Author/Owner(s)	Caroline Lamoureux	Management System Coordinator
Approver(s)	Operational Top Management	
End User(s)	Operating Authority	

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1.0 ELEMENT 1: QUALITY MANAGEMENT SYSTEM

Under the *Safe Drinking Water Act (2002),* the Ministry of the Environment, Parks and Conservation (MECP) requires all owners of municipal drinking water systems to obtain a license for the operation of their systems. To satisfy the requirements for the Municipal Drinking Water Licensing (MDWL) program, this Operational Plan documents the Drinking Water Quality Management System (DWQMS) developed by the City of Ottawa to meet the MECP's *Drinking Water Quality Management Standard (version 2.0, 2017)*. As required by the MECP's Director's Directions, completed Subject System Description Forms, Schedule "C", are provided in Appendix A.

This Operational Plan describes the 21 elements of the City of Ottawa's DWQMS and is based on the "Plan", "Do", "Check" and "Improve" concept of Quality Management. It applies to all seven of the City of Ottawa's drinking water systems described below:

- Central System: Britannia Water Purification Plant (WPP), Lemieux Island WPP, and Central Distribution System (MDWL #008-102)
- Carp Well System (MDWL #008-101)
- Kings Park Well System (MDWL #008-103)
- Munster Hamlet Well System (MDWL #008-104)
- Richmond West Well System* (MDWL #008-107)
- Shadow Ridge Well System (MDWL #008-106) (the City of Ottawa is the operator, not the owner)
- Vars Well System (MDWL #008-105)

*The recently constructed Richmond West Well System was commissioned, and with ownership assumed, in 2019.

The City of Ottawa is the Operating Authority for each of the seven drinking water systems. The documentation in the Operational Plan applies to all seven drinking water systems, except where specifically noted.

1.1 Glossary

Item	Definition
Controlled Document	A document required by the DWQMS, including the Operational Plan and its associated policies, procedures, forms, tables, appendices, flowcharts, or other documents that are subject to revision.
Critical Control Limit (CCL)*	The point at which a Critical Point response procedure is initiated.
Critical Control Point (CCP)*	An essential step or point in the drinking water system at which control can be applied by the Operating Authority to prevent or eliminate a Drinking Water Health Hazard or to reduce it to an acceptable level.

Item	Definition
Official Business Record (OBR)	Documents that record a decision, commit the City to an action, document any obligation or responsibility, or comprise information connected to the accountable business of the City.
Operating Authority*	Any person or entity that is given the responsibility to operate, manage, maintain and/or alter the drinking water systems.
Operational Top Management (OTM)	Consists of Water Distribution (WD) Manager, Water Purification (WP) Managers (East and West), Water Quality (WQ) Engineer, and Management System Coordinator (and Quality Management System (QMS) Representative).
Corporate Top Management (CTM)	Consists of General Manager of Infrastructure and Water Services Department (IWSD), Director of Water Facilities and Treatment Service (WFTS), Director of Water Linear and Customer Service (WLCS), Director of Infrastructure Service (IS), Director of Asset Management Service (AMS), Manager of Business and Technology Support Services (BTSS), and MS Coordinator (and QMS Representative).
Remote Facilities	Includes municipal well systems, pump stations, tanks, and reservoirs.
Water Production	Includes treatment, storage, and pumping of drinking water in the central system and municipal well systems.
Water Production Management Team	Includes WPP Managers (East and West), Senior Operations Engineers (East and West), Supervisory Control and Data Acquisition (SCADA) Program Lead, Water Quality Engineer, and Water Quality Supervisor.
Water Distribution	Includes linear water infrastructure such as watermains, valves and hydrants.
Water Distribution Management Team	Includes Water Distribution Manager, Senior Operations Engineers and Linear Systems Supervisors.

Definitions for Critical Control Limit, Critical Control Point, and Operating Authority are derived from definitions described in the ‘Ontario’s Drinking Water Quality Management Standard Pocket Guide’ (March 2018).

2.0 ELEMENT 2: DWQMS POLICY

2.1 Purpose

The City of Ottawa has developed a DWQMS policy to comply with the Drinking Water Quality Management Standard and ensure the organization's commitment to safe drinking water for the residents of Ottawa.

2.2 Procedure

The DWQMS Policy has been developed and agreed to by the Operating Authority and the Top Management team. The DWQMS Policy is communicated as part of the ongoing DWQMS awareness training. Copies of the policy are posted at each of the drinking water facilities. The DWQMS Policy is presented below for reference:

DWQMS Policy

The City of Ottawa is committed to consistently deliver high quality drinking water to the people of Ottawa. In particular, the organization is committed to:

- Provide a reliable supply of safe drinking water to the consumer.
- Meet or exceed applicable legislation and regulations.
- Implement, maintain and continually improve the Quality Management System, infrastructure and technology.
- Deliver excellent customer service through responsiveness, accountability and innovation.

3.0 ELEMENT 3: COMMITMENT AND ENDORSEMENT

The Corporation of the City of Ottawa, including the Operational and Corporate Top Management, are committed to:

1. Ensuring that a QMS is in place that meets the requirements of the MECP's Drinking Water Quality Management Standard;
2. Ensuring that the Operating Authority is aware of applicable legislative and regulatory requirements;
3. Communicating the QMS according to procedures; and
4. Determining, obtaining or providing the resources needed to maintain and continually improve the QMS.

3.1 Operational and Corporate Top Management Commitment

Management demonstrates their commitment and endorsement to the City's DWQMS through the following ongoing activities:

- OTM approves the Operational Plan and the Management Review Report. Other DWQMS-related documents (Internal Audit Schedule and Plan and Risk Assessment records) are developed in consultation with OTM. In addition, members of OTM participate in the Management Review meeting discussions (OTM meetings) and meet on a quarterly basis to discuss DWQMS items and progress; and
- CTM participates in the annual Management Review (CTM presentation).

The City's commitment and endorsement of the DWQMS is represented by the signatures presented on the document *DWQMS – Top Management Commitment and Endorsement*. This document is signed by members of CTM during the annual CTM Management Review meeting. The electronic copy is stored in the Business Information Management System (BIMS) and DWQMS SharePoint site.

3.2 Council Endorsement

The QMS Representative shall ensure Council endorsement is received for the current Operational Plan following changes in Council due to elections or otherwise. The Owner (in this case, the Municipal Council of the City of Ottawa) endorses the Operational Plan through Council resolution, as documented in the Council meeting minutes. A copy of the *Council meeting minutes* endorsing the Operational Plan is saved electronically in the DWQMS SharePoint site and BIMS.

4.0 ELEMENT 4: QMS REPRESENTATIVE

This element identifies how the QMS Representative is appointed, specific responsibilities of the QMS Representative, and where the record of this appointment is documented.

4.1 Procedure

The General Manager, IWSD, appoints and provides authority to the QMS Representative, irrespective of their other responsibilities. The QMS Representative acts as the liaison between Top Management and the Operating Authority to ensure ongoing maintenance and implementation of the QMS. The authority, roles and responsibilities of the QMS Representative are described in the *Organizational Structure, Roles, Responsibilities and Authorities System Procedure (Element 9)*.

The appointment of the QMS Representative is documented in the Notice of Appointment, which is signed by the General Manager, IWSD. The electronic copy is stored in the BIMS and DWQMS SharePoint site.

4.2 Appointment of QMS Representative

The General Manager, IWSD, appointed the QMS Representative to be the QMS Coordinator, TIES, IWSD. The QMS Representative alternate is designated to the position of Performance & Management Systems Specialist, TIES, IWSD.

The QMS Representative acts as the liaison between Top Management (OTM and CTM) and the Operating Authority. The QMS Representative, irrespective of other responsibilities shall:

- Administer the QMS by ensuring that processes and procedures needed for the QMS are established and maintained.
- Report to Top Management on the performance of the QMS and any need for improvement.
- Ensure that current versions of documents required by the QMS are being used at all times.
- Ensure that personnel are aware of all applicable legislative and regulatory requirements that pertain to their duties for the operation of the City of Ottawa's drinking water systems.
- Promote awareness of the QMS throughout the Operating Authority and other City of Ottawa departments.

5.0 ELEMENT 5: DOCUMENT AND RECORDS CONTROL

5.1 Purpose and Scope

This procedure explains how key documents and records are stored and accessed. The document control is provided to ensure that:

- Documents required by the QMS are kept current, legible, readily identifiable, and retrievable; as well as stored, protected, retained and disposed of.
- Records are kept legible, readily identifiable, retrievable, securely stored, protected, retained, and disposed of appropriately.

The QMS Coordinator is responsible for ensuring that the most current version of documents and records required by the QMS are accurately referenced in the *Document Master List* and the *Record Master List*. These lists are stored electronically in the DWQMS SharePoint site.

5.2 Document and Record Control Process

The Document Control Procedure (DWP-O-P000598) defines the process steps, roles and responsibilities that apply to the control of QMS documents and records. Specific requirements applicable to the DWQMS are described below.

Audits and management reviews: the results of internal audits, external audits, and management reviews are stored on the network shared drive and/or in BIMS.

Distribution system drawings: *Construction As-Built drawings* and *Water System District Plans* are maintained by the Planning, Real Estate and Economic Development (PRED) Department. These drawings are provided to the Operating Authority in hard copy (annual updates) and are also available on-line through the City of Ottawa's GIS and geo-Ottawa. Corrections identified by field staff are submitted by the Water Distribution Unit to PRED for updating.

Controlled documents: Controlled documents include the Operational Plan and its associated policies, forms, templates, procedures, Operations Manuals, or other documents that are subject to revision and controlled distribution. The number, location and custody of printed copies are documented, and the storage locations for electronic and printed copies have restricted access.

5.2.1 Document Review, Revision and Approval

The DWQMS Operational Plan, as a whole, is approved and authorized by OTM. The Document Control Procedure (DWP-O-P000598) outlines the process for creating of DWQMS-related documents.

5.2.2 Draft Controlled Documents

If a controlled document is in draft form, 'Draft' will be indicated at the beginning of the title. This information is removed when the document is finalized.

5.2.3 Legible and Readily Identifiable

Operating Authority staff are responsible to ensure that QMS documents remain legible and readily identifiable. If a controlled document has been damaged or made illegible, staff are to request a replacement copy from the QMS Coordinator, or the appropriate person responsible for approving and controlling the document.

5.2.4 Retrievable, Stored and Protected

QMS documents and records can be retrieved from the electronic and/or hard copy storage locations noted on the *Document and Record Master Lists*. Storage locations may include:

- The City of Ottawa's RMS (hard copy)
- Controlled hard copies
- Shared computer network servers (electronic records storage)
- SharePoint sites
- SAP business application (integrated corporate software)
- My City (City of Ottawa's internal website)
- BIMS (electronic records storage)
- City of Ottawa public website (Ottawa.ca)
- Watertrax (water quality data from field and laboratory analysis)

5.3 Document and Record Management Tools

DWQMS documents and records are stored in the following locations:

Shared Servers: Shared computer servers are located at the following locations: 951 Clyde Avenue, Britannia WPP, Lemieux WPP, and 100 Constellation (distribution system drawings). The Lemieux WPP server houses the QMS Operational Plan and associated records, Production procedures, Operations Manuals, and other QMS documents and records. Distribution procedures are located on the Clyde Avenue computer server. Water Quality data is stored on the Britannia server and in WaterTrax, a web-based data management service located in Vancouver, British Columbia. Security of these records is achieved by limiting access to the necessary staff members, and through daily/weekly/monthly computer backups, with the monthly backup being stored off-site. As new documents are created or revised, they are being saved in BIMS and published on My City (City's intranet website).

Records Management System (RMS): Records management is conducted in accordance with the City of Ottawa's RMS (physical records) and BIMS (electronic records), as described in the Corporate Records Classification Scheme (CRCS). CRCS serves as a timetable for identifying the length of time a record must be retained in active/inactive status and describes the final disposition schedule for each record. It is accessible on the City's intranet website, My City.

6.0 ELEMENT 6: DRINKING WATER SYSTEM

The municipal drinking water systems operated by the City of Ottawa are listed below:

1) Central System: Britannia Water Purification Plant (WPP), Lemieux Island WPP, and Central Distribution System (MDWL #008-102)
2) Carp Well System (MDWL #008-101)
3) Kings Park Well System (MDWL #008-103)
4) Munster Hamlet Well System (MDWL #008-104)
5) Richmond West Well System* (MDWL #008-107)
6) Shadow Ridge Well System (MDWL #008-106) (the City of Ottawa is the operator, not the owner)
7) Vars Well System (MDWL #008-105)

*The recently constructed Richmond West Well System was commissioned, and with ownership assumed, in 2019.

In addition to operating these water supply systems, the City of Ottawa provides water on a wholesale basis to the Township of Russell, as described below.

6.1 Owner and Operating Authority

The City of Ottawa is the Owner and Operating Authority of each of the municipal drinking water systems listed above with the exception of the Shadow Ridge Well System that is operated by the City of Ottawa and currently under private ownership.

6.2 Supply of Water to the Corporation of the Township of Russell

The City of Ottawa and the Corporation of the Township of Russell have a long term License of Occupation and Water Supply Agreement. Under this agreement, the City provides a supply of central distribution system water through a privately owned watermain within the City's municipal right-of-way to Russell Township's drinking water system.

The system includes the Leitrim Pumping Station and a Metering Chamber that is connected to the Township’s watermain. The Metering Chamber houses a water meter that is used to measure the quantity of water provided to the Township, and includes a backflow check valve and totalizer. These facilities are owned, operated and maintained by the City of Ottawa. The Agreement requires the City to supply the Township with up to 11,860,560 litres of water per day.

The Township is responsible for the quality, testing and any further treatment of the water. However, the agreement states that the water supplied to the Township shall be potable at the point at which it passes through the meter and enters the Township watermain.

6.3 Drinking Water System Descriptions

The following descriptions provide an overview of the source water, treatment, and distribution system for each of the municipal water systems operated by the City. Additional information can be obtained from a number of reference documents including: Annual MECP Inspection Reports, Engineer Reports, Annual Reports,

Summary Reports, Source Water Protection Reports, Process Flow Diagrams, Source Water Reference Guide, and Operations Manuals.

The QMS Coordinator collaborates with the Senior Operations Engineer – WP and Water Quality Engineer to update the drinking water system descriptions as needed.

6.4 Central System

6.4.1 Drinking Water Source Description

6.4.1.1 Watershed

The Ottawa River drainage basin is 146,300 km^2 in area and the entire river is 1,270 km long, covering a portion of southwest Quebec and southeast Ontario. Much of the watershed (and its tributaries) are controlled and regulated by the Ottawa River Regulation Planning Board through approximately 30 storage reservoirs and 43 hydroelectric generating stations.

Approximately 65% of the upstream drainage basin exists within the boreal forests of west Quebec. The remaining 35% of the watershed draining into the western portion of the Ottawa River is primarily comprised of forest and agricultural lands in eastern Ontario.

The Ottawa River is considered to be a relatively pristine source of water with only minor impacts from human, industrial, or agricultural activities. The river is virtually free from industrial/agricultural contaminants such as trace organics, heavy metals, or pesticides. However, as a natural water source, microorganisms are present including algae and a number of waterborne pathogens. In addition, analytical methods can now detect trace levels of several pharmaceutical substances, arising from various upstream sewage effluents.

The Ottawa River can be characterized by its low turbidity (1 – 40 NTU, average=3.5 NTU), low hardness (30 mg/L CaCO3) and alkalinity (18 – 40 mg/L, average=26 mg/L), as well as the relatively high organic content (DOC=7.5 mg/L) and high colour (30 – 40 TCU). These properties can be attributed to the vast region of forest and vegetation that naturally give the water a ‘tea’ colour. The river flows over sedimentary bedrock and as such does not contain appreciable amounts of water hardness (calcium and magnesium).

6.4.1.2 Description of Land Uses

The following table indicates the relative types of land-use in the watershed:

Description	Area (Km^2) Watershed	
Forest	109,657	75.20%
Wetland	1,978	1.40%
Grassland/Shrub	8,081	5.50%
Agriculture	8,908	6.10%
Rock/Barren	870	0.60%
Water	14,741	10.10%
Developed	948	0.60%
Other/Unclassified	733	0.50%
Total	**145,916**	**100.00%**

Forestry (logging, pulp and paper industry) was the major land use of the Ottawa River basin historically, and resulted in the main source of pollution in the Ottawa River. Two upstream pulp and paper mills currently exist in Quebec at the towns of Portage-du-Fort and Témiscaming (approximately 100km and 400km northwest of the City of Ottawa, respectively).

Agricultural, urban and industrial development has been, for the most part, relatively recent and largely limited to the lower part of the basin, downstream from Ottawa to Carillon, Quebec. Exceptions include the nuclear energy facilities in the Chalk River area, the agricultural area near New Liskeard, northwest of Lake Timiskaming, and the two upstream pulp and paper mills noted above.

6.4.1.3 Common Source Water Fluctuations and Resulting Operational Challenges and Threats

From time to time, the Ottawa River experiences changes in water quality that can pose a challenge for water treatment. Several of the key challenge conditions are presented in the table below for reference:

Type	Cause	Affected Plant		Operational Challenges/Threats
		Britannia	Lemieux	
Event	Frazil ice blocking the screens		X	Every 1-2 years, Frazil ice can form on the Lemieux Island intake pipe and travelling screens resulting in a severe flow restriction and/or plant shutdown for several days.

Type	Cause	Affected Plant		Operational Challenges/Threats
		Britannia	Lemieux	
Event	Low river level due to dam operation		X	Maintenance or failure of the Chaudiere dam might lower the river level to affect the intake for the Lemieux Island WPP. Typically, notification is given by the Dam Operator so that a plant shutdown can be scheduled.
Event	Extreme rainfall and/or windstorm	X	X	Turbidity in raw water generally increases after a heavy rainfall or very high winds over Lac Deschenes (Britannia).
Event	Water Temperature	X	X	Settling characteristics pose a challenge during winter cold water conditions (water temperature <1 ºC) resulting in limited plant production capacity. During summer, biological growth in the distribution system can affect water quality.
Seasonal	Summer weather	X	X	Demand for water is generally higher in the summer months.
Event	Flooding / heavy rainfall	X	X	Both WPPs are built at 1-in-100 year flood line boundary – low/moderate risk for Lemieux low-lift station and Britannia high-lift pump-house.
Historical Variation	Weather patterns, upstream dams	X	X	The river fluctuates between minimum and maximum flow values of approximately 300 and 5800 m^3/s. Since the City typically draws only 3 m^3/s on a typical day, this does not pose a high risk.
Event	Elevated E. coli Levels		X	Seagull population near the Lemieux Island intake leads to increased bacterial counts (eg. E.coli) from faecal shedding during early summer. The treatment process can easily handle these increased levels of bacteria.
Event	Water quality impact of low water levels		X	Low water level at the Lemieux Island intake can result in different water characteristics including turbidity and taste/odour, usually associated with changes at the dam.
Event	Changes in river ecology	X	X	Every 3-4 years, the Ottawa River can experience a more pronounced musty/earthy odour, usually lasting 2-4 weeks; this can result in many customer calls;

Type	Cause	Affected Plant		Operational Challenges/Threats
		Britannia	Lemieux	
Event	Landslide in upstream watershed	X	X	Upstream tributary experiences landslide or release of mud/soil into river (eg. Bonnechere River, 2016) may affect raw water turbidity.
Event	Spill	X	X	Potential spill of chemical or fuel into upstream portion of river (eg. diesel fuel, tritium, phenol, glycol, etc.). River spill model developed to predict travel time and magnitude of spill concentration.
Event	Spill or sewage by-pass	X	X	Upstream release of untreated sewage effluent, or by-pass of sewage treatment could discharge microbial contamination into river. Levels are typically handled by treatment barriers.

6.4.2 Description of the central treatment plants and distribution system

The City of Ottawa owns and operates two treatment plants to supply drinking water – Lemieux Island WPP (capacity: 400 ML/d; constructed in 1931) and Britannia WPP (capacity: 360 ML/d; constructed in 1961). The source water for both plants is the Ottawa River. Both plants use identical water treatment processes and have undergone significant expansion and modernization over the years.

Raw water enters the treatment plants through large intake pipes that extend into the main flow of the river. The treatment process makes use of the “multiple barrier” principle. A series of treatment steps successively remove undesirable substances such as colour, suspended particles, algae, bacteria, and viruses from the water.

The purification process in Ottawa consists of the following steps:

1. coagulation
2. flocculation
3. sedimentation
4. filtration
5. primary disinfection
6. pH adjustment
7. secondary disinfection
8. fluoridation

The treatment processes are illustrated in the flow charts provided for the Lemieux Island WPP and the Britannia WPP below:

Figure 1 - Lemieux WPP Flow Chart

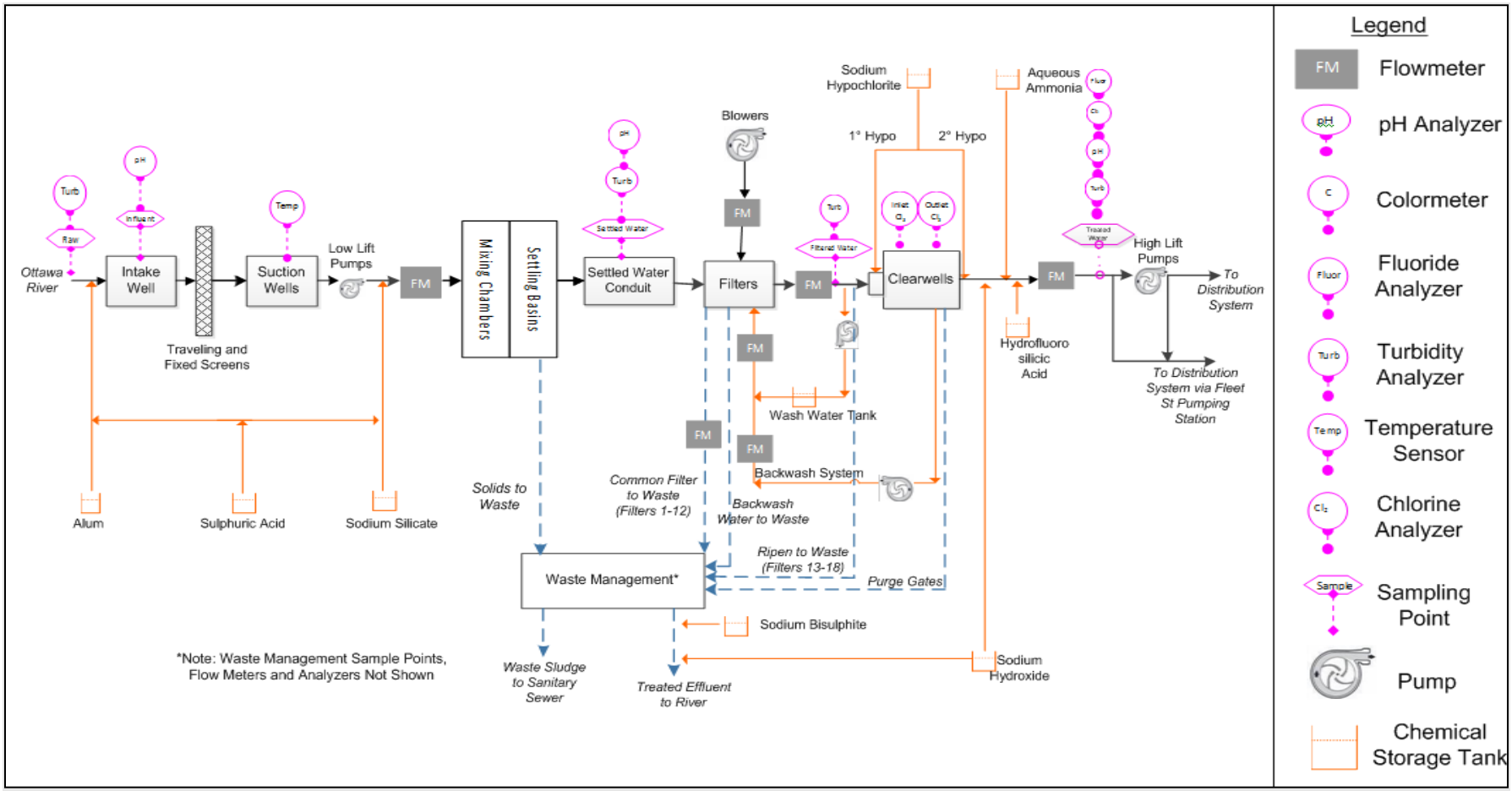
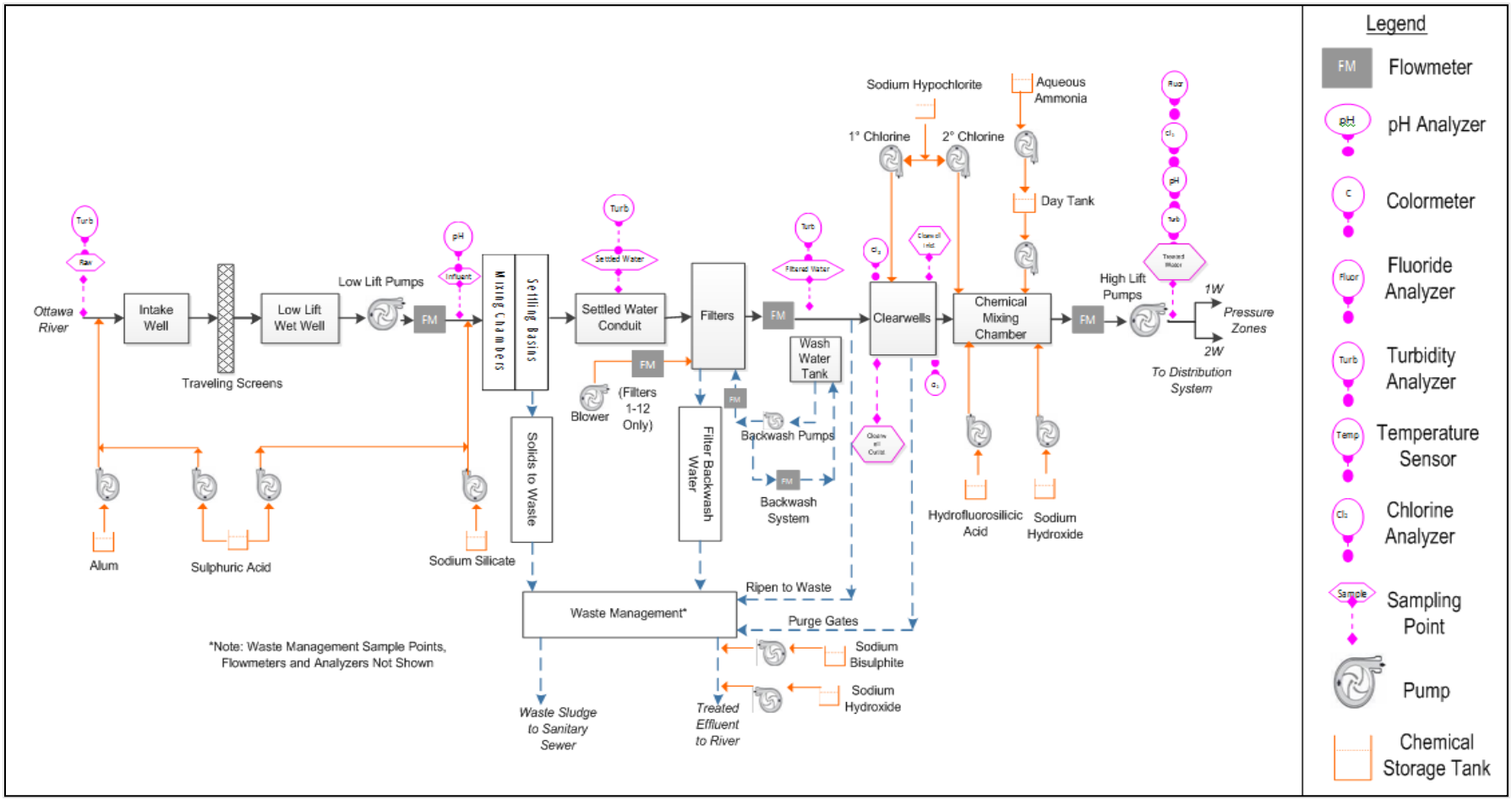


Figure 2 - Britannia WPP Flow Chart



The multi-barrier treatment process results in water that is clear, palatable, and safe to drink – consistently meeting all Provincial standards and Federal guidelines for drinking water quality. After the treatment process, water is pumped through the distribution network of watermains (over 3,000 km of watermain piping) to reach over 900,000 customers over an area roughly 25 km by 50 km. Treated water from both the Britannia and Lemieux Island WPPs is blended as it travels through a common distribution system. Pressure and storage requirements are met through the operation of 16 pumping stations, 5 reservoirs and 4 elevated tanks located throughout a distribution system of 12 pressure zones. The pressure zones associated with the Central Distribution System are identified in the map provided in Appendix B and described below:

Pressure Zone	Elevated Tanks	Reservoirs	Pump Stations	Supplied From	Supply To
1W	-	Carlington Heights	Lemieux High Lift Britannia High Lift Fleet Street	Ottawa River Ottawa River Lemieux	
1E	-	Orleans	Hurdman Bridge	1W	MONT, 2E, 2W2C
2W2C	-	Glen Cairn, Fallowfield	Britannia High Lift, Carlington Heights	Ottawa River 1W	ME, MG, 3W, 3SW
2C2W	Conroy Road	Ottawa South	Billings Bridge	1W	1E, 2W2C
2E	Innes Road	-	Forest Ridge, Orleans	1E	2E
3W	Stittsville	-	Glen Cairn Campeau Drive	2W	3SW
3SW	Moodie	-	Barrhaven	2W	BARR
MONT	-	-	Montreal Road, Brittany Drive	1E	MONT
MG	-	-	Morgan’s Grant	2W2C	MG

Pressure Zone	Elevated Tanks	Reservoirs	Pump Stations	Supplied From	Supply To
SUC	-	-	Ottawa South South Gloucester	2W2C	3C
LEIT	-	-	Leitrim	SUC	LEIT, Township of Russell

The total volume of water stored in reservoirs is 275 Million Litres, which is roughly equivalent to the average daily amount of water produced. All treatment, pumping, and storage systems are controlled by a dedicated computer control system and monitored by MECP-certified Water Treatment Operators 24 hours per day. In the event of an interruption of utility power, all remote pumping stations and well systems are equipped with a backup power supply by means of a standby generator and/or diesel-driven pumps.

Wastewater from both WPPs originate from various processes, such as filter backwash, settling basin sludge, process analyzers and floor drains. This waste is collected and sent to the Waste Management Facility (WMF) and then is either directed to the Ottawa River or to the sanitary sewer as required. A number of control items exist to treat and direct these wastewater streams. The WMF has four Decant Tanks, one Equalization Tank and several sets of redundant pumps that direct wastewater from the tanks. There is also a chemical system that controls pH and chlorine levels as wastewater re-enters the Ottawa River. The sludge from this process is sent to the City's Robert O. Pickard Environmental Centre (ROPEC) via a force main.

6.4.3 Critical Processes Relied Upon

Rapids, dams and control structures: numerous dams and generating facilities exist on the Ottawa River upstream and/or downstream of the Lemieux and Britannia WPPs. The integrated management of the principal reservoirs of the Ottawa River basin is completed by the Ottawa River Regulation Planning Board. However, the WPPs do not rely on any critical upstream or downstream processes to ensure the provision of safe drinking water.

Wastewater treatment: ROPEC, operated by the City of Ottawa, treats the waste residual solids generated during the water treatment process from both the Britannia and Lemieux Island WPPs. These waste solids are discharged directly into the sanitary sewer system from each treatment plant.

6.5 Carp Well System

6.5.1 General

The Carp Well System is a communal water supply that provides drinking water to the residents and businesses of Carp, Ontario. The system is owned and operated by the City of Ottawa and serves a population of approximately 2,000 residents.

6.5.2 Description of aquifer and well sources

The local sand and gravel aquifer is the water bearing formation that supplies the communal wells. Studies have determined that the aquifer is primarily recharged via infiltration through the extensive sand deposits that come to the surface in the higher land adjacent to the Carp Ridge as well as to the north end of the village where the 'Diefenbunker' museum is located.

Groundwater flow in the sand and gravel aquifer is inferred to occur from south to north based on groundwater elevations recorded from the MECP Water Well Information System. Locally, within the village of Carp, groundwater flow directions will be affected by pumping of the communal supply wells and the sandy infiltration areas along the Carp Ridge. The water table at each well varies seasonally and when the well pump is running. The water level in Well No. 1 ranges between 3.95 metres and 4.2 metres below the well cap elevation. The water level in Well No. 2 ranges between 4.1 metres and 4.65 metres below the well cap elevation. During severe summer drought conditions, water levels in the Carp production wells were not adversely impacted, indicating a stable and steady supply of groundwater.

The wells are situated within the Carp village, a few blocks east of the main intersection. To the northeast of the facility there are grazing lands, to the south lies the CNR right-of-way. The well site is neighboured by residential properties to the north, east and west. The agricultural land used for pasture is situated approximately 200 metres east of the well site. A farm and fertilizer supply store located on the south side of the CNR tracks, approximately 150 metres southwest of the well site, recently terminated operations. However, the former land use is still considered a potential risk.

6.5.2.1 Source water quality

The source water has a moderate level of hardness (170 mg/L) and a noticeable concentration of naturally occurring hydrogen sulfide, which is oxidized during treatment to result in an objectionable "sulphur" taste/odour in the treated water. Both supply wells contain natural levels of ammonia ranging from 0.2 – 0.4 mg/L. Fluoride is present naturally in the groundwater at a concentration of approximately 0.6 mg/L. In addition, there is a measurable concentration of bromide (0.15 mg/L) that occurs naturally in the geology. The presence of bromide results in a higher proportion of brominated compounds in the disinfection by-products for Carp. Most importantly, routine bacteriological testing over many years have demonstrated that both wells No.1 and No.2 are clear from the presence of Total coliform or E.coli bacteria.

6.5.2.2 Monitoring Wells

The Carp Well System has six monitoring wells installed at two site locations, drawing samples from various groundwater depths in the aquifer. These "sentinel" wells are currently inactive but could be tested in the event of a spill or concern for aquifer contamination. Early warning of aquifer contamination is however provided through extensive monitoring of the production wells, testing that is above and beyond regulatory requirements.

6.5.2.3 Common Source Water Fluctuations and Resulting Operational Challenges and Threats

Type of Fluctuation	Cause of Fluctuation	Operational Challenges/Threats
Water level	Prolonged hot and dry weather could impact aquifer	Past drought periods have not impacted well levels or capacity

6.5.3 Description of the treatment and distribution system

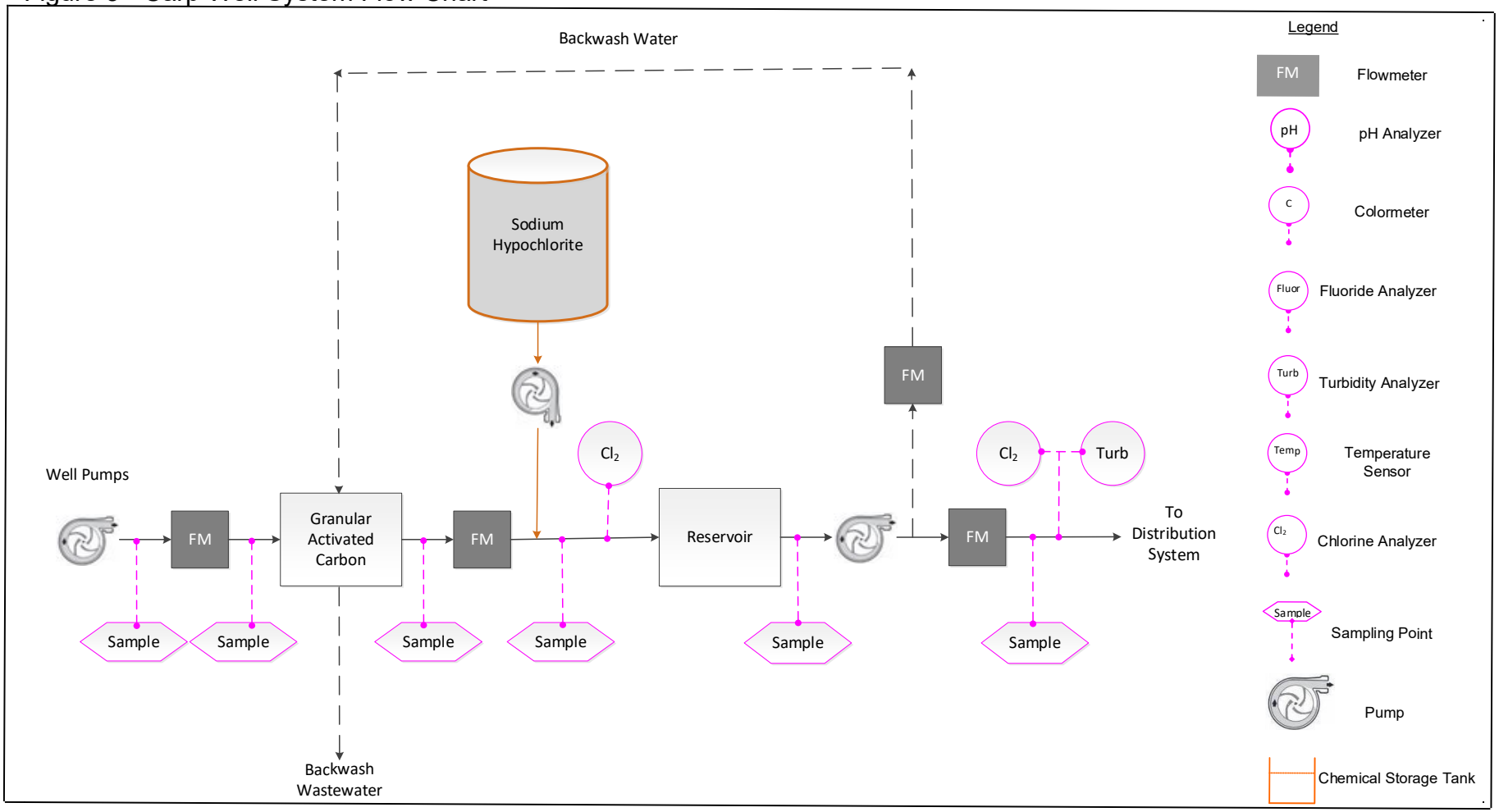
The treatment process for the Carp Well System consists of the following steps:

1. Chlorine disinfection
2. Water storage
3. High-lift pumping

Due to the natural ammonia present in the source water, chlorine is dosed at a high enough concentration to achieve “breakpoint” chlorination resulting in a stable free chlorine residual for disinfection. Since the source water is considered to be secure groundwater (non-Groundwater Under Direct Influence (GUDI)), it requires a minimum disinfection level of 2-log virus inactivation at all times. The existing chlorine dose and contact time easily meet these regulatory requirements. The treatment process results in water that is clear and safe to drink although there is a noticeable sulphur taste that is of aesthetic concern to some customers.

The process flow chart below illustrates the treatment process at the Carp Well System:

Figure 3 - Carp Well System Flow Chart



Treated water is pumped through the distribution network with a free chlorine concentration in the range of 1.0 mg/L maintained throughout the supply system. Water is delivered to the distribution system by a 400 mm diameter watermain connecting to a 200 mm water main on Salisbury Street. From there, the water is distributed throughout the Village of Carp. On-line analyzers are used to monitor the chlorine residual at the treatment plant and within the distribution system (on-line analyzer at the Carp Arena). All treatment, pumping, and storage systems are controlled by a dedicated computer control system and monitored by MECP-certified Water Treatment Operators 24 hours per day from the Britannia WPP control room. A certified operator visits the well system twice per week to collect water samples and conduct on-site water quality tests.

The distribution system is operated as a “closed” pressure zone, relying on mechanical pump operation to provide water pressure to the system. A standby generator and/or diesel-powered pump are installed to provide water pumping in the event of a power failure.

6.6 Kings Park Well System

6.6.1 General

The Kings Park Well System is a communal water supply that provides drinking water to a small residential area located within Richmond, Ontario. The system is owned and operated by the City of Ottawa and serves a population of approximately 500 residents

6.6.2 Description of aquifer and well sources

Both source wells draw from the Nepean Formation aquifer that is known to produce groundwater of high quality. Flow in this aquifer is mainly through fractures due to the low primary porosity of the sandstone. Groundwater flow in the area is from west to east. The static water level, measured from the top of the well casing, is typically 4.2 metres and 4.0 metres for wells No.1 and No.2, respectively. When the well pumps are in operation, the depth to the water level from the top of the well casing is about 4.3 metres and 4.1 metres for wells No.1 and No.2, respectively. Pumphouse No.1 is located within a residential area. Pumphouse No.2 is neighboured by a residential area (south and west) and by an open park (north and east).

6.6.2.1 Source water quality

The source water has a moderately high level of hardness (340 mg/L). The groundwater contains a slight amount of ammonia (0.08 mg/L), and fluoride is present at a concentration of approximately 0.45 mg/L. In addition, there is a substantial concentration of bromide (0.43 mg/L) that occurs naturally in the geology. The presence of bromide results in a higher proportion of brominated compounds in the disinfection by-products for this system. The source water also contains iron at a concentration of 0.4 mg/L, which is above the aesthetic guideline of 0.3 mg/L. Iron can be oxidized during chlorination and can at times result in rust or iron deposits in the water distribution system. Most importantly, routine bacteriological testing over many years have demonstrated that both Well No.1 and No.2 are clear from the presence of Total coliform or E.coli bacteria.

6.6.2.2 Monitoring Wells

The Kings Park Well System has nine monitoring wells installed at two site locations, drawing samples from various groundwater depths in the aquifer. These “sentinel” wells are currently inactive but could be tested in the event of a spill or concern for aquifer contamination. Early warning of aquifer contamination is however provided through extensive monitoring of the production wells, testing that is above and beyond regulatory requirements.

6.6.2.3 Common Source Water Fluctuations and Resulting Operational Challenges and Threats

Type of Fluctuation	Cause of Fluctuation	Operational Challenges/Threats
High Iron	Raw water quality	Occasional rusty iron deposits result in discoloured water in the distribution system, watermain cleaning and flushing required
Water Level	Prolonged hot and dry weather could impact aquifer	Past drought periods have not impacted well levels or capacity

6.6.3 Description of the treatment and distribution system

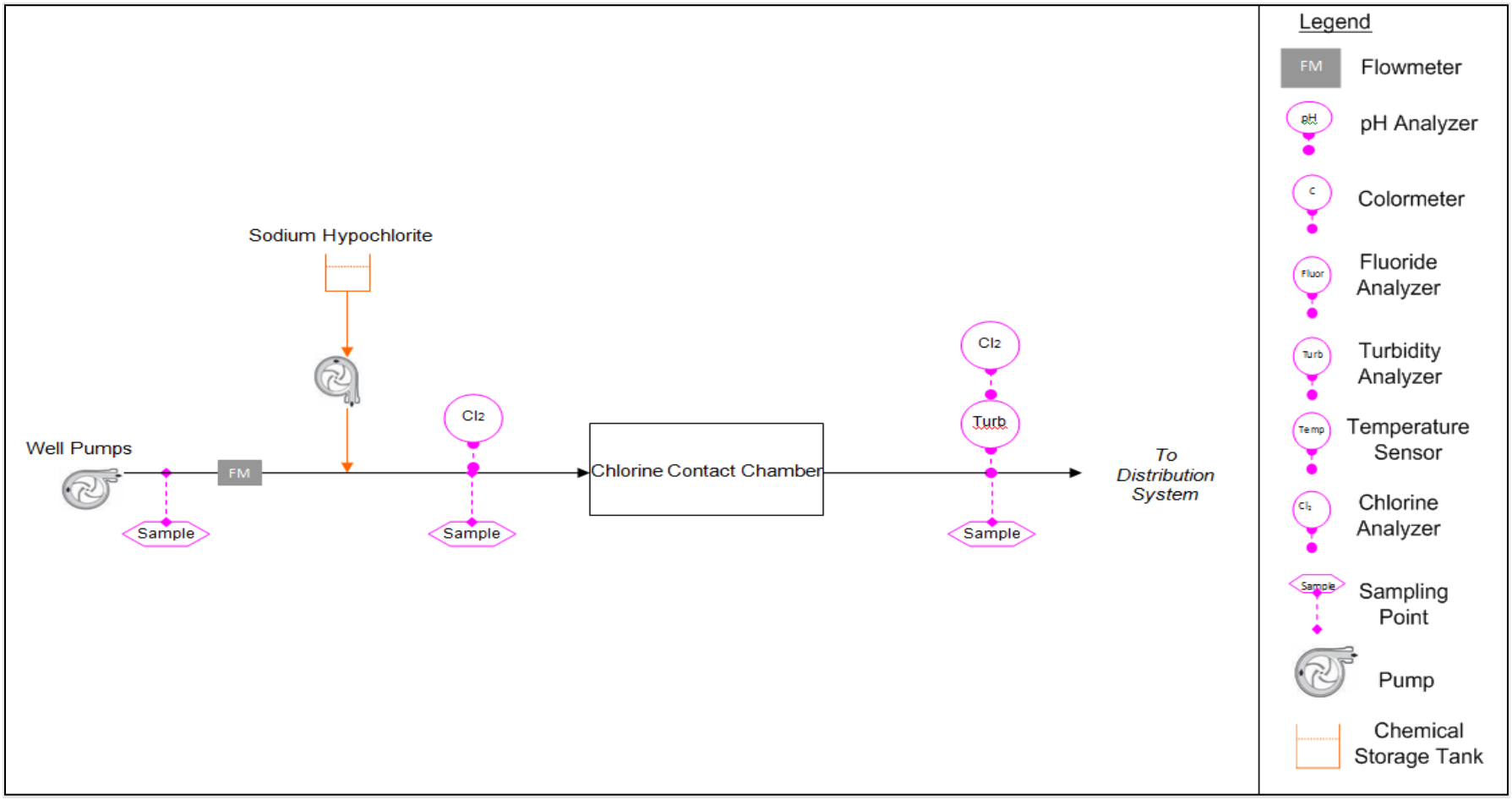
The treatment process for the Kings Park Well System consists of the following steps:

1. Pumping
2. Chlorine disinfection
3. Chlorine contact chamber

Since the source water is considered to be secure (non-GUDI) groundwater, it requires a minimum disinfection level of 2-log virus inactivation at all times. The existing chlorine dose and contact time easily meet these regulatory requirements. The treatment process results in water that is clear and safe to drink.

The process flow chart illustrates the treatment processes at the Kings Park Well System.

Figure 4 - Kings Park Well System (No.1 and No.2) Flow Chart



Treated water is pumped into the distribution system with a free chlorine concentration in the range of 1.0 mg/L. Both the treatment and pumping systems are controlled by a dedicated computer control system and monitored by MECP-certified Water Treatment Operators 24 hours per day from the Britannia WPP control room. Since the two stations are at far ends of the distribution system, the chlorine analyzer at the standby station provides continuous measurement of distribution chlorine residual concentration. Additionally, a certified operator visits each well station twice per week to collect water samples and conduct on-site water quality tests.

The distribution system is operated as a “closed” pressure zone, relying on mechanical pump operation to provide water pressure to the system. A standby generator and/or diesel-powered pump are installed to provide water pumping in the event of a power failure.

6.7 Munster Hamlet Well System

6.7.1 General

The Munster Well System is a communal water supply that provides drinking water to the community of Munster Hamlet, Ontario. The system is owned and operated by the City of Ottawa and serves a population of approximately 1,350 residents.

6.7.1.1 Description of aquifer and well sources

The production wells both draw from the Nepean Formation that is known to be a good groundwater producing aquifer. Flow in this aquifer is mainly through fractures due to the low primary porosity of the sandstone. Groundwater flow in this area is from west to east. The static water level, measured from the top of the well casing, is typically 17.5 metres and 19.6 metres, for wells No.1 and No.2, respectively. When the well pumps are in operation, the water level decreases to approximately 37.5 metres and 39.0 metres below the top of the well casing for wells No.1 and No.2, respectively. The well facility is located with a residential area to the north and an open field to the south.

6.7.1.2 Source water quality

The source water has a moderately high level of hardness (270 mg/L). The groundwater contains a small amount of free ammonia (0.11 mg/L), and fluoride is present at a concentration of approximately 0.60 mg/L. In addition, there is a measurable concentration of bromide (0.22 mg/L) that occurs naturally in the geology. The presence of bromide results in a higher proportion of brominated compounds in the disinfection by-products for this system. The source water also contains iron at a concentration ranging from 0.15 – 0.65 mg/L, which at times is above the aesthetic guideline of 0.3 mg/L. Iron can be oxidized during chlorination and can at times result in rust or iron deposits in the water distribution system. Most importantly, routine bacteriological testing over many years have demonstrated that both Well No.1 and No.2 are clear from the presence of Total coliform or E.coli bacteria.

6.7.1.3 Monitoring Wells

There are no monitoring or sentinel wells associated with the Munster Well System.

6.7.1.4 Common Source Water Fluctuations and Resulting Operational Challenges and Threats

Type of Fluctuation	Cause of Fluctuation	Operational Challenges/Threats
Elevated Turbidity	Simultaneously operating both wells at the same time.	Well No.2 has experienced high turbidity levels in the past. Both well discharge valves are throttled to limit flow and reduce turbidity levels.
Aquifer Level	Operation of pumps	When pumping, the water level in wells No.1 and No.2 drop to approximately 37.5 m and 39.0 m from the well cap, respectively. This is not an operational concern for the well system, but could be an issue for the neighbouring private wells.
High Iron	Raw water quality	Occasional rusty iron deposits result in discoloured water in the distribution system, watermain cleaning and flushing required
Water Level	Prolonged hot and dry weather could impact aquifer	Past drought periods have not impacted well levels or capacity
Ammonia levels	Seasonal increase during spring	Slight fluctuations in natural ammonia in source wells requires adjustment of the chlorine dose

6.7.2 Description of the treatment and distribution system

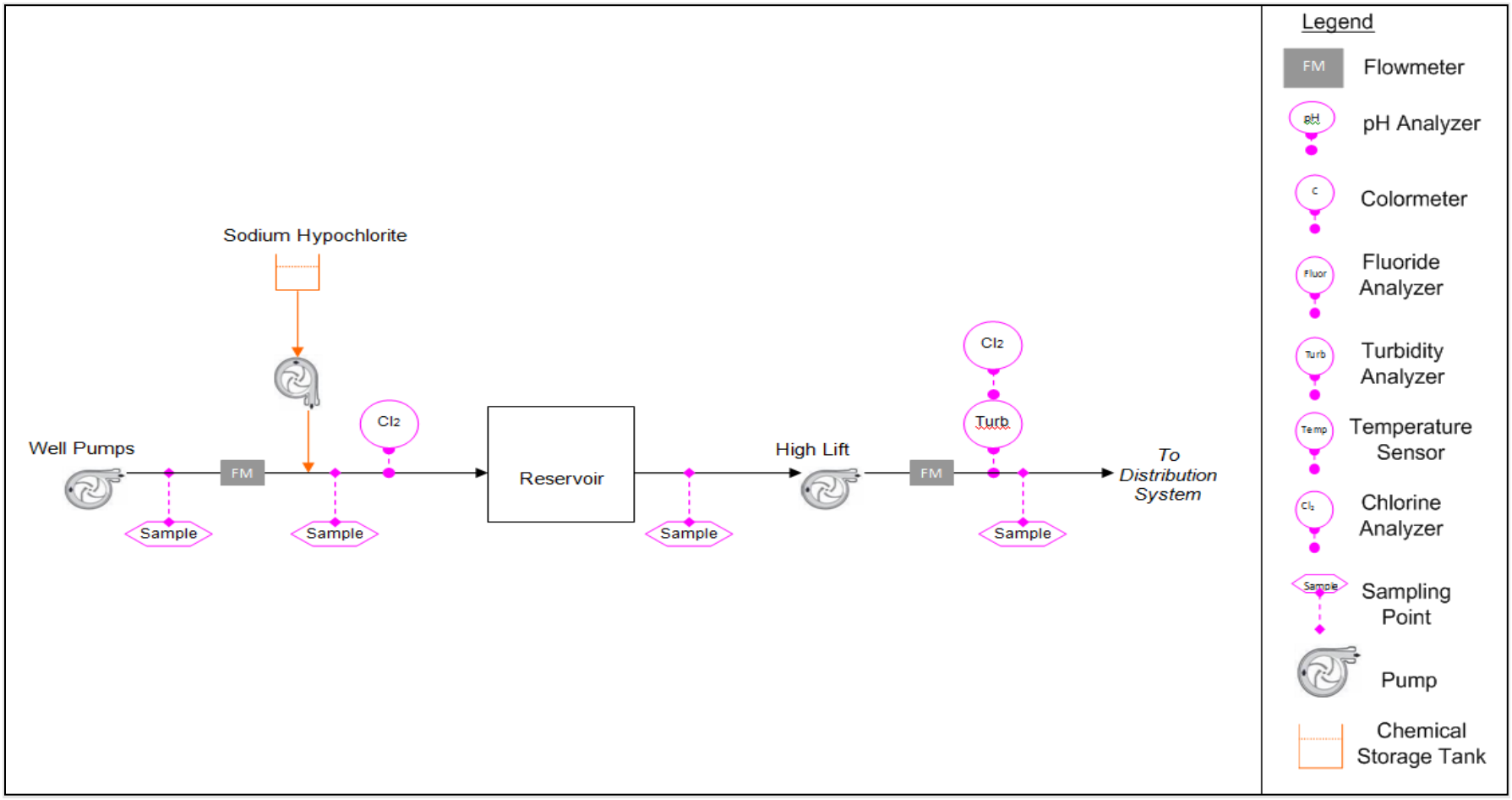
The treatment process for the Munster Well System consists of the following steps:

1. Chlorine disinfection
2. Water storage
3. High-lift pumping

Due to the natural ammonia present in the source water, chlorine is dosed at a high enough concentration to achieve “breakpoint” chlorination resulting in a stable free chlorine residual for disinfection. Since the source water is considered to be secure (non-GUDI) groundwater, it requires a minimum disinfection level of 2-log virus inactivation at all times. The existing chlorine dose and contact time easily meet these regulatory requirements. The presence of free chlorine also oxidizes natural dissolved iron to form an iron oxide precipitate in the reservoir and distribution piping. The system requires occasional flushing and swabbing operations to remove iron sediment. Overall, the treatment process results in water that is clear and safe to drink.

The process flow chart below illustrates the treatment processes at the Munster Well System:

Figure 5 - Munster Hamlet Well System



Treated water is then pumped through the distribution network to reach water customers in Munster Hamlet. All treatment, pumping, and storage systems are controlled by a dedicated computer control system and monitored by MECP-certified Water Treatment Operators 24 hours per day from the Britannia WPP control room. On-line analyzers are used to monitor the chlorine residual at the treatment plant and within the distribution system (on-line analyzer at the Munster Community Centre). In addition, a certified operator visits the well system twice per week to collect water samples and conduct on-site water quality tests.

The distribution system is operated as a “closed” pressure zone, relying on mechanical pump operation to provide water pressure to the system. A standby generator and a diesel-powered pump are installed to provide water pumping in the event of a power failure.

6.8 Richmond West Well System

6.8.1 General

The recently constructed Richmond West Well System was commissioned, and with ownership assumed, in 2019. The Richmond West Well System is a communal water supply that provides drinking water to a residential area located in Richmond, Ontario. The system is owned and operated by the City of Ottawa and is anticipated to service up to 1,000 housing units in its first ten years of operation.

6.8.2 Description of aquifer and well sources

Both source wells draw from the Nepean Formation aquifer, which consists of interbedded sandstone and dolostone, and is known to produce groundwater of high quality. Flow in this aquifer is mainly through fractures, due to the low primary porosity of the bedrock. Groundwater flow in the area is from west to east.

There are two source wells, PW09-1 and PW08-1. Both are artesian wells with positive pressure head at the ground surface (the static hydraulic head of both wells is at a higher elevation than the top of the well casing). Well pump tests completed at the site suggest a stable and steady supply of groundwater.

The wells are situated at the western edge of the Village of Richmond, within the village limits. There are some commercial developments located to the east of the facility. Once built, the facility will be surrounded by the residential area it is designed to serve. Further to the north, west and south of the facility are rural properties used for agricultural purposes, and forested lands. To the east is the Village of Richmond.

6.8.2.1 Source water quality

Based on sampling done to assess treatability, prior to construction of the communal well system, the source water was found to have a moderately high level of hardness (310 mg/L). The source water also contains iron at a concentration of 0.23 mg/L, which is below the aesthetic guideline of 0.3 mg/L. No Total Coliform or E.coli indicator bacteria were detected in any of the samples taken.

Richmond water has a slightly elevated natural sodium concentration (24 mg/L) which is common in most area groundwater sources. This level is not a concern for the general

public, but is slightly above the 20 mg/L advisory limit for people with high blood pressure. Accordingly, the City will advise residents of this situation, and will likely be reportable as an Adverse Water Quality Incident for sodium, reportable every 5 years as per MECP regulations.

6.8.2.2 Common source water fluctuations and operational challenges

Information regarding source water fluctuations and operational challenges will be included as part of a future revision of the Operational Plan, following the commissioning of the facility.

6.8.3 Description of the treatment and distribution system

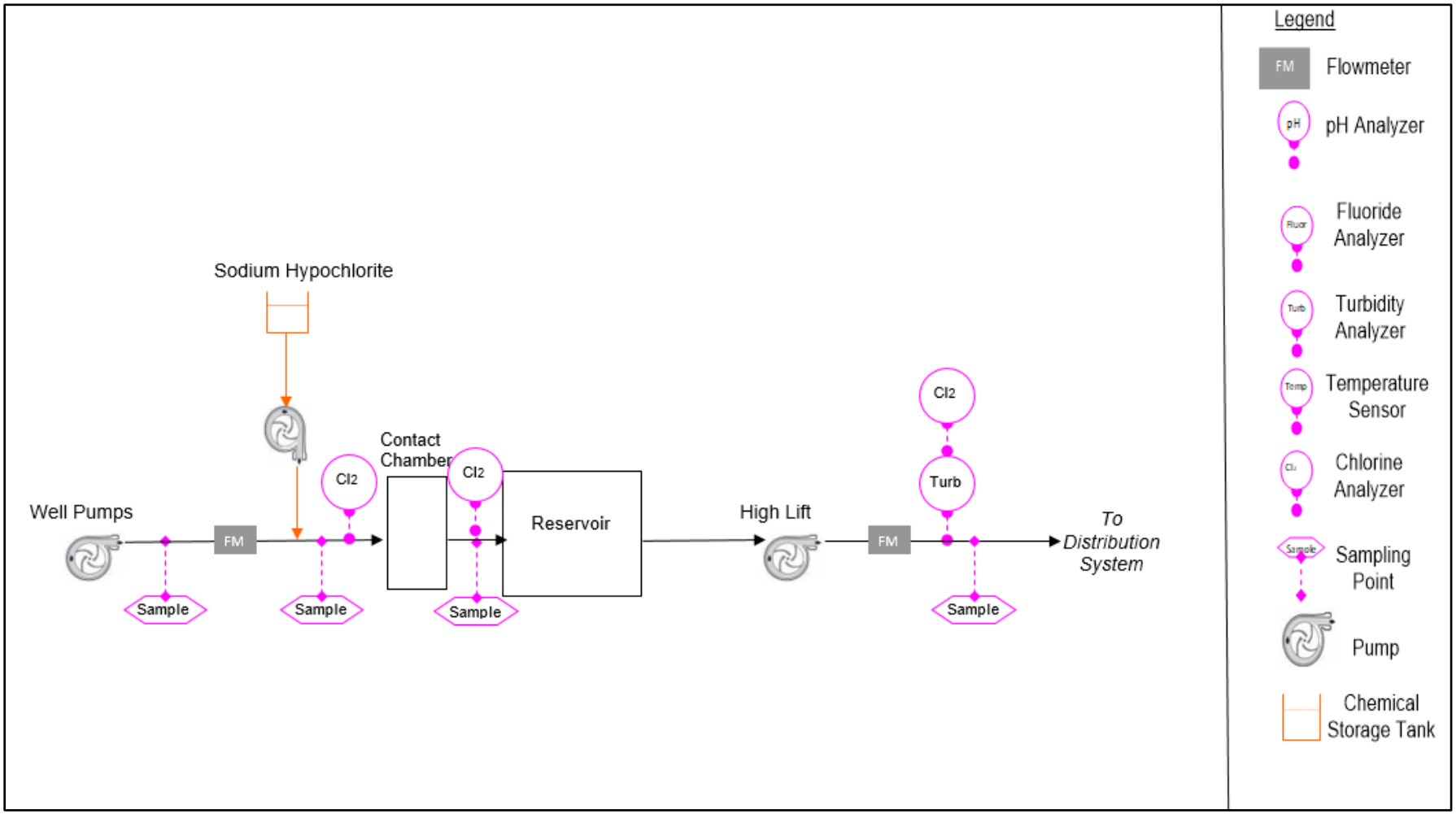
The treatment process for the Richmond West Well System consists of the following steps:

1. Groundwater pumping
2. Chlorine disinfection
3. Chlorine contact chamber
4. Treated water storage
5. High lift pumping

Treated water is pumped via a combination of five high lift pumps into the distribution system with a free chlorine concentration in the range of 1.0 mg/L. Water is delivered to the distribution system by either a larger header for the high flow (e.g. fire) pumps or a smaller header for typical water delivery. The two headers combine into one before the leaving the facility. From there, the water is distributed throughout the Richmond West development. On-line analyzers are used to monitor the chlorine residual immediately after the addition of chlorine, at the outlet of the contact chamber, leaving the treatment plant, and within the distribution system (in a dedicated chlorine monitoring station).

The process flow chart below illustrates the treatment processes at the Richmond West Well System:

Figure 6 – Richmond West Well System



Both the treatment and pumping systems will be controlled by a dedicated computer control system and monitored by MECP-certified Water Treatment Operators 24 hours per day from the Britannia WPP control room. Additionally, a certified operator visits the well station twice per week to collect water samples and conduct on-site water quality tests.

The distribution system is operated as a “closed” pressure zone, relying on mechanical pump operation and pressure relief valves to provide water pressure to the system. Two standby generators are installed to provide water pumping in the event of a power failure; one generator to supply backup power to the well pumps, facility and high lift pumps 1 through 4, and the second generator dedicated to high lift pump 5.

6.9 Shadow Ridge Well System

6.9.1 General

The Shadow Ridge Well System is a communal water supply that provides drinking water to a residential community located near Greely, Ontario. The system is operated by the City of Ottawa but is owned by Donwell Holdings Ltd., serving a population of approximately 500 residents.

6.9.2 Description of aquifer and well sources

Both source wells draw from the coarse granular overburden aquifer and are completed at the bedrock of the Oxford formation. Regional groundwater flow in the overburden and gravel/weathered bedrock aquifer is deemed to be towards the southeast. The static water level, measured from the top of the well casing, is typically 6.4 metres and 6.2 metres, for wells No.1 and No.2, respectively. These levels can vary seasonally. The long-term aquifer level in the well was calculated in the *Hydrogeological Assessment by Simmering & Associates Ltd.* (Simmering, 1998). The maximum drawdown expected is 0.21 metres after 10 years at full development. For Phase I, the maximum drawdown expected is 0.07 metres. A residential area is located north of the water treatment facility and to the south is a sand and gravel quarry.

6.9.2.1 Source water quality

The source water has a moderately high level of hardness (325 mg/L). The groundwater has low organic carbon content and low amounts of fluoride (0.07 mg/L), iron (0.04 mg/L), or manganese (0.003 mg/L). Of particular note is the level of nitrate present in the source wells, likely resulting from surface impacts into the aquifer. The nitrate concentration has steadily increased each year with current levels of 4.5 mg/L (as N) which is nearly half of the Maximum Acceptable Concentration of 10.0 mg/L for nitrate. When the well system was built, a GUDI study was not completed by the owner/developer. Therefore, for regulatory purposes, the source wells are considered to be GUDI with minimum treatment requirements in accordance with O.Reg.170/03. Routine bacteriological testing over many years has demonstrated that both wells No.1 and No.2 are clear from the presence of Total coliform or E.coli bacteria.

6.9.2.2 Monitoring Wells

The Shadow Ridge Well System has thirteen monitoring wells located upstream of the production wells in four locations. These “sentinel” wells are currently inactive but could be tested in the event of a spill or concern for aquifer contamination. Early warning of aquifer contamination is however provided through extensive monitoring of the production wells, testing that is above and beyond regulatory requirements.

6.9.2.3 Common Source Water Fluctuations and Resulting Operational Challenges and Threats

Type of Fluctuation	Cause of Fluctuation	Operational Challenges/Threats
Water Level	Prolonged hot and dry weather could impact aquifer	Past drought periods have not impacted well levels or capacity
Nitrate	Increasing nitrate concentration in both source wells, likely from surface impacts in the aquifer	Gradual increase in nitrate from 1.5 mg/L to 5 mg/L over 10 years could eventually exceed the health-based drinking water standard of 10 mg/L
High water flowrate and disinfection level	High water demand from customers, flushing, or increased development	At very high flowrates (>1200 m3/d), the chlorine contact chamber may not provide the minimum required 0.5-log Giardia inactivation

6.9.3 Description of the treatment and distribution system

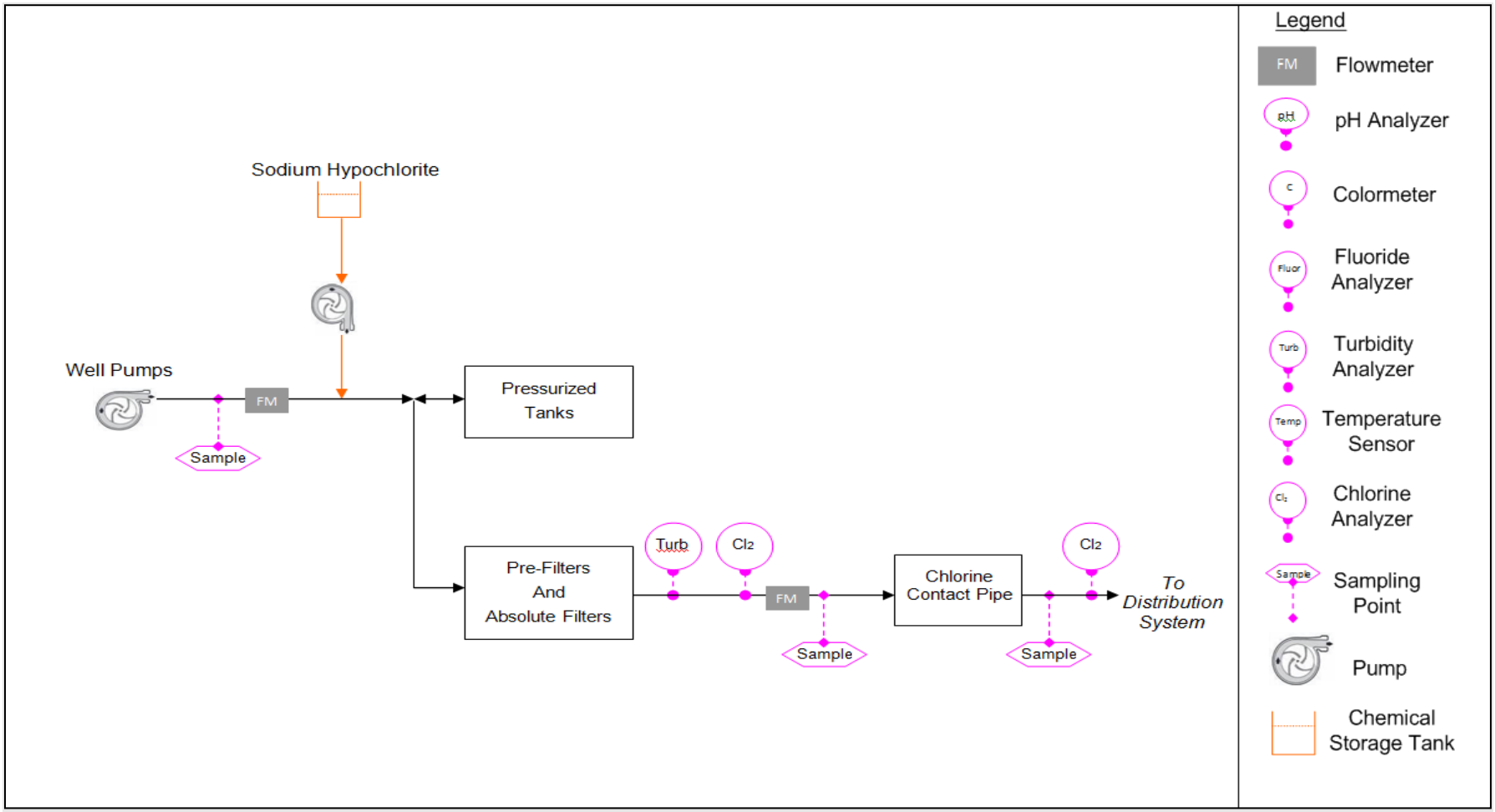
The treatment process for the Shadow Ridge Well System consists of the following steps:

1. Pumping
2. Microfiltration using cartridge filters (5 micron and 1 micron)
3. Chlorine disinfection
4. Chlorine contact chamber
5. Pressure tanks to sustain pressure in the distribution system

Since the source water is considered to be GUDI groundwater, it requires a minimum 3-log Giardia reduction and 4-log virus reduction. Since the cartridge filters are credited with 2.5-log physical removal of Giardia, chlorine disinfection is required to meet 0.5-log Giardia inactivation and 4-log virus inactivation at all times. The existing chlorine dose and contact time consistently meet these regulatory requirements. The treatment process results in water that is clear and safe to drink.

The process flow chart illustrates the treatment process for the Shadow Ridge Well System.

Figure 7 - Shadow Ridge Well System



Treated water is pumped into the distribution system with a free chlorine concentration in the range of 0.8 mg/L. All treatment, pumping, and storage systems are controlled by a dedicated computer control system and monitored by MECP-certified Water Treatment Operators 24 hours per day from the Lemieux Island WPP control room. On-line analyzers are used to measure chlorine residual concentration and turbidity (cloudiness) of the treated water. In addition, a certified operator visits the well system twice per week to collect water samples and conduct on-site water quality tests. Chlorine residuals are taken daily in the distribution system to verify acceptable levels of chlorine.

The distribution system is operated as a “closed” pressure zone, relying on mechanical pump operation to provide water pressure to the system. A standby generator and/or diesel-powered pump are installed to provide water pumping in the event of a power failure.

6.10 Vars Well System

6.10.1 General

The Vars Well System is a communal water supply that provides drinking water to the community of Vars, Ontario. The system is owned and operated by the City of Ottawa and serves a population of approximately 1,200 residents.

6.10.2 Description of aquifer and well sources

The Vars water supply draws from either of two wells located approximately 15 meters apart at the treatment facility. Both wellheads are about 0.5 meters above ground surface and there is minimal potential for contamination from surface water. The water level in the Vars source wells is quite stable. The water level fluctuates within 1.1 metres due to the lower ground water table during dry season (not related to the rate of withdrawal). A large permanent surface water pond is located immediately west of the western security fence. The pond is located approximately 20 metres west of wells No.1 and No.2 and was created by aggregate removal operations that predated construction of the wells. Production Well No.1 is located near the south west corner of the enclosed portion of the Vars property. The hydraulic zone of influence for each well is within a radius of approximately 500 metres. There are no developments or agricultural activities within this zone of influence.

6.10.2.1 Source water quality

The groundwater is relatively high in colour (15 TCU), dissolved organic carbon (3.8 mg/L), iron (0.94 mg/L), and manganese (0.09 mg/L). It is important to remove the natural organic content of the groundwater prior to disinfection in order to minimize the formation of disinfection by-products such as trihalomethanes. In addition, the removal of iron and manganese are necessary to prevent aesthetic problems with sediment and metal scaling in the distribution system. The source water has a moderate level of hardness (200 mg/L) and a measurable amount of ammonia (0.20 mg/L). Fluoride is present at a concentration of 0.17 mg/L. Routine bacteriological testing over many years have demonstrated that both Well No.1 and No.2 are clear from the presence of Total coliform or E.coli bacteria.

6.10.2.2 Monitoring Wells

There are no monitoring or sentinel wells associated with the Vars Well System.

6.10.2.3 Common Source Water Fluctuations and Resulting Operational Challenges and Threats

Type of Fluctuation	Cause of Fluctuation	Operational Challenges/Threats
Seasonal Fluctuation	Aquifer level	Slight seasonal variation in aquifer depth, but well capacity not affected during previous droughts.
Iron, manganese, colour, and organics	Naturally present in source water	The Greensand and GAC filters provide adequate removal of these contaminants, reducing THM levels in treated water

6.10.3 Description of the treatment and distribution system

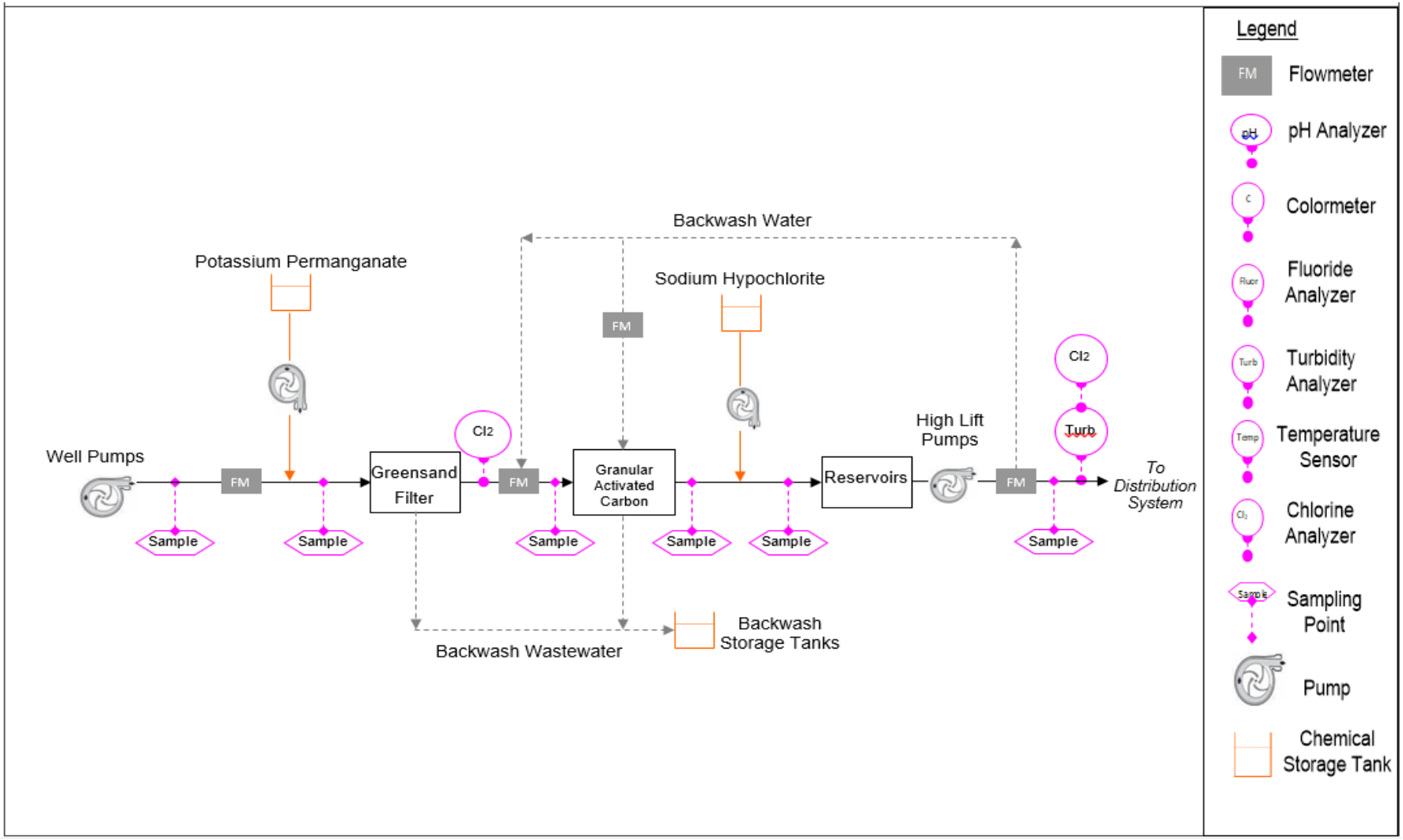
A series of treatment steps successively remove undesirable substances such as iron, manganese, organic carbon, and colour. The treatment process in Vars consists of the following steps:

1. Oxidation with Potassium Permanganate
2. Greensand filtration
3. Granular activated carbon filtration
4. Chlorine disinfection
5. Water storage
6. High-lift pumping

Since the source water is considered to be secure (non-GUDI) groundwater, it requires a minimum disinfection level of 2-log virus inactivation at all times. The existing chlorine dose and contact time easily meet these regulatory requirements. The presence of free chlorine also oxidizes small amounts of dissolved iron to form an iron oxide precipitate in the reservoir and distribution piping. The system requires occasional flushing and swabbing operations to remove iron sediment. Overall, the treatment process results in water that is clear and safe to drink.

The process flow chart below illustrates the treatment process for the Vars Well System:

Figure 8 - Vars Well System



Treated water is pumped into the distribution system with a free chlorine concentration in the range of 1.0 mg/L. All treatment, pumping, and storage systems are controlled by a dedicated computer control system and monitored by MECP-certified Water Treatment Operators 24 hours per day from the Lemieux Island WPP control room. On-line analyzers are used to monitor the chlorine residual at the treatment plant. In addition, a certified operator visits the well system twice per week to collect water samples and conduct on-site water quality tests. Chlorine residuals are taken daily in the distribution system to verify acceptable levels of chlorine.

The distribution system is operated as a “closed” pressure zone, relying on mechanical pump operation to provide water pressure to the system. A standby generator and/or diesel-powered pump are installed to provide water pumping in the event of a power failure.

7.0 ELEMENT 7: RISK ASSESSMENT PROCESS

7.1 Purpose and Scope

The purpose of this procedure is to document the risk assessment process that will:

- Consider potential hazardous events and associated hazards, as identified in the document titled 'Potential Hazardous Events for Municipal Residential Drinking Water Systems', dated February 2017 as it may be amended;
- Identify additional potential hazardous events and associated hazards that could affect safe drinking water quality;
- Assess and rank the risks associated with the hazards;
- Identify the control measures to address the potential hazards and hazardous events;
- Identify critical control points;
- Identify a method to verify, at least once every calendar year, the currency of the information and the validity of the assumptions used in the risk assessment;
- Ensure that the risks are assessed at least once every 36 months; and
- Consider the reliability and redundancy of the water treatment process equipment and distribution field practices.

7.2 Risk Assessment Process

At least once every calendar year, or following a major process change, the QMS 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 general, the Risk Assessment teams include the following participants:

- WPP Managers and/or Water Distribution Manager
- Operations Engineers
- Process Engineer – Water Quality
- Water Quality Supervisor
- Water Production Supervisors
- Water Distribution System Supervisors
- SCADA Program Lead
- QMS Coordinator
- Other technical and operational staff (as required)

Each year, the outcomes from the previous year's Risk Assessment are reviewed to ensure that the current list of hazards associated with drinking water treatment and the distribution system are accurately identified, described and appropriately ranked. The team must also list any new hazards that may have occurred or been identified since the previous Risk Assessment. Hazards are ranked based on Likelihood (1 to 5) and Consequence (1 to 5), as described in section 7.3 (Risk Assessment Rating and Hazard

Types Guidance). The annual review is typically limited to existing Critical Control Points (CCP) and hazards with a risk value of 8 or higher.

At least once every thirty-six months, a comprehensive review of the Risk Assessment Outcomes Table is conducted. This also provides an opportunity for the team to review the efficacy of the risk assessment process. In the years when a comprehensive review is completed, the annual Risk Assessment is deemed to have been completed.

When completing the annual or triennial risk assessment, the following may be considered:

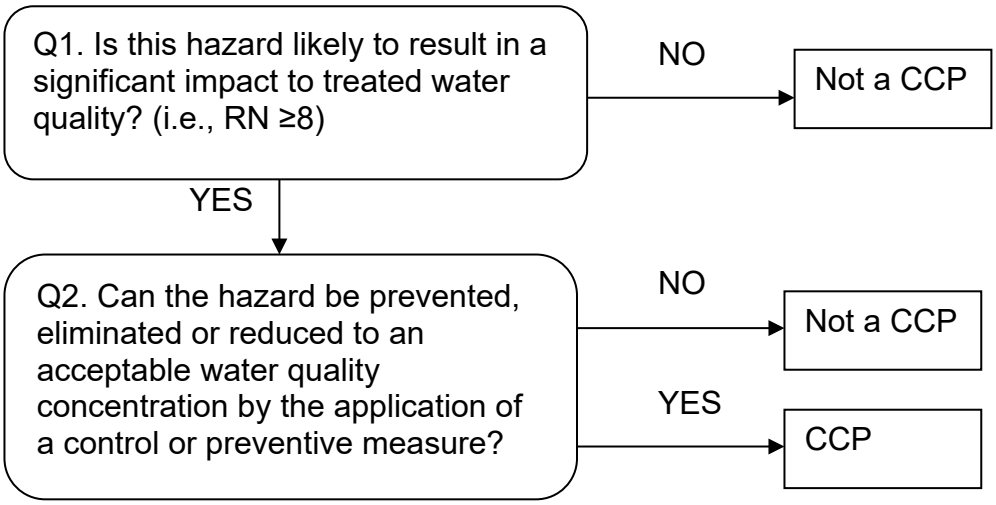
- Process changes;
- Emergency incidents or near-miss events (Continual Improvement Summary Table)
- Reliability and redundancy of equipment;
- Critical Control Limit deviations;
- New research or scientific information regarding risks in drinking water systems; and
- Any potential hazardous events and associated hazards, as identified and applicable in the document titled 'Potential Hazardous Events for Municipal Residential Drinking Water Systems' (dated February 2017, as it may be amended).

A description of the columns in the Risk Assessment Outcomes Table is provided below:

Column	Information in Risk Assessment Form Column
A – Process Step	Treatment and distribution system process steps and/or components.
B – Hazard Description	Hazards associated with the process step. A hazard is described as a biological, chemical or physical agent that could potentially cause an impact to water quality in the absence of its control.
C – Control and Preventive Measures	Brief description of the applicable preventative and control measures that address the hazard.
D – Likelihood (L)	Likelihood of a hazardous event occurring. The hazard is assessed on a scale of 1-5 using the Risk Assessment Rating and Hazard Types Guide (Section 7.3).
E – Consequence (C)	Consequence of a hazardous event occurring. The hazard is assessed on a scale of 1-5 using the Risk Assessment Rating and Hazard Types Guide (Section 7.3).
F – Risk (R)	The risk is then assigned for each hazard by multiplying the likelihood of the event occurring by the consequence of the event (R = L x C).

Column	Information in Risk Assessment Form Column
G through I – Establishing CCPs	The review team answers the questions outlined in the CCP decision tree to determine if the hazard warrants designation as a CCP. Q1. Is this hazard likely to result in a significant impact to treated water quality? (i.e., RN ≥8) Q2. Can the hazard be prevented, eliminated or reduced to an acceptable water quality concentration by the application of a control or preventive measure?
J – CCP#	The identified CCPs are numbered and highlighted.
NEW – Consider for Infrastructure Review	Items highlighted in this column will be included as inputs for the infrastructure review discussed during item 'n' of the annual Management Review.

CCPs represent process steps where significant hazards can be prevented, eliminated or reduced to an acceptable level. The following CCP decision tree is based on the formal Hazard Analysis and Critical Control Points (HACCP) process:



7.3 Risk Assessment Rating and Hazard Types Guidance

The general relationship to determine a risk value for each hazard event is as follows: Risk = Likelihood (1-5) x Consequence (1-5). Likelihood is determined based on the following rating categories:

Description	Likelihood of Hazardous Event Occurring	Rating
Rare	May occur in exceptional circumstances, and has not occurred in past	1
Unlikely	Could occur at some time, historically has occurred less than once every 5 to 10 years	2
Possible	Has occurred or may occur once every 1 to 5 years	3

Description	Likelihood of Hazardous Event Occurring	Rating
Likely	Has occurred or may occur on a yearly basis	4
Very Likely	One or more occurrences on a monthly or more frequent basis	5

The consequence of a hazard event is assigned based on the following categories:

Description	Consequence of Hazardous Event Occurring	Rating
Insignificant	Insignificant impact, little public exposure, little or no health risk	1
Minor	Limited public exposure, minor health risk	2
Moderate	Minor public exposure, health impact for smaller population	3
Major	Major public exposure, larger population at risk	4
Catastrophic	Major impact for large population, complete failure of systems	5

8.0 ELEMENT 8: RISK ASSESSMENT OUTCOMES

The updated Risk Assessment Outcomes Table is submitted to all participants for their review and comments. The Summary of CCPs Table, which includes the procedures associated with each CCP, is also updated with any necessary revisions. Following any required revisions, the Risk Assessment Outcome Table and the Summary of CCPs Table are submitted for OTM review. The risk assessment review exercise is documented in a report or meeting minutes format that includes any follow-up action items that resulted from the review.

Following the completion of this exercise, the risks highlighted as inputs for the infrastructure needs identification will be considered during the annual Management Review, item ‘n’ discussion.

The CCL for the required CCPs are reviewed by WP and documented in the ‘CCL and Operational Target – Operator Quick Reference Sheet’ that is reviewed and approved, prior to being made available on Ozone. The process for reporting, recording and reviewing deviations from the CCL is described in Element 21.

The Risk Assessment Table and Summary of CCPs Table are confidential. Access to these records may be requested from the QMS Coordinator, or designate, subject to acceptability.

9.0 ELEMENT 9: ORGANIZATIONAL STRUCTURE, ROLES, RESPONSIBILITIES AND AUTHORITIES

9.1 Purpose and Scope

The purpose of this procedure is to:

- Identify the Owner, Operating Authority, Operational Top Management (OTM), and Corporate Top Management (CTM) groups and their responsibility with respect to the Management Review
- Describe the organizational structure of the Operating Authority
- Document the roles, responsibilities and authorities of positions within the Operating Authority
- Document the responsibilities of Top Management as required by the Drinking Water Quality Management Standard

9.2 Responsibilities

The QMS Coordinator is responsible to identify and update the Operational Plan and supporting documents, regarding the organizational structure, roles, responsibilities and authorities under the QMS.

9.3 Procedure

9.3.1 Organisational Structure

A summary view of the organizational structure, as it relates to the City of Ottawa drinking water Operating Authority is documented in the *Organisational Structure of the Operating Authority and Top Management* (DWS-O-P000891) chart.

The City of Ottawa (Council) is the Owner of the drinking water systems covered by the Operational Plan, and the Operating Authority includes staff under the Infrastructure and Water Services Department (IWSD) and the Planning, Real Estate and Development (PRED) department.

The Top Management Team is separated into the Corporate Top Management (CTM) and the Operational Top Management (OTM). The CTM and OTM members are defined in the *Organisational Structure of the Operating Authority and Top Management* chart.

9.3.2 Identifying Operating Authority personnel

The overall responsibilities and authorities for Operating Authority personnel are documented in *Organizational Roles, Responsibilities, and Authorities of the Operating Authority Personnel* (DWS-O-P000892) spreadsheet. The information covered in the spreadsheet includes the responsibilities of Top Management as required by the Standard and with respect to the Management Review process.

10.0 ELEMENT 10: COMPETENCIES

For personnel that perform duties that directly affect drinking water quality, it is important that competencies are developed and maintained. This section of the Operational Plan describes:

- competencies required for key personnel.
- activities to develop and/or maintain competencies for personnel performing duties directly affecting drinking water quality.
- efforts to make staff aware of how their duties affect safe drinking water.

  These efforts are primarily carried out by staff in WS: WD, WP, and WQ. The BTSS branch provides a key support role for training and development activities.

10.1 Competencies

The WD, WP, and WQ Managers and delegates are responsible for identifying required competencies for employees performing duties that directly affect drinking water quality, as identified in the *Competencies Table* (Appendix C). In general, competency is established when an individual meets the requirements documented within their job description (i.e. education, training, skills, experience and MECP operator certification requirements). It is important to note that under the provincial regulations, Operators designated as 'Operators in Training' can be working towards their MECP Water Treatment or Water Distribution Certification.

Competency requirements can be satisfied through the use of in-house, off-site, or on-line training, attendance at seminars/conferences, presentations by subject matter experts or on-the-job training. On-the-job training may include using a "job shadowing system" to demonstrate and monitor how to perform various job duties using the appropriate documented procedures.

Job descriptions are developed by Managers or delegates and periodically reviewed for currency. Human Resources maintains job descriptions, job postings and qualifications.

There is a probationary period for new or transferred employees; at the end of the probationary period the Supervisor evaluates the employee's competency. Competency for management positions is on-going and focused on coaching and Individual Development Plans.

10.2 Training Needs

The WD, WP, and WQ Managers and delegates identify training needs for employees performing duties directly affecting drinking water based on the identified competencies. The need for training may also be determined based on the following:

- Comparison of the person's skills and abilities with the requirements of the job posting and qualifications, in particular for new, temporary and transferred employees
- Corrective action (eg. resulting from internal audits or non-conformance), if the need for additional training is identified
- Changes due to updates to the risk assessment outcomes

- Changes in legislative/regulation requirements
- New treatment processes and/or equipment

10.3 Training Plan

The WD, WP, and WQ Managers, Supervisors, and/or chosen delegates meet with the Training and Development Program Coordinator at least annually to plan the training for employees for the next year and to develop the training schedule. They refer to the required competencies, the completed training from previous years, and other currently available courses to develop the training program.

The Training and Development Program Coordinator provides a report to the WD, WP, and WQ Managers and Supervisors on a quarterly basis to track staff training hours in relation to operator certification requirements as per O.Reg.128/04 (eg. MECP Director-approved CEUs, on-the-job training). The Training and Development Program Coordinator maintains records of all training received by certified operating staff. Copies of current licenses and training certificates are maintained and filed by the Training and Development Program Coordinator.

10.4 Employee DWQMS Orientation

The QMS Coordinator sends a request by e-mail four times each year to Supervisors and Operating Authority Managers for a list of new hires, transferred employees, or employees returning to work following an extended absence over six months in order to create a list of employees requiring DWQMS awareness training. The QMS Coordinator presents a DWQMS awareness training session to these employees, which includes the following types of information:

- Background on the DWQMS
- Overview of the 21 elements of the DWQMS
- Review of pertinent procedures and Standard Operating Procedures
- Review of the DWQMS policy (Element 2)
- The relevance of the participant's duties compared with DWQMS requirements and how they affect safe drinking water

The QMS Coordinator provides the list of participants and the duration of training for all sessions provided to staff to the Learning and Support Unit. This information is recorded in SAP in each employee's electronic training record.

10.5 Training Records

Sign-in sheets are used to track the completed training and are provided to the Training and Development Program Coordinator. Where sign-in sheets are not used, the onus is on the employee and his/her supervisor to notify the Training and Development Program Coordinator that the training has been completed.

The Training and Development Program Coordinator is responsible for maintaining records of completed training. These records are used to track regulatory requirements as well as required training to meet competencies identified in the *Competencies Table* (Appendix E). DWQMS awareness training is also tracked in this manner.

A report sorted by the expiry date of operator's certification is provided quarterly by the Training and Development Program Coordinator to the WS Managers and Supervisors to identify upcoming certificate renewals and prioritize training needs.

10.6 Effectiveness of Training

When external trainers conduct courses, the trainer may verify training effectiveness through various means (eg. quiz, test, or knowledge assessment required for CEU courses). If the employee is knowledgeable and able to demonstrate the skills, then the external trainer issues a certificate to indicate that the participant completed the course and that the training was effective.

When internal training courses are conducted, the trainer will evaluate the trainee's understanding of the information through practical application and discussion. In some cases, this may include the use of a written or multiple-choice test to evaluate the participants learning.

As noted in Section 10.2 (Training Needs), additional training needs may occasionally be identified through the Continual Improvement process (Element 21) and documented in a Corrective Action/Preventive Action (CAPA) report. In these cases, WD, WP, and WQ Managers are responsible for ensuring that training is completed, and the key competency is achieved. The results are reported to the QMS Coordinator and Training and Development Program Coordinator.

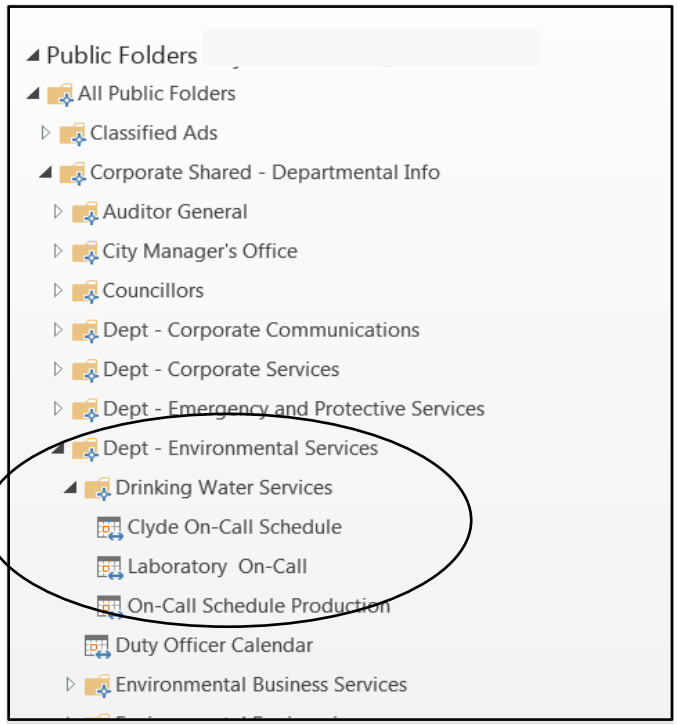
On-the-job training is provided to employees through courses, meetings, and job shadowing, in accordance with the MECP's guideline for on-the-job training requirements.

11.0 ELEMENT 11: PERSONNEL COVERAGE

This section explains how competent personnel are made available to perform duties that directly affect drinking water quality.

11.1 Overall Responsible Operator (ORO)

ORO positions are designated in both the WP and WD units. The WD ORO schedule is maintained on a Microsoft Outlook on-line calendar. The calendar is located under Public Folders and includes cell-phone contact information. The folder path is shown below:



A shift schedule spreadsheet identifies the Process Supervisor (WP ORO), Process Operator and Senior Process Operator for every 12-hour shift (2 shifts per day) on a yearly basis. The WP Operator schedule is saved in an operations folder on the Lemieux shared drive.

The ORO is kept informed of operational issues and emergencies such as watermain breaks, loss of pressure, treatment failures, and other events that may have an impact on water quality.

11.2 Water Production and Water Quality

The WP ORO holds a valid Ontario Drinking Water Treatment Class III or Class IV certification license and is either a Process Supervisor or a Senior Process Operator.

11.2.1 Regular Work Hours - Water Purification Plants (WPPs)

At least one certified Process Supervisor and one certified Process Operator must be located at each WPP 24 hours per day, 7 days per week. The Process Supervisor or

Process Operator cannot leave until their replacement arrives. A Senior Process Operator can act as a Process Supervisor or Process Operator.

The WPPs and remote facilities are monitored continuously by the SCADA system.

11.2.2 Regular Work Hours - Remote Facilities

Remote Facility Operators in the WP and WQ sections are certified water treatment operators that work away from the WPPs at the various remote facilities (pumping stations, reservoirs and well systems), rotating between the facilities as needed. Their working hours are typically Monday to Friday from 7:00 am to 4:30 pm.

11.2.3 Regular Work Hours - Other Staff

Other WP and WQ staff includes skilled trades, technical and administrative staff. Their regular hours are typically between the hours of 7:00 am and 4:30 pm Monday to Friday. Many employees work a compressed work schedule, which results in one WPP covering off the other WPP on alternating Fridays (i.e. Britannia WPP one week, Lemieux Island WPP the following week).

11.2.4 Off-Hours Coverage and Response

In addition to the Process Supervisor and Process Operator at each WPP (24 hours a day, 7 days a week), key operational staff are placed on-call to respond to problems or emergencies:

- Process On-Call
- Remote Facilities Operator
- Electrical
- Mechanical
- SCADA / Instrumentation

11.2.5 Process On-Call

Process On-Call personnel, designated by Plant Managers and the Water Quality Engineer, provide guidance and support for water production and water quality incident response and escalation during off-hours. The Process On-Call schedule is developed and updated by the Process On-Call group and posted in the Microsoft Outlook on-line calendar under Public Folders, Production On-Call Schedule. The *Process On-call Procedure* and *Operator Notification Procedure* provide guidance for emergency response and notification.

11.2.6 Remote Facilities and Trades Staff

In the event of an off-hours alarm at a remote facility, the Process Supervisors at both WPPs are alerted. The Process Supervisors maintain a current list of on-call staff to respond, investigate, and correct urgent operational problems. If required, the Process Supervisor can dispatch the on-call Remote Operator, Electrical, Mechanical, or SCADA/instrumentation staff.

The on-call staff respond to the situation and contact the Process Supervisor or Process On-Call if required to discuss appropriate actions required, and to determine if additional help is needed to respond to the situation.

11.3 Water Distribution

11.3.1 Regular Work Hours

Certified distribution operators, maintenance staff, and technical and administrative personnel are available from 7:30 am to 4:00 pm Monday to Friday. A WD Supervisor is designated as ORO during the day and after hours, as scheduled in the Microsoft Outlook on-line calendar under Public Folders, Clyde On-Call Schedule (see Section 11.1).

11.3.2 Off-Hours Coverage and Response

At least two First Response personnel are available at 951 Clyde Avenue, 24 hours per day, 7 days per week. The First Response Coordinator working during off-hours is a certified WD Operator. The First Response Supervisor is responsible for ensuring First Response Coordinator coverage.

Additional WD staff are available off-hours on an on-call basis and include the WD ORO and other core positions (i.e. repair crew). The WD Management Team develops the on-call list seasonally based on operational requirements. The On-call schedule is maintained in the Microsoft Outlook on-line calendar under Public Folders, Clyde On-Call Schedule.

- Core positions are added to the on-call list based on skills and competency.
- At least one Operator-in-Charge (OIC) is present for on-call repairs.
- The ORO will be contacted by First Response if First Response deems that there is an emergency that should be evaluated or addressed. The ORO will determine if the on-call crew needs to be called in to address the emergency.
- The ORO will follow escalation procedures if deemed appropriate.
- The ORO will contact Fleet Services if hired equipment is required to assist with repairs. Essential Supplies and Services are procured as outline in the Essential Supplies and Services System Procedure (Element 13).

11.4 Certified Operator Availability

Although certified Operators are unionized, they do not have the right to strike. Therefore, a strike plan is not required. However, in the event of a catastrophic emergency, WS Management personnel with appropriate drinking water certification requirements could continue the operation of the drinking water system(s), as applicable.

12.0 ELEMENT 12: COMMUNICATIONS

This section documents how relevant aspects of the QMS are communicated between Top Management and:

- The Owner (Council);
- Operating Authority;
- Suppliers that have been identified as essential under Element 13; and
- Public

Top Management in this procedure encompasses both Corporate and Operational Top Management. Members of Top Management have the overall responsibility to ensure that relevant aspects of the QMS are communicated in accordance with this procedure.

12.1 The Owner

Communication between the Owner and Top Management regarding the QMS can occur through staff reports, memos or presentations to Council following established corporate communication protocols. Communication with Council may be documented in the Council minutes and can include:

- Revised copies of the Operational Plan are provided following changes in Council;
- A report from the results of the Management Review, provided on an annual basis, as described under Element 20 - Management Review;
- The QMS Representative and/or other members of Top Management may communicate relevant aspects to Council as required; and
- Communication with Council may be documented in the Council minutes.

Council can communicate directly to Top Management through formal Council meeting minutes, Council motions and Council Inquiries. Informal communication such as e-mails or phone calls may also be sent from a Councillor to Top Management and/or the Operating Authority, however these are not considered to be a formal Council request and would instead be considered as communication on behalf of the public.

12.2 Operating Authority Personnel

Top Management communicates aspects of the QMS to and from the Operating Authority personnel through various regularly held meetings such as staff meetings. Generally, the process for relaying information related to drinking water issues from Top Management to personnel is achieved through the following tiered approach:

1. Top Management to WS, through various meetings;
2. WS Managers to Supervisors and staff, through various meetings; and
3. Supervisors relay applicable information to staff, often through staff meetings.

Other forms of communication between Top Management and Operating Authority personnel may include written documentation (i.e., emails, meeting minutes), verbal discussions, training sessions and posting of material on bulletin boards or on Ozone.

12.3 Suppliers

Top Management communication to and from Suppliers for supplies and services that have been identified as essential under the *Essential Supplies and Services* is addressed by purchasing procedures that are in accordance with established corporate protocols and other written correspondence, as described below:

- Communication between Top Management and Suppliers includes purchase orders and contracts.
- Communication to/from Suppliers to Top Management is via City staff through written correspondence, email, phone calls, and the purchasing process.
- Operating Authority personnel contact suppliers directly if problems occur with the supplier.

12.4 Public

Communication to the public is often centralized through the Public Information and Media Relations Services group and is achieved through various means, including written correspondence (regular and registered mail, water bill inserts, etc.), postings on the City of Ottawa website and public media (public service announcements, social media, etc.).

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, forwards more complex questions to IWSD-Customer Support (CS) Unit. These public inquiries and their responses are tracked, and are either resolved by phone/email, or may require a site investigation and response. Water Quality staff have a procedure for handling customer complaints based on the nature of the complaint. All information related to a customer complaint, inquiry, or field investigation are recorded in SAP and an EXCEL spreadsheet maintained by the Water Quality Supervisor. A summary of all customer inquiries and investigations is reported annually to Top Management during the annual management review.

Calls regarding specific water issues (i.e., lead pipe replacement program) may be forwarded by the Water Information Line to a specialist (subject matter expert) in IWSD. The specialists either return the public call directly or forward information to the Water Information Line for communication to the caller.

13.0 ELEMENT 13: ESSENTIAL SUPPLIES AND SERVICES

This section documents how the quality of essential supplies and services is ensured, in as much as they may affect drinking water quality. The procedure identifies essential supplies and services required for the delivery of safe drinking water and states, for each supply or service, the means to ensure its procurement. The procedure also describes the procedures followed to ensure that quality requirements for supplies and services are met.

13.1 Identification of Supplies and Services and Requirements

WS – WD, WP and WQ ensures that the supplies and services meet the requirements and/or specifications identified in the documentation. The essential supplies and services critical to the provision of safe drinking water are documented in the record *Essential Supplies and Services* for WS – WD, WP and WQ, which is maintained by the QMS Coordinator and updated on an annual basis in coordination with WS personnel.

PRED Maintains the *Approved Water Distribution Products Listing*. Additions, removals or changes to the material product listing and the approved products list is reviewed by a Product Review Committee and updated by PRED on a regular basis. Inclusion of material deemed essential to the provision of safe drinking water on this list requires approval by the Operating Authority.

13.2 Monitoring Supplies and Services

WS ensures that the supplies and services meet the requirements and/or specifications identified in the documentation. The following summarizes monitoring measures and procedures followed when an essential supply or service is not up to standard:

- A spreadsheet is maintained by the Water Quality Technologist (WP) to track all loads of chemicals, including if a load is rejected. The Process Operator informs the Water Quality Technologist, Process Supervisor (ORO) and Water Production Supervisor, if a load of chemicals is rejected.
- The Supply Branch contact is notified regarding problems with products ordered through Purchasing or Stores. In addition, PRED is notified regarding distribution supplies and services ordered through stores that do not meet the specifications in the *Approved Water Distribution Products Listing*.
- The supplier is contacted directly by the Manager and/or Supervisor to rectify concerns regarding supplies or services not ordered through Stores or if the supplies are not on the *Approved Water Distribution Products Listing*.
- When tendered products or services do not meet requirements, Production and Distribution staff work directly with the supplier to resolve deficiencies. Deficiencies are noted by the Supervisor on the Purchase Order and a copy is forwarded to Supply Branch and, if required, PRED. Recurring problems are forwarded to Supply Branch and/or PRED and are dealt with by Supply Branch and/or PRED directly.

13.3 Procurement Process

The acquisition of goods and services is completed in accordance with the City of Ottawa's Purchasing By-Law. Essential Supplies and Services are acquired by WS through the following means:

- Competitive bid solicitations
- Sole source contracts
- In-house Stores
- Purchasing card

When appropriate, bidding templates contain the *DWQMS Policy* informing suppliers, contractors and consultants of the existence of the QMS and its commitments.

The Procurement Branch contacts WS to obtain input for preparing tenders, standing offers and RFPs prior to their expiry date and/or when new ones are to be issued. Input will include drinking water related specifications and/or relevant procedures or specifications. A copy of such procedures or specifications is included in the bid solicitation documents where appropriate.

Managers ensure that procedures are developed as required for specific contractor activities (i.e., delivery of bulk chemicals) to establish conduct/specifications of suppliers and contractors.

Specifications on quality requirements (i.e., AWWA, ANSI, NSF standards) and the process for sample tests and assays, where applicable, may also be noted within the bid solicitation documents.

13.3.1 Materials Management (Stores)

Parts for water production and distribution (i.e., piping, valves, hydrants) are ordered through Stores located at Lemieux WPP and 951 Clyde Avenue, which has contracts in place for purchasing of products from an approved vendors list. Various site-specific procedures are in place to govern the acceptance and testing of purchased products.

A Supervisor can remove in-stock supplies from Stores during off-hours. The Supervisor leaves the form with Stores for any material removed during off-hours. During emergency situations the City of Ottawa personnel may purchase supplies from the list of approved waterworks suppliers and services in accordance with the emergency provisions outlined in the City of Ottawa's Purchasing By-Law.

Distribution supplies ordered through Stores must be on the *Approved Water Distribution Products Listing*.

13.3.2 Essential Supplies and Services Requirements

In addition to Tenders and RFPs, essential supplies and services requirements may be maintained in the following documents:

- Ottawa Standard Tender Documents For Unit Price Contracts (*Approved Water Distribution Products Listing*)
- Water Facility Standard Designs
- Ottawa Design Guidelines

All material products specifications utilized within the water distribution system are documented in the *Approved Water Distribution Products Listing*. This listing is utilized in competitive bid solicitations and by Stores during acquisition and for field verification prior to installation.

Bulk water treatment chemicals are referenced in the AWWA/ANSI Standards Specifications and must meet NSF Standard 60/61 for safe application to drinking water. A comprehensive procedure is in place at both treatment plants to verify and test all chemical shipments prior to unloading. Detailed laboratory analysis is carried out on all treatment chemicals from time to time to check for trace levels of chemical impurities. These QA/QC measures help to ensure that chemicals are safely unloaded, stored, and applied during the treatment process. All chemical shipment information including on-site measurements and Chemical Acceptance Forms are stored as operating records at both treatment plants.

During emergency situations, the City of Ottawa may purchase supplies and services in accordance with the emergency provisions outlined in the City’s Purchasing By-Law.

14.0 ELEMENT 14: REVIEW AND PROVISION OF INFRASTRUCTURE

This section describes the annual process for reviewing the adequacy of the infrastructure necessary to operate and maintain the drinking water systems. The objective of the annual review is to identify new drinking water infrastructure needs related to:

- growth requirements and system optimization
- upgrade or renewal requirements to existing infrastructure to optimize drinking water operations and system maintenance
- outcomes of the DWQMS risk assessment that could impact the infrastructure review

The procedure also describes how these infrastructure needs are communicated to Council.

14.1 Overall Responsibilities

Several key stakeholders within the City work collaboratively to plan and provide for drinking water infrastructure. These stakeholders include the following groups:

- Infrastructure and Water Services Department
  - Water Facilities and Treatment Service
    - Water Production Branches (East and West)
    - Facilities Maintenance & Support Branch
  - Water Linear and Customer Service
    - Water Distribution Branch
    - Linear Maintenance/Support Services Branch
  - Asset Management Services
    - Capital Planning/Strategic Asset Management Branch
    - Water Resources Planning and Engineering Branch
    - Facilities Asset Management Branch
    - Linear Asset Management Branch
  - Infrastructure Services
- Planning, Real Estate and Economic Development Department
  - ROW, Heritage and Urban Design Services
  - Planning Services
- Corporate Services Department
  - Financial Services Branch

Specific tasks are led by one of these groups as noted in this procedure.

14.2 Review and Provision of Infrastructure Process

The review and provision of the City of Ottawa's drinking water infrastructure needs is achieved through one of two processes, depending on whether the infrastructure needs are:

- growth related (i.e. related to expansion and intensification); or
- non-growth related (i.e. related to renewal or rehabilitation).

The review cycle of the infrastructure needs is concluded with the budget submission of the Capital Budget for Council approval. The stakeholder roles, tasks and deliverables are described in Sections 14.3 (Review of Infrastructure Needs) and 14.4 (Provision of Infrastructure Needs). The following schedule provides a general guideline and will be adjusted and communicated by FS based on corporate direction for the budget submission timeline:

General Review Cycle – Non-Growth Related

Schedule	Action
January - April	Needs identifications period
May - August	Draft Submission, Circulation for Review and Comment
September	Final Review Meeting and Draft Approval
October - December	Capital Budget Submission to Council

Note: Schedule subject to annual budget direction from FS

14.3 Review of Infrastructure Needs

14.3.1 Growth-Related Needs

Asset Management Services (AMS) is responsible for the review and provision of growth-related drinking water infrastructure (facilities and distribution), which includes the requirements for:

- new infrastructure needs; and
- existing infrastructure needs to meet growth demands (i.e. service expansion).

The results of the growth-related drinking water infrastructure needs review are recorded in the following documents:

Document	General Provision
Official Plan (OP)	Long term planning for growth-related infrastructure starts with the development and updating of the OP which provides the policy framework to guide the provision of infrastructure within the City of Ottawa. Updates focus on new growth forecasts based on revised population projections, land use and infrastructure development policies.
Infrastructure Master Plan (IMP)	The IMP (prepared by AMS) supports the OP and provides the basis for the review and planning for growth-related infrastructure improvements within the entire water system. The IMP is based on infrastructure growth planning and the existing asset management strategy. It also identifies the various capital projects and schedule to accommodate growth. Projects include new infrastructure and upgrades or expansions.

Document	General Provision
Development Charges (DC) Background Study	DCs are one-time fees levied on new residential and non-residential development within the City of Ottawa that assist in financing a portion of the capital costs associated with new infrastructure and municipal service expansion needed to support growth. Planning, Real Estate and Development (PRED) Department is responsible for Development Charges Background Study and leads this review. The review considers the IMP, the DC Study (lead by PRED) as well as project plans.
Community Design Plans (CDPs)	CDPs are prepared by PRED for specific growth areas within Ottawa to establish the land use and generally servicing requirements in conformance with the OP and IMP.
Master Servicing Studies (MSSs)	MSSs are normally coordinated by AMS in order to determine the specific needs and timing for drinking water infrastructure growth to support specific CDP areas in conformance with the OP and IMP.

The OP, IMP and other DC By-Law-funded projects are reviewed periodically and generally updated on a 5-year cycle. Council must approve any amendments to the OP, IMP and DC Bylaw.

14.3.2 Non-Growth Related Needs

AMS, Water Facilities and Treatment Service (WFTS), and Water Linear and Customer Service (WLCS) are responsible for the review of existing infrastructure for non-growth related projects.

14.3.2.1 Production Infrastructure

AMS and WFTS are responsible for the review and provision of production infrastructure needs, including facilities, building systems, SCADA, electrical and mechanical components. These needs are established by the key stakeholders. The following information may be considered when identifying the needs:

- High maintenance costs
- Results of preventative, predictive, corrective maintenance programs (Element 15)
- Condition Assessment Program
- Age, capacity, reliability and optimization of infrastructure
- Obsolete equipment/parts
- Community forecast growth
- Service level requirements
- Hydraulic modelling
- Available funds determined in annual budget review
- DWQMS Risk Assessment Outcomes

The outcome of this review is the *Drinking Water Production Infrastructure Needs List*, which documents recommended production rehabilitation and renewal projects for the upcoming year, as well as a forecast for the next three to five years. This list, which also includes budget estimates, is used to prioritize needs within the budget authority as further discussed in the Section 14.5 (Provision of Infrastructure Needs).

14.3.2.2 Distribution Infrastructure

AMS and WLCS are responsible for the review of distribution infrastructure needs.

The review of all small and large watermain needs is achieved through development of the *Watermain Renewal Needs List*. The watermain renewal needs are established by the key stakeholders by analysing the following information:

- Condition assessment of existing watermains including age, capacity, reliability and optimization
- Water quality concerns in localized areas within the distribution system
- Community forecast growth/IMP project requirements
- Hydraulic modelling
- Operational and maintenance requirements identified by WS
- AMS Risk Assessment
- DWQMS Risk Assessment Outcomes

Other operational concerns identified by WLCS will be provided to AMS through regular updates to the *Watermain Renewal Needs List* including the proposed cost estimate and schedule. AMS will circulate the program list and meet with WLCS to review the Watermain Renewal Needs list and recommend changes.

AMS reviews the approved watermain needs into two programs:

1) Integrated Renewal Capital Program in context with other municipal infrastructure needs such as roads, sewers or bridges needs; and
2) Watermain Only Renewal Capital Program in context of standalone watermain needs.

These programs are prepared by AMS for the following budget year and with a 3-year outlook prior to circulation for comments and final review. The key stakeholders are included in the circulation. Based on comments received, a final list of projects is established and issued by AMS as part of the annual capital budget review process.

The review of other smaller distribution infrastructure rehabilitation and renewal needs, such as hydrants, valves, minor watermain replacements and service renewals is achieved through leak surveys, valve inspections and valves exercising. The WD Unit leads the review by analysing:

- High maintenance costs
- Results from preventative, predictive and corrective maintenance programs
- Age, capacity and reliability of infrastructure
- Obsolete parts and materials
- Community forecast growth
- Service level requirements
- Hydraulic modelling

- Available funds determined in annual budget review
- Maintenance Key Performance Indicators (KPIs)
- Results from the Large Diameter Condition Assessment Program
- Water quality concerns

WS maintains an operational rehabilitation needs list for hydrants and valves and performs replacement and renewals on a scheduled basis. Information on the field condition of infrastructure is provided to AMS to assist in developing and maintaining an operational improvements program list. This program documents recommended distribution rehabilitation and renewal projects for the upcoming year as well as a forecast for the next three to five years. Rehabilitation and renewal needs are prioritized in this program. The program also includes budget estimates and is used to prioritize needs within the budget authority as further discussed in Section 14.5 (Provision of Infrastructure).

14.4 Provision of Infrastructure Needs

14.4.1 Growth Related Infrastructure

The provision of infrastructure is achieved through the LRFP and the annual capital budget.

- The LRFP is a ten-year forecast used for long term financial planning and is updated as needed.
- The Capital Budgets are developed annually for priority infrastructure projects.

Both the LRFP and the Draft Capital Budget (Rate Supported Programs) are brought forward to Council for approval. Funding sources that enable the provision of infrastructure include rate-based charges and development charges. If additional budget authority is required outside the normal annual budget process, a report must be submitted to Council for approval.

14.4.2 Non-Growth Related Infrastructure

Key stakeholders within AMS, WFTS and WLCS lead the process for reviewing existing infrastructure needs.

Based on inputs from the key stakeholders, a final list of needs is established and issued by AMS as part of the annual capital budget review process.

14.4.3 Implementation

Project management responsibility lies with PRED for local water distribution projects that are delivered by Developers through subdivision or site plan applications. Project Management responsibility lies with PRED and IWSD for council approved programs for rehabilitation and renewal of water assets that are approved by Council through the annual capital budget process. Generally, the stages of implementation include:

- Project Chartering
- Design, review and City approvals
- Construction
- Site inspections

- Commissioning
- Final Acceptance / Substantial Performance

15.0 ELEMENT 15: INFRASTRUCTURE MAINTENANCE, REHABILITATION AND MONITORING

This section describes infrastructure maintenance, rehabilitation and renewal programs for the drinking water systems. This is a continuation from the review and provision of infrastructure and is a summary of the City of Ottawa's infrastructure rehabilitation, renewal and maintenance programs and activities.

Records of inspection reports are saved in BIMS and accessed through a Master Worksheet also in BIMS as a transitory document and the individual reports are attached to SAP.

15.1 Overall Responsibilities

The following groups contribute directly to the maintenance, rehabilitation and renewal of drinking water infrastructure:

- Infrastructure and Water Services Department
  - Water Facilities and Treatment Service
    - Water Production Branches (East and West)
    - Facilities Maintenance & Support Branch
  - Water Linear and Customer Service
    - Water Distribution Branch
    - Linear Maintenance/Support Services Branch
  - Asset Management Services
    - Capital Planning/Strategic Asset Management Branch
    - Water Resources Planning and Engineering Branch
    - Facilities Asset Management Branch
    - Linear Asset Management Branch
  - Infrastructure Services
- Planning, Real Estate and Economic Development Department
  - ROW, Heritage and Urban Design Services
  - Planning Services

15.2 Maintenance, Renewal and Rehabilitation

The maintenance, renewal and rehabilitation infrastructure needs are met for both WP and WD through implementation of various programs and projects. A summary of the maintenance, rehabilitation and renewal programs pertaining to our drinking water infrastructure may include:

- Water Distribution Systems Program (such as hydrants, valves, minor watermain replacements and service renewals)
- Water Storage Tanks and Reservoirs Rehabilitation Program
- Water Treatment Program
- Water Pumping Stations Rehabilitation Program
- Water System General Rehabilitation Program
- Water Communal Well Systems Rehabilitation Program
- Management Review item 'n': Results of the Infrastructure Review
- Capital Review

These programs, and the groups responsible for managing them, are listed in the Water Projects Portion of the Annual Capital Budgets, which is an outcome of the annual Review and Provision of Infrastructure (Element 14). Rehabilitation and renewal of drinking water infrastructure is achieved through implementation of specific projects under these programs. As noted under 14.4.1, the provision of infrastructure is achieved through the LRFP (ten-year forecast) and the annual capital budget. New drinking water infrastructure is documented as a new asset within SAP (WP) and Maximo/GIS (WD).

15.2.1 Maintenance of Infrastructure: Water Production

Production infrastructure includes water purification plants, process equipment, remote facilities (e.g. communal well systems, reservoirs and pump stations), SCADA system, and non-process related infrastructure managed by Facility Maintenance.

Production system maintenance work activities are documented through Computerized Maintenance Management System (CMMS) work orders (available in SAP).

- The MMSS and administration staff generate work orders and associated drawings to be marked up by Trades personnel, as required. These are distributed to Water Treatment Maintenance Supervisors of the associated Work Centre for assignment to appropriate staff.
- Once work has been completed, Supervisors initial and date completed work orders and return them to the Maintenance Planner.
- The Maintenance Planner checks for completeness (level of detail of comments and drawing mark-ups clarity) and contacts the Supervisor if information is incomplete.
- Completed work orders are forwarded to the Data Entry Clerk for entry into CMMS and to close out the work order and the drawings are sent to DCTS.

15.2.1.1 Infrastructure Equipment Criticality Rating

The MMSS, Facility Systems Unit develops a list of infrastructure assets in CMMS. Equipment criticality is rated when equipment is initially entered into the system and existing equipment is usually replaced with the same type (‘like for like’). The criticality rating is assigned to each piece of infrastructure by Water Production and the MMSS, Facility Systems Unit based on these weighted factors: capacity, environment, health and safety, water quality and cost. The assigned criticality is either A (high), B (medium) or C (low). The Equipment Criticality Rating list can be found through a query to the CMMS (SAP Plant Maintenance). Equipment criticality is reassessed if suggested by staff or supervisors, or if the annual risk assessment identifies a Critical Control Point involving the equipment.

15.2.1.2 Predictive Maintenance

Predictive maintenance includes techniques that monitor and assess the condition of in-service equipment in order to predict when preventive or corrective maintenance should be performed. Predictive maintenance may include work activities and/or programs such as:

- Monitoring vibration in rotating equipment to identify deficiencies such as imbalance, misalignment and premature bearing failures
- Use of temperature-sensing equipment (thermography) to identify premature failure in electrical, mechanical and civil structures
- Motor current analyzers to determine motor performance
- Oil analysis (mechanical wear or failures)
- Equipment performance testing

These programs are ongoing and are reviewed and/or revised on an as-needed basis by the LCPO Unit, in cooperation with Water Production. The Program Engineer, Asset Reliability (LCPO) communicates the predictive maintenance and trend analysis results to Plant Managers and Maintenance Supervisors. The predictive maintenance results may lead to preventive and/or corrective maintenance, or identification of rehabilitation and renewal needs (brought forward in the infrastructure review process described in the Review and Provision of Infrastructure System Procedure – Element 14).

15.2.1.3 Preventive Maintenance

Preventive maintenance consists of the care and servicing by personnel for the purpose of maintaining equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of emerging failures either before they occur or before they develop into major defects. Preventive maintenance is conducted to keep equipment working and/or extend the life of the equipment and may include work activities and/or programs such as:

- SCADA equipment maintenance
- Instrumentation calibration and maintenance (e.g. flow meter calibration)
- Structural inspections (e.g. clearwell, water storage facilities and chemical tank reliability inspection)
- Mechanical systems and piping (e.g. lubrication and cleaning), electrical, HVAC, and facilities inspections and maintenance

Preventive maintenance activities are documented in maintenance plans issued by the Program Coordinator, MMSS, through CMMS, except for equipment on the ‘C’ criticality list, which is normally “run to failure”. The LCPO Unit develops Preventative Maintenance procedures based on the Root Cause Failure Analysis results, equipment failures and new equipment installation. The Maintenance Planners, Program Engineer (MMS), Maintenance Supervisors and Maintenance staff review and develop the preventive maintenance plans on an ongoing basis.

Upcoming and completed planned preventive maintenance activities are coordinated and scheduled in regular planning meetings attended by Maintenance Supervisors and Managers from Water Production, LCPO Unit, and OEPI.

The preventive maintenance programs are ongoing and are reviewed and/or revised on an as-needed basis by LCPO Unit, in collaboration with Water Production.

15.2.1.4 Corrective Maintenance (Planned)

Corrective maintenance work activities and/or programs include system improvements, and repairs to equipment identified from predictive, preventative maintenance findings or non-emergency failures.

CMMS work orders are generated to address deficiencies as they are identified and forwarded to the appropriate Water Treatment Maintenance Supervisors for implementation.

15.2.1.5 Corrective Maintenance (Unplanned)

Unplanned corrective maintenance is typically categorized as an event that requires immediate mobilization of staff and equipment to initiate and complete the required repairs. Unplanned Corrective Maintenance is referred to in CMMS as “Emergency Breakdown”.

Water Treatment Maintenance Supervisors coordinate the work. CMMS work orders are typically generated as repairs are initiated.

15.2.2 Maintenance of Infrastructure: Water Distribution

Water Distribution infrastructure includes horizontal linear components, comprised of watermains, service laterals, valves and hydrants.

Distribution system maintenance work activities are documented through work orders using an Enterprise Asset Management System (Maximo). Work order management processes are documented in detail within several administrative procedures on Ozone.

15.2.2.1 Predictive Maintenance

Predictive maintenance includes work activities and/or programs such as:

- Active Leak Detection
- Watermain Condition Assessment
- Small and Large Valve Inspection
- Hydrant Inspections
- Service Post Inspection
- Cathodic Protection Monitoring
- Water Quality Monitoring

Programs are ongoing, and are reviewed, adjusted and implemented on an annual basis.

Based on the predictive maintenance investigations, follow-up notifications for preventive or corrective maintenance activities are created by Project Coordinators and/or Maintenance Planners as CMMS work orders. The predictive maintenance results may also lead to the identification of larger scale rehabilitation and renewal needs (brought forward in the infrastructure review process described in the Review and Provision of Infrastructure System Procedure, Element 14).

15.2.2.2 Preventive Maintenance

Preventive maintenance includes work activities and/or programs such as:

- Small and Large Valve Exercising
- Hydrant Flow Inspection and Testing
- Cathodic Protection Anode Installation
- Re-commissioning of Existing Water Plant
- Water Quality Monitoring

Staff within the WD (Manager and other required staff) hold meetings at least monthly to review seasonal needs and issues (includes regulatory operational and maintenance requirements).

Leadership is responsible for assessing the annual work activities and programs, including reviewing staff and equipment resources; Project Coordinators, Supervisors or Maintenance Planners create the schedule and generate the required CMMS work orders; and the Distribution Supervisors manage the daily work-flow for their field staff and verify that maintenance activities are on work orders. This information is then entered into the CMMS.

15.2.2.3 Corrective Maintenance (Planned)

Corrective maintenance includes work activities and/or programs such as:

- System Improvements Program
- Watermain and Service Break Repair
- Service Post Adjustment
- Water Quality Flushing and Swabbing

CMMS work orders are generated to address deficiencies as they are identified and forwarded to the appropriate Supervisors for implementation.

15.2.2.4 Corrective Maintenance (Unplanned)

Unplanned corrective maintenance is typically categorized as an event that requires immediate mobilization of staff and equipment to initiate and complete the required repairs. The need for unplanned corrective maintenance is raised through customer service requests or staff that report failures, deficiencies or damage identified within the system through the predictive maintenance activities. Corrective maintenance includes work activities such as:

- Watermain and Service Break Repair
- Water Quality Flushing and Disinfection
- Hydrant Thawing
- Valve Repair
- Hydrant Repair

The Supervisor, First Response, Project Coordinators, Maintenance Planners or Linear Systems Supervisors can initiate CMMS work orders as required. Typically work orders are initiated by Maintenance Planners and First Response.

15.3 Monitoring Effectiveness of Maintenance

The MMSS, Facility Systems Unit provides information on performance indicators such as cost analysis (type of work order versus labour and material costs), failure analysis

(for unplanned events), backlog and notification to the Water Production and Water Distribution Management Teams during the Asset Management and KPI meetings. The summary of infrastructure maintenance, rehabilitation and renewal programs is reviewed during these annual Water Production and Water Distribution meetings.

To review the effectiveness of maintenance programs, KPIs for Maintenance Management, are reviewed with the MMSS, Facility Systems Unit (Program Manager or Program Coordinator, Maintenance Management Systems) and the WS Managers (Distribution, Production). The Maintenance Program KPIs are reviewed on a quarterly basis with the Water Production team and on a semi-annual basis with the Water Distribution team. In addition, the LCPO Unit reviews various Predictive Maintenance Programs with Operations for accuracy and effectiveness.

15.4 Supporting Infrastructure Renewal and Maintenance

The following infrastructure supports the operation of the drinking water system but is not managed by the Operating Authority.

- Drinking Water Vehicle Fleet: Maintenance and the Fleet Growth Program are managed by Fleet Services.
- Information Technology (computers hardware, software, telephones): maintenance services and replacement program is managed by Information Technology Services.

16.0 ELEMENT 16: SAMPLING, TESTING AND MONITORING

This section describes the sampling, testing and monitoring activities completed for process control and to verify treated and distributed drinking water quality. This includes a description of any relevant upstream sampling, testing or monitoring activities. The procedure below describes how the sampling, testing and monitoring results are recorded and shared with the Owner, where applicable.

Sampling, testing and monitoring is completed on raw, process, treated and distributed water in order to:

- Provide operators with key operating data to maintain optimal treatment conditions at each stage of the process, including Critical Control Points
- Verify and maintain treated water quality
- Ensure water quality is maintained throughout the distribution system
- Ensure compliance with applicable Ontario Drinking Water Regulations
- Evaluate long-term trends or changes in drinking water quality

For the purposes of this procedure, ‘sampling’ is defined as the process of collecting water samples for subsequent laboratory analysis, and ‘testing’ refers to a chemical or physical measurement using bench-top or laboratory equipment. ‘Monitoring’ consists of on-site data collection (i.e. using on-line analyzers, SCADA instrumentation or handheld field instruments) and analysis.

16.1 Responsibilities

Department/Group or Position	Responsibilities
Water Quality Supervisor	• Reviews and updates the Water Quality Sampling Program annually. • Prepares annually a sampling schedule for the well systems and central water system based on the sampling plan outlined in the Water Quality Parameters and Sampling Frequency Tables. • Maintains a list of distribution system locations that require ongoing flushing, auto-flushing, residual checks, or temporary services. • Maintains Water Quality Parameters and Sampling Frequency Tables. • Maintains Water Distribution and Water Quality sample locations in Geo Ottawa.
Water Quality Engineer	• Reviews and updates the Water Quality Sampling Program annually. • Ensures sampling is carried out in accordance with the Sampling Program.

16.2 Sampling and Testing

16.2.1 Water Quality Sampling Program

Drinking water samples are collected at approximately 75 locations throughout the drinking water system (including raw water, process water, treated water and distributed water) for microbiological, chemical, physical and radiological analysis. The water quality sample locations cover all areas of the distribution system to include pressure zones, long retention times, dead-ends, and known problem areas. The sampling points and corresponding analysis, frequency of sampling, laboratory and sampler are listed in the Water Quality Parameters and Sampling Frequency Tables for the Central System and the Well Systems (Kings Park, Munster, Vars, Richmond West and Shadow Ridge). The Distribution sample locations are identified in Geo Ottawa and updated annually by the Water Quality Supervisor.

Sampling Procedures are provided in the Production and Distribution Standard Operating Procedure Manuals.

16.2.2 Sampling and Testing Results

Analytical results are compared to the MECP's Ontario Drinking Water Standards (O. Reg. 169/03) and the Guidelines for Canadian Drinking Water Quality, as well as internal City of Ottawa objectives and guidelines.

The analytical results, approximately 100,000 test results per year, are compiled annually and reported along with the associated Drinking Water Standards for each parameter tested. These annual results are reported in the annual Water Quality Summary Table for each plant and well system. All routine water quality test results are regularly uploaded and stored in an external database (Watertrax). The Water Quality Data Analyst is responsible for maintaining this database and verifying the validity of test results in collaboration with the Water Quality Supervisor. The Water Quality Data Analyst compiles and reports all water quality data for regulatory reports and inspections, and for ad-hoc data requests from public and external stakeholders. All water quality data is openly shared with the public and other agencies as a means of transparency and diligence.

The Water Quality monitoring program in Ottawa is comprehensive and well beyond regulatory requirements. Sufficient data is collected to ensure compliance with current and emerging standards and guidelines. Water Quality staff are notified about any test results that exceed drinking water standards by the laboratories and also by alert e-mails sent from the Watertrax database system. Should the analytical results indicate an adverse condition, as defined by O.Reg. 170/03, the following SOPs indicate how these adverse conditions are reported and addressed:

- Operator Notification Procedure
- Adverse Water Quality Incidents (AWQI) Notification Procedure

16.2.3 Monitoring

16.2.3.1 Source and Raw Water

For the treatment plants, river water conditions (levels, temperature, turbidity and pH) are monitored continuously by on-line analyzers. Process operators conduct additional physical and chemical tests each shift to evaluate raw water quality. For the well systems, well water levels, temperature and pH are measured routinely by Remote Facility Operators and recorded on daily log sheets and subsequently entered into the Watertrax database. In addition, bacteriological samples of each well system are taken twice per week by the Remote Facility Operators.

Water Quality staff review raw water quality results throughout the year and if necessary respond to any unusual or anomalous test results. In addition, an annual review of raw water quality is conducted to discern long-term trends and any potential concerns for the quality of our source water. The Water Quality Engineer summarizes this review in the annual Management Review Report.

The well systems source water is monitored primarily through comprehensive testing of the production wells. In addition, sentinel wells upgradient from the Carp and Kings Park production wells provide additional analysis of aquifer water quality if a concern should arise.

16.2.3.2 Process and Treated Water

On-line analyzers, SCADA instrumentation, bench top equipment and handheld equipment are used to monitor for water quality at each stage of the treatment process, and throughout the distribution system. Monitored parameters include: turbidity, pH, chlorine, fluoride, ammonia, metals, bacteria, anions, TKN, flow, pressure, levels, and temperature.

Monitoring results from on-line instrumentation are trended, alarmed, and stored in the SCADA control system.

16.2.4 Reporting to the Owner

As required by Ontario Regulation 170/03, WS is responsible for completing and publishing MECP Annual Reports for each water system to summarize annual water quality and to report on any AWQIs. All Annual Reports must be completed by February 28th and are published on the City of Ottawa website (www.ottawa.ca). In addition, WS is required to prepare a Summary Report for each water system and provide these reports to the members of Council annually. The Summary Reports must document any items of non-compliance observed during the previous calendar year and must be presented to Council by March 31st each year.

The Water Quality Engineer also convenes an annual meeting with the Medical Officer of Health and Ottawa Public Health staff to review the annual reports and to discuss any other issues of concern related to drinking water quality. A copy of meeting notes and action items are sent to the QMS Coordinator as verification of the meeting.

17.0 ELEMENT 17: MEASUREMENT AND RECORDING (EQUIPMENT CALIBRATION AND MAINTENANCE)

This section describes the programs that enable calibration and maintenance of measurement and recording equipment used for sampling, testing and monitoring required for maintaining drinking water quality.

17.1 Responsibilities

The following groups contribute directly to the calibration and maintenance of measurement and recording equipment:

- Infrastructure and Water Services Department
    - Water Facilities and Treatment Service
        - Water Production Branch
            - Operations Engineering Unit
            - Drinking Water Quality Unit
            - SCADA Unit
        - Facilities Maintenance & Support Branch
            - MMS SAP Water Plants/PS & SW
    - Water Linear and Customer Service
        - Water Distribution Branch
        - Water Utilities and Customer Service
            - Water Quality Monitoring Unit

Specific responsibilities are described in the following sections.

17.2 Definitions

In order to ensure the accuracy and reliability of measurement and recording equipment, several techniques are used.

Item	Definition
Calibration	Application of a “known” physical or chemical standard, followed by adjustment of the instrument to match the standard value.
Maintenance	Routine cleaning and maintenance includes replacement of worn parts, replenishing chemical solutions, and may also include a re-calibration procedure.
Control-check	A measurement taken using a control material or secondary standard in order to verify that the instrument has not “drifted” and is reading within the expected range.
Cross-check	A comparison between two different instruments analyzing the same sample. Ideally, two independent methods should be compared and the results should agree within a tolerable margin.

17.3 Procedure

As a minimum, measurement and recording equipment is maintained and calibrated as per equipment manufacturer’s specifications. Specific equipment may be calibrated and

cross-checked on a more frequent basis, with the exception of benchtop equipment that is typically calibrated weekly or as recommended by the manufacturer. However, cross-checks are completed every 12 hours to confirm reliability. The following sections describe the two processes for coordinating and reviewing requirements for calibration and maintenance, depending on the two equipment types:

- On-line analyzers, benchtop equipment and portable field instruments
- SCADA Instrumentation

17.3.1 On-line analyzers, benchtop equipment and portable field instruments

In WP, CMMS is used to initiate and document calibration and maintenance requirements for measurement and recording equipment requiring maintenance or calibration at a frequency of quarterly or less frequently. Documentation of the remainder of the maintenance and calibration (required at a frequency greater than quarterly) is completed through check lists held and maintained by the Water Quality Technologist - WP.

In WQ, records documenting the calibration and cross checks of portable handhelds are maintained by the Water Quality Supervisor,

In WD, CMMS is used to initiate the cross checks and recording of the portable handheld instruments utilized by field personnel. Records documenting the cross checks and annual calibration of the portable instruments is maintained by the respective Supervisors.

The calibration and maintenance requirements for on-line analyzers, benchtop equipment and portable equipment used to maintain drinking water quality for WP and WD is summarized in the *Summary of Maintenance and Calibration Requirements for Water Quality Measurement and Recording Equipment Table*. The table is updated annually by the QMS Coordinator in collaboration with WS.

17.3.2 SCADA Instrumentation

The SCADA group is responsible for the calibration and maintenance of instrumentation that can also affect drinking water quality (e.g. flow, pressure, level). Specific instrumentation, and calibration and maintenance requirements are documented below:

- MMSS is responsible for generating the list of specific SCADA instrumentation in CMMS on an annual basis. This annual review is triggered by a CMMS work order
- SCADA Systems – WP verifies the list to ensure that removed equipment has been deleted from the CMMS and new equipment has been added to CMMS and that maintenance plans have been prepared

18.0 ELEMENT 18: EMERGENCY MANAGEMENT

This section describes how the Operating Authority maintains a state of emergency preparedness.

18.1 Responsibilities

The WS Managers are responsible for ensuring the correct sections of the Incident Escalation Response Plan (IERP) are referenced in this procedure.

18.2 Requirements

List of Emergency Management requirements and supporting Information

Item	Reference	How Maintained
List of potential emergency situations or service interruptions	This list is generated through the risk assessment process.	Maintained as part of Element 8 – Risk Assessment Outcomes.
Processes for emergency response and recovery	• IERP with supporting appendices and documents. • Other WS – emergency related procedures.	• Maintained as noted in the IERP. • Maintained according to QMS Document and Record Control procedure.
Emergency response training and testing requirements	Annual desktop emergency exercises are completed to evaluate the IERP and competency of relevant WS and supporting personnel. Exercises are designed using specific objectives to evaluate plans and procedures, information flow, decision making and systems or equipment. Exercises provide personnel an opportunity to practice assigned roles and build confidence prior to an incident. During times of actual emergencies, these events can be used to replace the annual desktop emergency exercise, ensuring that the event is recorded as such and that the necessary documentation is completed, including debrief report and follow-up action items, when applicable. Additional emergency-related training provided to WS personnel is	Results from exercise debriefs will identify plan gaps and limitations and will be used to improve and revise the plans.

Item	Reference	How Maintained
	based upon organizational needs and legislative requirements.	
Owner and Operating Authority responsibilities during emergency situations	Generic responsibilities are outlined in IERP and in greater detail in the "Responsibilities" section.	Maintained as noted in the IERP.
References to municipal emergency planning measures	A description of how this plan fits with other city plans is provided in the IERP.	Maintained as noted in the IERP.
Emergency communication protocol and emergency contacts	• Escalation and Notification process is described in the IERP and other WS – emergency related procedures. • Contact lists are maintained as a requirement of the IERP and uploaded on Ozone.	Maintained as noted in the IERP.

19.0 ELEMENT 19: INTERNAL AUDITS

This section describes the internal audit process, which satisfies the following requirements:

- Evaluates conformity of the Operational Plan with current operational practices the requirements of the Drinking Water Quality Management Standard.
- Identifies internal audit frequency, scope, methodology and record keeping processes.
- Considers previous internal and external audit results.
- Describes how DWQMS corrective actions that result from internal audits are identified and initiated.

19.1 Overall Responsibilities

The QMS Coordinator is responsible for coordinating the completion of the Internal Audit.

19.2 Audit Team Structure and Roles

All members of the audit team may prepare for and conduct internal audit interviews. The audit team is comprised of people carrying out the following roles:

- The audit team reviews current practices to evaluate conformity of the Drinking Water Quality Management Standard and documented procedures associated with the DWQMS.
- A Lead Auditor is responsible for auditor training, required audit meetings, production of the audit report and management of Corrective Actions. The lead auditor is responsible for overseeing the internal audit process and preparing the audit report.
- Auditors prepare for and conduct internal audit interviews. Also, auditors participate in opening, daily and closing meetings, when applicable.

19.3 Auditor Training, Qualifications and Selection

The Lead auditor ensures that all audit team members are:

- Knowledgeable of the Drinking Water Quality Management Standard and Ottawa's DWQMS.
- Able to make and record objective observations.
- Are familiar with auditing protocols such as audit process and reporting; how to conduct audit interviews; and understanding of conformance.

19.4 Audit Process

19.4.1 Scope and Criteria

At a minimum, all elements of the DWQMS will be audited at least once every calendar year. Additional audits can be scheduled based on the importance of the process or

area, changes to procedures or documentation, or in response to previous corrective action audits finding.

In coordination with OTM, the QMS Coordinator develops the annual Audit Schedule and Plan that includes the processes and elements to be audited throughout the year, ensuring auditors do not conduct interviews covering work or processes they are directly involved with. Previous internal and external audit results are considered when developing the Audit Schedule and Plan for the upcoming year.

19.4.2 Auditor Preparation

To understand and be able to recognize conformance for, auditors review the Drinking Water Quality Management Standard, appropriate elements of the Operational Plan and related documents and records (procedures, previous audit findings, etc.) before conducting interviews.

19.4.3 Opening Meeting

Before the audit interviews, the Lead Auditor may organize and lead an opening meeting with members of the audit team, personnel selected for interviews and members of OTM when deemed necessary. This meeting is an opportunity for introductions as well as a review of the audit scope, audit processes and important logistical matters. These items may also be discussed at the beginning of an audit interview with the auditee rather than as a separate opening meeting.

19.4.4 Audit Interviews

During audit interviews, auditors document conformance, non-conformance (NC) and areas for improvement. If NC or areas for improvement are observed, auditors document the specifics of the finding(s).

19.4.5 Audit Findings and Daily Meetings

At the end of each audit day or after audit interviews, members of the audit team may discuss findings that require guidance or group discussion or may influence upcoming interviews (by any of the audit team).

19.4.6 Closing Meeting

The closing meeting is an informal presentation of findings of non-conformance and areas for improvement. The audit team may discuss the results, including findings of non-conformance, at a closing meeting or as part of the audit interview with Managers/Supervisors included in the audit.

19.4.7 Audit Report

The Lead Auditor is responsible for drafting the Internal Audit Report. Findings of NC and areas of improvement are organized by QMS element or work process. Once a draft report is completed, it is sent to the Manager responsible for the audited process for review and approval. Once finalized, the Internal Audit Report can be submitted to members of the audit team and/or members of OTM. To address identified non-

conformances, the Lead Auditor drafts corrective actions in collaboration with the Manager and/or Supervisor responsible for the audited process.

19.4.8 Audit Follow Up and Review

Findings of non-conformance and areas for improvement, along with details of proposed corrective, preventive or opportunities for improvement (OFI) actions, are documented and tracked through the Continual Improvement process (Element 21).

Depending on the significance of the audit findings, a follow up audit may be carried out to verify that the corrective actions have been effectively implemented. Otherwise, current audit findings and corrective actions may be assessed in subsequent internal audits.

20.0 ELEMENT 20: MANAGEMENT REVIEW

This section describes how:

- Top Management evaluates the continuing suitability adequacy and effectiveness of the QMS during the management review and reports the results to the Owner.
- Necessary information is collected for the management review.
- Top Management records decisions and actions made during the management review related to the QMS.
- Records of the reviews are maintained.

20.1 Responsibilities

The Management Review is completed once every calendar year, at a minimum and involves the members of both CTM and OTM.

Department/Group or Position	Responsibilities
QMS Coordinator / QMS Representative	• Sets the management review meetings • With input from the Operating Authority, develops the annual Management Review Report • Facilitates the Management Review meetings • Prepares the CTM review meeting presentation. Recording any action items deemed necessary as part of the OTM and CTM (if held) Management Review meetings • Maintains approval of final report and action items • Inputs final Management Review action items into the Continual Improvement Process • Ensures the management review results, including identified deficiencies, decisions and action items, are conveyed to CTM and the Owner (through Council)
CTM Members	• Participates in the CTM Management Review meeting • Reviews the OTM Management Review meeting action items
OTM Members	• Participates in the OTM Management Review meetings • Approves the Management Review meeting action items • Approves the final Management Review Report

20.2 Management Review

20.2.1 Operational Top Management Review

The OTM review is held a minimum of once every calendar year to review the overall suitability, adequacy and effectiveness of the QMS. The Management Review Report is developed with input from members of the Operating Authority.

20.2.2 Corporate Top Management Review

The CTM review may be achieved through a meeting or the electronic circulation of the report.

20.3 Management Review Report

The final report is approved by Operational Top Management members. The report details the review items listed below:

a) Incidents of regulatory non-compliance
b) Incidents of adverse drinking water tests
c) Deviations from critical control point limits and response actions
d) Effectiveness of the risk assessment process
e) Results of audits (internal and external)
f) Results of relevant emergency response testing
g) Operational performance
h) Raw water supply and drinking water quality trends
i) Follow-up action items from previous management reviews
j) Status of management action items identified between reviews
k) Changes that could affect the QMS
l) Summary of consumer feedback
m) Resources needed to maintain the QMS
n) Results of the infrastructure review
o) Operational Plan currency, content and updates
p) Summary of staff suggestions

In addition to the required review items, approved meeting action items, assigned personnel and proposed timelines for implementation, are included in the final Management Review Report. Final reports are produced and made available to staff.

The QMS Representative will ensure the management review results are conveyed to CTM and the Owner (through Council).

Once the annual management review has been completed, action items from the Operational, Corporate and Council meetings are entered and tracked through the Continual Improvement Process (Element 21).

21.0 ELEMENT 21: CONTINUAL IMPROVEMENT

This section describes the process used by the Operating Authority to continually improve the effectiveness of its QMS by;

- reviewing and considering applicable best management practices (BMPs); and
- documenting a process for identifying, implementing and managing corrective and preventive action items.

Continual improvement actions are developed in response to actual or potential non-conformances, incidents, opportunities for improvement, management review processes or in response to Critical Control Limit (CCL) deviations. These actions are aimed at trying to correct or prevent the current or potential issue. Ultimately, the actions are carried out in order to improve the delivery of safe drinking water.

21.1 Responsibilities

Continual Improvement is the responsibility of all Operating Authority personnel. The QMS Coordinator is responsible for monitoring and tracking progress in all areas identified for continual improvement and for reporting the results to OTM.

21.2 Review of BMPs

Along with various Operating Authority personnel, the QMS Coordinator will review and consider applicable BMPs at least once every thirty-six months. This could include:

- reviewing BMPs published by the MECP;
- participation in water industry conferences, workshops, seminars, and webcasts (i.e., WRF, AWWA, etc.);
- review BMPs from other water utilities through surveys and informal communications;
- participation on drinking water and treatment committees, OWWA, CWWA, etc.;
- attending the annual DWQMS workshop facilitated by the Walkerton Clean Water Centre, when feasible, to learn any BMPs from other utilities; and
- communicating with peers about BMPs through reviewing and contributing to discussions on the Municipal Water Wastewater Regulatory Committee (MWWRC) online forum, http://municipaldrinkingwater.ning.com, as appropriate.

Any follow-up action items derived from the BMP review will be captured in the DWQMS Corrective Action/Preventive Action (CAPA) database and monitored by the QMS Coordinator for completion.

21.3 Triggers for Continual Improvement

Triggers for Continual Improvement arise from the various processes and mechanisms listed below. For the purposes of the QMS, a non-conformance (NC) is defined as an event or condition that is not in accordance with the MECP Drinking Water Quality Management Standard, the DWQMS Operational Plan or SOPs. Corrective Actions (CAs) are consequently created to rectify any identified non-conformity and to prevent

the non-conformity from re-occurring. While Preventive Actions (PA) are created to address potential non-conformities and to prevent a potential non-conformity from occurring. Opportunities for Improvement (OFIs) speak to those items that are not specific requirements of the Standard, the Operational Plan or SOPs, however, may improve the quality of the QMS once addressed. Additional details for investigating an incident and/or source of non-conformance is described in the Incident Response and Investigation procedure. A review of the effectiveness of an implemented CA or PA taken to correct or prevent a non-conformity or potential non-conformity is also described in this procedure. The CAs, PAs, and OFIs are documented and managed by the QMS Coordinator, as described in the CAPA Process procedure.

Triggers for Continual Improvement may include:

- Near Misses that does not result in impacts to released drinking water
- Deviations of CCLs that does not result in impacts to released drinking water
- Risk Assessment Findings
- Incidents (event or condition that results in adverse water quality, significant service interruption or major treatment upset)
- Trends identified in KPI reviews
- Audit findings (internal and external audit reports)
- Management Review Findings
- Regulatory Non-Compliance

The occurrence of the above-listed triggers is separated into two categories and managed accordingly:

1) CCL Deviations and operational near-miss occurrences are documented, tracked and monitored by the Senior Operations Engineers through the Continual Improvement Summary Table (WP and WD). The manager/supervisor is responsible for investigating and recording details of any events that occur in their respective area. The events are reviewed by a technical review committee during meetings that occur every two months or as needed.

2) All other occurrences are documented by the QMS Coordinator in the Incident Reports, when applicable (described below). Significant incidents that warrant detailed investigation and root-cause analysis are documented in the Incident reports. Incidents are deemed significant and should be documented in the Incident Report when there is an actual or potential impact to water quality, including depressurization, media implications (i.e., precautionary boil water advisory) and/or systematic recurrences relating to drinking water quality.

All action items (CAs, PAs or OFIs) described above are tracked and monitored through the DWQMS CAPA database, assigned a priority level and a lead staff person is identified along with a target completion date. The effectiveness review of the implemented actions is determined on a case by case scenario. Additional details regarding the management of the CAs, PAs and OFIs is described in the CAPA Process procedure.

21.4 Incident Report

The Incident Report is completed by QMS Coordinator, who organizes and facilitates the investigation in coordination with the Manager of the affected unit. The Incident Report must, at a minimum, include the following information:

- A description of the incident.
- Route Cause/Failure Analysis, if applicable.
- Meeting Attendees.
- A list of factors that may have caused and/or contributed to the event.
- Action items in response to likely and probably causes or contributing factors.
- Persons responsible for completing action items.

Once approved by the Manager of the Unit, the actions detailed in the report are entered into the DWQMS CAPA database for monitoring.

21.5 Exceptions

The following exceptions are not included as part of this procedure:

- The process for notification and documentation of AWQIs is documented as part of a separate AWQI procedure; and
- Customer complaints related to water quality are typically received by the Customer Services section. These inquiries are tracked through the corporate call-tracking system database (Maximo). If necessary, field staff from the Water Quality section will carry out an on-site investigation and prepare a report of the findings for the customer. These investigations are tracked through a yearly “Customer” spreadsheet maintained by the Water Quality Supervisor. Additionally, discoloured and Water Quality Investigations are all logged in Maximo and tracked in a Customer excel Spreadsheet maintained by the Water Quality Supervisor.

22.0 REFERENCES AND/OR RELATED DOCUMENTS

Element/ Section	Document	Document Title
5	Information Technology	City of Ottawa Records Management Policy
6.0	MECP	Procedure for Disinfection of Drinking Water in Ontario, 2016
6.0	Simmering and Associated Ltd. Consulting Engineers	Hydrogeological Assessment Downwel Holdings Ltd. Shadow Ridge Estates, July 1998
6.0	Simmering and Associated Ltd. Consulting Engineers	Preliminary Hydrogeological Investigation Downwel Holdings Ltd. Shadow Ridge Estates Subdivision, December 1995
6.0	Golder Associates	Wellhead Protection Study Carp Communal Wells, MVCA Study Group 2003
6.0	Mississippi-Rideau Source Protection Region	Watershed Characterization Report version 2.0
6.0	R.V. Anderson Associate Limited	Carp: First Engineers Report, May 2001
6.0	Stantec Consulting	Operations Manual, Revised 2005
6.0	WESA	Carp Communal Water Supply Project, February 1987
6.0	Constenoga-Rovers and Associates	King's Park Subdivision Communal Well System Engineers' Report, January 2001
6.0	Golder Associates	Wellhead Protection Study Munster Hamlet and Kings Park Communal Wells, MVCA Study Group 2003
6.0	Stantec Consulting	Operations Manual, November 2005
6.0	Stantec	Munster Hamlet Communal Well System Engineers' Report, January 2001
6.0	MECP	Procedure for Disinfection of Drinking Water in Ontario, June 2006
6.0	Stantec	Engineer's Report, November 2000
10.0	MECP	Guide to Drinking Water Operator Training Requirements in O. Reg. 128/04, November 2014

23.0 REVISION LOG

Version	Section	Revised By	Description of Change	Date Released
0	All	Quality Management Coordinator	n/a	Nov. 26, 2008
0.1	5, 9,10,13, 16, 17, 19, 21	Quality Management Coordinator	n/a	Sept. 30, 2009
0.2	All updated, sig. revisions to 7,8, 13-F1 and 21	Quality Management Coordinator	n/a	Apr. 16, 2010
1.0	All	Lysa Drewniak	Procedure update and revision from the previous DWS format. Document transfer to the ESD template (includes the assignment of a controlled document number and version control).	Jan 02, 2014
2.0	All	Lysa Drewniak	Procedure update throughout: each element was updated for re-organizational changes and to reflect current practices within the Operating Authority. Reformatted and renumbered DWM-P000002 version 1.0.	July 11, 2017
3.0	6	Meagan Wheeler-Cuddihy	Updated Element 6 (Section 6.8) to include additional details for Richmond West Well System.	2018/01/24
3.1	1, Appendices	Lysa Drewniak	Added Subject System Description Forms, Schedule “C”, to Element 1 and as Appendix A.	2018/11/07
4.0	All	Lysa Drewniak	-Updated to meet MECP Standard (2017) 2.0 requirements -Revised Richmond West Well System commissioning date to 2019 -Removed reference to ‘Water Distribution and Water Quality Sampling Points’ map as sample locations to be maintained in Geo Ottawa	2019/04/25
4.1	1, 6.8	Scott Gray	Revised commissioning date and future ownership of Richmond West Well System.	2019/08/08
5.0	1) 1,6 2) 1, 9, 20 3) 1, 9 4) 7 5) 15 6) 16 7) 18 8) 19 9) 21 10) Appendix B 11) Appendix C	Lysa Drewniak	1) Update for ownership of Richmond West Well System 2) Updated CTM: • Added General Manager of Planning, Infrastructure and Economic Development (PIED), and • Added Director of Infrastructure Services (IS) • Removed requirement for CTM to approve Management Review Report 3) Removed ‘Operations’ and ‘Maintenance’ WD Manager – leaving only ‘Water Distribution Manager’	2020/09/18

Version	Section	Revised By	Description of Change	Date Released
	12) Appendix D		4) Added requirement to review 'Potential Hazardous Events for Municipal Residential Drinking Water Systems' (Ministry of Environment, dated February 2017) in procedure section 5) Added a statement to clarify that provision of infrastructure is achieved through the LRFP and annual budget, as per 14.4.1 6) Added that a copy of meeting notes and action items between WS and OPH are sent to the QMS Coordinator as verification of the meeting 7) Added that actual emergency events can replace desktop scenarios 8) Replaced 'once every 12 months' to 'once every calendar year' for the completion of internal audits of each element 9) Clarified the descriptions of non-conformity and potential non-conformity 10) Updated with 2020 Pressure Zone Map 11) Updated to reflect revised roles and organizational structure 12) Updated to reflect revised roles and organizational structure	
6.0	1) Title Page 2) 1.0 & 6.0 3) 1.1, 3.0, 4.0, 9.0, 12.1, 19.1, 20.1, 21.1 and Appendix C 4) 3.0 5) 6.0 6) 8.0 7) 12.3 8) 15.3 9) 19.4.1	Lysa Drewniak	1) Removed names, QMS Representative 2) Added MDWL numbers for each system 3) Revisions associated with changes to QMS Representative from Director of WS to QMS Coordinator, added Performance & Management System Specialist as alternate QMS Rep. Also revised OTM commitment and approval of DWQMS-related records, where required 4) Require all members of CTM to sign off on endorsement during each CTM Management Review meeting 5) Removed EMR from Central Distribution System description. Revised on-line analyzer locations for Richmond West (contact chamber) 6) Risk Assessment records are reviewed by OTM (do not require approval) 7) Added 'to' for communication btn Suppliers and Top Management	2021/04/16

Version	Section	Revised By	Description of Change	Date Released
			8) Removed requirement for the Director, WS to attend the annual MMS KPI meetings 9) Audit Plan and Schedule is created in coordination with OTM but no longer requires approval	
7.0	a) All b) All c) E9 d) E6	Caroline Lamoureux	a) Change in department structure, including CTM members' position, branch/unit/position name, etc. b) Revised storage location of documents/records whenever shared drives or Ozone are mentioned, to reflect the adoption of SharePoint collaborative sites and the change to the My City internal website. c) Revised element 9, moved the content of the chart and Operating Authority staff identification (Appendix C and D) to a controlled and tracked document. d) Updated Carp Well System description, GAC process	2023-09-01

APPENDIX A - SUBJECT SYSTEM DESCRIPTION FORMS, SCHEDULE "C"

Ontario

Ministry of the Environment and Climate Change

Schedule C – Director's Directions for Operational Plans (Subject System Description Form)

Municipal Residential Drinking Water System

Fields marked with an asterisk (*) are mandatory.

Owner of Municipal Residential Drinking Water System *
City of Ottawa

Name of Municipal Residential Drinking Water System *
Central Drinking Water System

Subject Systems

☑ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in the below table.

	Name of Operational Subsystems(if Applicable)	Name of Operating Authority *	DWS Number(s) *
1		City of Ottawa	220003207
2		City of Ottawa	220003154

Provide the information outlined in the 'Contact Information' section for **each** Operational Subsystem.

Contact Information 1

Last Name *	First Name *	Middle Initial
Rose	Tammy	
Title *	**Phone Number ***	
Director, Water Services	613 580-2424	

Email Address *
Tammy.Rose@ottawa.ca

Contact Information 2

Last Name *	First Name *	Middle Initial
Wheeler Cuddihy	Meagan	
Title *	**Phone Number ***	
Senior Operations Engineer	613 580-2424	

Email Address *
Meagan.WheelerCuddihy@ottawa.ca

Ontario

Ministry of the Environment and Climate Change

Schedule C – Director's Directions for Operational Plans (Subject System Description Form)

Municipal Residential Drinking Water System

Fields marked with an asterisk (*) are mandatory.

Owner of Municipal Residential Drinking Water System *
City of Ottawa

Name of Municipal Residential Drinking Water System *
Carp Well System

Subject Systems

☑ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in the below table.

	Name of Operational Subsystems(if Applicable)	Name of Operating Authority *	DWS Number(s) *
1		City of Ottawa	210002272

Provide the information outlined in the 'Contact Information' section for **each** Operational Subsystem.

Contact Information 1

Last Name *	First Name *	Middle Initial
Rose	Tammy	
Title *	**Phone Number ***	
Director, Water Services	613 580-2424	

Email Address *
Tammy.Rose@ottawa.ca

Contact Information 2

Last Name *	First Name *	Middle Initial
Wheeler Cuddihy	Meagan	
Title *	**Phone Number ***	
Senior Operations Engineer	613 580-2424	

Email Address *
Meagan.WheelerCuddihy@ottawa.ca

  Disponible en français

Ontario

Ministry of the Environment and Climate Change

Schedule C – Director's Directions for Operational Plans (Subject System Description Form)

Municipal Residential Drinking Water System

Fields marked with an asterisk (*) are mandatory.

Owner of Municipal Residential Drinking Water System *
City of Ottawa

Name of Municipal Residential Drinking Water System *
Kings Park Well System

Subject Systems

☑ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in the below table.

	Name of Operational Subsystems(if Applicable)	Name of Operating Authority *	DWS Number(s) *
1		City of Ottawa	220007999

Provide the information outlined in the 'Contact Information' section for **each** Operational Subsystem.

Contact Information 1

Last Name *	First Name *	Middle Initial
Rose	Tammy	

Title *	Phone Number *
Director, Water Services	613 580-2424

Email Address *
Tammy.Rose@ottawa.ca

Contact Information 2

Last Name *	First Name *	Middle Initial
Wheeler Cuddihy	Meagan	

Title *	Phone Number *
Senior Operations Engineer	613 580-2424

Email Address *
Meagan.WheelerCuddihy@ottawa.ca

Ontario

Ministry of the Environment and Climate Change

Schedule C – Director's Directions for Operational Plans (Subject System Description Form)

Municipal Residential Drinking Water System

Fields marked with an asterisk (*) are mandatory.

Owner of Municipal Residential Drinking Water System *
City of Ottawa

Name of Municipal Residential Drinking Water System *
Munster Well System

Subject Systems

☑ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in the below table.

	Name of Operational Subsystems(if Applicable)	Name of Operating Authority *	DWS Number(s) *
1		City of Ottawa	220008006

Provide the information outlined in the 'Contact Information' section for **each** Operational Subsystem.

Contact Information 1

Last Name *	First Name *	Middle Initial
Rose	Tammy	

Title *	Phone Number *
Director, Water Services	613 580-2424

Email Address *
Tammy.Rose@ottawa.ca

Contact Information 2

Last Name *	First Name *	Middle Initial
Wheeler Cuddihy	Meagan	

Title *	Phone Number *
Senior Operations Engineer	613 580-2424

Email Address *
Meagan.WheelerCuddihy@ottawa.ca

Ontario

Ministry of the Environment and Climate Change

Schedule C – Director's Directions for Operational Plans (Subject System Description Form)

Municipal Residential Drinking Water System

Fields marked with an asterisk (*) are mandatory.

Owner of Municipal Residential Drinking Water System *
City of Ottawa

Name of Municipal Residential Drinking Water System *
Shadow Ridge Well System

Subject Systems

☑ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in the below table.

	Name of Operational Subsystems(if Applicable)	Name of Operating Authority *	DWS Number(s) *
1		City of Ottawa	260089639

Provide the information outlined in the 'Contact Information' section for **each** Operational Subsystem.

Contact Information 1

Last Name *	First Name *	Middle Initial
Rose	Tammy	

Title *	Phone Number *
Director, Water Services	613 580-2424

Email Address *
Tammy.Rose@ottawa.ca

Contact Information 2

Last Name *	First Name *	Middle Initial
Zawada	Yvonne	

Title *	Phone Number *
Senior Operations Engineer	613 580-2424

Email Address *
Yvonne.Zawada@ottawa.ca

Ontario

Ministry of the Environment and Climate Change

Schedule C – Director's Directions for Operational Plans (Subject System Description Form)

Municipal Residential Drinking Water System

Fields marked with an asterisk (*) are mandatory.

Owner of Municipal Residential Drinking Water System *
City of Ottawa

Name of Municipal Residential Drinking Water System *
Vars Well System

Subject Systems

☑ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in the below table.

	Name of Operational Subsystems(if Applicable)	Name of Operating Authority *	DWS Number(s) *
1		City of Ottawa	210002263

Provide the information outlined in the 'Contact Information' section for **each** Operational Subsystem.

Contact Information 1

Last Name *	First Name *	Middle Initial
Rose	Tammy	

Title *	Phone Number *
Director, Water Services	613 580-2424

Email Address *
Tammy.Rose@ottawa.ca

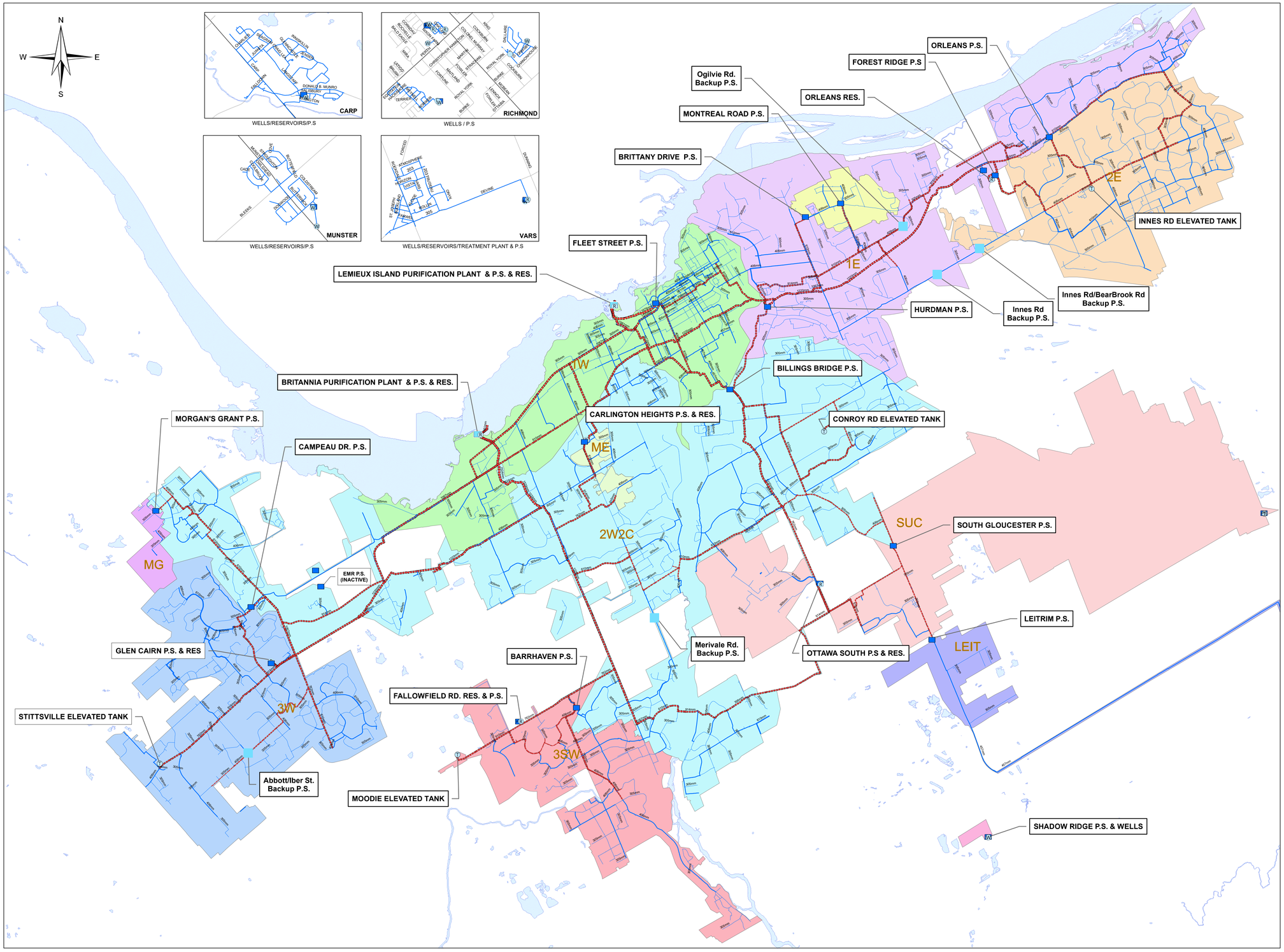
Contact Information 2

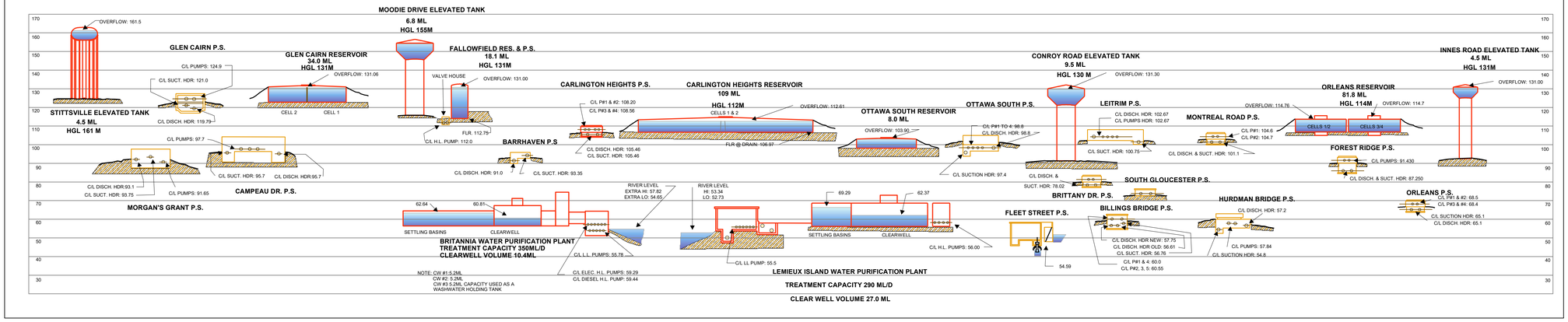
Last Name *	First Name *	Middle Initial
Zawada	Yvonne	

Title *	Phone Number *
Senior Operations Engineer	613 580-2424

Email Address *
Yvonne.Zawada@ottawa.ca

APPENDIX B - CENTRAL DISTRIBUTION SYSTEM - PRESSURE ZONE MAP





LEGEND

Water System Structure

Structure Type, Life Cycle Status

- WTP — DWTP, In Service
- DWPS, In Service
- DWPS, Proposed
- DWWS, In Service
- RESE, In Service
- RESI, In Service

Watermains

Priority, Internal Diameter

- Backbone 1524mm - 1981mm
- Backbone 1067mm - 1372mm
- Backbone 610mm - 914mm
- Backbone 406mm - 508mm
- Backbone 152mm - 305mm
- Distribution 1676mm - 1981mm
- Distribution 1067mm - 1372mm
- Distribution 610mm - 914mm
- Distribution 406mm - 508mm
- Distribution 305mm - 381mm

Water Pressure Zone

Zone IDs

- 1E
- 1W
- 2E
- 2W2C
- 3SW
- 3W
- LEIT
- ME
- MG
- MONT
- SHADOW RIDGE
- SUC

Ottawa

Planning, Infrastructure and Economic Development Department
Right of Way, Heritage & Urban Design Services
Infrastructure Services

0 1,000 2,000 4,000 6,000

Metres

Water Distribution System Facilities & Feedermains

Geospatial Analytics, Technology and Solutions — May 2020

APPENDIX C - COMPETENCIES TABLE

DWQMS Competencies Table

	MECP/OETC WT Certification Levels (If Required)	Workplace health and Safety	Distribution System Knowledge	Water Treatment Knowledge	SCADA System Knowledge	Mechanical Systems Knowledge	Electrical Systems Knowledge	Water Quality and Lab Analysis (QA/QC)	Emergency Response	Water Loss Control Principles	Maintenance Management	Fleet, General & Heavy Equipment Operation	Water Related Legislation
Water Facilities and Treatment Service													
Director, Water Facilities and Treatment Service		x	x	x	x	x	x	x	x	x	x	x	x
Water Production (East and West) Branches													
Plant Managers		x	x	x	x	x	x	x	x	x	x		x
Water Production Supervisor	IV	x	x	x	x	x	x	x	x	x	x	x	x
Process Supervisor	IV	x	x	x	x	x	x	x	x	x	x		x
Senior Process Operator	III	x	x	x	x	x	x	x	x	x	x	x	x
Process Operator	II	x	x	x	x	x	x	x	x	x	x		x
Maintenance Operator	I	x	x	x	x	x	x	x	x		x	x	x
Remote Facilities Operators	II	x	x	x	x	x	x	x	x	x	x	x	x
SCADA System, Program Lead	I	x	x	x	x	x	x	x	x	x	x	x	x
Senior Operations Engineer	II	x	x	x	x	x	x	x	x	x	x		x
Operations Engineer In Training	II	x	x	x	x	x	x	x	x	x	x		x

Ottawa

DWQMS Competencies Table

	MECP/OETC WT Certification Levels (If Required)	Workplace health and Safety	Distribution System Knowledge	Water Treatment Knowledge	SCADA System Knowledge	Mechanical Systems Knowledge	Electrical Systems Knowledge	Water Quality and Lab Analysis (QA/QC)	Emergency Response	Water Loss Control Principles	Maintenance Management	Fleet, General & Heavy Equipment Operation	Water Related Legislation
Supervisor, Water Treatment Maintenance (Mechanical and Electric)	I	x	x	x	x	x	x	x	x	x	x	x	x
Industrial Millwright/Operator	I	x	x	x	x	x	x	x	x		x	x	x
Diesel Mechanic/Operator	I	x	x	x	x	x	x	x	x		x	x	x
Water Linear and Customer Service													
Director, Water Services-Linear		x	x	x	x	x	x	x	x	x	x	x	x
Water Distribution Branch													
Manager		x	x	x		x		x	x	x	x	x	x
Senior Operations Engineer	III	x	x	x		x		x	x	x	x		x
Linear Systems Supervisor	III	x	x	x		x		x	x	x	x	x	x
Operator In Charge	II	x	x	x		x		x	x	x	x	x	x
Water Distribution Operator	I	x	x	x		x		x	x	x	x	x	x
Water Utility and Customer Services Branch													
Supervisor, First Response	II	x	x	x		x		x	x	x	x	x	x

DWQMS Competencies Table

	MECP/OETC WT Certification Levels (If Required)	Workplace health and Safety	Distribution System Knowledge	Water Treatment Knowledge	SCADA System Knowledge	Mechanical Systems Knowledge	Electrical Systems Knowledge	Water Quality and Lab Analysis (QA/QC)	Emergency Response	Water Loss Control Principles	Maintenance Management	Fleet, General & Heavy Equipment Operation	Water Related Legislation
Shift Coordinator, First Response	I	x	x			x		x	x	x	x	x	x
Leak Detector	I	x	x			x		x	x	x	x	x	x
Customer Serviceperson, First Response	I	x	x			x		x	x	x	x	x	x
Water Quality Supervisor	II	x	x	x	x	x	x	x	x	x	x	x	x
Water Distribution Operator	I	x	x					x	x	x	x	x	x