2020 Management Review Report

Finalized July 22, 2021

City of Ottawa Drinking Water Quality Management System

January 1 – December 31, 2020
Review Period

DRINKING WATER
pure and simple

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Introduction

This Drinking Water Quality Management System (DWQMS) annual management review report considers the entire 2020 calendar year and, where appropriate, details activities that have continued into 2021. It is a summary of information that Top Management must annually review in accordance with the Ontario Drinking Water Quality Management Standard. The annual Management Review is a requirement of the Standard (Element 20) and covers 16 key aspects for managing our municipal drinking water systems.

The City was awarded its 'Full Scope – Entire DWQMS' accreditation in October 2011, with reaccreditation awarded in October 2014, 2017 and 2020, for each of its systems listed below*. This Management Review report encompasses the municipal drinking water systems owned and/or operated by the City of Ottawa, namely:

- Central System (Britannia and Lemieux Island Water Purification Plants and central water distribution system)
- Carp Well System
- Kings Park Well System
- Munster Hamlet Well System
- Richmond West Well System*
- Shadow Ridge Well System (owned by a private developer, operated, and maintained by the City of Ottawa)
- Vars Well System

*The Richmond West Well System was under development in 2018, with commissioning completed in 2019. This system underwent a Limited Scope Audit in 2018 and a Full Scope Audit in 2019 to fulfill the DWQMS accreditation requirements.

Management Review Meetings

In order to discuss items (a) to (p) of the annual Management Review, the City of Ottawa conducts a series of meetings that include the Operational Top Management Team (OTM) and guests, and one meeting with Corporate Top Management (CTM). It should be noted that the 2020 Management Review meetings were completed virtually via MS Teams due to the COVID-19 pandemic distancing measures that were implemented as a result. The information included within this report reflects the topics

discussed as part of these Management Review meetings. Action items that arise from these meetings are captured in the report, with a summary table of action items provided at the end of the report.

OTM Meeting #1: April 19, 2021	
Attendees	Position Title, Unit – Branch, Department
Douglas, Ian	Water Quality Engineer, Drinking Water Quality - Water Services (WS), PWES
Drewniak, Lysa/ Saby, Coralie	Management Systems (MS) Coordinator, Management Systems Unit (MSU) - Technology, Innovation and Engineering Services (TIES), PWES
Gray, Scott	Plant Manager (West), Water Production - WS, PWES
Hall, Carol	Manager, Water Distribution - WS, PWES
Montgomery, Paul	Plant Manager (East), Water Production - WS, PWES

OTM Meeting #2: April 27th, 2021	
Attendees	Position Title, Unit – Branch, Department
Bradley, Lila (guest)	Supervisor, Permits & Data Service, TIES, PWES
Douglas, Ian	Water Quality Engineer, Drinking Water Quality - Water Services (WS), PWES
Saby, Coralie	MS Coordinator, MSU - TIES, PWES
Gray, Scott	Plant Manager (West), Water Production - WS, PWES
Hall, Carol	Manager, Water Distribution - WS, PWES
Lafrance, Maxime (guest)	Senior Operations Engineer (West), Water Production - WS, PWES
Montgomery, Paul	Plant Manager (East), Water Production - WS, PWES
Wilson, Penny (guest)	Water Quality Supervisor, Water Quality - WS, PWES

OTM Meeting #2: April 27th, 2021	
Attendees	Position Title, Unit – Branch, Department
Zawada, Yvonne (guest)	Senior Operations Engineer (East), Water Production - WS, PWES
OTM Meeting – Item 'N': May 3rd, 2021	
Attendees	Position Title, Unit – Branch, Department
Alting-Mees, Birgitte	Senior Engineer, Infrastructure Renewal - AM, PIED
Douglas, Ian	Water Quality Engineer, Drinking Water Quality - Water Services (WS), PWES
Drewniak, Lysa/ Saby, Coralie	MS Coordinator, MSU - TIES, PWES
Fatema, Jannat	Program Engineer, Asset Reliability-FAC/NET Sys, Engineering Support Services – TIES, PWES
Gray, Scott	Plant Manager (West), Water Production - WS, PWES
Hall, Carol	Manager, Water Distribution - WS, PWES
Howard, Christopher	Program Coordinator, Asset Management & Investment, PIED
Khawam, Walid	Senior Engineer, Asset Management - Infrastructure Renewal, PIED
McKay, Peter	Program Manager, Infrastructure Renewal, PIED
Montgomery, Paul	Plant Manager (East), Water Production - WS, PWES
Moore, Jo-Anne	Program Mgr (Acting), Asset Management - Infrastructure Renewal, PIED
Nielsen, Gen	Manager (Acting), Asset Management, PIED
Rogers, Christopher	Program Manager, Infrastructure Policy - AM, PIED

CTM Meeting: June 14th, 2021	
Attendees	Position Title, Branch
Curry, Court (guest)	Manager, ROW, Heritage and Urban Design Services, PIED
Douglas, Ian	Water Quality Engineer, Drinking Water Quality - WS, PWES
Hall, Carol	Manager, Water Distribution - WS, PWES
Montgomery, Paul	Plant Manager, Water Purification - WS, PWES
Saby, Coralie	MS Coordinator, MSU - TIESS, PWES
Journeaux, Marilyn	Director - WS, PWES
Laberge, Scott	Director (Acting) – TIESS, PWES
Stephenson, Dylan	In place of the Manager, Business & Technical Support Services - BTSS, PWES
Willis, Stephen	General Manager - PIED
Wylie, Kevin	General Manager - PWES

Following the approval of this report by members of OTM and CTM, a summarized Management Review report is prepared and presented to the City's Standing Committee on Environmental Protection, Water and Waste Management and City Council on September 21st and 27th, 2021, respectively.

a) Incidents of Regulatory Non-compliance

The ***Safe Drinking Water Act (2002)*** sets out a number of requirements for owners and operators of drinking water systems. Any deviation or failure to meet these requirements could be considered to be an incident of regulatory non-compliance. The Summary Report for all (8) municipal water systems were provided to City Council on March 31st as required by O.Reg 170/03. The 2020 Summary Report was tabled at the Standing Committee of Environmental Protection, Water and Waste Management on June 16th, 2020.

As part of the DWQMS Management Review, the items of non-compliance noted in the 2020 Summary Report are presented for discussion and review. In preparing the reports, internal staff carefully reviewed the following records for evidence of non-compliance during the operating period January 1st – December 31st, 2020:

- MECP inspection reports for each waterworks and distribution system
- Operator certification records for Drinking Water Services
- Water flow data for raw and treated
- Water quality records
- Lead testing regulatory requirements
- MECP Officer and Environment Canada Orders
- Annual and Summary Reports
- Municipal Drinking Water Licenses
- DWQMS Continual Improvement Table

Summary of non-compliance events

The combined Summary Report prepared for the each of the (8) municipal water systems include a Compliance Table that lists all regulatory requirements for drinking water, along with a verification of compliance or non-compliance as noted. Any item of non-compliance that was observed during 2020 is described in the Section entitled 'Items of Non-Compliance' of the Summary Report (dated March 31st, 2021), along with any actions or preventive measures taken. During 2020, there were (2) incidents of non-compliance noted for Ottawa's municipal drinking water systems. Each incident is described below, including corrective actions taken and the impact on water quality.

1. Chlorine residual in waste effluent outside target range at Britannia WPP - The continuous chlorine analyzer on the main drain recorded two events on April 29th with a measurement above the effluent chlorine target of <0.02 mg/L. The events lasted for 27 minutes and 20 minutes respectively, exceeding the 15-minute criteria. The events were the result of unstable standby power operations. In both events, the operator adjusted the sodium bisulphite dose to neutralize chlorine in the effluent, but the process took longer than 15 minutes to respond. These events were reviewed with technical staff and instructions were provided to plant operators to prevent future occurrences.

2. Required number of distribution bacteriological samples were not achieved in Carp and Vars well systems - Due to COVID-19, sampling at some distribution locations was suspended to minimize contact with public and protect staff and residents. Therefore, only 8 bacteriological samples were taken during the months of May and September, while 9 monthly samples are required by regulations. In response, the Carp Fire Hall was added to provide an additional sample point for Carp, and the sample frequency at the Vars fire hydrant was increased to meet regulatory requirements. This minor correction had no impact on drinking water quality.

In each case, staff took corrective actions to promptly address each of the non-compliance issues. Most importantly, the non-compliance incidents noted were technical and/or administrative in nature and did not affect the quality of drinking water supplied to the public.

In addition, certain incidents of non-compliance are reviewed by operations staff through the DWQMS Continual Improvement process.

A team of operational and technical staff review all incidents and through discussion identify any corrective measures required in order to prevent or mitigate similar incidents in the future.

No Action Items were identified as part of the Management Review Meetings.

b) Incidents of Adverse Drinking Water Tests

The drinking water regulations identify several “Indicators of Adverse Water Quality” for which the waterworks must immediately notify health officials and the MECP and carry out specific corrective actions. These are key parameters that indicate a potential health concern with the water supply, such as the presence of bacteria. Adverse Water Quality Incidents (AWQIs) also include any exceedance of a health-based drinking water standard (approximately 70 parameters) or a situation that directs improperly disinfected water to consumers. In each case, City of Ottawa staff immediately notified Ottawa Public Health and the MECP as required by regulations. Corrective actions, re-sampling, and reporting were carried out in collaboration with Ottawa Public Health.

In total, 14 AWQIs occurred during 2020. Of these, 12 were in the water distribution system, and 2 occurred in the municipal well systems collectively. The table below shows the breakdown of 2020 AWQIs, listed by operational area:

Table 1 - Number of AWQI events for 2020 by operational area

Britannia	Lemieux	Distribution	Carp Well	Kings Park Well	Munster Well	Shadow Ridge Well	Vars Well	Richmond West Well	TOTAL
0	0	12	0	0	0	2	0	0	14

Most of the AWQI events were similar in number to previous years, with a few notable trends described below.

Multiple low chlorine residuals: of the 12 events in the distribution system, 4 were related to low chloramine residuals resulting from either closed valves or a dead end watermain with low flow. Once discovered, the watermains were flushed to restore the chloramine levels.

Improperly disinfected water directed to water users: 4 events were related to possible improperly disinfected water being directed to customers. Of these, 3 resulted in precautionary boil water advisories:

1) A Category 3 watermain break occurred in the vicinity of a broken sewer line in the excavation pit;

2) A backflow event in the distribution system occurred as a result of a private irrigation system with improper valving that was being blown out in preparation for the winter;

3) A service pipe that was not disinfected prior to installation to a building; and

4) A large area of distribution system was depressurized during a planned shut at both the Britannia WPP and within the distribution system.

Discussion: overall, the number of AWQIs during 2020 (n=14) are fairly consistent with previous years (n=20–25 range).

In comparison to previous years, the statistics for water distribution show an increase for AWQIs related to watermain breaks and low chlorine residual, as illustrated in the table below. This is due in part to heightened awareness amongst distribution operators.

Table 2 – 2020 AWQI categories for central water distribution system by type

AWQI type	2016	2017	2018	2019	2020
Routine WQ sampling	8	2	3	1	2
Temporary services	2	0	0	0	1
Watermain break/repair	3	0	6*	3	3
Low Cl_2 residual	2	0	6*	12	4
Improperly disinfected water directed to users	3	2	1	1	4
Annual total	18	4	16	17	14

*repeat AWQI

No Action Items were identified as part of the Management Review Meetings.

c) Deviations from Critical Control Point (CCP) Limits and their Response Actions

Through the DWQMS risk assessment process, nine Critical Control Points (CCPs) are identified within Water Production and nine CCPs identified within Water Distribution. A CCP is defined as a step at which controls can be applied to prevent or eliminate a drinking water hazard or reduce it to an acceptable concentration that is within the established Critical Control Limit (CCL). Deviations from the CCLs are captured and reviewed in order to determine potential preventative measures for implementation.

Water Production CCL Deviations

Throughout 2020, the responsibility to identify and escalate water production CCL deviations rested with the WPPs' operating personnel. Investigations into those deviations were then carried out by the Production Supervisors, Operation Engineers, and the Plant Managers. These events were documented in the 2020 Continual Improvement Summary Table, aided by the following information sources:

- Communications from operating personnel
- Supervisory Control and Data Acquisition (SCADA) trends and event logs
- 2020 Operator logbooks
- 2020 Process spreadsheets for Britannia and Lemieux WPPs
- Review and discussion by plant technical staff
- Root cause failure investigation and reporting by operational and reliability engineering staff

Table 3 - Water Production CCL deviations identified during 2020

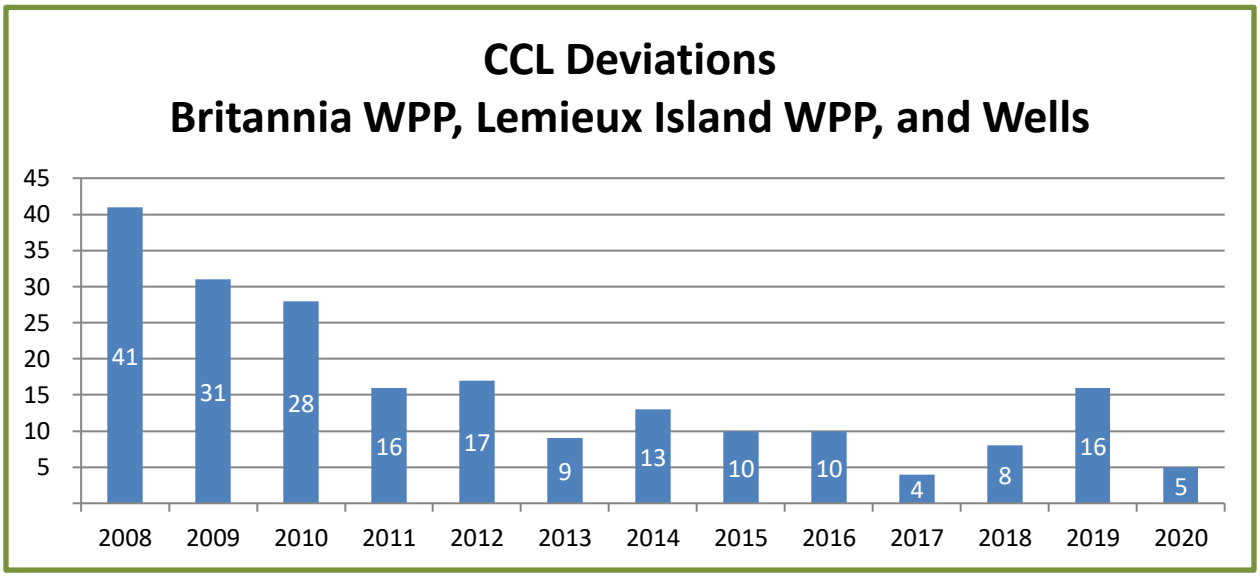
Water Production CCPs		Number of CCL Deviations in 2020
P1	Coagulation process upset	2
P2	Filtration process upset	2
P3	Inadequate primary disinfection	1
P4	Effluent treatment chemicals improper dosage	0
P5	Loss of pressure in the central distribution system	0

Water Production CCPs		Number of CCL Deviations in 2020
P6	Loss of pressure in a well distribution system	0
P7	Inadequate primary disinfection in a well system	0
P8	Water storage contamination due to animal presence	0
P9	Lemieux Island WPP Intake Pipe Blockage	0

In total there were 5 Water Production CCL Deviation events in 2020. All events occurred in water treatment plants.

The number of CCL deviations per year are illustrated in the trend graph below. The total CCL count for 2020 has decreased to 5, from 16 in 2019.

Figure 1 - Total number of CCL deviations per year between 2008 and 2020 (Britannia WPP, Lemieux WPP, and Well Systems)



The total CCL count for 2020 has decreased to 5, from 16 in 2019.

It should be noted that CCL deviations at the well systems were included beginning in 2010, and additional CCPs were added in 2014 (P8) and 2015 (P9). In general, the

following actions continue to help reduce the number and severity of CCL deviations and to assist operators in responding to these deviations:

- Regular review of CCL events by technical staff including action items to reduce risk;
- Regular review of CCL events during operator training sessions;
- Detailed analysis of potential process impacts prior to completing maintenance work on major plant systems;
- Prior to plant isolations or shutdowns, plan and coordinate the occurrence of multiple maintenance activities;
- Requirement for written submission of isolation requests from contractors prior to performing work, followed by receipt of written approval to proceed;
- Weekly coordination meetings to review all isolation requests, maintenance work and response to emergency breakdowns;
- Update and communication of lock out procedures for all system isolations; and
- Use of automated alarms and tracking for CCL events through the SCADA system.

In reviewing the CCL deviation events for 2020, it was determined that the operators responded appropriately to prevent unsafe or inadequately treated water from leaving the treatment plants throughout the year.

Water Production CCL deviation events and corrective actions

The five (5) CCL deviation events during 2020 included the following:

- 1 coagulation process upset (P1) at Lemieux Island WPP;
- 1 coagulation process upset (P1) at Britannia WPP;
- 1 filtration upset (P2) at Lemieux Island WPP;
- 1 filtration upset (P2) at Britannia WPP; and
- 1 primary disinfection upset (P3) at Britannia WPP.

The five CCL events are described in more detail below.

Table 4 – Description of Water Production CCL Deviations in 2020

CCP	Root Cause	Results	Corrective Action(s)
P1	February 19th, Britannia – Low lift venturi erroneous	Plant load was 115 MLD, however venturi was reading 85 MLD resulting	Low lift venturis rodded during subsequent plant shut. Semi annual PM in

CCP	Root Cause	Results	Corrective Action(s)
	reading due to low plant loads.	in low Alum dose (approx. 22 mg/L) and high pH (6.2) condition for 14 min.	place. Added to water production comprehensive development plan for replacement review following high lift.
P1	March 18th, Lemieux – Sulphuric Acid pump failed to start on plant start-up due to no carrying water available.	Acid pump failed to start due to interlock conditions not cleared (lack of 50 L/h dilution water flow) leading to aborted plant start.	Documented interlock conditions in emails to operators and revised SOPs to make existence of interlock clearer.
P2	April 29th, Britannia – Generator transfer trip lead to multiple filter turbidity rise upon plant start up.	Multiple filter turbidity spike event caused by 2-hour plant shut resulting in particle shedding during startup (>0.10 NTU for 5 min. or more).	SOP developed for plant power failure. Trials underway to determine how long filters can be out of service and not require ripening/backwash.
P2	August 24th, Lemieux –Sodium silicate line was blocked.	Blocked sodium silicate line caused loss of properly activated sodium silicate leading to settled water turbidity increase which ultimately led to a multiple filter turbidity spike (>0.10 NTU for 5 min. or more).	Sodium silicate system currently being upgraded and to be commissioned in May 2021.
P3	July 11th, Britannia – Primary sodium hypochlorite feed to clearwell 1 failed due to failed gear pump.	Sodium hypochlorite pump 1 failed and backup pump 2 did not work resulting in a loss of sodium hypochlorite flow greater than 5 minutes	Chlorine pump failure investigated with pump repaired and spare parts ordered. Ongoing testing to replace positive

CCP	Root Cause	Results	Corrective Action(s)
			displacement gear pumps with peristaltic.

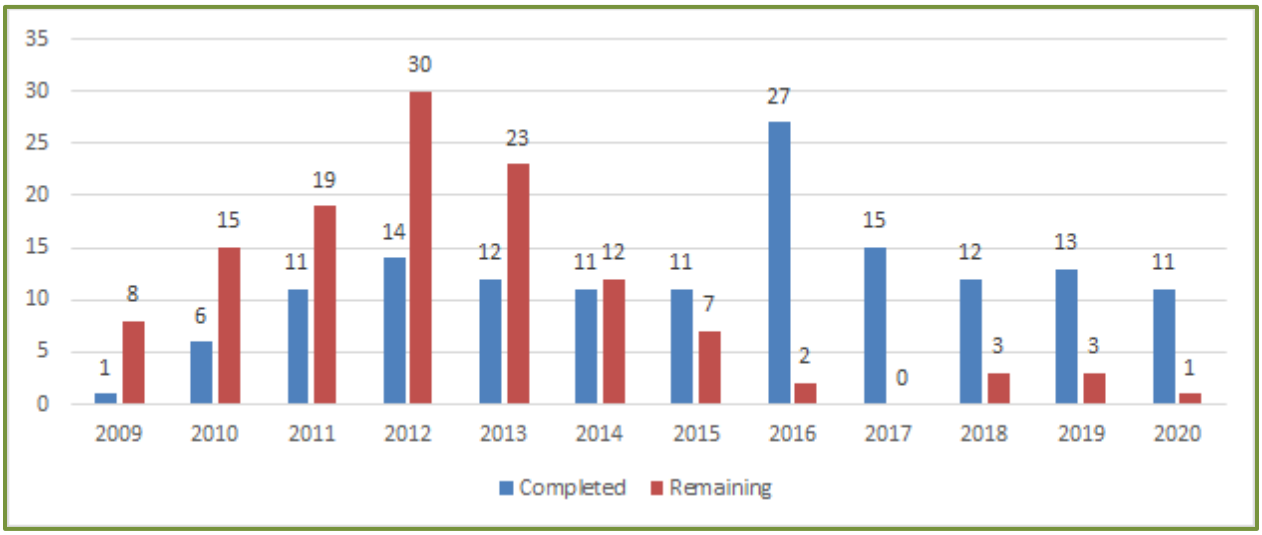
In all events, the treated water quality was continuously monitored to ensure inadequately treated water was not reaching the distribution system, and in the events where the treated water quality was unacceptable the plant was purged in order to ensure the water quality in the distribution system was unaffected.

All CCL deviations, corrective actions and improvements are tracked and reviewed as part of the DWQMS Continual Improvement process. During 2020, 81 new Priority 1, 2 and 3 action items were identified as part of the Continual Improvement process. A total of 73 action items were completed, including 11 Priority 1 action items; 3 identified in previous years and 8 of the 9 Priority 1 action items identified* in 2020.

**Note that this does not include Priority 1 action items identified and completed as a result of CAPAs.*

Since 2008, a total of 142 Priority 1 action items have been identified and 141 of them have been completed.

Figure 2 - Status of Priority 1 Action Items from 2009 to 2020



Some important Continual Improvement actions that have been completed in 2020 include the following:

- The continual improvement framework was revamped including the tracking sheet and meeting format. Action item reminders are now sent to stakeholders monthly;
- Ongoing initiative to improve filter backwash logic including new HMI screens for operators is ongoing at both WPP;
- Improvement of settling basin 4 and 5 plate packs to increase settling capacity were completed. Basin high flow trial are to be completed in 2021;
- Completed spill response SOPs for bulk chemicals in consultation with operations staff;
- Identification of training opportunities for operators and trades, topics including: critical control point awareness training for trades, manual chemical dosage adjustments, and operating strategies during challenging conditions (e.g. cold water, changing water temperature);
- The Britannia WPP high-lift flow meter project was restarted in the fall of 2020 which was originally delayed due to COVID-19; and
- A study of peristaltic pump usage for both sodium hypochlorite and sulphuric acid at the plants was initiated and is ongoing to replace positive displacement gear pumps that are proving harder to source parts for.

Continued implementation of chemical feed control and carrying water system configuration improvements on several of the WPPs' chemical feed systems – part of ongoing Chemical Upgrade Project that will continue into 2021 Lemieux Island WPP Sodium Silicate and Alum systems to be commissioned in 2021.

Water Distribution CCL Deviations

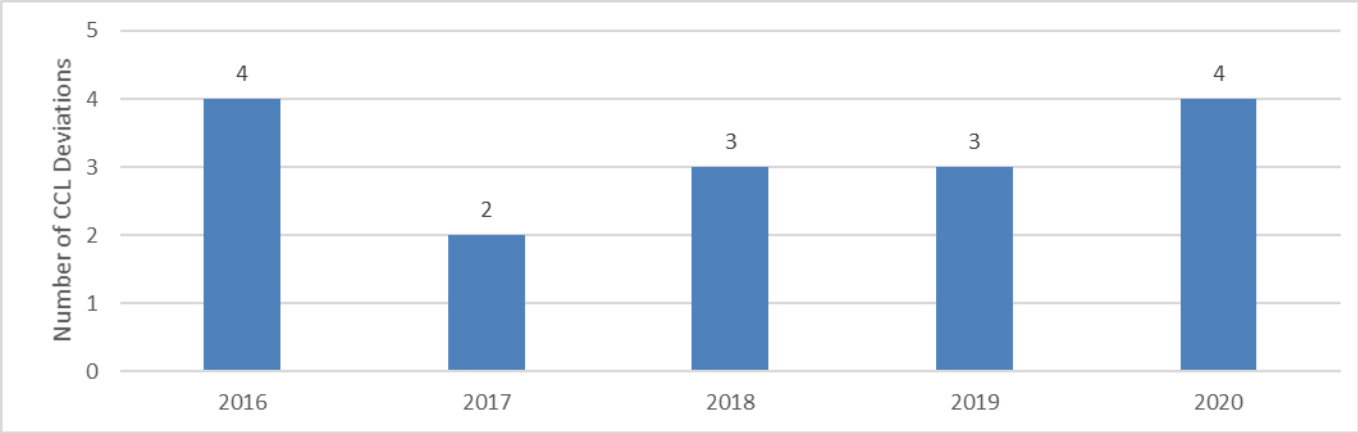
The Critical Control Points for Water Distribution are shown in the table below, along with the number of CCL deviations noted during 2020.

Table 5 - Water Distribution CCL deviations identified during 2020

Water Distribution CCPs		Number of CCL Deviations in 2020
D1	Known or suspected contamination in the distribution system due to a watermain break (e.g. E.coli confirmed, sewers, fuel or other chemicals resulting in contaminated groundwater, explosion)	1
D2	Potential contaminant infiltration from uncontrolled loss of pressure greater than 60 min. in the distribution system (due to loss of power, equipment failure, component failure or by overdraw on hydrant, fire fighting, closed valves, etc.), Backbone watermain break.	2
~~D3~~	~~Known or suspected contamination in the distribution system associated with a temporary service~~	~~0~~
D4	Contamination in the distribution system due to a backflow caused by operational activities in the distribution system	0
D5	Contamination - high levels of lead in water due to leaching from pipe/plumbing	0
D6	Contamination in the distribution system associated with a new watermain installation (high chlorine slug, non-potable water, contractor operates valves or completes connections, debris left in w/m from construction, etc.)	1
D7	Contamination during contractor hydrant use (dirty hose, lack of backflow prevention)	0

The figure below illustrates the total number of water distribution CCL deviations per year for the period 2015 – 2019.

Figure 3 - Total number of water distribution CCL deviations per year 2016 to 2020



CCL deviations detected in the distribution system have been relatively consistent since 2012 in the range of 2 to 4 per year. During 2020, CCL deviation events were noted, as described below.

Table 6 - Description of Water Distribution CCL Deviations in 2020

CCP	Root Causes	Results	Corrective Action(s)
D1	Broken sewer lateral in same excavation as watermain	Category 3 watermain break repair	• Precautionary Boil Water Advisory • The watermain was flushed using high velocity flushing, a temporary dead end was created, and a continual flush was set up overnight • Two sets of clear Bacteriological samples were taken from dead end.
D2	Richmond Road watermain repair over 24h	Depressurisation >24 hours (not reported as AWQI - no evidence of improper	• Precautionary Boil Water Advisory issued to affected building in consultation with OPH

CCP	Root Causes	Results	Corrective Action(s)
		disinfection/ contamination)	
D2	Britannia plant shutdown and restricted water supply to 1W pressure zone	Wide-spread depressurization	• Restored pump operation • Flushing and sampling in the affected area of pressure zone
D6	Insufficient communication, procedures not followed as documented	Disinfected sections of watermain that had been outside the care and control of a licensed water distribution operator were installed on the job site	• Precautionary Boil Water Advisory issued for the connected building. • Service was flushed extensively • Clear bacteriological samples

Aging Report for CCL Deviation and DWQMS Priority 1 Action Items

The 2015 Management Review report recommended that a report be sent to OTM for aging Priority 1 action items that remain *In Progress*. These action items may have resulted from past CCL deviation incidents or general DWQMS actions. For the purposes of this report, aging action items are considered to be items that have been *In Progress* for ≥ 2 years. An aging report has been presented on a quarterly basis to OTM, beginning in 2018.

At the end of 2020, there were a total of four Priority 1 action items that remained *In Progress* (between 2010 and 2018), all of which were derived from DWQMS triggers. A summary table below summarizes these items:

Table 7 - Aging Priority 1 Action Items

Year	Action	Target for Completion
2012	The Relief Valve Settings across the City need to be calculated, documented and implemented in Operations Manuals and on PM Work Orders. *The changes have been calculated, documented and are awaiting implementation.*	2021
2015	Develop, document and implement a process for reverse flow events.	2021
2017	Review all current blowoffs in the distribution system and determine compliance with backflow program. Implement changes as required. *This item was upgraded to a Priority 1 in 2019, in order to meet regulatory requirements.*	2021
2018	Initiate a project that will update the watermain disinfection procedure for short pipe sections, that currently do not fit in realm of our current disinfection procedure.	2021

The action items described above are being tracked for completion by the QMS Coordinator. No aging Priority 1 action items were closed in 2020.

Action Item identified as part of the Management Review Meetings:

- OTM #1: Britannia low-lift venturi flowmeter is not reliable in low flow range (80 – 120 ML/d) and has led to several coagulation failures in recent years. Management recommends replacement of Britannia's low-lift venturis as a priority capital project. This project is likely to be identified in the WPP Development Plan Report but should be created as a separate capital project due to risk of failure. Previously identified and tracked as Action #794 in CAPA Database.

d) Effectiveness of the Risk Assessment Process

Risk Assessment Review

The DWQMS Risk Assessment process that has been implemented at the City of Ottawa reviews existing hazards and potential new hazards where applicable. At least once every calendar year, or following a major process change, the MS Coordinator facilitates a formal review with the risk assessment team. Since the specific nature of processes and risks differ between water treatment and distribution, the Risk Assessments for Water Production and Water Distribution are carried out by two different teams. In 2020, an annual risk assessment review was completed.

In the first stage of the annual risk assessment exercise, participants reviewed incidents from 2020 that had the potential to impact water quality (Continual Improvement Summary Table for 2020 and DWQMS incident investigations, as applicable). Any newly identified hazards were added to the Risk Assessment Outcomes tables and ranked for likelihood (L) or consequence (C).

During the final stage of the risk assessment exercise, participants assessed the remaining hazards that were previously identified in 2019 (2019 Risk Assessment Outcomes Table) with a Risk Number of ≥8 for validity by reviewing historical occurrences and improvements made to operations.

As part of the risk assessment review, hazards are considered for inputs for the infrastructure review discussions that occur throughout the year and if required, included as part of the Management Review meeting for item ‘n’. This would be documented under column ‘K – Consider for Infrastructure Review’, where deemed necessary.

Outcome

Tables for the 2020 Risk Assessment Outcomes and Summary of CCPs were updated as part of the review. Changes (i.e., increases/decreases to likelihood or consequence resulting in a critical risk) were captured in the “notes” column in the Risk Assessment Outcomes.

Below is a summary of the significant changes made to the 2020 Risk Assessment Outcomes Table for Water Distribution:

- NEW CCP (D8): Dead ends in the distribution system - release of stagnant water into the distribution system through the opening of a closed (seldom operated) valve (dead ends or new developments with low activity).

Below is a summary of the changes made to the 2020 Risk Assessment Outcomes Table for Water Production:

- NEW hazard: Backup power failure (generator trip or fails)
- DELETED hazard: #68 Silicate only: lines plug (lines not flushed). This hazard is included in the CCP P1 (Coagulation process upset).

Items Flagged for Infrastructure Review

The following items have been identified for consideration during the infrastructure review discussions:

Table 8 - Water Distribution and Water Production Risk Assessment Outcomes for Infrastructure Review Discussions.

#	Hazard Description	Notes from Risk Assessment Meeting with WD
16	Contamination - high levels of lead in water due to leaching from pipe/plumbing	Need to report on the amount of lead service pipe removed from the system every year as a result of the LRP and the capital renewal projects
#	Hazard Description	Notes from Risk Assessment Meeting with WP
69	CCP P1 - Coagulation failure or non-optimal capture of particles/ microbial pathogen	Identify a need for the replacement of low lift venturi with Mag meters @ Britannia – WPP Comprehensive Development Plan

Further details regarding the 2020 annual risk assessment exercise, including action items, is provided in the 2020 Risk Assessment Report. The items described above and action items resulting from the risk assessment exercise are being tracked for completion by the QMS Coordinator.

Action Item identified as part of the Management Review Meetings:

- OTM #2: Include amount of lead service pipes removed from the system every year as a result of the LRP and the capital renewal projects within the Management Review reports going forward. Previously identified and tracked as Action #821 in CAPA Database.

e) Results of Internal and External Audits

The Ontario Drinking Water Quality Management Standard requires the Operating Authority to conduct an internal audit of each element at least once every calendar year. As well, external desktop surveillance (annual) audits and on-site verification audits (every 3 years) of the Management System must be completed by a recognized accreditation body.

Internal Audits

The objective of the internal audit is to document evidence of conformance to the Quality Management Standard, the current version of the Operational Plan, and other controlled documents, such as SOPs. Corrective Actions (CAs) are created to address non-conformances. CAs, Preventive Actions (PAs) and Opportunities for Improvement (OFIs) are discussed with auditee teams and if accepted, follow-up action items are generated. Action items are tracked as part of the DWQMS Continual Improvement process. The 2020 internal audit results are summarized in the table below:

Table 9 - Internal Audits and Findings for 2020

Internal Audit Process	Completion Date	Findings		
		CAs	PAs	OFIs
2020-032 Analyzer Failure	March 2020	2	2	2
2020-033 Chemical Ordering (acceptance, QA/QC, supply)	June 2020	1	0	0
2020-034 Training & Competencies*	September 2020	1	0	7
2020-035 Accessing Critical Drawings	December 2020	1	0	1
TOTAL		**5**	**2**	**10**

*The 2020 Internal Audit Schedule and Plan Form was revised in August 2020 for the previously approved process, ‘SCADA Backups / Data Integrity’, to be replaced with ‘Training & Competencies’. The OTM team determined this internal audit revision to be

more advantageous given that SCADA Backups / Data Integrity had been recently audited by Corporate IT.

As a result of the COVID-19 pandemic restrictions, all internal audits, except for the 2020-032 Analyzer Failures, had to be completed virtually through the use of MS Teams meetings and electronic sharing of documents/records in order to maintain social distancing. Limitations of the virtual audits included:

- Secondary observations were less likely to be observed. For example, during live audits, audit issues can often be detected when reviewing records and documents for alternate purposes; and
- Records observed would have been limited to what was provided by the auditee and may not have allowed for a more random sample of records.

Below is a summary of the non-conformances and resulting action items:

- **2020-032 Analyzer Failure:** Both non-conformances for this audit related to updating the hard copy records (Analyzer Service Priorities and Available Contingencies table SOP and the Summary Table for CCPs) at the WPP control rooms. These items were completed and closed at the end of 2020 / early 2021.
- **2020-033 Chemical Ordering:** A tentative auditee declined to participate in the audit noting a lack of practice with respect to bulk chemical acceptance responsibilities, despite their oversight in this process as an operator. In addition, the Chemical Acceptance Form was not being filled-in completely by the operators. Refresher training for the analysis and acceptance of a chemical load will be provided to the Process Operators, Senior Operators and Process Supervisors in 2020. This action has been transferred to the Continual Improvement Summary Process (managed by Water Production Operations) for tracking as it relates to an incident with similar action items for completion. The training of operators has been scheduled for early 2021.
- **2020-034 Training & Competencies:** Auditees noted that there were no meetings in 2019 to plan for the 2020 training schedule, as described in the DWQMS Operational Plan. In addition, the 2020 training schedule was incomplete, in comparison to the 2019 training schedule. Meetings were held in late 2020 between the Drinking Water Branches and the Training and Development Branch to create a training schedule for 2021. This action item was completed and closed in early 2021.

- **2020-035 Accessing Critical Drawings:** This audit revealed a lack of business process for ensuring that operational drawings are received and updated internally to meet the regulatory requirements set out in the Municipal Drinking Water Licensing Program and to meet operational demands. Given the complexity of this issue, support groups will be working with the Drinking Water Branches in 2021 to determine appropriate actions for improvements to the drawing management processes.

In total, 248 actions have been created in response to internal audit findings since 2009, 229 of which have been closed by the end of 2020; this represents a completion rate of 92%. The only Priority 1 action item that remains in progress relates to developing a process for identifying and investigating reverse flow events that could be resulting in backflow incidents. This action item is being led by the Backflow Prevention Program Coordinator and is expected to be completed in 2021.

External Audit

The City was awarded its 'Full Scope – Entire DWQMS' accreditation on October 3, 2011 for the seven existing municipal water systems, with reaccreditation awarded on September 4, 2014, on October 2, 2017 and most recently with the external auditor's report received on September 14, 2020. It is subject to a tri-annual re-accreditation process, as well as annual surveillance audits.

The 2020 third-party accreditation body (NSF International Strategic Registrations (NSF)) conducted their accreditation audit of the City's DWQMS via virtual meetings with City of Ottawa personnel and electronic submission of requested documents and records. Accreditation audits are typically completed on-site, however due to COVID-19 pandemic restrictions, it was agreed to by both the external auditor and the QMS Coordinator that the audit should be conducted virtually. The results of this audit demonstrated zero findings of non-conformance for the City's drinking water systems.

The 2020 external audits marked the 9th year of receiving 0 non-conformances for its DWQMS.

No Action Items were identified as part of the Management Review Meetings.

f) Results of Relevant Emergency Response Testing

The DWQMS, specifically *Element 18 – Emergency Management*, requires the Operating Authority to conduct an annual exercise to evaluate the drinking water Incident Escalation and Response Plan (IERP). However in lieu of a mock emergency exercise, Water Services opted to use an actual emergency encountered by the City in 2020 to assess its existing emergency-related procedures. The 2020 DWQMS Emergency Exercise Report was compiled by personnel from Business and Technical Support Services, who participated in the emergency response discussions with Water Services (Drinking Water). A summary of the 2020 DWQMS Emergency Exercise Report is provided below.

The City of Ottawa, including Water Services (Drinking Water), entered into a State of Emergency declared on March 25, 2020 for the COVID-19 Pandemic.

The pandemic consisted of several challenges including Supply, Logistics, Staffing, Personal Protective Equipment, Communications, Continuity of Operations, Cases in the Workplace, Self Isolation, Emotional and Physical Tolls to name a few. The event of responding to the first positive case in the workplace included participants from Water Distribution, Water Quality, Water Production and Wastewater Collection and Treatment.

Based on observations made during the emergency event and in consequent debrief discussions, it was concluded that the group generally achieved the identified objectives and practiced effective decision-making processes.

Based on observations made during the emergency event, WS implemented the following proactive measures:

- The emergency event was quickly escalated throughout the leadership team and operational updates were thoroughly provided, as necessary, to the OEM.
- Notification to internal stakeholders (OPH, Corporate Communications) were promptly communicated.
- Consideration was given to ensure that staffing levels were maintained to critical minimum.
- COOP Plans were well organized and effective.

- Water Services acted quickly to implement new procedures to minimize the risk of COVID-19 spread.
- There is redundancy for the production of drinking water, having two WPPs allows backup should one WPP have to shut downt.
- Several options were discussed for providing back-up support should this have spread further.
- Communication was enhanced to effectively keep all employees updated and confident in the departments approach.

Recommendations for continual improvement were determined by Water Services Management team and implemented as applicable. These recommendations are documented in the 2020 DWQMS Emergency Exercise Report.

No Action Items were identified as part of the Management Review Meetings.

g) Operational Performance

In order to track operational performance, Key Performance Indicators (KPIs) have been developed in the following categories: Customer Service, Water Distribution, Water Production and Water Quality. Operational KPIs are tracked and described below.

Customer Service KPIs

Water Quality on-site customer investigations: The number and type of water quality investigations during 2020 are summarized in the table and graph below.

Table 10 - Number of Water Quality Customer Complaints Investigated

KPI	2016	2017	2018	2019	2020
Lead Testing	148	129	127	534	460
Discoloured Water	111	63	105	87	39
Taste and Odour	37	34	44	37	46
Health	25	37	26	17	11
Chlorine	4	4	3	2	11
Cloudy	25	16	16	30	15
Metals	4	9	5	41	43
Pink Bacteria	2	4	7	10	6
Sediment	9	11	18	8	9
Basic WQ		9	22	21	22
Other (canvassers, appearance, White particles, hardness)	20	12	6	11	20
Total Water Quality Investigations	**384**	**328**	**378**	**798**	**682**

The number of water quality investigations in 2019 and 2020 was consistent with previous years with the exception of lead testing. Customer interest in lead testing showed a sharp increase due to heightened public awareness and frequent media reports in 2019 following the change in the Maximum Acceptable Concentration (MAC) of lead by Health Canada from 10 ppb to 5 ppb. In 2020 the Lead Pipe Replacement Program (LPRP) was updated and as a result 30,000 letters and brochures were to be mailed to customers in areas that it was thought to have lead services (pre-1955

homes). Due to COVID-19 pandemic restrictions, the mail out was suspended until 2021 after just over 5,000 letters were sent out, but lead requests increased in the area that received the letters. In addition, in 2019 and 2020, the number of metals samples appeared to have increased, this is a result of reclassification of any sample that was submitted to the lab and included a metal scan we reclassified for tracking purposes since the metals analysis takes longer than the general bacteriological samples.

Discoloured water calls were lower in 2020 as a result of employee turnover (retirement) at which time, discoloured water calls were sent to the first response group for flushing purposes until the position could be filled.

Customer investigation changes due to COVID-19 pandemic restrictions: In March of 2020, as a result of the COVID-19 pandemic, all in-home sampling was suspended in order to protect both the homeowner and City employees. Customers were notified of the situation and for homeowners requesting lead samples, they were put in a queue until sampling could resume. In May 2020, a modified lead sampling procedure was developed, where water operators dropped off sample bottles and homeowners were able to take their own samples for lead only. For non-lead samples, homeowners were contacted to discuss/troubleshoot the issue and if sampling was required, samples were taken from a hydrant on the customers street and in some instances from outside taps of homes (during warmer weather). For customers requiring only metals analysis, sampling was carried out using the modified lead sampling procedure.

A breakdown on how customer investigations were carried out are listed below:

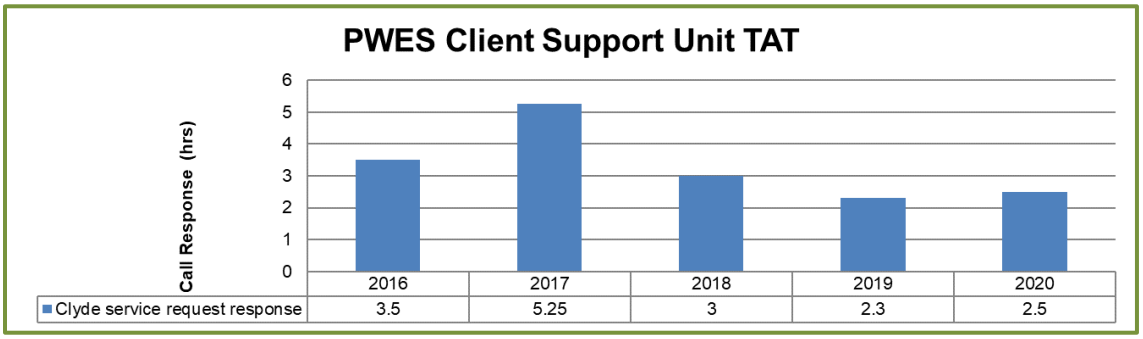
Table 11 - Customer investigations

	Prior to March 2020	After March 2020	Total
LEAD	151	309	460
NON-LEAD	53	53	106
Phone/email troubleshooting	-	116	116
Total			682

Response times for water quality customer investigations: As discussed above, response times after March 2020 were not tracked as a result of COVID-19 sampling restrictions.

In June of 2016, the PWES Client Support Unit (located at Clyde Avenue) began tracking their response times for sending service requests to the Water Quality following initial contact from 311. During 2020, the average PWES (Clyde) response time was 2.5 hours.

Figure 4 - PWES Client Support Unit response time



Water Distribution KPIs

Watermain breaks: Breaks per 100 kilometer is an industry standard used when comparing break rates to other utilities. 2020 was an average year with 169 watermain breaks and a break per 100 km rate of 5.2. 69% of the watermain breaks experienced occurred in older cast iron watermains. These watermain breaks typically occur during freeze/thaw cycles. As older infrastructure is renewed and cast iron watermains are replaced, it is expected that the annual number of watermain breaks will decrease; however, climate change may increase the number of freeze/thaw cycles, which can contribute to the number of watermain breaks in the remaining cast iron watermains in the distribution system. Pipe length (public) increases on average by 35km/year.

The following graphs illustrate the 2020 results in comparison to previous years, presented as # of breaks per 100km of watermain, annual # of watermain breaks, and monthly trends.

Figure 5 - Number of watermain breaks, per 100 km of pipe, from 2016 to 2020

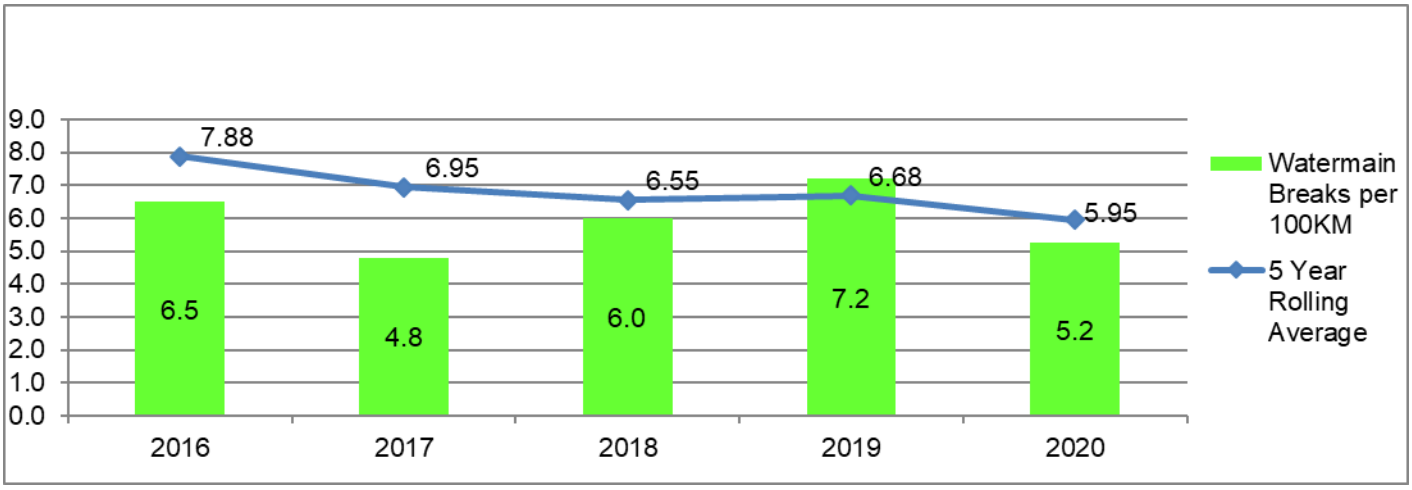


Figure 6 - Total Number of Watermain Breaks per Year from 2016 to 2020

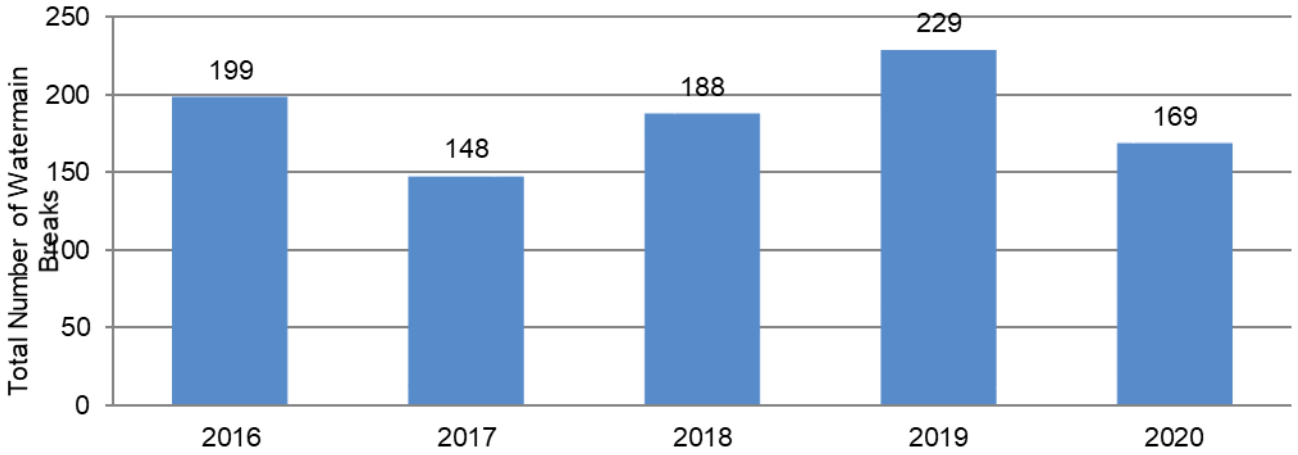
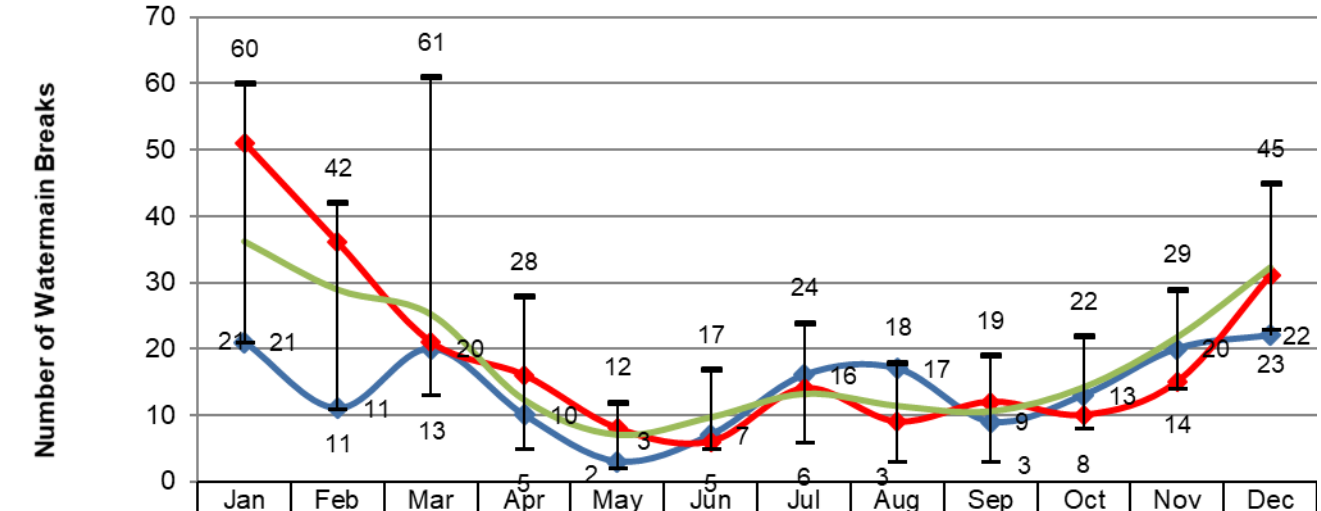


Figure 7 illustrates the number of watermain breaks by month in the current year compared to the previous year. The 10-year average, 10-year maximum and 10-year minimum for each month is also illustrated in this figure. 2020 was typical of the 10-year trend.

Figure 7 – Watermain Break Monthly from 2016 to 2020



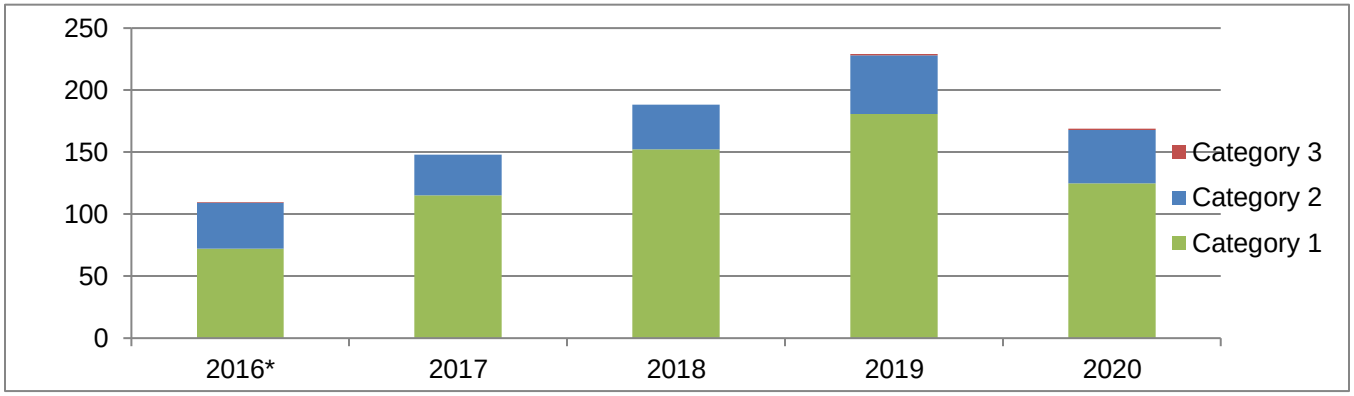
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	21	11	20	10	3	7	16	17	9	13	20	22
2019	51	36	21	16	8	6	14	9	12	10	15	31
10 Yr Ave	36	29	25	12	7	10	13	11	11	14	22	32
10 Yr Max	60	42	61	28	12	17	24	18	19	22	29	45
10 Yr Min	21	11	13	5	2	5	6	3	3	8	14	23

Watermain break categories: The watermain disinfection procedure requires a risk assessment to take place on the potential for contamination in the watermain throughout the repair process to categorize the repair type. The resulting disinfection measures are based on these repair categories defined below:

- **Category 1** (very low risk): positive flow is maintained through the break area during excavation until an air gap is created. The exposed pipe is free and clear of pit water and there is no visual evidence of contamination into the watermain
- **Category 2** (low risk): the watermain is isolated during the excavation and positive flow is not maintained. There is a minor potential for soil/water intrusion during the excavation, and contamination is either evident or suspected
- **Category 3** (potential risk): there is evidence of suspected sewage or chemical contamination in the excavation

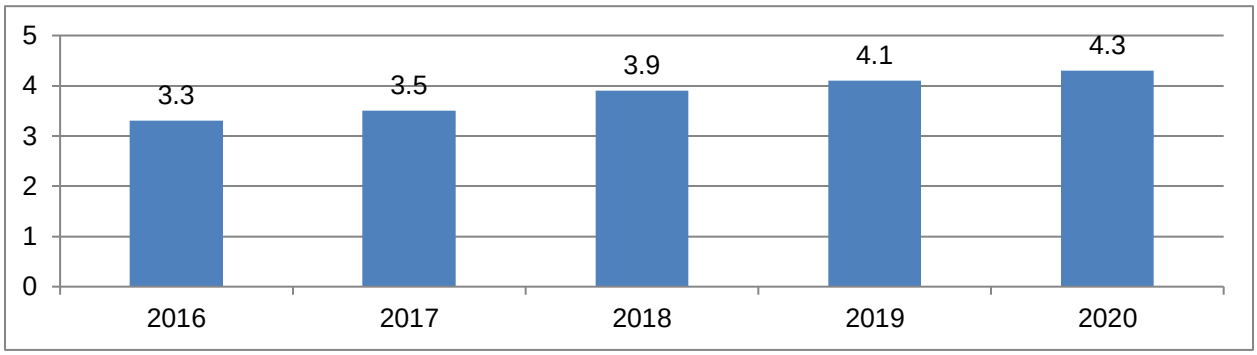
In 2020, 74% of repairs were assessed to be very low risk Category 1. The following graph indicates the distribution of Category 1,2,3 watermain breaks from 2016 to 2020.

Figure 8 - Watermain break categories



** New KPI in 2017, new watermain break procedure was effective as of April 2016, as such category totals for 2016 do not represent full year.*

Figure 9 - Infrastructure Leakage Index

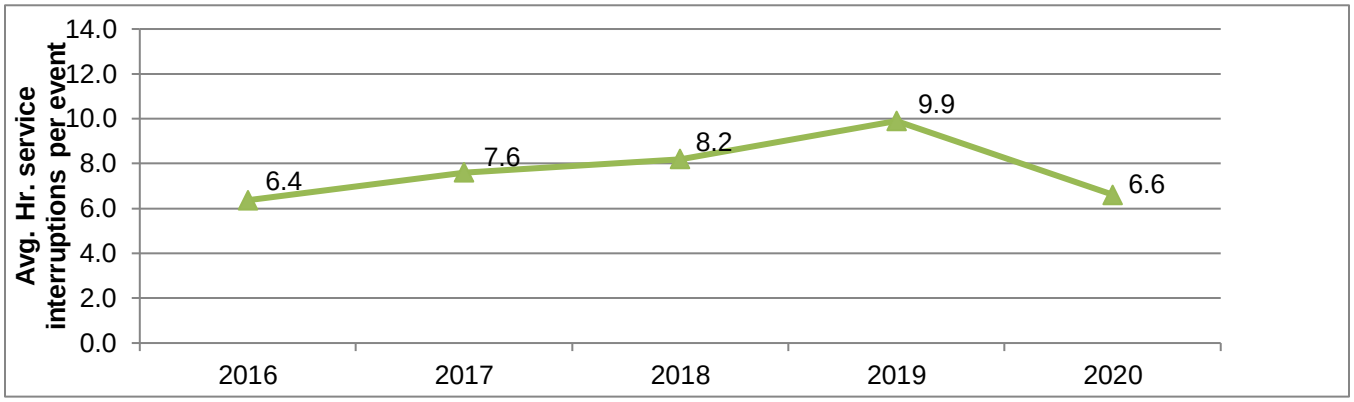


The ILI is the industry-wide key performance indicator that measures the amount of leakage in the water distribution system. In 2020, it was calculated at 4.3 (+4.9%) from 4.1 in 2019. The City of Ottawa's ILI is considered "below average" when compared to an ILI data-set of similar size municipalities. The ILI has increased every year since 2016 and the target has been to be below 3.0 for some time.

The Water Loss Group underwent a transition in late 2020 to improve ILI and develop a more proactive water loss and leak detection strategy that better utilizes customer meter AMI data. A more data driven approach will lead to increased leakage identification, awareness and improved field experiment planning. It is anticipated, this new approach will lead to an ILI reduction for the first time in many years.

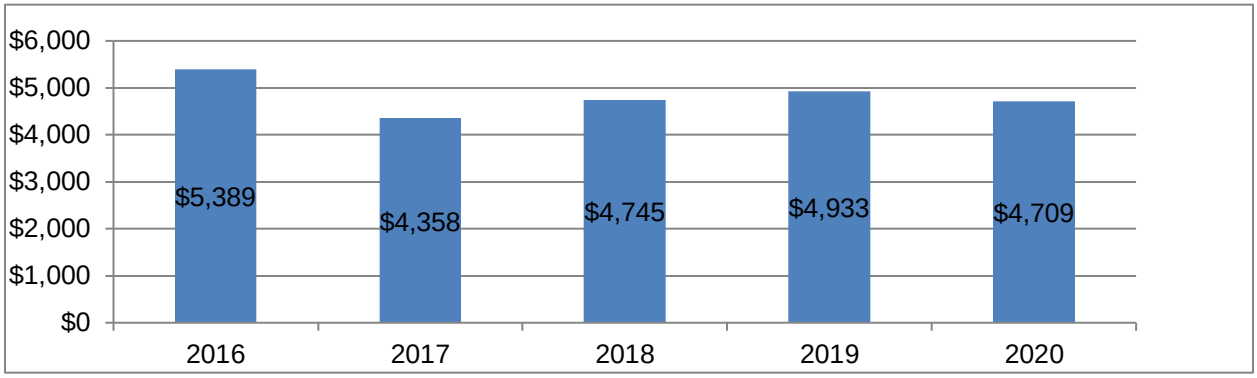
Water service interruption: The average service interruptions hours resulting from a watermain break repair decreased significantly in 2020. Of the 169 watermain breaks in 2020, 35 resulted in a water service outage exceeding 12 hours, while 44 resulted in service interruptions of fewer than 4 hours. Many of these longer-duration repairs were repairs of multiple breaks on the same or adjacent length of watermain in cast iron watermains and were considered to be one repair when viewed from the customer perspective. In these cases, the additional breaks were discovered during the flushing process, so customers did not experience a restoration of water service for any length of time prior to the watermain being placed out of service for the additional repairs. A total of 2970 customer connections experience water service interruptions due to watermain breaks in 2020.

Figure 10 - Average Number of Hours that Water Service Interruption per Event from 2016 to 2020



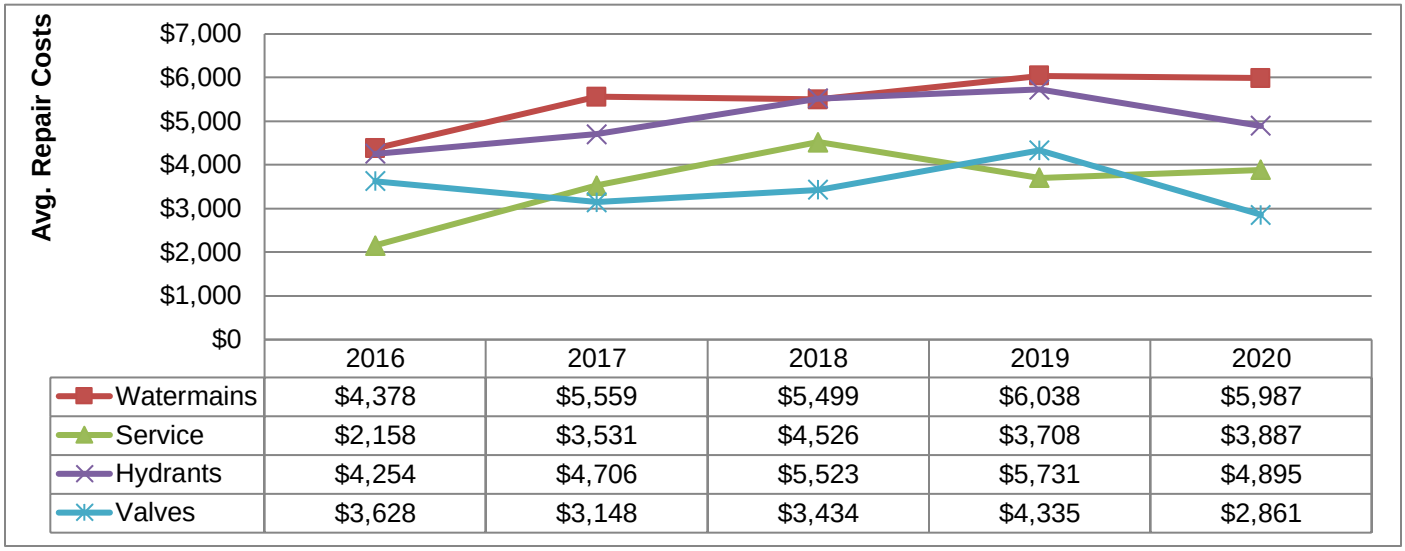
Water Distribution operating and maintenance costs: The total Water Distribution costs per kilometer of watermain for 2020 was $4,709, which is below the 5-year average of $4,827. As a result of a departmental reorganization in 2016, the Water Meter and Locates group were moved to other areas, and the First Response group was included in Water Distribution. This led to an overall reduction in resources and costs per kilometer of pipe.

Figure 11 - Total water distribution costs per km of watermain from 2016 to 2020



The average repair costs of all water distribution components decreased by approximately $500 per repair in 2020. The repair costs of watermains, valve, hydrants decreased while the repair cost of water services increased. In 2019 Water Distribution undertook the repair of several inoperable/broken large valves requiring replacement of major valve components. Similar repairs were not planned in 2020. As a result of a departmental reorganization in 2016, it was anticipated that hired equipment costs would increase in 2017. As expected, there was a steep increase in repairs that required excavation, such as watermain and water service repairs, and to some degree, hydrant and valve repairs. Additionally, in 2018, more stringent restrictions were placed on when planned repairs could be scheduled on certain road types, resulting in increased overtime costs for staff and premium costs for hired equipment and traffic control. As expected, the overall repair costs increased further in 2019 as the definition of the peak traffic period expanded and restrictions to roadway activities were enforced. These costs have been somewhat mitigated in 2020 through improved planning and scheduling.

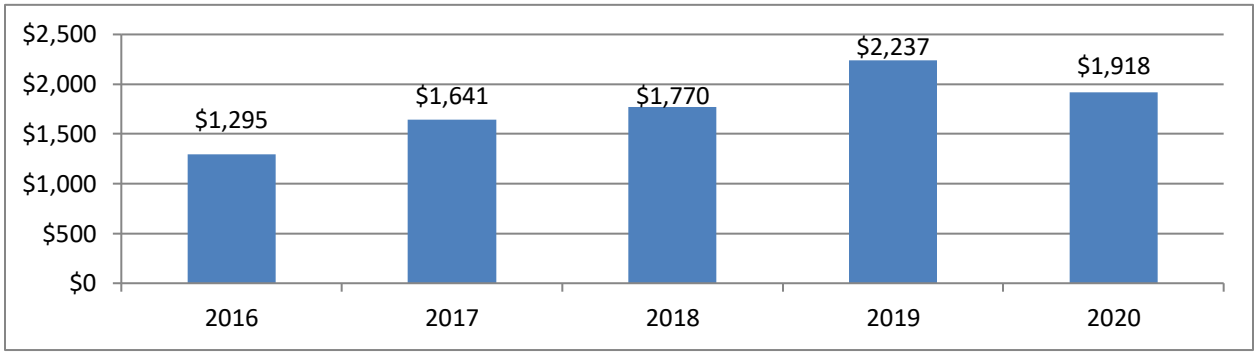
Figure 12 - Average Repair Costs by Water Distribution System Component



	2016	2017	2018	2019	2020
Watermains	$4,378	$5,559	$5,499	$6,038	$5,987
Service	$2,158	$3,531	$4,526	$3,708	$3,887
Hydrants	$4,254	$4,706	$5,523	$5,731	$4,895
Valves	$3,628	$3,148	$3,434	$4,335	$2,861

The average reinstatement cost decreased by $319 from 2019 to 2020. There were 3 large area or more complicated (involving asphalt and concrete) reinstatements (Merritt = 101m^2, Levadia – 143m^2, Harvest Cres - 135m^2) that resulted in costs greater than $10,000. The average area of all repairs was approximately 20 m^2 in 2020.

Figure 13 - Average costs of reinstatement per year (all excavation activities)



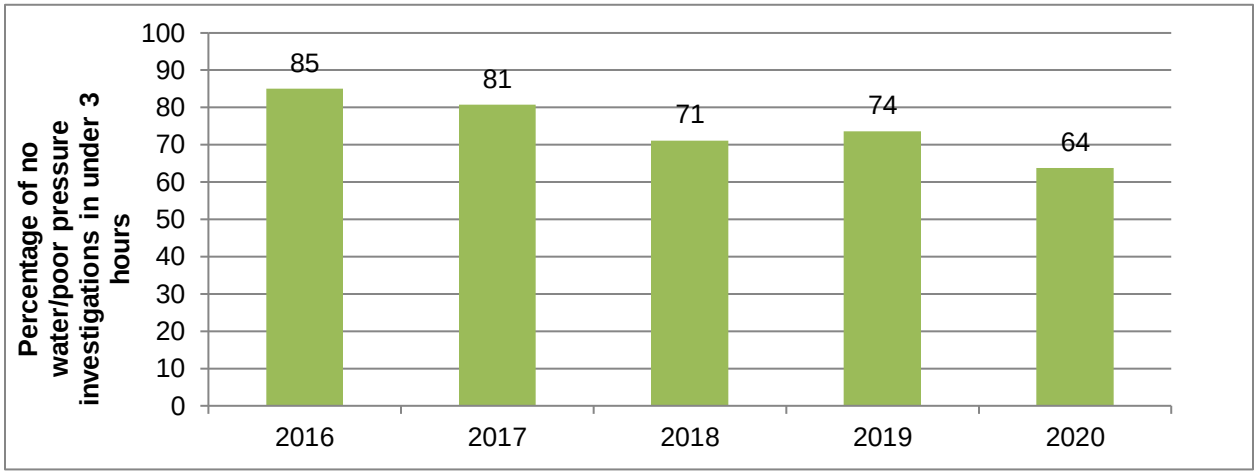
As part of a departmental stabilisation exercise in 2018, seven (7) water distribution resources were reallocated to other areas of Water Services. Improvements to processes and programs as well as a focus on cross-training and effective planning of resources has allowed Water Distribution to continue to deliver safe drinking water with 3.7 FTE/100km.

Table 12 - Number of full-time employees per 100KM of distribution pipe

KPI	2016	2017	2018	2019	2020
FTEs per 100KM	5.2	4.1	3.8	3.7	3.7

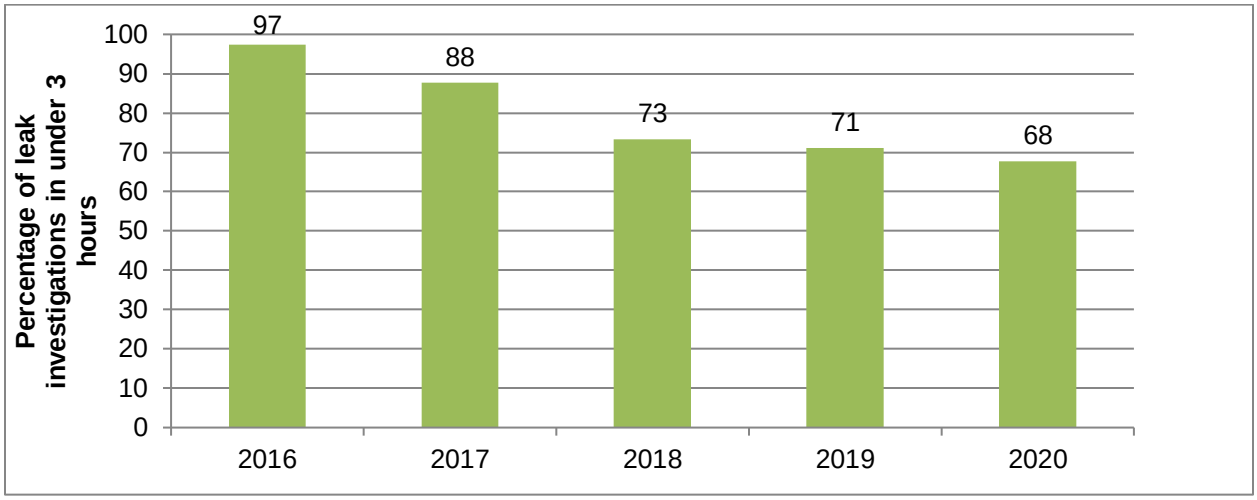
First Response Investigations: In 2020, 64% of the requests met the service level target of under 3 hours. 45% of all requests were addressed in under 1.5 hours. The majority of requests over 3 hours were either due to work processing issues or Maximo outages and the automated time stamp was not updated manually.

Figure 14 – % Number of Investigations initiated within 3 Hours of service request receipt



In 2020, 64% of the requests related to leak investigation met the service level target of under 3 hours. 53% of all requests were addressed in under 1.5 hours. Similar to the low pressure investigations, the majority of requests over 3 hours were either due to work processing issues or Maximo outages and the automated time stamp was not updated manually. In November 2020, the Leak Detection team members of First Response were transferred to the Water Loss group, which also impacted the ability to gather data and report on this metric due to a change in work units. This will be reviewed in 2021 to determine how best to report on service delivery.

Figure 15 - % Number of Leak investigations initiated within 3 hours or service request receipt



Water Production KPIs

The annual inspection ratings are shown below for 2016 to 2020, by system.

Table 13 – MECP Annual Inspection Ratings for municipal water systems

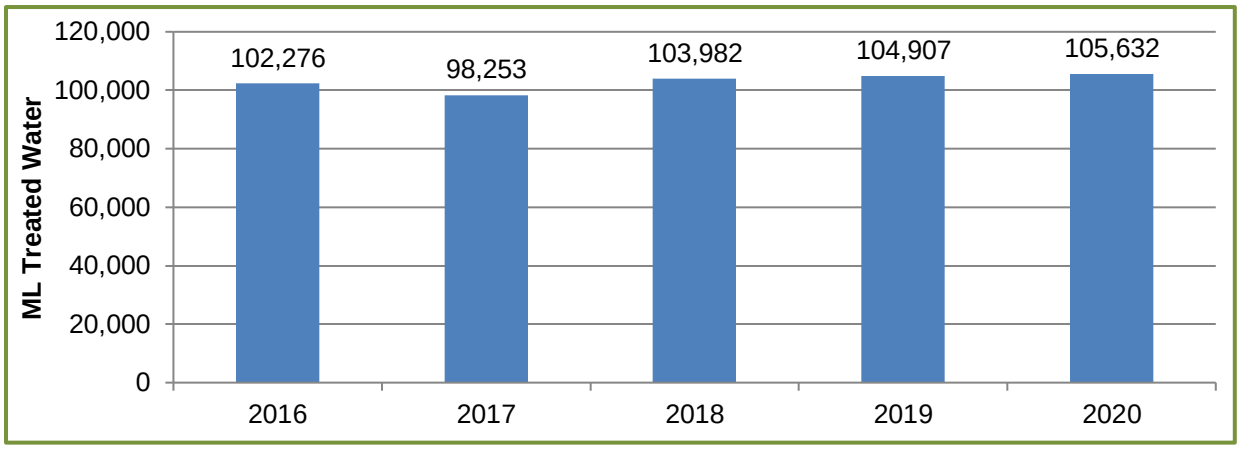
Water System	Target	2016	2017	2018	2019	2020
Britannia	**100%**	100%	100%	100%	100%	100%
Lemieux Island	**100%**	100%	100%	100%	99.3%	100%
Carp Well	**100%**	100%	100%	100%	100%	100%
Kings Park	**100%**	100%	100%	100%	100%	100%
Munster	**100%**	100%	100%	99.1%	100%	100%
Vars	**100%**	100%	100%	100%	100%	100%
Shadow Ridge	**100%**	100%	100%	98.4%	100%	100%
Richmond West	**100%**	-	-	-	100%	100%

MECP Inspection Ratings: during the 2020 MECP inspection year, all eight waterworks were inspected by the MECP. The resulting inspection reports identified 100% MECP inspection ratings for all eight systems. The inspection rating is a comprehensive risk-

based score based on more than 100 inspection and compliance questions covering 15 aspects of water operations and management.

Annual water production: the annual water production (measured in million liters (ML)) increased by 1% in 2020 vs. 2019 but remains consistent with the general trend in the past several years. The graph below shows the total water production rates over the last five years.

Figure 16 - Total Annual Water Production



Operating costs: When compared to 2019, the total cost per ML for water production has increased by 6% (to $307, see Figure 17 below). Further, when compared to 2016, this normalized cost has increased by 8.7% and remains less than the rate of inflation over the last five-year period.

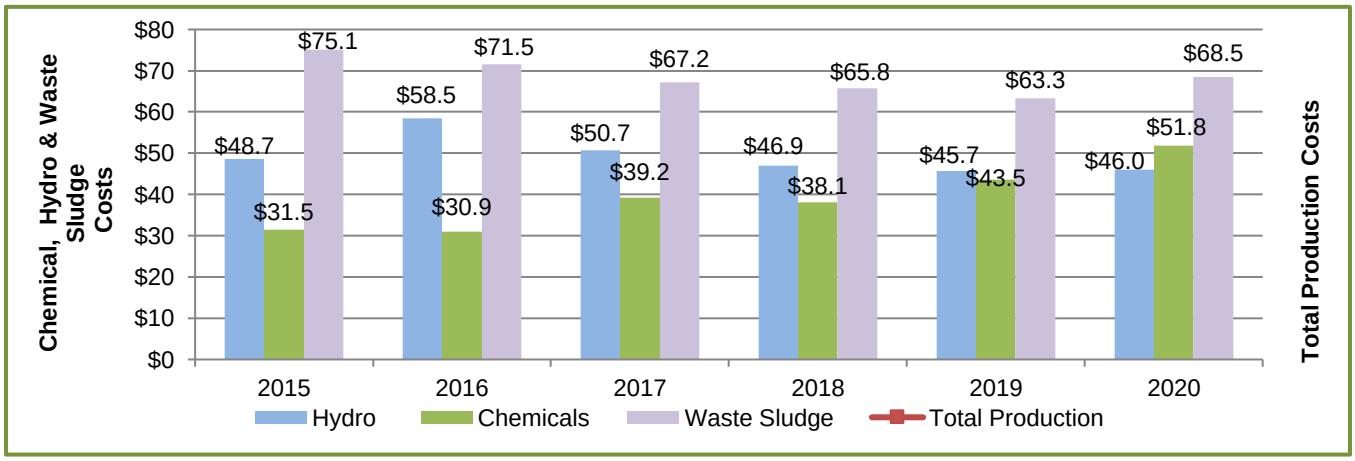
In 2020, the cost of electrical energy per ML of water production remined the same when compared to 2019, and can generally be attributed to ongoing savings through the utilization of the City's Fleet Street Pumping Station. The total cost of electrical energy necessary to treat and distribute drinking water, from the City's Central supply system increased by approximately 1.4% when compared to 2019, while treated water production volumes increased by 1%.

The cost of chemicals per ML of water production increased significantly in 2020. While all water treatment chemicals are acquired through bulk tenders, the total cost of chemicals required to treat the water increased by 19.8%, when compared to 2019. The majority of this cost increase can be attributed to tendered unit price increases for alum

(3%), caustic (12.7%) and hypo (1.1%), and Ammonia (18.2%). In addition, the cost increase is also attributed to a 1% increase in treated water production.

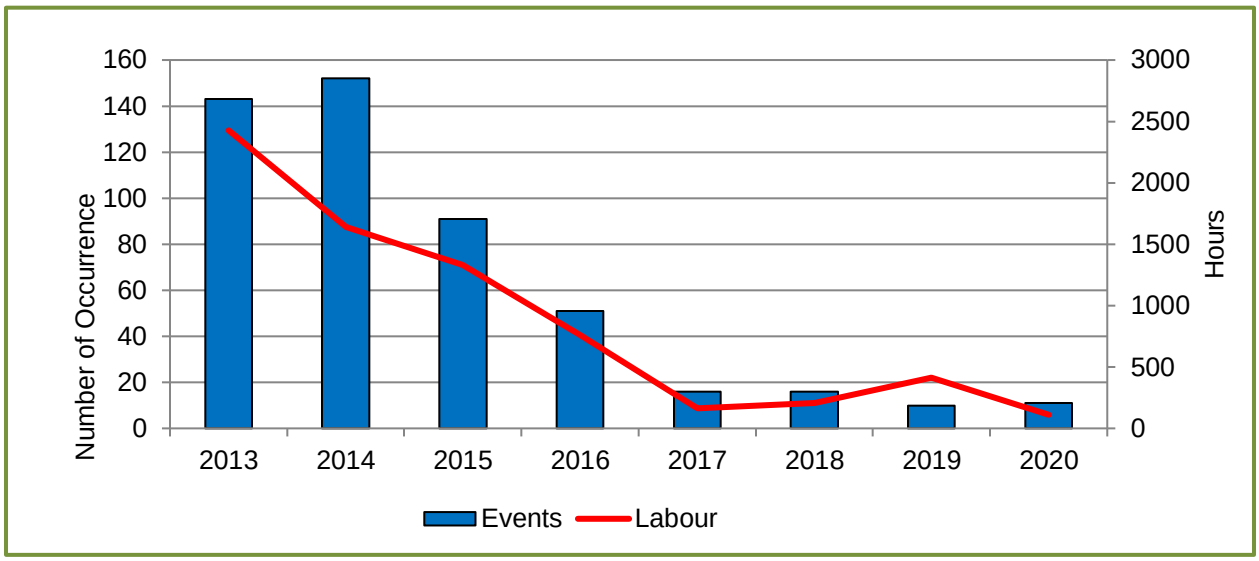
In 2020, the cost per ML, for the treatment of process waste sludge (or treatment residuals) increased by 7.9%, when compared to 2019. This cost includes both a volumetric charge, as well as a solids charge and this increase is attributed to additional settled water duct maintenance and draining of settled water conduits for inspection.

Figure 17 - Annual Production Costs (costs/ML of water produced at WPPs and Remote Pumping Stations)



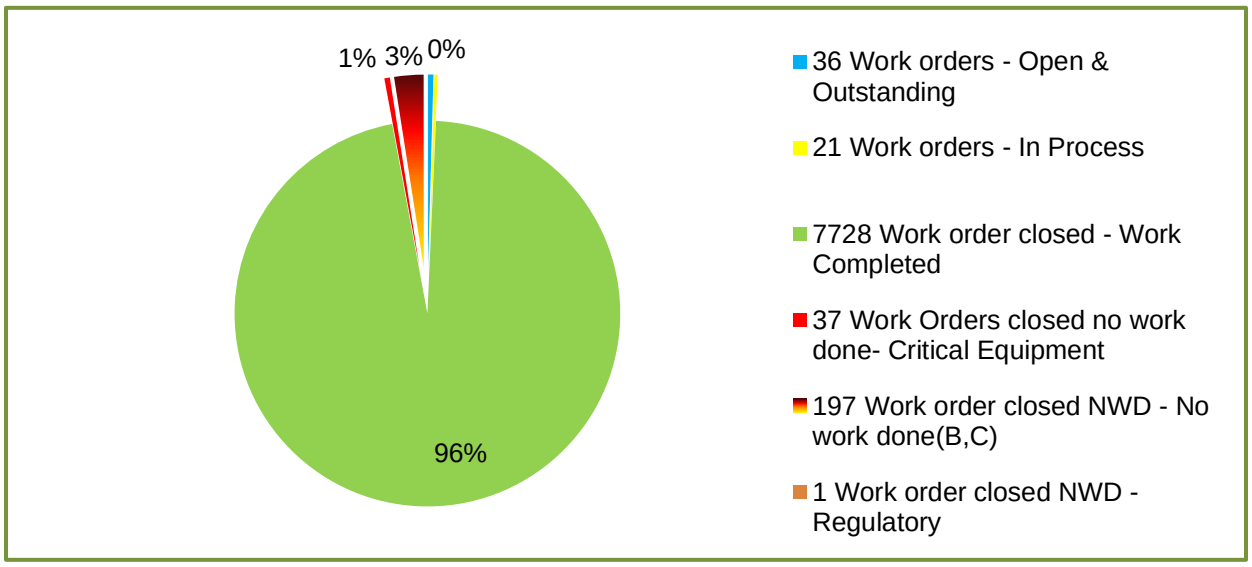
Maintenance Programs: As recommended in the 2016 Management Review report, additional KPIs have been included in this year's report to provide a brief overview of the maintenance activities for Water Production, including breakdown emergencies and preventive maintenance program completion.

Figure 18 - Breakdown Emergency Occurrences and associated Labour Hours



From the above figure, the number of breakdown emergencies, as well as the total amount of labour hours resulting from the repair of emergency breakdowns has been stable and well managed for the past 5 years. The trend from 2013 is attributed to a sustained increase in the completion of the planned preventative maintenance program, as well as continued efforts to improve the definition and coding of breakdown emergencies.

Figure 19 - Preventive Maintenance Program Completion for 2020



The above figure demonstrates that the completion of the planned preventive maintenance program remains a key priority, for Water Production's maintenance teams. The following initiatives, beginning in 2016, have contributed to a positive trend in the completion of preventive maintenance:

- Communication of an established guideline promoting a consistent approach to assigning priorities
- Reviewing of the priority 1 or 2 notifications in weekly meetings
- Increase of maintenance planning activities with more maintenance planners

The overall preventive maintenance completion ratio has been 95% or above since 2018, contributing to better equipment reliability.

Water Quality KPIs

Water quality and operating staff conduct more than 100,000 tests per year to ensure the safety of Ottawa's drinking water supply. As a composite measure, two water quality index scores have been developed covering both the microbial and chemical quality of Ottawa's drinking water. The index values for 2016 – 2020 are summarized in the table below.

Table 14 - Water Quality Health Index (WQHI) KPIs

KPI	Target	2016	2017	2018	2019	2020
Water Quality Health Index – **Microbial:** Percent treated water that met pathogen removal targets	**100**	100	100	100	100	100
Water Quality Health Index – **Chemical:** 0 – 100 index score	**100**	100	100	100	100	100

Water Quality Health Index – Microbial: the index is a score from 0 to 100 that indicates the percentage of treated water produced that met all pathogen removal targets. The index is based on a calculation of pathogen removal performance for 5 reference pathogens used in the Health Canada Quantitative Microbial Risk Assessment (QMRA) model. The index applies to the central water supply (Britannia and Lemieux) as well as

the 6 municipal well systems. A value of 100% indicates that treated water met all pathogen removal targets. For the two surface WPPs (Britannia and Lemieux), this would include log-inactivation/removal rates for 5 reference pathogens: *Cryptosporidium, Giardia, Virus, Campylobacter, E.coli O157*.

For the municipal well systems, pathogen reduction targets (internal) are based on 5-log inactivation of virus for the (5) non-GUDI well systems: Carp, Richmond West, Kings Park, Munster, and Vars. These disinfection targets are beyond the minimum requirement of 2-log virus inactivation as per the MECP Procedure for Disinfection and 4-log for Richmond West but are based on actual virus concentrations measured in the source wells. Furthermore, the 5-log virus target better aligns with the newly revised MECP directive of minimum 4-log virus inactivation in secure non-GUDI groundwater sources and Health Canada's guidance on virus inactivation. For the Shadow Ridge Well System, an overall removal/inactivation target of 5-log virus and 3.0-log *Giardia* is used as a benchmark since the source wells are considered GUDI (groundwater under the direct influence of surface water).

If a score below 100% is noted, it means that the treated water directed to the distribution system had the potential for presence of pathogenic organisms and would likely have resulted in a drinking water advisory through consultation with Ottawa Public Health. A score of 100% indicates that the treated drinking water met pathogen removal targets at all times during the year.

During 2020, a pathogen challenge test was conducted for the Shadow Ridge membrane filtration system, to validate the treatment requirement of 2.0-$\log_{10}$ (99%) and 2.5-$\log_{10}$ (99.7%) removal of protozoan cysts *Cryptosporidium* & *Giardia* respectively. Field trials were conducted by Water Quality and Water Production staff on July 24th, 2020 using 6-micron polystyrene microspheres as surrogate particles for the protozoa. Performance samples were shipped to the EPCOR laboratory (Edmonton AB) for analysis by microscopy. The results indicate that the 1-micron filter cartridges achieved >5.9-log10 removal in both treatment trains. This finding validates that the current membrane filtration system meets the minimum treatment requirements as stated in the MDWL license. A copy of the technical report was sent to the MECP for their records.

During 2020, a WQHI-Microbial score of 100% was achieved for all 8 drinking water systems.

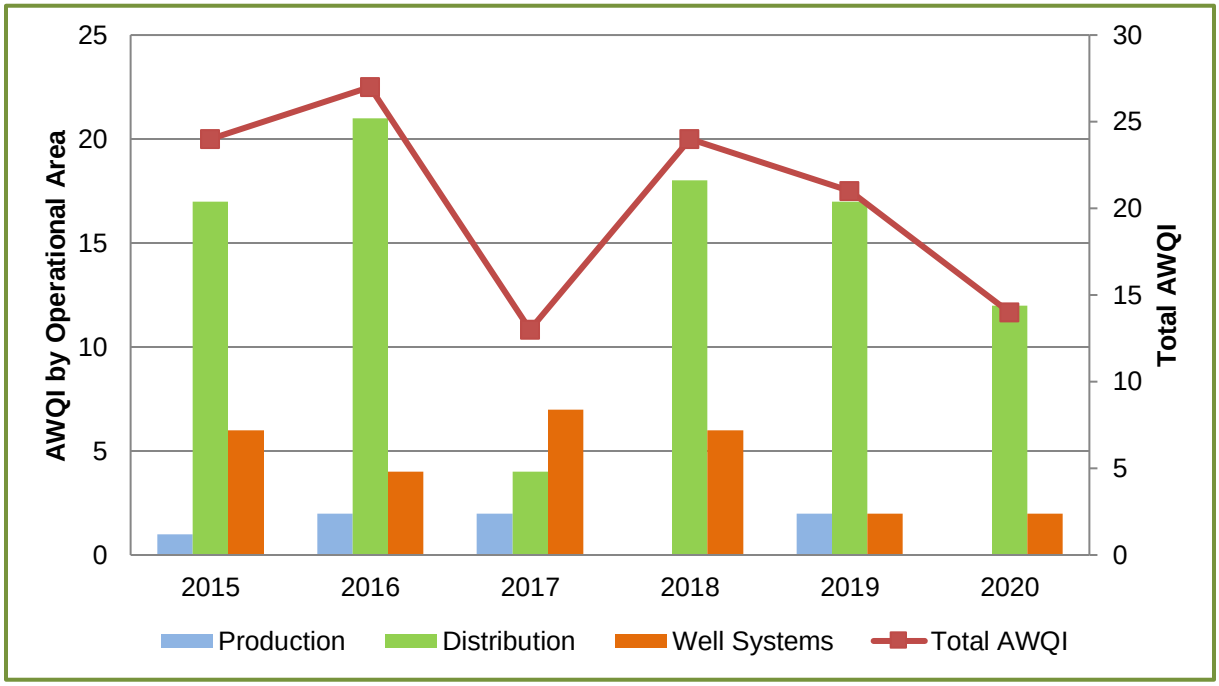
Water Quality Health Index – Chemical: This index is based on the number of water quality test results during the year that exceeded a health-based standard (Ontario Drinking Water Standards O. Reg 169/03). There are currently 67 chemical substances for which a health-based MAC (Maximum Acceptable Concentration) has been established in Ontario. The index ranges from 0 to 100 and is a composite value that reflects the frequency, scope, and amplitude of any MAC exceedances observed during the year. A score of 100 for the Chemical WQHI would indicate that all test results were below drinking water MAC values during the year. This measure is applied to the central water supply and the 6 municipal well systems.

During 2020, a WQHI-Chemical score of 100 was achieved for all 8 drinking water systems.

Number of Adverse Water Quality Incidents (AWQIs)

The trend for the number of AWQIs is shown on the graph below for reference, by operational area.

Figure 20 - Number of AWQIs by operational area (2015 to 2020)



It can be seen from the graph that the year-to-year trend for number of AWQIs has been fairly steady during 2015 – 2020 except for a sharp decrease in 2017 and again in 2020. Specific causes and trends for AWQIs are discussed previously in Section b) incidents of adverse drinking water tests of the report.

Drinking Water Advisories

During 2020, there were four Drinking Water Advisory (DWA) events as described in the table below:

Table 15 – Summary table of DWA events during 2020

Date	System	Description	~ # of households	~ # of people affected	duration of DWA (days)	~ # of person days
Feb. 20/20	Central	*Erie Ave:* Category 3 watermain break involving a broken sewer	15	42	2	84
Apr. 16/20	Central	*Richmond Road*: Broken watermain down for extended amount of time	1	3	3	9
Oct. 30/20	Central	*Smoketree Cres*: Backflow event from an irrigation system	60	168	1	168
Nov. 23/20	Central	*Fifth Ave*: Service pipe installed with improper disinfection	Office complex	10	2	20

Erie Ave watermain break (February 20th, 2020) - this event occurred as result of a broken sewer pipe that was observed in the excavation during a watermain break repair on Simpson Road. Since this represented a Category 3 main break, Ottawa Public Health issued a precautionary boil water advisory for the localized portion of the distribution system that was isolated for the watermain repair. The advisory affected approximately 15 households and was lifted after three days once two sets of clear bacteriological samples were obtained.

797 Richmond Rd (April 16th, 2020) – A broken watermain on Richmond Rd at Cleary was isolated and depressurized for over 24 hours before it could be repaired, affecting

the water supply to a dental office. A precautionary Boil Water Advisory was issued until clear bacteriological test results were obtained.

Smoketree Crescent (October 30th, 2020) – this event was a result of an irrigation system that was being "blown out" for winter at a private residence and improper valving inside the home caused air to be pushed into the central system. A precautionary Boil Water Advisory was issued for approximately 60 homes. The advisory was lifted after 1 day after the system was flushed and clear bacteriological test results were obtained.

Fifth Avenue (November 23rd, 2020) – a portion of pipe to be installed on the water service line to a commercial building was left unattended overnight and was not re-disinfected before installation as required by regulation. A precautionary Boil Water Advisory was issued for the building which contained two restaurants, a bakery and a dental office. The advisory was lifted after two days, once clear bacteriological test results were received.

In each case, as soon as clear water quality test results were obtained, the advisories were lifted and residents were directly notified. It is important to note that all advisories were issued on a precautionary basis and there was no evidence of contamination in the water supply.

The following table lists the number of Drinking Water Advisories issued over the last five years as well as the impact in terms of "person-days" (number of persons affected times the number of days the advisory was in effect).

The following table lists the number of Drinking Water Advisories issued over the last five years as well as the impact in terms of "person-days" (number of persons affected times the number of days the advisory was in effect).

Table 16 - Drinking Water Advisories and impact in person-days

KPI	2016	2017	2018	2019	2020
Number of Drinking Water Advisories	6	1	1	2	4
Number of Person Days Impacted	12,002	100	150	454	281

No Action Items were identified as part of the Management Review Meetings.

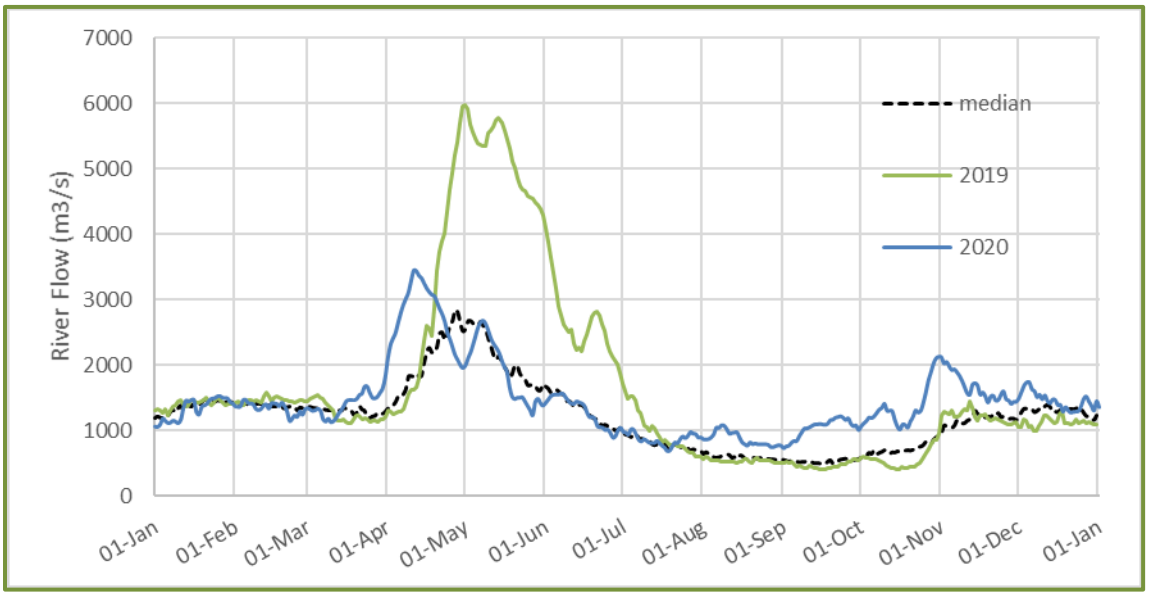
h) Raw water supply and drinking water quality trends

Britannia and Lemieux WPPs

General: During 2020, there were no chemical or radiological substances detected that exceeded Ontario Drinking Water Standards (ODWS) or Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ). With regard to raw water microbiological quality, pathogen levels were similar to previous years and were easily handled by the treatment barriers at both water purification plants.

Flows, levels, and physical characteristics: Ottawa River flow rates and levels were typical of long-term average values. The graph shows the 2020 river flowrate compared to median values and a comparison with record setting 2019 spring flows. The average river flow rate was 1,444 (m^3/s) which is slightly above long-term average (1,217 m^3/s) but lower than the 1,720 (m^3/s) and 1,641 (m^3/s) averages during 2017 and 2019 respectively.

Figure 21 - Ottawa River flowrates (m3/s) during 2019/2020 in comparison to long-term median flow (1960 – 2020)

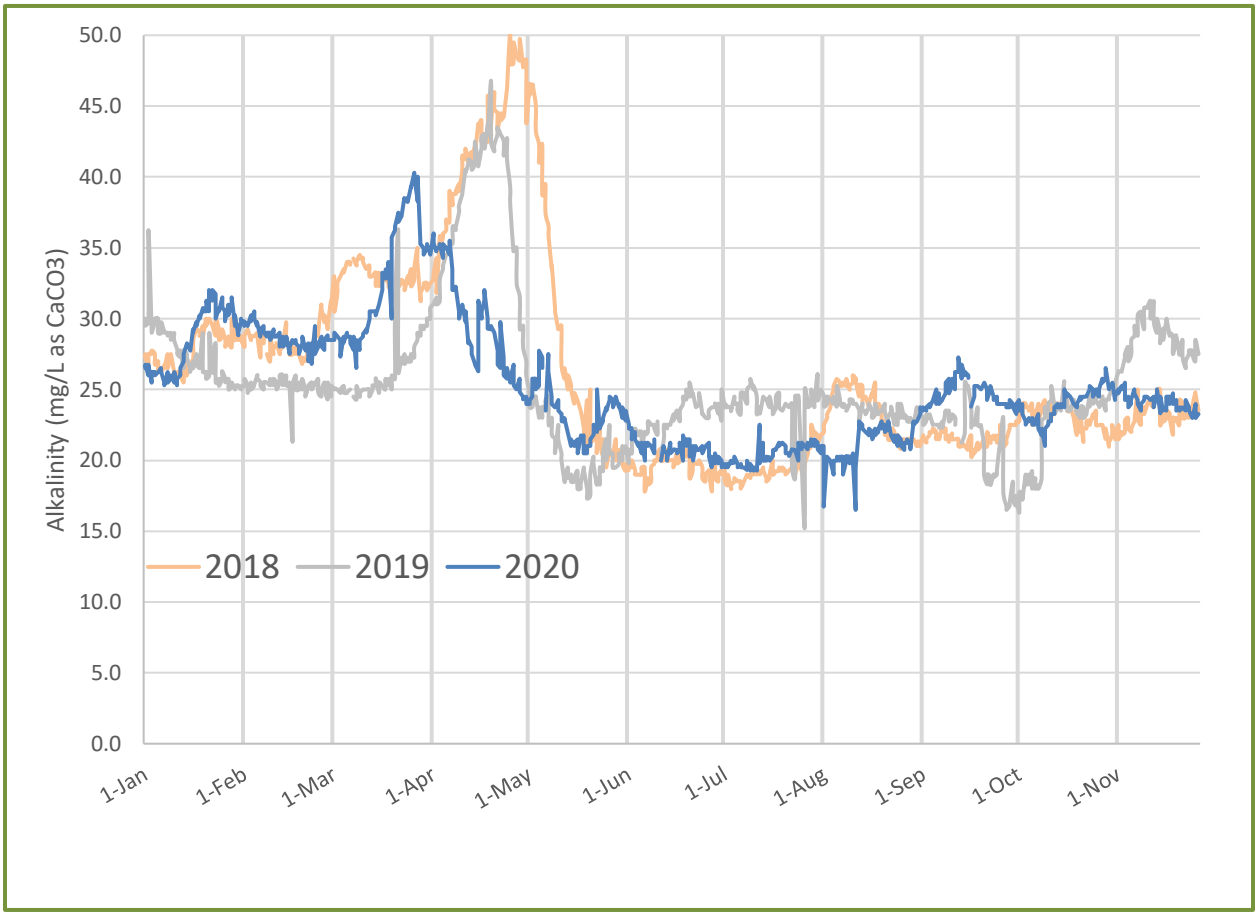


The minimum daily flow rate of 692 m^3/s (July 17th) was greater than the typical 300 – 400 m^3/s observed in previous years, mainly due to elevated amounts of precipitation in the last four months which typically have lower flow rates. The river quantity was more than sufficient to meet water demand. For example, even during the minimum flow

condition, Ottawa's average daily water demand (287.8 ML/d) represented only 0.5 % of the total river flow.

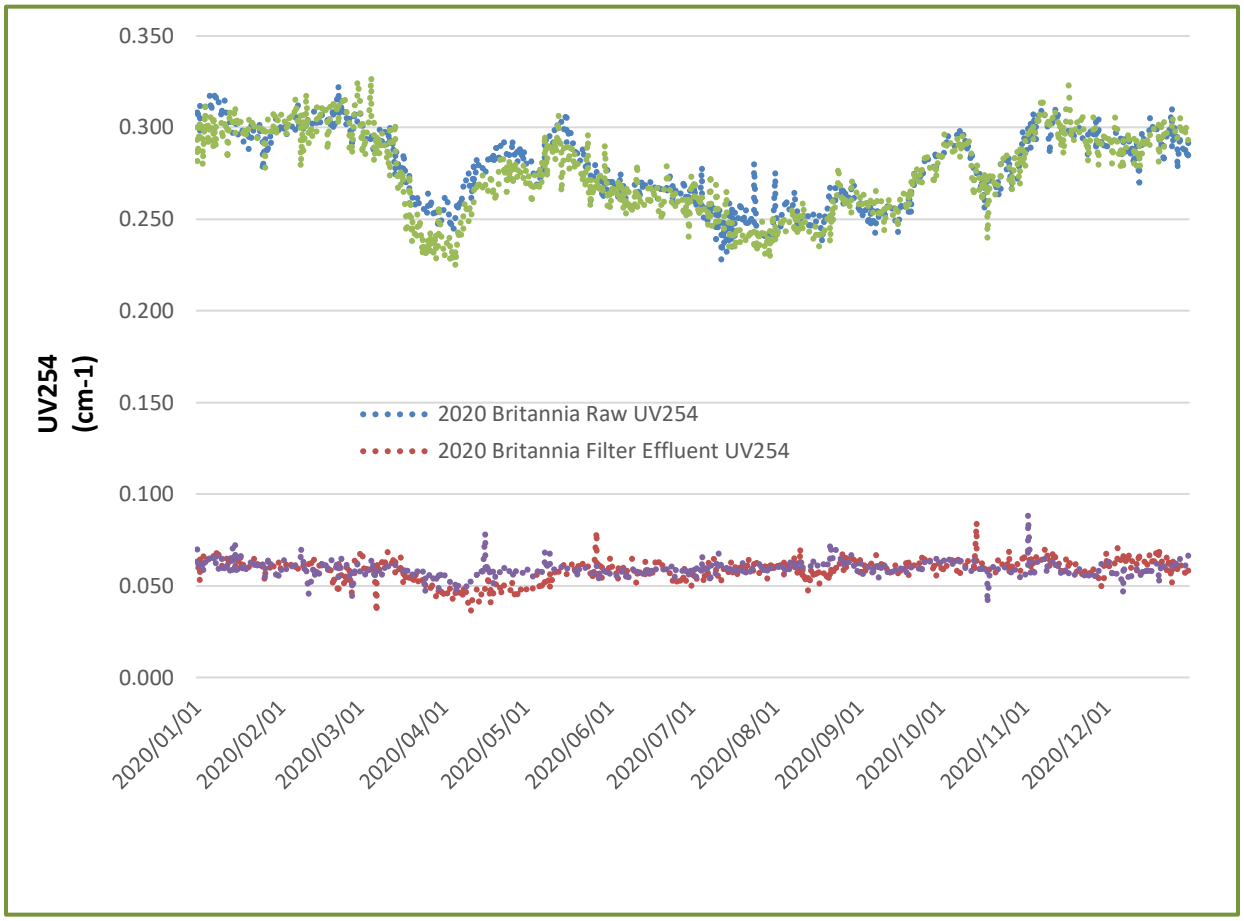
Raw water turbidity levels reached 16.9 NTU at Britannia and 20.2 NTU at Lemieux, which is somewhat lower than typical during the spring run-off period (typical 30 – 40 NTU). The WPPs also experienced lower levels of alkalinity during 2020 spring run-off, compared to the previous two years, although the average raw water alkalinity was 25.5 mg/L which is comparable to previous years (26.5 mg/L for 2018 & 26.8 mg/L for 2019). The graph below shows the alkalinity trend comparison.

Figure 22 - Raw water Total Alkalinity trend for 2018, 2019 & 2020



In terms of dissolved organic content, the source water UV254 values were similar to previous years and did not show the sustained level that was observed during the wet weather conditions during summer 2017. The filter effluent UV254 levels were consistent through the year indicating optimal coagulation during 2020.

Figure 23 - Raw water and filter effluent UV254 absorbance values for 2020 at both treatment plants



Microbiological**:** *Cryptosporidium/Giardia*: pathogen concentrations of protozoa are tested in the raw water at Britannia and Lemieux during the winter months (November to April). During 2020, *Giardia* cysts were present in a total of 2 out of 8 samples of raw water with a peak concentration of 44 cysts/100L. *Cryptosporidium* oocysts were not detected in any of the 8 samples collected. These pathogen levels were slightly lower than previous years, and laboratory QA/QC measures are being investigated. However, these levels are consistent with the 4-log *Giardia* treatment requirement for Britannia and Lemieux plants specified in the MDWL.

Total Coliforms / E.coli: Raw water bacteria levels were similar to previous years in both Britannia and Lemieux raw intakes. E.coli levels reached just over 100 (cfu/100mL) during summer months with Lemieux showing higher levels during early summer due to seagull nesting upstream of the intake. Overall, the source water microbial levels

observed during 2020 did not pose a threat or challenge for the water treatment process.

Figure 24 - Britannia and Lemieux Raw Water - Total Coliform levels 2020

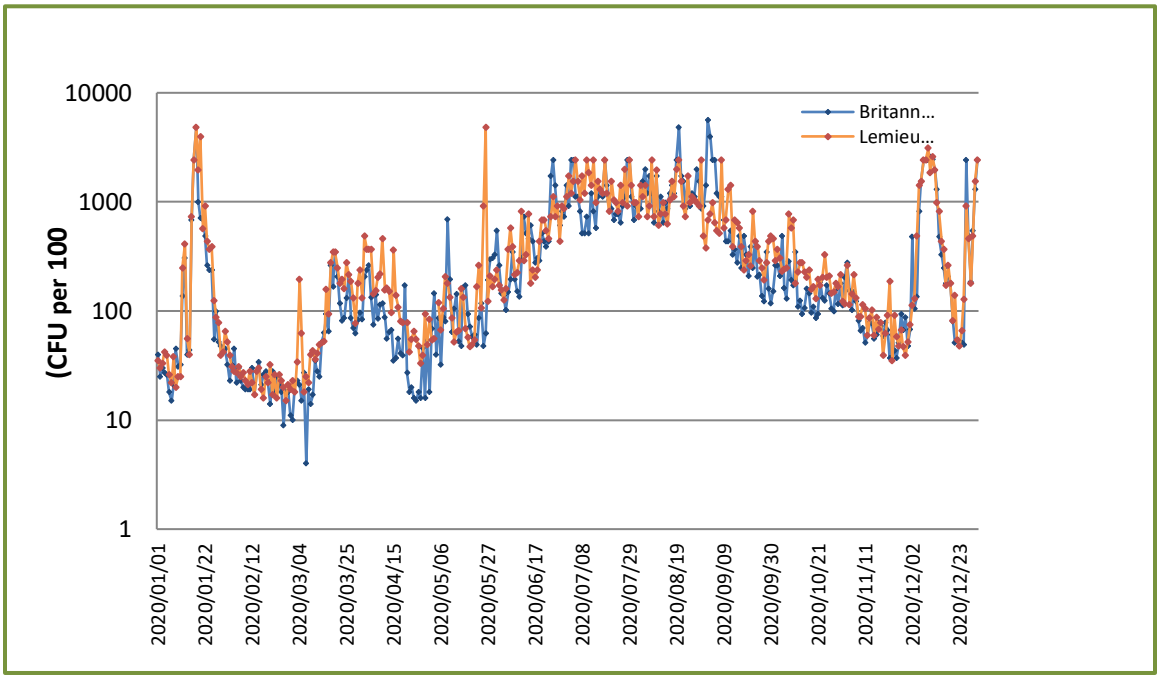
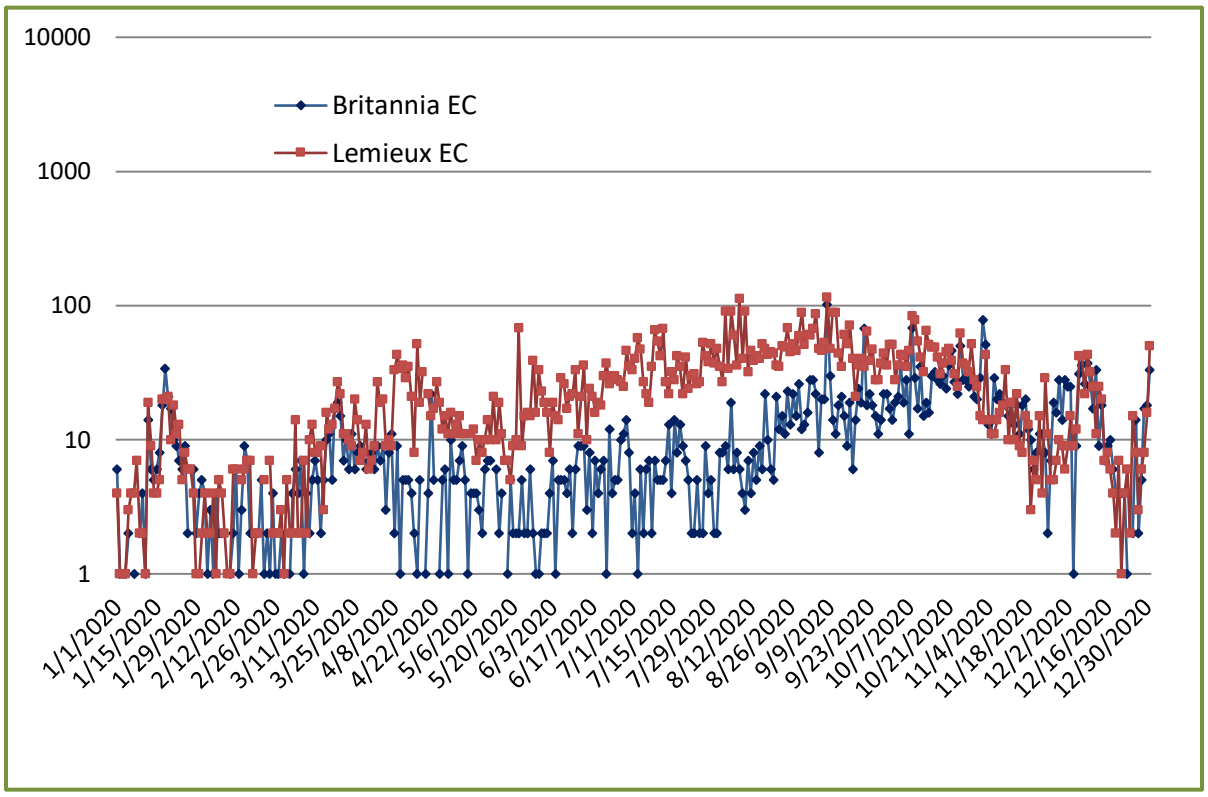


Figure 25 - Britannia and Lemieux Raw Water – *E.coli* levels during 2020



Chemical: Test results for inorganic and trace organic parameters showed normal values that were well within drinking water standards and guidelines. There were no MAC exceedances observed during 2020, except for occasional sodium levels that exceeded the health advisory concentration of 20 mg/L. The average sodium concentration was 18.2 mg/L. There were no significant taste/odour events during 2020.

Radiological: With increasing awareness of the Chalk River Laboratories and the proposed Near Surface Disposal Facility, daily/weekly radiological monitoring continued for gross alpha, gross beta, and tritium. Since tritium is considered the most likely and relevant radionuclide for our treatment plants and public concern, a new low-level tritium method (<1.1 Bq/L) was used at the Andre E. Lalonde AMS Laboratory. Tritium levels were found to be consistent in the 1.6 – 3.0 Bq/L range with 2020 average values of 2.4 Bq/L (Britannia) and 2.3 Bq/L (Lemieux). The DW guideline for tritium is 7000 Bq/L.

Pharmaceuticals: Testing is conducted quarterly for 45 trace pharmaceutical substances. Similar substances were observed as in previous years, with 6 substances detected in at least one sample of raw or treated water. The drug metformin (anti-

diabetic drug) continued to be the most persistent compound detected at an average concentration of 19.8 ng/L (ppt - parts per trillion) in treated water. The maximum concentrations of pharmaceutical compounds observed in treated water were as follows: *metformin 27.1 ng/L, 17b-Estradiol 14.9 ng/L, 17a-Estradiol 7.7 ng/L, acetaminophen 4.7 ng/L, carbamazepine 0.4 ng/L and diphenhydramine 0.3 ng/L.* These results were similar to previous years, and do not indicate any significant change in water quality. These substances continue to be unregulated in drinking water.

Perfluorinated alkyl substances (PFAS): The presence of perfluorinated alkyl substances have become an increasing for the environment and human health. These substances are stable and persistent organic compounds that are widely used in industry and consumer products: Teflon, furniture fabric, and firefighting foams. Health Canada recently established guidelines for (2) PFAS substances: PFOS with a MAC of 600 ng/L and PFOA with a MAC of 200 ng/L. Other jurisdictions have established more stringent MAC values in the range of 70 ng/L (US EPA). Treated water samples are collected annually from all eight municipal water systems and sent to AXYS Laboratory (British Columbia) for analysis of 33 PFAS substances. The only significant occurrence of PFAS substances was found in the Carp Well System for which 12 PFAS substances were detected, totaling 60.6 ng/L which is within the current drinking water standards. In 2020, the raw well water was also tested, with Well #2, the duty well, found to be the prime source of PFAS substances for Carp. The source of these PFAS compounds is not known but is possibly related to a previous fire station located on land adjacent to the well system. Fortunately, the Carp treatment system is scheduled to commission a GAC (Granular Activated Carbon) filter system for taste/odour removal, which will effectively remove all PFAS substances as a best available technology. The GAC system is expected to be commissioned in 2021.

Carp, Kings Park, Munster, Shadow Ridge, Richmond West and Vars Well Systems

The source wells for the Carp, Kings Park, Richmond West, Munster, and Vars water supplies are considered to be secure groundwater. For the Shadow Ridge system, the source wells are deemed to be GUDI wells (groundwater under the direct influence of surface water), since a formal GUDI study was not conducted. Therefore, treatment requirements applicable to a GUDI source have been designed and implemented for Shadow Ridge.

Total coliform / E.coli testing in raw water: in each system, “raw” wells are sampled and tested for the presence of bacteria twice per week. During 2020, there were 9 raw water samples that were positive for the presence of Total Coliform bacteria, 5 at Carp (Well #1), 1 at Vars (Well #2) and 3 sample at Richmond West (Well#1). *E. coli* bacteria were not detected in any of the samples. These low occurrence rates are not of concern and may be related to biological growth on the sample pipe surface rather than in the bulk water of the source well. The table below summarizes the raw water bacti. results obtained during 2020.

Table 17 - Raw water bacteriological test results at well systems during 2020

Location	# of positive Total Coliform results	# of positive *E.coli* results	Total number of samples
Carp: Well #1 and #2	5	0	208
Kings Park: Well #1 and #2	0	0	149
Munster: Well #1 and #2	0	0	208
Shadow Ridge: Well #1 and #2	0	0	210
Vars: Well #1 and #2	1	0	208
Richmond West #1 and #2	3	0	200

The table below provides a longer-term trend of weekly raw water bacteriological test results for each municipal source well during the period 2006 – 2020. Carp #1 Well, Munster #2 Well, and Vars #2 Well have historically been the most notable in terms of positive Total Coliform results. *E. coli* has never been detected in any of the source wells in over 25 years of monitoring.

Table 18 - Number of positive total coliform tests in raw source wells 2006 – 2020

	Carp		Richmond West		Kings Park		Munster		Shadow Ridge		Vars	
	Well #1	Well #2	Well #1	Well #2	Well #1	Well #2	Well #1	Well #2	Well #1	Well #2	Well #1	Well #2
2006	2	0			0	0	0	0			0	0

	Carp		Richmond West		Kings Park		Munster		Shadow Ridge		Vars	
2007	3	0			0	0	0	0			0	1
2008	1	0			0	0	0	0	0	0	0	0
2009	1	0			0	0	0	0	0	0	1	19
2010	1	0			0	0	2	2	4	0	0	21
2011	0	0			1	0	0	0	2	0	0	2
2012	0	0			0	0	0	0	0	1	0	0
2013	3	0			0	0	0	0	0	0	0	0
2014	8	0			0	0	1	10	0	0	1	0
2015	0	0			0	0	0	1	0	0	0	1
2016	2	1			0	0	0	2	0	0	0	0
2017	0	0			0	0	1	0	1	0	0	0
2018	0	0			0	0	2	0	0	2	0	0
2019	8	1	0	0	0	1	1	0	0	0	0	0
2020	5	0	3	0	0	0	0	0	0	0	0	1
Total:	**34**	**2**	**3**	**0**	**1**	**1**	**7**	**15**	**7**	**3**	**2**	**45**

Chemical characteristics: Test results for trace organic and inorganic parameters showed normal values that were well within drinking water guidelines. During 2020, there were no MAC exceedances with the exception of sodium, which is above the health advisory concentration of 20 mg/L in all five well systems. Sodium occurs naturally in groundwater wells.

The nitrate concentrations in the Shadow Ridge well system continue to be high, compared to water quality in the other well systems. Nitrate concentrations in the source wells have shown a gradual but steady increase from approximately 1.5 mg/L in 2008 to levels in the range of 3.5 – 4.6 mg/L during 2018 but have leveled off in 2019 and 2020. The treated water nitrate concentration averaged 3.18 mg/L during 2020, which is within the Ontario Drinking Water Standard of 10 mg/L as a Maximum Allowable Concentration.

Table 19 - Shadow Ridge annual average nitrate concentrations

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Well#1	2.24	2.55	2.68	3.11	3.56	3.57	3.41	3.54	3.25	2.94
Well#2	2.86	3.03	3.20	3.95	4.38	4.60	4.50	4.64	3.77	3.47
Treated	**2.67**	**2.80**	**3.11**	**3.83**	**4.01**	**4.47**	**4.45**	**4.30**	**3.41**	**3.18**

As shown on the graphs, the trend for nitrate has gradually increased by approximately 0.30 – 0.40 mg/L every year but levelled off during 2017/2018 and is slightly lower in 2019/2020. The graphs below provide a long-term trend of nitrate levels in the Shadow Ridge individual wells and treated water.

In order to provide a long-term solution for the nitrate issue, the City is working on a project to drill new well sources located deeper into the aquifer. Geofirma and the City are working on testing in 2020/2021 to review the quality of the water from the deeper aquifer to confirm the location and the suitability for the new source water to supply Shadow Ridge. The City is hoping to drill the new source wells in 2021.

Figure 26 - Nitrate concentration (mg/L as N) in Well #1 and #2 at Shadow Ridge (2008 – Feb 2021)

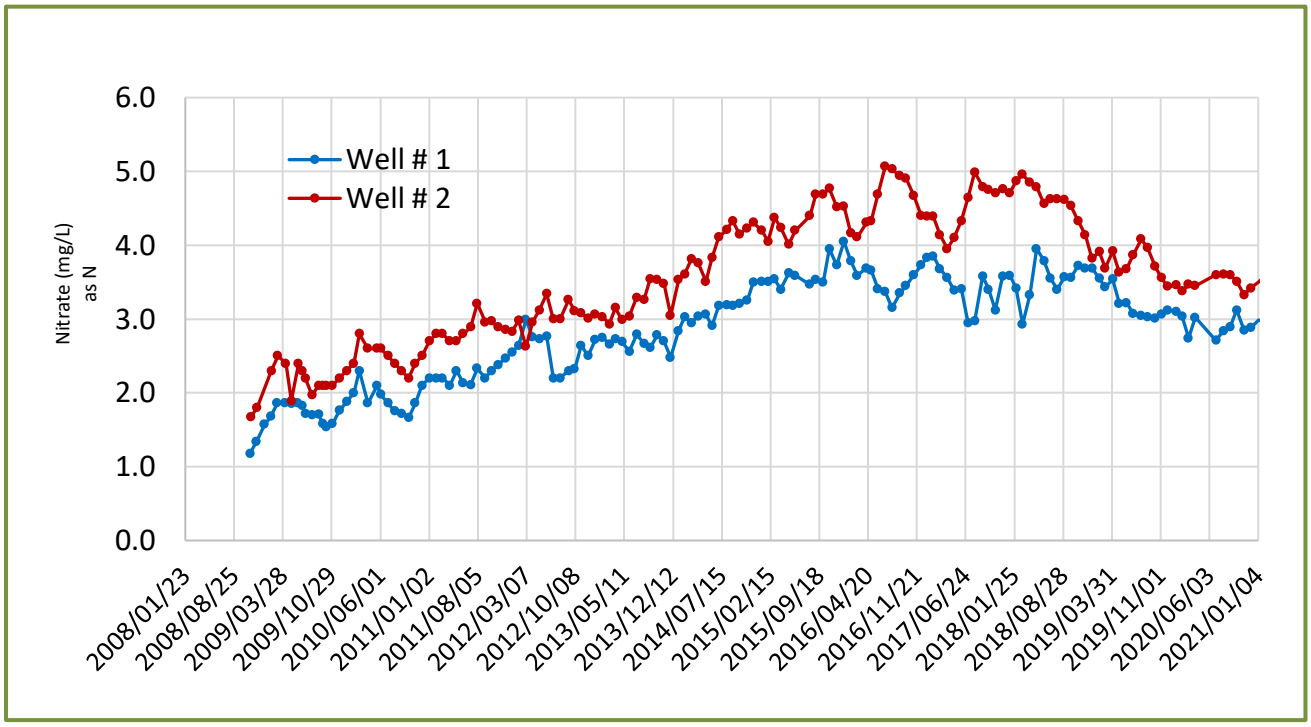
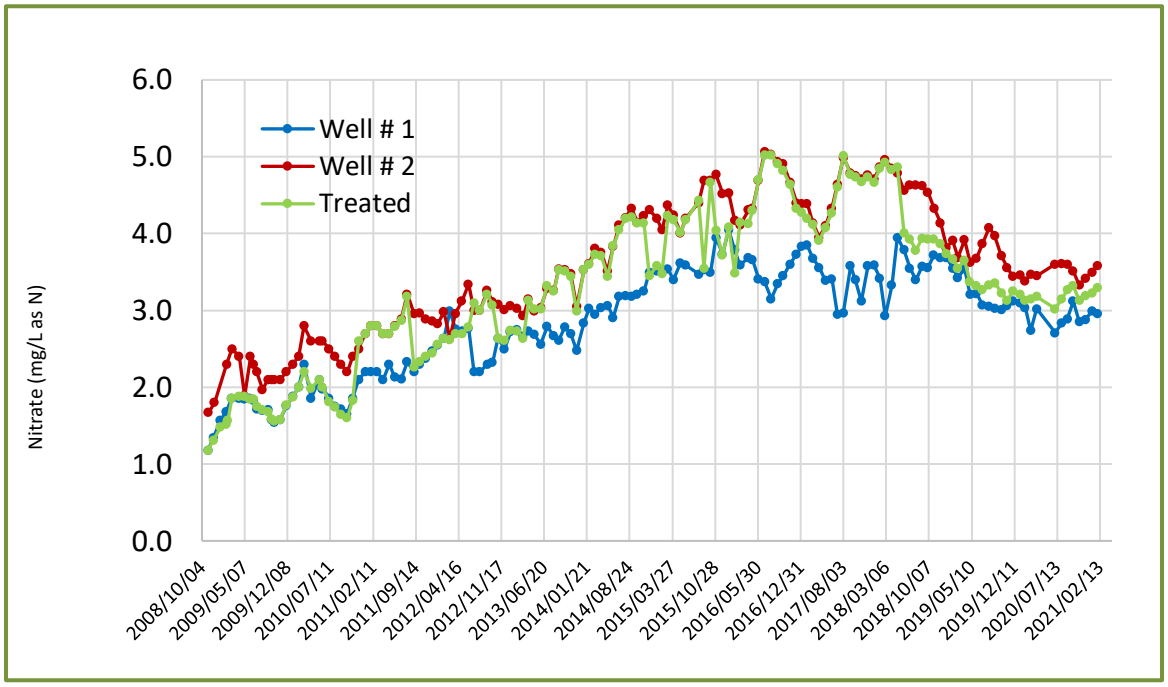


Figure 27 - Nitrate level in Shadow Ridge treated water and source wells (2008 – 2021)



Radiological *characteristics*: treated water samples from each well system are normally tested quarterly for gross-alpha and gross-beta radioactivity. In 2020, due to COVID-19, this testing was only conducted in the first quarter, with quarterly sampling resuming as normal in 2021. In the first quarter testing of 2020, all results were within the screening values for **gross-alpha** (0.5 Bq/L) and **gross-beta** (1.0 Bq/L) and tritium was also tested in the first quarter of 2020, using a new low-level tritium method at the Andre E. Lalonde AMS Laboratory in Ottawa (detection limit <1.1 Bq/L). Using this "low-level" analytical method provided a more detailed picture of the tritium levels in the City of Ottawa communal wells. Tritium was non detect (<1.1 Bq/L) in all the wells systems except Shadow Ridge (1.3 Bq/L) and Kings Park #2 (1.1 Bq/L) which were just above the detection limit.

***Volatile Organic Compound (VOC) testing*:** approximately 60 volatile organic compounds are tested annually in each of the source wells and treated water. All of the test results were non-detect during 2020, except NDMA (N-nitrosodimethyl amine) was detected at least once in 3 of the 6 well systems (Munster, Shadow Ridge and Vars). The max NDMA concentrations observed were only slightly above the detection limit in the range of 0.001 ppb, which is well within the Ontario Drinking Water Standard of

0.009 ppb for NDMA. This compound is typically detected as a disinfection by-product resulting from ammonia/chlorine reactions during the treatment process.

COVID19 Impacts on water quality monitoring

Water sampling and testing activities were modified during 2020 in order to better protect staff and Ottawa residents. Routine sampling sites were shifted to water facility locations without public access or person-to-person contact. All in-home water quality testing activities were suspended on March 16th, 2020. Modified procedures were adopted to test water quality without entering the resident's home. In this way, a total of 682 customer inquiries and complaints were handled during the year, including 460 residences tested for lead concentrations in their tap water.

Due to the suspension of in-home testing protocols, the City of Ottawa applied for and received regulatory relief for the winter and summer sessions of lead sampling in the Richmond West well system (Dec 15, 2019 – Apr 15, 2020 and Jun 15 – Oct 15, 2020). Similarly, regulatory relief was granted for the summer session of lead testing in the central distribution system.

Shadow Ridge pathogen challenge testing: The treatment process for the Shadow Ridge Well System includes membrane filtration to remove *Cryptosporidium* and *Giardia* cysts that could be present in a GUDI well source. The original certified membrane cartridges are no longer available as NSF-certified. Since an alternate filter cartridge is in use, a pathogen challenge testing was conducting during July 2020 to verify the removal performance for these organisms. Microsphere test particles were introduced as a surrogate for *Cryptosporidium* and *Giardia* during two experiments. The overall log-removal was found to be >5.9-log (99.9999% removal) which easily meets the treatment requirement of 2.5-log (99.7%) stated in the MDWL. The findings were documented in a technical report (I.Douglas) which was sent to the MECP for their records.

Summary

Overall, the test results indicate that safe drinking water quality was maintained throughout 2020. Due to the COVID19 pandemic, the water quality testing program was modified slightly in order to protect staff and Ottawa residents. Customer in-home testing was suspended on March 16th, 2020 and modified procedures were developed to safely sample for lead in older homes. During 2020, a total of 460 homes were tested for lead using the modified procedure. Based on the review, there are no outstanding

concerns with source or treated water quality trends or emerging contaminants, with the exception of the ongoing nitrate issue in the Shadow Ridge Well System. To address this problem, the City is actively working on a project to drill new source wells for the Shadow Ridge water system.

No Action Items were identified as part of the Management Review Meetings.

i) Follow-up Action Items from Previous Management Review

Between 2009 and 2020, a total of 147 action items have been generated from the Management Review Process. A total of 5 Management Review action items were closed during 2020, with 10 Management Review action items remaining In Progress at the end of the year. The table below illustrates the action items developed through the annual Management Review process from previous years that remain *In Progress*:

Table 20 - Action Items from Previous Management Review that Remain *In Progress*

Mgt Review Report Year	#	Action Required	Priority	Owner (Services)	Target Date for Completion
2012	252	Update the Incident and Escalation Response Plan	2	TIES/WS	*Completed in January 2021*
2013	296/ 297	Establish a training framework for operators and trades staff that would identify training requirements within the 3-year cycle. *[combined as 1 action item given the similarity of the action items]*	2	BTSS	Rescheduled to 2021
2013	308	Develop and implement design standards for communal wells	2	TIES	Rescheduled to 2021
2017	600	Review the operating and control strategy for chemical systems at both WPPs with a focus on reliability and operability during plant shutdown and start-up events, in order to minimize risk of process upsets	2	Water Services	Rescheduled to 2021
2017	601	Bench and pilot testing to compare the performance of	2	Water Services	Rescheduled to 2021

Mgt Review Report Year	#	Action Required	Priority	Owner (Services)	Target Date for Completion
		activated silica to commercial polymers based on settling performance, maintenance, and cost			
2017	604	Prepare an operations guidance document for Operators to achieve optimal coagulation in water treatment	2	Water Services	Rescheduled to 2021
2017	605	Identify a governance structure for the Large Diameter Watermain Condition Assessment Program and ensure that the roles and responsibilities are clearly outlined for the accountability and performance of the program	2	TIES/PIED	Rescheduled to 2021
2017	607	Assess the impact of climate change on the drinking water infrastructure and identify projects and/or mitigation measures necessary to increase the infrastructure resiliency while maintaining levels of service	2	TIES	Rescheduled to 2021

Mgt Review Report Year	#	Action Required	Priority	Owner (Services)	Target Date for Completion
2018	698	Investigate possible causes of and minimize future “false” positive E.coli test results. Including, the completion of (i) site visit to ROPEC laboratory to review procedures and potential routes of sample contamination, and (ii) a review of all routine sample sites including faucet disinfection procedures, reference photos, and plumbing modifications where needed	2	WS	Rescheduled to 2021
2019	772	Develop and implement a process for responding to a series of consecutive positive Total Coliform (TC) sample results at the well systems (i.e., notification, chlorination of well, etc.)	2	WS	2021

Of the 10 action items from past management reviews that remained *In Progress*, none were considered to be Priority 1. The 2019 Management Review resulted in 1 action item for implementation, which remains *In Progress*.

Continued efforts to address and complete these items are underway and tracked by the QMS Coordinator through regular meetings with the responsible delegates.

No Action Items were identified as part of the Management Review Meetings.

j) Status of Management Action Items Identified Between Reviews

Aside from the Management Review process, no additional management action items were identified in 2020.

No Action Items were identified as part of the Management Review Meetings.

k) Changes that Could Affect the QMS

COVID-19 Pandemic Impacts to Operations and the QMS

The City of Ottawa, including Water Services (Drinking Water), entered into a State of Emergency on March 25, 2020 for the COVID-19 Pandemic. Declaring a State of Emergency helped the City deploy its emergency operations and staff, enabled a flexible procurement process, as well as the redeployment of resources and staff to support essential services and adapt to a rapidly evolving situation, all while ensuring the continuity of drinking water operations and maintaining drinking water for the residents of Ottawa.

Response actions were primarily related to the protection of our essential workers that operate and maintain our drinking water systems. During 2020, there were no positive cases of COVID19 for the 282 staff that work in drinking water. A number of operational measures were implemented including: rotating maintenance crews, PPE, physical distancing, air/ventilation improvements, shift-change procedures, self-screening, disinfection of work surfaces, and staff isolation while awaiting test results. Some of these measures are further described below:

- Personnel deemed essential (Certified Drinking Water Operators, Trades staff, etc.) were scheduled to work on rotating shift basis and decreased personnel to minimize staff encounters. In addition, safety measures were implemented (i.e., PPE, COVID-19 screening, plastic dividers between workspaces, etc.) to eliminate or reduce the potential spread of COVID-19.
- Both treatment plants developed 5-stage levels of emergency response ranging from Level 1 (normal operation) to Level 5 (full lockdown, staff shelter in place) to respond to potential decreasing staff levels due to COVID.
- Improvements to heating and ventilation for shift operator control rooms to provide more fresh air and reduce risk of airborne viruses.
- Control room disinfection protocol and shift-change procedures that eliminated direct contact between operators.
- DWQMS audits (internal and external) were scheduled to be completed virtually after March 2020.
- Other DWQMS-related meetings, including this 2020 Management Review, risk assessment, quarterly DWQMS Updates with OTM, were completed virtually using MS Teams.

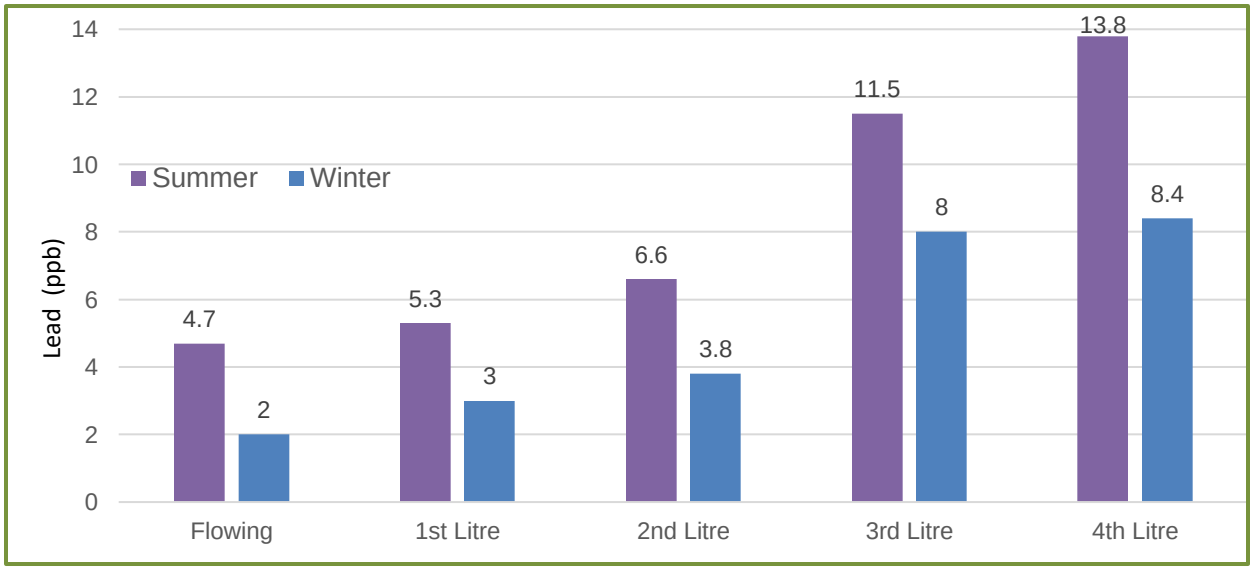
- DWQMS General Awareness Training was conducted virtually for each of the quarterly sessions in 2020. In addition, a session was recorded in September and the link made accessible for personnel unable to attend the scheduled live training sessions. A training attendance sheet was developed for tracking personnel who participated in the live or recorded training sessions.
- On the Job training events were completed virtually. In lieu of the semi-annual operator training sessions typically organized for Drinking Water Production, an itemized list of training presentations or videos was made available and a knowledge verification was created to ensure completion.
- A training room was set up at the WPPs with two HMI screens, one with control and one a mirror image of the screen in the control room. This space was designated as the training space for new Senior Operators.
- Water Operator Certificates that expired during the period between March 23, 2020 and October 31, 2020 were automatically given a 6-month extension as per the temporary emergency order issued by the MECP under the Emergency Management and Civil Protection Act.
- Temporary regulatory relief for reduced sampling of lead testing in customer homes due to suspension of in-home visits; Granted by MECP for central distribution and Richmond West.
- Modification of water quality sampling locations to minimize personal contact for field staff.
- Developed guidance document and slide presentation for flushing to restore drinking water quality in buildings that were vacated for extended periods; provided to OPH and Building Services.
- Assessment of risk of coronavirus as a waterborne pathogen, for communication with public and staff.
- Internal work, capital projects, development – increased notification period for residents to provide them with additional time to prepare for planned water service outages.
- Watermain repairs – where possible, provided residents with additional time to prepare for water service interruptions.

Lead in drinking water

Due to increasing concerns about health impacts from lead, Health Canada, on March 8th, 2019, published a new stringent guideline of 5 ppb for lead in drinking water, expressed as a Maximum Acceptable Concentration (MAC). The new guideline also included the provision of ALARA (as low as reasonably achievable), to encourage water providers to make every effort to minimize lead exposure beyond the MAC.

Ottawa has been using pH adjustment to minimize lead corrosion and leaching in homes with lead service pipes. The lead concentrations (90th percentile values) are shown below for the 2008 – 2020 testing period. The graph indicates that lead concentrations in Litre1 and Litre2 would exceed the 5 ppb standard if adopted in Ontario.

Figure 28 - Tap Water Lead Levels in Ottawa Homes with Lead Service Lines (90th Percentile Values)



Based on pilot experiments conducted in Ottawa, a low-dose phosphate treatment process has been selected to update the corrosion control strategy at both water treatment plants. The project is currently in design phase and expected to be commissioned in 2022/2023. In consideration of lead concentrations that are currently exceeding 5 ppb in some homes, **it is important that management keep close oversight of the phosphate design/construction project to ensure steady progress leading to timely implementation**. Tap water lead concentrations of 5 ppb still carry some health risk for children, and the project seeks to achieve lead concentrations <1

ppb for older homes with lead service pipes. In Ottawa, there are approximately 27,945 homes that have lead service lines currently in use.

During 2020, there were 83 older homes that had their lead service lines (LSL) replaced and are no longer supplied with lead service pipes. Of these, 57 were City + Private LSL replacements (through Lead Pipe Replacement Program (LPRP)) and 26 were Private only. In addition, there were 274 LSL replacements of lead service pipes through watermain rehabilitation during 2020, although this would still have the Private LSL still in place. Of these, 57 were full City + Private LSL replacements (through LPRP program) and 26 were for Private LSL replacements only. This means that a total of 83 homes were converted to non-LSL service during 2020. In addition, there were 274 replacements of lead service pipes through watermain rehabilitation during 2020, although the Private LSL portion remains for these homes. For context, there were an estimated 28,076 homes with City + Private LSL portions at the start of 2020. Since 83 homes were converted to non-LSL during 2020, there are an estimated 27,945 LSL homes remaining.

A spreadsheet maintained by Water Quality is used to track the number of LSL homes in order to evaluate the potential lead exposure for Ottawa residents. The table below summarizes the tracking of LSL homes in Ottawa during 2020.

Table 21 - Lead service line (LSL) replacements during 2020.

# [City] LSLs replaced through w/main rehab	274	Source: B.Cole in PIED
# [City + Private] LSLs replaced by LPRP	57	Source: R.Black
# [Private] LSLs replaced by LPRP rebate	26	Source: R.Black
Total number of [City] LSLs replaced	331	Calculation
Total homes converted to non-LSL supply	**83**	Calculation
Total homes with LSL (City and/or Private) at year end	**27,945**	Calculation

In addition to the phosphate project, revisions to the LPRP and outreach communications have been implemented by staff, starting in 2020. The mail-out program was halted due to COVID19 but expects to resume in summer 2021. Committee and Council approved additional funding for the LPRP. These measures will assist residents to replace lead service pipes and minimize their exposure to lead in tap water.

Shadow Ridge New Source Wells

As noted in item *h) Raw Water Supply and Drinking Water Quality Trends* of this report, nitrate levels are levelling off in the Shadow Ridge (Greely) source wells. Although the 2020 annual average of 3.18 mg/L meets the Ontario Drinking Water Standard of 10 mg/L, the City has initiated a project to drill new source wells into a deeper aquifer that is not susceptible to nitrate.

Testing for the new wells was completed in late 2020 and the results show both good water quality and quantity, for the water supply. A project charter was completed in early 2021 and the undertaking is now with ISD - Design and Construction, for implementation. An engineering design consultant assignment is expected later this year with construction anticipated in 2022. A well head protection study will also be undertaken in 2021 to support the project and meet agency requirements.

Once finished, this project will provide a more secure source of water for the Shadow Ridge water supply. The consequence of such works, to the Shadow Ridge Facility, will be reviewed as part of ongoing risk assessment reviews.

Spring Flooding Mitigation Measures, at the WPPs

In preparation of the 2021 Spring Freshet, flooding contingency plans were developed and temporary flood mitigation supplies were acquired, for the Lemieux Island and Britannia WPP sites. Training, on these plans, was delivered to staff in April of 2021. The installation of non-return valves, on several storm outfalls at the WPPs, is planned for the summer of 2021. Larger, more permanent mitigation strategies are being investigated, as part of the later described WPP Comprehensive Development Plan undertaking. The consequence of such works, to the WPPs, will be reviewed as part of ongoing risk assessment reviews.

Lemieux Island Intake Replacement

The design of a new, deeper raw water intake, for Lemieux Island, continued through 2020. This Council approved project was initiated to further mitigate the risk of frazil ice shutting down the Lemieux Island WPP. With a proposed intake location on the Quebec side of the Ottawa River, the design for this new intake is essentially complete, and the project team continues to work with Quebec and Ontario regulatory approval agencies, prior to starting construction. Upon completion of this new infrastructure, the consequence of these works will be reviewed as part of ongoing risk assessment reviews.

Changes to Asset Management Legislative Requirements

As part of O.Reg. 588/17, “every municipality shall prepare an asset management plan in respect of its core municipal infrastructure assets by July 1, 2022, and in respect of all of its other municipal infrastructure assets by July 1, 2024.” Core municipal infrastructure is defined in the regulation to include assets related to water, wastewater, stormwater management, road, bridges and culverts. Staff in Asset Management Branch have been working to develop the service level asset management plan for Water Service assets related to collection, production, treatment, storage, supply and/or distribution of water, including the definition of current levels of service to meet the 2021 deadline.

Historically, while Infrastructure Services (IS) is responsible for corporate asset management including the linear network assets of Water Services, there has been no clear business unit responsible or accountable for the full range of asset management activities related to Water Services facilities (ROPEC, Lemieux and Britannia), Communal Well Systems and drinking water and wastewater pumping stations, including reservoirs and elevated storage tanks. As the Asset Management Branch (AMB) within IS has expertise in comprehensive asset management for the City as a whole, in 2019, Water Services, TIESS and IS worked collaboratively to develop a future-state vision, where the roles and responsibilities for asset management are defined amongst the three different branches. Progress in 2020 included staffing and information gathering on asset management inventories, compilation of existing condition data, and a preliminary software build in the asset management system. In 2021, the asset management program for Water Facilities will continue to move forward with a focus on building risk frameworks, needs assessment and prioritization processes, and a condition assessment program. The implementation of this vision will be a multi-year initiative, involving all three groups, as each group transitions to their

new roles and clarifies workflows and processes. This implementation will occur, together with a communication strategy to guide staff moving forward. Once the implementation is complete and roles are more clearly defined, the DWQMS procedures related to Infrastructure will need to be updated to reflect the changes identified.

Best Management Practices

As a requirement of the MECP Standard 2.0 under *element 21 – Continual Improvement*, the Operating Authority shall review and consider applicable best management practices (BMPs), including any that may be published by the MECP. The MECP had not released any BMPs by the end of 2020.

The Operational Top Management team has not reviewed any applicable best management practices since 2019. However, Water Services personnel continue participate in water industry conferences, workshops, seminars and webcasts, including the Ontario Water Works Association, the Canadian Water Works Association, the Water Research Foundation, American Water Works Association. In addition, the QMS Coordinator regularly attends DWQMS Workshops and engages with other municipalities to discuss relevant practices, when required. BMPs are regularly discussed with members of these organizations and circulated amongst Water Service management for consideration and if applicable, implementation into drinking water processes.

No Action Items were identified as part of the Management Review Meetings.

l) Summary of Consumer Feedback

Customer inquiries and complaints related to drinking water are typically received and answered by the 3-1-1 Call Centre. The 3-1-1 Call Centre, either forwards call to the PWES Client Support Unit-West staff (Clyde Avenue) that are more familiar with specific water quality issues or will create a service request.

Customer Inquiries, Investigations and Service Requests

Table 22 – Customer Inquiries, Investigations and Service Requests from 2016 to 2020

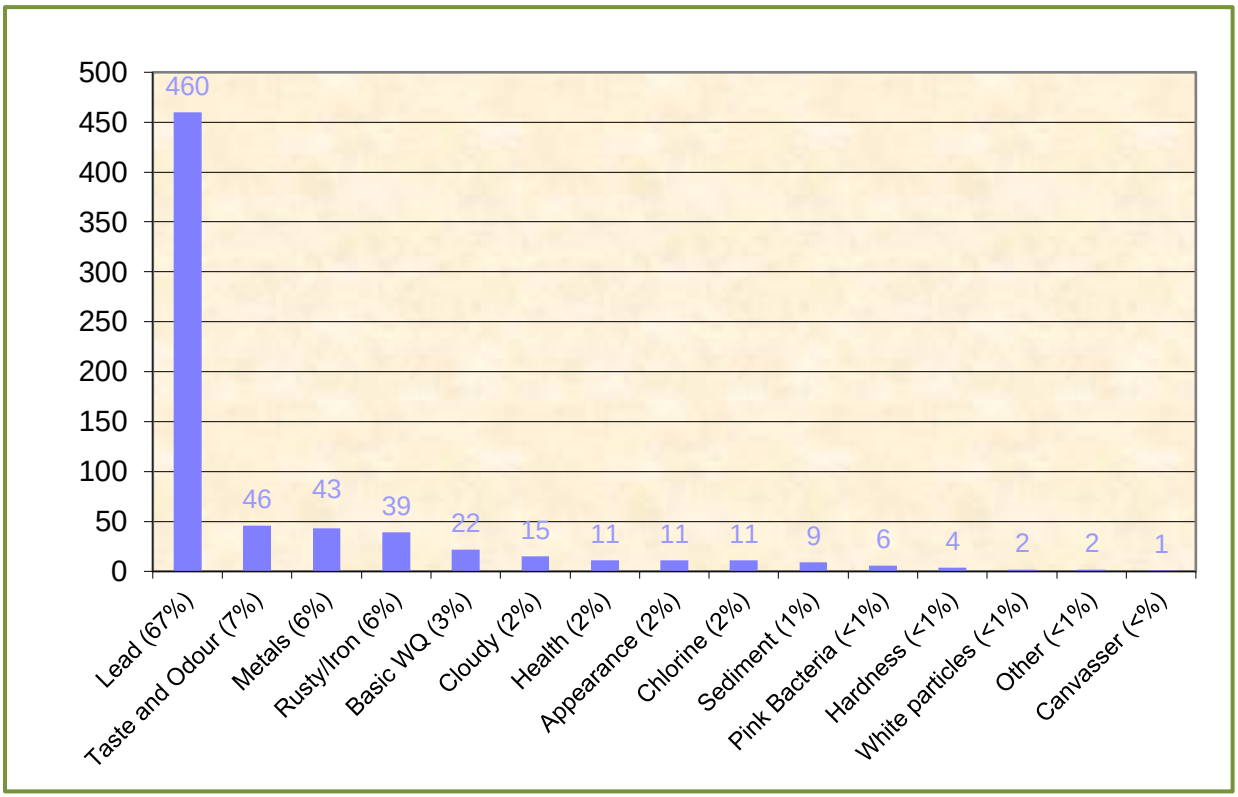
Type of Inquiry	Description	2016	2017	2018	2019	2020
Total of all General Information requests concerning drinking water	Calls or service requests received into the PWES Client Support Unit-West (3-1-1, Revenue, info water, etc.)	16,307	15,238	9,929	7,032	5,258
DWS Service Requests (Water efficiency, AMI, Lead Pipe Replacement Program (LPRP), Water pressure, WQ requests, etc.)	Service requests including tracking and customer information requests dealing with DWS	1,321	1,458	826	1,660	685
Water Quality service requests (info or service)	Service requests created by the PWES Client Support Unit-West that relate to drinking water quality	518	424	412	867	712
Water Quality site investigation requests	Water Quality requests received by the WQ group that require a site investigation	326	328	378	798	682**

In 2020 the overall number of general information calls/service requests received by the PWES Client Support Unit (Clyde) staff and the resulting service requests was again lower than previous years. The drop in 2018 and 2019 was a direct result of the Water Meter Group moving to Water Billing and Systems Unit, as a large amount of the calls received related directly to the appointments and maintenance of water meters as well as account information. These calls are now being received by a separate extension supporting the Water Meter Group. In 2020, all service requests were lower as a result of COVID and the reduction in services due to City centers being closed.

**Water Quality site investigations were tracked differently in 2020 as a result of COVID-19. This is discussed earlier in the report in section G.

During 2020, the number of water quality service requests and investigation requests increased as a result of the increased requests for lead testing. Following the media attention during 2019, the Lead Pipe Replacement Program was in the process of mailing out 30,000 letters and brochures to homes built prior to 1955 when the COVID-19 pandemic hit in March. Just over 5,000 letters had been sent out and this resulted in a large increase in requests for samples, especially leads. Of the 712 service requests for water quality, 682 service requests were handled by the water quality group. The chart below shows the nature of 2020 water quality investigations, by category:

Figure 29 - 2020 Water Quality requests received



Water quality inquiries and investigations provide an excellent opportunity to resolve concerns, demonstrate the quality of City services, and to enhance public confidence in Ottawa's drinking water. During 2020, even though home testing was suspended responding to customer concerns was still a top priority. As discussed previously all customers who had a concern were contacted to discuss their concerns.

The City of Ottawa website also provides information related to water production, water distribution, water quality, and water efficiency. Customers can email information requests to info-water@ottawa.ca or waterwise@ottawa.ca.

No Action Items were identified as part of the Management Review Meetings.

m) Resources needed to maintain the QMS

Capital Projects

The resources necessary to support capital project delivery, by Water Production staff, is significant. While it is recognized that asset replacement, renewal and upgrade projects cannot be TIES continues to lead a Capital Project Delivery Review initiative, together with its departmental project partners including Water Services, in order to establish actionable goals to better manage project planning and delivery. The consequential impact of supporting capital projects, on Water Production personnel, will continue to be monitored in 2021.

Water Services Strategic Review

Water Services is conducting a review of key initiatives that would have significant impacts to build capacity for further enhancements. A number of priority areas where there is opportunity to enhance technical and operational effectiveness were identified. Project teams have been established for SCADA Practices and Standards, Engineers and Operational Support, and Water Distribution Leadership. The resource needs will continue to be assessed and monitored through this review.

No Action Items were identified as part of the Management Review Meetings.

n) Results of the infrastructure review

DWQMS 2020 Risk Assessment Outcomes

As required by the Drinking Water Quality Management Standard (version 2.0, released 2017), outcomes of the DWQMS Risk Assessments must be considered during the review and provision of infrastructure. Hazards and hazardous events identified during the 2020 DWQMS Risk Assessment are described below:

Table 23 - Risk Assessment Outcomes for Infrastructure Review Discussions

#	Hazard Description	Note from Risk Assessment Meeting with WD	Update
16	Contamination - high levels of lead in water due to leaching from pipe/plumbing	Need to report on the amount of lead service pipe removed from the system every year as a result of the LRP and the capital renewal projects	Water Distribution Management will work with corporate stakeholders to implement the reporting of lead service pipes removed from the system during the LRP and capital review projects
#	Hazard Description	Note from Risk Assessment Meeting with WP	Update
69	CCP P1 - Coagulation failure or non-optimal capture of particles/ microbial pathogen	Identify a need for the replacement of low lift venturi with Mag meters @ Britannia – WPP Comprehensive Development Plan	Include the need for the replacement of the low lift venturi with Mag meters @ the Britannia WPP in the WPP Comprehensive Development Plan – as part of the infrastructure review discussion

These action items are tracked as part of the DWQMS Continual Improvement process.

Water Production Infrastructure

A number of activities were undertaken in 2020 in order to improve or maintain the reliability and performance of the water production plants and remote facilities. The work completed was prioritized using a risk-based approach that focuses on important factors that could affect the operation such as health and safety, regulatory impacts,

environmental impact, among others. This framework continues to be used to prioritize the sequencing of capital projects.

State of the Asset Report

The City's water infrastructure assets are safe. The City continues to apply recognized asset management practices to maintain its water infrastructure in a state of good repair, and proactively inspects and maintains assets using a risk management approach, considering the likelihood and consequence of failure and risk to service.

In the last couple of years, there have been significant investments to provide redundancy to areas outside of the greenbelt. In case of failure of the primary transmission mains, the impact to the service would be reduced.

Table 24 - State of the Asset Report Ratings from 2017 and 2012

Asset Category	2017 Rating	2012 Rating	Change
Treatment Plants	Good	Good	None
Pump Stations	Fair	Fair	None
Communal Well Systems	Good-Fair	Fair-Good	Increase
Storage	Good-Fair	Good-Fair	None
Transmission Mains	Good-Fair	Good	Decrease
Distribution Pipes	Good-Fair	Good	Decrease

Between 2012 and 2016, the Communal Wells Systems improved their rating from "Fair-Good" to "Good-Fair", primarily as a result of the improvements at the Kings Park Wells and Munster system. Further, between 2012 and 2016, the transmission mains and distribution pipes reduced their rating from "Good" to "Good-Fair". This decrease was primarily due to the implementation of a new, risk-based rating approach that focuses on Likelihood of Failure (LOF). In the past, the ratings were based on qualitative input from subject matter experts. This new method will form a new baseline and so although the ratings have decreased, it is not indicative of an actual deterioration in physical state.

Based on the last State of the Asset Report, 79% of the water assets are in a good to very good condition. The State of the Asset report is prepared and presented once per

Term of Council. There are discussions currently underway to determine the timing. It's anticipated that the next State of the Asset Report will be prepared and presented in 2021.

Structural Condition Assessments

Structural condition assessments for the various bridges under which watermains reside have also been completed. The City of Ottawa undertakes inspections of its bridge structures on a two-year cycle in accordance with the Ontario Structure Inspection Manual (OSIM) procedures and requirements. Maintenance and repair items identified through the visual assessments are reviewed, programmed and acted upon as necessary. Structures that have larger potential rehabilitation needs identified through the bi-annual inspections are scheduled for a detailed condition assessment and options analysis study. The outcomes of the detailed assessment are recommendations for both minor and major bridge renewal that is programmed as part of the City's capital construction programs. The investments needed for repairs or renewals are prioritized based on risk to the service from a social, environmental and economical perspective. The latest results are summarized in the table below:

Table 25 – Structural Condition Assessments for Bridges Situated Above Watermains

Structure	Total Span Length	Year Built	Type	# of Spans	Last Rehab	Renewal program	Comments
017150, Fleet St Pumping Station Access Bridge	7.10 m	1910	Steel beam	1	2013	n/a	The 2020 OSIM inspection carried out by Morrison Hershfield states that the bridge is in 'Good' overall condition, however, the bridge has a Bridge Condition Index (BCI) of 58 due to the severity of localized defects. There is currently no rehabilitation scheduled for this structure in the 5-year renewal forecast. A major renewal (strengthening) was completed in 2013 by PWES as part of the Tailrace Structural Rehabilitation.
017170-1, Lemieux Island Road Bridge [South Span]	80 m	1989	Steel Open Spandrel Arch	2	2008	none	The 2020 OSIM inspection carried out by Morrison Hershfield states that the bridge is in 'Good' overall condition with a BCI of 73. There is currently no rehabilitation scheduled for this structure in the 5-year renewal forecast. The bridge was

Structure	Total Span Length	Year Built	Type	# of Spans	Last Rehab	Renewal program	Comments
							retrofitted to seismic design standard in 2008.
017170-2, Lemieux Island Road Bridge [Bell Island]	54 m	1989	Concrete Rigid Frame	1	2008	none	The 2020 OSIM inspection carried out by Morrison Hershfield states that the bridge is in 'Good' overall condition with a BCI of 74. There is currently no rehabilitation scheduled for this structure in the 5-year renewal forecast. The bridge was retrofitted to seismic design standard in 2008.
017170-3, Lemieux Island Road Bridge [North Span]	80 m	1989	Steel Open Spandrel Arch	2	2008	none	The 2020 OSIM inspection carried out by Morrison Hershfield states that the bridge is in 'Good' overall condition with a BCI of 73. There is currently no rehabilitation scheduled for this structure in the 5-year renewal forecast. The bridge was retrofitted to seismic design standard in 2008.
017160, Lemieux	187 m	1936	Steel Truss	6	2019	Substructure renewal	According to the 2020 OSIM inspection by Morrison Hershfield, the bridge is in 'Good'

Structure	Total Span Length	Year Built	Type	# of Spans	Last Rehab	Renewal program	Comments
Island Pipe Bridge						completed substantially on October 6, 2019	overall condition with a BCI of 75. A seismic retrofit feasibility study was completed in 2013 by AMB. The study concluded that the bridge is seismically deficient however it would be cost prohibitive to retrofit the structure. Current strategy is to follow the joint AMB & ISD action plan based on the 2010 CH2MHILL Risk Assessment Study to complete routine maintenance of the substructure in the near term and bridge replacement at the end of service life around 2036 while completing an EA and detailed design and shelving it as a contingency measure. The substructure renewal was completed in 2019. Funding for an EA for bridge replacement was provided in the 2020 budget to adhere to agreed upon risk management strategy. DWS and AMB will revisit the 2010 recommendations and EA schedule.

WPP Comprehensive Development Plan

As Ottawa experiences population and economic growth over time, infrastructure requirements for the WPPs need to be assessed periodically to ensure capital works occur in a timely manner to meet the increased drinking water demands. The two WPPs currently have an amalgamated Water Purification Plants Development Plan (WPPDP), which assesses the ability for the plants to meet future growth demands from a capacity perspective, and lists capital works that are required over the forecasted planning horizon due to growth, renewal and process upgrades. Along with the WPPDP, the plants have SCADA and Electrical master plans that look at respective capital upgrades required for SCADA and electrical components within the plants.

The WPPDP was last updated in 2012 and an update is now required for the upcoming planning horizon, which will be up to the year 2046. This update will in turn support updates to the City's Water Master Plan (WMP) and Infrastructure Master Plan (IMP).

The purpose of this assignment is to develop a document that will allow the City to comprehensively understand the growth, renewal and capacity related infrastructure requirements at the two WPPs for the 2046 planning horizon, along with understanding the respective costs, funding sources and risks. This will in turn support the development of the City's overall Infrastructure Master Plan, in addition to developing a comprehensive master projects list for the WPPs.

Drinking Water Asset Management Plan

The Infrastructure for Jobs and Prosperity Act (2015), and Ontario Regulation 588/17 have legislated the practice of asset management in Ontario. Regulatory requirements specify that each municipality must create an Asset Management Plan, the first version of which must be developed by July 2022 for core assets, which includes water infrastructure.

As part of its asset management journey in 2017, the City of Ottawa published its Strategic Asset Management Plan (SAMP), which developed several core components of its overall Asset Management System. Building on the success of the SAMP, the City is endeavoring to develop service-focused asset management plans (AMP), which will detail the City's strategies to manage, maintain and fund infrastructure in order to achieve each service's objectives. This project will undertake the development of the

City's Drinking Water Asset Management Plan (DWAMP), in alignment with regulatory requirements and timelines including the July 1, 2022 deadline for core infrastructure. The primary objectives of the DWAMP will be to provide the City with an understanding of its asset portfolio as well as strategies to maintain levels of service, mitigate risk and provide efficient and financially sustainable service delivery.

Water Distribution Infrastructure

Large-Diameter Watermain Condition Assessment Program

The City has continued to move forward with the large-diameter watermain condition assessment program. The main benefit of this program is the ability to proactively assess and identify deficiencies that can be addressed in a planned and controlled fashion without negatively impacting customers. There are currently 235 km of large-diameter watermains (≥610mm) in the City. The expected service life is between 80 and 110 years and the average age is approximately 32 years.

Although the program was formally established in June 2012, PWESD has been engaged in watermain condition assessment activities since 2007.

The program continues to be governed by a working group composed of technical experts and management representatives from multiple City branches, including PIED Asset Management, WS Production and Distribution and TIESS Network Implementation and Support. The working group discusses alternatives and puts forth recommendations for the inspection program. They take into consideration the risk-based prioritization and competing priorities within the drinking water system. A risk-based prioritization approach, considering competing priorities within the drinking water system, is used to establish the annual program. Of particular priority for inspection is approximately 52.6 km of pipeline that was installed from ~1972 to 1979 that has experienced a higher degree to wire breaks leading to premature failure. It is recognized industry-wide that the 1972-79 C301 pipe, have experienced a modest tendency for premature failure, as compared to CPP material manufactured and installed before and after this period. To date, the City has completed 37.89 km (72%) of structural condition assessment and 36.1 km (68.63%) of leak detection on this cohort of pipes. In total, 48.4 km (20%) of structural condition assessment and 96.2 km (40%) of leak detection have been completed on large-diameter watermains (≥610mm) in the City.

The following inspections were completed in 2020:

- Ottawa South A from Kaladar to South of Walkley - Structural inspection = 1.98 km (1.98 km was re-inspection)
- Eagleson A and B from Campeau to South of Timm Dr - Structural inspection =1.25 km
- Innes A and B Innes tank to Trim road - Leak detection = 5.16 km
- Hurdman discharge and St. Laurent watermain from Riverside drive to St. Laurent Blvd and Montreal road intersection - Leak detection = 3.81 km
- Eagleson A and B from Campeau pumping station to Hazeldean road - Leak detection = 2.97 km

Through this program, 11.9 km of large-diameter watermain was inspected for leaks and 3.2 km for structural deficiencies in 2020. Each type of inspection provides unique condition information upon which rehabilitation and replacement decisions are made. Completion of both types of condition assessment often takes multiple years. A watermain segment is considered to be completely inspected when both leak detection and structural condition have been assessed, as appropriate based on engineering analysis, pipe material and current technology available on the market. In 2020 both leak detection and structural analysis was done on 1.25 km length of watermain which is lower than last year. Due to ongoing light rail construction works, other capital project priorities and water demand management, structural inspections of two watermain segment were postponed until 2021. The table below provides a summary of the completed assessments.

Table 26 – Inspection Distances by Year (km)

Year	Structural	Leak Detection	Fully Completed
2007	n/a	1.0	n/a
2008	3.8	n/a	n/a
2011	8.5	3.5	3.5
2012	4.1	3.6	3.6
2013	4.2	n/a	n/a
2014	1.9	2.2	3.3

Year	Structural	Leak Detection	Fully Completed
2015	9.7	10.8	7.0
2016	1.5	16.8	11.4
2017	7.2	22.4	3.7
2018	0.9	10.9	8.2
2019	3.6	17.6	9.7
2020	3.2	11.9	1.25

The figure below illustrates the progress to date for the Large Watermain Condition Assessment Program - the left-side shows the total large diameter watermains (including the cohort of pipes installed from ~1972 to 1979) and the right side shows the cohort of the pipes installed from ~1972 to 1979.

Figure 30 – Large Diameter Condition Assessment Progress Results to Date (km)

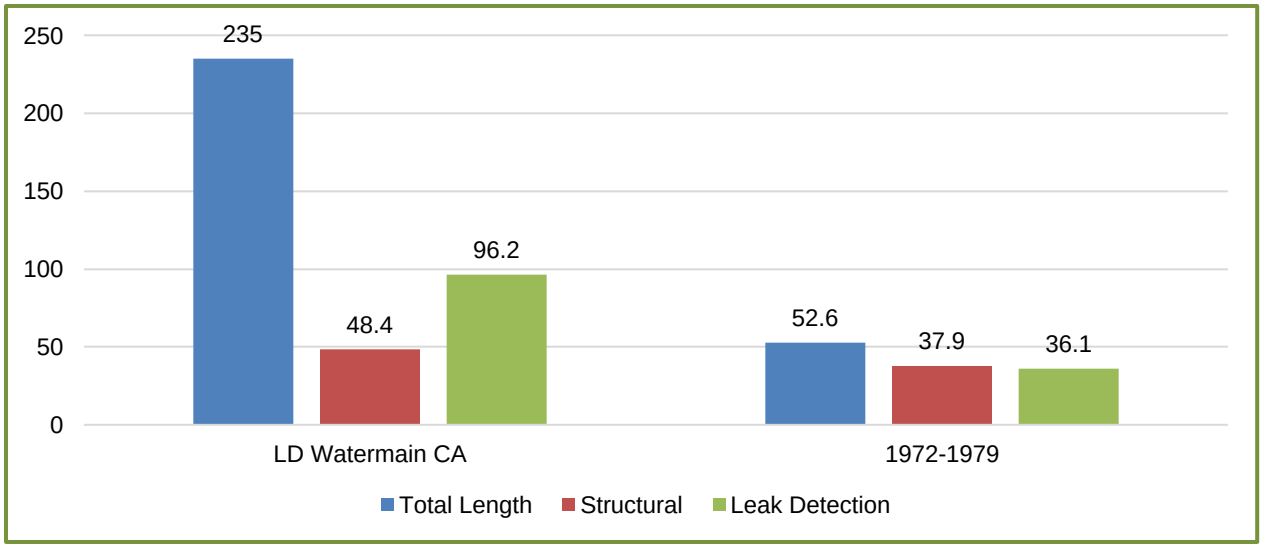


Table 27 - Summary Condition Assessment Results from 2015 to 2020

Description	Total Distance (m)	# of Distressed Pipes				Total # of Pipes inspected	% of Distressed Segments	Last Inspection Date
		Immediate action Required	Short-Term Action n Required	To be Monitored Long-Term	Total			
Eagleson A and B	1250	0	2	3	5	261	1.9%	2020
Ottawa South A	1988*	0	0	3**	3	342	0.9%	2020
Morgan's Grant Ph 2B	383	0	0	1	1	63	1.6%	2019
Morgan's Grant Ph1	938	0	0	1	1	149	0.7%	2019
Bridlewood B	1309	0	3	7	10	186	5.4%	2019
Baseline 4	890	0	1	0	1	153	0.7%	2019
Morgan's Grant Ph 2A	394	0	0	0	0	63	0.0%	2018
Orleans D	2230	0	0	0	0	371	0.0%	2017
Bridlewood A Ph1	1451	0	0	2	2	222	0.9%	2017
Britannia B	2615	0	0	45	45	555	8.1%	2017
Woodroofe A North	1009	0	0	3	3	179	1.7%	2017
Morgan's Grant Ph 3	867	0	0	0	0	108	0.0%	2016
Loretta North	602	0	9**		9**	192	4.7%	2016
Orleans A	1680	0	0	3	3	287	1.0%	2015
Lorry Greenberg	300*	0	0	0	0	41	0.0%	2015
Bridlewood A Ph 2	616	0	0	0	0	89	0.0%	2015
Ogilvie	315	0	0	0	0	65	0.0%	2015
Ottawa South A/B	6984	0	2	6	8	1227	0.7%	2015

** Distance estimated*

*** includes pipes exhibiting anomalous signals with distress-like properties and/or longitudinal cracking, further inspection may be required to confirm results*

It should be noted that the Pure Technologies has found that the current average % of distressed segments across all of their inspections is around 3.00% (The Water Research previously published industry distress rate in 2012 was 3.7%). To provide more details regarding the actions taken based on assessment results, the following definitions were used:

- Immediate Action Required: Pipe segment condition is such that it needs to be repaired or replaced before bringing the pipe back into service. Urgent Repair.
- Short-Term Action Required: Pipes should be scheduled for repair or replacement in the next few years. The timeline depends on the severity of the distress and professional opinion of the structural engineer. The pipe can be put back in service, but steps should be taken to repair or replace it. Planned Repair
- To Be Monitored Long-Term: There is distress in the pipe section, but it is relatively minor. No repair or replacement intervention planned. The pipe will be reassessed after the next inspection. The timing of the next inspection is to be determined through regular program planning.

Table 28 – Summary Leak Detection Results for 2020

Description	Total Distance (m)	# of Leaks	Management Strategy
Innes A and B	5156	1	A leak was detected on Ductile Iron pipe section located between Mer-Bleue Rd and Frank Bender St, water distribution crew will follow-up on this
Hurdman Discharge St.	3806	0	-
Laurent Eagleson A and B	2973	1	Identified valve 352018V190 at Kakulu Road was leaking, water distribution crew adjusted and fixed the valve

All inspections happen in Q4 of the inspection year, this is to allow time for the inspections and, if required, any repairs before May of the following year when water demands typically increase. As such, repair and replacement occur in the following year(s). Repair to be completed include:

Eagleson A and B - 5 distressed pipes were found in 2020. A Failure Risk Analysis was performed by SG&H. Although the SG&H report recommended repair, the repair is not required within next 5 years. However, it was decided that two of the distressed pipes with the higher number of wire breaks will be repaired/replaced sooner to avoid the risk of unplanned failure. This decision was made considering this watermain has a cohort of pipes installed between 1972 and 1979 and the location of the distressed pipes are in a busy intersection. A repair project was initiated by Asset Management in 2020 and will be executed by Design and Construction within next 1-2 years depending on the system availability and other constraints. The rest are to be monitored long term.

The plan for 2020 is to build upon existing initiatives, including the following:

- Explore potential for new technology and vendors
- Pilot new condition assessment technologies
- Continue program planning over a 3 to 5-year horizon
- Continued improvement on inspection planning

- Formalize documentation process for storing inspection reports
- Continue to work with Water Distribution on aligning the watermain condition assessments with large valve and chamber condition assessments and repair to reduce the downtime of the watermains

The plans provided in the table below are impacted by some constraints such as:

- Level of service expectations
- Resources
- Hydraulic impacts
- Other concurrent capital construction projects

Table 29 - Proposed 2021, 2022, 2023 Large Watermain Condition Assessment Program

Pipeline Name	Age (Yrs)	Risk Rank	Inspection Length (km)	
			Condition Assessment	Leak Detection
2021				
Orleans D	48	8	1.2	0
Orleans C	47	1	0.8	0
Kanata B	44	39	1.8	1.8
Fallowfield B	31	49	0	2.0
Britannia Discharge A	41	20	0	1.4
Britannia Discharge B	44	5	0	2.6
Woodroffe A	46	7	0	2.7
Woodroffe C	9	44	0	0.9
Woodroffe D	42	11	0	2.9
2022				
Laurier	18	31	1.4	1.4
Gloucester	21	58	0	1.3
Fallowfield A	42	17	1.9	1.9
St. Joseph A	47	20	2.3	2.3
Hazeldean A2	48	19	1.2	1.2
Hazeldean B2	8	68	0	0.9
2023				
Hazeldean C	10	36	0	1.6
David Drive	46	38	0.7	7.7
Baseline Phase 3	45	13	1.2	0
Orleans Res	48	10	2.2	0
Forest Ridge	28	64	1.2	0

Watermain Renewal [tie in watermain break KPIs]

The City continues to apply recognized asset management practices to maintain its water infrastructure in a state of good repair. The repair and replacement of watermains is completed through watermain only and integrated programs in order to provide continued service and prevent failures. Our approach to watermain renewal is to operate watermains as long as possible, taking into account sewer and road needs. The number of annual watermain breaks has been decreasing as a result of the renewal program (watermain only or integrated) and the application of strategic cathodic protection to existing mains.

A risk assessment model for the City's distribution and transmission mains has been established which provides a refined method to identify watermain needs and addresses both the likelihood of a watermain failure as well as the consequence of failure. Risk assessment provides a repeatable and defendable method of choosing renewal candidates. Risk assessment is particularly important for transmission mains where the scoring is used to identify and select higher risk watermains for condition assessment as opportunities and funding permit. The results of the condition assessment allow the City to correct and repair any issues in good time to prevent premature failure of the infrastructure.

Table 30 – Watermain Renewal Work Undertaken in 2020 [summarize list of projects]

Project	Constr. Completed	Status
Arch - Cantebury - Plesser	No	In Design
Ashburn - Hogan - Wigan - Ness	No	In Construction
Aylmer - Fulton - Carlyle - Rosedale	No	In Construction
Bel-Air Dr, Bedbrooke St et al	No	In Design
Borthwick-Quebec-Gardenvale	No	In Construction
Broadview Ave	No	In Design
Caroline Ave - Huron Ave N	No	In Design
Claymor & Senio	No	In Construction
CWWF Deerpark-Hilliard-Fisher et al.	No	In Construction
CWWF Queensway Terrace North Sewer	No	In Design

Project	Constr. Completed	Status
CWWF Vanier Parkway - Presland Rd et al	No	In Construction
Fairbairn-Bellwood-Willard-Belmont	No	In Construction
Gibson-Denver-Tampa-Orlando	No	In Construction
Grove Ave & Grosvenor	No	In Design
Hamlet Rd	Yes	Construction Complete
Larkin-Larose-Lepage	No	In Design
Longpre - Marquette- Michel Cir	No	In Design
Maclaren St - Lyon St	No	In Design
Piccadilly Ave (Wellington - Bassett)	No	In Design
Pretoria Ave (Metcalfe-Bank)	No	In Design
St Denis - Lavergne - Ste Monique	No	In Design
Sullivan Ave.	Yes	Construction Complete
Valley Dr Storm Sewer	No	In Construction
Winona Ave & Wilmont Ave	No	In Design
**** Integrated Road, Sewer & Water Program**		
Albert St. - Slater St. (Bay to Elgin)	No	In Design
Bank St (Riverside-Ledbury)	No	In Design
Bronson Ave (Arlington-Rideau Canal)	No	In Design
Byron-Athlone-Highcroft	No	In Design
Carling Ave - Churchill Ave - Kirkwood	No	In Design
City Centre Ave & Elm St	No	In Design
CWWF Avenue N-O-P-Q-R-S-T-U	No	In Design
CWWF McLeod - Florence	No	In Construction
CWWF ORAP - Loretta Ave N&S - Laurel St	No	In Design
Elgin (Lisgar - Isabella)	No	In Construction
Main Greenfield Echo Concord et al	No	In Construction
Mann-Range-Russell-Templeton	No	In Construction

Project	Constr. Completed	Status
Montreal Rd (N River Rd-St Laurent Blvd)	No	In Construction
N River Rd (Montreal-Dead End N of Coupal)	No	In Construction
O-OTM Bronson (Canal-Carling)	No	In Design
O-OTM Carling Ave (Bronson-Bayswater)	No	In Design
O-OTM Main St (Echo-Springhurst)	No	In Design
ORAP Albert St-Bronson Ave-Slater St	No	In Design
Queen St (Bronson-Elgin)	No	In Design
Scott St. (West of Smirle Ave)	No	In Construction
**** Integrated Rehab-Intensification Areas**		
Albert St. - Slater St. (Bay to Elgin)	No	In Design
**** Integrated Rate - Infrastructure Serv.**		
2017 Watermain Improvements	No	General Account - Ongoing Projects
2018 Transmission/Distribution WM Rehab	No	General Account - Ongoing Projects
2018 Watermain Improvements	No	General Account - Ongoing Projects
2019 Watermain Improvements	No	General Account - Ongoing Projects
2019 WM Transmission/Distribution Rehab	No	General Account - Ongoing Projects
2020 WM Transmission/Distribution Rehab	No	General Account - Ongoing Projects
Bank St (Rideau Rd-Mitch Owens)	No	In Design
LRT2 W1 Hwy 174 - Shefford Rd	No	In Construction
Water System Improvements	No	General Account - Ongoing Projects
2017 Watermain Improvements	No	General Account - Ongoing Projects

Project	Constr. Completed	Status
2018 Transmission/Distribution WM Rehab	No	General Account - Ongoing Projects
**** Water System Rehabilitation Program**		

Growth Related Infrastructure

The City of Ottawa's 2021 capital budget process identified adjustments to project funding needs based on progress on several major water supply projects that are required to support growth, as identified in the 2013 Infrastructure Master Plan (IMP).

In 2020, several major growth-related water infrastructure projects were active at various stages of planning, design and construction. These projects include the following:

Functional Design

- Campeau Drive, Solandt Road and March Road watermain FDR completed 2020
- Kanata West Feedermain

Preliminary and Detail Design

- Manotick Watermain (Phase 2)
- Greenbank Road Watermain
- Carlington Heights Pump Station Upgrade
- Ottawa South Pump Station Upgrade

Construction

- Manotick Feedermain Phase 1 under construction
- North Island Link watermain under construction
- Strandherd Drive watermain under construction. Project combined with the Strandherd Drive road expansion
- The Brittany Drive Pump Station tender anticipated in 2021. Delayed due to reliability improvements at Montreal Road Pump Station, which supplies the same pressure zone
- Carlington Heights Pump Station tender anticipated in 2021

The Ottawa South Pump Station project is the last major infrastructure upgrade associated with the planned reconfiguration of pressure zones in the City's South Urban Community. The Fallowfield Reservoir Pump Station project (completed in 2016), and the Barrhaven Pump Station project (completed in 2017) also supports the reconfiguration. Final design of the Ottawa South Pump Station Project was delayed pending a resolution to local servicing issues on the Ottawa International Airport campus and is now expected to be completed in Q3 2022. Resolution of these issues has resulted in an adjustment to the planned zone reconfiguration.

Planning Level Studies

Work on a City-wide Infrastructure Master Plan (IMP) was initiated in 2020 to update the current version of the plan, which was completed in 2013. This plan will support the City's New Official Plan, which is expected to be adopted by Council in Q4 2021. The updated IMP is expected to be approved by Q2 2022. The IMP will review the need for any projects from the 2013 plan which have yet to be implemented and identify new trunk-level projects that will be needed to support urban intensification and expansion. Master servicing work was carried out in a number of future development areas in 2019. The bulk of this work is carried out by proponents of development, subject to City review and approval. In terms of water supply, this planning work identifies the principal watermain networks to be constructed in Greenfield areas. For intensification areas, development projections typically provide input to the local watermain renewal program. In 2021, progress on Master Servicing Studies were active in the following geographic areas of the City:

- Village of Manotick
- Village of Carp
- Village of Richmond

Future Infrastructure review reports will continue to track and comment on the IMP and the timeliness and success of project delivery.

No Action Items were identified as part of the Management Review Meetings.

o) Operational Plan currency, content, and updates

The DWQMS Operational Plan was revised and released on September 18, 2020 (version 5.0). Revisions made to the DWQMS Operational Plan included the following changes:

- Update the status of Richmond West Well System, as it was commissioned, and the City of Ottawa took ownership in 2020
- Update to the Corporate Top Management team to include the General Manager of PIED and the Director of Infrastructure Services
- Remove requirement for CTM to approve the annual Management Review report. However, CTM will continue to receive a presentation summarizing the annual Management Review report discussions and have an opportunity to provide recommendations to ensure the success of the DWQMS
- Clarified text within elements 7/8 (Risk Assessment), 14 (Review and Provision of Infrastructure), 19 (Internal Audits), and 21 (Continual Improvement) to meet recommendations made by the DWQMS external auditor
- Add that actual emergencies can be used as replacements to the emergency desktop exercise, in order to meet the annual requirement of emergency testing

For each major revision of the Operational Plan, a memo containing a summary of the changes is distributed to the Operating Authority and the DWQMS General Awareness Training presentation is updated, as required.

No Action Items were identified as part of the Management Review Meetings.

p) Summary of staff suggestions

Employee suggestions were generated during semi-annual operator training and staff meetings in 2020, which were completed virtually as a result of COVID-19 restrictions. It was suggested that Water Production continue this as an ongoing approach, post-COVID. All CEU training in the first part of 2021 was offered online given on-going restrictions. Operational Management will need to assess and balance in person training with virtual moving forward.

In addition, recommendations for OFIs made during the internal audit discussions are often a reflection of employee suggestions and captured in the audit findings. These OFIs are recorded as part of internal audit continual improvement action items.

No Action Items were identified as part of the Management Review Meetings.

Management Review Action Items

The following action items were identified as part of the meetings completed during the 2020 Management Review discussions and will be tracked by the Quality Management Coordinator as part of the DWQMS Continual Improvement process:

Table 31 - 2020 Management Review Action Items

Number	Management Review Action Item	Target Date	Owner
OTM#1	Britannia low-lift venturi flowmeter is not reliable in low flow range (80 – 120 ML/d) and has led to several coagulation failures in recent years. Management recommends replacement of Britannia's low-lift venturis as a priority capital project. This project is likely to be identified in the WPP Development Plan Report but should be created as a separate capital project due to risk of failure. Previously identified and tracked as Action #794 in CAPA Database.	Dec./21	WP
OTM#2	Include amount of lead service pipes removed from the system every year as a result of the LRP and the capital renewal projects within the Management Review reports going forward. Previously identified and tracked as Action #821 in CAPA Database.	Sep./21	WQ