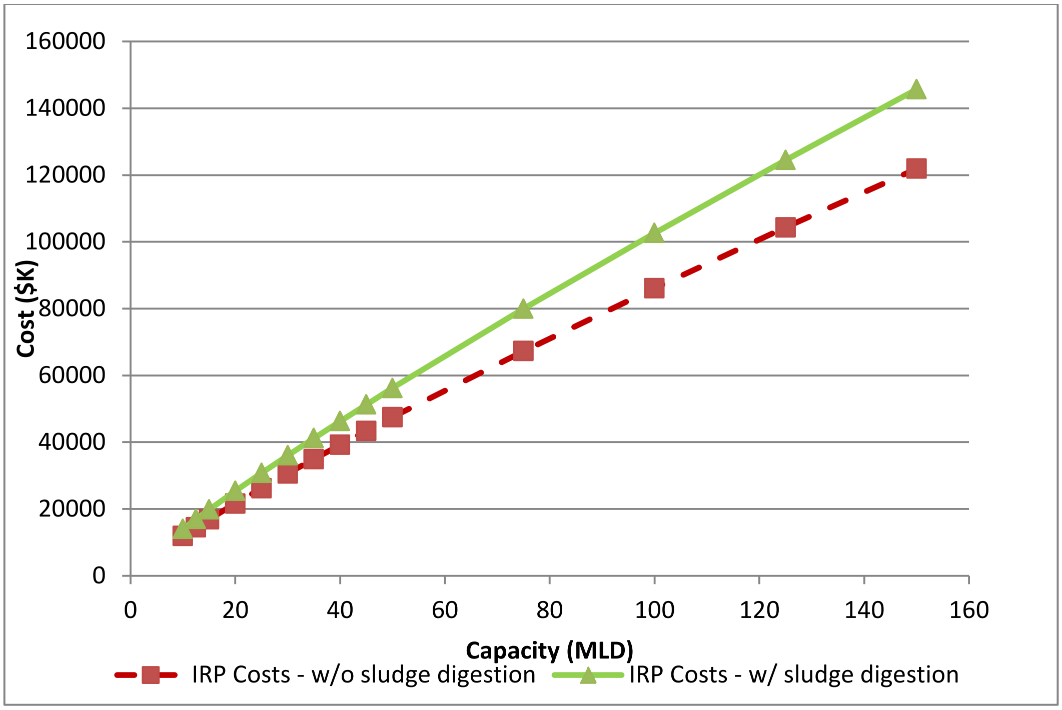

Figure 1 Estimated Construction Costs for a New Primary WWTF

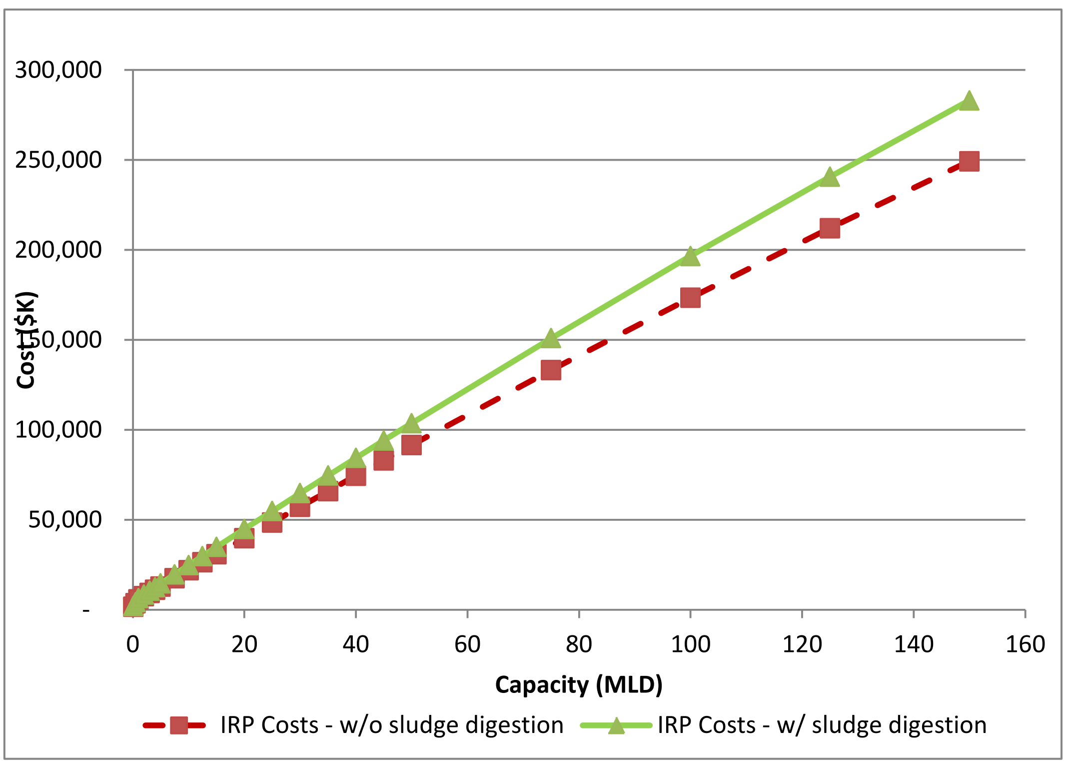

Figure 2 Estimated Construction Costs for a New Secondary WWTF

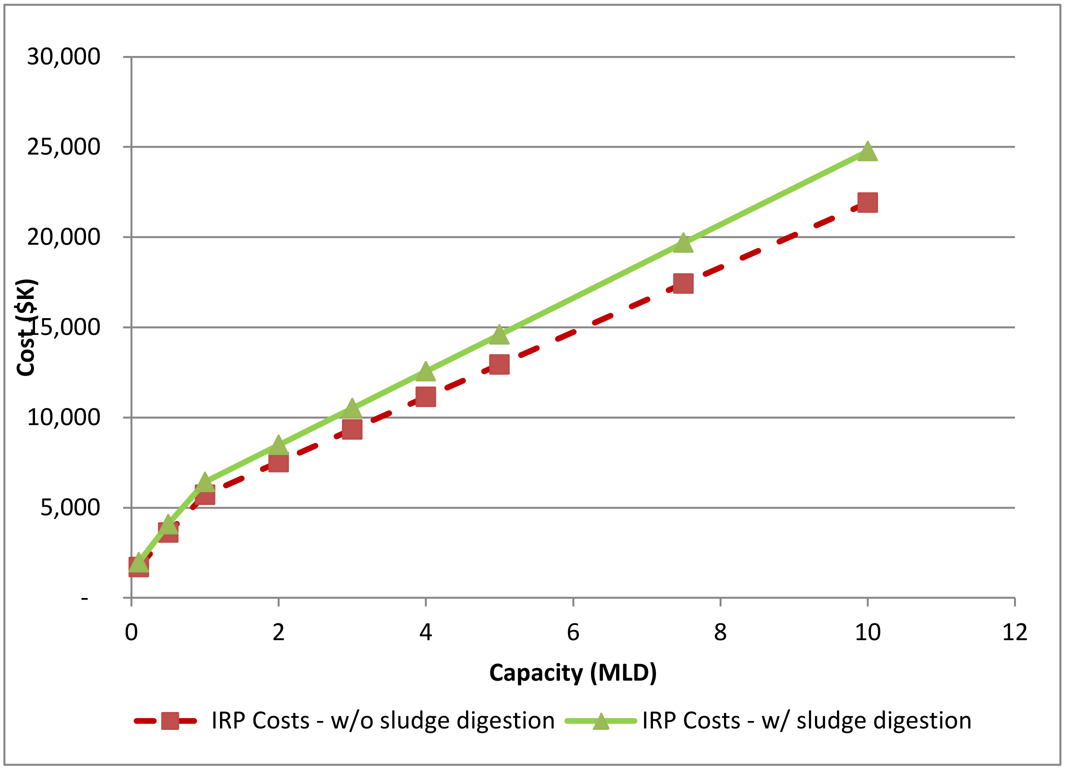

Figure 3 ***Estimated Construction Costs for a New Secondary WWTF - 0.1 to 10 ML/D Capacity Range***

When developing replacement costs for treatment facilities, the applicable cost curve(s), along with the design capacity of the treatment facility, were used to estimate the construction cost. For tertiary treatment facilities, cost curve(s) associated with secondary WWTFs were used, and allowances were included for additional infrastructure associated with the tertiary treatment system. To estimate the construction costs associated with providing a new Biological Aerated Filter (BAF) system at the Harbour Solutions facilities, a unit cost of $728K per ML/d of capacity was used, based on experience for the construction of new BAF treatment trains to upgrade primary treatment facilities elsewhere.

When developing cost estimates for the construction of new treatment facilities (such as the new Wellington WWTF to replace the existing facility), the applicable cost curve(s), along with the design capacity of the treatment facility, were used to estimate the construction cost.

In the case of estimating the construction costs associated with expanding the capacity of an existing treatment facility, the following approach was used:

- The replacement cost of the existing facility (at the current PtO rated capacity) was estimated based on the applicable cost curve(s);
- The cost to construct a new treatment facility at the future projected (2046) design capacity was estimated based on the applicable cost curve(s);
- The estimated construction cost associated with expanding the treatment facility to accommodate growth was determined by subtracting the estimated facility replacement cost from the cost to construct a new facility at the projected future (2046) rated capacity; and
- The construction cost was scaled to project cost using the agreed to 1.6 multiplier.

3. SUMMARY OF CONSTRUCTION AND PROJECT COSTS DUE TO GROWTH

For all facilities requiring expansion, Table 3 presents the projected capacity increase requirements, as well as the associated estimated construction and project costs.

Table 3 Summary of Construction and Project Costs Due to Growth

WWTF	Existing PTO Capacity (ML/d)	Capacity Increase Required (ML/d)	Future (2046) Design Capacity (ML/d)	Estimated Construction Cost (2012 dollars)	Estimated Project Cost (2012 dollars)
Dartmouth	83.8	16.06	99.86	$24.5M	$39.2M
Herring Cove	28.5	53.55	82.05	$84.9M	$135.8M
AeroTech	1.4	6.25	7.65	$13.6M	$21.8M

HALIFAX WATER
INTEGRATED RESOURCE PLAN
VOLUME 3 APPENDIX C
COSTING PROCEDURES TECHNICAL MEMORANDUM
(COST ESTIMATION AND UNIT COSTS)

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Tables

1. PURPOSE

The purpose of this Appendix is to present the details used for the asset renewal models. The unit rates (e.g. cost per meter of pipe), asset life data, and other aspects of the project costing procedures for the water, wastewater, and stormwater systems are presented in this section.

2. COSTING

Unit rates for the IRP were developed by the consultants and Halifax Water Staff. The costs are based on 2012 Canadian dollars. An on-cost multiplier of 1.6 was used on top of the estimated construction cost. The on-cost multiplier accounts for overhead, contingencies, HST, and interest. A detailed breakdown of components is provided in Table 2.1.

Table 2.1 Halifax Water IRP On-Cost and Overhead Calculation (V3)

	Component of On-Cost		Percentage of Construction Costs (%)	Comments
1	Construction cost	1.00		Ensure base construction cost **DOES NOT** also contain a contingency amount; this is covered under line 7 below.
2	Engineering/Design - includes planning, pre-design, detailed design, training, commissioning - excludes construction management/ contract administration	0.10	10% of construction cost	Could range from 5% to 15% depending on the project; assume 10% as average
3	Professional Fees - includes legal, survey, testing, flow monitoring, etc.	0.01	1% of construction cost	
4	Construction Management/Contract Administration	0.10	10% of construction cost	Could range from 5% to 15% depending on the project; assume 10% as average
5	Labour/Wages (internal staff time charged to project) - engineering, CAD, site inspection	0.02	2% of construction cost	Where project undertaken in-house (water + limited WW/SW projects), may be a higher % however, the contract admin and engineering/ design % would then be lower.
6	**Subtotal 1**	**1.23**		

Table 2.1 Halifax Water IRP On-Cost and Overhead Calculation (V3)

	Component of On-Cost		Percentage of Construction Costs (%)	Comments
7	Contingency	0.25	20% x "Subtotal 1" value	Could range from 10% to 40%; for IRP (planning level) use 20% x "Subtotal 1" value
8	**Subtotal 2**	**1.48**		
9	Net HST (4.286%)	0.06	Charged on "Subtotal 2" value	
10	**Subtotal 3**	**1.54**		
11	Interest & Overhead (4%)	0.06	Charged on "Subtotal 2" value	
12	**TOTAL**	**1.60**		

3. ASSET RENEWAL UNIT RATES

This section will break down each of infrastructure system (Water, Wastewater, and Stormwater) and further to each asset class to the assumptions that were made for the unit costs. The asset service life estimates (design life) were based on best industry practices. For the complex point assets such as pump stations and treatment facilities separate service life estimates were broken down to civil (structural), mechanical-electrical (M&E), and instrumentation and control (ICA). A fraction of the total asset value was assigned to each component.

For purposes of the asset renewal modelling the civil-structural components of complex assets such as pump stations and treatment plants were considered to be presently in new condition. Considering the 50-year life of the components this did not figure in the asset renewal requirements over the 30-year IRP planning period. Halifax Water staff reviewed the status of the M&E and ICA systems of major water and wastewater treatment facilities and provided specific estimates of current asset age. The current asset age was used as the starting point for the modelling of the point assets.

- Point assets such as concrete/steel reservoirs or dams were not modelled but rather subjected to individual analysis to estimate required renewal over the 30-year period. These were high-level estimates.

3.1 WATER

The unit rates for each linear asset (distribution and transmission mains) and point asset (meters, PRVs, valves, water pumping stations, concrete/steel reservoir, dams, and WSP) are explained in detail in this section.

3.1.1 Distribution Mains / Transmission Mains

The service life of the distribution and transmission mains was estimated to be 75 year based on the Water Utility Accounting and Reporting handbook 3040-Depreciation. Water distribution mains include hydrants, new water meters, and service connections. The construction cost of pipe per meter was derived from HRM's 2007 Database, with additional build up and including 2% indexing per year from 2007 to 2012. The additional build up costs assume install costs are 60% of supply cost, fill is $65 per meter and excavation is $20 per m. The pipe material to be used is ductile iron (DI) unless otherwise noted. A breakdown of the unit rate according to diameter is in Table 3.1.

The total cost of the distribution/transmission system is broken down in Table 3.2 and Table 3.3.

The unit costs were used for the asset renewal models and for costing the transmission main projects related to the WaterCAD model (Volume 3 Appendix A).

Table 3.1 Unit Cost Breakdown of Distribution and Transmission Mains

Diameter (mm)	Construction Costs ($/m)	Total Unit Cost (1.6) ($/m)
200	712	1,140
250	800	1,281
300	933	1,494
350	977	1,564
400	1,021	1,635
450	1,065	1,706
500	1,110	1,776
550	1,154	1,847
600	1,198	1,918
675	1,507	2,320
750	1,595	2,528
900	1,772	2,784
1,050	2,214	3,412
1,200	2,390	3,774
1,350	2,920	4,516
1,500	3,627	5,595

Table 3.2 Size Breakdown of Distribution Mains

Breakdown of Water Distribution Mains			
Dia (mm)	**Length (km)**	**Cost Rate ($/m)**	**Total Cost ($k)**
<75	4	1,140	4,413
75	1	1,140	860
100	11	1,140	13,035
150	281	1,140	319,936
200	333	1,140	380,079
225	35	1,140	39,564
250	110	1,281	140,556
300	261	1,494	390,414
350	26	1,564	39,992
375	14	1,635	22,687
400	77	1,635	126,333
450	11	1,706	19,574
500	16	1,776	28,061
400*(Aerotech)*	7	1,635	11,510
Total (km)	**1,187**	**Total ($k)**	**1,537,014**

Table 3.3 Transmission Main Cost Summary

Total Length (km)	Replacement Cost ($)
217.1	$494,668,604

3.1.2 Meters

The service life of meter was modelled as 20 years: based on the Water Utility Accounting and Reporting Handbook 3040-Depreciation. The average instantiation unit costs for both residential and commercials meters are from Halifax Water's database. The cost of new water meters is incorporated as part of the water main unit cost. The unit cost breakdown is in Table 3.4.

The cost breakdown of meters in Halifax Water's system is in Table 3.5.

Table 3.4 Unit Cost Breakdown of Meters

	Construction Cost ($ per meter)	Total Unit Cost (1.6) ($ per meter)
Residential Meters: Average Installation Cost per Unit ($)	200	320
Commercial Meter: Average Installation Cost per Unit ($)	500	800

Table 3.5 Breakdown of Meters

	Number of Meters	Total Replacement Cost ($)
Residential	76,366	24,450,762
Commercial	4,621	3,698,864
Total	**80,987**	**28,149,626**

3.1.3 PRVs, Meter Chambers, and Control Valve Chambers

Construction costs for PRV's are based on Halifax Water's 2011 insurance costs with 2% indexing to 2012. The civil component has an expected life of 50 years; it is assumed new and thus not replaced during the IRP. No ICA component is considered. An age distribution was created and assumed PRVs were installed from 1993 onwards.

Table 3.6 and Table 3.7 show the unit rates for the PRV's and meter chambers, and control value chambers.

Meter Chambers and Control Valve chambers asset value was considered to be 100% civil, therefore since the civil structure is in relative good sharp replacement was not needed during the IRP. Table 3.8 and Table 3.9 shows the assumption for PRV's, and meter chambers and control value chambers.

Table 3.6 Unit Rate of PRV's and Meter Chambers

		Number of Locations / Location	Construction Costs ($)	Total Unit Cost(1.6) ($)
PRVs	**Small PRV**	4	54,567	87,307
	Medium PRV	66	163,702	261,923
	Large PRVs			
	Water Robie Street No. 1 PRV		1,309,619	2,095,390
	Water Rockmanor Pumping Station		545,675	873,079
	Water Titus & Evans PRV		436,540	698,463
	Chain Control PRV		327,405	523,848
	Water Sackville Drive PRV		327,405	523,848
	MacDonald Bridge PRV		272,837	436,540
	Water Robie Street No. 2 PRV		272,837	436,540
	Bluewater Road PRV		218,270	349,232
	Water Zinck Avenue PRV		218,270	349,232
	Lancaster Drive Emergency PRV		109,135	174,616
	Dunbrack St N of Main St PRV		103,938	166,301
			Total:	**24,263,247**
Meter Chambers	**New**	22	54,567	87,307
	Other Meter Chambers			
	Kearney Lake Rd Meter Chamber		109,135	174,616
	Flynn Park Meter		163,702	261,924
	Blue Mountain Meter		218,270	349,232
	Lucasville Road Meter		272,837	436,540
	Hammond Kearney Meter		763,944	1,222,311
			Total:	**4,365,380**

Table 3.7 Unit Rate of Control Value Chambers

		Number of Locations / Location	Construction Costs ($)	Total Unit Cost ($)
Control Value Chambers	**Small Values**	2 (at Aerotech)	54,567	87,307
	Other Control Value Chambers			
	Near Aerotech STP		218,270	349,232
	Hemlock Control Chamber		818,512	1,309,619
	Lyle Street Control Chamber		818,512	1,309,619
	Main No. 2 Control Chamber		654,809	1,047,695
	Main No. 1 Control Chamber		1,746,158	2,793,853
	Mount Edward Rd Control Chamber		436,540	698,463
	Orchard Control Chamber		654,809	1,047,695
	East - Topsail Drive		436,540	698,463
	Cowie Hill Road PRV		873,079	1,396,927
	Kearney Control		436,540	698,463
			Total:	**11,524,644**

Table 3.8 Asset Valve and Expected Life Assumption for Meter Chambers and Control Valve Chambers

Assumptions for Meter Chambers and Control Valve Chambers		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	100%	50

Table 3.9 Asset Valve and Expected Life Assumption for PRVs

Assumptions for PRV		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	20

Note Water Chamber, and control valves were assumed to be 100% civil components and in reasonable condition. Therefore were not replaced or modelled for the IRP.

3.1.4 Valves

The expect life of valves was modelled to be 75 years, the same as the distribution/transmission mains. Costs for valves are from the HRM database with 1.6 on cost multiplier. Costs for valves with diameters between 150 mm to 600 mm are reported. To determine the total replacement costs an average cost of $5,867 was used for the approximate 13,000 valves that Halifax Water owns and operates. Table 3.10 shows the breakdown of valves. Table 3.11 summarizes the replacement costs for the valves.

Table 3.10 Unit Rate Breakdown of Valves

Description	Construction Cost ($/valve)	Total Cost (1.6) ($/valve)
150 mm Gate Valve	1,000	1,601
200 mm Gate Valve	1,650	2,641
250 mm Gate Valve	2,500	4,002
300 mm Gate Valve	3,000	4,803
350 mm Gate Valve	3,500	5,603
400 mm Gate Valve	4,000	6,404
450 mm Gate Valve	4,500	7,204
500 mm Gate Valve	5,000	8,004
550 mm Gate Valve	5,500	8,805
600 mm Gate Valve	6,000	9,605

Table 3.11 Replacement Costs for Valves

Replacement Costs ($)	
Average Cost ($)	5,867
Number of Valves	13,027
Total Replacement Cost ($)	**76,432,974**

3.1.5 Water Pumping Stations

Construction costs per MLD are based on averaging the 2011 Halifax Water Insurance renewal values of the pumping station inventory. The 1.6 on-cost multiplier is then assed to the $/MLD. For the asset renewal models the civil structure was assumed new and thus not replaced during the IRP. M&E and ICA were replaced based on the assumptions table. Table 3.12 3.12 shows the breakdown for water pumping stations. Table 3.13 is a breakdown of cost for each water pumping station. The asset valve and expected life assumption is shown in Table 3.14.

Table 3.12 Unit Costs for Water Pumping Stations

Construction Cost per MLD ($/MLD)	Total Unit Cost (1.6)($/MLD)
150,000	240,134

Table 3.13 Costing of Each Water Pumping Station using Unit Costs

Water Pumping Station	MLD	Total Cost
Bennery Lake / Aerotech Pumping Station	27.3	6,544,844
Beaverbank Pumping Station	12.8	3,062,987
Bedford South Pumping Station	13.0	3,121,891
Bedford Village Pumping Station	17.2	4,123,252
Crestview Pumping Station	2.6	626,996
Eaglewood Pumping Station	0.1	26,179
Lively Booster Station	0.5	124,352
No. 7 Highway Pumping Station	9.5	2,290,695
Rockmanor Pumping Station	10.5	2,520,454
Silverside Pumping Station	2.1	510,498
Upper Hammonds Plains Pumping Station	2.2	523,588
Lyle Street Control Chamber	9.1	2,182,051
Mount Edward Pumping Station	19.8	4,764,647
Charles Road Pumping Station	5.2	1,236,976
Cowie Reservoir Pumping Station	9.5	2,277,606
Leiblin Pumping Station	11.3	2,701,712
Parkdale Pumping Station	7.2	1,727,839
Robie Street Emergency Pump. Station	27.3	6,544,844
St. Margarets Bay Road Pumping Station	6.5	1,570,763
Total Replacement Cost		**46,482,172**

Table 3.14 Asset Valve and Expected Life Assumption for Water Pumping Stations

Assumptions for Water Pumping Stations		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	20
ICA, Telemetry & SCADA	10%	10

Appendix 1 shows the calculations for the unit rate of water pumping stations in $ per MLD.

3.1.6 Concrete Storage Reservoirs

During the IRP, concrete storage reservoirs were replaced by a steel reservoir of the same capacity. The cost of a steel tank replacement was based on the Reed-Steel Linear regression provided by HALCROW using the current capacity of the concrete tank. The 1.6 on cost multiplier was then included. Detailed calculations for costing the new steel storage reservoirs are provided in Appendix 2.

Table 3.15 shows the projects for the replacement of concrete tank with steel tanks inputted into the financial model.

The current total replacement costs based on replacing the whole concrete structure is $53,013,000. The current total replacement cost is from Halifax Water insurance costs with 2% indexing from 2011 to 2012, and 1.6 multiplier from Halifax Water.

Table 3.15 Replacement Cost of Concrete Tanks with Steel Tanks

Concrete	Capacity ML	Replacement Year (from HW)	Replacement Steel Cost ($k)(1.6)
Mount Edward 1 Replacement with Steel Tank	22.7	2022	7,855
Cowie Hill Replacement with Steel Tank	11.4	2027	4,163
Geizer 123 Replacement with Steel Tank	31.8	2032	10,829
Lakeside/Timberlea Replacement with Steel Tank	5.4	2037	2,202
Meadowbrook Replacement with Steel Tank	9.1	2042	3,411
Middle Musquodoboit	0.3	2064	535
Robie	15.9	2060	5,633

3.1.7 Steel Storage Reservoirs

Steel water reservoirs are in reasonable shape and will not need to be fully replaced during the IRP. To extend the life of a steel reservoir, an interior coating is needed every 20 years. Based on estimates from Halifax Water a coating on a small tank with the 1.6 multiplier is $320,000. A small tank is considered a reservoir that is less than 12.2ML. Coating on a large tank with the 1.6 multiplier will cost $960,000. A large tank is considered a reservoir that is greater than 12.2ML. The cost of interior coating and replacement year for the steel storage reservoirs is shown in Table 3.16.

Table 3.17 displays the cost assumptions for the steel tanks.

The total replacement costs of the whole steel structure based on current insurance costs with a 1.6 multiplier from Halifax Water is $86,479,000.

Table 3.16 Cost of Interior Coating and Year for Steel Storage Reservoirs

Steel	Capacity ML	Install Date	Coating Year (from HW)	Size Class. Of Tank (Small or Large)	Cost per coating ($k) (1.6)
Aerotech Coating in 2014 and 2034	4.1	1986	2014, 2034	Small	320
Akerley Blvd. Coating in 2021 and 2041	37.7	1986	2021, 2041	Large	960
Beaver Bank Coating in 2027	6.9	2007	2027, 2047	Small	320
Geizer 158 Coating in 20115 and 2035	36.4	1986	2015, 2035	Large	960
Mount Edward 2 Coating in 2018 and 2033	22.7	1998	2018, 2038	Large	960
North Preston Coating in 2013 and 2033	1.6	1988	2013, 2033	Small	320
Sampson Coating in 2029.	12.2	1970	2029	Small	320
Stokil Coating in 2020 and 2040.	23.6	1991	2020, 2040	Large	960
Waverley Coating in 2019 and 2039	1.3	1982	2019, 2039	Small	320
				Total During IRP	**10,240**

Table 3.17 Cost Assumptions for Steel Reservoirs

Cost Assumption for Steel Tanks		
	Estimation from HW ($k)	**With on-cost multiple(1.6) ($k)**
Small Tank	200	320
Large Tank	600	960

Insurance costs for the steel and concrete reservoirs are located in Appendix 3.

3.1.8 Dams

The total dam cost (asset value) was calculated using the Halifax Water 2011 insurance renewal values with additional 2% indexing for 2012 and the 1.6 multiplier. The surficial concrete and mechanical renewal of the dams is to be done every 20 year at a cost of 20% of the dam's asset value. Replacement of the core dam is approximately 100 years. Exact year is determined by the staff at Halifax Water and is shown, along with the costs, in Table 3.18.

Table 3.18 Repairs/Replacement Costs and Years for Dams

Name of Dam	Type of Dam	Insurance Cost ($k)	Total Dam Cost ($k) with on cost (1.6) (asset value)	Year to Replace or Repair Dam	% of Asset Value	Cost ($k) in Financial Model
Pockwock Lake	Earth fill with clay core	4,420	7,076	2025 (repair)	20	1,415
Bayers Lake	Granular Fill with HDPE Core	2,254	3,608	2025 (repair)	20	722
Chain Lake	Gravel and loam with concrete core wall	2,701	4,324	2040 (replace)	100	4,324
Lake Lamont	Earth fill (Till)	819	1,310	2020 (repair)	20	262
Lake Major	Rocked filled Timber Crib	1,310	2,097	2017 (replace)	100	2,097
East Lake	Concrete	2,254	3,608	2020 and 2040 (repair)	20	722
		Insurance Cost with On cost	**22,023**	**Total Replaced during IRP**		**10,263**

3.1.9 Water Supply Plants

The construction costs for the WSP (Table 3.18) is from the Halifax Water 2011 insurance renewal value with additional 2% indexing for 2012. For asset renewal it was assumed that all civil components were new and did not need to be replaced during the IRP. Only the M&E and ICA were renewed. An expected life of 30 year is used for the M&E instead of 20 years, 20 years is consistent with the water/wastewater pumping stations and PRVs. The expected life of 30 years is used due to the staff at the WSP maintaining the equipment thus increasing the expected life.

Table 3.19 Cost Summary of the Water Supply Plants

Facility	Firm Capacity	Estimated Construction Cost ($k)	Total with On-Cost ($k)	Type of WSP for Asset Renewal
J.D. Kline WSP	227MLD	51,293	82,115	large
Lake Major WSP	90MLD	50,013	80,066	large
Storage Building		11	18	large
Garage		11	18	large
Bennery Lake WSP	4MLD	10,913	17,471	Aerotech
Low Lift		546	874	Aerotech
Five Island lake	25m^3/day	109	175	small
Collins park	160m^3/day	1,964	3,145	small
Middle Musquodoboit	260m^3/day	1,855	2,970	small
Silver Sands	144m^3/day	204	327	small
Miller Lake	55 m^3/day	204	327	small
Bomont	20 m^3/day	437	699	small
Chain Lake Back up Supply		273	437	small
Pumping plant (emergency)		819	1,310	small
Lake Lamont Backup Supply Plant		2,183	3,494	Small
		Total:	**193,446**	

Table 3.20 Asset Value and Expected Life Assumptions for Water Supply Plants

Assumptions for Water Supply Plants		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	30
ICA, Telemetry & SCADA	10%	10

3.2 WASTEWATER

The unit rates for each linear asset (collections and trunk sewers) and point assets (forcemains, pumping stations, and treatment facilities) are presented in this section.

3.2.1 Collections and Trunk Sewers

The expected life of the collections (sanitary) and trunk sewers were modelled to be 100 year which is consistent with best industry practices. The unit costs for the sanitary and trunk sewers used in the IRP are also used in the Regional Wastewater Functional Plan (RWWFP). The RWWFP developed the unit costs through construction industry indices and discussion with Halifax Water staff. The costs assume a 5 m gravity sewer and included wastewater manholes and service connections. Table 3.21 shows the breakdown of unit rates for collections and trunk sewers. Table 3.2 shows the breakdown of the collections sewers. The breakdown of the trunk sewers is shown in

Table 3.21 Unit Rate Breakdown of Collections and Trunk Sewers

Dia. (mm)	Unit Cost *($/m)*	Total Unit Cost (1.6)($/m)
300	783	1,253
375	840	1,345
450	895	1,432
525	954	1,528
600	1,060	1,697
675	1,312	2,101
750	1,439	2,303
825	1,505	2,409
900	1,796	2,875
975	2,642	4,229
1050	2,941	4,708
1200	3,275	5,243
1350	3,687	5,902
1500	4,119	6,595
1650	4,555	7,292
1800	5,124	8,203
2100	5,793	9,275
2400	7,457	11,938
3000	10,116	16,194

Table 3.22 Size Breakdown of Collection Sewers

Breakdown of Collections Sewers			
Dia (mm)	**Length (km)**	**Cost Rate $/m**	**Cost ($k)**
200	403	1253	504,616
250	477	1253	597,322
300	146	1253	182,402
375	97	1345	129,760
450	48	1432	68,096
525	21	1528	32,645
300	3	1253	3,886
Total Km	**1193**	**Total Cost $k**	**1,518,727**

Table 3.23 Size Breakdown of Trunk Sewers

Breakdown of Trunk Sewers			
Dia (mm)	**Length (km)**	**Cost Rate $/m**	**Cost ($k)**
600	42	1697	71,352
750	21	2303	49,193
900	44	2875	125,687
1050	10	4708	46,498
1200	16	5243	82,849
1200+	12	8830	107,849
Total Km	**145**	**Total Cost $k**	**483,428**

3.2.2 Forcemains

The design life of the forcemain is 50 years. A design life was 50 years was considered over 75 years. The deterioration of forcemains has a very high consequence and the operational regime tends to be more aggressive than other assets. The forcemain should not last longer than the civil assets (at 50 years).

The forcemain unit costs include valves and fittings. The costs are from the RWWFP, which is calculated using the recommended UR 2012$ with 40% uplift for twin installation. The breakdown of the unit costs for forcemains is shown in Table

3.24.**Error! Reference source not found.**Table 3.25 shows the breakdown of forcemains that Halifax Water owns.

Table 3.24 Unit Rate Breakdown of Forcemains

Diameter (mm)	Construction Cost ($/m)	Total Unit Cost (1.6)($/m)
150	729	1,167
200	788	1,261
250	851	1,362
300	926	1,483
350	1193	1,910
400	1414	2,263
450	1629	2,609
500	1857	2,973
600	2329	3,728
750	2499	4,000
900	2891	4,629
1050	3379	5,410
1200	3871	6,198

Table 3.25 Size Breakdown of Forcemains

Breakdown of Forcemains			
Dia	**Length km**	**Cost Rate $/m**	**Cost $k**
75	3.0	1167	3,532
100	12.1	1167	14,109
150	12.2	1167	14,191
300	16.7	1483	24,700
500	22.1	2973	65,686
1050	0.6	5410	3,029
150	23.8	520	12,367
*(Aerotech)*300	0.19	1483	282
*(Aerotech)*100	0.19	1167	222
Total km	**90.7**	**Total Cost $k**	**138,116**

3.2.3 Wastewater Pumping Stations

Wastewater pumping stations costs are based on insurance costs. The wastewater pumping stations were grouped into four (4) ranges based on building type, HP, and insurance cost. The insurance cost for an each HP range was averaged and the 1.6 on cost multiplier was added. Civil components are considered new and thus are not replaced during the IRP. **Error! Reference source not found.**Table 3.26 shows the unit rate breakdown of the wastewater pumping stations. The assumptions on asset value and expect life are shown in Table 3.27. The unit rate for wastewater pumping storage is shown in Table 3.28.

Table 3.26 Unit Rate Breakdown of Wastewater Pumping Stations

Type	Range	Number of Stations	Insurance Cost ($k)	Rounding ($k)	With On-Cost Multiplier (60%)($k)	Total Replacement Cost ($k)
Monument	< 47hp	108	214	220	352	38,016
Building	< 35hp	35	590	600	960	33,600
Building	36 to 99hp	13	1,052	1100	1,760	22,880
Building	> 100hp	13	2,332	2300	3,680	47,840
Not Under HW Ownership at this time		3			**Total**	**142,336**
	Total # of Stations	**172**				

Table 3.27 Asset Value and Expected Life Assumption for Wastewater Pumping Stations

Assumptions for WW Pumping Station		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil	40%	50
M&E	50%	20
ICA, Telemetry & SCADA	10%	10

Table 3.28 Unit Rate Assumptions for Wastewater Pumping Storage

Storage for Wastewater Pumping Stations	
In Ground Storage (from HW)	$2000 per m^3

Note: For wastewater pumping stations in the RWWFP, a set of greenfield (new) pumping stations unit rates (RWWFP Appendix E – Vertical Rate Wastewater) are used instead of the unit rates derived from existing wastewater pumping stations. The unit rates are different because the RWWFP was building new wastewater pumping station, whereas the IRP needed to determine unit rates for existing conditions for asset renewal. This information was discusses in a meeting with the RWWFP consultant team and the IRP team on Jan 31, 2012.

3.2.4 Wastewater Treatment Facility

The costs of the wastewater treatment facilities were calculated by XCG (see memo Summary of IRP Growth and Cost Estimates) through cost curves (Table 3.29). Percentage of Asset Value and expected life is shown in Table 3.30. The civil components were assumed new and thus not replaced during the IRP. Only the M&E and ICA were renewed during the IRP. An expected life of 30 years is used for the M&E, equipment instead of 20 years. 20 years is consistent with the water/wastewater pumping stations and PRVs. The expected life of 30 years is used due to the staff at the WWTP maintaining the equipment thus increasing the expected life.

Table 3.29 Cost Breakdown of the Wastewater Treatment Facilities

Facility	Estimated Construction Cost – no contingencies (2012 $)	Project Cost (2012 $, 1.6 multiplier applied to construction costs)
Halifax WWTF	121,400,000	194,240,000
Dartmouth WWTF	78,300,000	125,280,000
Herring Cove WWTF	30,900,000	49,440,000
Lockview MacPherson WWTF	3,000,000	4,800,000
Middle Musquodoboit WWTF	1,600,000	2,560,000
North Preston WWTF	4,000,000	6,400,000
Uplands Park WWTF	1,700,000	2,720,000
Wellington WWTF	1,700,000	2,720,000
Frame WWTF	1,700,000	2,720,000
Springfield Lake WWTF	3,800,000	6,080,000
Mill Cove WWTF	59,600,000	95,360,000
Eastern Passage WWTF	22,900,000	36,640,000
BLT WWTF	13,700,000	21,920,000
Aerotech WWTF	12,500,000	20,000,000
	Total	**570,880,000**

Table 3.30 Asset Value and Expected Life Assumption for Wastewater Treatment Facilities

Assumptions for WWTF		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	30
ICA, Telemetry & SCADA	10%	10

3.3 STORMWATER

This section presents the unit rate for the point assets (stormwater pipes, culverts, and stormwater structures) related to the stormwater system.

3.3.1 Stormwater Pipes

The design life of the stormwater pipes is 75 years. The construction unit costs for stormwater pipes are from the HRM's 2007 Database with build-up and 2% indexing per year from 2007 to 2012. The build-up assumes installation costs are 60% of the supply costs, fill is $183 per m, and excavation is $62 per m. For storm pipe where the diameter is unknown, a 900 mm diameter at a depth of 2.5 m is assumed. A breakdown of the unit costs for the stormwater pipes is in Table 3.31. An age breakdown of the stormwater pipes is shown in Table 3.32. The diameters of stormwater pipe are currently unknown and thus were modelled at a 900 mm diameter pipe made of concrete.

Table 3.31 Unit Rate Breakdown of Stormwater Pipes

Diameter (mm)	Storm Sewer - *PVC* *($/m)*	Storm Sewer - *Concrete 65D ($/m)*	Total Unit Cost(1.6) ($/m)
250	552	-	884
300	591	-	946
375	640	-	1,025
450	751	-	1,202
300	-	694	1,112
375	-	730	1,168
450	-	765	1,225
525	-	818	1,310
600	-	871	1,395
750	-	924	1,479
900	**-**	**977**	**1,564**
1050	-	1,048	1,677

Table 3.31 Unit Rate Breakdown of Stormwater Pipes

Diameter (mm)	Storm Sewer - *PVC* *($/m)*	Storm Sewer - *Concrete 65D ($/m)*	Total Unit Cost(1.6) ($/m)
1200	-	1,154	1,847
1350	-	1,595	2,554
1500	-	1,949	3,120
1650	-	2,125	3,402
1800	-	2,302	3,685
2100	-	2,655	4,251
2400	-	3,009	4,816
3000	-	3,715	5,948

Table 3.32 Year Breakdown of Stormwater Pipes

Breakdown of Storm Sewers		
Decade	Length (km)	Replacement Cost $k
1950 - 59	24	36,967
1960 - 69	55	86,256
1970 - 79	118	184,834
1980 - 89	197	308,057
1990 - 99	197	308,057
2000 - 09	197	308,057
Total	**788**	**1,232,227**

3.3.2 Culverts

The expected life of a culvert was modelled to be 50 years. Unit construction costs are from HRM's 2007 unit rate with build-up and 2% indexing per year from 2007 to 2012. The build-up cost assumes the installation costs are 85% of the supply costs for concrete and 45% for HDPE; fill is $62 per m. Replacement is done with a 900 mm concrete culvert. The culvert crossing is approximately 20 m, 2.5 m depth to bottom of bedding, 1:1 construction with no trench box, 0.5 m between pipe and trench wall, and 0.3 m of bedding. The costs include headwall, traffic control, environmental protection, and restoration. The Unit rate breakdown of culverts is in Table 3.33. The size breakdown of culverts is shown in Table 3.34.

Table 3.33 Unit Rate Breakdown of Culverts

Diameter (mm)	Unit Cost ($/m)	Total Unit Costs (1.6)($/m)
Concrete		
450	706	1,131
525	714	1,143
600	825	1,320
750	963	1,542
900	1,102	1,764
1,050	1,195	1,913
1,200	1,287	2,061
1,350	1,657	2,653
1,500	2,027	3,245
1,800	2,397	3,838
HDPE		
450	1,519	2,432
500	1,567	2,509
550	1,631	2,612
600	1,695	2,714
650	1,759	2,817
700	1,823	2,919
750	1,887	3,022
800	2,032	3,252
900	1,951	3,124
1,000	2,112	3,380
1,050	2,192	3,509
1,200	2,272	3,637

Table 3.34 Size Breakdown of Culverts

Breakdown of Culverts		
Dia (mm)	**Length km**	**Total Cost($k)**
450	1.35	1,531
525	0.12	136
600	3.33	4,405
750	0.91	1,405
900	0.69	1,223
1,050	0.50	948
1,200	0.39	796
1,500	0.32	1,043
1,800	0.67	2,571
2,100	0.16	622
Total	**8.45**	**14,680**

3.3.3 Stormwater Structures

Stormwater structures replacement costs were based on replacing the culvert associated with a particulate stormwater structures: summarized in Table 3.35. Culvert replacement for the stormwater structures was done when the stormwater structure age reached 50 years (expected life of a culvert). Unit costs for culverts assumed the culverts are replaced by a concrete culvert of the same size; culverts were 20 m long, a diameter of 900 mm was assumed if the culvert did not have a diameter. Information about structures was provided by the Halifax Water Dam and other water control structure inventory/final report (September 2009). A detailed description of cost calculations is provided in Appendix 4.

Table 3.35 Summary of Stormwater Structures

Name	Type of Structure	Capacity (m^3)	Year of Constr.	Estimated Replacement Cost ($)
Oceanview Drive Retention Pond	Retention Pond	3,700	1990	98,040
Meadowbrook Retention Pond	Retention Pond	190	1980	80,520
Transom Drive Retention Pond	Retention Pond	9,900	2007	less than 50 yrs. at the end of IRP
Glenbourne Estates Retention Pond	Retention Pond	430	1990	105,840
Parkland Avenue Retention Pond	Retention Pond	36,000	1990	76,080
Glen Forest Weir / Retention Pond	Retention Pond	12	1960	96,960
Lacewood Retention Pond	Retention basin, dam and spillway	5,300	1970	141,660

Table 3.35 Summary of Stormwater Structures

Name	Type of Structure	Capacity (m^3)	Year of Constr.	Estimated Replacement Cost ($)
Susie Lake Control Structure	Concrete Sluice gate. Drains to Black Duck Pond	35,600	1989	n/a
Volvo West Retention Pond	Retention Pond	55,600	1990	n/a
Old Sambro Road Retention Pond	Retention Pond	20	1980	26,400
Graystone Road Retention Pond	Retention Pond	300	1980	no purpose n/a
Tamarack Drive Retention Pond	Retention Pond	270	1990	70,560
Heritage Hills Retention Pond	Retention Pond	13,800	1998	less than 50 yrs. at the end of IRP
Clement Street Retention Pond	Control Gates	244,000	1979	n/a
Maynard Lake Dam	Pipe and Gate	172,000	1960	n/a
Sullivan's Pond Culvert	Grated inlet to Culvert	44,000	1971	n/a (it is a dam)
Shubie Drive Retention Pond	Retention Pond	19,500	2007	less than 50 yrs. at the end of IRP
Countryview Drive Retention Pond	Retention Pond	3,200	2006	less than 50 yrs. at the end of IRP
Commodore Drive Retention Pond	Retention Pond	9,400	2006	less than 50 yrs. at the end of IRP
Lemlair Row Retention Pond	Retention Pond	15,300	2006	less than 50 yrs. at the end of IRP
Forest Hills Retention Pond	Retention Pond	5,000	1980	61,680
Cole Harbour Commons Retention Pond	Timber Headwall and Culvert	2,000	2007	less than 50 yrs. at the end of IRP
Guysborough Retention Pond	Retention Pond	9,000	1979	105,840
John Stewart Dr Retention Pond	Retention Pond	550	2005	less than 50 yrs. at the end of IRP
Stewart Harris Drive Retention Pond	Retention Pond	160	1978	116,880
Cranberry Lake Retention Pond	Retention Pond	108	1980	41,220
Gregory Drive Retention Pond	Retention Pond	80	2003	less than 50 yrs. at the end of IRP
Main Street Retention Pond	Retention Pond	130	1980	22,620
Kuhn Marsh Dam	Retention Pond and Dam	60,000	2008	less than 50 yrs. at the end of IRP
			Total	**$1,044,300**

4. CONCLUSIONS

This section provided the detail of the unit rates for the IRP. The unit rates are high level estimated due to the long term planning nature of the IRP.

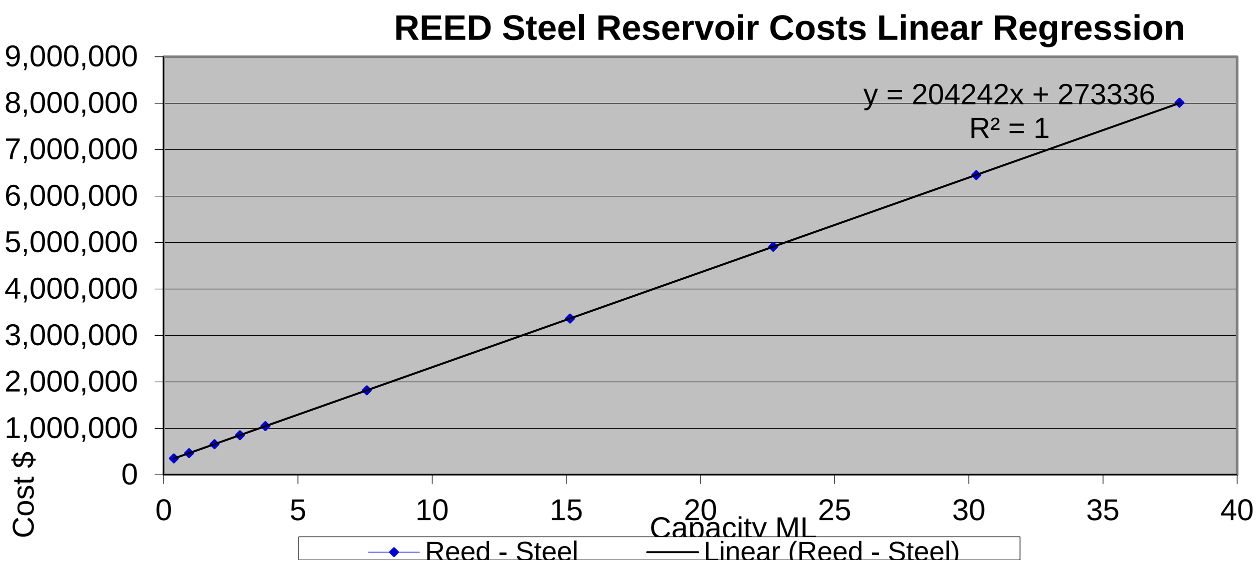
APPENDIX 1: WATER PUMPING STATIONS: CALCULATION OF THE UNIT RATE

2011 Insurance Renewal Values	NAME	CONSTRUCTION YEAR	PUMP CAPACITY	p1 (US gpm)	p2 (US gpm)	p3 (US gmp)	Qmax (US gpm)	Qmax (MLD)	$/MLD in 2011	$/MLD (elimating fire stations)
	Airport Fire Pumping Station (HIAA)	1960	2 fire pumps, 1@2000 USgpm, 1@1000 USgpm	2,500	1,250					
$802,463	Bennery Lake / Aerotech Pumping Station	1986	1 fire pump, 1@5000 USgpm	5,000			5,000	27	$29,443	
$534,975	Beaverbank Pumping Station	1999	2 reservoir feed pumps, 2@1170 USgpm	1,463	1,463		1,463	8	$67,106	
$427,980	Bedford South Pumping Station	2004	3 domestic pumps, 1@165 USgpm, 2@360 USgpm, 1 fire pump 1@1500 USgpm	660	720	655	720	4	$109,047	$109,047
$427,980	Bedford Village Pumping Station	1990	3 domestic pumps, 1@110 USgpm, 2@270 USgpm, 1 fire pump 1@2500 USgpm	440	491	491	491	3	$159,907	$159,907
$427,980	Crestview Pumping Station	1994	3 domestic pumps, 1@89 USgpm, 2@195 USgpm, no fire pump	356	355	355	356	2	$220,545	$220,545
$101,900	Eaglewood Pumping Station	1984	2 domestic pumps, 2@10 USgpm, no fire pump	13	13		13	0.1	$1,495,507	
$427,980	Lively Booster Station	2008	2 domestic pumps, 2@47.5 USgpm, no fire pump	59	59		59	0.3	$1,322,343	
$427,980	No. 7 Highway Pumping Station	1975	2 domestic pumps, 2@375 USgpm, 1 fire pump 1@1000 USgpm	469	469		469	3	$167,497	$167,497
$160,493	Silverside Pumping Station	1983	3 domestic pumps, 1@70 USgpm, 2@160 USgpm	280	291	291	291	2	$101,178	$101,178
$427,980	Upper Hammonds Plains Pumping Station	1999	2 domestic pumps, 2@200 USgpm, no fire pump	250	250		250	1	$314,057	$314,057
$34,773	Lyle Street Control Chamber	1991	1 emergency pump, 1@1667 USgpm	1,667			1,667	9	$3,827	
$1,069,950	Mount Edward Pumping Station	2004	3 domestic pumps, 1@340 USgpm, 2@650 USgpm, 1 fire pump 1@2000 USgpm	1,360	1,182	1,164	1,360	7	$144,327	$144,327
$427,980	Charles Road Pumping Station	1996	3 domestic pumps, 1@175 USgpm, 2@385 USgpm, no fire pump	700	700	700	700	4	$112,163	$112,163
$641,970	Cowie Reservoir Pumping Station	1975	2 domestic pumps, 2@870 USgpm, no fire pump	1,088	1,088		1,088	6	$108,295	$108,295
$267,488	Leiblin Pumping Station	1966	2 domestic pumps, 2@282 USgpm, 1 fire pump 1@1500 USgpm	353	353		353	2	$139,210	$139,210
$320,985	Parkdale Pumping Station	1984	2 domestic pumps, 2@160 USgpm, 1 fire pump 1@1000 USgpm	200	200		200	1	$294,428	
$534,975	Robie Street Emerg. Pump. Station	1990	1 emergency pump, 1@5000 USgpm	500			500	3	$196,285	$196,285
$427,980	St. Margarets Bay Road Pumping Station	2008	2 reservoir feed pumps, 2@600 USgpm	750	750		750	4	$104,686	$104,686
								Average	**$282,770**	**$156,433**

APPENDIX 2: CONCRETE RESERVOIRS: CALCULATIONS FOR REED STEEL RESERVOIRS

Summary of Cost Calculations using REED Steel Cost Linear Regression

Reservoir	Capacity (ML)	Cost Equation (y($)=204242x(ML)+273336)	With 1.6 Multiplier	Cost ($k) for Steel Reservoir Replacement
Mount Edward 1	22.7	$4,909,629	$7,855,407	$7,855
Cowie Hill	11.4	$2,601,695	$4,162,712	$4,163
Geizer 123	31.8	$6,768,232	$10,829,171	$10,829
Lakeside/Timberlea	5.4	$1,376,243	$2,201,988	$2,202
Meadowbrook	9.1	$2,131,938	$3,411,101	$3,411
Middle Musquodoboit	0.3	$334,609	$535,374	$535
Robie Street	15.9	$3,520,784	$5,633,254	$5,633



APPENDIX 3: INSURANCE COSTS FROM HALIFAX WATER FOR STEEL AND CONCRETE WATER RESERVOIRS

Summary of Insurance Cost for Water Storage Reservoirs

Reservoir Name & Elevation (S - Steel, C- Concrete)	Capacity (ML)	Insurance Renewal Values ($ 2012) [1,2]	Total Reservoir Cost ($k)
Geizer 158 (S)	36.4	12,223,109	19,556,974
Res Chamber		436,540	698,463
Geizer 123 (C) (interior)	31.8	5,744,861	9,191,778
Ext		4,950,359	7,920,574
Reservoir Meter		272,838	436,540
Reservoir Chamber		436,540	698,463
Dump Valve Control Chamber		545,675	873,079
Cowie (C)	11.4	3,666,933	5,867,092
Robie (C)	15.9	5,347,610	8,556,176
Lakeside/Timberlea (C)	5.4	2,182,698	3,492,317
Res Chamber		272,838	436,540
Mount Edward 1 (C)	22.7	5,456,745	8,730,792
Mount Edward 2 (S)	22.7	5,456,745	8,730,792
Akerley Blvd. (S)	37.7	13,139,842	21,023,747
Res Chamber		327,405	523,848
North Preston (S)	1.6	2,182,698	3,492,317
Meadowbrook (C)	9.1	3,274,047	5,238,475
Res Chamber		545,675	873,079
Sampson (S)	12.2	4,889,244	7,822,790
Res Chamber		218,270	349,232
Stokil (S)	23.6	7,945,021	12,712,033
Res Chamber		272,838	436,540
Waverley (S)	1.3	818,512	1,309,620
Res Chamber		272,838	436,540
Middle Musquodoboit (C)	0.3	436,540	698,463
Aerotech (S)	4.1	2,728,373	4,365,396
Beaver Bank (S)	6.9	2,864,791	4,583,666
Res Chamber		272,838	436,540

Notes:

1. Construction cost based on HW 2011 Insurance Renewal values with additional 2% for indexing.
2. Construction costs exclude land acquisition, and all off site costs

APPENDIX 4: COSTING METHODOLOGY OF STORMWATER STRUCTURES

Halifax Water owns twenty-nine (29) stormwater structures that consist of a variety of retention ponds with culverts, dams, control gates, and berms. In terms of asset renewal, the culverts were the only component to be replaced. Culverts are included in the unit costs for the IRP with an expected life of 50 years. Stormwater structures that were less than 50 years at the end of the IRP were not account for while stormwater structures that were greater than 50 years were replacement. Costing of control gates, dams, and berms was difficult as there were no unit costs available and all are unique. Stormwater structures that contained unique items were left out of the cost analysis.

For the cost analysis of the stormwater structures, the twenty-nine (29) items were broken down into four (4) groups:

1. Stormwater Structures that will be **greater** than 50 years at the end of the IRP (thirteen (13) structures). Replacement costs were calculated for the IRP.

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP	age to replace (at 50 years)
Oceanview Drive Retention Pond	Retention Pond	3700	1990	52	2040
Meadowbrook Retention Pond	Retention Pond	190	1980	62	2030
Glenbourne Estates Retention Pond	Retention Pond	430	1990	52	2040
Parkland Avenue Retention Pond	Retention Pond	36000	1990	52	2040
Glen Forest Weir / Retention Pond	Retention Pond	12	1965	77	2015
Lacewood Retention Pond	Retention basin, dam and spillway	5300	1970	72	2020
Old Sambro Road Retention Pond	Retention Pond	20	1980	62	2030
Tamarack Drive Retention Pond	Retention Pond	270	1990	52	2040
Forest Hills Retention Pond	Retention Pond	5,000	1980	62	2030
Guysborough Retention Pond	Retention Pond	9,000	1979	63	2029
Stewart Harris Drive Retention Pond	Retention Pond	160	1978	64	2028
Cranberry Lake Retention Pond	Retention Pond	108	1980	62	2030
Main Street Retention Pond	Retention Pond	130	1980	62	2030

2. Stormwater Structures that will be **less** than 50 years at the end of the IRP (ten (10) structures). These structures culvert costs were not calculated as structures have yet to reach the expected life of a culvert (50 years).

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP
Transom Drive Retention Pond	Retention Pond	9900	2007	35
Heritage Hills Retention Pond	Retention Pond	13800	1998	44
Shubie Drive Retention Pond	Retention Pond	19500	2007	35
Countryview Drive Retention Pond	Retention Pond	3200	2006	36
Commodore Drive Retention Pond	Retention Pond	9,400	2006	36
Lemlair Row Retention Pond	Retention Pond	15,300	2006	36
Cole Harbour Commons Retention Pond	Timber Headwall and	2,000	2007	35
John Stewart Dr Retention Pond	Retention Pond	550	2005	37
Gregory Drive Retention Pond	Retention Pond	80	2003	39
Kuhn Marsh Dam	Retention Pond and	60,000	2008	34

3. Stormwater Structures that need more investigation for cost estimates that are greater than 50 years at the end of the IRP (five (5) structures).

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP
Susie Lake Control Structure	Concrete Sluice gate.	35600	1989	53
Volvo West Retention Pond	Retention Pond	55600	1990	52
Clement Street Retention Pond	Control Gates	244000	1979	63
Maynard Lake Dam	Pipe and Gate	172000	1960	82
Sullivan's Pond Culvert (it is more of a Dam)	Grated inlet to Culvert	44,000	1971	71

Note: Clement Street Retention pond has an item in the Financial Model (1.006 Clement Street Berm removal and inlet structure reconfiguration" in 2016-17 for $100k.

4. Stormwater Structures that had an unknown purpose according to the "Halifax Water Stormwater Dams and other Water Control Structures Inventory Report" (there is one (1) structure)

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP
Graystone Road Retention Pond	Retention Pond	300	1980	62

Calculations for costs were only done the stormwater structures in item 1 (thirteen (13) stormwater structures). When using the unit costs for the culverts, the following was assumed:

- Culverts were to be replaced by concrete culverts of the same size
- Culverts were assumed to be 20m long
- The unit costs used assumed 2.5 depth to bottom bedding, 1:1 construction with no trench box, 0.5m between pipe and trench wall, and 0.3m bedding. Unit costs also included headwall, traffic control, environmental protection and restoration.
- For culverts that did not have a diameter, a diameter of 900mm was assumed
- If the exact size of a culvert was not accounted for in the unit costs, the next size up was used.

The cost breakdowns of the stormwater structure culverts with the above assumptions are shown in the following table:

				Cost for Inlet Culvert(s)				Cost of Outlet Culvert(s)				
Name	**age to replace (at 50 years)**	**Inlet**	**Outlet**	**#**	**dia (mm)**	**unit cost ($/m)**	**Total**	**#**	**dia (mm)**	**unit cost ($/m)**	**Total**	**TOTAL Cost for Culvert Replacement**
Oceanview Drive Retention Pond	2040	Three inlet culverts (two PVC 0.3m dia, and one conc. 0,6m)	One 0.6m diameter oncrete culvert	2	300	1131	$45,240	1	600	1320	$26,400	$98,040
				1	600	1320	$26,400					
Meadowbrook Retention Pond	2030	Two inlet steel culvert 0.4m in dia.	Outlet concrete box culvert (1.2m by 0.6m) cost at 0.9m dia	2	400	1131	$45,240	1	900	1764	$35,280	$ 80,520
Glenbourne Estates Retention Pond	2040	Two inlet culverts (assume 0.9m dia)	One outlet culvert (assume 0.9m conc.)	2	900	1764	$70,560	1	900	1764	$35,280	$ 105,840
Parkland Avenue Retention Pond	2040	Three concrete culvert inlet pipes (0.75m, 0.45m, and 045m in dia)	Control Weir	1	750	1542	$30,840					
				2	450	1131	$45,240					$ 76,080
Glen Forest Weir / Retention Pond	2015	Two inlet concrete culverts with a 0.6m diameter	Control weir in a box culvert that flows into a 0.6m concrete pipe	2	900	1764	$70,560	1	600	1320	$26,400	$ 96,960
Lacewood Retention Pond	2020	Inlet concrete culvert 1.5m dia, concrete overflow wall	Concrete outlet culvert 1.8m, concrete overflow wall	1	1500	3245	$64,900	1	1800	3838	$76,760	$ 141,660
Old Sambro Road Retention Pond	2030	One concrete inlet culvert 0.6m dia	0.6m opening to allow for flow	1	600	1320	$26,400					$ 26,400
Tamarack Drive Retention Pond	2040	One conc inlet culvert 0.9m in dia	One conc inlet culvert 0.9m in dia with concrete wall and PVC elbo	1	900	1764	$35,280	1	900	1764	$35,280	$ 70,560
Forest Hills Retention Pond	2030	Two conc culverts 0.9m and 0.6m in diameter	Berm	1	900	1764	$35,280					$ 61,680
				1	600	1320	$26,400					
Guysborough Retention Pond	2029	Three inlet culverts (assume 0.9m dia)	One outlet structure	3	900	1764	$105,840					$105,840
Stewart Harris Drive Retention Pond	2028	Two 0.3m and one 0.6m dia concrete culverts	Two 0.3m diameter steel pipes that will be replaced by conc. Culverts	2	300	1131	$45,240	2	300	1131	$45,240	$ 116,880
				1	600	1320	$26,400					
Cranberry Lake Retention Pond	2030	One concrete culvert 1.2 diameter	Marshy area	1	1200	2061	$41,220					$ 41,220
Main Street Retention Pond	2030	Intake structure	One concrete culvert 0.4m in dia					1	400	1131	$22,620	$ 22,620

The total cost of the culverts in stormwater structures during the IRP is $1,044,000. For each stormwater structure, a separate line item was included in the financial plan. The cost for replacement was put in when the stormwater structure would be 50 years old. The 50 years was used as it is the expected life of a culvert used for the IRP.

Currently in the Financial Plan, there is capital expenditure between 2013 and 2016 for a “Stormwater Structure Replacement Program”.

Operating cost of the stormwater structures are not accounted for as the IRP only incremental costs are considered.

VOLUME 3 – APPENDIX C

Cost Estimation and Unit Costs

HALIFAX WATER
INTEGRATED RESOURCE PLAN
VOLUME 3 APPENDIX C
COSTING PROCEDURES TECHNICAL MEMORANDUM
(COST ESTIMATION AND UNIT COSTS)

Table of Contents

Tables

1. PURPOSE

The purpose of this Appendix is to present the details used for the asset renewal models. The unit rates (e.g. cost per meter of pipe), asset life data, and other aspects of the project costing procedures for the water, wastewater, and stormwater systems are presented in this section.

2. COSTING

Unit rates for the IRP were developed by the consultants and Halifax Water Staff. The costs are based on 2012 Canadian dollars. An on-cost multiplier of 1.6 was used on top of the estimated construction cost. The on-cost multiplier accounts for overhead, contingencies, HST, and interest. A detailed breakdown of components is provided in Table 2.1.

Table 2.1 Halifax Water IRP On-Cost and Overhead Calculation (V3)

	Component of On-Cost		Percentage of Construction Costs (%)	Comments
1	Construction cost	1.00		Ensure base construction cost **DOES NOT** also contain a contingency amount; this is covered under line 7 below.
2	Engineering/Design - includes planning, pre-design, detailed design, training, commissioning - excludes construction management/ contract administration	0.10	10% of construction cost	Could range from 5% to 15% depending on the project; assume 10% as average
3	Professional Fees - includes legal, survey, testing, flow monitoring, etc.	0.01	1% of construction cost	
4	Construction Management/Contract Administration	0.10	10% of construction cost	Could range from 5% to 15% depending on the project; assume 10% as average
5	Labour/Wages (internal staff time charged to project) - engineering, CAD, site inspection	0.02	2% of construction cost	Where project undertaken in-house (water + limited WW/SW projects), may be a higher % however, the contract admin and engineering/ design % would then be lower.
6	**Subtotal 1**	**1.23**		

Table 2.1 Halifax Water IRP On-Cost and Overhead Calculation (V3)

	Component of On-Cost		Percentage of Construction Costs (%)	Comments
7	Contingency	0.25	20% x "Subtotal 1" value	Could range from 10% to 40%; for IRP (planning level) use 20% x "Subtotal 1" value
8	**Subtotal 2**	**1.48**		
9	Net HST (4.286%)	0.06	Charged on "Subtotal 2" value	
10	**Subtotal 3**	**1.54**		
11	Interest & Overhead (4%)	0.06	Charged on "Subtotal 2" value	
12	**TOTAL**	**1.60**		

3. ASSET RENEWAL UNIT RATES

This section will break down each of infrastructure system (Water, Wastewater, and Stormwater) and further to each asset class to the assumptions that were made for the unit costs. The asset service life estimates (design life) were based on best industry practices. For the complex point assets such as pump stations and treatment facilities separate service life estimates were broken down to civil (structural), mechanical-electrical (M&E), and instrumentation and control (ICA). A fraction of the total asset value was assigned to each component.

For purposes of the asset renewal modelling the civil-structural components of complex assets such as pump stations and treatment plants were considered to be presently in new condition. Considering the 50-year life of the components this did not figure in the asset renewal requirements over the 30-year IRP planning period. Halifax Water staff reviewed the status of the M&E and ICA systems of major water and wastewater treatment facilities and provided specific estimates of current asset age. The current asset age was used as the starting point for the modelling of the point assets.

- Point assets such as concrete/steel reservoirs or dams were not modelled but rather subjected to individual analysis to estimate required renewal over the 30-year period. These were high-level estimates.

3.1 WATER

The unit rates for each linear asset (distribution and transmission mains) and point asset (meters, PRVs, valves, water pumping stations, concrete/steel reservoir, dams, and WSP) are explained in detail in this section.

3.1.1 Distribution Mains / Transmission Mains

The service life of the distribution and transmission mains was estimated to be 75 year based on the Water Utility Accounting and Reporting handbook 3040-Depreciation. Water distribution mains include hydrants, new water meters, and service connections. The construction cost of pipe per meter was derived from HRM's 2007 Database, with additional build up and including 2% indexing per year from 2007 to 2012. The additional build up costs assume install costs are 60% of supply cost, fill is $65 per meter and excavation is $20 per m. The pipe material to be used is ductile iron (DI) unless otherwise noted. A breakdown of the unit rate according to diameter is in Table 3.1.

The total cost of the distribution/transmission system is broken down in Table 3.2 and Table 3.3.

The unit costs were used for the asset renewal models and for costing the transmission main projects related to the WaterCAD model (Volume 3 Appendix A).

Table 3.1 Unit Cost Breakdown of Distribution and Transmission Mains

Diameter (mm)	Construction Costs ($/m)	Total Unit Cost (1.6) ($/m)
200	712	1,140
250	800	1,281
300	933	1,494
350	977	1,564
400	1,021	1,635
450	1,065	1,706
500	1,110	1,776
550	1,154	1,847
600	1,198	1,918
675	1,507	2,320
750	1,595	2,528
900	1,772	2,784
1,050	2,214	3,412
1,200	2,390	3,774
1,350	2,920	4,516
1,500	3,627	5,595

Table 3.2 Size Breakdown of Distribution Mains

Breakdown of Water Distribution Mains			
Dia (mm)	**Length (km)**	**Cost Rate ($/m)**	**Total Cost ($k)**
<75	4	1,140	4,413
75	1	1,140	860
100	11	1,140	13,035
150	281	1,140	319,936
200	333	1,140	380,079
225	35	1,140	39,564
250	110	1,281	140,556
300	261	1,494	390,414
350	26	1,564	39,992
375	14	1,635	22,687
400	77	1,635	126,333
450	11	1,706	19,574
500	16	1,776	28,061
400*(Aerotech)*	7	1,635	11,510
Total (km)	**1,187**	**Total ($k)**	**1,537,014**

Table 3.3 Transmission Main Cost Summary

Total Length (km)	Replacement Cost ($)
217.1	$494,668,604

3.1.2 Meters

The service life of meter was modelled as 20 years: based on the Water Utility Accounting and Reporting Handbook 3040-Depreciation. The average instantiation unit costs for both residential and commercials meters are from Halifax Water's database. The cost of new water meters is incorporated as part of the water main unit cost. The unit cost breakdown is in Table 3.4.

The cost breakdown of meters in Halifax Water's system is in Table 3.5.

Table 3.4 Unit Cost Breakdown of Meters

	Construction Cost ($ per meter)	Total Unit Cost (1.6) ($ per meter)
Residential Meters: Average Installation Cost per Unit ($)	200	320
Commercial Meter: Average Installation Cost per Unit ($)	500	800

Table 3.5 Breakdown of Meters

	Number of Meters	Total Replacement Cost ($)
Residential	76,366	24,450,762
Commercial	4,621	3,698,864
Total	**80,987**	**28,149,626**

3.1.3 PRVs, Meter Chambers, and Control Valve Chambers

Construction costs for PRV's are based on Halifax Water's 2011 insurance costs with 2% indexing to 2012. The civil component has an expected life of 50 years; it is assumed new and thus not replaced during the IRP. No ICA component is considered. An age distribution was created and assumed PRVs were installed from 1993 onwards.

Table 3.6 and Table 3.7 show the unit rates for the PRV's and meter chambers, and control value chambers.

Meter Chambers and Control Valve chambers asset value was considered to be 100% civil, therefore since the civil structure is in relative good sharp replacement was not needed during the IRP. Table 3.8 and Table 3.9 shows the assumption for PRV's, and meter chambers and control value chambers.

Table 3.6 Unit Rate of PRV's and Meter Chambers

		Number of Locations / Location	Construction Costs ($)	Total Unit Cost(1.6) ($)
PRVs	**Small PRV**	4	54,567	87,307
	Medium PRV	66	163,702	261,923
	Large PRVs			
	Water Robie Street No. 1 PRV		1,309,619	2,095,390
	Water Rockmanor Pumping Station		545,675	873,079
	Water Titus & Evans PRV		436,540	698,463
	Chain Control PRV		327,405	523,848
	Water Sackville Drive PRV		327,405	523,848
	MacDonald Bridge PRV		272,837	436,540
	Water Robie Street No. 2 PRV		272,837	436,540
	Bluewater Road PRV		218,270	349,232
	Water Zinck Avenue PRV		218,270	349,232
	Lancaster Drive Emergency PRV		109,135	174,616
	Dunbrack St N of Main St PRV		103,938	166,301
			Total:	**24,263,247**
Meter Chambers	**New**	22	54,567	87,307
	Other Meter Chambers			
	Kearney Lake Rd Meter Chamber		109,135	174,616
	Flynn Park Meter		163,702	261,924
	Blue Mountain Meter		218,270	349,232
	Lucasville Road Meter		272,837	436,540
	Hammond Kearney Meter		763,944	1,222,311
			Total:	**4,365,380**

Table 3.7 Unit Rate of Control Value Chambers

		Number of Locations / Location	Construction Costs ($)	Total Unit Cost ($)
Control Value Chambers	**Small Values**	2 (at Aerotech)	54,567	87,307
	Other Control Value Chambers			
	Near Aerotech STP		218,270	349,232
	Hemlock Control Chamber		818,512	1,309,619
	Lyle Street Control Chamber		818,512	1,309,619
	Main No. 2 Control Chamber		654,809	1,047,695
	Main No. 1 Control Chamber		1,746,158	2,793,853
	Mount Edward Rd Control Chamber		436,540	698,463
	Orchard Control Chamber		654,809	1,047,695
	East - Topsail Drive		436,540	698,463
	Cowie Hill Road PRV		873,079	1,396,927
	Kearney Control		436,540	698,463
			Total:	**11,524,644**

Table 3.8 Asset Valve and Expected Life Assumption for Meter Chambers and Control Valve Chambers

Assumptions for Meter Chambers and Control Valve Chambers		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	100%	50

Table 3.9 Asset Valve and Expected Life Assumption for PRVs

Assumptions for PRV		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	20

Note Water Chamber, and control valves were assumed to be 100% civil components and in reasonable condition. Therefore were not replaced or modelled for the IRP.

3.1.4 Valves

The expect life of valves was modelled to be 75 years, the same as the distribution/transmission mains. Costs for valves are from the HRM database with 1.6 on cost multiplier. Costs for valves with diameters between 150 mm to 600 mm are reported. To determine the total replacement costs an average cost of $5,867 was used for the approximate 13,000 valves that Halifax Water owns and operates. Table 3.10 shows the breakdown of valves. Table 3.11 summarizes the replacement costs for the valves.

Table 3.10 Unit Rate Breakdown of Valves

Description	Construction Cost ($/valve)	Total Cost (1.6) ($/valve)
150 mm Gate Valve	1,000	1,601
200 mm Gate Valve	1,650	2,641
250 mm Gate Valve	2,500	4,002
300 mm Gate Valve	3,000	4,803
350 mm Gate Valve	3,500	5,603
400 mm Gate Valve	4,000	6,404
450 mm Gate Valve	4,500	7,204
500 mm Gate Valve	5,000	8,004
550 mm Gate Valve	5,500	8,805
600 mm Gate Valve	6,000	9,605

Table 3.11 Replacement Costs for Valves

Replacement Costs ($)	
Average Cost ($)	5,867
Number of Valves	13,027
Total Replacement Cost ($)	**76,432,974**

3.1.5 Water Pumping Stations

Construction costs per MLD are based on averaging the 2011 Halifax Water Insurance renewal values of the pumping station inventory. The 1.6 on-cost multiplier is then assed to the $/MLD. For the asset renewal models the civil structure was assumed new and thus not replaced during the IRP. M&E and ICA were replaced based on the assumptions table. Table 3.12 3.12 shows the breakdown for water pumping stations. Table 3.13 is a breakdown of cost for each water pumping station. The asset valve and expected life assumption is shown in Table 3.14.

Table 3.12 Unit Costs for Water Pumping Stations

Construction Cost per MLD ($/MLD)	Total Unit Cost (1.6)($/MLD)
150,000	240,134

Table 3.13 Costing of Each Water Pumping Station using Unit Costs

Water Pumping Station	MLD	Total Cost
Bennery Lake / Aerotech Pumping Station	27.3	6,544,844
Beaverbank Pumping Station	12.8	3,062,987
Bedford South Pumping Station	13.0	3,121,891
Bedford Village Pumping Station	17.2	4,123,252
Crestview Pumping Station	2.6	626,996
Eaglewood Pumping Station	0.1	26,179
Lively Booster Station	0.5	124,352
No. 7 Highway Pumping Station	9.5	2,290,695
Rockmanor Pumping Station	10.5	2,520,454
Silverside Pumping Station	2.1	510,498
Upper Hammonds Plains Pumping Station	2.2	523,588
Lyle Street Control Chamber	9.1	2,182,051
Mount Edward Pumping Station	19.8	4,764,647
Charles Road Pumping Station	5.2	1,236,976
Cowie Reservoir Pumping Station	9.5	2,277,606
Leiblin Pumping Station	11.3	2,701,712
Parkdale Pumping Station	7.2	1,727,839
Robie Street Emergency Pump. Station	27.3	6,544,844
St. Margarets Bay Road Pumping Station	6.5	1,570,763
Total Replacement Cost		**46,482,172**

Table 3.14 Asset Valve and Expected Life Assumption for Water Pumping Stations

Assumptions for Water Pumping Stations		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	20
ICA, Telemetry & SCADA	10%	10

Appendix 1 shows the calculations for the unit rate of water pumping stations in $ per MLD.

3.1.6 Concrete Storage Reservoirs

During the IRP, concrete storage reservoirs were replaced by a steel reservoir of the same capacity. The cost of a steel tank replacement was based on the Reed-Steel Linear regression provided by HALCROW using the current capacity of the concrete tank. The 1.6 on cost multiplier was then included. Detailed calculations for costing the new steel storage reservoirs are provided in Appendix 2.

Table 3.15 shows the projects for the replacement of concrete tank with steel tanks inputted into the financial model.

The current total replacement costs based on replacing the whole concrete structure is $53,013,000. The current total replacement cost is from Halifax Water insurance costs with 2% indexing from 2011 to 2012, and 1.6 multiplier from Halifax Water.

Table 3.15 Replacement Cost of Concrete Tanks with Steel Tanks

Concrete	Capacity ML	Replacement Year (from HW)	Replacement Steel Cost ($k)(1.6)
Mount Edward 1 Replacement with Steel Tank	22.7	2022	7,855
Cowie Hill Replacement with Steel Tank	11.4	2027	4,163
Geizer 123 Replacement with Steel Tank	31.8	2032	10,829
Lakeside/Timberlea Replacement with Steel Tank	5.4	2037	2,202
Meadowbrook Replacement with Steel Tank	9.1	2042	3,411
Middle Musquodoboit	0.3	2064	535
Robie	15.9	2060	5,633

3.1.7 Steel Storage Reservoirs

Steel water reservoirs are in reasonable shape and will not need to be fully replaced during the IRP. To extend the life of a steel reservoir, an interior coating is needed every 20 years. Based on estimates from Halifax Water a coating on a small tank with the 1.6 multiplier is $320,000. A small tank is considered a reservoir that is less than 12.2ML. Coating on a large tank with the 1.6 multiplier will cost $960,000. A large tank is considered a reservoir that is greater than 12.2ML. The cost of interior coating and replacement year for the steel storage reservoirs is shown in Table 3.16.

Table 3.17 displays the cost assumptions for the steel tanks.

The total replacement costs of the whole steel structure based on current insurance costs with a 1.6 multiplier from Halifax Water is $86,479,000.

Table 3.16 Cost of Interior Coating and Year for Steel Storage Reservoirs

Steel	Capacity ML	Install Date	Coating Year (from HW)	Size Class. Of Tank (Small or Large)	Cost per coating ($k) (1.6)
Aerotech Coating in 2014 and 2034	4.1	1986	2014, 2034	Small	320
Akerley Blvd. Coating in 2021 and 2041	37.7	1986	2021, 2041	Large	960
Beaver Bank Coating in 2027	6.9	2007	2027, 2047	Small	320
Geizer 158 Coating in 20115 and 2035	36.4	1986	2015, 2035	Large	960
Mount Edward 2 Coating in 2018 and 2033	22.7	1998	2018, 2038	Large	960
North Preston Coating in 2013 and 2033	1.6	1988	2013, 2033	Small	320
Sampson Coating in 2029.	12.2	1970	2029	Small	320
Stokil Coating in 2020 and 2040.	23.6	1991	2020, 2040	Large	960
Waverley Coating in 2019 and 2039	1.3	1982	2019, 2039	Small	320
				Total During IRP	**10,240**

Table 3.17 Cost Assumptions for Steel Reservoirs

Cost Assumption for Steel Tanks		
	Estimation from HW ($k)	With on-cost multiple(1.6) ($k)
Small Tank	200	320
Large Tank	600	960

Insurance costs for the steel and concrete reservoirs are located in Appendix 3.

3.1.8 Dams

The total dam cost (asset value) was calculated using the Halifax Water 2011 insurance renewal values with additional 2% indexing for 2012 and the 1.6 multiplier. The surficial concrete and mechanical renewal of the dams is to be done every 20 year at a cost of 20% of the dam's asset value. Replacement of the core dam is approximately 100 years. Exact year is determined by the staff at Halifax Water and is shown, along with the costs, in Table 3.18.

Table 3.18 Repairs/Replacement Costs and Years for Dams

Name of Dam	Type of Dam	Insurance Cost ($k)	Total Dam Cost ($k) with on cost (1.6) (asset value)	Year to Replace or Repair Dam	% of Asset Value	Cost ($k) in Financial Model
Pockwock Lake	Earth fill with clay core	4,420	7,076	2025 (repair)	20	1,415
Bayers Lake	Granular Fill with HDPE Core	2,254	3,608	2025 (repair)	20	722
Chain Lake	Gravel and loam with concrete core wall	2,701	4,324	2040 (replace)	100	4,324
Lake Lamont	Earth fill (Till)	819	1,310	2020 (repair)	20	262
Lake Major	Rocked filled Timber Crib	1,310	2,097	2017 (replace)	100	2,097
East Lake	Concrete	2,254	3,608	2020 and 2040 (repair)	20	722
		Insurance Cost with On cost	**22,023**	**Total Replaced during IRP**		**10,263**

3.1.9 Water Supply Plants

The construction costs for the WSP (Table 3.18) is from the Halifax Water 2011 insurance renewal value with additional 2% indexing for 2012. For asset renewal it was assumed that all civil components were new and did not need to be replaced during the IRP. Only the M&E and ICA were renewed. An expected life of 30 year is used for the M&E instead of 20 years, 20 years is consistent with the water/wastewater pumping stations and PRVs. The expected life of 30 years is used due to the staff at the WSP maintaining the equipment thus increasing the expected life.

Table 3.19 Cost Summary of the Water Supply Plants

Facility	Firm Capacity	Estimated Construction Cost ($k)	Total with On-Cost ($k)	Type of WSP for Asset Renewal
J.D. Kline WSP	227MLD	51,293	82,115	large
Lake Major WSP	90MLD	50,013	80,066	large
Storage Building		11	18	large
Garage		11	18	large
Bennery Lake WSP	4MLD	10,913	17,471	Aerotech
Low Lift		546	874	Aerotech
Five Island lake	25m^3/day	109	175	small
Collins park	160m^3/day	1,964	3,145	small
Middle Musquodoboit	260m^3/day	1,855	2,970	small
Silver Sands	144m^3/day	204	327	small
Miller Lake	55 m^3/day	204	327	small
Bomont	20 m^3/day	437	699	small
Chain Lake Back up Supply		273	437	small
Pumping plant (emergency)		819	1,310	small
Lake Lamont Backup Supply Plant		2,183	3,494	Small
		Total:	**193,446**	

Table 3.20 Asset Value and Expected Life Assumptions for Water Supply Plants

Assumptions for Water Supply Plants		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	30
ICA, Telemetry & SCADA	10%	10

3.2 WASTEWATER

The unit rates for each linear asset (collections and trunk sewers) and point assets (forcemains, pumping stations, and treatment facilities) are presented in this section.

3.2.1 Collections and Trunk Sewers

The expected life of the collections (sanitary) and trunk sewers were modelled to be 100 year which is consistent with best industry practices. The unit costs for the sanitary and trunk sewers used in the IRP are also used in the Regional Wastewater Functional Plan (RWWFP). The RWWFP developed the unit costs through construction industry indices and discussion with Halifax Water staff. The costs assume a 5 m gravity sewer and included wastewater manholes and service connections. Table 3.21 shows the breakdown of unit rates for collections and trunk sewers. Table 3.2 shows the breakdown of the collections sewers. The breakdown of the trunk sewers is shown in

Table 3.21 Unit Rate Breakdown of Collections and Trunk Sewers

Dia. (mm)	Unit Cost *($/m)*	Total Unit Cost (1.6)($/m)
300	783	1,253
375	840	1,345
450	895	1,432
525	954	1,528
600	1,060	1,697
675	1,312	2,101
750	1,439	2,303
825	1,505	2,409
900	1,796	2,875
975	2,642	4,229
1050	2,941	4,708
1200	3,275	5,243
1350	3,687	5,902
1500	4,119	6,595
1650	4,555	7,292
1800	5,124	8,203
2100	5,793	9,275
2400	7,457	11,938
3000	10,116	16,194

Table 3.22 Size Breakdown of Collection Sewers

Breakdown of Collections Sewers			
Dia (mm)	**Length (km)**	**Cost Rate $/m**	**Cost ($k)**
200	403	1253	504,616
250	477	1253	597,322
300	146	1253	182,402
375	97	1345	129,760
450	48	1432	68,096
525	21	1528	32,645
300	3	1253	3,886
Total Km	**1193**	**Total Cost $k**	**1,518,727**

Table 3.23 Size Breakdown of Trunk Sewers

Breakdown of Trunk Sewers			
Dia (mm)	**Length (km)**	**Cost Rate $/m**	**Cost ($k)**
600	42	1697	71,352
750	21	2303	49,193
900	44	2875	125,687
1050	10	4708	46,498
1200	16	5243	82,849
1200+	12	8830	107,849
Total Km	**145**	**Total Cost $k**	**483,428**

3.2.2 Forcemains

The design life of the forcemain is 50 years. A design life was 50 years was considered over 75 years. The deterioration of forcemains has a very high consequence and the operational regime tends to be more aggressive than other assets. The forcemain should not last longer than the civil assets (at 50 years).

The forcemain unit costs include valves and fittings. The costs are from the RWWFP, which is calculated using the recommended UR 2012$ with 40% uplift for twin installation. The breakdown of the unit costs for forcemains is shown in Table 3.24.

Table 3.25 shows the breakdown of forcemains that Halifax Water owns.

Table 3.24 Unit Rate Breakdown of Forcemains

Diameter (mm)	Construction Cost ($/m)	Total Unit Cost (1.6)($/m)
150	729	1,167
200	788	1,261
250	851	1,362
300	926	1,483
350	1193	1,910
400	1414	2,263
450	1629	2,609
500	1857	2,973
600	2329	3,728
750	2499	4,000
900	2891	4,629
1050	3379	5,410
1200	3871	6,198

Table 3.25 Size Breakdown of Forcemains

Breakdown of Forcemains			
Dia	Length km	Cost Rate $/m	Cost $k
75	3.0	1167	3,532
100	12.1	1167	14,109
150	12.2	1167	14,191
300	16.7	1483	24,700
500	22.1	2973	65,686
1050	0.6	5410	3,029
150	23.8	520	12,367
*(Aerotech)*300	0.19	1483	282
*(Aerotech)*100	0.19	1167	222
Total km	**90.7**	**Total Cost $k**	**138,116**

3.2.3 Wastewater Pumping Stations

Wastewater pumping stations costs are based on insurance costs. The wastewater pumping stations were grouped into four (4) ranges based on building type, HP, and insurance cost. The insurance cost for an each HP range was averaged and the 1.6 on cost multiplier was added. Civil components are considered new and thus are not replaced during the IRP.

Table 3.26 shows the unit rate breakdown of the wastewater pumping stations. The assumptions on asset value and expect life are shown in Table 3.27. The unit rate for wastewater pumping storage is shown in Table 3.28.

Table 3.26 Unit Rate Breakdown of Wastewater Pumping Stations

Type	Range	Number of Stations	Insurance Cost ($k)	Rounding ($k)	With On-Cost Multiplier (60%)($k)	Total Replacement Cost ($k)
Monument	< 47hp	108	214	220	352	38,016
Building	< 35hp	35	590	600	960	33,600
Building	36 to 99hp	13	1,052	1100	1,760	22,880
Building	> 100hp	13	2,332	2300	3,680	47,840
Not Under HW Ownership at this time		3			**Total**	**142,336**
	Total # of Stations	**172**				

Table 3.27 Asset Value and Expected Life Assumption for Wastewater Pumping Stations

Assumptions for WW Pumping Station		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil	40%	50
M&E	50%	20
ICA, Telemetry & SCADA	10%	10

Table 3.28 Unit Rate Assumptions for Wastewater Pumping Storage

Storage for Wastewater Pumping Stations	
In Ground Storage (from HW)	$2000 per m^3

Note: For wastewater pumping stations in the RWWFP, a set of greenfield (new) pumping stations unit rates (RWWFP Appendix E – Vertical Rate Wastewater) are used instead of the unit rates derived from existing wastewater pumping stations. The unit rates are different because the RWWFP was building new wastewater pumping station, whereas the IRP needed to determine unit rates for existing conditions for asset renewal. This information was discusses in a meeting with the RWWFP consultant team and the IRP team on Jan 31, 2012.

3.2.4 Wastewater Treatment Facility

The costs of the wastewater treatment facilities were calculated by XCG (see memo Summary of IRP Growth and Cost Estimates) through cost curves (Table 3.29). Percentage of Asset Value and expected life is shown in Table 3.30. The civil components were assumed new and thus not replaced during the IRP. Only the M&E and ICA were renewed during the IRP. An expected life of 30 years is used for the M&E, equipment instead of 20 years. 20 years is consistent with the water/wastewater pumping stations and PRVs. The expected life of 30 years is used due to the staff at the WWTP maintaining the equipment thus increasing the expected life.

Table 3.29 Cost Breakdown of the Wastewater Treatment Facilities

Facility	Estimated Construction Cost – no contingencies (2012 $)	Project Cost (2012 $, 1.6 multiplier applied to construction costs)
Halifax WWTF	121,400,000	194,240,000
Dartmouth WWTF	78,300,000	125,280,000
Herring Cove WWTF	30,900,000	49,440,000
Lockview MacPherson WWTF	3,000,000	4,800,000
Middle Musquodoboit WWTF	1,600,000	2,560,000
North Preston WWTF	4,000,000	6,400,000
Uplands Park WWTF	1,700,000	2,720,000
Wellington WWTF	1,700,000	2,720,000
Frame WWTF	1,700,000	2,720,000
Springfield Lake WWTF	3,800,000	6,080,000
Mill Cove WWTF	59,600,000	95,360,000
Eastern Passage WWTF	22,900,000	36,640,000
BLT WWTF	13,700,000	21,920,000
Aerotech WWTF	12,500,000	20,000,000
	Total	**570,880,000**

Table 3.30 Asset Value and Expected Life Assumption for Wastewater Treatment Facilities

Assumptions for WWTF		
Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	30
ICA, Telemetry & SCADA	10%	10

3.3 STORMWATER

This section presents the unit rate for the point assets (stormwater pipes, culverts, and stormwater structures) related to the stormwater system.

3.3.1 Stormwater Pipes

The design life of the stormwater pipes is 75 years. The construction unit costs for stormwater pipes are from the HRM's 2007 Database with build-up and 2% indexing per year from 2007 to 2012. The build-up assumes installation costs are 60% of the supply costs, fill is $183 per m, and excavation is $62 per m. For storm pipe where the diameter is unknown, a 900 mm diameter at a depth of 2.5 m is assumed. A breakdown of the unit costs for the stormwater pipes is in Table 3.31. An age breakdown of the stormwater pipes is shown in Table 3.32. The diameters of stormwater pipe are currently unknown and thus were modelled at a 900 mm diameter pipe made of concrete.

Table 3.31 Unit Rate Breakdown of Stormwater Pipes

Diameter (mm)	Storm Sewer - *PVC* *($/m)*	Storm Sewer - *Concrete 65D ($/m)*	Total Unit Cost(1.6) ($/m)
250	552	-	884
300	591	-	946
375	640	-	1,025
450	751	-	1,202
300	-	694	1,112
375	-	730	1,168
450	-	765	1,225
525	-	818	1,310
600	-	871	1,395
750	-	924	1,479
900	**-**	**977**	**1,564**
1050	-	1,048	1,677

Table 3.31 Unit Rate Breakdown of Stormwater Pipes

Diameter (mm)	Storm Sewer - *PVC ($/m)*	Storm Sewer - *Concrete 65D ($/m)*	Total Unit Cost(1.6) ($/m)
1200	-	1,154	1,847
1350	-	1,595	2,554
1500	-	1,949	3,120
1650	-	2,125	3,402
1800	-	2,302	3,685
2100	-	2,655	4,251
2400	-	3,009	4,816
3000	-	3,715	5,948

Table 3.32 Year Breakdown of Stormwater Pipes

Breakdown of Storm Sewers		
Decade	Length (km)	Replacement Cost $k
1950 - 59	24	36,967
1960 - 69	55	86,256
1970 - 79	118	184,834
1980 - 89	197	308,057
1990 - 99	197	308,057
2000 - 09	197	308,057
Total	**788**	**1,232,227**

3.3.2 Culverts

The expected life of a culvert was modelled to be 50 years. Unit construction costs are from HRM's 2007 unit rate with build-up and 2% indexing per year from 2007 to 2012. The build-up cost assumes the installation costs are 85% of the supply costs for concrete and 45% for HDPE; fill is $62 per m. Replacement is done with a 900 mm concrete culvert. The culvert crossing is approximately 20 m, 2.5 m depth to bottom of bedding, 1:1 construction with no trench box, 0.5 m between pipe and trench wall, and 0.3 m of bedding. The costs include headwall, traffic control, environmental protection, and restoration. The Unit rate breakdown of culverts is in Table 3.33. The size breakdown of culverts is shown in Table 3.34.

Table 3.33 Unit Rate Breakdown of Culverts

Diameter (mm)	Unit Cost ($/m)	Total Unit Costs (1.6)($/m)
Concrete		
450	706	1,131
525	714	1,143
600	825	1,320
750	963	1,542
900	1,102	1,764
1,050	1,195	1,913
1,200	1,287	2,061
1,350	1,657	2,653
1,500	2,027	3,245
1,800	2,397	3,838
HDPE		
450	1,519	2,432
500	1,567	2,509
550	1,631	2,612
600	1,695	2,714
650	1,759	2,817
700	1,823	2,919
750	1,887	3,022
800	2,032	3,252
900	1,951	3,124
1,000	2,112	3,380
1,050	2,192	3,509
1,200	2,272	3,637

Table 3.34 Size Breakdown of Culverts

Breakdown of Culverts		
Dia (mm)	**Length km**	**Total Cost($k)**
450	1.35	1,531
525	0.12	136
600	3.33	4,405
750	0.91	1,405
900	0.69	1,223
1,050	0.50	948
1,200	0.39	796
1,500	0.32	1,043
1,800	0.67	2,571
2,100	0.16	622
Total	**8.45**	**14,680**

3.3.3 Stormwater Structures

Stormwater structures replacement costs were based on replacing the culvert associated with a particulate stormwater structures: summarized in Table 3.35. Culvert replacement for the stormwater structures was done when the stormwater structure age reached 50 years (expected life of a culvert). Unit costs for culverts assumed the culverts are replaced by a concrete culvert of the same size; culverts were 20 m long, a diameter of 900 mm was assumed if the culvert did not have a diameter. Information about structures was provided by the Halifax Water Dam and other water control structure inventory/final report (September 2009). A detailed description of cost calculations is provided in Appendix 4.

Table 3.35 Summary of Stormwater Structures

Name	Type of Structure	Capacity (m^3)	Year of Constr.	Estimated Replacement Cost ($)
Oceanview Drive Retention Pond	Retention Pond	3,700	1990	98,040
Meadowbrook Retention Pond	Retention Pond	190	1980	80,520
Transom Drive Retention Pond	Retention Pond	9,900	2007	less than 50 yrs. at the end of IRP
Glenbourne Estates Retention Pond	Retention Pond	430	1990	105,840
Parkland Avenue Retention Pond	Retention Pond	36,000	1990	76,080
Glen Forest Weir / Retention Pond	Retention Pond	12	1960	96,960
Lacewood Retention Pond	Retention basin, dam and spillway	5,300	1970	141,660

Table 3.35 Summary of Stormwater Structures

Name	Type of Structure	Capacity (m^3)	Year of Constr.	Estimated Replacement Cost ($)
Susie Lake Control Structure	Concrete Sluice gate. Drains to Black Duck Pond	35,600	1989	n/a
Volvo West Retention Pond	Retention Pond	55,600	1990	n/a
Old Sambro Road Retention Pond	Retention Pond	20	1980	26,400
Graystone Road Retention Pond	Retention Pond	300	1980	no purpose n/a
Tamarack Drive Retention Pond	Retention Pond	270	1990	70,560
Heritage Hills Retention Pond	Retention Pond	13,800	1998	less than 50 yrs. at the end of IRP
Clement Street Retention Pond	Control Gates	244,000	1979	n/a
Maynard Lake Dam	Pipe and Gate	172,000	1960	n/a
Sullivan's Pond Culvert	Grated inlet to Culvert	44,000	1971	n/a (it is a dam)
Shubie Drive Retention Pond	Retention Pond	19,500	2007	less than 50 yrs. at the end of IRP
Countryview Drive Retention Pond	Retention Pond	3,200	2006	less than 50 yrs. at the end of IRP
Commodore Drive Retention Pond	Retention Pond	9,400	2006	less than 50 yrs. at the end of IRP
Lemlair Row Retention Pond	Retention Pond	15,300	2006	less than 50 yrs. at the end of IRP
Forest Hills Retention Pond	Retention Pond	5,000	1980	61,680
Cole Harbour Commons Retention Pond	Timber Headwall and Culvert	2,000	2007	less than 50 yrs. at the end of IRP
Guysborough Retention Pond	Retention Pond	9,000	1979	105,840
John Stewart Dr Retention Pond	Retention Pond	550	2005	less than 50 yrs. at the end of IRP
Stewart Harris Drive Retention Pond	Retention Pond	160	1978	116,880
Cranberry Lake Retention Pond	Retention Pond	108	1980	41,220
Gregory Drive Retention Pond	Retention Pond	80	2003	less than 50 yrs. at the end of IRP
Main Street Retention Pond	Retention Pond	130	1980	22,620
Kuhn Marsh Dam	Retention Pond and Dam	60,000	2008	less than 50 yrs. at the end of IRP
			Total	**$1,044,300**

4. CONCLUSIONS

This section provided the detail of the unit rates for the IRP. The unit rates are high level estimated due to the long term planning nature of the IRP.

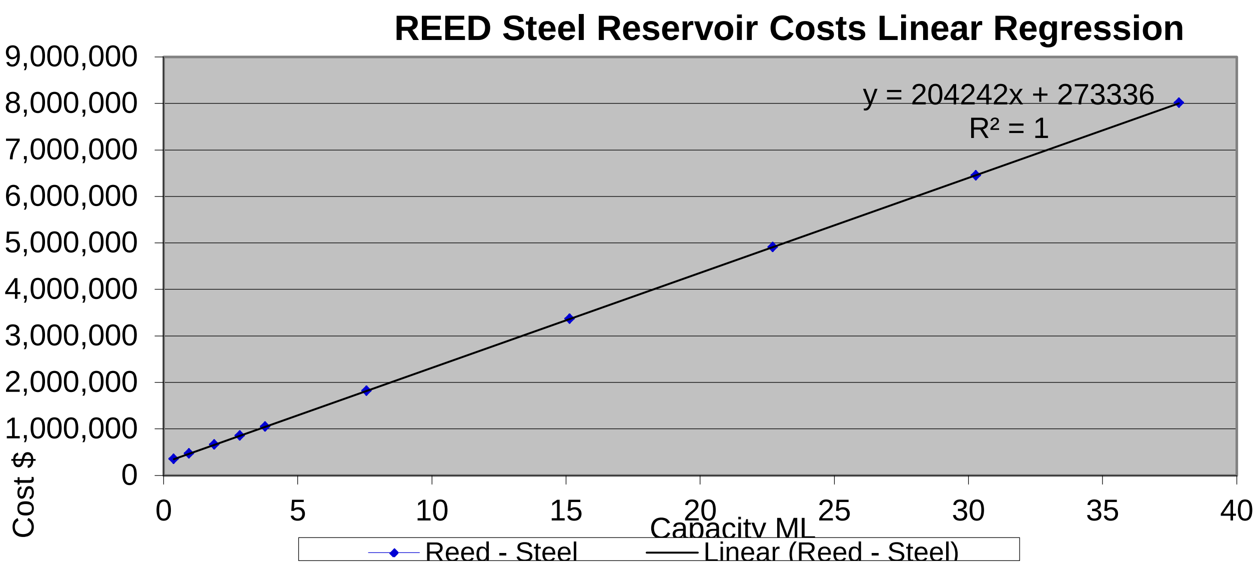
APPENDIX 1: WATER PUMPING STATIONS: CALCULATION OF THE UNIT RATE

2011 Insurance Renewal Values	NAME	CONSTRUCTION YEAR	PUMP CAPACITY	p1 (US gpm)	p2 (US gpm)	p3 (US gmp)	Qmax (US gpm)	Qmax (MLD)	$/MLD in 2011	$/MLD (elimating fire stations)
	Airport Fire Pumping Station (HIAA)	1960	2 fire pumps, 1@2000 USgpm, 1@1000 USgpm	2,500	1,250					
$802,463	Bennery Lake / Aerotech Pumping Station	1986	1 fire pump, 1@5000 USgpm	5,000			5,000	27	$29,443	
$534,975	Beaverbank Pumping Station	1999	2 reservoir feed pumps, 2@1170 USgpm	1,463	1,463		1,463	8	$67,106	
$427,980	Bedford South Pumping Station	2004	3 domestic pumps, 1@165 USgpm, 2@360 USgpm, 1 fire pump 1@1500 USgpm	660	720	655	720	4	$109,047	$109,047
$427,980	Bedford Village Pumping Station	1990	3 domestic pumps, 1@110 USgpm, 2@270 USgpm, 1 fire pump 1@2500 USgpm	440	491	491	491	3	$159,907	$159,907
$427,980	Crestview Pumping Station	1994	3 domestic pumps, 1@89 USgpm, 2@195 USgpm, no fire pump	356	355	355	356	2	$220,545	$220,545
$101,900	Eaglewood Pumping Station	1984	2 domestic pumps, 2@10 USgpm, no fire pump	13	13		13	0.1	$1,495,507	
$427,980	Lively Booster Station	2008	2 domestic pumps, 2@47.5 USgpm, no fire pump	59	59		59	0.3	$1,322,343	
$427,980	No. 7 Highway Pumping Station	1975	2 domestic pumps, 2@375 USgpm, 1 fire pump 1@1000 USgpm	469	469		469	3	$167,497	$167,497
$160,493	Silverside Pumping Station	1983	3 domestic pumps, 1@70 USgpm, 2@160 USgpm	280	291	291	291	2	$101,178	$101,178
$427,980	Upper Hammonds Plains Pumping Station	1999	2 domestic pumps, 2@200 USgpm, no fire pump	250	250		250	1	$314,057	$314,057
$34,773	Lyle Street Control Chamber	1991	1 emergency pump, 1@1667 USgpm	1,667			1,667	9	$3,827	
$1,069,950	Mount Edward Pumping Station	2004	3 domestic pumps, 1@340 USgpm, 2@650 USgpm, 1 fire pump 1@2000 USgpm	1,360	1,182	1,164	1,360	7	$144,327	$144,327
$427,980	Charles Road Pumping Station	1996	3 domestic pumps, 1@175 USgpm, 2@385 USgpm, no fire pump	700	700	700	700	4	$112,163	$112,163
$641,970	Cowie Reservoir Pumping Station	1975	2 domestic pumps, 2@870 USgpm, no fire pump	1,088	1,088		1,088	6	$108,295	$108,295
$267,488	Leiblin Pumping Station	1966	2 domestic pumps, 2@282 USgpm, 1 fire pump 1@1500 USgpm	353	353		353	2	$139,210	$139,210
$320,985	Parkdale Pumping Station	1984	2 domestic pumps, 2@160 USgpm, 1 fire pump 1@1000 USgpm	200	200		200	1	$294,428	
$534,975	Robie Street Emerg. Pump. Station	1990	1 emergency pump, 1@5000 USgpm	500			500	3	$196,285	$196,285
$427,980	St. Margarets Bay Road Pumping Station	2008	2 reservoir feed pumps, 2@600 USgpm	750	750		750	4	$104,686	$104,686
								Average	**$282,770**	**$156,433**

APPENDIX 2: CONCRETE RESERVOIRS: CALCULATIONS FOR REED STEEL RESERVOIRS

Summary of Cost Calculations using REED Steel Cost Linear Regression

Reservoir	Capacity (ML)	Cost Equation (y($)=204242x(ML)+273336)	With 1.6 Multiplier	Cost ($k) for Steel Reservoir Replacement
Mount Edward 1	22.7	$4,909,629	$7,855,407	$7,855
Cowie Hill	11.4	$2,601,695	$4,162,712	$4,163
Geizer 123	31.8	$6,768,232	$10,829,171	$10,829
Lakeside/Timberlea	5.4	$1,376,243	$2,201,988	$2,202
Meadowbrook	9.1	$2,131,938	$3,411,101	$3,411
Middle Musquodoboit	0.3	$334,609	$535,374	$535
Robie Street	15.9	$3,520,784	$5,633,254	$5,633



APPENDIX 3: INSURANCE COSTS FROM HALIFAX WATER FOR STEEL AND CONCRETE WATER RESERVOIRS

Summary of Insurance Cost for Water Storage Reservoirs

Reservoir Name & Elevation (S - Steel, C- Concrete)	Capacity (ML)	Insurance Renewal Values ($ 2012) [1,2]	Total Reservoir Cost ($k)
Geizer 158 (S)	36.4	12,223,109	19,556,974
Res Chamber		436,540	698,463
Geizer 123 (C) (interior)	31.8	5,744,861	9,191,778
Ext		4,950,359	7,920,574
Reservoir Meter		272,838	436,540
Reservoir Chamber		436,540	698,463
Dump Valve Control Chamber		545,675	873,079
Cowie (C)	11.4	3,666,933	5,867,092
Robie (C)	15.9	5,347,610	8,556,176
Lakeside/Timberlea (C)	5.4	2,182,698	3,492,317
Res Chamber		272,838	436,540
Mount Edward 1 (C)	22.7	5,456,745	8,730,792
Mount Edward 2 (S)	22.7	5,456,745	8,730,792
Akerley Blvd. (S)	37.7	13,139,842	21,023,747
Res Chamber		327,405	523,848
North Preston (S)	1.6	2,182,698	3,492,317
Meadowbrook (C)	9.1	3,274,047	5,238,475
Res Chamber		545,675	873,079
Sampson (S)	12.2	4,889,244	7,822,790
Res Chamber		218,270	349,232
Stokil (S)	23.6	7,945,021	12,712,033
Res Chamber		272,838	436,540
Waverley (S)	1.3	818,512	1,309,620
Res Chamber		272,838	436,540
Middle Musquodoboit (C)	0.3	436,540	698,463
Aerotech (S)	4.1	2,728,373	4,365,396
Beaver Bank (S)	6.9	2,864,791	4,583,666
Res Chamber		272,838	436,540

Notes:

1. Construction cost based on HW 2011 Insurance Renewal values with additional 2% for indexing.
2. Construction costs exclude land acquisition, and all off site costs

APPENDIX 4: COSTING METHODOLOGY OF STORMWATER STRUCTURES

Halifax Water owns twenty-nine (29) stormwater structures that consist of a variety of retention ponds with culverts, dams, control gates, and berms. In terms of asset renewal, the culverts were the only component to be replaced. Culverts are included in the unit costs for the IRP with an expected life of 50 years. Stormwater structures that were less than 50 years at the end of the IRP were not account for while stormwater structures that were greater than 50 years were replacement. Costing of control gates, dams, and berms was difficult as there were no unit costs available and all are unique. Stormwater structures that contained unique items were left out of the cost analysis.

For the cost analysis of the stormwater structures, the twenty-nine (29) items were broken down into four (4) groups:

1. Stormwater Structures that will be **greater** than 50 years at the end of the IRP (thirteen (13) structures). Replacement costs were calculated for the IRP.

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP	age to replace (at 50 years)
Oceanview Drive Retention Pond	Retention Pond	3700	1990	52	2040
Meadowbrook Retention Pond	Retention Pond	190	1980	62	2030
Glenbourne Estates Retention Pond	Retention Pond	430	1990	52	2040
Parkland Avenue Retention Pond	Retention Pond	36000	1990	52	2040
Glen Forest Weir / Retention Pond	Retention Pond	12	1965	77	2015
Lacewood Retention Pond	Retention basin, dam and spillway	5300	1970	72	2020
Old Sambro Road Retention Pond	Retention Pond	20	1980	62	2030
Tamarack Drive Retention Pond	Retention Pond	270	1990	52	2040
Forest Hills Retention Pond	Retention Pond	5,000	1980	62	2030
Guysborough Retention Pond	Retention Pond	9,000	1979	63	2029
Stewart Harris Drive Retention Pond	Retention Pond	160	1978	64	2028
Cranberry Lake Retention Pond	Retention Pond	108	1980	62	2030
Main Street Retention Pond	Retention Pond	130	1980	62	2030

2. Stormwater Structures that will be **less** than 50 years at the end of the IRP (ten (10) structures). These structures culvert costs were not calculated as structures have yet to reach the expected life of a culvert (50 years).

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP
Transom Drive Retention Pond	Retention Pond	9900	2007	35
Heritage Hills Retention Pond	Retention Pond	13800	1998	44
Shubie Drive Retention Pond	Retention Pond	19500	2007	35
Countryview Drive Retention Pond	Retention Pond	3200	2006	36
Commodore Drive Retention Pond	Retention Pond	9,400	2006	36
Lemlair Row Retention Pond	Retention Pond	15,300	2006	36
Cole Harbour Commons Retention Pond	Timber Headwall and	2,000	2007	35
John Stewart Dr Retention Pond	Retention Pond	550	2005	37
Gregory Drive Retention Pond	Retention Pond	80	2003	39
Kuhn Marsh Dam	Retention Pond and	60,000	2008	34

3. Stormwater Structures that need more investigation for cost estimates that are greater than 50 years at the end of the IRP (five (5) structures).

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP
Susie Lake Control Structure	Concrete Sluice gate.	35600	1989	53
Volvo West Retention Pond	Retention Pond	55600	1990	52
Clement Street Retention Pond	Control Gates	244000	1979	63
Maynard Lake Dam	Pipe and Gate	172000	1960	82
Sullivan's Pond Culvert (it is more of a Dam)	Grated inlet to Culvert	44,000	1971	71

Note: Clement Street Retention pond has an item in the Financial Model (1.006 Clement Street Berm removal and inlet structure reconfiguration" in 2016-17 for $100k.

4. Stormwater Structures that had an unknown purpose according to the "Halifax Water Stormwater Dams and other Water Control Structures Inventory Report" (there is one (1) structure)

Name	Type of Structure	Capacity (m3)	Year of Construction	Age at the end of the IRP
Graystone Road Retention Pond	Retention Pond	300	1980	62

Calculations for costs were only done the stormwater structures in item 1 (thirteen (13) stormwater structures). When using the unit costs for the culverts, the following was assumed:

- Culverts were to be replaced by concrete culverts of the same size
- Culverts were assumed to be 20m long
- The unit costs used assumed 2.5 depth to bottom bedding, 1:1 construction with no trench box, 0.5m between pipe and trench wall, and 0.3m bedding. Unit costs also included headwall, traffic control, environmental protection and restoration.
- For culverts that did not have a diameter, a diameter of 900mm was assumed
- If the exact size of a culvert was not accounted for in the unit costs, the next size up was used.

The cost breakdowns of the stormwater structure culverts with the above assumptions are shown in the following table:

				Cost for Inlet Culvert(s)				Cost of Outlet Culvert(s)				
Name	**age to replace (at 50 years)**	**Inlet**	**Outlet**	**#**	**dia (mm)**	**unit cost ($/m)**	**Total**	**#**	**dia (mm)**	**unit cost ($/m)**	**Total**	**TOTAL Cost for Culvert Replacement**
Oceanview Drive Retention Pond	2040	Three inlet culverts (two PVC 0.3m dia, and one conc. 0,6m)	One 0.6m diameter oncrete culvert	2	300	1131	$45,240	1	600	1320	$26,400	$98,040
				1	600	1320	$26,400					
Meadowbrook Retention Pond	2030	Two inlet steel culvert 0.4m in dia.	Outlet concrete box culvert (1.2m by 0.6m) cost at 0.9m dia	2	400	1131	$45,240	1	900	1764	$35,280	$ 80,520
Glenbourne Estates Retention Pond	2040	Two inlet culverts (assume 0.9m dia)	One outlet culvert (assume 0.9m conc.)	2	900	1764	$70,560	1	900	1764	$35,280	$ 105,840
Parkland Avenue Retention Pond	2040	Three concrete culvert inlet pipes (0.75m, 0.45m, and 045m in dia)	Control Weir	1	750	1542	$30,840					
				2	450	1131	$45,240					$ 76,080
Glen Forest Weir / Retention Pond	2015	Two inlet concrete culverts with a 0.6m diameter	Control weir in a box culvert that flows into a 0.6m concrete pipe	2	900	1764	$70,560	1	600	1320	$26,400	$ 96,960
Lacewood Retention Pond	2020	Inlet concrete culvert 1.5m dia, concrete overflow wall	Concrete outlet culvert 1.8m, concrete overflow wall	1	1500	3245	$64,900	1	1800	3838	$76,760	$ 141,660
Old Sambro Road Retention Pond	2030	One concrete inlet culvert 0.6m dia	0.6m opening to allow for flow	1	600	1320	$26,400					$ 26,400
Tamarack Drive Retention Pond	2040	One conc inlet culvert 0.9m in dia	One conc inlet culvert 0.9m in dia with concrete wall and PVC elbo	1	900	1764	$35,280	1	900	1764	$35,280	$ 70,560
Forest Hills Retention Pond	2030	Two conc culverts 0.9m and 0.6m in diameter	Berm	1	900	1764	$35,280					$ 61,680
				1	600	1320	$26,400					
Guysborough Retention Pond	2029	Three inlet culverts (assume 0.9m dia)	One outlet structure	3	900	1764	$105,840					$105,840
Stewart Harris Drive Retention Pond	2028	Two 0.3m and one 0.6m dia concrete culverts	Two 0.3m diameter steel pipes that will be replaced by conc. Culverts	2	300	1131	$45,240	2	300	1131	$45,240	$ 116,880
				1	600	1320	$26,400					
Cranberry Lake Retention Pond	2030	One concrete culvert 1.2 diameter	Marshy area	1	1200	2061	$41,220					$ 41,220
Main Street Retention Pond	2030	Intake structure	One concrete culvert 0.4m in dia					1	400	1131	$22,620	$ 22,620

The total cost of the culverts in stormwater structures during the IRP is $1,044,000. For each stormwater structure, a separate line item was included in the financial plan. The cost for replacement was put in when the stormwater structure would be 50 years old. The 50 years was used as it is the expected life of a culvert used for the IRP.

Currently in the Financial Plan, there is capital expenditure between 2013 and 2016 for a "Stormwater Structure Replacement Program".

Operating cost of the stormwater structures are not accounted for as the IRP only incremental costs are considered.

VOLUME 3 – APPENDIX D

Data Review Report

Halifax Water
Halifax Regional Water Commission

HALIFAX WATER INTEGRATED RESOURCE PLAN
TECHNICAL MEMORANDUM 1
WP1.6: DATA COLLECTION

TABLE OF CONTENTS

1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

In response to the Nova Scotia Utility and Review Board's (UARB) January 5, 2011 Order, Halifax Water initiated the development of an Integrated Resources Plan (IRP). The IRP was developed in order to balance competing priorities associated with delivering water, wastewater, and stormwater municipal services while respecting regulatory requirements, public health and good fiscal management.

This working paper is one of a series prepared in support of preparation of the IRP.

The specific objectives of this Data Collection Working Paper are to:

- Document information and data reviewed for the Halifax Water IRP Project;
- Consolidate interview notes; and,
- Identify any data gaps and, where applicable, recommend additional data collection.

1.2 DATA SOURCES

The following data sources were requested from Halifax Water and used to develop this Data Collection Working Paper 1.6:

- Historical consultants reports (list available from Halifax Water IRP RFP (Appendix B) were requested during the Kick-Off meeting with Halifax Water on June 23, 2011;
- Operational data, design briefs/drawings, year-end reports, permits to operate, flow quality data, and design briefs/drawings of planned WWTF upgrades, WaterTRAX data, and environmental risk assessments were requested from Halifax Water through e-mail correspondence;
- Asset management and financial information was requested from Halifax Water by e-mail correspondence;
- GIS information was collected from Halifax Water on compatible disc (CD);
- On-going Regional Wastewater Functional Plan Model data sets were obtained from CBCL Limited and AECOM on CD;
- Shearwater Hourly Precipitation Data was obtained from the Atlantic Climate Centre, Environment Canada, Fredericton, NB;
- Other relevant documentation was obtained through Halifax Water following discussions in various project progress meetings, Stakeholders meetings, workshops, etc.

2. WASTEWATER TREATMENT DATA COLLECTION

2.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop the Wastewater Treatment Baseline Review for capacity demand analysis, level-of-service requirements, and flow analysis and inflow/infiltration demands:

- Historic operating data for the previous three years, including raw wastewater flows, overflows, influent characteristics, treated effluent quality, and WWTF operational parameters;
- Design Briefs / drawings of plant construction / upgrades;
- Flow monitor details;
- Prior process and hydraulic assessments;
- Standard operating procedures (SOPs) and process control narratives;
- Design briefs / drawings for planned construction / upgrades;
- Receiving water assessments;
- Effluent requirements;
- Treatment operating Costs; and,
- Asset condition reports.

2.2 WASTEWATER TREATMENT DATA COLLECTED

Wastewater Treatment

- Dillon Consulting Limited, September 2003. HRM Wastewater Treatment Upgrade Study, Final Report prepared for Halifax Regional Municipality.

  This document provides information summaries for each treatment plant including proposed improvements, and associated capital costs and timing of the works.

- Halifax Regional Municipality, November 2004. HRM Wastewater Treatment Plants Risk Analysis, report prepared internally by Environmental Management Services.

  This document provides a risk analysis of each WWTP based upon data available as of October 2004 considering such factors as average daily flow, sewershed population, design capacity, remaining capacity, potential for expansion, infill potential, and projected population growth.

- HRWC, November 2009. CCME Canada-Wide Strategy for the Management of Municipal Wastewater Effluent – Work Plan, prepared internally.
- HRWC, August 2011. Wastewater Treatment Facilities (WWTF) Compliance Plan (Work-In-Progress), prepared internally.
- HRWC, August 2011. Tables: Halifax Water Wastewater Treatment Facilities Flow Analysis for 2007, 2008, 2009, and 2010, prepared internally.
- Jacques Whitford, March 1998. Moving Forward: A Concept Plan for Halifax Harbour Wastewater Treatment, Summary Document prepared for Halifax Regional Municipality.

  This document provides key information and analyses that were considered in developing a concept plan for this regional system. The concept plan itself includes a discussion of the issues and objectives, an assessment of major alternatives, estimates of costs, and recommendations.
- Jacques Whitford, April 2001. Screening Level Human Health Risk Assessment – Halifax Harbour Solutions Project, report prepared for Halifax Regional Municipality.

  This document is an undertaking of a Screening Level Risk Assessment to evaluate the potential risks to public health associated with the construction and operation of four proposed municipal sewage treatment plants that comprise the Halifax Harbour Solutions Project.

Wastewater Treatment Facilities (WWTFs)

- HRWC, November 2009. Business Plan – Wastewater Treatment Facilities, prepared internally.
- HRWC, June 2011. General Wastewater Treatment Data Needs for all WWTFs, prepared internally.
- HRWC, June 2011. Table: NSE Compliance Criteria for Wastewater Treatment Facilities, prepared internally.
- HRWC, June 2011. Table: WWTF Inventory including PID #'s, Treatment methods, sludge storage, back-up power, flow recorder, receiving watercourse, effluent parameters, and design average and peak flow data, prepared internally.

WWTF Design Briefs

- CBCL, July 2008. Mill Cove Wastewater Treatment Facility, South Side Secondary Clarifiers Assessment, RFP 07-330, prepared for Halifax Water.

- CBCL Limited, 2008. Halifax International Airport and Aerotech Water Supply and Wastewater Management Plan, report prepared for Halifax Regional Municipality.
- Degremont, November 2003. Halifax Sewage Treatment Plant Process Systems – Basis of Design, Document No.: HRM-STS-HX-STP-000-DOC-003, Original Issue, prepared for the Halifax Regional Municipality.
- Degremont, March 2006. Dartmouth Sewage Treatment Plant Process Systems – Basis of Design, Document No.: HRM-STS-DT-STP-DOC-GE-005, Issue for 65% Submittal, prepared for the Halifax Regional Municipality.
- Degremont, September 2007. Herring-Cove Sewage Treatment Plant Process Systems – Basis of Design, Document No.: HRM-STS-HC-STP-DOC-GE-005, Issue for Construction, prepared for the Halifax Regional Municipality.

WWTF Performance Charts

- HRWC, June 2011. Lakeside –Timberlea WWTF Rainfall–Flow to the WWTF – Non-Compliance Performance Chart for February 1, 2010 to June 30, 2011, prepared internally.
- HRWC, June 2011. Springfield Lake WWTF Rainfall–Flow to the WWTF – Non-Compliance Performance Chart for October 1, 2010 to June 30, 2011, prepared internally.

WWTF Bypass Events

- HRWC, December 2010. Tables: Mill Cove Overflow Data including Surge Tank Overflow Events 2007-2010 and Bedford Pump Station By-Pass Events 2007-2010, prepared internally.
- HRWC, June 2011. Tables: North Preston Overflows/By-Pass Events for September 2007 to July 2011, prepared internally.
- HRWC, July 2011. Tables: Eastern Passage Daily Flow and By-Pass Events for January 2010 to July 2011, prepared internally.
- HRWC, July 2011. Personal Correspondence regarding Overflow Events at Aerotech, Eastern Passage, Mill Cove, North Preston, Halifax, Dartmouth and Herring Cove WWTF overflow events, internal e-mail.

WWTF Operational Data

- HRWC, June 2011. Monthly Wastewater Treatment Facility Compliance Summaries, Rolling Averages for January 2010 to May 2011, tables prepared internally from WaterTrax Data.

- HRWC, June 2011. Regional CSO/SSO Reports for January 2010 and January 2011 to May 2011, tables prepared internally from WaterTrax data.
- HRWC, June 2011. Daily Measured Flows and Daily Rainfall – All WWTFs for July 2005 to June 2011, tables prepared internally.
- HRWC, September 2011. Halifax and Dartmouth including WWTF CSO/SSO Reports for April to June 2011, tables prepared internally from WaterTrax data.
- WaterTrax, December 2009. Wastewater Treatment Facility Compliance Summaries for period of January to December 2009, tables prepared by Halifax Regional Water Commission.
- WaterTrax, March 2010. Wastewater Treatment Facility Compliance Summaries for period of January to March 2010 (Q1), prepared by Halifax Regional Water Commission.
- WaterTrax, June 2010. Wastewater Treatment Facility Compliance Summaries for period of April to June 2010 (Q2), prepared by Halifax Regional Water Commission.
- WaterTrax, September 2010. Wastewater Treatment Facility Compliance Summaries for period of July to September 2010 (Q3), prepared by Halifax Regional Water Commission.
- WaterTrax, December 2010. Wastewater Treatment Facility Compliance Summaries for period of October to December 2010 (Q4), prepared by Halifax Regional Water Commission.
- WaterTrax, March 2011. Wastewater Treatment Facility Compliance Summaries for period of January to March 2011 (Q1), prepared by Halifax Regional Water Commission.

WWTF Permits to Operate

- NSDOE and Department of Public Health, August 1973. Joint Certificate of Approval for Municipal Water and Sewage Services, Steeves Subdivision sewage treatment plant, Approval No. 73-141, prepared for the Municipality of the County of Halifax.
- NSDOE and Department of Public Health, September 1980. Joint Certificate of Approval for Municipal Water and Sewage Services, Improvement and Reconditioning of the Frame Subdivision sewage treatment plant, prepared for the Municipality of the County of Halifax.
- NSDOE and Department of Public Health, October 1980. Joint Certificate of Approval for Municipal Water and Sewage Services, Improvement and Reconditioning of the Uplands Park sewage treatment plant, Approval No. 80-65, prepared for the Municipality of the County of Halifax.

- NSDOE and Department of Public Health, February 1982. Joint Certificate of Approval for Municipal Water and Sewage Services, Lakeside-Timberlea sewage treatment plant, prepared for the Municipality of the County of Halifax.
- NSDOE and Department of Public Health, January 1987. Joint Certificate of Approval for Municipal Water and Sewage Services, Eastern Passage Pollution Control Plant, prepared for the Municipality of the County of Halifax.
- NSDOE and Department of Public Health, September 1988. Joint Certificate of Approval for Municipal Water and Sewage Services, Springfield Lake Sewage System, Approval No. 88-103, prepared for Halifax County Municipality.
- NSDOE, August 1993. Permit to Construct and Operate Sewage Works, Lockview-MacPherson WWTF, PTC No. 93-35, prepared for the Municipality of the County of Halifax.
- NSDOE, August 1995. Approval to Construct and Operate Sewage Works, Mill Cove Sewage Treatment Plant Expansion, Phase 1, Package 2, Aeration and Digestion Systems, Bedford, Approval No. 95-77, prepared for the Municipality of the County of Halifax.
- Nova Scotia Environment, September 2004. Approval No. 2004-042134, Sewage Treatment Plant/ Sludge Dewatering for Aerotech Park, prepared for Halifax Regional Municipality.
- Nova Scotia Environment, January 2006. Approval No. 2005-048309, Approval to Construct and Operate Sewage Treatment Upgrade at North Preston, prepared for Halifax Regional Municipality.
- Nova Scotia Environment, February 2010. Approval No. 2010-070726, Approval to Transfer – Sludge Treatment Facility, N-Viro, prepared for Halifax Regional Municipality.
- Nova Scotia Environment, September 2010. Approval No. 2010-070605-A01, Approval to Operate – Dartmouth Sewage Collection & Treatment Plant, prepared for Halifax Regional Municipality.
- Nova Scotia Environment, September 2010. Approval No. 2010-074148, Approval to Operate – Herring Cove Sewage Collection & Treatment Plant, prepared for Halifax Regional Municipality.
- Nova Scotia Environment, December 2010. Approval No. 2010-075214, Approval to Operate – Halifax Sewage Collection & Treatment Plant, prepared for Halifax Regional Municipality.

WWTF Receiving Water Assessments

- ABL Environmental, January 2011. Wellington WWTF Replacement Receiving Water Supply Results, prepared for Halifax Water.

WWTF Standard Operating Procedures

- HRWC, November 2008. Calibration of Galvanic Chlorine Analyzer Standard Operating Procedure, prepared internally.

  The purpose of this task is to Bump Test the Galvanic Chlorine Analyzer.
- HRWC, April 2009. Mill Cove Water pollution Control Centre, Confined Space Entry Procedure, prepared internally.

  The purpose of this document is to describe HW Procedures for confined spaces at the Mill Cove WPCC.
- HRWC, June 2009. Biweekly partial draining and cleaning of DensaDeg Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure and maintain the proper operation of the DensaDeg system.
- HRWC, June 2009. Daily Check Aerzen Grit Blowers (Belt) Standard Operating Procedure, prepared internally.

  The purpose of this task is to check belt condition and tension on Aerzen grit blowers in grit blower room.
- HRWC, June 2009. Daily Check Sludge Sensor Standard Operating Procedure, prepared internally.

  The purpose of this task is to perform a daily check of sludge sensor for DensaDeg system.
- HRWC, June 2009. DensaDeg Daily Routine Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure and maintain the proper operation of the polymer injection system.
- HRWC, June 2009. DensaDeg Weekly Routine Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure and maintain the proper operation of the polymer injection system.
- HRWC, June 2009. Lawn Mowing Standard Operating Procedure, prepared internally.

  The purpose of this task is to Mow and whip grounds at waste treatment plant.
  HRWC, June 2009. Six monthly cleaning of polymer injection ring Standard Operating Procedure, prepared internally.
  The purpose of this task is to ensure and maintain the proper operation of the polymer injection system.

- HRWC, June 2009. Lockout/Tagout Standard Operating Procedure, prepared internally.

  The purpose of this task is to Lockout/Tagout.

- HRWC, June 2009. Use of Auto scrubber (micromatic 14e) Standard Operating Procedure, prepared internally.

  This is to ensure the safe and proper operation of the Auto scrubber equipment.

- HRWC, June 2009. Weekly Check For Filters Aerzen Grit Blowers Standard Operating Procedure, prepared internally.

  The purpose of this task is to perform weekly checks for grit on blowers.

- HRWC, Rev. June 2009. Activated Carbon Reactors Daily Check Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure and maintain the proper operation of the Activated Carbon Reactors, differential pressure, and potable water flow percentage.

- HRWC, Rev. June 2009. Activated Carbon Reactors (Weekly) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform weekly preventative maintenance on Activated Carbon Reactor System.

- HRWC, Rev. June 2009. Contractors on site Standard Operating Procedure, prepared internally.

  This is to ensure outside contractors are aware of Halifax Water policies on safety and security as well as SOP's directly related to the particular facility.

- HRWC, Rev. June 2009. Daily Oil Check Aerzen Grit Blowers Standard Operating Procedure, prepared internally.

  The purpose of this task is to check oil &top up if necessary on the Aerzen grit blower in grit blower room.

- HRWC, Rev. June 2009. Densadeg Lamellar Tube Cleaning Standard Operating Procedure, prepared internally.

  The purpose of this task is to safely reduce the sludge build up on the inside of Lamellar tubes.

- HRWC, Rev. June 2009. 50 hour lawn tractor maintenance Standard Operating Procedure, prepared internally.

  The purpose of this task is to lube all pivot points to ensure proper and continued operation of lawn tractor.

- HRWC, Rev. June 2009. Floor Degreasing Standard Operating Procedure, prepared internally.

  The purpose of this task is to remove any significant build-up of dirt on painted concrete floors.

- HRWC, Rev. June 2009. Mowing/Whipping Grass at North and South Gates Standard Operating Procedure, prepared internally.

  This is to ensure the North and South gates are locked out before cutting the grass in and around that general area.

- HRWC, Rev. June 2009. Odour Readings Standard Operating Procedure, prepared internally.

  The purpose of this task is to monitor hydrogen sulfide (H2S) levels in and around the HWWTF.

- HRWC, Rev. June 2009. Stilling Plate Removal Standard Operating Procedure, prepared internally.

  The purpose of this task is to remove stilling plates for cleaning and/or inspection.

- HRWC, Rev. June 2009. UV Module Removal Standard Operating Procedure, prepared internally.

  The purpose of this task is to remove UV modules to allow for service, inspection or cleaning.

- HRWC, Rev. June 2009. Weekly fine screens cleaning Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure the fine screening bar screens are kept free of debris build up, which if left unattended could interfere with proper operation of equipment.

- HRWC, Rev. June 2009. Wet Scrubber System (1 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform 1 month maintenance of the Wet Scrubber System.

- HRWC, Rev. June 2009. Wet Scrubber System (12 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform yearly maintenance of the Wet Scrubber System.

- HRWC, Rev. June 2009. Wet Scrubber System (3 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform quarterly maintenance of the Wet Scrubber System.

- HRWC, Rev. June 2009. Wet Scrubber System: Daily Checks Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure and maintain the proper operation of the wet scrubber system.

- HRWC, Rev. July 2009. 100 hour lawn tractor maintenance Standard Operating Procedure, prepared internally.

  The purpose of this task is to lube all pivot points, change engine oil and filter, replace spark plugs, replace fuel filter, replace air filter elements, clean engine cooling fins, check mower belts, sharpen/replace blades, clean bottom of mower deck, and check tire pressure, all to keep equipment operating in a satisfactory and efficient manner.

- HRWC, Rev. July 2009. Activated Carbon Reactor (12 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform 12 month preventative maintenance on Activated Carbon Reactor System.

- HRWC, Rev. July 2009. Activated Carbon Reactor (3 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform 3 month preventative maintenance on Activated Carbon Reactor System.

- HRWC, Rev. July 2009. Odour Control Fans (1 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform monthly preventative maintenance of Odour Control Fans System.

- HRWC, Rev. July 2009. Odour Control Fans (12 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform yearly preventative maintenance of Odour Control Fans System.

- HRWC, Rev. July 2009. Odour Control Fans (6 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform 6 month preventative maintenance of Odour Control Fans System.

- HRWC, Rev. June 2009. Odour Control Fans (Daily) Standard Operating Procedure, prepared internally.

  The purpose of this task is to check the overall condition and operation of the Odour Control Fans (Daily).

- HRWC, Rev. July 2009. Odour control Instruments (12 month) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform 12 month preventative maintenance on the Odour Control System's instrumentation.

- HRWC, Rev. July 2009. Odour control Instruments (Bi-Weekly) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform Bi-weekly preventative maintenance on the Odour Control System's instrumentation

- HRWC, Rev. July 2009. Odour control Instruments (Weekly) Standard Operating Procedure, prepared internally.

  The purpose of this task is to inspect and perform weekly preventative maintenance on the Odour Control System's instrumentation.

- HRWC, October 2009. Wet Well Entry Standard Operating Procedure, prepared internally.

  This is to ensure Halifax Water employees, contractors and visitors are aware of Halifax Water's policy and procedure in regards to entry into the wet well.

- HRWC, June 2010. Fire Alarm Bypass Standard Operating Procedure, prepared internally.

  The purpose of this task is to acknowledge and/or bypass the fire alarm system.

- HRWC, June 2009. Weekly Inspection of Oil Interceptor Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure proper operation of oil interceptor and prevent the release of sludge and hydrocarbons into the storm drains.

- HRWC, October 2009. Generator Failure Standard Operating Procedure, prepared internally.

  The purpose of this task is to ensure what to do in the event of a permanent generator failure.

- HRWC, unknown. List of Standard Operating Procedures at the Mill Cove WWTF, prepared internally.

  A list of standard operating procedures at the Mill Cove WPCC.

- HRWC, unknown. Standard Operating Procedures at the Mill Cove WWTF, prepared internally.

  Standard Operating Procedures at the Mill Cove WPCC.

2.3 WASTEWATER TREATMENT DATA GAPS

The following wastewater treatment data gaps were identified during the data collection process:

- Historical capital expenditure for WWTFs;
- No breakdown of assets to equipment/component level;
- No process/equipment installation dates (design briefs for Springfield Lake); and,
- No facility/equipment condition data.

Design Briefs missing for the following WWTFs

- Middle Musquodoboit.
- Springfield Lake.
- Uplands Park.
- North Preston.
- Lakeside-Timberlea.
- Mill Cove – only have a secondary clarifiers assessment, but not full plant.
- Fall River.
- Eastern Passage.

Drawings missing for the following WWTFs

- Wellington.
- Eastern Passage.
- Uplands Park – only have drawings for the UV Disinfection upgrade, but not full plant.

3. WATER TREATMENT DATA COLLECTION

3.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop the Water Treatment Baseline Review for capacity demand analysis and level-of-service requirements:

- Raw water source including any source water protection information;
- Historic operating data for the previous three years, including raw water flows, raw water characteristics, finish water quality, and WTP operational parameters;
- Design briefs/ drawings of plant construction/ upgrades;
- Prior process and hydraulic assessments;
- Standard Operating Procedures (SOPs) and process control narratives;
- Design briefs/drawings for planned construction/upgrades;
- Treatment operating costs; and,
- Asset condition reports.

3.2 WATER TREATMENT DATA COLLECTED

Water System Assessment Reports

- CBCL Limited, March 2004. Bennery Lake, System Assessment Report for Water Works, report prepared for Halifax Regional Municipality.

  This document provides a System Assessment Report for the Halifax International Airport (HIA) and the Aerotech Business Park water system as per the NSDEL Terms of Reference. The objective of the report was to evaluate and document the ability of the existing water supply, including the watershed, raw water intake, treatment facility, transmission system, distribution system, operational procedures, monitoring program, and management plan, to continually provide safe drinking water and indicate what improvements are necessary to meet accepted drinking water standards, including but not limited to, the Surface Water Treatment Standard.

- CBCL Limited, March 2004. Lake Major, System Assessment Report for Water Works, Final Report prepared for Halifax Regional Municipality.

  This document provides a System Assessment Report for the HRWC's East Region, consisting of the Lake Major Water Supply System servicing areas of the former City of Dartmouth, Cole Harbour, Forest Hills, Eastern Passage and Cherrybrook/Humber Park/Ross Road as per the NSDEL Terms of Reference. The objective of the report was to evaluate and document the ability of the existing water supply, including the watershed, raw water intake, pumping station, *treatment facility, transmission system, distribution system, operational procedures, monitoring program, and management plan, to continually provide safe drinking water and indicate what improvements are necessary to meet accepted drinking water standards, including but not limited to, the Surface Water Treatment Standard.*

- CBCL Limited, April 2004. Pockwock, System Assessment Report for Water Works, Final Report prepared for Halifax Regional Municipality.

  This document provides a System Assessment Report for the HRWC's Central and Western Regions, consisting of the Pockwock Water Supply System servicing areas of the former City of Halifax, Bedford, Sackville, Lakeside-Timberlea, Waverley, and Beaverbank as per the NSDEL Terms of Reference. The objective of the report was to evaluate and document the ability of the existing water supply, including the watershed, raw water intake, treatment facility, transmission system, distribution system, operational procedures, monitoring program, and management plan, to continually provide safe drinking water and indicate what improvements are necessary to meet accepted drinking water standards, including but not limited to, the Surface Water Treatment Standard.

- HRWC, March 2011. 2010 Annual Drinking Water Systems Reports, Final Report prepared for Nova Scotia Environment.

  This document is an annual drinking water systems report as required by HRWC's permits for Pockwock Lake (2008-061444-R02), Lake Major (2009-067618), Bennery Lake (2009-067617), and five small systems.

Water Permits

- Nova Scotia Department of the Environment, January 1985. Application for the Withdraw of Water from Lake Fletcher for Domestic Water Supply in Collins Park Subdivision, issued to the Municipality of the County of Halifax.

  Application for water withdraw from Fletchers Lake for the Collins Park Subdivision.

- Nova Scotia Department of the Environment, January 1990. License under the Water Act, Water Withdrawal from Bennery Lake, issued to the Municipality of the County of Halifax and The Halifax County Industrial Commission.

  This License is for the withdrawal of water from Bennery Lake to supply water to Aerotech Business Park and the Halifax International Airport.

- Nova Scotia Department of the Environment, January 1990. License Under the Water Act, Water Withdrawal from Chain Lakes (First and Second Lakes), issued to the Municipality of the County of Halifax and The Halifax County Industrial Commission.

This License is for the withdrawal of water and maintenance of Chain Lakes (First and Second Lakes) as a backup municipal water supply for use when needed to augment the supply from Pockwock Lake. The nature of works includes the dam and pump house at the outlet of Chain Lakes; a diversion dam on Bayers Brook, and water conveyance structures between Long Lake and Chain Lakes.

- Nova Scotia Department of the Environment, January 1992. License Under the Water Act, Water Withdrawal from Lamont and Topsail Lakes, issued to the City of Dartmouth Water Utility.

  This License is for the withdrawal Lamont and Topsail Lakes with the average rate of withdrawal being 45 million litres per day and the maximum rate of withdrawal being 67 million litres per day for the municipal water supply.

- Nova Scotia Department of the Environment and Labour, November 2002. Approval, for Withdrawal and Water Distribution (Elmsdale), issued to the Municipality of the County of Halifax.

  Approval for withdraw and distribution of groundwater to supply local water haulers with potable water (one drilled well, 150mm diameter).

- Nova Scotia Environment and Labour, March 2008. Approval to Operate – Water Supply System Serviced by a Surface Water Treatment Facility (Bennery Lake), Approval No. 2008-061096, issued to Halifax Regional Water Commission.

  This Approval #2008-061096 is for operation of a Water Supply System serviced by a surface water treatment facility at Enfield, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2003-032187-R01 which is now null and void.

- Nova Scotia Environment and Labour, March 2008. Approval to Operate – Water Supply System Serviced by a Surface Water Treatment Facility (Lake Major), Approval No. 2008-061077, issued to Halifax Regional Water Commission.

  This Approval #2008-061077 is for operation of a Water Supply System serviced by a surface water treatment facility at 341 Cherry Brook Rd, Westphal, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2003-032060 which is now null and void.

- Nova Scotia Environment and Labour, March 2008. Approval to Operate – Water Treatment Facility (Collins Park), Approval No. 2008-061168, PID#20010105, issued to Halifax Regional Water Commission.

  This Approval #2008-061168 is for operation of a Water Treatment Facility in Wellington, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2003-032041 which is now null and void.

- Nova Scotia Environment and Labour, March 2008. Approval to Operate – Water Treatment Facility, Approval No. 2003-031924, PID#40052664 (Five Island Lake), issued to Halifax Regional Water Commission.

  This Approval #2003-031924 is for operation of a Water Treatment Facility at Five Island Lake, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2003-031924 which is now null and void.

- Nova Scotia Environment and Labour, March 2008. Approval to Operate – Water Treatment Facility, Approval No. 2008-061166, PID#40583908 (Middle Musquodoboit), issued to Halifax Regional Water Commission.

  This Approval #2008-061166 is for operation of a Water Treatment Facility in Middle Musquodoboit, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2003-032598 which is now null and void.

- Nova Scotia Environment and Labour, March 2008. Approval to Operate – Water Treatment Facility (Miller Lake), Approval No. 2008-061211, PID#40103244, issued to Halifax Regional Water Commission.

  This Approval #2008-061211 is for operation of a Water Treatment Facility in Fall River, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2002-031152-R01 which is now null and void.

- Nova Scotia Environment and Labour, March 2008. Approval to Operate – Water Treatment Facility (Silver Sands), Approval No. 2008-061151, PID#40192775, issued to Halifax Regional Water Commission.

  This Approval #2008-061151 is for operation of a Water Treatment Facility in Cow Bay, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2003-032043 which is now null and void.

- Nova Scotia Environment, December 2008. Approval to Withdrawal Water – Lake Major, Approval No. 2006-055292, issued to Halifax Regional Water Commission.

  This Approval #2006-055292 is for water withdrawal from Lake Major in Halifax County, Nova Scotia for surface water supply for Municipal Drinking Water Supply.

- Nova Scotia Environment, December 2008. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Middle Musquodoboit) – PID #40583908, HRM, NS, issued to Halifax Regional Water Commission.

  NSE indicates that the facility will not be in compliance with 2004 municipal standards. Letter indicates that remedial measures will have to be implemented as prescribed.

- Nova Scotia Environment, December 2008. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Miller Lake) – PID #40103244, HRM, NS, issued to Halifax Regional Water Commission.

  NSE indicates that the facility will not be in compliance with 2004 municipal standards. Letter indicates that remedial measures will have to be implemented as prescribed.

- Nova Scotia Environment, December 2008. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Silver Sands) – Densadeg PID #40192775, HRM, NS, issued to Halifax Regional Water Commission.

  NSE indicates that the facility will not be in compliance with 2004 municipal standards. Letter indicates that remedial measures will have to be implemented as prescribed.

- Nova Scotia Environment, January 2009. Approval to Withdrawal Water – Fletcher's Lake, Amended, issued to Halifax Regional Water Commission.

  This Approval #2009-069294-A01 was amended from Approval #2009-069294 to correct a typographical error is amount of water allocated for maximum withdrawal (160,000 litres per day).

- Nova Scotia Environment, February 2009. Letter regarding Application for Approval to Withdrawal Water (groundwater), 11 Dyke Road, Cow Bay (Silver Sands Subdivision), issued to Halifax Regional Water Commission.

  A letter stated acknowledgement for the Application for Approval for water withdraws from Cow Bay.

- Nova Scotia Environment, April 2009. Approval for Groundwater Withdrawal – Halifax Regional Water Commission, 11 Dyke Road, Cow Bay (Silver Sands Well Field), Application No. 2009-065889, PID#40844631, issued to Halifax Regional Water Commission.

  This Approval #2009-065889 is for water withdraw from the Well#2 located at 11 Dyke Road in Cow Bay, NS.

- Nova Scotia Environment and Labour, June 2009. Approval to Operate – Water Supply System Serviced by a Surface Water Treatment Facility (Bennery Lake), Approval No. 2009-067617, issued to Halifax Regional Water Commission.

  This Approval #2009-067617 is for operation of a Water Supply System serviced by a surface water treatment facility at Enfield, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2008-061096 which is now null and void.

- Nova Scotia Environment and Labour, June 2009. Approval to Operate – Water Supply System Serviced by a Surface Water Treatment Facility (Lake Major), Approval No. 2009-067618, issued to Halifax Regional Water Commission.

  This Approval #2009-067618 is for operation of a Water Supply System serviced by a surface water treatment facility at 341 Cherry Brook Rd, Westphal, Halifax Regional Municipality, Nova Scotia. This Approval replaces previous approval number 2008-061077 which is now null and void. This Approval is a copy of the previous Approval 2008-061077 and has been reissued to correct NSE database issue.

- Nova Scotia Environment, August 2009. Approval to Withdraw Water – Musquodoboit River, issued to Halifax Regional Water Commission.

  This Approval #2009-065892 is for water withdraw from the Musquodoboit River.

- Nova Scotia Environment, September 2009. Approval to Withdrawal Water – Lamont Lake, Approval No. 2009-067056, issued to Halifax Regional Water Commission.

  This Approval #2009-067056 is for water withdrawal from Lamont Lake in Halifax Regional Municipality, Nova Scotia.

- Nova Scotia Environment, October 2009. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Five Island Lake) Amended Oct. 9, 2009 – PID #40052664, HRM, NS, issued to Halifax Regional Water Commission.

  NSE outlines amendments to sampling protocols and reporting requirements.

- Nova Scotia Environment, October 2009. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Miller Lake) Amended Oct. 9, 2009 – PID #40103244, HRM, NS, issued to Halifax Regional Water Commission.

  NSE outlines amendments to sampling protocols and reporting requirements.

- Nova Scotia Environment, October 2009. Letter regarding Environmental Act – Measures as required by an Inspector – January 1, 2009 – Water Treatment Facility (Silver Sands) – Amended – PID #40192775, HRM, NS, issued to Halifax Regional Water Commission.

  NSE outlines amendments to sampling protocols and reporting requirements.

- Nova Scotia Environment, December 2009. Extension of Time, File No. 18-86-0025-09, License No. 2840 – Bennery Lake, Halifax Regional Municipality, issued to Halifax Regional Water Commission.

  This Extension of Time was granted to Authorization #2840 under the Environment Act with the expiry date extended to August 31, 2010. This extension is to be attached to the Approval.

- Nova Scotia Environment, December 2009. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Collins Park) – PID #20010105, HRM, NS, issued to Halifax Regional Water Commission.

  NSE indicates that the facility will not be in compliance with 2004 municipal standards. Letter indicates that remedial measures will have to be implemented as prescribed.

- Nova Scotia Environment, December 2009. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Five Island Lake) – PID #40052664, HRM, NS, issued to Halifax Regional Water Commission.

  NSE indicates that the facility will not be in compliance with 2004 municipal standards. Letter indicates that remedial measures will have to be implemented as prescribed.

- Nova Scotia Environment, December 2009. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Collins Park) Amended – December 29, 2009 – PID #20010105, HRM, NS, issued to Halifax Regional Water Commission.

  NSE appended the directive 2008-061168-DIR-090101 to 2009-061168-DIR-090101-A1. I.e. On or before March 31, 2010, the Owner shall implement the required construction and operational systems to ensure that the treated water meets the following treatment standards and provide a report by March 17, 2010 indicating compliance with this provision.

- Nova Scotia Environment, December 2009. Letter regarding Environmental Act – Measures as Required by an Inspector – January 1, 2009 – Water Treatment Facility (Middle Musquodoboit) Amended – December 29, 2009 – PID #400583908, HRM, NS, issued to Halifax Regional Water Commission.

  NSE appended the directive 2008-061166-DIR-090101 to 2009-061166-DIR-090101-A1. I.e. On or before March 31, 2010, the Owner shall implement the required construction and operational systems to ensure that the treated water meets the following treatment standards and provide a report by March 17, 2010 indicating compliance with this provision.

- Nova Scotia Environment, March 2010. Approval No. 2009-068230, Authorization No. 284, Water Withdrawal (Bennery Lake), issued to Halifax Regional Water Commission.

  This Approval #2009-068230 is for water withdrawal from Bennery Lake. The Average Rate of Withdrawal is 2,300,000 litres/day (averaged over 30 days) and the Maximum Rate of Withdrawal is 2,300,000 litres/day (averaged over 3 days).

- Nova Scotia Environment, December 2010. Approval to Operate – Water Treatment Facility, Approval No. 2008-061444-R02, PID#00330985 (Pockwock), issued to Halifax Regional Water Commission.

  This Approval #2008-061444-R02 is for operation of a water treatment facility at 1749 Pockwock Rd, Halifax, Halifax Regional Municipality, Nova Scotia. The Approval supersedes existing approval number 2008-061444-R01 which is now null and void.

- Nova Scotia Environment, January 2011. Extension of Time, Water Withdrawal Authorization #3056, Water Withdrawal from Chain Lakes (First and Second Lakes) for emergency backup water supply issued to Halifax Regional Water Commission.

  This Extension of Time was granted to Authorization #3056 under the Environment Act with the expiry date extended to June 30, 2011. This extension is to be attached to the Approval.

- Nova Scotia Environment, February 2011. Approval to Operate – Water Supply System Serviced by Non-GUDI Wells with Disinfection only, Approval No. 2010-074268, issued to Halifax Regional Water Commission.

  This Approval #2010-074268 is for operation of a Water Supply System Serviced by Non-GUDI Wells with disinfection only at 130 Dreamcatcher Lane, Hubley, Halifax Regional Municipality, Nova Scotia. This Approval replaces Directive number 2003-031924-R01-DIR-090101 which is now null and void.

- Nova Scotia Environment, March 2011. Approval to Operate – Water Supply System Serviced by Non-GUDI Wells with Disinfection only, Approval No. 2010-074268-A01, issued to Halifax Regional Water Commission.

  This Approval #2010-074268-A01 is for operation of a Water Supply System Serviced by Non-GUDI Wells with disinfection only at 130 Dreamcatcher Lane, Hubley, Halifax Regional Municipality, Nova Scotia. This Approval replaces Directive number 2010-074268 which is now null and void.

- Nova Scotia Environment, March 2011. Letter regarding Removal of Chemical Advisory from Five Island Lake Water Supply System, issued to Halifax Regional Water Commission.

  This letter recommends removal of the chemical advisory and enhanced sampling.

- Nova Scotia Environment, June 2011. Approval for Storage of Water/Water Withdrawal for the Purpose of Emergency Backup Water Supply-Chain Lakes: Approval No. 2010-072107, Authorization #3056, issued to Halifax Regional Water Commission.

  This Approval #2010-072107 is for Storage of Water/Water Withdrawal for the purpose of Emergency Backup Water Supply – Chain Lakes at Halifax, Halifax Regional Municipality, Nova Scotia. The Maximum Rate of Withdrawal is 82,000,000 litres/day (averaged over 3 days).

- Nova Scotia Environment, August 2011. Approval for Storage of Water/Water Withdrawal for the Purpose of Emergency Backup Water Supply-Chain Lakes: Approval No. 2010-072107 – A01, Authorization #3056, issued to Halifax Regional Water Commission.

  This Approval #2010-072107-A01 is for Storage of Water/Water Withdrawal for the purpose of Emergency Backup Water Supply – Chain Lakes at Halifax, Halifax Regional Municipality, Nova Scotia. The Maximum Rate of Withdrawal is 82,000,000 litres/day (averaged over 3 days).

- Nova Scotia Environment, August 2011. Approval to Operate – Water Supply System Serviced by Non-GUDI Wells with Greensand Filtration and Disinfection, Approval No. 2011-077957, issued to Halifax Regional Water Commission.

  This Approval #2011-077957 is for operation of a Water Supply System Serviced by Non-GUDI Wells with greensand filtration and disinfection at 11 Dyke Road in Cow Bay, Halifax Regional Municipality, Nova Scotia.

- Nova Scotia Water Resources Commission, June 1971. Application for Water Rights, Application No. 71-W-32, File No. 80-20L (Pockwock Lake), issued to Public Service Commission of Halifax.

  This Application was for the provision of a source supply capacity for the public water supply system serving present and future consumers in the City of Halifax and present and future consumers residing in the Municipality of the County of Halifax. Includes portion of the Northeast River, so called, in the counties of Halifax and Hants, commencing at the outlet of Pockwock Lake and extending upstream to include all of Pockwock Lake and all lakes and streams tributary to Pockwock Lake.

- Nova Scotia Water Resources Commission, June 1971. Application for Water Rights, Application No. 71-W-33, File No. 80-21L (Tomahawk Lake), issued to Public Service Commission of Halifax.

  This Application was for the provision of a source supply capacity for the public water supply system serving present and future consumers in the City of Halifax and present and future consumers residing in the Municipality of the County of Halifax. Includes portion of the Sackville River, so called, in the county of Halifax, commencing at the outlet of Tomahawk Lake and extending upstream to include all of Tomahawk Lake and all lakes and streams tributary to Tomahawk Lake.

Water System Headworks

- CBCL et al., 1977. Records Drawings, Regional Water Supply System, Contract No. 72306, Pockwock Water System, issued to Public Service Commission of Halifax.

  This set of documents includes the record drawings for the Pockwock Water System including General Site Works (8 dwgs), Dam (11 dwgs), Pumping Station (34 dwgs), Treatment Plant Site Works (14 dwgs), Treatment Plant Structure (65 dwgs), Treatment Plant Mechanical (19 dwgs), Treatment Plant Electrical (29 dwgs), and Supervisory System drawings (3 dwgs).

- UMA et al., November 1985. Aerotech Business Park Water Treatment Plant, issued Halifax County Industrial Commission.

  This set of documents includes the drawings for the Aerotech Water Treatment Plant including layout plans, sections and details.

3.3 WATER TREATMENT DATA GAPS

The following water treatment data gaps were identified during the data collection process:

- Historical capital expenditure for treatment plants;
- No breakdown of assets to equipment/component level;
- No process/equipment installation dates; and,
- No facility/equipment condition data.

4. WATER DISTRIBUTION DATA COLLECTION

4.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop the Water Distribution Baseline Review for capacity demand analysis and level-of-service requirements:

- Pressure one delineation maps;
- Water distribution system plan;
- Water distribution system attribute data (pipes, valves, and other appurtenances);
- Water pumping station design and capacity data;
- Storage facilities location, capacity;
- System control and monitoring capabilities;
- Water demand data;
- Water distribution system design criteria;
- Planning, capacity assessment and design reports;
- Asset condition reports and mapping;
- Water efficiency programs;
- System model(s) and documentation;
- System performance requirements; and,
- System operating costs.

4.2 WATER DISTRIBUTION DATA COLLECTED

Water Master Plans

- CBCL Limited, May 1998. Beechville/Lakeside/Timberlea Water Infrastructure Master Plan, report prepared for Halifax Regional Water Commission.

  This document provides the results of a hydraulic study, both in the short-term and in the long-term for the fully developed Beechville/Lakeside/Timberlea water service district. The study included assessment of possible integration of the pipe networks from the Pockwock transmission system, proposed reservoirs and future pressure zones for the adjacent areas.

- CBCL Limited, May 1999. Birch Cove North / Bedford West Water Infrastructure Master Plan, report prepared for Halifax Regional Water Commission.

  This document provides the results of a hydraulic study, both in the short-term and in the long-term for the fully developed Birch Cove North/Bedford West water service district. The study included assessment of possible integration of the pipe networks from the Pockwock transmission system, proposed reservoirs and future pressure zones for the adjacent areas.

- CBCL Limited, July 1999. East Region (Dartmouth) Water Infrastructure Master Plan, report prepared Halifax Regional Water Commission

  This document provides an assessment of the hydraulic conditions in Dartmouth while the Lake Lamont Pump Station was in operation and when the recently constructed Lake Major Water Treatment Plant and 1050mm diameter transmission main where commissioned. The report identifies and prioritizes cost infrastructure improvements required to enhance system performance and reliability in Central Dartmouth (downtown), North Dartmouth (Burnside), South Dartmouth (including Woodside), and East Dartmouth including Westphal, Port Wallis, Woodlawn, Portland Estates and the existing pumped zone south o Mount Edward Road.

- CBCL Limited, April 2007. Duke Street / Glendale Avenue Area Water Master Plan, report prepared for Halifax Regional Water Commission.

  This document presents an analysis of the local distribution system in the Duke Street and Glendale Ave area and develops a water servicing plan that will not only provide an adequate, reliable supply to the proposed development, but will maximize opportunities to create an integrated water network for the future, long term needs of development in adjacent areas, including lands located between Bedford and Dartmouth (Burnside Industrial Park).

- CBCL Limited, March 2008. Services Extension to Lively Subdivision – Water System Master Plan, report prepared for Halifax Regional Municipality.

  This study presents a water services plan for both short-term and long-term development scenarios in the area of the Lively Subdivision.

- EarthTech (Canada) Inc. and CBCL, January 2006. Water Quality Master Plan, Main Report – Final prepared for Halifax Regional Water Commission.

  This document describes the decision-making process of the HRWC regarding drinking water quality, including source water protection. In addition, a decision on how the new and upgraded water treatment infrastructure will be implemented in future is included. The Plan will provide direction on water quality targets to be achieved at the HRWC and outline a rational process for decision making as standards change and issues emerge.

- HRWC, January 2007. Table – Water Quality Master Plan, table prepared internally.

  This document presents several global water quality goals, as well as HRWC water quality goals, strategies, and tasks/programs between 2006 and 2011.

- Vaughan Engineering, July 2000. Morris – Russell Lake Water Service Master Plan, report prepared for Halifax Regional Water Commission.

  This document presents an analysis of existing and future water transmission and storage systems required for development of the Morris Lake and Russell Lake lands. The study also includes an assessment of the water service to Eastern Passage.

Servicing and Regional Water Studies

- CBCL Limited, March 1991. Analysis of Bedford South Water Study, prepared for Halifax County Municipality.

  This document reviews and evaluates the Bedford South Water Study prepared by Project Consultants Ltd. for the Town of Bedford. The reason for this analysis was to focus on the engineering aspect of the study and future extensions to strengthen the Halifax County's water transmissions and distribution system and thus provide a consistent and reliable service. This review is directed more toward the development strategy and concepts for servicing the area (which is outside of the original serviceable boundary) rather than comment on the great array of computer network models presented in the study.

- CBCL Limited, September 1993. Metropolitan Area of Halifax County, Regional Water Study, Engineering and Financing, prepared for Nova Scotia Department of Municipal Affairs, Halifax County Municipality, Halifax Water Commission, and Dartmouth Water Utility.

  This document evaluates the technical and economic feasibility of a Regional Water Supply System for the Metropolitan area of Halifax County. This area includes all regional serviceable lands of the Halifax Water Commission, the City of Dartmouth Water Utility and the Halifax County Water Utility. Regional demands for water were projected over twenty years based on water production and consumption statistics from the past five years and serviced population projections.

- CBCL Limited, June 2007. Consulting Services – Watershed Study, Musquodoboit Harbour, Final Report prepared for Halifax Regional Municipality.

  This document provides HRM with the information necessary to make some decisions with respect to future development in Musquodoboit Harbour. Specific objectives include: Identifying opportunities or development in a study area that *includes the community of Musquodoboit Harbour as well as the peninsula between Musquodoboit Harbour and Petpeswick Inlet; and developing a site specific plan showing all land suitable for development complete with recommended development densities and the services required to allow these densities to be realized. Potential for provision of services was based on the general work conducted and presented in the Final Report on "Options for On-site & Small Scale Wastewater Management", Land Design Engineering Services et al, March 2005.*

- CBCL Limited, August 2009. Hubbards Watershed Servicing Study, Final Report prepared for Halifax Regional Municipality.

  This document provides a mean to evaluate opportunities for the provision of services required for the development of the Hubbards including potable water, wastewater treatment and disposal and stormwater management while minimizing negative impacts on the natural environment. As requested by the study's Steering Committee, the development opportunities and system designs were assessed for the settlement as a whole and did not consider separate systems for HRM and Chester District.

- CBCL Limited, May 2010. Musquodoboit Harbour Follow-Up Study Report, Draft Report prepared for Halifax Regional Municipality.

  This document assessed the assimilative capacity that could be made available by reducing inputs from known, suspected defective or malfunctioning wastewater collection and treatment systems; defined an optimum configuration for a small scale wastewater management system; determined the feasibility and cost of providing central water supply without other services; confirmed the suitability of the Musquodoboit River and Little River as potential supplies of raw water for a central water system; determined the impacts o possible contaminant sources on water taken from potential wells adjacent to the Musquodoboit River; estimated future achievable population growth, density and distribution over a 5 to 10 year horizon in the community with on-site services, central water only or central water and wastewater services, accounting for projected commercial development; and analyzed existing water quality data for the Little River and assess potential sources.

- Dillon Consulting Limited, February 2003. Nine Mile River Assimilation Study, Final Report prepared for Halifax Regional Municipality.

  This document provides the results of the assimilation study completed to assist HRM in setting long-term environmental and development objectives within the Lakeside-Timberlea service area and within the watershed of the Nine Mile River. The document also provides a discussion paper regarding the upgrade and *expansion of the Beechville-Lakeside-Timberlea (BLT) Wastewater Treatment Plant including historical development, changes in the regulatory regime, and the proposed expansion and upgrade program for the facility. The document includes a sub-report prepared by Jacques Whitford entitled "Stream Flow Gauging at Nine Mile River," that was completed on November 18, 2005.*

- Jacques Whitord, March 2009. Fall River-Shubenacadie Lakes Watershed Study, report prepared for Halifax Regional Municipality.

  There were two phases of the Fall River-Shubenacadie Lakes Watershed Study project: Phase I involved the assessment of specific options for water and wastewater servicing with specific emphasis on the Fall River Growth Centre and all River Commercial District; and Phase II involved the development of recommendations for sustainable environmental management of the watershed as a whole. In order to identify the constraints and opportunities that relate to effective watershed management and appropriate land development and growth boundaries, the following areas were studied: ecological resources; groundwater resources; receiving waters capacity; and water and wastewater servicing options based on area-specific technical considerations and financial costs.

- HRWC, July 2011. Table – Similar to Table 5.5.1 in the Report for a Water System to Service 720 Units or Equivalent, 100mm pipe, table prepared internally.
- HRWC, July 2011. Table – Similar to Table 5.5.1 in the Report for a Water System to Service 720 Units or Equivalent, 100mm and 150mm pipe, table prepared internally.
- HRWC, July 2011. Table – Similar to Table 5.5.1 in the Report for a Water System to Service 674 Units or Equivalent, 100mm pipe, table prepared internally.
- Dillon Consulting Limited, December 2002. HRM Water Resource Management Study Report prepared for Halifax Regional Municipality.

  This document summaries key water resource management issues for HRM and provides recommendations and implementation mechanisms for addressing these issues.

- Porter Dillon Limited, May 1997. Sackville Servicing Study Phase B Future Growth Impact Assessment, Final Report prepared for Halifax Regional Municipality.

  This report documents the study objectives, the future growth candidates development areas assessed, existing municipal services, future infrastructure requirements to service Candidate Areas, capital cost estimates and recommendations for short term remedial action.

- Harbour Engineering, July 1999. Integrated Servicing Study, Final Report prepared for Halifax Regional Municipality, Regional Operation.

  The primary object of this study was to identify development constraints and opportunities in the urban region with respect to trunk services, road networks, and public transit corridors and facilities.

- CBCL Limited, May 2004. Herring Cove Water and Sewer Services, Pre-Design Study prepared for Halifax Regional Municipality.

  The main objective of this pre-design report was to determine the layout and sizing of municipal infrastructure require to service Herring Cove with water and sanitary sewer as well as to identify any required upgrades to the infrastructure "upstream" of the community. The other main objective was to develop a detailed cost estimate of the water and sanitary services.

- Minister of Transport et al., June 1987. Agreement to Integrate the Airport and Aerotech Park Water and Sewer Systems.

  This document outlines the legal agreement and conveyances made by Her Majesty the Queen, the Municipality of the County of Halifax, and the Halifax County Industrial Commission to integrate the Airport and Aerotech Park water and sewer services.

Water Models

- Halifax Regional Water Commission, On-going. Central and East Water System Model, prepared and maintained internally.
- Halifax Regional Water Commission, On-going. Halifax Water System Model, prepared and maintained internally

  **Need description of the water models reviewed.*

NSE Water Quality Reports

- HRWC, July 2007. 2006 Annual Report – Halifax Regional Water Commission Plant Operations, prepared for Nova Scotia Environment & Labour.

  This annual report is a permit requirement for Pockwock, Lake Major, Bennery Lake, and seven small systems.

- HRWC, July 2007. 2006 Annual Report – Halifax Regional Water Commission Plant Operations, prepared for Nova Scotia Environment & Labour.

  This annual report is a permit requirement for Pockwock, Lake Major, Bennery Lake, and seven small systems.

- HRWC, March 2008. 2007 Annual Water Systems Report, prepared for Nova Scotia Environment & Labour.

  This annual report is a permit requirement for Pockwock, Lake Major, Bennery Lake, and seven small systems.
- HRWC, March 2009. 2008 Annual Water Systems Report, prepared for Nova Scotia Environment.

  This annual report is a permit requirement for Pockwock, Lake Major, Bennery Lake, and seven small systems.
- HRWC, March 2010. 2009 Annual Drinking Water Systems Report, prepared for Nova Scotia Environment.

  This annual report is a permit requirement for Pockwock, Lake Major, Bennery Lake, and five small systems.
- HRWC, March 2011. 2010 Annual Drinking Water Systems Report, prepared for Nova Scotia Environment.

  This annual report is a permit requirement for Pockwock, Lake Major, Bennery Lake, and five small systems.

Reservoir Maintenance Program

- HRWC, April 2011. Reservoir Maintenance Program, Revised, prepared internally.

  This document provides HRWC Reservoir Maintenance Program procedures to complete for the eight concrete reservoirs within the HRWC system. All concrete reservoirs will undergo a detailed exterior/interior inspection on a 5-year cycle basis and monthly, annual and 5-year Cathodic Protection inspection programs. The document also provides design parameter data for the eight reservoirs and maintenance history for each tank.

Beach Closing Protocol

- HRM, 2011. HRM Beaches Program, Water Quality Monitoring Summary for Beach Supervisors, Summer 2011, prepared internally.

  This document describes the Summer 2011 Water Quality Program for HRM beaches, including weekly sampling protocols (E. Coli & Enterococci) for the following beaches: Black Rock, Dingle, Campbell Point, Chocolate, Cunard, Kearney, Kidston, Long Pond, Albro, Birch Cove, Penhorn, Shubie, Kinsmen, Sandy, Saunders, Springfield, Kinap, Lake Echo, Malay Falls, Government Wharf, Pleasant Dive, Webber's, and Oakfield. The documents also includes a list of beach locations (Appendix A), a Sodium Thiosulate MSDS (Appendix B), a sample *laboratory chain of custody (Appendix C), and procedures for responding to sewage overflows at Dingle or Black Rock Beaches (Appendix D).*

- HRM, 2011. HRM Water Quality Monitoring Procedures & Protocols, Beaches Recreation Program, Summer 2011, prepared internally.

  This document describes the role of water quality in the operation of HRM's Aquatic Services Beaches Program. The HRM Supervised Outdoor Swim (Beaches Program) is offered as a public service during the summer months of every year, from July 1 through the last Friday before Labour Day. The document covers sampling procedures, beach closure protocols, re-testing procedures, and HRM Beach Program Staff Contacts.

4.3 WATER DISTRIBUTION DATA GAPS

The following water distribution data gaps were identified during the data collection process:

Water Distribution and Transmission Mains

- Historical capital expenditure.
- Only about half of the water mains are digitised in GIS.
- 39% of water main material is unknown.
- 99% of water mains on GIS have installation dates, but in effect only 50% of all water mains have dates.
- Main renewal data for 2009/10 and 2010/11.

Hydrants, Valves, Water Meters

- Historical capital expenditure.
- 74% of hydrants, 20% of valves and all water meters have installation dates.
- There is no condition or performance data on hydrants, valves and water meters.
- No Maintenance Expenditure Data on hydrants, valves and meters each year.

Water Pumping Stations

- Historical capital expenditure.
- No breakdown of assets to equipment/component level.
- No data on pumping station failures and their impact on network service levels.
- No database of pumping station and forcemain performance including pump hydraulic test results.

- No data on pump station overflows to the environment (some overflow metering systems currently being installed).

Service Reservoirs

- Historical capital expenditure.
- No condition data.
- No database of chlorine residuals into and out of storage reservoirs.

Hydraulic Network Models (East, West, and Central)

- Three models provided by HRWC missing detail on water distribution systems at BLT, Mainland South and many of the newer suburban subdivisions. (GENIVAR has combined the models into a single integrated regional model and added some of the missing areas as part of IRP).
- No model provided for Aerotech system.
- Piping on DND lands not included in model.
- Demands in models are approximately 2 times average daily demands as provided by HRWC in the 2010 regional water metering database.
- Model does not accurately represent the boundaries of the various pressure zones although variations are relatively minor.
- West area model is a skeleton model of the trunk piping only. Distribution system should be added.

5. SANITARY/COMBINED COLLECTION SYSTEM DATA COLLECTION

5.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop the Sanitary/Combined Collection System Baseline Review for capacity demand analysis, level-of-service requirements, and flow analysis and inflow/infiltration demands:

- Sewershed delineation maps;
- Collection system plan and profile;
- Collection system attribute data (pipes, manholes, overflows, regulators, and other structures);
- Major pumping station design and capacity data;
- Minor pumping station design and capacity data;
- System control and monitoring capabilities;
- Flow data at key nodes and overflow quantity and quality data;
- Sewer system design criteria;
- Planning, capacity assessment and design reports;
- Asset condition reports and mapping;
- I/I and other wet weather flow reduction programs;
- System model(s) and documentation;
- System performance requirements; and,
- System operating costs.

5.2 SANITARY/COMBINED COLLECTION SYSTEM DATA COLLECTED

Wastewater Servicing and Management Plans

- ABL Environmental and AMEC, August 2008. North Preston Wastewater Management Plan, report prepared for Halifax Regional Municipality.

  This document provides a tool that will identify funding needs and define priorities. It also addresses the wet weather flow problems within the North Preston WWTF sewershed.

- Annapolis Group, November 2003. Bedford West Planning Area Sanitary Sewer Servicing Concepts, report prepared for Halifax Regional Municipality.

  This document outlines a conceptual plan for the provision of Sanitary Sewer Services for the Bedford West Planning area with some additional emphasis on the Annapolis component known as Bedford West.

- CBCL Limited, May 2004. Ellenvale Wastewater Management Strategy Volume 2, report prepared for Halifax Regional Municipality.

  This document provides a study to assess the sources and magnitude of inflows and infiltration in the Ellenvale sanitary sewers and recommend the most feasible means to reduce these extraneous flows.

- CBCL Limited, February 2005. Quigley's Corner Pumping Station Sewershed Wastewater Management Study, Final report prepared for Halifax Regional Municipality.

  This document's objectives were to assess the magnitude and source of inflows and infiltration in the sanitary sewer system tributary to the Quigley's corner pumping station and recommend the most feasible means to reduce the extraneous flows; and to develop a wastewater management strategy for dealing with the remaining flows that minimizes the impact on the receiving environment.

- CBCL Limited, March 2005. Dartmouth Cove Wastewater Management Study – Phase 1, Final Report prepared for Halifax Regional Municipality.

  This document provides an assessment of the sewershed and trunk sewers tributary and adjacent to Dartmouth Cove (pumping stations at Park Avenue, King Street, Dartmouth Cove, Maitland Street, Old Ferry Road, as well as the sewer outfalls at Tupper Street and Cuisack Street. The objectives of the study were to assess the physical condition of the largest trunk sewers and compare these to the wastewater lows expected from the system (current and future) and to develop optimum wastewater management strategies for dealing with conveyance system deficiencies.

- CBCL Limited, May 2005. Wastewater Management Study for Six (6) Sewersheds – Gaston Road PS Sewershed, report prepared for Halifax Regional Municipality.

  This document assesses the magnitude and source of inflows and infiltration in the sanitary sewer system that serves the Gaston Road Pumping Station sewershed and recommends the most feasible means to reduce the extraneous flows; and develops a wastewater management strategy for dealing with the remaining flows that minimizes the impact on the receiving environment.

- CBCL Limited, May 2005. Wastewater Management Study for Six (6) Sewersheds – Lively Subdivision STP Sewershed, report prepared for Halifax Regional Municipality.

  This document assesses the magnitude and source of inflows and infiltration in the sanitary sewer system that serves the Lively Subdivision sewershed and recommends the most feasible means to reduce the extraneous flows; and *develops a wastewater management strategy for dealing with the remaining flows that minimizes the impact on the receiving environment.*

- CBCL Limited, May 2005. Wastewater Management Study for Six (6) Sewersheds – Stuart Harris Drive PS Sewershed, report prepared for Halifax Regional Municipality.

  This document assesses the magnitude and source of inflows and infiltration in the sanitary sewer system that serves the Stuart Harris Pumping Station sewershed and recommends the most feasible means to reduce the extraneous flows; and develops a wastewater management strategy for dealing with the remaining flows that minimizes the impact on the receiving environment.

- CBCL Limited, May 2005. Wastewater Management Study for Six (6) Sewersheds – Wellington STP Sewershed, report prepared for Halifax Regional Municipality.

  This document assesses the magnitude and source of inflows and infiltration in the sanitary sewer system that serves the Wellington Drive sewershed and recommends the most feasible means to reduce the extraneous flows; and develops a wastewater management strategy for dealing with the remaining flows that minimizes the impact on the receiving environment.

- CBCL Limited, July 2005. Wastewater Management Study for Six (6) Sewersheds – Balsam Street Sewershed, report prepared for Halifax Regional Municipality.

  This document assesses the magnitude and source of inflows and infiltration in the sanitary sewer system that serves the Balsam Street sewershed and recommends the most feasible means to reduce the extraneous flows; and develops a wastewater management strategy for dealing with the remaining flows that minimizes the impact on the receiving environment.

- CBCL Limited, July 2005. Wastewater Management Study for Six (6) Sewersheds – Frame Subdivision STP Sewershed, report prepared for Halifax Regional Municipality.

  This document assesses the magnitude and source of inflows and infiltration in the sanitary sewer system that serves Frame Subdivision and recommends the most feasible means to reduce the extraneous flows; and develops a wastewater management strategy for dealing with the remaining flows that minimizes the impact on the receiving environment.

- CBCL Limited, June 2006. Main Street Pumping Station Sewershed Wastewater Management Study, report prepared for Halifax Regional Municipality.

  This document defines the current operation of the sanitary sewer system, including pumping station during dry weather and wet weather, peak flow conditions; identifies recent modifications to the system; develops and assesses *additional modification possibilities and recommends the most feasible; and delineates maintenance requirements to main the system in optimal condition.*

- CBCL Limited, October 2006. Eastern Passage Wastewater Management Plan, Volume I Summary Report prepared for Halifax Regional Municipality.

  This document provides a framework and summary for the overall Wastewater management Plan for the foreseeable future.

- CBCL Limited, October 2006. Eastern Passage Wastewater Management Plan – Volume II Eastern Passage Wastewater Treatment Plant – Pre-Design Report prepared for Halifax Regional Municipality.

  This document presents a detailed assessment of the condition and functionality of the existing EPWWTP and purposes specific upgrading and expansion options to overcome prevailing deficiencies.

- CBCL Limited, October 2006. Eastern Passage Wastewater Management Plan – Volume III Wastewater Collection System Analysis, report prepared for Halifax Regional Municipality.

  This document describes the condition and competence of the existing sewage collection system and outlines various options and costs that would be incurred to overcome capacity limitations and overflow occurrences.

- HRWC, February 2009. Summary of Consultants Reports and Recommendations, prepared internally.

  This spreadsheet shows a summary of wastewater reports prepared for Halifax Regional Municipality and the Water Commission and the report recommendations. Limited information is available to document if recommendations were carried out.

- Porter Dillon Limited, October 1996. Sackville Servicing Study Phase "A" Sanitary Sewer Evaluation, Final Report prepared for Halifax Regional Municipality.

  This document entails monitoring present day sanitary sewage flow, construction of a hydraulic model of the trunk sewerage system, assessment of constraints with the existing sanitary sewerage collection system and recommendations of short-term remedial measures.

- UMA Engineering Inc., July 1992. Pre-Design Report for Sewage Treatment Plant, Lockview/MacPherson Sewage Works, Fall River, Nova Scotia, prepared for Halifax Regional Municipality.

  This document provides addresses only the requirements of the sewage treatment plant since the collection system has been discussed in previous submissions to the regulatory agencies.

- Porter Dillon Limited, May 1997. Sackville Servicing Study Phase B Future Growth Impact Assessment, Final Report prepared for Halifax Regional Municipality.

  This report documents the study objectives, the future growth candidates development areas assessed, existing municipal services, future infrastructure requirements to service Candidate Areas, capital cost estimates and recommendations for short term remedial action.

- Harbour Engineering, July 1999. Integrated Servicing Study, Final Report prepared for Halifax Regional Municipality, Regional Operation

  The primary object of this study was to identify development constraints and opportunities in the urban region with respect to trunk services, road networks, and public transit corridors and facilities.

- CBCL Limited, May 2004. Herring Cove Water and Sewer Services, Pre-Design Study prepared for Halifax Regional Municipality.

  The main objective of this pre-design report was to determine the layout and sizing of municipal infrastructure require to service Herring Cove with water and sanitary sewer as well as to identify any required upgrades to the infrastructure "upstream" of the community. The other main objective was to develop a detailed cost estimate of the water and sanitary services.

- Minister of Transport et al., June 1987. Agreement to Integrate the Airport and Aerotech Park Water and Sewer Systems.

  This document outlines the legal agreement and conveyances made by Her Majesty the Queen, the Municipality of the County of Halifax, and the Halifax County Industrial Commission to integrate the Airport and Aerotech Park water and sewer services.

Wastewater Pumping Stations

- Fenco Shawinigan, January 1998. Fish Hatchery Sewage Pumping Station, Bedford, Nova Scotia Pre-Design Brief prepared for Halifax Regional Municipality.

  This document includes review of the Mill Cove maximum hydraulic loading of the headworks and the ultimate capacity of the plant. It also investigates and recommends the type of pumping station including screening and future pumping capacity, recommends an appropriate site for the proposed pumping station, recommends pumping philosophy and controls to interface between Mill Cove Pumping Station, Treatment Plant, and the Fish Hatchery Pumping Station, and investigates the adequacy of the existing forcemains.

- SNC-Lavalin Inc., January 2004. Supplemental Report: Pumping Station Elimination Analysis, report prepared for Halifax Regional Municipality.

  This document summaries additional investigations and recommendations for the following pumping stations: Colpitt Lake Road, Auburn Avenue, Punch Bowl Drive, India Street, Balsam Road, York Lane, and White's Street.

- SNC-Lavalin Inc., October 2004. HRM Pumping Stations and Related Facilities – Remedial Works Priority Lists – Final Report (Rev. 3), report prepared for Halifax Regional Municipality.

  This document was developed as a tool to assist HRM in prioritizing remedial works for pumping stations and related facilities.

- SNC-Lavalin Inc., November 2007. Roach's Pond Pumping Station Upgrade and Forcemain Replacement, Pre-Design Report prepared for Halifax Regional Municipality.

  This document includes study and detailed design for the replacement of the forcemains, and study and production of a preliminary design for upgrading and rehabilitation of the pumping station structure and equipment.

- HRWC, August 2011. Personal Correspondence regarding recent Pumping Station Upgrades, internal e-mail.

  This document describes activities conducted at 18 pumping stations within the past ten years including upgrades, reduction of overflows and closures.

Wastewater Trunk Sewers

- SNC-Lavalin Inc., January 2005. McIntosh Run Sanitary Trunk Sewer Study, Final Report prepared for Halifax Regional Municipality.

  The primary focus of this investigation was to identify the sources and location of inflow and infiltration and to recommend short-and long-term remedial measures. Other work included in the project was a manhole attribute survey; and an assessment of the access route to the trunk sewer and manholes located in the sewer easement.

- Terrain Group Inc., December 2004. Bedford/Sackville Trunk Sewer Hydraulic Model, Final Report prepared for Halifax Regional Municipality.

  This document includes completion of a detailed hydraulic model of the Bedford/Sackville trunk sanitary sewer system, which extends from the recently upgraded pumping station at Fish Hatchery Park to Millwood Drive in Middle Sackville.

- Terrain Group Inc., October 2005. Bedford/Sackville Trunk Sewer SSO Storage Tank – Conceptual Design, Final Report prepared for Halifax Regional Municipality.

  The main goal of this report was to develop a conceptual level plan for the reduction or elimination of SSOs from the trunk sewer through the use of one or more overflow storage tanks.

- Terrain Group Inc., January 2006. Bedford/Sackville Trunk Sewer – Lively Subdivision Capacity Evaluation, Final Report prepared for Halifax Regional Municipality.

  This document's purpose is to estimate the hydraulic capacity reclaimed in the Bedford/Sackville Trunk Sewer through recent manhole rehabilitation works and to determine if some of this recovery hydraulic capacity can be used to service the existing residents of the Lively Subdivision and adjacent areas in Middle Sackville, without exacerbating the potential for sanitary overflow.

- Wallace Macdonald & Lively, March 2003. Bedford/Sackville Trunk Sewer Study, report prepared for Halifax Regional Municipality.

  This document includes completion of a field investigation and access route plan for the trunk sanitary sewer system which extends from the recently upgraded pumping station at Fish Hatchery Park in Bedford to Millwood Drive in Sackville.

Wastewater Hydraulic Model

- AECOM and CBCL Limited, July 2011. Figures – Overflow Analysis for Each Overflow Location, prepared for Halifax Regional Water Commission.

  These figures details the annual total overflow volume versus the return period (yrs) modeled for each overflow location in Halifax Regional Municipality including Flows above Peak Design Capacity.

- AECOM and CBCL Limited, July 2011. Halifax Water Regional Wastewater Functional Plan Schedule, prepared for Halifax Regional Water Commission.

  This document outlines the schedule and milestones for the Halifax Water Regional Wastewater Functional Plan.

- AECOM and CBCL Limited, July 2011. Generalized Model Assumptions, RWWFP, list prepared for purposes of IRP project review.

  This document lists the generalized Regional Wastewater Functional Plan Model assumptions.

- AECOM and CBCL Limited, July 2011. Summary of Overflow Results from Baseline Long Term Modeling, prepared for Halifax Regional Water Commission.

  This table lists the average number of overflow events per year, average frequency of overflows, approximate rainfall amount, and average total annual overflow volume for each associated WWTF in Halifax Regional Municipality for Baseline Long Term Modeling.

- AECOM and CBCL Limited, July 2011. Summary of Overflow Results from Future Development Long Term Modelling, prepared for Halifax Regional Water Commission.

  This table lists the average number of overflow events per year, average frequency of overflows, approximate rainfall amount, and average total annual overflow volume for each associated WWTF in Halifax Regional Municipality for Future Development Long Term Modeling.

- CBCL Limited, June 2011. Memorandum, Method of Selection of Standard Dry Weather Flow Pattern and Rainfall Response I/I Flows for Growth Area Modelling, prepared for Kenda MacKenzie, Halifax Water.

  This memorandum documents the approach taken by CBCL Limited and AECOM for modelling of the Regional Wastewater Functional Plan growth scenarios.

- CBCL Limited, July 2011. Halifax Water Regional Wastewater Functional Plan, Figures – System Capacity at Peak 1 in 1, 1 in 2, 1 in 5, 1 in 10, 1 in 25, 1 in 50, and 1 in 100 Year Flows and Dry Weather Flows, Central Region, prepared for Halifax Regional Water Commission.
- CBCL Limited, July 2011. Halifax Water Regional Wastewater Functional Plan, Figures – System Capacity at Peak 1 in 1, 1 in 2, 1 in 5, 1 in 10, 1 in 25, 1 in 50, and 1 in 100 Year Flows and Dry Weather Flows, Eastern Region, prepared for Halifax Regional Water Commission.
- CBCL Limited, July 2011. Halifax Water Regional Wastewater Functional Plan, Figures – System Capacity at Peak 1 in 1, 1 in 2, 1 in 5, 1 in 10, 1 in 25, 1 in 50, and 1 in 100 Year Flows and Dry Weather Flows, Western Region, prepared for Halifax Regional Water Commission.
- HRWC, October 2011. Household Growth Projection for Serviced Development (Baseline, High and Low Growth) RWWFP, growth projections prepared for purposes of IRP project review.

  This internal document lists the baseline, high growth, and low growth population projections for HRM.

- HRWC, October 2011. Map of HRM Development Area, Rev. 3, growth projections prepared for purposes of IRP project review.

  This internal document shows the growth population projections for various areas in HRM.

Schematics

- Harbour Engineering and Dexter, August 2005. Halifax Harbour Solutions Project, CSO Chamber – Maitland St, Civil, Structural, Electrical & Mechanical Drawings, Issued for Construction, prepared for Halifax Regional Municipality.
- Harbour Engineering and Dexter, March 2006. Halifax Harbour Solutions Project, Outfall – Maitland St, Civil Drawings, Issued for Construction, prepared for Halifax Regional Municipality.
- Harbour Engineering and Dexter, April 2009. Halifax Harbour Solutions Project, CSO Chamber & Piping Diversion – Young Street, Civil, Structural, Electrical & Mechanical Drawings, Record Drawings, prepared for Halifax Regional Municipality.
- HRWC, date unknown. Dartmouth SCS Schematic, prepared internally.
- HRWC, June 2009. Halifax SCS Schematic, prepared internally.
- HRWC, January 2011. Halifax Water Emergency Response Plan, Potential Wastewater Release, Wet Weather Events, Schematic, prepared internally.

CSOs – SSOs

- HRWC, September 2011. Draft Halifax Harbour Solutions Plant Overflow Levels, prepared internally.

  This table lists CSO locations in Dartmouth and Halifax including the designed weir elevations.

- HRWC, September 2011. CCME Strategy CSO Risk Points Calculations, prepared internally.

  This spreadsheet shows the CCME Strategy CSO Risk Point Calculations for the Dartmouth and Halifax systems including frequency of CSO events.

- HRWC, September 2011. Young Street CSO Chamber and Wet well Levels, prepared internally.

  This spreadsheet details the Young Street CSO Chamber and Wet Well levels between January 1, 2011 and August 31, 2011. Rainfall data is also listed in the spreadsheet.

I/I Reduction Programs

- ADI and Hydro-com Technologies Inc., April 2003. Inflow/Infiltration Reduction Program, Sackville, Sub-Sewersheds 6 and 7, Sanitary Sewer System, report prepared for Halifax Regional Municipality.

  This document provides an Inflow/Infiltration reduction program within the Sackville sanitary sewer system in sub-sewersheds six and seven. The objectives of the study were to identify sanitary sewer I/I sources and locations, and recommend rehabilitation options. An addition report entitled "Closed Circuit Video Inspection of Sanitary Sewers On: Sackville Drive and Parmac Drive (Lower Sackville)" completed by Chris Longaphy is included in the ADI/Hydro-Com report.

- HRWC, July 2011. Stormwater Inflow Reduction Program – Draft Priority Rating Process, prepared internally.

  This Priority Rating Process has been developed as a means to assess the priority for doing SIR Program work within sewersheds, including new storm sewer projects to facilitate the removal of private property I/I from the wastewater system. The rating process is expected to be useful for determining priorities among similar-sized sewersheds, say for the sewersheds of wastewater treatment facilities with wet weather flow problems, or for the sewersheds of pumping stations which have wet weather overflow issues. The process may be less useful for making decisions on a street-by-street basis within a sewershed.

- HRWC, July 2011. Stormwater Inflow Reduction Program – Individual Sewershed Rating Sheets, prepared internally.

  These individual sewershed rating sheets provide criteria information including public health, environmental impact, private property damage, loss of system capacity for development, volume and frequency, likelihood of success, operational efficiencies and regulatory compliance data for each sewershed studied.

- HRWC, July 2011. Table: Preliminary SSO and CSO Release Report v10 with CCME Estimates, prepared internally.

  This spreadsheet shows the preliminary cost estimates to upgrade each HRWC wastewater facility to CCME Standards for CSOs and SSOs.

- HRWC, July 2011. Table: Stormwater Inflow Reduction Program, Sewershed Priority Ratings, prepared internally.

  This table presents a prioritized list of the various sewersheds throughout the HRM.

5.3 SANITARY/COMBINED COLLECTION SYSTEM DATA GAPS

The following sanitary/combined collection system data gaps were identified during the data collection process:

Collection and Trunk Sewer Network

- Historical capital expenditure.
- 248km of sewer (18%) is not on GIS.
- Pipe Diameter – 25% of sewer length is unknown.
- Material – 37% of sewers unknown material.
- Age data: only 25% of sewers have an installation date.
- No condition data.
- No sewer flooding data.
- Limited blockage and collapse data.
- No data on the replacement/renewal rates of the collection system.

Force Mains

- Historical capital expenditure.
- 23km of forcemains (25%) are not on GIS.
- Pipe Diameter – 26% of length is unknown.
- Material – 37% unknown material.
- Only 42% of the force mains have an installation date.
- No condition data.
- No renewal/replacement data.

Wastewater Pumping Stations

- Historical capital expenditure.
- No breakdown of assets to equipment/component level.
- No data on pumping station failures and their impact on network service levels.

Sewershed Delineation Maps

- Sewershed boundaries for all service areas are defined.
- Sub-sewersheds associated most pump stations are also well defined.
- Sub-sewersheds for new pump stations and/or abandoned pump stations tend to be out of date.

Collection System Attribute Data (Pipes, Manholes, Overflow, Regulators, Other Structures)

- Incomplete data throughout all systems.
- The GIS data model is comprehensive, but the data is incomplete.
- Data was found to be missing, incomplete, and/or out of date in all areas.
- Regulating points are not well defined, there is no clear numeration of regulating points (overflow, outfalls, storage, and other diversion or flow control points).
- Schematics still used in some areas where GIS is incomplete.
- New system data/or system changes are not readily available in GIS.

Major Pumping Station Design and Capacity Data

- Detailed design and capacity information not readily available
- Various reports on specific stations contain detailed information
- 2004 SNC report provides basic inventory, this has been updated as recently as 2011.
- HW does has an inventory of stations but the inventory does not contain complete information
- Records provide information on HP but little or no information on actual station capacities.

Minor Pumping Station Design and Capacity Data

- Same comments at major.
- GIS not updated when minor stations abandoned or decommissioned. Not all newer minor pump stations are captured in GIS.

Storage Facilities Location, Capacity

- Information on size and location available.
- Operational or performance information not well documented.
- Operation staff have a good understanding of operation however this information is not well documented.

System Control and Monitoring Capabilities

- SCADA system at major CSO/PS as part of HHS infrastructure.
- Not sure the extent of coverage of SCADA.Flow Data at Key Nodes and Overflow Quantity and Quality Data
- Historical flow data has been collected throughout.

- Data typically collected as part of local sewershed studies.
- Historical data has been used in model development.
- No long-term monitoring strategy or ongoing monitoring.
- Available data represents a range of dry and wet weather conditions.
- Data coverage covers major sewershed, but does not provide sufficient coverage overall to characterize flows throughout major sewershed.
- No water quality data collected regarding the wastewater collection system.

Sewer System Design Criteria

- HW design criteria available.

Planning, Capacity Assessment and Design Report

- Numerous reports on system capacity associated with the project area under study.
- Regional Wastewater Function Servicing Plan (RWWFSP) provides capacity assessment within major infrastructure.
- Design reports are not readily available.

Asset Condition Reports and Mapping

- Limited information, local reports and inspection records are available but not in an organized format readily available.
- Limited coverage.

I/I and Other Wet Weather Flow Reduction Programs

- No active programs.

System(s) Model and Documentation

- Recently models developed for planning level modeling as part of RWWFSP.
- Documentation not yet available.

System Performance Requirements

- No documentation on performance requirements.

System Operating Costs

- Limited information.
- Information on WWTP.
- Historical information on pump station (2004 report).

6. STORMWATER SYSTEM DATA COLLECTION

6.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop the Stormwater System Baseline Review for capacity demand analysis and level-of-service requirements:

- Soil mapping;
- Topographic mapping;
- Climatologically data;
- Delineation of piped, ditch and no-storm sewer areas;
- Delineation of watershed areas including lakes;
- Piped system plan and profile;
- Piped system attribute data (pipes, manholes and other structures);
- Stormwater detention facilities location and design details;
- Stormwater management guidelines and system design criteria;
- Asset condition reports;
- Planning, capacity assessment and design reports; and,
- Flow and water quality monitoring data.

6.2 STORMWATER SYSTEM DATA COLLECTED

Precipitation Data

- Environment Canada, August 2011. Hourly Rainfall Data between June 2008 and August 2011, Shearwater.

  This spreadsheet lists hourly precipitation data for the Shearwater weather station between June 2008 and August 2011.

Dams

- HRM/Halifax Water, September 2009. Stormwater Dams and Other Water Control Structures, Final Report prepared for Halifax Water.

  This document develops an inventory of stormwater structures within HRM and catalogues pertinent data for each.

- HRM/Halifax Water, September 2009. Table – Stormwater Dams and Other Water Control Structures, prepared internally.

  This spreadsheet is an inventory of stormwater structures within HRM including life safety risks, environmental & cultural impact, and infrastructure and economic risk.

- AMEC, January 2009. Table – Stormwater Dams and Other Water Control Structures, approved by merger oversight committee September 10, 2009.

  This document lists the various retention ponds, dams, and stormwater control structures located throughout HRM.

- AMEC, January 2009. Stormwater Dams and Other Water Control Structures, prepared for Halifax Water.

  This document lists the various retention ponds, dams, and stormwater control structures located throughout HRM.

- AMEC, August 2005. Dam Safety Review, Final Report prepared for Halifax Regional Water Commission.

  This document summarizes the site inspection findings of the various water-retaining structures in HRWC's system, as well as the results of the hydrologic and hydraulic analysis. This report also includes the results of the stability analysis of the concrete structures to meet the requirements of the 1999 Dam Safety Guidelines published by the Canadian Dam Association. Dam inspection locations included Pockwock Dam, Bayers Lake Dam, Chain Lake Dam, Lake Lamont Dam, Lake Major Dam, and East Lake Dam.

6.3 STORMWATER SYSTEM DATA GAPS

The following stormwater system data gaps were identified during the data collection process:

All Stormwater Asset Classes

- Historical capital expenditure.

Stormwater Pipes, Culverts, Ditches

- 190km (24%) of stormwater pipes are no in GIS.
- Limited data in GIS for stormwater culverts (only 8km recorded).
- No asset data on stormwater ditches.
- 31% of stormwater pipes and 21% of stormwater culverts lack data on diameter.
- There is no condition data on the stormwater collection network.
- There are no service levels or performance indicators for the stormwater collection network.
- No historical renewal/rehabilitation activity recorded for the stormwater collection network.

Soil Mapping

- Available.

Topographic Mapping

- Available.

Climatological Data

- Available.

Delineation of Piped, Ditch and No-Storm Sewer System

- Poor records, incomplete.
- No service area delineation.

Delineation of Watershed Areas Including Lakes

- Not available.

Pipe System Plan and Profiles

- Poor records.

Pipe System Attribute Data (Pipes, Manholes, and Other Structures)

- Very limited data.
- GIS data very limited.

Stormwater Detention Facilities Location and Design Details

- Not available.

Stormwater Management Guidelines and System Design Criteria

- Available.

Asset Condition Report

- Limited records, complaint driven inspection.

Planning, Capacity Assessment and Design Reports

- No reports available or provided.

Flow and Water Quality Monitoring Data

- No information available.

7. PLANNING, POLICIES, POPULATION AND LAND USE DATA COLLECTION

7.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop the Planning, Policies, Population and Land Use Baseline Review:

- HRM Official Plan and amendments;
- HRM and Halifax Water policies and procedures;
- Baseline and projected residential and employment populations; and,
- Social context.

7.2 PLANNING, POLICIES, POPULATION AND LAND USE DATA COLLECTED

GIS Information

- HRWC, July 2011. GIS, prepared internally.

  The Halifax Water GIS was reviewed including general documents, Halifax Harbour Solutions Drawings, Maps, Pressure Meter Zones, Wastewater and Water infrastructure.

Growth Plans

- CBCL Limited, January 2005. HRM Business Park Assessment and Growth Plan, Final Draft, issued to Halifax Regional Municipality.

  This report assesses the twelve business parks within HRM and possible future expansion of Burnside, Bayer's Lake, Ragged Lake, and the Aerotech Parks as well as cost analysis for development each of these five parks.

- Colliers International (Atlantic) Realty Advisors, June 2008. HRM Business Park Functional Plan: Part 1, issued to Halifax Regional Municipality.

  This document provides the Functional Plan for the HRM Business Parks. The report incorporates market research, interviews with HRM staff and developers, business park stakeholders, and inputs from meetings with various business associations.

- Colliers International (Atlantic) Realty Advisors, May 2009. HRM Business Park Functional Plan: Part 2 – Bayers Lake and Ragged Lake, issued to Halifax Regional Municipality.

  This Plan provides strategic direction on future land use for the Bayers Lake and Ragged Lake Business Parks.

7.3 PLANNING, POLICIES, POPULATION AND LAND USE DATA GAPS

The following planning, policies, population and land use data gaps were identified during the data collection process:

- Future population projections for residential and employment lands were not readily available for the planning period. HW staff working with HRM and developed future population highlighting intensification and development areas.

8. FINANCIAL DATA COLLECTION

8.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop other criteria in the Baseline Review:

- Business Plans;
- Capital Cost and maintenance Budgets;
- Financial Analysis; and,
- Existing infrastructure capital and operational planning.

8.2 FINANCIAL DATA COLLECTED

Capital Cost Site Analysis

- CBCL Limited, February 2008. Bedford West Capital Cost Contribution Analysis, report prepared for Halifax Regional Municipality.

  This document reports the baseline study for servicing the Bedford West area.
- CBCL Limited, October 2005. Cost of Servicing Plan, Regional Planning Greenfield Sites, report prepared for Halifax Regional Municipality.

  Proposal to complete the Cost of Servicing Plan and Regional Planning of the Greenfield sites.
- CBCL Limited, May 2005. Morris-Russell Lake Area, Capital Cost Contribution Analysis, report prepared for Halifax Regional Municipality.

  This document is intended to provide HRM with a mechanism to identify oversized and required infrastructure that provides benefits for a defined Charged Area.
- CBCL Limited, February 2009. Cost of Servicing Plan, Regional Planning Greenfield Sites, report prepared for Halifax Regional Municipality.

  This document evaluates the costs to provide municipal services and transportation links to areas designated "Urban Settlement" under the HRM Regional Plan.
- CBCL Limited, November 2008. Bedford West Capital Cost Contribution Analysis, Baseline Study, report prepared for Halifax Regional Municipality.

  This document reports the baseline study for servicing the Bedford West area.

- SGE Group Inc., February 2002. Business Case & Analysis: Wentworth Estates/Bedford South Master Plan Area, report prepared for Halifax Regional Municipality.

  This document assesses the cost to provide services (potable water, wastewater, stormwater, streets, intersections, traffic signals and bus bays) by analysing the infrastructure requirements for development of the Master Plan Area.

- CBCL Limited, October 2002. Greenfield Areas Servicing Analysis, report prepared for Halifax Regional Municipality.

  This document outlines the opportunities and constraints, land use and transportation concepts, servicing analysis, and capital cost contribution for ten Greenfield areas in HRM including Eastern Passage / Shearwater, NS Home for Coloured Children Lands, Dartmouth East/Port Wallace, Dartmouth North/Anderson Lake, Sackville/Beaverbank, Jack's Lake, Bedford West/Bedford South, Birch Cove Lakes/Governors Lake, Ragged Lake and Mainland South Backlands.

Halifax Water Business Plan and Capital Budget Tables

- Halifax Water, February 2010. Two-Year Business Plan, 2010/11 and 2011/12, report approved by the Halifax Water Board.

  This document presents the 2010/11 and 2011/12 capital budget for Halifax Water water, wastewater, and stormwater.

- Halifax Water, February 2010. Capital Budget Tables -2010/11, prepared internally.

  This document summarizes the 2010/11 capital budget for water, wastewater, stormwater, Aerotech water and wastewater, and blanket approvals.

- Halifax Water, February 2010. Draft Capital Budget Tables -2011/12, prepared internally.

  This document summarizes the Draft 2011/12 capital budget for water, wastewater, stormwater, Aerotech water and wastewater, and blanket approvals.

- Halifax Water, November 2011. Draft Capital Expenditure Program 2012-42, prepared internally.

- *This document summarizes the Draft 2012-2042 capital expenditure program for water, wastewater, and stormwater.*

- Grant Thorton, March 2011. Financial Statements (NSUARB Accounting and Reporting Handbook), prepared for Halifax Regional Water Commission.

  This document summarizes an independent audit of the financial statements for Halifax Regional Water Commission for 2010 and predicted for 2011.

- HRWC, August 2011. Response to Information Request, prepared for NS Utility and Review Board.
- Halifax Water, June 2008. Capital Budget Tables -2008/09, prepared internally.

  This document summarizes the 2008/09 capital budget for water, wastewater, stormwater, Aerotech water and wastewater, and blanket approvals.

- Halifax Water, April 2009. Capital Budget Tables -2009/10, prepared internally.

  This document summarizes the 2009/10 capital budget for water, wastewater, stormwater, Aerotech water and wastewater, and blanket approvals.

Annual Reports

- HRWC, March 2004. Eighth Annual Report, prepared internally.

  This annual report includes a letter from the chair, general information regarding the utility, a financial overview, financial review, customer service, plant operations, operations, engineering and information services, human resources, typical water analysis, auditor's report, and financial statements.

- HRWC, March 2005. Ninth Annual Report, prepared internally.

  This annual report includes a letter from the chair, general information regarding the utility, a financial overview, financial review, customer service, plant operations, operations, engineering and information services, human resources, typical water analysis, auditor's report, and financial statements.

- HRWC, March 2006. Tenth Annual Report, prepared internally.

  This annual report includes a letter from the chair, general information regarding the utility, a financial overview, typical water analysis, auditor's report, and financial statements.

- HRWC, March 2007. Eleventh Annual Report, prepared internally.

  This annual report includes a letter from the chair, general information regarding the utility, a financial overview, typical water analysis, auditor's report, and financial statements.

- HRWC, March 2008. Twelfth Annual Report, prepared internally.

  This annual report includes a letter from the chair, general information regarding the utility, a financial overview, typical water analysis, auditor's report, and financial statements.

- HRWC, March 2009. Thirteenth Annual Report, prepared internally.

  This annual report includes a letter from the chair, general information regarding the utility, a financial overview, typical water analysis, auditor's report, and financial statements.

Contract Bid Results

- HRWC, 2007. Tender No. 07-252, Desmond Ave and Scott St, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Tender No. 07-255, Nightingale Drive, Halifax, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Tender No. 07-265, Elliot St, Dartmouth, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Cleaning & Structural Lining of Watermains, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Cobequid Road Water Main Rehabilitation, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Freshwater Brook Sewer Replacement – Phase I, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Harris Road Service Extension, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Jamieson Street Trunk Sewer Replacement, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. JD Kline Chemical Pump, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. JD Kline Exterior Caulking, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. JD Kline Pilot Plant Room Construction, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Mount Edward Reservoir Site Drainage, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2007. Field Survey for Wellington Fire Department, RFQ Results, prepared internally.
- HRWC, 2007. Spider Lake Road Water Main Design, Phase I, RFP Results and Bid Evaluation Results, prepared internally.
- HRWC, 2008. Alderney and Ochterloney Water Main Replacement, Bid Evaluation and Tender Results, prepared internally.

- HRWC, 2008. Dingle Tower Pumping Station Upgrades, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Flow Monitoring of Sewers – Various Locations, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Freshwater Brook, Phase 2, Sewer and Water Main Replacement, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Freshwater Brook, Phase 3, Sewer and Water Main Replacement, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Kuhn Marsh Retention Berm & Culvert, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. North Dartmouth Trunk Sewer, Phase I & Lake Banook Canoe Course, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. North Dartmouth Trunk Sewer, Phase II & Lake Banook Canoe Course, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. North Preston Water Supply Extension, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Permanent Flow Meter Installations – Various Locations, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Roachs Pond Pumping Station Upgrade, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Spruce Hill Booster Station Refit, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Storm Culvert Replacement, Yankeetown Road and Fenerty Road, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Waverley Road Pumping Station Replacement & Street Reconstruction, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2008. Wellington Subdivision Sewer Upgrade, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. 12 Apostles Servicing, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Aerotech Reservoir Valving, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Aerotech Park Wastewater Treatment Facility HVAC Upgrades, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Almon Street and Windsor Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.

- HRWC, 2009. Balsam Circle Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Bedford Sackville Trunk Sewer Maintenance Access Route Construction, Phase 1, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Collins Park and Middle Musquodoboit Small System Upgrades, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Dartmouth Road (Hwy #7) Booster Station, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Fish Hatchery Park Pumping Station Screening Upgrade and Modifications, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Joffre Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Kearney Lake Road and Dunbrack Street Water Transmission Main Slip-Lining, Phase I, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Metropolitan Avenue Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. MicMac Street and Regent Road Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. North Preston Wastewater Treatment Facility Headworks Upgrades, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Ochterloney Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Reservoir Climbing Systems, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Spider Lake Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2009. Tupper Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Ascot Avenue Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Bayers Road and Romans Avenue Valve Replacement, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Greenhead Road Pumping Station Elimination & New Sanitary Sewer, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Joseph Howe Drive & Clinton Avenue Valve Replacement, Tender Results, prepared internally.

- HRWC, 2010. Lovett Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Main Street (Fader to Booth) Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Mill Cove STP Upgrade, South Side Secondary Clarifiers, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Monarch and Riverdale Water Extension, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Ontario Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Rufus Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Sampson Reservoir Rehabilitation, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Silver Sands Lower Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Vernon Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2010. Windgate Drive Culvert Replacement, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2011. Africville Water Main Extension, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2011. Chandler Drive & First Lake Drive Pumping Station – Forcemain Replacement, Bid Evaluation, prepared internally.
- HRWC, 2011. Coronet Cobequid Culvert Replacement Program, Bid Evaluation, prepared internally.
- HRWC, 2011. Frame Subdivision – Wastewater System Improvements, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2011. JD Kline – Pockwock Dam Water Control Structure, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2011. Nivens Avenue Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2011. Shawinigan Road Water Main Renewal, Bid Evaluation, prepared internally.
- HRWC, 2011. Valleyfield Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.

- HRWC, 2011. Vernon Street Water Main Renewal, Bid Evaluation and Tender Results, prepared internally.
- HRWC, 2011. Wellington Wastewater Treatment Facility, Bid Evaluation and Tender Results, prepared internally.

8.3 FINANCIAL DATA GAPS

The following financial data gaps were identified during the data collection process:

All Water, Wastewater, and Stormwater Asset Classes

- Historical capital expenditure

9. OTHER DATA COLLECTION

9.1 PRIMARY DATA REQUIRED

The following data sources were requested to develop other criteria in the Baseline Review:

- Other GIS data including road network, traffic zones, etc.
- Orthophotos;
- Industry trends;
- Regulatory requirements;
- Water and land environment;
- Stakeholder information; and,
- Existing infrastructure capital and operational planning.

9.2 OTHER DATA COLLECTED

SCADA Master Plan

- Westin Engineering Inc., January 2010. SCADA, Process Control and Communications Master Plan, issued to Halifax Regional Water Commission.

  As a result of recent mergers and amalgamations of various regional water, wastewater, and storm water agencies, the current SCADA Systems employed by the HRWC represent a wide variety of legacy applications and technologies. HRWC has engaged Westin to develop a SCADA Master Plan. The Master Plan also included a cyber security assessment and a SCADA communications evaluation; the information developed during these tasks is reflected in this Master Plan document.

Corporate Balance Scorecard

- HRWC, December 2010. Halifax Water Corporate Balance Scorecard, prepared internally.

  This document provides quarterly ratings for internal HRWC parameters measured including water quality, service excellence, responsible financial management, effective asset management, regulatory compliance, environmental stewardship, workplace safety & security, and motivated and satisfied employees.

State of the Utility

- HRWC, July 2010. State of the Utility Address, 2010/11 Fiscal Year, presentation to staff – July 2010 (36 slides), prepared internally.

  This presentation documents the state of Halifax Water during the 2010/11 fiscal year.

- HRWC, July 2011. State of the Utility Address, 2011/12 Fiscal Year, presentation to staff – July 2011 (65 slides), prepared internally.

  This presentation documents the state of Halifax Water during the 2011/12 fiscal year.

Asset Management

- CH2MHill, June 2011. Asset Management Assessment Project, Executive Summary Report, Final, prepared for Halifax Water.
- CH2MHill, June 2011. Asset Management Assessment Project, Final Report, prepared for Halifax Water.
- HRWC, March 2010. Managing Aging Infrastructure, Power-Point Presentation, prepared for Dalhousie University Site Infrastructure Course.

Road Network Studies

- Dillon Consulting Limited, January 2002. Cole Harbour Arterial Corridor and Interchange Study, Final Report prepared for Halifax Regional Municipality.

  This document provides a conceptual location of an interchange and the development of a corridor associated with an arterial road to provide a connection between Highway 111 and Caldwell Road.

9.3 OTHER DATA GAPS

The other data gaps identified during the data collection process are listed below:

- Information on receiving waters and the land environment is limited and generally not available. Receiving water quality information is available where an assimilative capacity assessment has been completed.

VOLUME 3 – APPENDIX E

Asset Renewal

WP2.3 Asset Renewal Requirements and Forecast Modelling

Document: 001 Version: 4

Halifax Water Integrated Resource Plan

Halifax Water

October 2012

Halcrow

WP2.3 Asset Renewal Requirements and Forecast Modelling

Halifax Water Integrated Resource Plan

Halifax Water

October 2012

Halcrow, Inc.
4343 Shallowford Road, Suite C-1, Marietta
GA 30062, United States of America
tel +001 678 461 3412 fax +001 678 461 3443
halcrow.com

Document history

WP2.3 Asset Renewal Requirements

Halifax Water Integrated Resource Plan

Halifax Water

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
0	31/10/2011	Draft	Martin Jones	Paul Conroy	Paul Conroy
1	28/11/2011	Draft issued for client comment	Martin Jones	Paul Conroy	Paul Conroy
2	11/01/2012	Final	Martin Jones	Paul Conroy	Paul Conroy
3	15/09/2012	Revision to include modelling	Alec Yeowell		
4	04/10/2012	Final		Sue De Rosa	Sue De Rosa

Contents

1 Summary

This report reviews Halifax Water's asset renewal requirements, assesses the data to support asset renewal and provides the assumptions needed to fill data gaps and forecast asset renewals for the Integrated Resource Plan. Updates to this report were made in September 2012 to include the methodology for asset renewal forecasting.

1.1 Maturity Assessment

Consultant CH2MHILL was employed by Halifax Water to assess its asset management maturity and develop an improvement program. Halifax Water scored an average of **2.35** for the water service, and **2.25** for the wastewater and stormwater service (out of 5) which puts its asset management maturity between Awareness and Development. High scoring areas included legal and regulatory compliance and business continuity and operations management. Low scoring areas identified included asset information, investment planning and risk management.

CH2MHILL identified a series of improvement initiatives as part of an overall Asset Management (AM) Roadmap. This is estimated to cost $5million over 5 years. Priority initiatives for implementation in the short term include implementation of asset management governance, develop a technology master-plan, implement additional core technology systems and expand the existing GIS mapping and asset attribute information. Additionally, Halifax Water's Executive Team identified the need to accelerate the development of a business process mapping and procedure master plan.

The improvement program developed with CH2MHILL will improve Halifax Water's approach to asset management as long as improvements become fully embedded in the organization. Investment in these initiatives will produce long term benefits in terms of more efficient and optimised management of assets.

1.2 Data Review

As part of the Baseline Assessment, Halcrow carried out a review of Halifax Water's asset data, including asset service levels and performance data, historical capital and operating expenditure and levels of asset renewal. The purpose of this review was to assess the quality and availability of this data and to identify gaps. This data will form the basis for the asset renewal plan.

Specific data gaps exist for the age profiles of the networks, condition of the wastewater and sewerage networks, performance of the wastewater network, asset data for water distribution network and condition data for structures and equipment. Some missing data can be estimated for the purposes of developing the initial integrated resource plan, but Halifax Water will need to undertake a comprehensive program of asset data collection to improve its knowledge of what assets it owns and their condition and performance.

A more comprehensive level of service framework needs to be developed, and, as asset data improves, the link between asset performance, condition and renewal with service levels should be established.

The table below summarises for each asset group quantity/numbers of assets and asset data availability:

Table 1 Data gap analysis summary

Asset Group	Quantity	Size Data	Age Data	Performance Data	Condition Data	Renewal Activity Data
Collection & Trunk Sewer Network	1335 km	75%	25%	Limited	None	None
Force mains	89.8 km	74%	50%	Some	None	None
Wastewater Pumping Stations	173 nr	99%	100%	Some	Some	Some
CSOs & SSOs	221 nr	n/a	n/a	Limited	None	None
Wastewater Treatment Works	15 nr	100%	For works only	Yes	None	Some
Distribution Mains	1307 km	50%	50%	Good	Good	Some
Transmission Mains		100%	67%			
Water Hydrants	8000	n/a	74%	n/a	n/a	None
Water Valves	13027	n/a	20%	n/a	n/a	None
Water Meters	80989	100%	90%	n/a	n/a	None
Water Pumping Stations	19 nr	100%	100%	Some	Some	Some
Service Reservoirs	16 nr	100%	100%	None	None	Some
Water Treatment Works	8 nr	100%	For works only	Good	None	Some
Stormwater Sewers	789 km	69%	30%	None	None	None
Stormwater Culverts	8 km	79%	30%	None	None	None
Stormwater Structures	29 nr	100%	100%	n/a	Yes	None

Key:

Poor Availability or No Data	Data Coverage needs Improvement	Good Data Availability

1.3 Asset Renewal Requirements

The overall performance of the water distribution network is good and historical renewal rates appear to have been sufficient. Renewal rates will have to increase gradually to account for the aging of the network. Halifax Water has developed an initial program of water mains renewals.

Some major transmission mains are in need of renewal or replacement following failures or material deterioration. A program of transmission mains relining, replacement and twinning has been developed.

There has been a limited service reservoir inspection and cleaning program, with minimal rehabilitation work. The inspection and cleaning frequency will need to increase, and this is likely to identify additional rehabilitation needs.

The collection network has suffered from a lack of investment in recent years, and is likely to require a comprehensive program of rehabilitation. Given the lack of data (specifically age, performance and condition) an initial data collection exercise is required, with CCTV survey and condition grading. Once Halifax Water has developed sufficient data on sewer condition and performance, it will be able to pro-actively target sewer replacements and be able to justify increases in replacement rates if required. Halifax Water has identified some specific renewal projects for collection sewers, trunk sewers and force mains.

Like the sanitary and combined sewers, the stormwater collection network has suffered from lack of investment in recent years; however its impact on service levels is less than that of the wastewater network. Additional information on assets and condition is required to develop a renewal program, but Halifax Water has already identified some stormwater pipe and culvert renewal projects, and is undertaking a program of cross-culvert inspections.

1.4 Asset Renewal for the Integrated Resource Plan (IRP)

There is insufficient asset, service, condition and performance data to develop detailed models for forecasting service levels for water, wastewater and stormwater pipe networks based on different asset renewal rates. Therefore asset renewal rates will need to be forecast based on comparison with typical renewal rates of other water utility companies. For the purposes of the IRP, network renewal will be estimated based on assumed renewal rates, with other assets replaced at the end of their expected useful life. The forecast number of assets older than their expected useful life will be used as a surrogate for service levels.

The scenario assumptions are set out in the following table:

Table 2 Asset Renewal Assumptions

Scenario variation	Aggressive	Moderate	Minimum
Network replacement rate impact on number of assets older than expected life	Number of assets older than expected life decrease	Number of assets older than expected life remain constant	Number of assets older than expected life increase
Other assets replaced at end of	Expected life – 20%	Expected life	Expected life +20%

2 Asset Management Maturity

2.1 Chapter Overview

This chapter summarises Halifax Water's current asset management maturity, based on the Asset Management Assessment Project undertaken by CH2MHILL in June 2011, as well as summarising the current status of Halifax Water's asset management systems, analysis, processes and procedures.

It is important to understand Halifax Water's capabilities for asset management planning in the context of the development of the Integrated Resource Plan, as this, along with data quality and availability will have an affect on the robustness and sophistication of the plan.

2.2 Asset Management Maturity Assessment

The objectives of the asset management maturity assessment were to:

- Evaluate asset information and asset data management
- Review policies, practices, procedures, tools and systems used for asset management
- Compare asset management practices against Industry best practices
- Provide a recommended program to close the gap between current practices and best practices

As part of CH2MHILL's Comprehensive Asset Management Review and Assessment (CAMRA), desktop reviews of documents were carried out, along with interviews and workshops with Halifax Water staff. Asset management maturity was assessed on a scale of 1 to 5:

Table 3 Asset Management Maturity Scale

Level	1	2	3	4	5
Maturity	Innocence	Awareness	Development	Competence	Excellence
Stage in AM Process	Learning	Applying	Embedding	Optimizing and Integrating	Continuous Improvement

Halifax Water scored an average of **2.35** for the water service, and **2.25** for the wastewater and stormwater service.

High scoring areas of the assessment were:

- Legal, Regulatory Compliance
- Business Continuity and Emergency Preparedness
- Continuous Improvement (Sustainability)

- Operations Management

Key low scores included:

- Technology Assets Planning
- Asset Information
- Document Data and Information Control
- Technology Systems Integration
- Asset Investment Plans Development & Implementation
- Risk Management
- Lack of AM Quality Assurance

2.3 Asset Management Systems, Processes and Procedures

CH2MHILL also undertook a review of Halifax Water's technology assets using their Systems Review Tool, with the focus on strategic technology practices, hardware, connectivity, software, data management and integration.

Table 4 Halifax Water's Current Systems

System Type	Systems
Computerised Work Management System (CWMS)	Hansen, MP2, SAP (Work Management Plant Maintenance)
Computerised Maintenance Management System	None
Financial System	SAP
Operations Systems	SCADA, Water Trax (compliance), Pi-Historian, Emerson DCS
Geospatial Information System (GIS)	ESRI
Document Management	EDL (for some record drawings; not a comprehensive document management system)
Modelling	WaterCAD, Bentley, PC SWMM

Halifax Water scored an average of **2.4** for the technology review.

High scoring areas of the assessment were:

- Hardware and Networking
- Corporate Levels of Service & Targets
- Technology Asset Governance/Management
- Implementation Process
- Knowledge Retention & Succession Planning

Low scoring areas were:

- Technology Assets Planning
- Business Case to Support Technology Assets
- Benefits Tracking
- Data Maintenance
- Lifecycle Management Strategies

2.4 Asset Management Improvement Roadmap

CH2MHILL identified a series of improvement initiatives as part of an overall Improvement Roadmap. This is estimated to cost $5million over 5 years.

Table 5 Improvement initiatives

No	Improvement Initiative (Strategy)	Phasing
S1	Develop corporate and departmental strategic plans with AM strategies	Short
S2	Develop and implement a people skills & competency master plan	Short-Medium
S3	Develop a business process mapping and procedure master plan	Short-Medium
S4	Development of an integrated resource plan (IRP)	Short-Medium

No	Improvement Initiative (Physical Assets)	Phasing
A1	Level of service (LOS) framework development	Short-Medium

No	Improvement Initiative (Physical Assets)	Phasing
A2	Develop & implement departmental asset management plans (AMPs) by major asset classes	Short-Medium
A3	Develop business case evaluation (BCE) framework	Short-Medium
A4	Develop standardized methodology for various asset condition assessment programs (including guidelines & framework)	Medium
A5	Expand existing risk-based decision model for rehab, replacement, O&M of assets	Short-Medium
A6	Develop & implement multi-criteria attribute analysis (MCAA) tool	Short-Medium

No	Improvement Initiative (Technology Assets)	Phasing
T1	Develop a technology master plan/policy & development an integrated technology solution (ITS)	Short-Medium
T2	Select & implement additional core technology systems	Medium-Long
T3	Develop & implement an effective knowledge management practice for assets	Medium-Long
T4	Expand and complete the existing GIS asset mapping and asset attribute information	Short

No	Improvement Initiative (Business Processes)	Phasing
B1	Enhance existing project delivery and project management guidelines	Short-Medium
B2	Establish AM procedures & standards guidelines	Short-Medium
B3	Develop and implement a strategic maintenance management program	Short-Medium
B4	Focus on efficiency and practice improvements	Medium-Long
B5	Implement a quality management and audit process	Long
B6	Develop & implement International Financial Reporting Standards (IFRS) strategy and policies	Short

No	Improvement Initiative (People)	Phasing
P1	Implement AM Governance	Short
P2	Enhance existing performance management program	Medium-Long

The priority initiatives identified by CH2MHILL for implementation in the short term are:

- P1 Implement Asset Management Governance
- S3 Develop a business process mapping and procedure master plan
- S4 Development of an Integrated Resource Plan
- T1 Develop a Technology Masterplan
- T2 Select & implement additional core technology systems
- T4 Expand and complete the existing GIS asset mapping and asset attribute information

In addition to the initiatives identified above Halifax Water should implement a company wide risk management framework.

The improvement program developed with CH2MHILL will improve Halifax Water's approach to asset management as long as improvements become fully embedded in the organization. Investment in these initiatives will produce long term benefits in terms of more efficient and optimised management of assets.

3 Data Review

3.1 Chapter Overview

As part of the Baseline Assessment, a review was carried out on Halifax Water's asset data, including asset service levels and performance data, historical capital and operating expenditure, and levels of asset renewal.

The purpose of this review was to assess the quality and availability of this data, and to identify gaps. This data will form the basis for the asset renewal plan, so the methodology and robustness of the asset renewal business case will depend heavily on the available data.

The data has been assessed separately for water, wastewater and stormwater.

3.2 Wastewater

3.2.1 Historical Financial Expenditure

The value of the wastewater asset additions over the last 4 years since the merger of wastewater and stormwater services at Halifax Water (August 2007) is shown in the table below. Paid for Additions is Halifax Water's capital expenditure on its assets (Halifax Water does not currently record capital expenditure by different drivers such as growth or asset renewal). Donated Additions includes assets received from Developers, from Water Dividend Funding, from CCC or received from Halifax Regional Municipality. The Donated Additions for the Harbour Solutions Scheme are shown separately.

Table 6 Wastewater Asset Additions

	2007-08	**2008-09**	**2009-10**	**2010-11**
Paid for Additions	0.60	1.23	3.75	4.82
Donated Additions	148.34	37.65	26.88	19.51
Harbour Solutions			147.70	143.38
Total $m	**148.95**	**38.88**	**178.35**	**167.72**

Operating expenditure over the last 3 years is shown in the table below. The information provided is based on the first fiscal year following the merger. The increase in expenditure for 2010-11 is primarily due to the commencement of operations at the Halifax wastewater treatment plant.

Table 7 Wastewater Operating Costs

	2008-09	2009-10	2010-11
Wastewater Treatment	12.67	10.58	17.84
Wastewater Pumping	3.25	3.62	4.21
Wastewater Collection	4.69	5.71	5.00
Total Operating Costs $m	**20.62**	**19.92**	**27.04**

3.2.2 Asset Base

3.2.2.1 Collection and Trunk Sewer Network

The total length of Halifax Water's collection and trunk sewer network is approximately 1,335 km. This includes 248 km of sewer that is not on the GIS system and is in schematic format. There are approximately 76133 wastewater connections.

Table 8 Wastewater network assets by length

Pipe Diameter	<=165mm	166 - 320	321 - 625	626 - 925	> 925mm	Unknown	**Total**
Length km	13.4	707.0	207.5	37.6	37.9	331.6	**1335.0**
Proportion	1%	53%	16%	3%	3%	25%	

The majority of the pipe network is made up of concrete pipe.

Material	AC	Concrete	VC	PVC	Other	Unknown	**Total**
Length km	104.9	435.9	93.4	188.5	14.9	498	**1335.0**
Proportion	8%	33%	7%	14%	1%	37%	

There is limited data on age of the network, with only 25% of the sewers having an installation date, the earliest of which was 1948. Halifax Water has much older sewers than this and this data set is significantly incomplete.

3.2.2.2 Force Mains

The total length of Halifax Water's force mains is 90 km, of which 67 km is on the GIS system.

Table 9 Force mains by length

Pipe Diameter	<= 165mm	166 - 320	321 - 625	626 - 925	> 925mm	Unknown	**Total**
Length km	26.7	16.7	22.1	0.0	0.6	23.8	**89.8**
Proportion	30%	19%	25%	0%	1%	26%	

Material	AC	CI	CONC	DI	PVC	Other	Unknown	**Total**
Length km	8.1	4.2	3.8	14.8	23.6	1.7	33.6	**89.8**
Proportion	9%	5%	4%	16%	26%	2%	37%	

Only 42% of the force mains have an installation date. The age profile for the known mains is shown in the graph below.

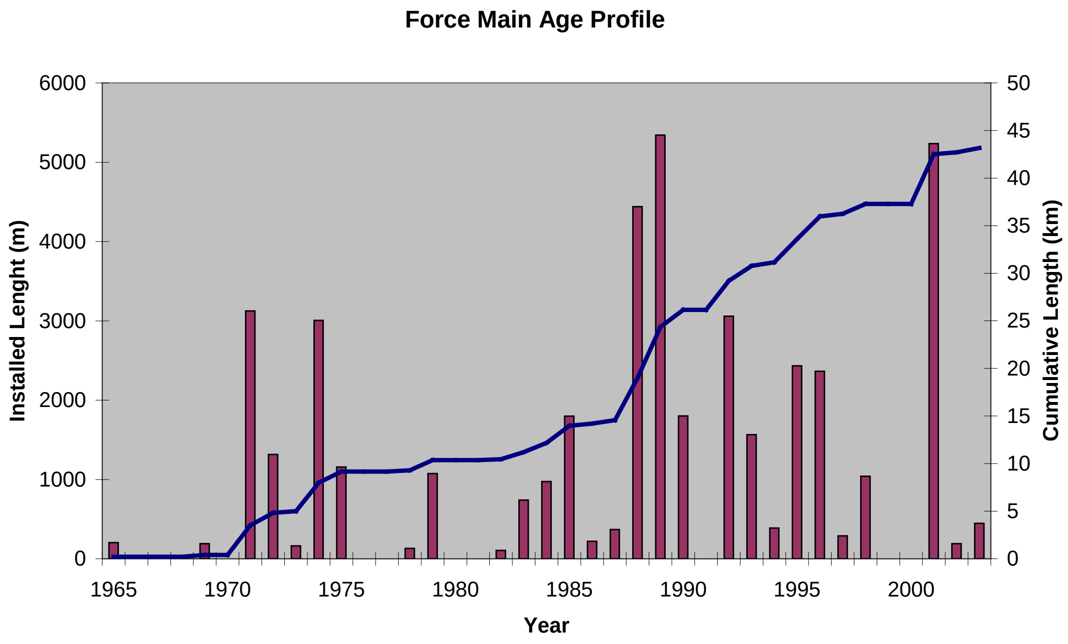


Figure 1 Force mains age profile

3.2.2.3 Pumping Stations

There are approximately 173 wastewater pumping stations within the collection network, over half of which are small pumping stations with an installed capacity of less than 20 horsepower.

Table 10 Wastewater Pumping Stations by Capacity

Capacity (HP)	<= 5	6 - 20	21 - 100	101 - 300	>300	Unknown	**Total**
Number	70	51	38	12	0	2	**173**

All the pumping stations have a known age of installation or upgrade, with over half installed between 1980 and 2000. The age profile is shown below.

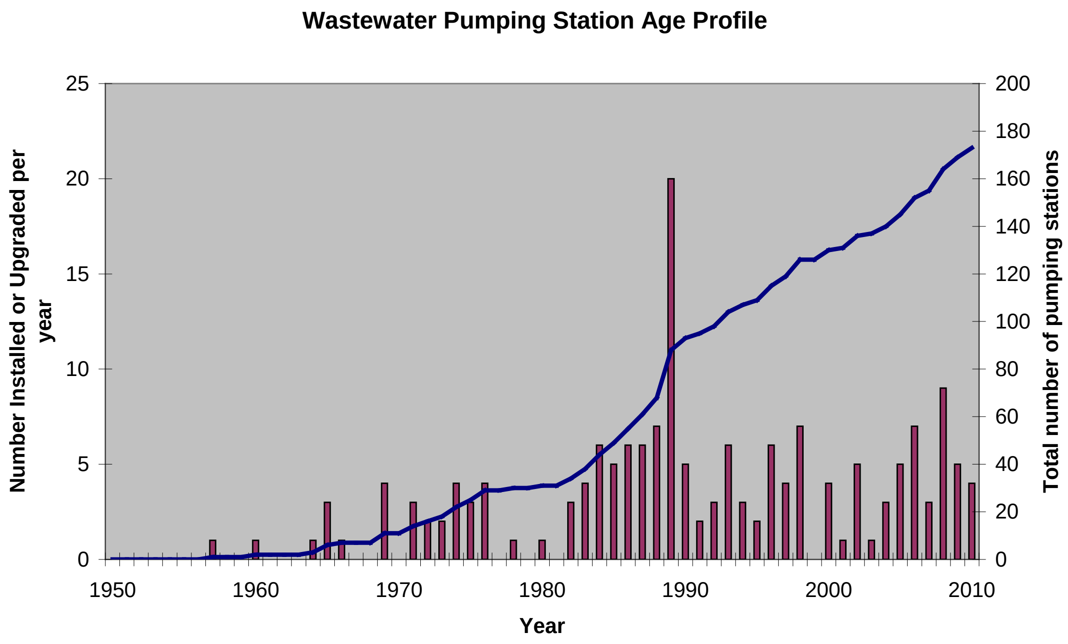


Figure 2 Wastewater pumping stations age profile

3.2.2.4 CSOs & SSOs

There are a total of 221 overflows in the collection network, at pumping stations and wastewater treatment works. The figures in the table below are based on the information originally provided by Halifax Water and is currently under review.

Table 11 CSOs & SSOs

Description	Number
Overflows at Pumping Stations	171
Overflows at WWTF	15
HHSP Structure	19
CSO	14
Hydraulic Relief Points	2
Total	**221**

3.2.2.5 Wastewater Treatment Works

Halifax Water owns and operates a total of 15 wastewater treatment works.

Table 12 Wastewater Treatment Works

Name	Year Constructed / Upgraded	Process	Design Average Flow (m3/d)
Halifax	2007	Enhanced Primary Treatment, Sludge Holding Tanks, Full Back Up Power	100,000
Dartmouth	2008		65,000
Herring Cove	2009		35,000
Aerotech	1986 (upgrade 2006)	Automatic Screen, Grit Removal, Flow Equilisation Tank, SBR, UV, Sand Filters and Nutrient Removal	1,430
Fall River Lockview-MacPherson	1994	Manual Bar Screen, Flow Equalisation Tank, Grit Removal, Extended Aeration, Secondary Clarification, UV, Sand Filter and Nutrient Removal (P only), Sludge Holding Tank	454
Frame Subdivision	1960's	Extended Aeration Package Plant, Hypochlorite	80
Mill Cove	1970's (upgrade 1997)	Automatic Screen, Grit removal, Primary Clarifiers, Pure-Ox Activated Sludge Plant, Secondary Clarifiers, UV, Primary and Secondary Digesters	28,390

Name	Year Constructed / Upgraded	Process	Design Average Flow (m3/d)
Springfield	1989	Automatic Screen, Extended Aeration Plant, Secondary Clarifier, Hypochlorite	520
Uplands Park	1969	Manual Bar Screen, Primary Clarifier Trickling Biological Filter, Secondary Clarifier, Hypochlorite, Wetland	90
Wellington	1976	Manual Bar Screen, Extended Aeration Plant, Hypochlorite	70
Belmont / Marion Heights Subdivision	1960's	Manual Bar Screen, Extended Aeration Plant, Hypochlorite	115
Eastern Passage	1974 (upgrade 1988)	Grit Removal, Automatic Screen, Primary Clarifier, Primary and Secondary Digesters	17,700
Middle Musquodoboit	1988	Flow Equalisation Tank, RBC, Secondary Clarifier, UV, Aerated Polishing Pond	140
North Preston	1989 (Expanded 2008 & 2010)	Automatic Screen, Grit Removal, Flow Equilisation Tank, SBR, UV, Wetland Nutrient removal	300
Lakeside / Timberlea	1993	Automatic Screen, Grit Removal Primary Clarifier RBC's , Secondary Clarifiers, Hypochlorite, Nutrient Removal	4,540

3.2.3 Asset Performance

3.2.3.1 Collection Network

The balanced scorecard, organizational indicator measures service outages of wastewater connections. Historical performance is shown in the table below, which indicates performance well within the current target. The reported figures suggest the target is too high and should be lowered.

Table 13 Service Outages of Wastewater (# connection hours / 1000 customers)

2008 - 2009	2009 - 2010	2010 - 2011	Target
No data	14.3	3	200

Performance indicators such as sewer flooding or sewer collapse are not reported for the sewer collection network, however the following data on sewer blockages has been recorded by Halifax Water operations:

East Region 31 sewer blockages since 2009

West Region 20 sewer blockages between January 2010 and July 2011

Central Region 4 sewer blockages between July 2009 and July 2011

This equates to approximately 27 blockages per 1000km per year, which is a very low figure when compared to the average for UK water companies of around 450 blockages per 1000km.

No sewer condition data has been captured; however, Halifax Water does now have an in-house CCTV survey capability.

There is no formal process in place for reporting force main breaks; however, the following information has been captured by Halifax Water in Hansen:

East Region 10 force main breaks since 2009

West Region 4 force main breaks between January 2010 and July 2011

Central Region 2 force main breaks between July 2009 and July 2011

This gives an average of approximately 10 breaks per year, or 115 breaks per 1000km per year. This is high when compared to typical UK figures of around 50 breaks per 1000km per year.

Halifax Water has identified the most problematic force mains and replacement or twinning projects have been included in the latest capital program.

3.2.3.2 Pumping Stations

The overall performance of the pumping stations has been assessed by Halifax Water as follows:

Table 14 Wastewater Pumping Station Performance

Grade	**1**	**2**	**3**	**4**	**5**
Description	Effective	Satisfactory	Deteriorating performance	Becoming ineffective	Ineffective
% Pumping Stations*	66%	20%	6%	3%	1%

*4% not graded for performance

However, no data is collected on pumping station failures and their impact on network service levels.

In addition the condition of the civil, mechanical and electrical components has been assessed, with the results shown in the following graph (grade 1 is very good condition, grade 5 is very poor condition):

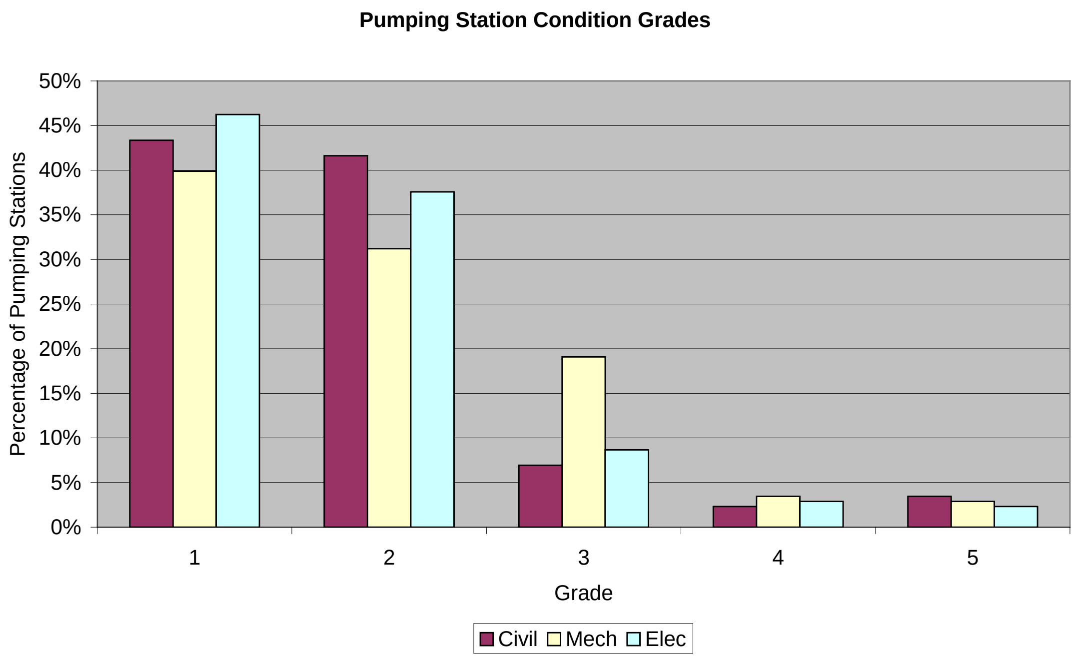


Figure 3 Wastewater Pumping station condition bands

The average condition profile for the pumping stations is summarised in the table below:

Table 15 Wastewater Pumping Stations Condition Profile

Grade	**1**	**2**	**3**	**4**	**5**

Description	Very Good	Good	Fair	Poor	Very poor
% Pumping Stations	44%	38%	12%	3%	3%

The pumping stations have also been assessed for their environmental impact during wet weather:

Table 16 Wastewater Pumping Stations Environmental Impact

Grade	Description	Percentage of Pumping Stations*
1	No release or high level alarms	76%
2	Releases or high level alarms. No public health concerns.	2%
3	Releases or high level alarms. Public health concerns. Releases are in salt water	3%
4	Releases or high level alarms. Public health concerns. Releases are in fresh water	5%
5	Significant operator intervention required to prevent releases	11%

*3% not graded

The overall condition and performance of the pumping stations is as can be expected for assets of this type and age. However, the risk of environmental impacts due to wet weather flows is high at a significant number of pumping stations.

3.2.3.3 CSOs & SSOs

A risk assessment has been carried out on the overflows by Halifax Water.

Table 17 CSO/SSO risk assessment

Risk Category	Description of Potential Release Point	Number of CSOs/SSOs
A	Drinking Water	12
B	Supervised HRM Beach and/or on-ground with high potential for human contact	87
C	Known unsupervised swimming areas and designated recreational areas (boat clubs, parks, etc.)	37
D	Other freshwater bodies and/or on ground with low potential for human contact	30
E	Other marine bodies	40

3.2.3.4 Wastewater Treatment Works

No condition assessments have been carried out at the Wastewater Treatment Works. Detailed performance assessments are included elsewhere in the Working Paper.

Treatment works compliance is reported as part of the Corporate Balanced Scorecard as follows:

Table 18 Wastewater Treatment Works Compliance

2008 - 2009	2009 - 2010	2010 - 11	Target
No data	66%	33%	80%

Percentage of wastewater treatment facilities meeting discharge regulations of their permits. (Does not include Harbour Solutions plants).

3.2.4 Renewal Activity

3.2.4.1 Collection Network and Force Mains

There is no available data on the amount of replacement/renewal of the wastewater collection system, but it has been limited to reactive replacements as there is no proactive renewal program in place.

3.2.4.2 Pumping Stations

Minor works and capital maintenance has been carried out on wastewater pumping stations over the last 3 years, although it is not possible to quantity the amount of expenditure, the asset value of the work is in the order of $7million. Typical work included pump replacements, pumping station upgrades and provision of standby generation.

Recent major upgrade activity includes:

Table 19 Wastewater Pumping Station Activity

2010	2009	2008
Dingle (40 HP)	Roaches Pond (150 HP) PS at Wellington WWTF (1HP)	Duffus Street (300 HP) Gaston Road (20 HP) Maitland Street (2HP)

In addition to these, there were other minor upgrades at other pumping stations which included pump replacements, panel replacements, and roof replacement.

3.2.4.3 CSOs & SSOs

There is no information on renewal or replacement activity for CSOs or SSOs. Typically where Halifax Water undertakes work on SSOs it is required by NSE to eliminate the SSO. Elimination is based on a particular design storm (for example a 1:5 year event). The current focus for CSO and SSO management is on monitoring. Halifax Water has prioritized a number of overflow sites where monitoring equipment is being installed.

3.2.4.4 Wastewater Treatment Works

North Preston WWTF was expanded and upgraded in 2008-2010. Minor capital works and upgrades have been ongoing for the last 3 years. Total asset value of the upgrades and expansions over 3 years is around $5million.

3.3 Water

3.3.1 Historical Financial Expenditure

The value of the water asset additions over the last 4 years is shown in the table below. Paid for Additions is Halifax Water's capital expenditure on its assets (Halifax Water does not currently record capital expenditure by different drivers such as growth or asset renewal). Donated Additions includes assets received from Developers, from Water Dividend Funding, from CCC or received from Halifax Regional Municipality.

Table 20 Water Asset Additions

	2007-08	2008-09	2009-10	2010-11
Paid for Additions	5.93	6.64	14.66	17.67
Donated Additions	8.39	8.86	9.22	11.67
Total $m	**14.32**	**15.50**	**23.88**	**29.33**

Operating expenditure over the last 5 years is shown in the table below:

Table 21 Water Operating Costs

	2006-07	2007-08	2008-09	2009-10	2010-11
Water Treatment	5.28	5.63	6.79	7.64	6.82
Hydrants	0.66	0.60	0.78	0.89	0.80
Reservoirs	0.06	0.09	0.03	0.05	0.66
Distribution System	3.99	4.58	5.85	5.85	5.56
Water Pumping Stations	0.20	0.19	0.18	0.18	0.26
Water Meters	0.62	0.72	0.64	0.66	0.79
Total Operating Costs $m	**10.18**	**11.08**	**13.63**	**14.61**	**14.89**

3.3.2 Asset Base

3.3.2.1 Distribution & Transmission Mains

There are approximately 1,300km of water mains owned and operated by Halifax Water, of which around 20km are classified as transmission mains.

Table 22 Water Mains by length

Diameter	<=165mm	166 - 320	321 - 625	>626mm	**Total**
Length (km)	296.7	739.2	201.4	69.6	**1306.9**

Only about half of the water mains are digitised in GIS. The remainder (principally the Dartmouth area) are shown schematically based on AutoCad drawings.

Based on the attribute data held on GIS, the material and age profiles of the mains are as follows:

Material	Ductile Iron	Cast Iron	Hyprescon	PVC	Other	Unknown	**Total**
Length (km)	387.1	313.0	77.8	21.2	3.2	504.7	**1306.9**
Proportion	30%	24%	6%	2%	0%	39%	

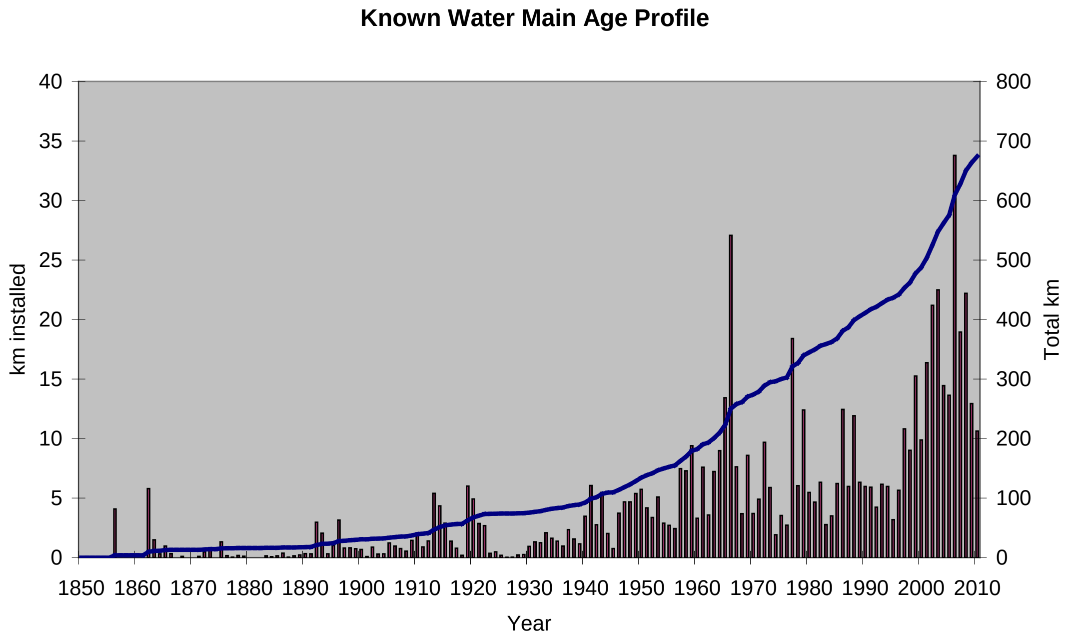


Figure 4 Water main age profile (known)

99% of the watermains in GIS have installations dates. 67% of the transmission mains (by length) have an installation date.

2.2 Hydrants, Valves, Water Meters

There are approximately 8,000 fire hydrants on the GIS database, 74% of which have an installation date. There are a total of 37,000 valves on GIS, with Halifax Water reporting a total of 13,027 main valves in the 2009 annual report. Only 20% of the valves have an installation date.

There are a total of 80,989 meters, of which 76,367 are 5/8th domestic water meters. The age profile of the meters shows a fairly linear installation rate.

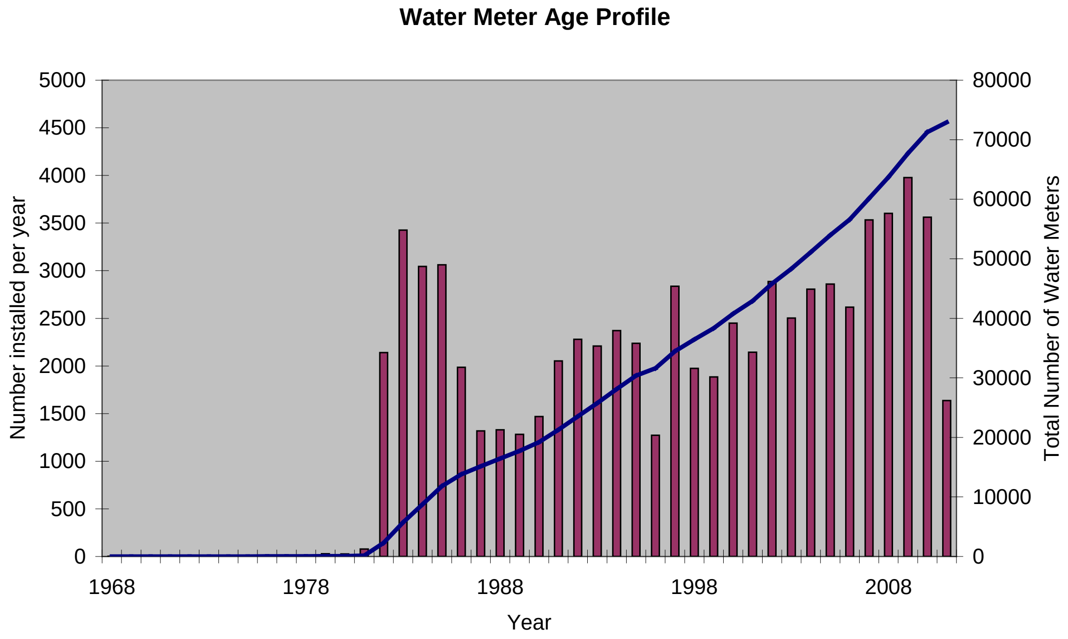


Figure 5 Water meter age profile

3.3.2.2 Water Pumping Stations

Halifax Water owns and operates 19 water pumping stations in the distribution network. This figure does not include Rockmanor Pumping Station which is not in use as the pumps can no longer provide adequate back-up role to the growing gravity-fed zone.

Table 23 Water Pumping Station Capacity

Capacity (USGal/min)	<=100	101 – 1000	1001 – 3000	>3000
Number	2	4	9	4

All pumping stations have installations and major upgrade dates.

3.3.2.3 Service Reservoirs

There are a total of 16 reservoirs in the distribution system.

Table 24 Service Reservoirs

Reservoir Name & Elevation	Capacity ML	Type	Year of Construction
Geizer 158 (158 m)	36.4	Steel	1986
Geizer 123 (123 m)	31.8	Concrete	1975
Cowie (113 m)	11.4	Concrete	1972
Robie (82 m)	15.9	Concrete	1913
Lakeside/Timberlea (119 m)	5.4	Concrete	1982
Mount Edward 1 (119 m)	22.7	Concrete	1979
Mount Edward 2 (119 m)	22.7	Steel	1998
Akerley Blvd. (119 m)	37.7	Steel	1986
North Preston (125 m)	1.6	Steel	1988
Meadowbrook (95 m)	9.1	Concrete	1971
Sampson (123 m)	12.2	Steel	1970
Stokil (123 m)	23.6	Steel	1991
Waverley (86 m)	1.3	Steel	1982
Middle Musquodoboit	0.3	Concrete	1989
Aerotech (174 m)	4.1	Steel	1986
Beaver Bank (156 m)	6.9	Steel	2008

There are an additional two reservoirs at Pockwock (13.6 ML) and Lake Major (9.1 ML), but these are not considered distribution system reservoirs.

3.3.2.4 Water Treatment Works

Halifax Water owns and operates a total of 8 water treatment works.

Table 25 Water Treatment Works

Name	Year Constructed / Upgraded	Process	Design Flow
J. Douglas Kline Water Supply Plant	1977	Dual media direct filtration, Iron and manganese removal	Capacity: 227 MLD Average production: 91 MLD
Lake Major Water Supply Plant	1999	Upflow clarification and trimedia filtration Iron and manganese removal	Capacity: 94 MLD Average production: 43 MLD
Bennery Lake	1987	Manganese removal, sedimentation, dual media filtration	Capacity: 7.9 MLD Average production: 3.4 MLD
Collins Park	2010	Membrane Plant	Average production: 0.073 MLD
Middle Musquodoboit	2010	Membrane Plant	Average production: 0.060 MLD
Five Island Lake	1994	Ultraviolet disinfection	Average production: 0.006 MLD
Silver Sands	1985. Upgraded and acquired by HW in 1998.	Green sand pressure filters, Iron and manganese removal	Average production: 0.021 MLD
Miller Lake	Early 60's. Upgrade and acquired by HW in 2002.	Arsenic removal with G2 Media	Average production: 0.026 MLD

3.3.3 Asset Performance

3.3.3.1 Distribution and Transmission Network

The network performance is measured using the Corporate Balanced Scorecard indicators of interruptions and leakage:

Table 26 Service Outages of Water (# connection hours / 1000 customers)

2007 - 2008	2008 - 2009	2009 - 2010	2010 - 11	Target
229.83	182.22	140.53	180	200

Table 27 Leakage - Infrastructure Leakage Index (ILI)

2005 - 06	2006 - 07	2007 – 08	2008 - 2009	2009 - 2010	2010 - 11	Target
3.0	3.0	3.1	3.2	3.1	3.0	2.9 - 3.3

Table 28 Leakage - litres per service connection per day

2009 - 2010	2010 - 11	Target
203	197	200 - 210

The median leakage level for Canadian Utilities is around 200 litres per connection per day (source: 2008, National Water and Wastewater Benchmarking Initiative).

In addition, water main breaks are a good indicator of water network performance.

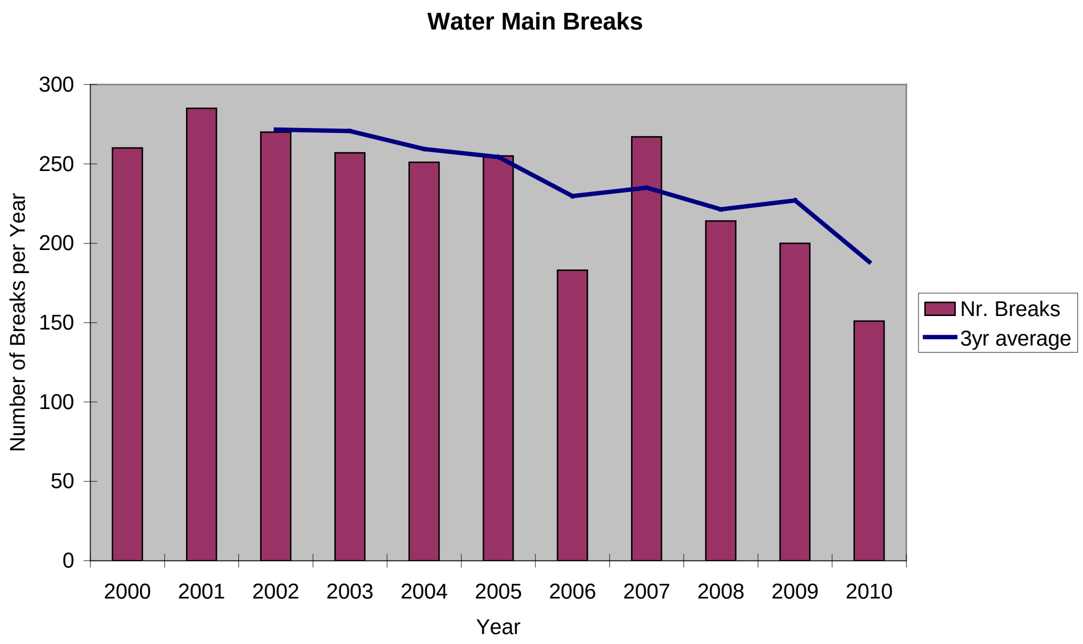


Figure 6 Water main breaks

The above graph shows an overall reduction in mains breaks, with an average rate over the last 3 years of around 150 breaks/1000 km/year. This compares to a Canadian median of 72 and maximum of 195 breaks/1000km/year (in 2008, source National Water and Wastewater Benchmarking initiative) and to a UK average of 200 breaks/1000km/year (source Ofwat June Return).

Halifax Water has undertaken a full review of its transmission mains following breaks on a number of mains and problems with 'hyprescon' (pre-stressed concrete cylinder pipe) mains. The mains have been assessed based on level of redundancy, performance/ effectiveness and failure consequence to give a risk score for prioritising renewal. A summary of the performance/effectiveness of the mains is given in the table below:

Table 29 Transmission Mains Performance & Effectiveness

Performance / Effectiveness	1 Very Effective	2 Effective	3 Average Effectiveness	4 Poor Effectiveness	5 Ineffective	Total
Length of Mains (km)	84.8	106.1	21.73	1.12	3.4	217.1
% Length of Mains	39%	49%	10%	1%	2%	

A list of some of the mains identified as suffering from poor condition and/or high break rates is as follows:

Table 30 Transmission Mains Performance History

Name	**Performance History**
Windmill Road Transmission Main	Existing 12" main is undersized and in very poor condition (high break rate)
Eastern Passage Transmission Main	There have been a number of leaks and breaks over the years along part of the Eastern Passage main
Pockwock Transmission Main Kearney Lake Road (Twin Culverts to Bluewater Road)	48" C301 Hyprescon pipe: same pipe material and age as downstream pipe sections that have failed and have been twinned One previous failure on this section of the transmission main
Peninsula Low 24" Transmission Main	Existing Cast Iron pipe was originally installed in 1862, portions were previously cleaned and lined in 1994 There have been a number of leaks and breaks over the years on this transmission line
Spruce Hill Transmission Main	There have been a number of leaks and breaks over the years on this transmission line
Herring Cove Transmission Main	There have been a number of leaks and breaks over the years on this transmission line and some sections of the line have been renewed
Bedford Connector 30"	30" C301 Hyprescon pipe: same pipe material and age as

	pipe sections that failed and were replaced along Hammonds Plains Road At least 3 breaks on this section of transmission main in the last few years
Windgate Drive Transmission Main	The existing single main along the Cobequid Road that was installed in the 1980s has ongoing severe corrosion problems and has failed several times. A section of the main has already been replaced.

3.3.3.2 Water Pumping Stations

The water pumping stations have been assessed for their reliability and performance, with grade 1 being very good and grade 5 being very poor.

Table 31 Water Pumping Station Reliability & Performance

Grade	1 – Very Good	2 – Good	3 – Average	4 – Poor	5 – Very Poor
Reliability	40%	25%	10%	25%	0%
Performance	40%	15%	25%	20%	0%

Pumping stations rated poor:

- Rockmanor Pumping Station
- Airport Fire Pumping Station (HIAA) – HIAA is addressing a list of repairs as identifed by HW
- Silverside Pumping Station
- Cowie Reservoir Pumping Station – FD controls are burned out for the domestic pumps Severe corrosion on some electrical components
- Leiblin Pumping Station - Consultant hired to do design work

3.3.3.3 Service Reservoirs

Halifax Water has a reservoir maintenance program, the status of which at September 2010 was:

Table 32 Service Reservoir Maintenance Program

Reservoir	Date of last inspection/cleaning	Years since last inspection/cleaning	Cleaning & inspection due
Akerley		24	Yes
Geizer 158	1993	17	Yes
Mt. Edward 2	2007	3	
North Preston		22	Yes
Sampson	2010		
Stokil	2007	3	

Waverley	2006	4	
Bennery Lake		24	Yes
Beaverbank	2008	2	
Cowie Hill	1996	14	Yes
Charles Road	2003	7	Yes
Meadowbrook	2000	10	Yes
Geizer 123 (int)	1995	15	Yes
Geizer 123 (ext)	1995	15	Yes
Robie Street	2000	10	Yes
Musquodoboit		21	Yes
Mt. Edward #1	2003	7	Yes

The majority of reservoirs are due a cleaning and inspection. AWWA guidelines recommend a 3 year cycle of cleaning and inspection. There is no available data on reservoir condition.

3.3.3.4 Water Treatment Works

Water treatment works compliance is assessed in more detail elsewhere in TM1. The service level indicators from the Corporate Balanced Scorecard indicate performance as follows:

Table 33 Bacteriological Tests

2007 - 2008	2008 - 2009	2009 - 2010	2010 - 11	Target
99.90%	99.80%	99.7	99.80%	99.30%

Table 34 Percentage of water supply plants meeting product regulations of their permits

2007 - 2008	2008 - 2009	2009 - 2010	2010 - 11	Target
No data	No data	100%	100%	100%

*Table 35 Disinfection, THMs, HAAs, Particle Removal, Corrosion Control**

2007 - 2008	2008 - 2009	2009 - 2010	2010 - 11	Target
40%	56%	49%	71%	90%

*These are emerging water quality parameters that Halifax Water has developed a water quality master plan to meet.

3.3.4 Renewal Activity

3.3.4.1 Distribution and Transmission Network

The water mains replacement rates are reported as follows by Halifax Water (no renewal rates have been calculated for 2009-10 or 2010-11):

Table 36 Water mains replacement rates

Year	2005-06	2006-07	2007-08	2008-09
Mains renewed (m)	3033	3517	2,283	3,246
Mains rehabilitated (m)	0	1136	2,664	-
Total mains length (m)	1,253,869	1,275,063	1,295,212	1,306,868
Replacement rate	0.24%	0.36%	0.38%	0.25%

For comparison, the average replacement rates for the water and sewerage companies in England and Wales over the last four years is 0.55%, but this does vary considerably between 0.23% and 1.29%.

3.3.4.2 Water Pumping Stations

Capital maintenance and upgrades have been carried out to the water pumping stations in recent years, with expenditure of approximately $400k in the last 3 years.

3.3.4.3 Service Reservoirs

Limited service reservoir rehabilitation work has been carried out in recent years:

2010 Sampson Reservoir

2004 Mt Edward#1, Robie Street

2003 Charles Road

2000 Meadowbrook, Robie Street

3.3.4.4 Water Treatment Works

There are no specific details available for asset renewals at the water treatment works, but approximately $1m of fixed asset value has been created in the last 3 years, most of which can be assumed to relate to asset renewal. In addition upgrades to Collins Park and Middle Musquodoboit have cost in the order of $3.5m.

3.4 Stormwater

3.4.1 Historical Financial Expenditure

The value of the wastewater asset additions over the last 4 years since the merger of wastewater and stormwater services at Halifax Water (August 2007) is shown in the table below. Paid for Additions is Halifax Water's capital expenditure on its assets (Halifax Water does not currently record capital expenditure by different drivers such as growth or asset renewal). Donated Additions includes assets received from Developers, from Water Dividend Funding, from CCC or received from Halifax Regional Municipality. The Donated Additions for the Harbour Solutions Scheme are shown separately.

Table 37 Stormwater Asset Additions

	2007-08	2008-09	2009-10	2010-11
Paid for Additions		0.05	0.02	0.26
Donated Additions	40.24	5.64	2.55	23.03
Harbour Solutions				20.47
Total $m	**40.24**	**5.69**	**2.57**	**43.76**

Operating expenditure over the last 3 years is shown in the table below:

Table 38 Stormwater Operating Costs

Stormwater Collection	2008-09	2009-10	2010-11
Operating Costs $m	4.25	4.14	4.44

3.4.2 Asset Base

3.4.2.1 Stormwater Pipes and Culverts

There is a total of 599km of stormwater sewers on the GIS, with a further 190km recorded on schematics. In addition there is 8km of stormwater culverts shown on GIS, but this is understood to be a significant underrepresentation. Halifax Water currently has an ongoing program to identify and survey stormwater cross culverts (culverts conveying water under roads but excluding driveway culverts). A future data collection project to quantify and gather condition information for driveway culverts may be considered.

Table 39 Stormwater Pipes & Culverts by Length

Pipe Size	<=165mm	166 - 320	321 - 625	626 - 925	> 925mm	Unknown	**Total**
Length km	10.8	206.6	235.6	55.4	36.8	243.8	**789.0**
Proportion	1%	26%	30%	7%	5%	31%	

Culvert Size	<=165mm	166 - 320	321 - 625	626 - 925	> 925mm	Unknown	**Total**
Length km	0.0	0.4	2.7	1.6	2.0	1.8	**8.4**
Proportion	0%	4%	32%	19%	24%	21%	

Pipes and culverts are predominately made of concrete. There is a lack of age data; only 30% of pipes and culverts have a date of construction.

3.4.2.2 Stormwater Structures

The table below lists all the stormwater dams and other water control structures as approved by the Merger Oversight Committee in September 2009.

Table 40 Stormwater Structures

Name	**Type of Structure**	**Owner**	**Capacity (m3)**	**Year of Construction**
Oceanview Drive Retention Pond	Retention Pond	HW	3700	1990
Meadowbrook Retention Pond	Retention Pond	HW	190	1980
Transom Drive Retention Pond	Retention Pond	HW	9900	2007
Glenbourne Estates Retention Pond	Retention Pond	HW	430	1990
Parkland Avenue Retention Pond	Retention Pond	HW	36000	1990
Glen Forest Weir / Retention Pond	Retention Pond	HW	12	1960
Lacewood Retention Pond	Retention basin, dam and spillway	HW	5300	1970
Big Indian Lake Dam	Concrete ogee crest Spillway	HRM		
Otter Lake Dam	Concrete Spillway	HRM		
Susie Lake Control Structure	Concrete Sluice gate. Drains to Black Duck Pond	HW	35600	1989
Volvo West Retention Pond	Retention Pond	HW	55600	1990
Old Sambro Road Retention Pond	Retention Pond	HW	20	1980
Graystone Road Retention Pond	Retention Pond	HW	300	1980
Tamarack Drive Retention Pond	Retention Pond	HW	270	1990
Heritage Hills Retention Pond	Retention Pond	HW	13800	1998
Clement Street Retention Pond	Control Gates	HW	244000	1979
Maynard Lake Dam	Pipe and Gate	HW	172000	1960
Sullivan's Pond Culvert	Grated inlet to Culvert	HW	44,000	1971
Lake Banook Dam	Gate	SCC / HRM		

Name	Type of Structure	Owner	Capacity (m3)	Year of Construction
Oathill Lake Dam	Logs	HRM		
Shubie Drive Retention Pond	Retention Pond	HW	19500	2007
Countryview Drive Retention Pond	Retention Pond	HW	3200	2006
Commodore Drive Retention Pond	Retention Pond	HW	9400	2006
Lemlair Row Retention Pond	Retention Pond	HW	15300	2006
Albro Lake Dam	Logs	HRM		
Russell Lake Dam	Logs	HRM		
Forest Hills Retention Pond	Retention Pond	HW	5000	1980
Cole Harbour Commons Retention Pond	Timber Headwall and Culvert	HW	2000	2007
Guysborough Retention Pond	Retention Pond	HW	9000	1979
John Stewart Dr Retention Pond	Retention Pond	HW	550	2005
Stewart Harris Drive Retention Pond	Retention Pond	HW	160	1978
Cranberry Lake Retention Pond	Retention Pond	HW	108	1980
Gregory Drive Retention Pond	Retention Pond	HW	80	2003
Main Street Retention Pond	Retention Pond	HW	130	1980
Kuhn Marsh Dam	Retention Pond and Dam	HW	60,000	2008

In total, Halifax Water (HW) owns 29 stormwater structures.

The dimensions of the dams are as follows:

Table 41 Stormwater Dams

Dam	Height (m)	Crest Length (m)	Construction Type
Lacewood Retention Pond	2.5	9	Concrete
Susie Lake Control Structure	3.6	232	Combined Concrete & Earth Berm
Volvo West Retention Pond	4.3	1.5	Concrete (control structure)
Clement Street Retention Pond	2.6	61	Earth Berm
Kuhn Marsh Dam	3	50	Earth Berm
Sullivan's Pond Culvert	4	20	

3.4.3 Asset Performance

3.4.3.1 Stormwater Pipes & Culverts

There is no data on the condition or performance of the stormwater collection system.

3.4.3.2 Stormwater Structures

A review of the stormwater structures was undertaken in 2009 which included an inventory of the assets, data collection, review of condition and classification of dams.

3.4.4 Renewal Activity

Halifax Water has not undertaken any significant renewal activity on the stormwater pipes and culverts.

4 Requirements for Asset Renewal

4.1 Chapter Overview

Based on the review of the service level, asset performance, condition data and other available information, this chapter sets out some of the main requirements for asset renewal for each of the three services: water, wastewater and stormwater.

4.2 Water Renewal Requirements

The overall performance of the water distribution network is good and historical renewal rates appear to have been sufficient. Renewal rates will have to increase gradually to account for the aging of the network. Halifax Water has developed an initial program of water mains renewals.

Major transmission mains are in need of renewal or replacement. A program of transmission mains relining, replacement and twinning has been developed.

Remedial works have been identified for the water pumping stations in poor condition. Ongoing minor capital maintenance will be required.

There has been a limited service reservoir inspection and cleaning program, with minimal rehabilitation work. The inspection and cleaning frequency will need to increase, and this is likely to identify additional rehabilitation needs.

The Pockwock water treatment works has been identified as requiring asset renewal works, specifically a replacement disinfection system, a new mixing system and general improvements. Mechanical & Electrical equipment will need replacing in the short-term.

4.3 Wastewater Renewal Requirements

The collection network has suffered from a lack of investment in recent years, and is likely to require a comprehensive program of rehabilitation. Given the lack of data (specifically age, performance and condition) an initial data collection exercise is required, with CCTV survey and condition grading. Once Halifax Water has developed sufficient data on sewer condition and performance, it will be able to pro-actively target sewer replacements and be able to justify increases in replacement rates if required.

Halifax Water has identified some specific renewal projects for collection sewers, trunk sewers and force mains.

A number of wastewater pumping stations have been identified as being in poor condition; these will need to be targeted first in the renewal program.

Upgrades and replacements for wastewater treatment works in the short term have been identified by Halifax Water. This includes Wellington WWTF replacement, Uplands Park WWTF upgrades, Eastern Passage WWTF upgrades, Beechville-Lakeside-Timberlea (BLT) WWTF capacity upgrades, Aerotech WWTF capacity upgrades, and rehabilitation work at Mill Cove WWTF. It is likely that the main drivers for capital expenditure at wastewater treatment works will be growth and regulatory compliance; however, asset renewal requirements should be taken into account in these projects.

4.4 Stormwater Renewal Requirements

Like the sanitary and combined sewers, the stormwater collection network has suffered from lack of investment in recent years, however its impact on service levels is less than that of the wastewater network. Additional information on assets and condition is required to develop a renewal program, but Halifax Water has already identified some stormwater pipe and culvert renewal projects, and is undertaking a program of culvert inspections.

Similar to the wastewater and combined sewer systems, significant effort is required for a data collection exercise related to stormwater systems. This in addition to basic condition information will lead to a future stormwater system renewal program (including both operational and capital activities) with more significant reinvestment needs.

5 Data Gaps and Assumptions

5.1 Chapter Overview

This chapter summarises the key data gaps identified during the data review, identifies the data needs for the asset renewal forecasts and recommends assumptions to be used to fill the data gaps.

5.2 Data Requirements for Asset Renewal Forecasting

Data Type	Use in Asset Renewal Forecasting
Historical capital and operating costs by asset class	Used in analysis of historical expenditure, service levels and renewal rates. Forecast expenditure can be compared to historical.
Historical construction costs (new or renewal)	Used to estimate asset renewal costs
Asset size/capacity, pipe length and diameter	Data used with cost data to estimate renewal costs; used for asset deterioration modelling. Assets can be grouped and analysed according to size.
Asset material type	Asset renewal modelling can be refined for different material types which have different deterioration rates and expected lives. Required for deterioration modelling.
Asset construction/installation date	Asset age can be a component of deterioration modelling. Simplified asset renewal modelling is based on sewer age and expected life
Asset condition	Asset condition grades used to inform renewal priorities. Can be used in deterioration models.
Historical asset performance / service level indicators	Allows assessment of asset performance and service levels. Can be used with forecasting models to forecast service levels based on different renewal rates and options
Activity rates	Allows analysis of historical asset renewal rates, and comparisons with service levels and expenditure. Activity rates can also include operational activities such as inspections and mains cleaning.

5.3 Wastewater

5.3.1 Data Gaps

All wastewater asset classes

- Historical capital expenditure

Collection and Trunk Sewer Network

- 248km of sewer (18%) is not on GIS
- Pipe Diameter – 25% of sewer length is unknown
- Material – 37% of sewers unknown material
- Age data: 75% of sewers do not have an installation date
- No condition data
- No sewer flooding data
- Limited blockage and collapse data
- No data on the replacement/renewal rates of the collection system

Force Mains

- 23km of forcemains (25%) are not on GIS
- Pipe Diameter – 26% of length is unknown
- Material – 37% unknown material
- Only 58% of the force mains do not have an installation date
- No break data linked to assets
- No condition data
- No renewal/replacement data

Wastewater Pumping Stations

- No breakdown of assets to equipment/component level
- No data on pumping station failures and their impact on network service levels

Wastewater Treatment Facilities

- No breakdown of assets to equipment/component level
- No process/equipment installation dates
- No facility/equipment condition data

5.3.2 Assumptions

The following assumptions have been made in order to fill the gaps in the data required to forecast asset renewal rates and costs:

Collection and Trunk Sewer Network

- Collection sewer diameter: assume 250mm diameter (sensitivity range 200mm to 300mm).
- Trunk sewer diameter: assume 900mm diameter (sensitivity range 700mm to 1200mm)
- Assume sewer material to be concrete
- Age profile assumed as per table

Decade	Assumed	Length (km)
1880 - 89	1%	13.4
1890 - 99	2%	26.7
1900 - 09	2%	26.7
1910 - 19	3%	40.1
1920 - 29	2%	26.7
1930 - 39	2%	26.7
1940 - 49	6%	80.1
1950 - 59	8%	106.8
1960 - 69	13%	173.6
1970 - 79	15%	200.3
1980 - 89	14%	186.9
1990 - 99	12%	160.2
2000 - 09	20%	267.0
Total	**100%**	**1335.0**

The age profile has been assumed by Halifax Water staff based on known sewer installation dates, comparison with the water main age profile and local knowledge. The first sewers were laid in the 1880s and there is an allowance for increased growth post 1960 taking into account the Nova Scotia housing project growth.

- Expected useful life of concrete sewers is 100 years, for other materials is 75 years

Force Mains

- Force main diameter: assume 200mm diameter (sensitivity range 150mm to 250mm).
- Material assumed to be PVC
- Age profile assumed as per table

Decade	Assumed	Length (km)

1960 - 69	1%	0.9
1970 - 79	23%	20.7
1980 - 89	32%	28.7
1990 - 99	30%	26.9
2000 - 09	14%	12.6
Total	**100%**	**89.8**

The age profile has been assumed based on the known age date for 50% of the force mains.

- Expected useful life of force mains is 50 years

Wastewater Pumping Stations

- Assumed breakdown of asset sub-category and expected useful lives as follows:

Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	50%	50
Pumping M&E Equipment	40%	20
ICA, Telemetry & SCADA	10%	10

Wastewater Treatment Works

- Assumed breakdown of expected useful lives as follows:

Asset Sub-category	**Expected Life (years)**
Civil structures / Building	50
Process M&E Equipment	20
ICA, Telemetry & SCADA	10

The split between different sub categories will be estimated for each treatment works depending on the process type.

5.4 Water

5.4.1 Data Gaps

All water asset classes

Halcrow

- Historical capital expenditure

Water distribution and transmission mains

- Only about half of the water mains are digitised in GIS
- 39% of water main material is unknown
- 99% of water mains on GIS have installation dates, but in effect only 50% of all water mains have dates
- Main renewal data not available for 2009/10 and 2010/11

Hydrants, valves, water meters

- 74% of hydrants, 20% of valves and 90% of water meters have installation dates
- There is no condition or performance data on hydrants, valves and water meters

Water pumping stations

- No breakdown of assets to equipment/component level
- No data on pumping station failures and their impact on network service levels

Service Reservoirs

- No condition data

Water Treatment Works

- No breakdown of assets to equipment/component level
- No process/equipment installation dates
- No facility/equipment condition data

5.4.2 Assumptions

The following assumptions have been made in order to fill the gaps in the data required to forecast asset renewal rates and costs:

Water distribution and transmission mains

- Distribution pipe material is either Cast Iron or Ductile Iron
- 50% of the water distribution main data is not captured in GIS, however the data that does exist gives good coverage. Assume that the missing water main data has the same age profile as the known data. Assume that renewal rates calculated for the known data can be applied to the whole water distribution network.

- The missing transmission mains dates have been provided by Halifax Water based on known ages or assumptions based on local knowledge.
- Expected useful life of water mains is 75 years.

Hydrants, valves, water meters

- Assume age profile for hydrants without installation dates follows that for the hydrants with dates.

Decade	Hydrants with data	Hydrants Assumed	Total Nr. Hydrants
1900 - 09	3	1	4
1910 - 19	13	5	18
1920 - 29	36	13	49
1930 - 39	11	4	15
1940 - 49	124	44	168
1950 - 59	262	94	356
1960 - 69	572	205	777
1970 - 79	433	155	588
1980 - 89	421	151	572
1990 - 99	549	197	746
2000 - 09	1214	435	1649
2010 - 19	70	25	95

- Assume age profile of valves follows that of the water mains, allowing for earliest recorded installation date for a valve is 1920.

Decade	Watermains	Adjusted for Valves	Nr. Valves
1850 - 59	1%	0%	0
1860 - 69	1%	0%	0
1870 - 79	0%	0%	0
1880 - 89	0%	0%	0
1890 - 99	2%	0%	0
1900 - 09	1%	0%	0
1910 - 19	4%	0%	0
1920 - 29	2%	2%	262
1930 - 39	2%	2%	319
1940 - 49	6%	7%	847
1950 - 59	8%	8%	1098
1960 - 69	14%	15%	1976

1970 - 79	10%	12%	1502
1980 - 89	10%	11%	1424
1990 - 99	11%	12%	1567
2000 - 09	28%	31%	4032

- Expected useful asset lives:

Asset Category	Expected Life (years)
Residential water meters	20
Commercial water meters	20
Hydrants	75
Valves	75 (included in water mains)

Water pumping stations

- Assumed breakdown of asset sub-category and expected useful lives as follows:

Asset Sub-category	**% of Asset Value**	**Expected Life (years)**
Civil structure / Building	40%	50
Pumping M&E Equipment	50%	30
ICA, Telemetry & SCADA	10%	10

Service Reservoirs

- Assume a 3 year inspection and cleaning regime for the service reservoirs as a baseline, with a sensitivity of 5 and 10 years.
- Expected useful life of service reservoirs is 75 years

Water Treatment Works

- Assumed breakdown of expected useful lives as follows:

Asset Sub-category	Expected Life (years)
Civil structures / Building	50
Process M&E Equipment	30
ICA, Telemetry & SCADA	10

The split between different sub categories will be estimated for each treatment works depending on the process type.

5.5 Stormwater

5.5.1 Data Gaps

All stormwater asset classes

- Historical capital expenditure

Stormwater pipes, culverts, ditches

- 190km (24%) of stormwater pipes are not in GIS
- Limited data in GIS for stormwater culverts (only 8km recorded)
- No asset data on stormwater ditches
- 31% of stormwater pipes and 21% of stormwater culverts lack data on diameter
- There is no condition data on the stormwater collection network
- There are no service levels or performance indicators for the stormwater collection network
- No historical renewal/rehabilitation activity recorded for the stormwater collection network

5.5.2 Assumptions

Stormwater pipes

- Stormwater collection sewer diameter: assume 300mm diameter (sensitivity range 250mm to 375mm).

- Stormwater trunk sewer diameter: assume 750mm diameter (sensitivity range 600mm to 900mm)
- Assume pipe material is concrete
- Age profile assumed as follows:

Decade	Assumed	Length (km)
1950 - 59	3%	23.7
1960 - 69	7%	55.2
1970 - 79	15%	118.3
1980 - 89	25%	197.2
1990 - 99	25%	197.2
2000 - 09	25%	197.2
Total	**100%**	**789.0**

The age profile assumptions are based on known ages and local knowledge of Halifax Water staff, correlated with age profiles for water mains and sewers and taking into account the Nova Scotia housing project in late 1970s through to early 1990s.

Stormwater Culverts

- Culvert size: assume average 600mm diameter
- Assume same age profile as for stormwater pipes

6 Asset Renewal Forecast Modelling

This section describes the renewal modelling process that was undertaken for Halifax Water to inform long term budget setting and the financial analysis requirements for the Integrated Resource Plan (IRP).

The Halcrow Investment Tool (HIT) was used to complete the investment modelling exercise.

There is insufficient asset, service, condition and performance data to develop detailed models for forecasting service levels for water, wastewater and stormwater pipe networks based on different asset renewal rates. Therefore asset renewal rates will need to be forecast based on comparison with typical renewal rates of other water utility companies for pipelines, and based on useful asset lives.

Asset renewals were forecast using an asset life model. The model forecasts renewal expenditure, replacement rates, weighted average life of the asset group, and the number of assets older than the expected life. Asset age will be used as a surrogate for service levels.

In the financial model that has been developed for the IRP asset renewal forecasts arise from:

- Renewal of existing assets to counter deterioration in the "Asset Renewal" section:
  - specified projects that are required to meet current known issues and renewals that may be required in the longer term IRP planning window
  - strategic level forecasts or longer term renewal requirements: modelled by asset type and function using age profiles
- Assets added from the capital plan or capital projects that will require renewal in the longer term IRP planning window

6.1 Industry Benchmarking of Renewal Rates

6.1.1 England & Wales Water Companies

Typical water main renewal rates for water and wastewater companies in England and Wales are shown in the table below.

Table 42 Water Main Renewal Rates – UK Companies

Year	2007 - 08	2008 - 09	2009 - 10	2010 - 11
Maximum	2.01%	1.39%	1.22%	0.55%

Average	0.88%	0.58%	0.39%	0.34%
Minimum	0.25%	0.19%	0.02%	0.17%

The average renewal rate over the period is 0.55%, which implies an expected life of a water main as 180 years. It is recognised by the industry that renewal rates will need to increase to take into account the increasing age of the water distribution networks.

Renewal rates for sewers are typically lower than that for water mains. Renewal rates for the England and Wales water companies are presented in the table below:

Table 43 Sewer Renewal Rates – UK Companies

Year	2007 - 08	2008 - 09	2009 - 10	2010 - 11
Maximum	0.26%	0.32%	0.18%	0.58%
Average	0.14%	0.13%	0.09%	0.14%
Minimum	0.03%	0.06%	0.04%	0.02%

The average renewal rate over the last four years is around 0.13%, implying an average expected life of a sewer as 786 years.

6.1.2 North American Water Utilities

No useful comparable information on renewal rates has been obtained for American or Canadian water utilities.

6.2 The Investment Modelling Methodology

The Halcrow Investment Tool (HIT) is a spreadsheet based computation engine that has been developed by Halcrow to support a range of investment planning functions. The core computation engine and planning principles have been in development over several years. The computation engine uses a combination of spreadsheet functions and VBA (Visual Basic for Applications) code to create a flexible approach to investment modelling. Bespoke reports and graphical outputs are created to meet the needs of particular projects.

The HIT tool sits at the centre of the asset renewal forecasting made for Halifax Water.

HIT Tool Summary:

- Flexible – can be applied to a range of asset types and data to simulate:
  - Age based replacement/prioritisation
  - Weibull/survival based replacement
  - Failure rate based replacement
- 'Tool' is spreadsheet calculation engine with specific outputs/reports/visualisations developed as required
- Based on the concept of cohorts
- Allows multiple replacement of assets over analysis period
- Analysis period up to 200 years to model long-life assets and their associated life cycles
- Simulation of investment strategies and the impact of alternative investment constraints

The HIT tool can be used at strategic, tactical and asset specific level and has been developed with options to make good use of relatively simple data. The tool can be used to make more sophisticated analysis of risk where more comprehensive data is available.

The computation engine uses a 'cohort' model as the basis for the analysis. A cohort is some appropriate grouping of assets:

- 'Functional Cohorts' can describe appropriate groupings of assets for renewal and replacement modelling
- Cohorts may have statistically discrete failure distributions
- Groupings may include:
  - Age or era constructed
  - Measures of Size
  - Location
  - Function or process
  - Materials
  - Factors that affect failure rate and consequences – for pipes, ground type, diameter, material, era of construction
  - Factors affecting replacement costs

6.3 Asset renewal criteria and constraints

The HIT tool, using the 'age-based 'replacement technique, was used as the basis of forecasting the asset renewal requirements for the majority of the asset classes in the IRP. For some asset classes, such as where the age distribution of assets was not known, a simple renewal rate model was constructed in MS Excel.

Age based replacement is simulated using asset age and replacement threshold criteria. The age based replacement technique is illustrated in Figure 7 where three asset cohorts are modelled without being subject to financial constraints. The assumptions for the analysis are shown in Table 44. The Age Replacement Threshold is used to reflect the typical expected life of the cohort. In this example, the initial age of the cohort describing the civil items has been set at 0 years to simulate the assets being in an 'un aged state'. The initial age of the M&E and ICA components has been set at the last refurbishment date.

Table 44 Example of age based replacement criteria

	Functional Cohort		
	Civil Assets	**Mechanical and Electrical Assets (M&E)**	**Information, Control and Automation Assets**
Install date or most recent date of refurbishment	2008	2008	2008
Initial Age (in 2013) Year Zero	0 years	5 years	5 years
Age Replacement Threshold	50	20	10
Cost of Replacement Activity	$50,112,000	$62,640,000	$12,528,000

The chart (Figure 7) shows the age of each functional cohort in each year of the analysis. The resulting 'saw-tooth' pattern reflects the replacement of each functional cohort as it reaches the assigned Age Replacement Threshold.

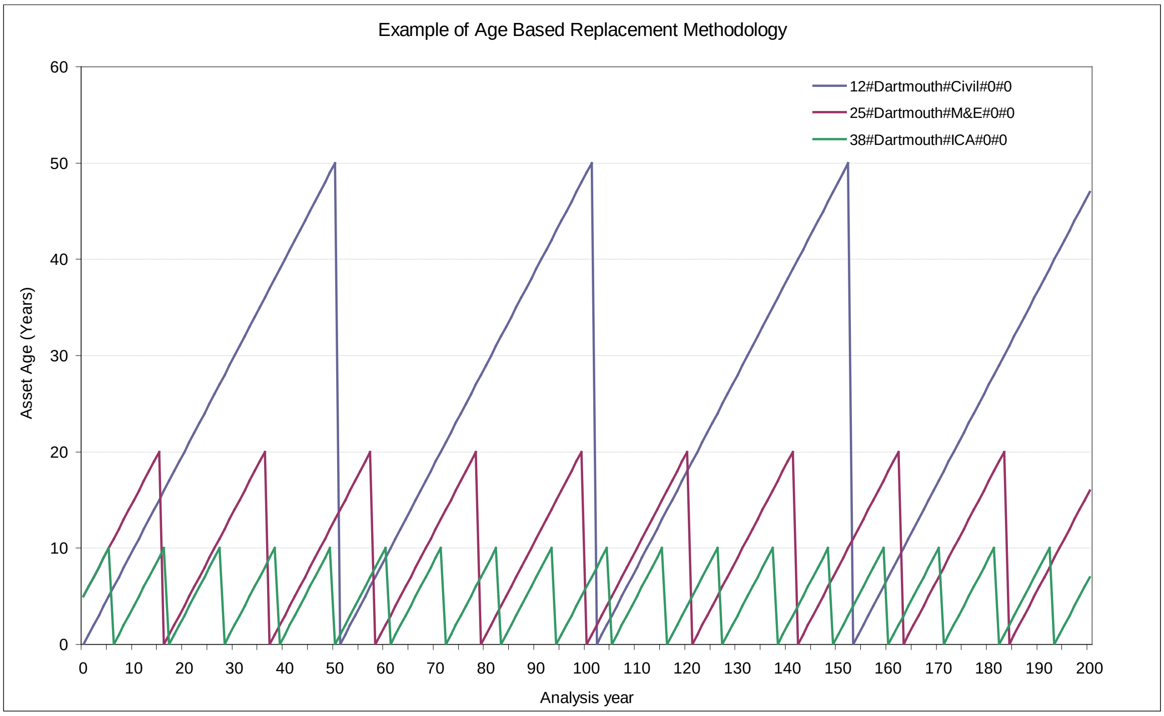


Figure 7 Age-based replacement simulation

In Figure 8 the expenditure associated with each replacement is shown in the year it is incurred. The most frequent expenditure is associated with the replacement of the functional cohort describing the ICA elements of the asset. The same expenditures are shown cumulatively in Figure 9 where the forecast of the renewal of the M&E functional cohort is most significant over the 200 year analysis period.

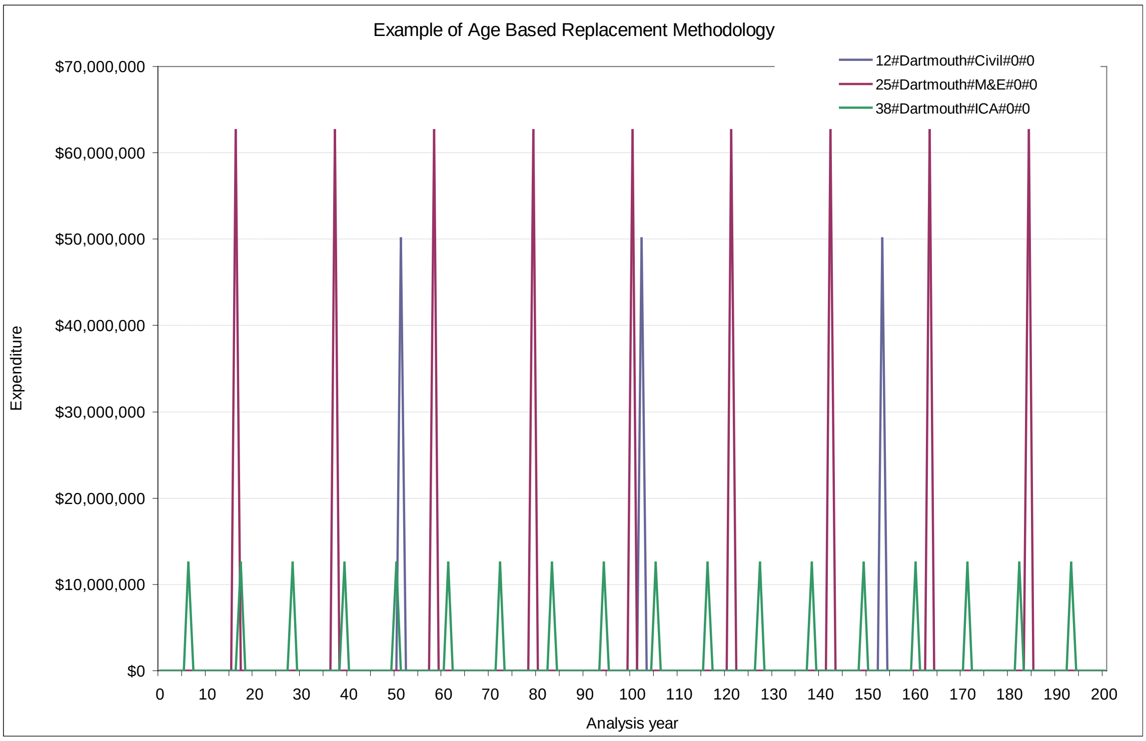


Figure 8 Expenditure from age-based replacement simulation

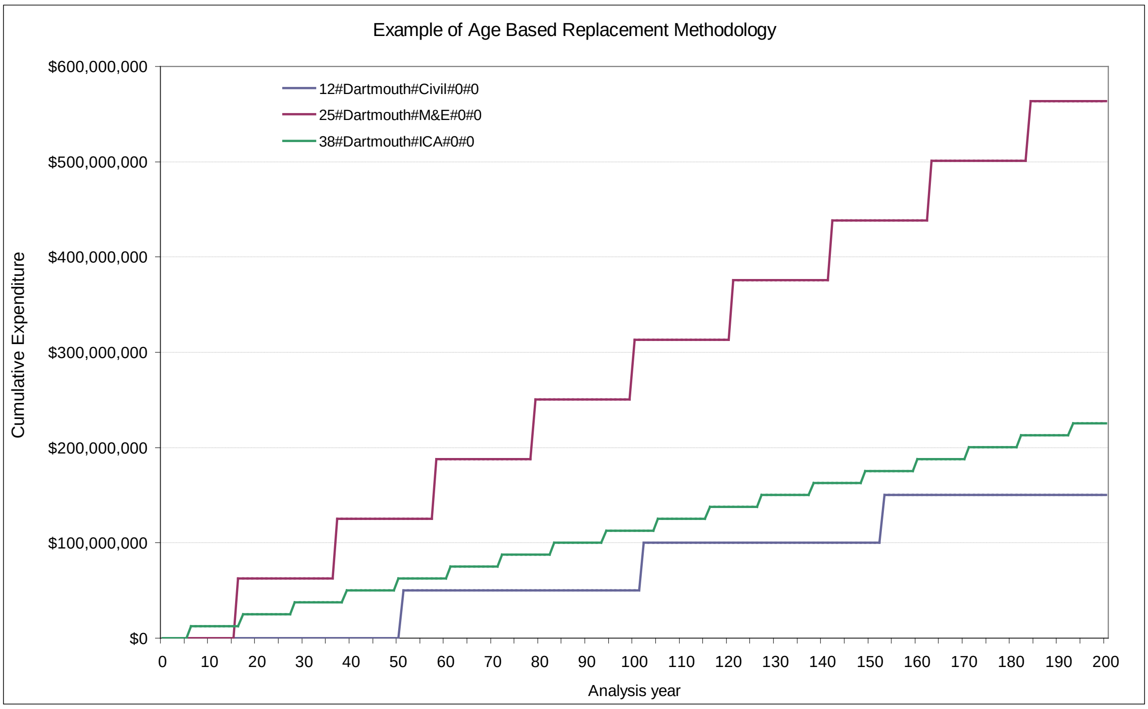


Figure 9 Cumulative expenditure from age-based replacement simulation

The HIT tool can be used to undertake a more sophisticated analysis which may take account of constraints on expenditure and simulate the costs and benefits associated with alternative investment strategies.

Several constraint types can be simulated using the age-based replacement prioritisation techniques. To defer or advance investment, and hence replacement, it is possible to:

- Change the base assumptions:
  - Expected life
  - Initial age
- Apply constraints to expenditure:
  - Upper constraint
  - Lower constraint
  - Upper and Lower constraints

A comparison of advancing or deferring investment is shown in Fig Figure 10 where the expected life of the M&E cohort has been reduced by 20% to represent a more aggressive replacement regime and increased by 20% to represent a less aggressive regime.

Figure 10 Investment advanced and deferred by changing expected life assumptions

It is also possible to apply financial constraints in addition to changing the base assumptions to model alternative investment strategies.

The following constraints were used in the age based replacement methodology to create the IRP renewal modelling scenarios:

- No constraint – described above; all cohorts are replaced in the year the replacement threshold is met.
- Upper constraint – when the upper constraint is applied the model will defer replacement of the next cohort if the forecast expenditure in the year exceeds the constrained value. If a cohort is scheduled to be replaced, because its age has exceeded the expected life, replacement will be deferred to the next year and the cohort will become a year older. The oldest cohort will be prioritised for replacement first.

An example of the upper constraint is shown in Figure 11, where an upper constraint has been applied to the investment forecast for a group of pipe cohorts.

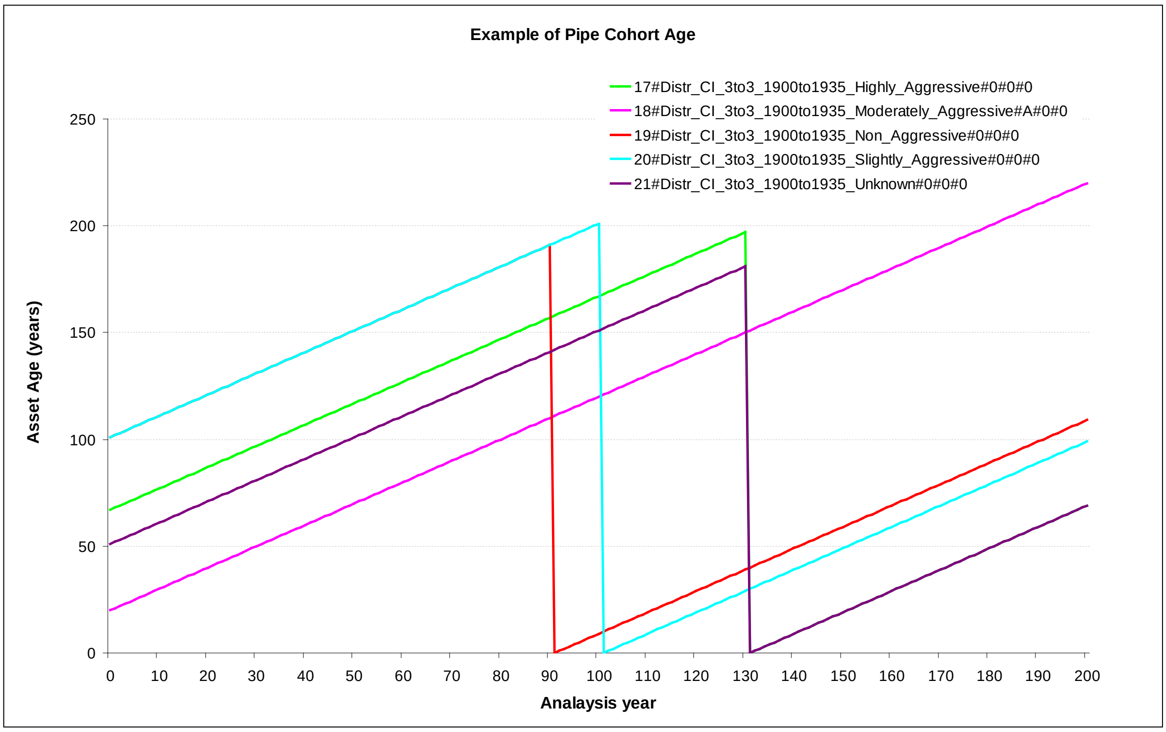


Figure 11 Example of pipe cohort renewal deferment

Under this constraint scenario, the influence of constraining the expenditure on cohort renewal can be seen by deferring asset replacement to later years. The replacement age threshold for the pipe cohort was set at 75 years, but the constraint on expenditure has resulted in cohort replacement being deferred and pipes remaining in the system beyond their expected life. The trade-off for the deferment could be measured in terms of an increased failure rate and costs of failure, but in this example it is demonstrated by the increasing weighted average age of the pipe network. The weighted average is computed from:

$$\frac{\sum Cohort\_length \times Cohort\_age}{\sum Cohort\_length}$$

In Figure 12 the upper constraint on expenditure has restricted replacement of the network and the weighted age has increased gradually over the 200 year analysis period.

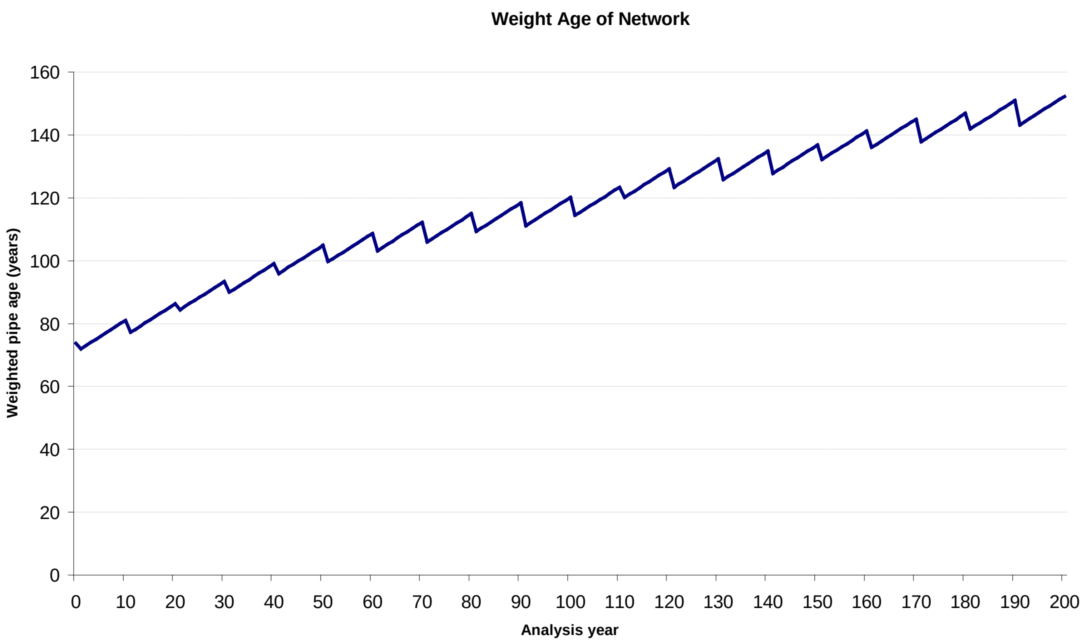


Figure 12 Example of weighted pipe age under constrained expenditure

Constraints can be applied on the model in a number of ways. In Figure 12 above, the 'saw-tooth' pattern has been created by applying a constraint to allow replacement in every tenth year. Figure 13 shows the constraint visually for the first one hundred years of the analysis period.

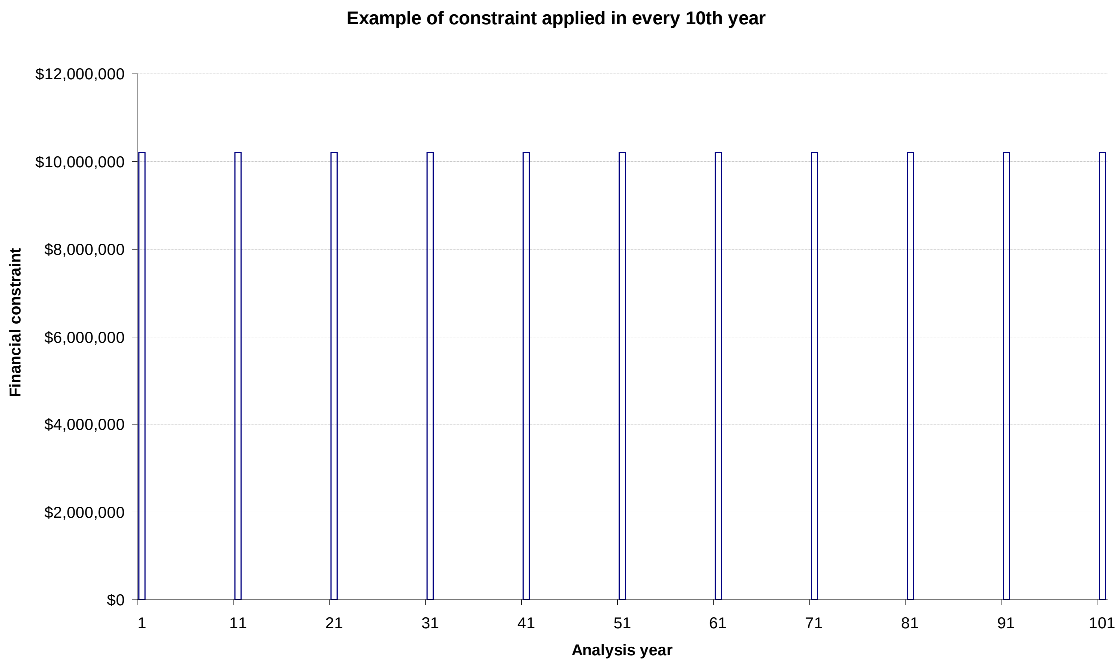


Figure 13 Example of expenditure constraint

The constraints can be applied in 'lumps' in a single year to represent lower annual average values. In the illustrated example, the upper constraint of approximately $10,000,000 has been applied in every 10 years to simulate an annual average replacement constraint of $1,000,000 of renewal expenditure. The specific application of constraints depends on several aspects of the modelling analysis including the granularity of the cohorts and the requirements for model run time.

6.4 Example annotated modelling outputs

This section describes the model outputs developed specifically for the Halifax Water IRP.

Section 6.4.1 describes typical outputs for a model using an upper financial constraint such as that used for linear assets.

Section 6.4.2 describes typical outputs for a model using an expected life variation to create alternative investment strategies. Expected life variations have been used to model the 'above ground assets' in the IRP.

6.4.1 Modelling with upper financial constraint

Y axis shows weighted average age of asset in years.

Profile shows how scheduled investments are influencing the weighted average age of the network over time.

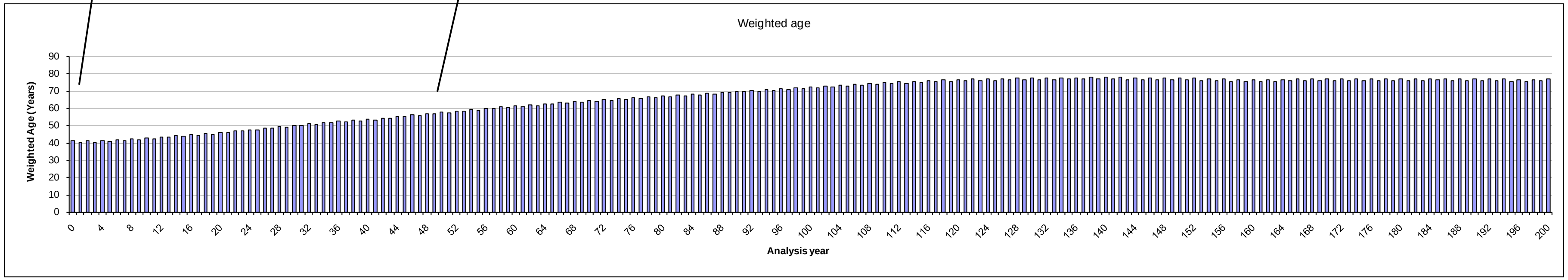


Figure 14 Weighted age over 200 year investment appraisal period for water distribution mains

Y axis shows length of asset exceeding the expected life.

Profile shows how scheduled investments are influencing the age profile of the network. Peaks outside 30 year IRP window.

A rising profile suggests replacement is not keeping pace with renewal requirement assumptions.

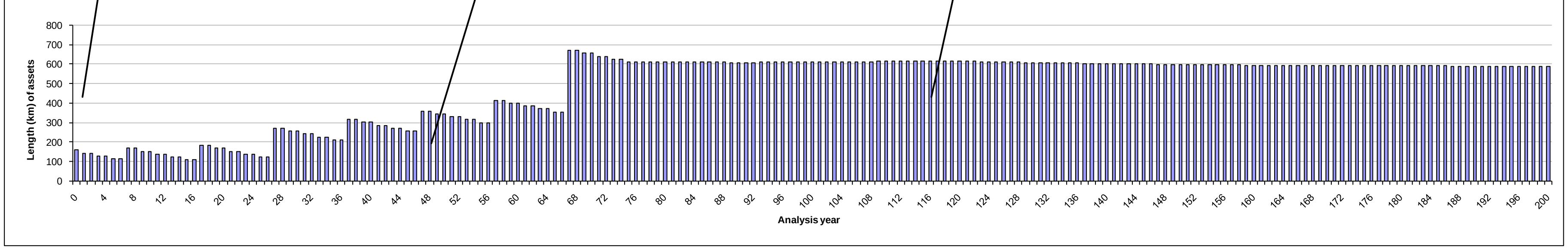


Figure 15 Length of water distribution system with an age greater than the expected life.

Y axis shows length of asset scheduled for replacement in each year

Profile depends on constraint and the cost of replacement

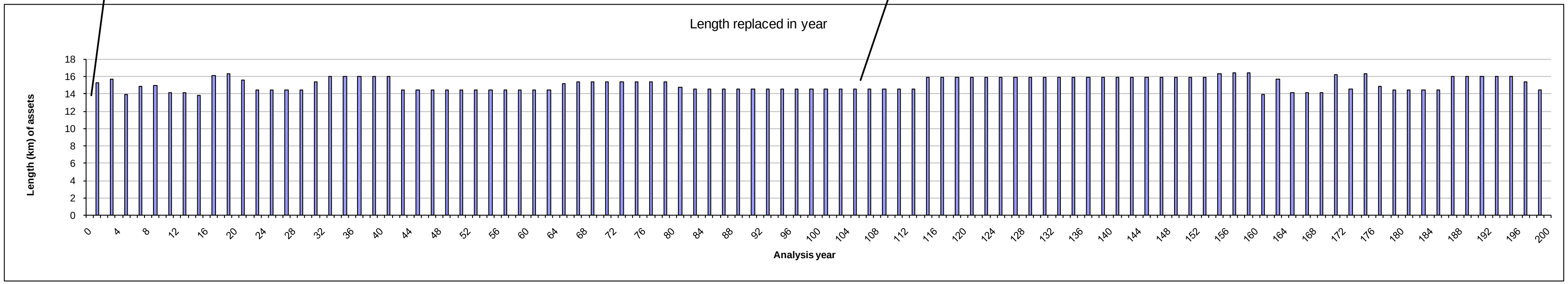


Figure 16 Length of pipe replaced in each year

Y axis shows annual expenditure

Pink line shows annual expenditure constraint

Blue bar shows expenditure on replacement against the constraint

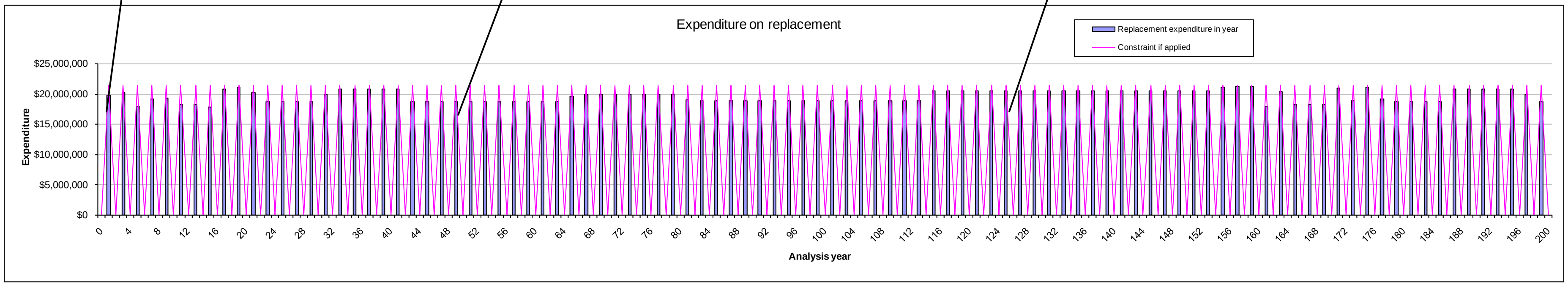


Figure 17 Expenditure on renewal in each year compared to defined constraint.

6.4.2 Modelling by expected asset life variation

Y axis shows weighted average age of asset in years.

Profile shows how scheduled investments are influencing the weighted average of the network over time.

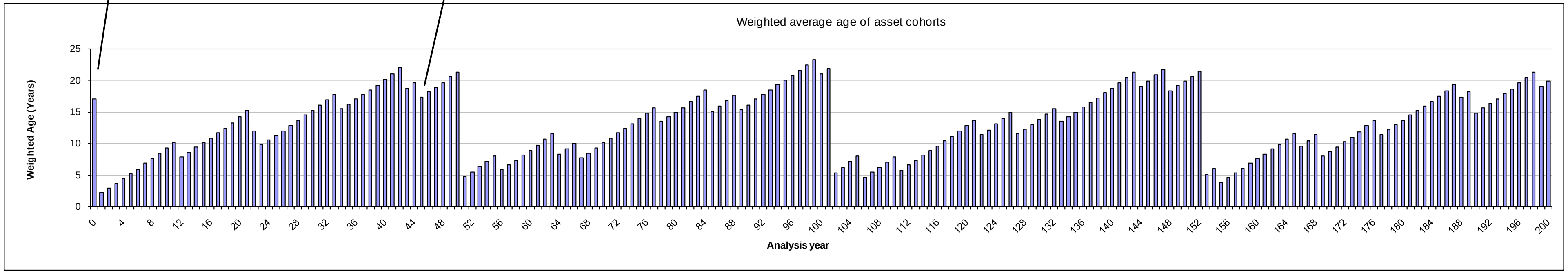


Figure 18 Weighted age over 200 year investment appraisal period for water distribution mains

Y axis shows number of cohorts exceeding the expected life.

In this modelling methodology there will not be any assets older than their expected life.

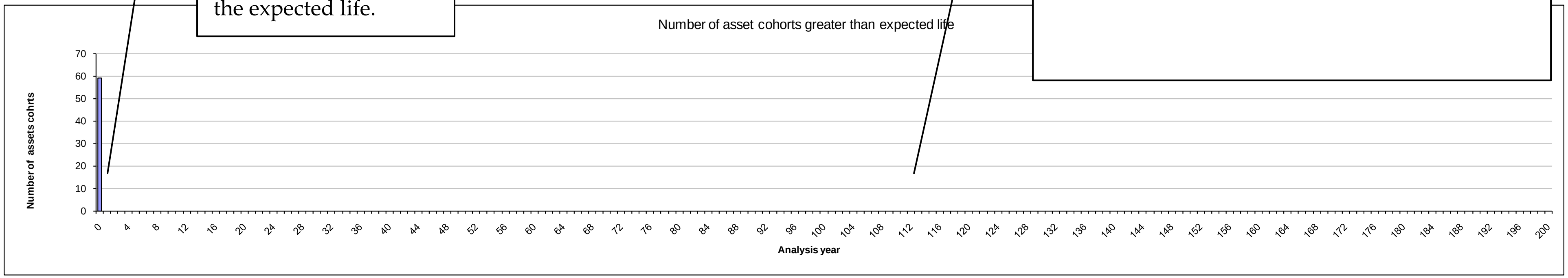


Figure 19 Number of asset cohorts with an age greater than the expected life.

Y axis shows the number of cohort groups scheduled for replacement in each year.

Profile depends on age of asset and age replacement threshold.

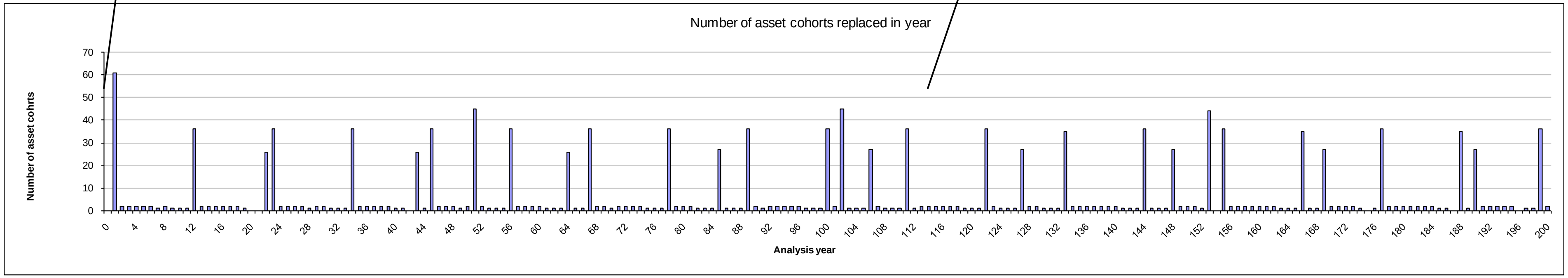


Figure 20 Length of pipe replaced in each year

Y axis shows annual expenditure

Blue bar shows expenditure on replacement

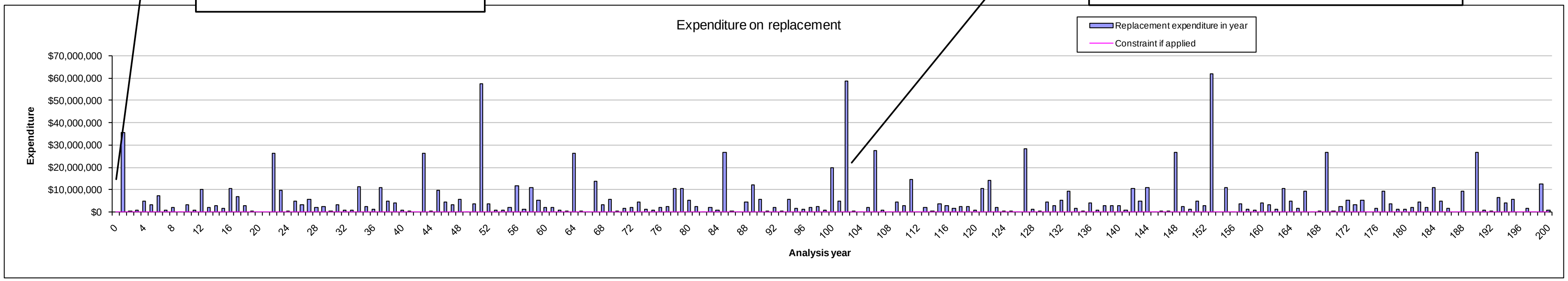


Figure 21 Expenditure on renewal in each year compared to defined constraint.

6.5 Asset life cycle and analysis period considerations

In asset renewal modelling it is important to adopt an analysis period that is consistent with the expected life of the assets that are being modelled. Where the analysis period is less than approximately two times the expected asset-life it is possible the full implications of the investment policy may not be seen. In particular, under investment in the assets may only become apparent when looked at in the longer term.

The planning horizon used in the IRP is set at thirty years. Thirty years is a relatively short period in comparison to the life cycle of linear assets and the civil engineering components of the asset base. To allow an informed decision to be made, the asset renewal simulations have been created for a 200 year analysis window and have been used to make a broader assessment of the IRP proposals. In most instances the upper constraint modelling approach has been applied to linear assets. This modelling approach may result in replacement activity being deferred further into the future, and potentially beyond the 30 year IRP window. For linear assets, the analysis has included investigating a range of upper constraints to enable comparisons against internationally benchmarked replacement rates and replacement rates that are consistent with the anticipated average asset lives. Although the implications of alternative investment strategies have been assessed over a 200 year analysis period, it is also important to consider the certainty with which long term investments can be planned in the context of changing technology and the practices used for the management of physical assets.

6.6 Expected life based renewal modelling considerations

Best practice in asset renewal modelling is usually based on the quantification of risk (probability x consequence). Risk based planning allows the benefits of the proposed investments to be compared to the costs of the investment and becomes the basis for demonstrating an optimised investment strategy.

The renewal modelling approach applied to the Halifax Water assets uses an ‘age-based’ investment prioritisation technique. Adopting the age-based prioritisation technique is considered a pragmatic approach to investment planning in the shorter term and will allow Halifax Water to demonstrate that a transparent and consistent planning methodology has been applied across the asset groups.

The data currently held by Halifax Water are not sufficient to allow a detailed risk based modelling approach to be applied. However, the IRP plans include a range of initiatives that will improve the data for future asset management activities.

There are some significant gaps in the data available to support the project which should be considered when interpreting the results of the analysis. It is intended that part of the function of this report is to compile the main assumptions in a single point of reference that can be used when considering the renewal elements of the IRP.

6.7 Uncertainty in asset renewal modelling

It is important to recognise the uncertainties that are inherent in any numerical modelling and forecasting activities so they can be considered as part of the decision making process. For the asset renewal forecasting undertaken for the IRP the main uncertainties in the model are:

- Asset attributes:
  - dimensions
  - number / length of assets
- Asset values and unit costs
- Asset age and asset age profile

The uncertainties and limitations associated with the renewal modelling will diminish in scale, and therefore importance as further business planning approaches are developed. It is important that Halifax Water implement the data acquisition and asset management initiatives proposed in the IRP investment program.

7 Conclusions and Recommendations

7.1 Conclusions

Halifax Water's asset management maturity level is currently one of awareness moving into development. Key gaps exist in asset information, investment planning and risk management, but in this Halifax Water is no different to a number of utilities at this stage in the journey to improve asset management. The improvement program developed with CH2MHILL will improve Halifax Water's approach to asset management as long as improvements become fully embedded in the organization. Investment in these initiatives will produce long term benefits in terms of more efficient and optimised management of assets.

Specific data gaps exist for the age profiles of the networks, condition of the wastewater and sewerage networks, performance of the wastewater network, asset data for water distribution network and condition data for structures and equipment. Some missing data can be estimated for the purposes of developing the initial integrated resource plan, but Halifax Water will need to undertake a comprehensive program of asset data collection to improve its knowledge of what assets it owns and their condition and performance.

A more comprehensive level of service framework needs to be developed, and as asset data improves the link between asset performance, condition and renewal with service levels should be established.

Renewal rates for the water distribution network will need to increase gradually to account for the aging of the network. Transmission mains have been identified as critical assets, some of which are in poor condition and present a high risk of failure; a renewal program has been developed by Halifax Water.

The collection network has suffered from a lack of investment in recent years, and is likely to require a comprehensive program of rehabilitation. However, additional data on condition and performance of the sewer network is required before the renewal requirements of the network are fully quantified.

For the purposes of the IRP, network renewal will be estimated based on assumed renewal rates, with other assets replaced at the end of their expected useful life. The forecast number of assets older than their expected useful life was used as a surrogate for service levels. The scenario assumptions are set out in the following table:

Scenario variation	Aggressive	Moderate	Minimum
Network replacement rate impact on number of assets older than expected life	Number of assets older than expected life decrease	Number of assets older than expected life remain constant	Number of assets older than expected life increase
Other assets replaced at end of	Expected life – 20%	Expected life	Expected life +20%

The data currently held by Halifax Water are not sufficient to allow a detailed risk based modelling approach to be applied. However, the IRP plans include a range of initiatives that will improve the data for future asset management activities.

The uncertainties associated with the forecast renewal plans for the IRP should be considered in a broader and longer-term context of business planning activities that will be undertaken by Halifax Water. In the next five to ten years it is anticipated that Halifax Water will be able to draw on significantly improved data describing their asset base and its condition, performance and service delivery. In future business planning activities, the improved data will lead to continuously improving asset renewal forecasts and these will replace the current strategic estimates made for this IRP. In the context of the IRP, the current asset renewal forecasts should only be considered as offering a strategic view of the potential envelope of future renewal requirements. However, accepting the pragmatic approach described in this document, the model results are considered to be robust in terms of providing a useful indication of the magnitude of the renewal activities that may be expected in the short and medium term. Additionally, the model results should enable renewal activities to be set at levels which are not detrimental to the longer term sustainability of service to customers.

7.2 Recommendations

It is recommended that Halifax Water continue to develop appropriate initiatives to improve and embed good asset management practices in the organisation. In particular the ability to relate the asset condition and performance to service provision is limited by the asset and performance data history.

It is recommended that the age based renewal forecasts made for this study are adopted as the best strategic estimates that can be made from the available data. As Halifax Water’s planned asset management initiatives begin to deliver benefits it will be possible to further refine renewal and improve planning methodologies.

Halcrow Group Limited
Burderop Park, Swindon, Wiltshire SN4 0QD
tel 01793 812479 fax 01793 812089
halcrow.com

Technical note

Project	**RHWIRP Halifax Water IRP**	**Date**	September 2012
Subject	Asset Depreciation	**Ref**	
Author	Alec Yeowell		

1 Introduction

This technical note describes the work undertaken to estimate the depreciated asset value or 'end of period value' for a version of the Halifax Water IRP BBA Financial model.

Asset depreciation is a relatively non contentious accounting concept used to describe the consumption of fixed assets over time in a way that reflects their reducing value. There are several methods for calculating the depreciated book value of the asset and the preferred method may vary by country and sector. Depreciated book value may be used to compare the attributes of investment plans, but it should be used with some caution, particularly when looking at a snapshot of the 'book value' in any particular year. The depreciated value calculations performed for the IRP were completed using a straight line depreciation methodology.

2 Depreciated End of period value

The Depreciated End of Period Value for investments proposed in the IRP are constructed from:

- the current (2012) estimated depreciated value of the existing assets, further depreciated over 30 years
- the 30 year depreciated value of the Capital investment programme and any subsequent renewals associated with it
- the 30 year depreciated value of the Renewal programme

The current value of the existing assets in 2012 was estimated from the data used in the renewal analysis which utilised the replacement values and estimates of the age profiles of the asset base. This value was used as the starting value for the End of Period Calculation.

Prepared by	Alec Yeowell	Date	September 2012
Checked by	Sue De Rosa	Date	October 2012
Approved by	Sue De Rosa	Date	October 2012

The depreciated value of the asset Renewal programme was estimated from the investments described as line items in the Financial Model.

The depreciated value of the Capital programme and the associated asset renewal was estimated from the investments described as line items in the Financial Model.

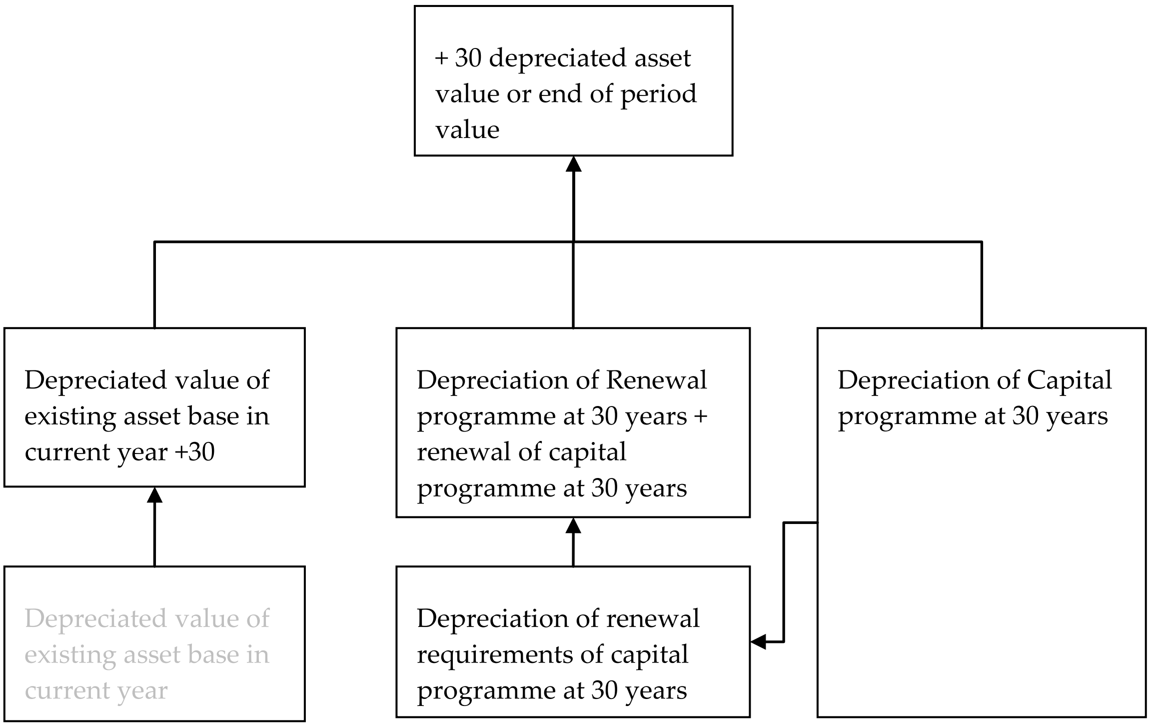


Figure 1 – Contributions to depreciated value

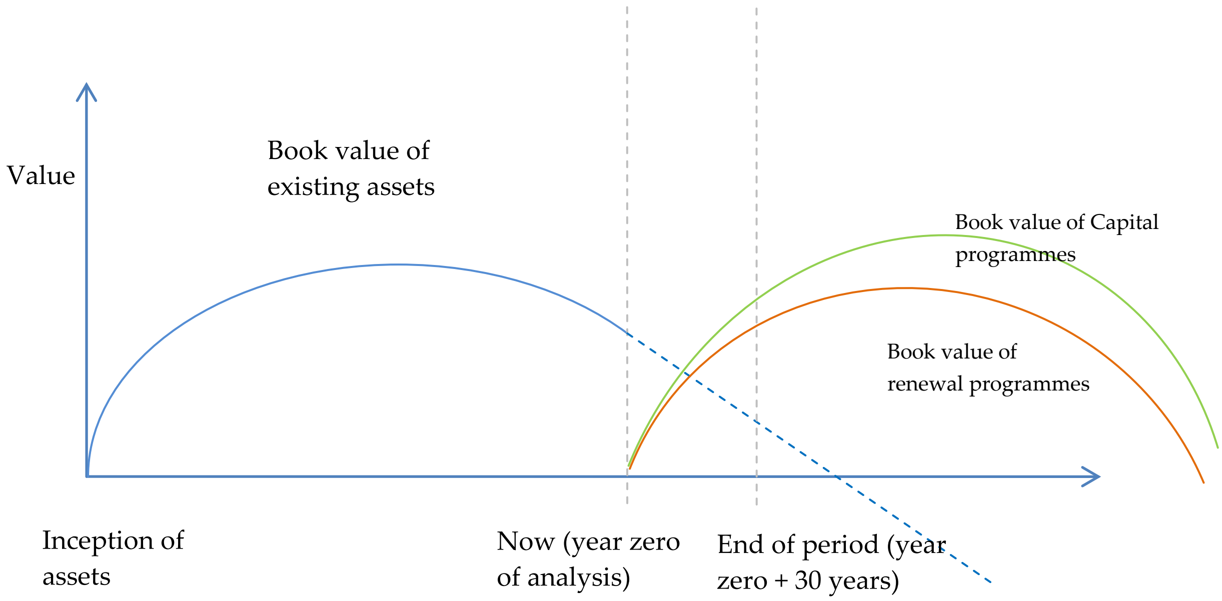


Figure 2 – Depreciated value estimate method

3 Composite depreciation methodology

The end of period value was estimated using a composite asset depreciation methodology as a pragmatic solution that worked at the level of granularity in the financial model.

The calculation for each investment line in the financial model was undertaken in the following way:

Annual Depreciation = (Cost of fixed asset investment $ – Salvage value $) / Useful economic life.

Where:

- Cost of fixed asset investment $ is the estimate of the original asset value or expenditure
- Salvage value $ is assumed to be zero
- Useful economic life (years) is the best estimate of the asset life and has been aligned with the life estimates used in the renewal modelling

The composite element of the depreciation analysis refers to the useful expected economic life assumption which controls the depreciation rate. The composite method may be applied to a collection of assets that are not similar and have different service lives. For example, civil, M&E and ICA are not similar, but all elements may be part of an investment that makes up a line item in the IRP. With the composite method, depreciation on all assets is determined using the straight-line-depreciation method with the useful economic rate set by proportion of the total expected expenditure. For example, as shown below for wastewater treatment facilities:

Wastewater - Treatment Facilities

Element	Proportion of expenditure	Useful Economic Life	Composite component
Civil	40%	50	40%*50 = **20**
M&E	50%	30	50%*30 = **15**
ICA	10%	10	10%*10 = **1**
Composite life			20+15+1 = **36** years

4 Depreciation in the IRP financial model

In the financial model that has been developed for the IRP, 'new' assets included in the depreciation calculation may result from:

- Renewal of existing assets to counter deterioration in the "Asset Renewal" program:
  - specified projects that are required for more immediate renewal
  - strategic level forecasts or longer term renewal requirements
- Assets from the capital plan:
  - to meet particular objectives such as quality or growth
  - renewal of capital projects that are needed in the IRP renewal window

Line items describing the anticipated expenditure for these reasons are identified in the financial model and used as the basis for the depreciation calculation which is contained in spreadsheet tabs:

- Dep_Asset_Renew –the asset renewal elements
- Dep_Cap_Prog –the capital programme elements
- Dep_Summary –the summary values and where the depreciation assumptions are set

4.1 Dep_Asset_Renew spreadsheet tab

This sheet references the Asset Renewal tab and refers to each of the renewal programme totals lines. For each total, there is a 30 by 30 table that computes the depreciation calc for each year. The tables each reference the Age matrix at the top of the sheet which computes the relative investment "age" in each year – thus the depreciated value for each year of the is made is vertically below it. Each renewal programme is separated by 50 rows.

4.2 Dep_Cap_Prog spreadsheet tab

As Dep_Asset_Renew described above, but refers to the Capital programme totals at asset levels.

4.3 Dep_Summary spreadsheet tab

Contains the asset life depreciation assumptions and the results for the 30th year as the end of period.

In the Dep_Cap_Prog section of the table the user can set the composite depreciation life by describing the proportion of the asset expenditure that would be expected in the categories of: Civil, M&E, ICA and Other. The total should add up to 100%. In the expected life category the user can set an expected life (in years) for each of the categories. The 'Other' category is used for assets such as "Land" and "IT" etc. The assumptions that can be altered are in 'blue' shaded cells. In column 'O' the 30 year depreciated value is returned. The Dep_Asset_Renew section contains the same set up for the Asset Renewal Programme.

5 Considerations

5.1 Existing assets

The depreciation estimates made in the final model are based on estimated useful economic life and therefore require an understanding of the current age profile of the assets on the asset register. The data describing asset installation dates were found to be sparse in the context of deterioration modelling and this is reflected in the estimate of the depreciated value of the current value of the existing assets. Using the Unit Cost data, it was possible to estimate a depreciated asset value for the following asset classes:

Item	Category	Asset
System	Stormwater	Sewer
Aerotech	Wastewater	WWTF
Aerotech	Wastewater	WWPS
System	Wastewater	Trunk Sewer
System	Wastewater	Sewer
System	Wastewater	Forcemains
System	Wastewater	WWPS
System	Wastewater	WWTF
System	Water	Commercial meters
System	Water	Domestic meters

System	Water	WPS
System	Water	Large WTF
System	Water	WTF
System	Water	Valves
System	Water	PRV
System	Water	Distribution
System	Water	Transmission
Aerotech	Water	WTF
Aerotech	Water	WPS
Airport	Water	WPS

5.2 Capital programme

Assets which are proposed to be added to the asset base as part of the IRP were included in the depreciated value in the Capital elements section. The components that reflect renewals associated with the capital programme assets are included in the Asset Renewal section.

Capital programme assets are:

Water Service Capital Expenditure
Water - Land
Water - Transmission
Water - Distribution
Water - Services
Water - Meters
Water - Hydrants
Water - Structures

Water - Treatment Facilities
Water - Airport Aerotech System
Water - Small Treatment Systems
Water - Energy
Water - Fleet
Water - IT
Water - Security
Water - Equipment

Wastewater Service Capital Expenditure
Wastewater - Land & Land Rights
Wastewater - Trunk Sewers
Wastewater - Collection Combined
Wastewater - Collection Sanitary
Wastewater - Forcemains
Wastewater - Structures
Wastewater - Laterals
Wastewater - Outfalls
Wastewater - Treatment Facilities
Wastewater - Airport Aerotech System
Wastewater - Small Treatment Systems
Wastewater - Energy
Wastewater - Fleet
Wastewater - IT

Wastewater - Security
Wastewater - Equipment

Stormwater Service Capital Expenditure
Stormwater - Pipes
Stormwater - Culverts/Ditches
Stormwater - Structures
Stormwater - Fleet
Stormwater - IT
Stormwater - Security
Stormwater - Equipment

5.3 Renewal programme

This section includes:

- Renewals to the asset base from either specified projects or strategic analysis
- Renewals of specified projects if required in the analysis window
- Renewals of the Capital programme

Renewal programme items are:

Water asset renewal		
	Renewal	Water Transmission Mains Asset Renewal Programs
	Renewal	Water Distribution Asset Renewal Programs
	Renewal	Water Meters Asset Renewal Programs
	Renewal	Water Valves Asset Renewal Programs
	Renewal	Water Pumping Stations Asset Renewal Programs
	Renewal	Large WSPs Asset Renewal

		Programs
	Renewal	Small WSPs Asset Renewal Programs
	Renewal	PRVs WSPs Asset Renewal Programs
	New asset renewals	Water Treatment Facilities
	New asset renewals	Water Structures
	New asset renewals	Water Meters
Aerotech	New asset renewals	Water Airport Aerotech System

Wastewater asset renewal		
	Renewal	Wastewater Sewers Asset Renewal Programs
	Renewal	Wastewater Forcemains Asset Renewal Programs
	Renewal	Wastewater Pumping Stations Asset Renewal Programs
	Renewal	Wastewater Treatment Facilities Asset Renewal Programs
	New asset renewals	Wastewater Structures
	New asset renewals	Wastewater Treatment Facilities
Aerotech	New asset renewals	Wastewater Airport Aerotech System

Storm water asset renewal		
	Renewal	Stormwater Sewers Asset Renewal Programs
	Renewal	Stormwater Culverts Asset Renewal Programs
	Renewal	Stormwater Structures Asset Renewal Programs
		Aerotech asset renewal
Aerotech	Renewal	Aerotech-Airport Water Treatment Asset Renewal Programs
Aerotech	Renewal	Pumping Station Airport Asset Renewal Programs
Aerotech	Renewal	Pumping Station Aerotech Asset Renewal Programs
Aerotech	Renewal	Aerotech-Airport Water Distribution System Asset Renewal Programs
Aerotech	Renewal	Wastewater Pumping Station Asset Renewal Programs
Aerotech	Renewal	Wastewater Forcemains Asset Renewal Programs
Aerotech	Renewal	Wastewater collections system Asset Renewal Programs

Aerotech	Renewal	Wastewater Treatment Facility Asset Renewal Programs