REPORT NO. 151-02944-00

Water and Wastewater Master Plan Updates

MASTER PLAN DOCUMENT – FINAL REPORT

February 27, 2017

WSP

WATER AND WASTEWATER MASTER PLAN UPDATES

FINAL REPORT

Utilities Kingston

Prepared for:
City of Kingston

Final Report

Project no: 151-02944-00
Date: February 27, 2017

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February 27, 2017

Ms. Katie Morrow / Mr. Mike Fischer
Utilities Kingston
1211 John Counter Blvd
Kingston, ON K7L 4X7

Subject: **City of Kingston Water and Wastewater Master Plan - Final Report**

Dear Ms. Morrow / Mr. Fischer:

We are pleased to provide our Final of the Water and Wastewater System Master Plan document for the City of Kingston service areas.

We trust that this submission meets your expectations and look forward to your comments.

Yours truly,

Matt Morkem, P. Eng.
Manager, Infrastructure, Kingston

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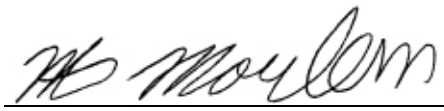

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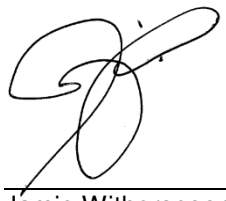

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REVISION HISTORY

VERSION	DATE	DESCRIPTION
1	12/12/2016	For Client Review
2	01/23/2016	For Client Review
3	02/27/2016	Final Document

PRODUCTION TEAM

CLIENT

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EXECUTIVE SUMMARY

WSP was retained by Utilities Kingston to complete a Master Plan to establish servicing strategies for water and wastewater infrastructure for the next 20 years. The Master Plan identifies projects to address the servicing needs of planned growth and development within the Urban Boundary. The Master Plan was conducted in accordance with the requirements for Schedule A projects following Approach 1 set out in the Municipal Class Environmental Assessment (Class EA) document (Municipal Engineers Association, Amended 2015). The Master Plan Study will identify the overall water and wastewater system's needs; proposing general locations for future infrastructure to support the City's development plans until 2036.

The Problem/Opportunity is defined as follows:

To plan for water and wastewater integrated infrastructure and pollution control to safely and reliably service the existing and projected residential and employment population, with a focus on intensification within the current urban and serviced boundary, while minimizing impacts on the natural, cultural and social features to ensure service excellence in the City of Kingston.

Background reports and relevant legislation/regulations were reviewed as part of this process. The previous master plans, Water Master Plan (2007) and Sewage Infrastructure Master Plan (2010), formed the foundation for the Master Plan updates.

The existing conditions of the water and wastewater systems in the City of Kingston were reviewed through the completion of a Condition Assessment. The existing conditions were evaluated to gain an understanding of the facilities that form part of the City's water and wastewater system and evaluate each facility's importance, condition, and reliability. A multidiscipline team completed an assessment of assets and assigned a reliability rating to each facility based on risk level, effective life, and condition rating.

Hydraulic models were developed for both the water and wastewater systems. For the water system, WSP audited and rebuilt the Infowater model. An all-pipe model of the system including pipes, key hydrants, storage tanks and system water sources was developed. For wastewater, the previously developed InfoSWMM trunk model was updated and validated to reflect the current sewer infrastructure and pumping station operation. The model included trunk sewers, forcemains, maintenance holes, key pumping stations and other system infrastructure. Simulations in the model included dry-weather flow, wet-weather design storm flow and an extended-period analysis which combined both the dry and wet-weather components.

Anticipated growth in the City of Kingston was forcasted through analysis and consolidation of background reports and other available information for residential, industrial, commercial and institutional growth in the City. Through discussions with Utilities Kingston, the City of Kingston Planning Department and a review of the previous Master Plans and available reports, five growth scenarios were developed: 2021, 2026, 2036, Full Build-out, and Ultimate.

These development scenarios were evaluated with the application of the hydraulic models for water and wastewater, facilitating the identification of gaps that develop in the existing water and wastewater infrastructure as a result of planned growth and development.

An 'Alternative Analysis' was completed to evaluate alternative methods of resolving gaps in the infrastructure. The alternatives were evaluated using natural environment, social and cultural, technical suitability, financial and economic criteria to determine the preferred servicing alternative. An evaluation matrix was applied to objectively assess the impacts and identify the preferred solution.

The recommended projects are detailed in the tables below, they have been separated into categories based on the primary trigger. The presented opinion of probable cost (OPC) is a Class D estimate.

Water

The following table details the projects which have been identified as required to satisfy growth and development in the City.

Table 1-1 Growth / Development Projects (Water)

GROWTH / DEVELOPMENT PROJECTS (WATER)	DESCRIPTION	TIMING	OPC (2016$)
Front Rd. - Interconnect	Install 1050 mm watermain along Front Rd. between Point Pleasant WTP and Sir John A. Blvd.	2018	$5.0M
Centennial Drive – New Watermain	Install new watermain between Resource Rd. and Centennial Dr.	2018	$700K
James St. BS - Capacity Upgrade	James St. Booster Station Phase 1 - Upgrade to 27.65 ML/day total and 14.69 ML/day stand-by capacity.	2021	$5.8M
Decommission Old Colony & Sydenham BS	Decommission Sydenham Rd. and Old Colony Rd. Booster Stations. Install a PRV/PSV at the former Sydenham BS.	2021	$600K
New Zone 3 Subzone	Install 3 PRV Chambers, ±2 km of 500 mm watermain and isolation valves to create a subzone in Zone 3 south of Gore Rd. (No reconstruction cost included - assumed to be coordinated with HWY 15 widening).	2021	$2.7M
Cataraqui Woods - New Watermain	Install a new 400 mm watermain along Cataraqui Woods Dr. from Centennial Dr. to Sydenham Rd.	2021	$690K
Augusta Dr.- New Watermain	New 400 mm watermain along Augusta Dr. from Atkinson St. to Cataraqui Woods Dr.	2021	$450K
Holden - New Watermain	Install ±420m of 300 mm watermain to extend along Holden St. from Beth Cres. to Cataraqui Woods Dr.	2021	$450K
O'Connor EST - Decommissioning	Decommission O'Connor EST once the Front Rd. interconnect is operational.	2021	$1.4M
Adjust Operational Levels in Innovation Dr. EST	Adjust operational levels in Innovation Dr. EST once new subzone in Zone 3 is implemented to increase storage.	2021	-
Adjust Operational Levels in Third Ave. Reservoir	Adjust operational levels in Third Ave. Reservoir to increase functional storage.	2021	-
CFB Kingston EST - Decommissioning	Decommission CFB Kingston EST – by DND.	2021	-
John Counter Blvd. - New Watermain	New 400 mm watermain along John Counter Blvd. from Indian Rd. to Princess St.	2021	$410K
Pearl Ave. - New Watermain	Install 300 mm watermain on Pearl Ave. from Kendal Ave. to Creekford Rd.	2021	$690K
Gardiners Rd. - Watermain Upsizing	Upsize Gardiners Rd. watermain (east) to a 500 mm pipe between O'Connor Reservoir and Fortune Cres.	2036	$2.6M
Cataraqui Woods Dr. - Watermain Upsizing	Upsize Cataraqui Woods Dr. watermain between Clyde Ct. and Midland Ave. to a 450 mm.	2036	$1.8M

The following table details the projects which have been identified as required to improve reliability and redundancy of the system.

Table 1-2 Reliability / Redundancy Projects (Water)

RECOMMENDED PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Calvin Park - Watermain Looping	New 150 mm watermain through easements to Norman Rogers Dr. located at Herchmer Cres. (±75m), Holland Cr. (±95m) out to Norman Rogers Dr., Michael Grass Cres. to Van Order Dr. (±85m).	2021	$250K
Lower Dr. - Watermain Looping	Install ±70m of 200 mm dia. watermain to loop between Lower Dr. and Bath Rd.	2021	$50K
Norman Roger's Ave. - Watermain Upsizing	Replace ±1 km of 300 mm dia. watermain on Norman Rogers Dr. and Roden Rd. between Van Order Dr. and Johnson St.	2026	$1.9M
Dalton Ave. - Watermain Replacement	Replace ±1 km of 300 mm watermain on Dalton Ave. between Division St. to Don St.	2026	$1.9M
Creekford Rd. - New Watermain	Install ±3.6 km of 300 mm watermain along Creekford Rd. to Westbrook Rd.	2026	$6.7M
Balsam Grove - Rideau Trail Watermain Looping	Install ±500m of 200 mm watermain to loop Balsam Grove. Extend from Queen Mary Rd. to Sherwood Dr.	2036	$350K
Dalton Ave. - Watermain Twinning	Twin watermain along Dalton Ave. between Sir John A. MacDonald Blvd. and Grant Timmins Dr. (±300m).	2036	$770K

The following table details the projects which have been identified as a result of condition or age. The projects were identified through the condition review completed as part of the Master Plan.

Table 1-3 Condition / Age Projects (Water)

RECOMMENDED PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Cana WTP - Piping	Replace pipe insulation to ensure longevity of pipework.	2021	$10K
King St. WTP - Condition Upgrade	Replace PLC, review process, review diesel pump, replace gaskets, pump outlet piping and header, replace hypochlorite tank due to age and condition.	2021	$175K
Third Ave. Reservoir - Condition Upgrade	Replace pumps; diesel motor for emergency pump and building electrical.	2021	$550K
Third Ave. Reservoir - Condition Upgrade	Replace process mechanical (excluding pumps); instrumentation; building mechanical and building electrical due to condition and age.	2026	$400K
King St. WTP - Condition Upgrade	Replace underground diesel tank, replace sludge tank baffles due to condition and age.	2026	$50K
Progress Ave. Reservoir - Condition Upgrade	Replace pump control panel due to condition and age.	2026	$40K
Tower St. Tower - Condition Upgrade	Replace building mechanical, actuated valve and manual valves due to condition and age.	2026	$250K
Forest Dr. Standpipe - Condition Upgrade	Replace auxiliary piping, instrumentation, process electrical, building mechanical and building electrical due to condition and age.	2031	$250K
James St. BS - Condition Upgrade	Replace pump control panel, roof replacement due to condition and age.	2036	$80K

RECOMMENDED PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Third Ave. Reservoir - Condition Upgrade	Roof replacement due to condition and age.	2036	$6K
Progress Ave. Reservoir - Condition Upgrade	Replace process mechanical, instrumentation (excluding pump control panel), process electrical, building mechanical, building electrical and roof due to condition and age.	2036	$286K
Tower St. Tower - Condition Upgrade	Replace instrumentation, process electrical and building electrical.	2036	$150K
King St. WTP - Condition Upgrade	Repair/rebuild structural concrete ceiling supports due to condition and age.	2036	$30K

Wastewater

The following table details the projects which have been identified as required to satisfy growth and development in the City.

Table 1-4 Growth / Development Projects (Wastewater)

RECOMMENDED GROWTH PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Westbrook PS - Capacity Upgrades	Upgrade the capacity of Westbrook PS to 30 L/s firm capacity.	2021	$500K
Westbrook PS - Flow Redirect	Redirect flow from Westbrook Rd. PS that currently discharges in the Collins Bay Collector at Beaver Cres by extending the forcemain approximately ±100m across Collins Bay Rd. to connect into the High Gate Park Drive Collector.	2021	$230K
Multiple Locations - Flow Monitoring	Conduct flow monitoring at Crerar Collector, McEwen Dr. collector, Bath-Collins Bay Road PS, Lakeshore Boulevard PS to confirm pattern and magnitude of flow.	2021	$20K
Hwy 15 Trunk Sewer - Upsize	Upsize the Hwy 15 trunk sewer from 0633-030 to 0631-030 to 450 mm and from 12010-010 to 12051-010 50 525mm. Work to be coordinated with Hwy 15 widening.	2021	$700K
King St. Collector - Upsize	Upsize King St. collector along King St. W just east of County Club Dr. to McDonald Ave. (manhole 0054-030 to 0051-104) from a 400/350 mm to a 450 mm, approximately ±550 m.	2021	$670K
Alfred/Elm Sewer Upsize	Upsize sewer from 375 mm to 450 mm on Alfred St. (Princess to Elm) and Elm St. (Alfred to Chatham).	2021	$450K
Schooner Dr. PS Replacement	Replace Schooner Dr. PS with new Riverview PS.	2021	$2.0M
Hillview Road PS - Forcemain Upsize	Replace ±10m of forcemain from just outside the wet well to the existing 350 mm forcemain with 300 mm pipe.	2021	$190K
North End Trunk Sewer – Twinning Phase 1	Twining of the sewer along Queen Mary Rd. heading north from Greenview Dr. to Sherwood Cres (manhole 9341-010 to 2284-131), ±900 m. Twin from Princess St. heading north to south of John Counter Blvd. (manhole 2284-010 to 509081) ±700 m	2021	$3.0M
Days Rd. PS Capacity Increase	Firm capacity to be increased to approximately 1,200 L/s.	2021	$9.2M

RECOMMENDED GROWTH PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Princess St. Collector – Upsize Phase 1	Indian Rd. to The Parkway Rd. to a 525 mm	2021	$1.2M
Notch Hill Collector - Upsize	Upsizing of the sewer along Notch Hill Rd. from Portsmouth Ave. to Runnymede Rd. (between manholes 9716-010 to 3942-030) from a 450 mm to a 600 mm, ±350 m.	2026	$660K
North West Collector between Lincoln Dr. to Pembridge Cres	Upsize along Bayridge Dr. from Lincoln Dr. to Mayfair Cres to just east of Pembridge Cres. and Truedell Rd. (between manholes 33306-010 & 33022-031) from a 450 mm to a 600 mm, ±1,300 m.	2026	$2.3M
Cataraqui Bay WWTP - Design	Planning and design for the Phase 2 upgrade.	2026	$1.0M
Princess St. Collector Phase 2	West of Sir John A. MacDonald Blvd. to Indian Rd. to a 450/525 mm.	2026	$1.9M
Palace Road PS - Back Up Power	Install permanent backup generator.	2036	$150K
Cataraqui Bay WWTP - Capacity Upgrade	Construction of Phase 2 upgrade.	2031	$20.0M
North End Trunk Sewer Phase 2	Twin sewer along John Counter Blvd. heading north to Dalton Ave. (manhole 614091 to 1760-010), ±1,900 m.	2036	$3.4M
Princess St. Collector – Upsize Phase 3	East of Mooalim Pl to west of Sir John A MacDonald Blvd. to a 450 mm.	2036	$1.2M

The following table details projects which have been identified as required to reduce sewer overflow volume and continue to work towards Utilities Kingston's goal of "Virtual Elimination" of CSO events.

Table 1-5 CSO Reduction Projects (Wastewater)

RECOMMENDED CSO PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Sewer Separation	Separate 45ha of combined sewers in the central collection area. Refer to CSO separation plan.	2021	$23.1M
West St. CSO - Weir Adjustment	West St. bypass (PCP#26) weir adjustment to an elevation of 75.5m	2015	$10K
King-Portsmouth PS - Capacity Upgrade and Flow Redirect	Upgrade the capacity of King-Portsmouth PS to 425 L/s firm capacity and install a new forcemain to redirect flow to Cataraqui Bay WWTP.	2021	$10.0M
Collingwood St. Collector - Upsize	Upsizing of the sewer along Helen St. to Mack St., along Mack St. to Regent St. and along Regent St. to Dundas St. (manhole 0423-010 to 04511-020) from a 300 mm to a 375 mm, ±400 m.	2021	$600K
Sewer Separation	Separate 36ha of combined sewers in the central collection area. Refer to CSO separation plan.	2026	$14.1M
River St. PS Inlet Trunk Sewer - Twinning	Twin 250m of sewer between Cataraqui St. and River St. pumping station.	2036	$1.1M
Sewer Separation	Separate 36ha of combined sewers in the central collection area. Refer to CSO separation plan.	2036	$14.2M

RECOMMENDED CSO PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Rideau St. Collector - Upsize	Upsize a ±250m section of the sewer at the downstream end before it connects in the Habourfront Trunk sewer from a 375 to a 600 mm	2036	$460K
Ravensview Trunk Sewer - Twinning	Twinning Ravensview Trunk Sewer entire length, approximately ±3,400m	2036	$27.0M
King St. PS - Twin Forcemain	Twin ±282m of 600 mm forcemain	2026	$560K
Charles St. Collector - Capacity Investigation	Confirm Local Sewer Capacity, Plug PCP#68	2036	$12K

The following table details the projects which have been identified as a result of condition or age. The projects were identified through the condition review completed as part of the Master Plan.

Table 1-6 Condition / Age (Wastewater)

RECOMMENDED CONDITION PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Dalton Ave. PS - Structural Review	Structural review to be completed - evidence of water ingress in dry well.	2021	$4K
Crerar PS - Hydraulic Investigation	Hydraulic investigation of Crerar PS to identify cause of discrepancy between ECA capacity and actual pumping capacity.	2021	$8K
John Counter Blvd. PS - Driveway Repair	Repair damaged location in the driveway.	2021	$3K
Morton St. PS - Flow Meter	Repair / replace flow meter due to condition.	2021	$10K
Bayridge PS - Pump Control Panel and Pipe Supports	Replace pipe supports and pump control panel due to condition and age.	2021	$95K
Coverdale PS - Control Panel Replacement	Replace pump control panel due to condition and age.	2021	$60K
Lakeshore Blvd. PS - Condition Upgrade	Replace pump control panel, repair/replace flow meter and replace generator controller due to condition and age.	2021	$105K
Rankin PS - Valves and Pipework	Replace pipework and valves due to condition and age	2021	$50K
Ravensview WWTP - Condition/Age Upgrades	Change grit channel conveyor drive, portable actuator to open headworks, verification of ventilation rates and gas detection system at headworks. Replace roof on anaerobic digesters.	2021	$1.2M
Bath Lower PS - Condition Upgrade	Replace pump control panel, main breaker and sensors/transmitters due to condition and age.	2021	$100K
James St. PS - Control Panel	Replace pump control panel due to condition and age.	2021	$40K
Kenwoods Circle PS - Valves and Piping	Replace pipework and valves due to condition and age.	2021	$150K
Notch Hill PS - Condition Review	Complete condition review of facility.	2021	$4K
Palace Rd. PS - Condition Review	Complete condition review of facility.	2021	$4K

RECOMMENDED CONDITION PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Young St. PS - Condition Review	Complete condition review of facility	2021	$4K
Barret Ct. PS - Condition Upgrade	Replace pumps, pump control panel, sensors and transmitters, instrument panel, transformer, distribution panel, main breaker, generator and diesel tank due to condition and age.	2026	$415K
King St. PS - Instrumentation Upgrade	Replace instrument panel and sensors/transmitters due to condition and age.	2026	$160K
King-Elevator Bay PS	Replace pipework, valves, instrument panel and sensor/transmitter.	2026	$200K
James St. PS - Condition Upgrade	Replace pumps, sensors/transmitters, instrument panel and building mechanical due to condition and age.	2026	$600K
Coverdale PS - Instrumentation Upgrade	Replace instrument panels and sensors/transmitters.	2026	$40K
King-Lake Ontario Park PS - Control Panel	Upgrade pump control panel due to condition and age.	2026	$30K
Bath-Collins Bay - Pipework Replacement	Replace pipework and valves due to corrosion.	2026	$50K
Greenview PS - Condition Review	Complete condition review of facility.	2026	$4K
Kenwoods Circle PS - Condition Upgrade	Replace pump control panel, instrument panel, sensors/transmitters, transformer due to condition and age.	2026	$400K
Ravensview WWTP - Condition/Age Upgrades	Upgrade heat exchanger due to corrosion, evaluate pumping system for effluent water (issues with reliability).	2026	$300K
Collins Bay PS - Condition Upgrade	Replace pipework and valves, pump control panel, instrument panel and sensors/transmitters due to condition and age.	2026	$150K
Hillview PS - Condition Upgrade	Replace pipework, valves, sensors / transmitters and instrument panel due to condition and age.	2026	$250K
Bath Lower PS - Condition Upgrade	Replace pipe work (add appropriate isolation valves) and instrument panel due to condition and age.	2026	$100K
Lakeshore Blvd. PS - Condition Upgrade	Replace instrument panel, sensors/transmitters, pipework and valves due to condition and age.	2026	$250K
Highway 15 PS - Condition Upgrade	Replace pumps, pipework, valves, instrumentation, transformer, generator, diesel tank, process electrical and building mechanical due to condition and age.	2031	$800K
Morton St. PS - Instrumentation Upgrade	Replace instrument panels and sensors/transmitters due to condition and age.	2031	$75K
Ravensview WWTP - Concrete Repairs	Review concrete decay and leaks in tunnels under primary clarifiers.	2031	$30K
Kenwoods Circle PS - Condition Upgrade	Replace all process electrical and building mechanical due to condition and age.	2031	$100K
King St. PS - Condition Upgrade	Replace pump control panel, process electrical (excluding generator) and building mechanical due to condition and age.	2031	$600K
Rankin PS - Instrumentation Upgrade	Replace instrumentation due to condition and age.	2031	$75K
Bath-Collins Bay	Replace instrument panel and sensors / transmitters due to condition and age.	2031	$60K

RECOMMENDED CONDITION PROJECT	DESCRIPTION	TIMING	OPC (2016$)
Crerar Blvd. PS - Condition Upgrade	Replace pump control panel, instrument panels and sensors/transmitters due to condition and age.	2031	$100K
King-Elevator Bay PS - Condition Upgrade	Replace pump control panel, pumps, flowmeter, diesel generator and tank due to condition and age.	2031	$500K
Barret Ct. PS - Condition Upgrade	Replace pipework, valves and instrumentation, HVAC and heaters due to condition and age.	2031	$150K
Dalton Ave. PS - Condition Upgrade	Pipework, valves and instrumentation to condition and age.	2031	$400K
Young St. PS - Condition Upgrade	Pump control panel and sensors/transmitters due to condition and age.	2031	$40K
Bayridge PS - Condition Upgrade	Replace pump discharge pipework and valves; instrument panel and sensors/transmitters due to condition and age.	2031	$175K
Notch Hill PS - Condition Upgrade	Pump control panel and sensors/transmitters due to condition and age.	2031	$40K
Palace Rd. PS - Condition Upgrade	Replace pipework, valves and instrumentation due to condition and age.	2031	$325K
River St. PS - Condition Review	Complete condition review of facility.	2031	$8K
Bath Rd. PS - Condition Upgrade	Replace pipework, valves and instrumentation due to condition and age.	2036	$250K
John Counter Blvd. PS - Instrumentation Upgrade	Replace instrumentation due to condition and age.	2036	$100K
Collins Bay PS - Electrical Upgrade	Main breaker replacement due to condition and age.	2036	$5K
Ravensview WWTP - Condition Upgrade	Replace corroded piping under the primary tanks.	2036	$250K
Coverdale PS - Pipework	Replace pipework and valves to be replaced due to condition and age.	2036	$85K
Morton St. PS - Condition Upgrade	Replace pipework, valves and pump control panel condition and age.	2036	$150K

GLOSSARY

ADD	Average Day Demand
ADF	Average Day Flow
BS	Booster Station
CMA	Census Metropolitan Area
CSO	Combined Sewer Overflow
EA	Environmental Assessment
EAA	Environmental Assessment Act
ECA	Environmental Compliance Approval
EST	Elevated Storage Tank
HGL	Hydraulic Grade Line
LOS	Level of Service
MDD	Max Day Demand
MEA	Municipal Engineers Association
MOE	Ministry of the Environment
MOECC	Ministry of the Environment And Climate Change
OPC	Opinion of Probable Cost
PLC	Process Logic Controller
PPCP	Pollution Prevention Control Plan
PPS	Provincial Policy Statement
PRV	Pressure Reducing Valve
PS	Pumping Station
PSO	Pump Station Overflow
PSV	Pressure Sustaining Valve
ROW	Right of Way
SSO	Sanitary Sewer Overflow
TO	Tank Overflow
UK	Utilities Kingston
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

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TABLES

FIGURES

APPENDICES

1 VOLUME 1 – BACKGROUND AND EXISTING CONDITIONS

1.1 FORWARD

Utilities Kingston has undertaken two separate Class Environmental Assessment (EA) studies to update their previously issued Water and Wastewater Master Plans, completed in 2007 and 2010, respectively. The updated Master Plan is based on projected growth to 2036 and identify short and long-term water and wastewater servicing strategies within the City of Kingston's (City) urban area. The Master Plan takes into account the City's population growth targets and any upgrades that were made to the servicing systems since the last Water and Wastewater Master Plans were finalized.

1.1.1 STUDY OBJECTIVES

The objective of the Water and Wastewater Master Plan Update is to update both the Water Master Plan (2007) and Sewage Infrastructure Master Plan (2010) by reassessing the future infrastructure requirements within the City of Kingston. The assessment is based on the state of the existing infrastructure, the environment and the servicing requirements for new growth and development. The analysis focuses on identifying the water and wastewater infrastructure projects required over the next 20 years, to 2036.

The Master Planning process is used for the planning of future infrastructure which results in an infrastructure implementation 'roadmap' that will ensure existing infrastructure servicing policies and future servicing and treatment capacity requirements are satisfied. The Master Plan focuses on optimizing the effectiveness of the existing infrastructure and identifying new infrastructure to service existing and future development. This process includes the evaluation of infrastructure alternatives based on each alternative's technical considerations as well as their impact on the natural, social, and economic environment. The Master Plan Update exercise is fundamental to planning for efficient use of financial resources used to fund water and wastewater utilities.

The Wastewater Master Plan Update also includes an update to the Pollution Prevention Control Plan, and the Water Master Plan Update includes the development of an operational guidance plan for the interconnected water distribution system.

1.1.2 RELATED POLICY DOCUMENTS AND PROVINCIAL PLANNING STUDIES

1.1.2.1 THE PLANNING ACT (1990)

The Planning Act establishes policies for land use planning in Ontario. The Act outlines how land uses may be controlled and who is permitted to do so. The Act determines the basis for the preparation of an Official Plan and planning policies for future development while providing municipalities with the independence to make decisions and streamline the planning process. The Act stipulates that local citizens are to be encouraged to provide input to municipal council and, where permitted, to appeal decisions to the Ontario Municipal Board. Through the Act, the Province issues Provincial Policy Statements and plans.

1.1.2.2 ONTARIO WATER RESOURCES ACT (1990)

The Ontario Water Resources Act, 1990, was passed for the purpose of conservation, protection, and management of Ontario's waters. The act identifies requirements for water works, including wells, and sewage works in relation to planning, design, siting, public notification and consultation, establishment, insurance, facilities, staffing, operation, maintenance, monitoring, and record-keeping. The Act is a general water management statute which applies to both groundwater and surface water. This Act specifies the requirements that the community must satisfy in order for the provincial government to grant approval for establishing, altering, extending, or replacing water and wastewater system components.

1.1.2.3 ONTARIO PLANNING AND DEVELOPMENT ACT (1994)

The Ontario Planning and Development Act, 1994, establishes the general approach that the Minister of Municipal Affairs and Housing uses to undertake Development Plans for development planning areas. The Development Plans may include policies for economic, social and physical development with respect to the following:

- The distribution and density of population within the development area;
- The location of employment areas;
- The identification of land use areas;
- The management of land and water resources;
- The control of all forms of pollution of the natural environment;
- The location and development of servicing communication and transportation systems; and
- The development and maintenance of educational, cultural, recreational, health and other social facilities.

There can also be policies relating to the financing and programming of public development projects as well as capital works and policies to coordinate planning and development among municipalities or planning boards within an area or within separate areas, among other considerations.

In many respects, a Development Plan under the Ontario Planning and Development Act is similar to an Official Plan under the Planning Act. The primary differences are:

1. The Province is the authority for both undertaking and approving the Development Plan; and
2. The legislative requirements for the preparation and approval of a Development Plan are unique to the Ontario Planning and Development Act.

1.1.2.4 SAFE DRINKING WATER ACT (2002)

The Safe Drinking Water Act, 2002, is in place to provide protection for human health and prevent drinking water health hazards. The Act controls and regulates drinking water systems and drinking water testing. Regulations made under the Act, such as Regulation 268/03 – Ontario Drinking Water Quality Standards, stipulate detailed requirements regarding drinking water systems, testing services, drinking water quality standards, certification of drinking water system operators and drinking water quality analysts and compliance and enforcement. This Act specifies the quality of the drinking water that any community is responsible for producing and delivering as well as how the area's drinking water treatment systems must be operated and managed.

1.1.2.5 PLACES TO GROW ACT (2005)

The Places to Grow Act, 2005, provides a structure for the Provincial government to coordinate planning and decision making for long-term growth and the renewal of infrastructure in Ontario. It gives the Province authority to determine areas for geographical growth and develop growth plans in collaboration with local officials and stakeholders to meet specific needs related to land use, population growth, policies and infrastructure across the Province. Growth plans developed under the Places to Grow Act integrate and build upon other initiatives such as the Greenbelt Plan, the Niagara Escarpment Plan, the Provincial Policy Statement, the Planning Act, municipal infrastructure planning, and source water protection planning. Growth plans can include population projections and allocations, policies, goals and criteria such as intensification and density, land supply, expansions and amendments to urban boundaries, the location of industry and co mmerce, protection of sensitive and significant lands (including agricultural lands and water resources), infrastructure development, affordable housing and community design. Municipalities are required to bring their official plans into conformity with the growth plan for their area. Decisions made under the Planning Act, and Condominium Act are also required to follow the relevant growth plans.

1.1.2.6 CLEAN WATER ACT (2006)

Ontario's Clean Water Act was passed in 2006 and is intended to ensure that communities are able to protect their municipal drinking water supplies through the development of collaborative, locally driven, science based protection plans (source water protection plans). The Act requires that local communities evaluate existing and potential threats to their water source(s) and subsequently implement the required actions to reduce or eliminate these threats. The community can use this information to make choices about the size and locations of water and wastewater servicing elements (e.g. treatment plants, pumping stations, transmission mains, and collection mains). Refer to Section 1.1.3.18 for the Cataraqui Source Water Protection Plan.

1.1.2.7 SAFEGUARDING AND SUSTAINING ONTARIO'S WATER ACT (2007)

The Province passed the Safeguarding and Sustaining Ontario's Water Act to enable implementation of the Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement and other amendments to the Permit to Take Water program.

The principles of the Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement, signed in 2005, include the Premiers of Ontario and Quebec and the Governors of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin. This agreement recognizes the following:

- The water of the Basin are a shared public treasure and the parties to the Agreement have a shared duty to protect, conserve and manage the waters;
- Conserving and restoring the waters and water dependent natural resources of the Basin will improve them; and
- Continued sustainable, accessible and adequate water supplies for the people and economy of the Basin are important.

1.1.2.8 PROVINCIAL POLICY STATEMENT (2014)

The Provincial Policy Statement (PPS), 2014, is an integral part of Ontario's planning system. The PPS sets policy direction on matters of provincial interest related to land use planning, growth management, environmental protection and public health and safety while aiming to provide a stronger policy structure that guides communities in Ontario toward a higher quality of life and a better long-term future.

The PPS establishes the various municipalities' roles in planning for growth, intensification, and redevelopment. New settlement area policies will only allow expansions where it is shown that opportunities for growth are not available through intensification, redevelopment or in designated areas. The PPS also requires municipalities to coordinate and provide direction on policies with cross municipal boundaries, such as natural heritage systems and resource management. The PPS provides the basis or context for all Provincial Plans and Municipal Official Plans.

The PPS outlines policies and policy reviews related to water, sewage and storm water infrastructure planning. These policies are based on addressing long-term population projections while creating sustainable, reliable and financially feasible resources for the Province.

1.1.2.9 ONTARIO MINISTRY OF THE ENVIRONMENT GUIDELINE F-5

The Ontario Ministry of the Environment and Climate Change Guideline F-5 is a policy document, made under the legislative authority of the Ontario Water Resources Act, RSO 1990, and Section 53. The purpose of the guideline is to ensure that sewage treatment works are located, designed, constructed and operated to minimize pollution of receiving waters as well as minimizing interference with water uses. It describes the levels of treatment required at municipal and private sewage treatment works, including outfall structures and emergency overflow facilities. The guideline states that the normal level of treatment required for sewage treatment works discharging to surface waters is secondary treatment or equivalent. The City of Kingston will use the design specifications within Guideline F-5 when siting, designing, and determining operational strategies for wastewater system components.

Ontario Ministry of the Environment Procedure F-5-5

Procedure F-5-5 is a supporting document for Guideline F-5. The MOECC has issued Procedure F-5-5 to regulate combined sewage by-pass events. The Procedure provides a guideline regarding the quality, quantity, and frequency of overflows. Required mitigation measures are also identified to address the potential adverse effects of sewer by-pass events.

1.1.3 RELATED CITY OF KINGSTON STUDIES

1.1.3.1 KINGSTON COMBINED SEWER CRITICAL EVALUATION (2006)

In 2006, the Combined Sewer Critical Evaluation was completed with the purpose of developing a policy to guide the rehabilitation of combined sewer areas. The study concluded that the preferred option was to separate sewers and not replace the combined sewers.

1.1.3.2 CITY OF KINGSTON OFFICIAL PLAN (MAY, 2010)

The City of Kingston Official Plan was approved in January 2010. A consolidated version of the Official Plan was developed in May 2015 and includes approvals, modifications and policy updates as requested by the Ministry of Municipal Affairs. This Plan, in accordance with the Planning Act (1990), identifies the City's general planning goals and policies for future land uses and development as well as its goal to become the most sustainable municipality in Canada. The Plan outlines the framework for the planning of infrastructure, regional services, land use, economic growth and population growth.

1.1.3.3 CITY OF KINGSTON AND KINGSTON CENSUS METROPOLITAN AREA POPULATION, HOUSING AND EMPLOYMENT PROJECTIONS (MERIDIAN PLANNING CONSULTANTS, 2013)

The Kingston Census Metropolitan Area (CMA) Population Housing and Employment Projections Study summarizes the growth projections targeted for the CMA from 2011 to 2041. The CMA includes the City of Kingston, the Township of South Frontenac, the Township of Frontenac Islands and Loyalist Township. In review of the CMA report and through discussions with Utilities Kingston, the "High Case" projection was used for the analysis related to the Water and Wastewater Master Plan Update. The "High Case" projections outlined in this report states that between 2011 and 2041 the population will increase by approximately 29,500.

The major planning implications identified by this study included revising the City of Kingston Official Plan in the following ways:

- Account for a population increase to 145,690 in the year 2026 and 154,290 in the year 2031;
- Account for an increase in housing to approximately 62,460 occupied dwellings in the year 2026 and 66,210 in the year 2031; and
- The employment projections in the Official Plan generally coincide with the projections made in this Study for the year 2026, however, the Official Plan should incorporate employment projections for the year 2031, which are approximately 85,280 total jobs.

The planning projections documented in this Study have been used as input into the Water and Wastewater Master Plan Updates.

1.1.3.4 EMPLOYMENT LAND STRATEGY REVIEW (WATSON & ASSOCIATES ECONOMISTS LTD. IN ASSOCIATION WITH DILLON CONSULTING LIMITED, 2015)

The purpose of the report was to develop a long term vision and plan for industrial growth within the City of Kingston. The report reviewed regional and local economic trends within the last decade to identify the employment and industrial land requirements within the City.

The key findings and recommendations of the report were the following:

- Industrial land supply must be expanded to meet the forecasted need;
- Former Nortel Lands and former Cohen Property are recommended to be converted from general industrial and residential/general to mixed-use and Business Park respectively;
- The City of Kingston should continue to be a key player in industrial land development through public-private partnerships;
- The City of Kingston should accommodate future growth within existing industrial areas; and
- The City of Kingston should also accommodate future growth within new industrial areas.

This report will serve as the basis for industrial growth and development assumptions for the Master Plan. The identified land requirement was broken up into two distinct land uses, Business Park and General Industrial. This distinction is maintained for the Master Plan analysis as these two land uses typically have significantly different servicing requirements.

1.1.3.5 COMMERCIAL INVENTORY AND MARKET ANALYSIS CITY OF KINGSTON, ON (URBAN METRICS INC., 2008)

The Commercial Inventory and Market Analysis Report reviewed the supply and need for additional commercial land in the City of Kingston. The analysis considered existing commercial occupancy, vacancy, development applications and anticipated development proposals. The warrant for additional commercial land was estimated over the analysis periods (2011, 2016, 2021 and 2026).

The key findings and recommendations of the report were the following:

- There will be demand for approximately 3.3 million square feet of new retail and new service spaces by the year 2026;
- There is currently 1.4 million square feet of commercial space proposed for 12 different locations within the City of Kingston; and
- For future commercial planning, the City should focus on: maintaining strength of the downtown core, ensure a geographically balanced approach to future big box and regional scale retail uses, strive for a balance between big box retail and more locally accessible retail, expanding the retail services of the former Pittsburgh Township and seeking opportunities to enhance the availability of local serving retail facility at the neighbourhood level.

This report will serve as the basis for the commercial growth and development assumptions for the Wastewater Master Plan.

1.1.3.6 MASTER PLAN FOR WATER SUPPLY FOR THE CITY OF KINGSTON URBAN AREA AND THE CLASS ENVIRONMENTAL ASSESMENT (SIMCOE ENGINEERING GROUP LIMITED, JUNE 2007)

Utilities Kingston completed a Water Supply Master Plan in June 2007. The purpose of the Study was to evaluate the current and projected requirements of the City's overall drinking water treatment facilities and water distribution networks. The focus was to satisfy the City of Kingston's current (2006) and projected (2026) drinking water, fire flow, and pressure demands. The report analyzed and reported on the drinking water demand and infrastructure planning based on three major areas: Kingston Central, Kingston West and Kingston East. The Central and East areas are considered as one water distribution system and West as another. The problem definition outlines that in order to ensure that the drinking water supply will be sufficient for the entire urban area, the two distribution systems will need to be interconnected. As part of the Water and Wastewater Master Plan Updates, operational guidance will be provided regarding the connection of the two systems.

The alternatives that were assessed in the 2007 Water Supply Master Plan were as follows:

- Leave the Kingston Central and East water distribution system and Kingston West Water distribution system independent;
- Interconnect the Kingston Central/East water distribution system with the Kingston West water distribution system, expand the Kingston West WTP and continue the same function of the Kingston Central Water Purification Plant;
- Interconnect the Kingston Central/East water distribution system with the Kingston west water distribution system, eliminate the Kingston Central Water Purification Plant and have all water supply from the Kingston West WTP; and

- Interconnect the Kingston Central/East water distribution system with the Kingston West water distribution system, eliminate both the water treatment and water purification plants and construct a new “Greenfield” WTP.

The preferred solutions selected included the interconnection of the Central/East and West systems with the expansion of the Kingston West WTP and continued functionality of the Kingston Central Water Purification Plant. The following works were identified for the short-term study year:

- Expansion of the Kingston West WTP (currently being commissioned as detailed in Section 1.1.3.9);
- Installation of O’Connor Drive Reservoir and Pumping Station (completed as detailed in Section 1.1.3.7);
- Expansion of the Third Avenue Reservoir and Pumping Station;
- Installation of Kingston Highway 15 Reservoir and Pumping Station;
- Additional watermain installation, the following of which have been completed since the 2007 Water Master Plan was issued:
  - Kingston West WTP 900 mm discharge header (1.1 km)
  - Front Road (Days Road to Bayridge Drive) 600 mm watermain (1.4 km)
  - New 600 mm watermain on O’Connor Drive (0.63 km)
  - New 400 mm watermain to interconnect the watermain on Princess Street (1 km)
  - New Bayridge Drive (Cedarwood Drive to Woodbine Road) 400 mm watermain (0.45 km)
  - New Avenue Road (Princess Street to McMahon Avenue) 400 mm watermain (0.40 km)
  - New Third Avenue (MacDonnell Street to Alfred Street) 500 mm watermain (0.65 km)
- Interconnection of watermains; and
- Retirement of Gardiners Road, Sydenham Road, Old Colony and Collins Bay Road Booster Stations.

1.1.3.7 O’CONNOR RESERVOIR AND PUMPING STATION CLASS ENVIRONMENTAL ASSESMENT (J.L. RICHARDS AND CH2M HILL, JULY 2008)

The 2007 Water Supply Master Plan for the City of Kingston’s Urban Area identified the need for additional water storage on O’Connor Drive. The O’Connor Reservoir and Pumping Station Schedule B Class EA was therefore undertaken to identify the location for a new reservoir and pumping station. The Study examined both the capacity required for the new pumping station as well as its proposed location.

The new reservoir and pumping station have been designed and implemented (construction concluded in March 2011). The reservoir was completed with a storage capacity of 13 ML and the pumping station with a capacity of 84.4 ML/day. This work also included the installation of a new 600 mm watermain from the new O’Connor Drive Pumping Station to Gardiners Road.

1.1.3.8 CONDITION ASSESSMENT OF WATER AND WASTEWATER PUMPING STATIONS (STANTEC, DECEMBER 2008)

The purpose of the Study was to assess the conditions of the existing water and wastewater pumping stations by conducting field investigations, evaluating the capital improvements and maintenance requirements at each station as well as evaluating a risk assessment. Using this information, a proposed plan was developed to prioritize capital improvements for the necessary station upgrades. Additionally, the assessment included completing operations and maintenance manuals, investigating station capacities and

analyzing the costs associated with the rehabilitation or replacement of the stations. After evaluating each of the water and wastewater pumping stations, a twenty-five year capital improvement plan was determined, which includes rehabilitation and replacement works.

1.1.3.9 POINT PLEASANT WATER TREATMENT PLANT EXPANSION ENVIRONMENTAL STUDY REPORT (J.L. RICHARDS AND CH2M HILL, MAY 2009)

The 2007 Water Supply Master Plan for the City of Kingston's Urban Area identified solutions to the growing water demand in the City including expansion of the Point Pleasant (formerly Kingston West) WTP. The purpose of this Schedule C Class EA Study was to assess potential alternative designs while considering water quality and capacity requirements for the plant. The major recommendations outlined in the Study determined the required expansion taking into account the current and future water demand/supply requirements, addressing the existing hydraulic pinch-points that create operator challenges, twinning of the single discharge trunk watermain and providing flexibility for further expansion.

The alternatives that were assessed were:

- Maintaining the status quo of the plant;
- Interconnecting the Kingston West and Kingston Central water distribution systems with the expansion of the Point Pleasant WTP while keeping the Central WTP in service;
- Interconnecting the two water distribution systems with the expansion of the Point Pleasant WTP to serve both areas without the Central WTP; and
- Interconnecting the two water distribution systems by creating a new "Greenfield" plant to serve both Kingston West and Central.

Interconnecting the Kingston West and Kingston Central water distribution systems with the expansion of the Point Pleasant WTP while maintaining the functionality of the Central WTP was determined to be the preferred solution.

The expansion of the Point Pleasant WTP is currently being commissioned to account for a capacity of 85 ML/day.

1.1.3.10 BAYRIDGE DRIVE TRUNK WATERMAIN CLASS ENVIRONMENTAL ASSESSMENT (J.L. RICHARDS AND CH2M HILL, OCTOBER 2011)

This Study built on the 2007 Water Supply Master Plan which recommended the connection of the Kingston Central/East water distribution system and the Kingston West water distribution system by providing additional watermain looping in the West area. The purpose of this Schedule B Class EA was to identify the preferred alignment to connect the two 900 mm watermains located to the north and south of Bath Road. The preferred recommendation was to install a 900 mm diameter watermain extending west along Cloverdale Drive to the access road, north along an existing trail, under Bath Road and the CN Mainline that connected to the existing watermains on Bayridge Drive and Forest Hill Drive East. The construction of the Bayridge Drive trunk watermain was completed in 2014.

1.1.3.11 WATER SUPPLY MASTER PLAN – 2013 UPDATE FOR THE KINGSTON EAST WATER SYSTEM (CH2M HILL, FEBRUARY 2014)

The purpose of this Master Plan was to update the Utilities Kingston Water Supply Master Plan that was completed in June 2007. The focus of the update was to assess drinking water demands and infrastructure planning specifically for the Kingston East Water System and for the formation of boundary conditions in this area. In comparison to the original 2007 Water Supply Master Plan, this update applies projected water

demands up to 2033, as opposed to 2036. The alternatives analyzed in this report focus on aging infrastructure that is losing functionality as well as the existing and projected operational and capacity needs of the booster pumping station that is supplying water to Kingston East.

The recommendations associated with this report center around storage, renewal/replacement projects and growth/reliability projects. The major recommendations were as follows:

- Since the new Innovation Drive Elevated Storage Tower stores such a large volume of water for the Kingston East Water System, extra storage facilities were considered redundant and were recommended for decommissioning (Gore Road Standpipe and CFB Kingston Elevated Storage Tank). The decommissioning of these storage tanks were noted to lead to the modification of the pressure zone boundaries;
- The James Street Booster Pumping Station was determined to be in need of upgrades due to its aging infrastructure and the anticipated servicing capacity increases to the year 2033;
- Further to decommissioning the Forest Drive Standpipe (recommended since it is no longer useful for the current and future distribution systems), a new elevated storage tank in the eastern boundary of the Canadian Forces Base Kingston was identified as being necessary; and
- Water conveyance upgrades on Highway 15 and Highway 2 including a new 500 mm transmission watermain on Highway 15 and new subzone.

1.1.3.12 JAMES STREET BOOSTER STATION ENVIRONMENTAL ASSESSMENT (CH2M HILL, APRIL 2014)

The James Street Booster Station Class EA was completed in April 2014. The purpose of this Schedule B Class EA was to investigate the potential upgrades necessary for the pumping station to provide reliable water to current and future residents and businesses in the Kingston East area. Given the planned increase in water demand through the pumping station, upgrades were identified to meet the increased capacity requirement to 2033, but also to ensure the infrastructure is robust, given its declining condition.

The main factors that were assessed in determining alternative solutions for these upgrades were the location, pumping capacity, storage, and conveyance upgrades. The recommended solution was to upgrade the booster pumping station in the existing location with an increased pumping capacity that would be increased over time, as necessary.

The James Street Booster Station Upgrades Project is currently being constructed and should be completed by January 2017. The upgraded station will include space for four additional pumps, necessary electrical equipment, a standby power generator, a chlorine dosing system and several other required appurtenances.

1.1.3.13 SEWAGE INFRASTRUCTURE MASTER PLAN FOR THE CITY OF KINGSTON URBAN AREA (CH2M HILL, SEPTEMBER 2010)

The purpose of the Study was to plan for the City of Kingston's wastewater infrastructure requirements to 2026. Some of the infrastructure changes or upgrades considered in the Study included: eliminate or virtually eliminate combined sewer overflows (CSOs), optimize the use and effectiveness of the City's sewer systems, and prioritize sewer system improvements. Recommendations were made regarding infrastructure upgrades based on the existing conditions, projected populations to 2026, sewer infrastructure conditions to 2026 and long-term development within the urban areas of the City. The major recommendations to note from this Master Plan are as follows:

- Upgrading the capacities of the following trunk sewers: Collins Bay Collector, Northwest Collector, Highway 15 Trunk, Ravensview Trunk and Princess Street Collector (none of these upgrades have been completed to date);
- Upgrading the following pumping stations: Days Road Pumping Station, Mona Drive Pumping Station, Front Road Pumping Station, Westbrook Pumping Station, Butternut Creek Pumping Station, B40 Pumping Station, Portsmouth Pumping Station (none of these upgrades have been completed to date); and
- Upgrading and expanding the Cataraqui Bay WWTP (currently being constructed).

The scope of the 2010 Sewer Infrastructure Master Plan also included an update to the Pollution Control Plan, finalized in July 2010. The Pollution Control Plan Update for the City of Kingston identified recommendations for improving combined sewage bypass contaminants and management. The recommended solutions presented in the plan explain several measures to address growth and mitigation of CSOs and to increase sewer separation. A number of programs and studies were also recommended such as end-of-pipe studies and storm outfall floatable controls and CSO monitoring programs.

The Master Plan also addresses the need for continued inflow and infiltration (I/I) reduction within the separated sewer system, with a specific focus on wet-weather flow reduction in the system. It was reported that these I/I reductions should focus on areas with historical basement flooding. Additionally, the Master Plan calls for the use of weeping tile, sump pump and roof leader disconnections as well as sewer lining and rehabilitation in areas of the City containing only partially separated systems. The locations recommended for continued I/I reduction investigations are the North End Pumping Station Service Area, Portsmouth Pumping Station Service Area, B-64 Pumping Station Service Area and Northwest Collector Service Area.

1.1.3.14 RIVER STREET PUMPING STATION TWIN-FORCEMAIN EXTENSION AND RAVENSVIEW TRUNK SEWER TWINNING CLASS ENVIRONMENTAL ASSESSMENT (CH2M HILL, JANUARY 2012)

The purpose of this Schedule B Class EA was twofold: to evaluate the potential alternatives to twin the River Street Pumping Station forcemain as well as rehabilitate or replace the original sections of the forcemain; and to assess the potential alternatives available for improving quality and increasing the capacity of the sewage infrastructure to provide safe, continuous and reliable conveyance.

The recommended solution for the River Street Pumping Station forcemain involved rehabilitation of the existing forcemain as well as the installation of a new, parallel forcemain to provide redundancy and additional capacity. The route that was considered to be the best solution for the forcemain was to follow the same alignment as the existing forcemain from the east side of the Cataraqui River to the James Lane and James Street intersection. The forcemain would then run east along James Street to the intersection of Highway No. 15 and Highway No. 2 and connect to the existing chamber approximately 110 m west of the Highway No. 2 and Niagara Park Drive intersection where it would discharge into the existing gravity sewer. The recommended solution to improve sewage conveyance through the Ravensview Trunk Sewer was to install a new trunk sewer with additional capacity. The preferred route for this trunk sewer would connect to the same chamber as the existing trunk sewer and would extend east along Highway No. 2. The trunk sewer would then align south along Gates Boulevard and east along LaSalle Boulevard towards the Ravensview Wastewater Treatment Plant (WWTP).

The River Street forcemain rehabilitation and new construction has been completed, however, the Ravensview trunk sewer twinning has not been scheduled for construction to date.

1.1.3.15 CATARAQUI BAY WASTEWATER TREATMENT PLANT UPGRADE CLASS ENVIRONMENTAL ASSESSMENT (J.L RICHARDS, OCTOBER 2012)

The upgrades identified for the Cataraqui Bay WWTP were considered a priority project in the City's 2010 Sewer Infrastructure Master Plan, based on capacity requirements. The purpose of this Schedule C Class EA was to evaluate the current conditions of the plant, investigate the challenges of meeting stricter effluent quality requirements, accommodate the needs of the projected urban development, and to provide recommendations regarding the plant's next expansion. The recommended solutions included: expanding the treatment plant's liquid train process with the use of Biological Aerated Filters (BAFs), expanding the solids train process with the use of anaerobic digestion and an enclosed biosolids cake storage facility, implementing a system to recirculate digester gas to the boilers for heat production and investigating the potential to implement a co-generation facility. The Cataraqui Bay WWTP expansion is currently under construction.

1.1.3.16 CANA WASTEWATER TREATMENT PLANT CLASS ENVIRONMENTAL ASSESSMENT (MAY, 2013)

The purpose of the Schedule C Class EA was to focus on the Cana community and its wastewater servicing needs. The Study considered alternatives that were economically sustainable, environmentally sound and reflective of the current and projected needs of the community. It also considered the challenges associated with providing improved effluent quality, evaluated alternative conveyance and treatment strategies for the area, selected the preferred treatment and conveyance strategies and determined the probable costs associated with the proposed treatment plant.

At the time that the Study was being completed, the Cana WWTP and collection system was aging and needed repairs and upgrades in order to accommodate projected capacity needs and reliable, effective and up to date infrastructure. The recommendations for the treatment plant upgrades included replacing the plant with a new and improved WWTP that would use screening, a sequencing batch reactors, equalization tanks, screening, chemically assisted tertiary filtration and a UV disinfection for the liquid train process. The WWTP is anticipated to be completed in 2017.

1.1.3.17 PORTSMOUTH PUMPING STATION FLOW DIRECTION ENVIRONMENTAL ASSESSMENT (WSP, JULY 2014)

The Portsmouth Pumping Station, which is centrally located in the City of Kingston, was projected to experience larger volumes of wastewater flow as development continues in the downtown core. The purpose of this Class EA was to investigate the potential to direct portions of the wastewater flow towards the Cataraqui Bay WWTP located in Kingston West. This would help to decrease the volumes of wastewater flow through the central and eastern portions of the wastewater network, thereby eliminating the need for additional linear infrastructure upgrades through the densely populated downtown area. Additionally, this Study also addressed opportunities to reduce CSOs within the central (downtown) wastewater network.

The preferred servicing solution was to pump the entire distance to the west using a new forcemain. Additional wastewater flows from sewer catchment areas located between the WWTP and the Portsmouth Pumping Station would be conveyed to the Portsmouth Pumping station. The preferred routing option was to implement a forcemain from the Portsmouth Pumping Station along the Kennedy Street, Union Street West and King Street West right-of-way to Portsmouth Avenue where it would follow King Street West and Front Road until Sand Bay Lane where it would connect to Cataraqui Bay WWTP. These preferred alternatives were chosen based on the evaluation of the impacts posed to the natural, social and cultural, and economic environments.

1.1.3.18 CATARAQUI SOURCE PROTECTION PLAN (MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE, NOVEMBER 2014)

The purpose of the Source Protection Plan was to determine the presence of any drinking water threats (existing and projected) as identified under the Clean Water Act as well as in any area that the Assessment Report (June 2011) identified as a potential area for producing significant drinking water threats. Some of the existing threats to drinking water are the use and storage of liquid fuel, agricultural material, commercial fertilizer, pesticides and road salt as well as sewage systems such as septic and holding tanks and combined sewer overflows. Any significant threats that may become evident in the future are prohibited based on section 57 of the Clean Water Act, decisions made under the Planning Act, or decisions made through prescribed instruments. Existing significant threats are investigated using risk management plans under section 58 of the Clean Water Act or by using alterations to the prescribed instruments. The Protection Plan prescribes policies for regional areas of sensitive groundwater, wellhead protection areas and surface water intake protection zones.

1.1.3.19 KINGSTON EAST – RIDEAU COMMUNITY SANITARY SYSTEM UPGRADES MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT (D.M. WILLS ASSOCIATES LTD., ONGOING)

The purpose of this Study was to provide recommendations for the sanitary sewer system upgrades required for the current and projected development in Kingston East within the boundary limits north of Gore Road to the Great Cataraqui River and Highway No. 15. Based on the analysis, it was expected that one or more sewage pumping stations will be required to produce effective and reliable servicing where new developments have been approved. Currently, the alternative that has been identified as a viable solution is to have a new sewage pumping station constructed; however, the recommended location for the facility is still being determined through an evaluation process. Additionally, a new sanitary forcemain will be required to transfer the sewage from the new pumping station to the existing trunk sewer located on Highway No. 15.

1.1.3.20 PORTSMOUTH SEWERSHED INFLOW AND INFILTRATION REDUCTION ASSESSMENT (D.M. ROBICHAUD ASSOCIATES, ONGOING)

This Study was initiated to address the high levels of I/I from groundwater and other sources that were noted in the sewage collection area for the Portsmouth Pumping Station. The increased I/I flow contributes to surcharging sewers, basement flooding and sewage bypassing in the Portsmouth Sewershed during peak rainfalls and snowmelt. The purpose of the Study is to identify the major sources of I/I in the system and implement repairs and upgrades to mitigate the levels of leakage in the system.

1.1.3.21 SEWER SEPARATION PROGRESS UPDATE (UTILITIES KINGSTON, 2015)

Utilities Kingston produced a technical memorandum dated May 1, 2015, that documented recent progress and projected progress of combined sewer separation as shown in Table 1-1. The goal through 2018 is to have over 45% of the 2007 combined sewer area separated. The purpose of this memorandum was to present information on the rate of progress towards the ultimate goal of full sewer separation, taking into consideration the 2015-2018 Capital Plan as ‘committed’ conditions to end-of 2018. The report also provided an estimate beyond 2022 with recommended future capital improvement projects.

Table 1-1 Utilities Kingston Current and Projected Combined Sewer Separation (2008 – 2018)

YEAR	RATE OF SEWER SEPARATION (BY CITY BLOCK)	RATE OF SEWER SEPARATION (BY SURFACE AREA)
2008-2011	21.2%	18.4 %
2012	5.1 %	1.2 %
2013	4.0%	2.0%
2014	2.2%	2.9%
2015	2.2%	12.5%
2016	3.3%	0.6%
2017	5.1%	6.3%
2018	2.5%	1.9%
Total	**45.5%**	**45.7%**

1.1.4 FEDERAL LEGISLATION

1.1.4.1 CANADA WATER ACT (1985)

The Canada Water Act, passed in 1970 and revised in 1985, provides management of water resources in Canada. The purpose of the Act is to provide a framework for cooperation with the provinces and territories regarding research, planning, and implementation of programs linked to water use, conservation, and development. The federal government has outlined regulations under the Canada Water Act including policies for fisheries, navigation and the conduct of external affairs.

1.1.4.2 FISHERIES ACT (1985)

The Fisheries Act contains habitat and pollution protection provisions which are necessary for all levels of government and the public. Subsection 35(1) of this Act states “no person shall carry out any work or undertaking that results in the harmful alteration, disruption or destruction (HADD) of fish habitat” unless authorized by the Minister of Fisheries and Oceans Canada. A subsection 35(2) Fisheries Act authorization may be issued when adverse effects cannot be avoided.

1.1.4.3 CANADIAN ENVIRONMENTAL PROTECTION ACT (1999)

The Canadian Environmental Protection Act was first passed in 1990. The purpose of passing this Act was to provide for the protection and conservation of the natural environment, by controlling discharges to air, land, and water. Regulations made under the Act propose limits on what can be discharged to the environment and allow for fines and other penalties when unauthorized discharges occur. This Act affects how a community can dispose of materials and approach its construction activities to ensure that there are no harmful effects on the environment.

1.2 ENVIRONMENTAL ASSESSMENT PROCESS

This section describes the Environmental Assessment process and the specific requirements associated with this Study.

1.2.1 ENVIRONMENTAL ASSESSMENT ACT

The Ontario Environmental Assessment Act (EAA) and the associated Codes of Practice require proponents to examine and document the environmental effects that might result from major projects or activities.

The Act defines the environment as:

- Air, land or water;
- Plant and animal life, including man;
- The social, economic and cultural conditions that influence the life of man or a community;
- Any building, structure, machine or other device or thing made by man;
- Any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirect from activities of man; and
- Any part or combination of the foregoing and the interrelationships between any two or more of them.

The purpose of the Act is the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management of the environment in the Province (RSO1990, c. 18, s.2).

1.2.2 PRINCIPLES OF ENVIRONMENTAL PLANNING

The Act sets a structure for a systematic, rational, and replicable environmental planning process that is based on five key principles, as follows:

- Consultation with affected parties - Consultation with the public and government review agencies is an integral part of the planning process. Consultation allows the proponent to identify and address concerns cooperatively before final decisions are made. Consultation should begin as early as possible in the planning process.
- Consideration of a reasonable range of alternatives - Alternatives to include functionally different solutions to the proposed undertaking as well as alternative methods of implementing the preferred solution. The “do nothing” alternative must also be considered.
- Identification and consideration of the effects of each alternative on all aspects of the environment - This includes the natural, social, cultural, technical, and economic environments.
- Systematic evaluation of alternatives in terms of their advantages and disadvantages, to determine their net environmental effects - The evaluation shall increase in the level of detail as the Study moves from the evaluation of alternatives to the proposed undertaking to the evaluation of alternative methods.
- Provision of clear and complete documentation of the planning process followed – This will allow traceability of decision-making with respect to the project. The planning process must be documented in such a way that it may be repeated with similar results.

1.2.3 MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

To meet the requirements of the EAA, this project is being conducted in accordance with the Class EA process. The requirements for undertaking a Class EA are described in the document Municipal Class EA, (October 2000, as amended in 2015), Municipal Engineers Association (MEA).

The Class EA planning process requires the integration of sound engineering judgment, sensible long-term planning, and protection of all aspects of the environment (natural, social, economic and cultural). This includes consultation with the public and affected agencies to obtain comments and input, to ensure regulatory compliance and ultimately achieve acceptance for the preferred alternative.

The overall result of the Class EA process is the identification of a preferred solution which results in minimal impact on the environment. For an infrastructure-specific Class EA, the preferred solution is typically the siting of the infrastructure required for the provision of services. In a Master Plan, the level of detail regarding the preferred solutions will change based on the Master Planning approach selected (more on this in Section 1.2.3.1)

The Municipal Class EA process was approved by the Minister of the Environment in 1987 for municipal projects having predictable and preventable impacts. The Class EA streamlines the planning and approvals process for municipal infrastructure projects (including water and wastewater projects) which have the following important characteristics in common:

- Recurring
- Similar in nature
- Usually limited in scale
- Predictable range of environmental effects
- Responsive to mitigation measures

The Class EA document applies to a group of projects that are approved under the EAA that are also planned for according to the requirements of the Class EA. The specific requirements of the Class EA document depend on the type of project, its complexity and the significance of potential environmental impacts. The Municipal Class Environmental Assessment (MCEA) document outlines the procedures to be followed to satisfy EA requirements for water and wastewater projects. The process includes five phases:

- Phase 1: Problem Definition
- Phase 2: Identification and Evaluation of Alternative Solutions to Determine a Preferred Solution
- Phase 3: Examination of Alternative Methods of Implementation of the Preferred Solution
- Phase 4: Documentation of the Planning, Design, and Consultation Process
- Phase 5: Implementation and Monitoring

Public and agency consultation are integral to the Class EA planning process. Projects subject to the Class EA process are classified into four possible “Schedules” depending on the degree of expected impacts. It is important to note that the Schedule assigned to a particular project is proponent-driven.

Agreements made or commitments given by the proponent to affected agencies or the public during the course of the screening process must be followed through and implemented. Otherwise, the EA approval will not be granted. If an affected agency or the public has a concern that cannot be resolved by discussion and negotiation with the proponent, then they can request a proponent to comply with Part II of the EA Act. Through the issuance of a Part II Order, Schedule C projects may be elevated to an individual EA, requiring the proponent to comply with Part II of the EA Act. Schedule B projects could also be elevated to a Schedule C project if subjected to a Part II Order.

The Class EA process flowchart is provided in Figure 1-1 below.

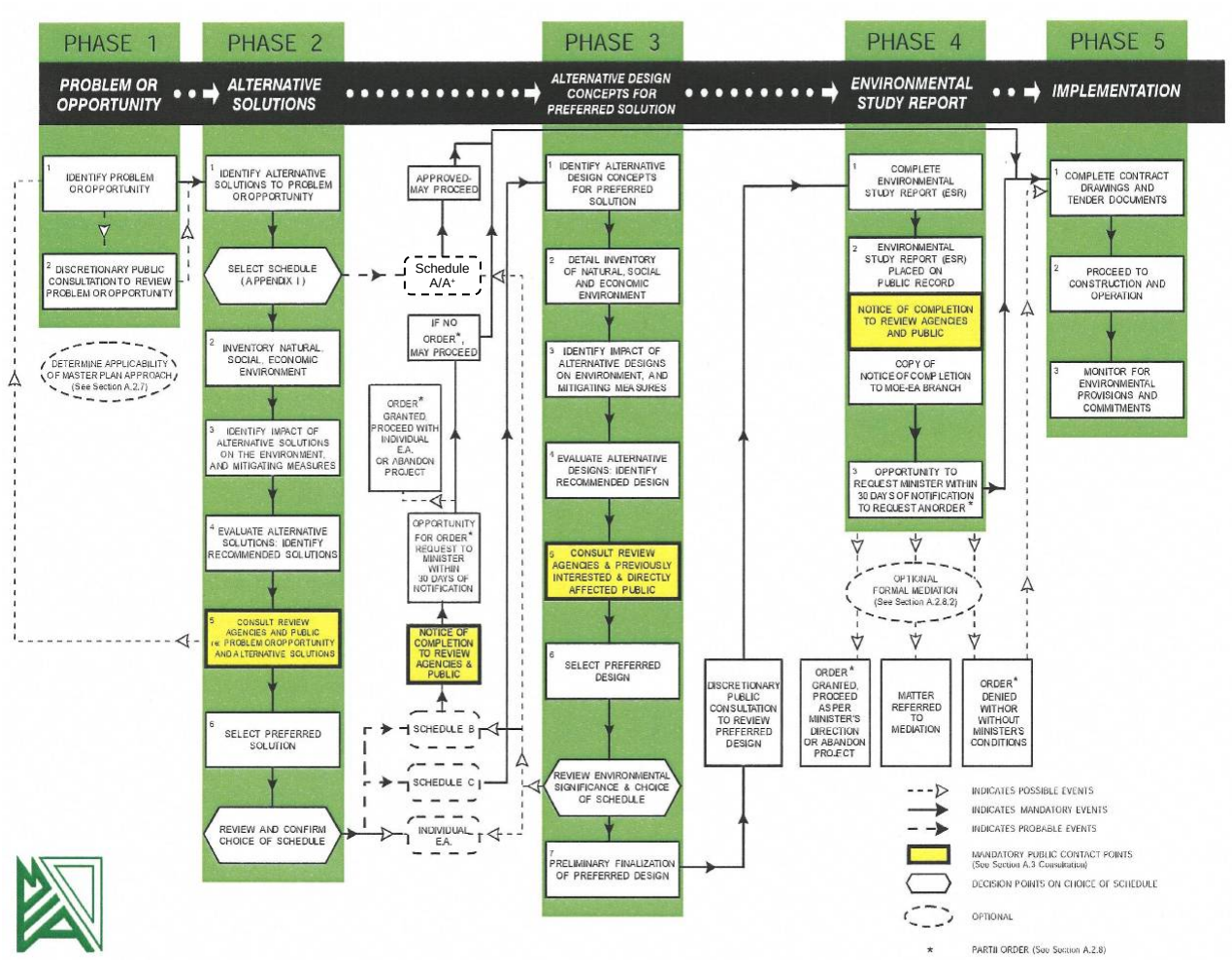


Figure 1-1 Municipal Class EA Process (Municipal Class EA Document, October 2000, as amended in 2015)

SCHEDULE A PROJECTS

Schedule A projects are minor, operational and maintenance activities and are pre-approved without the need for further assessment. Projects with this designation are typically limited in scale and have minimal adverse environmental impacts. Examples of Schedule A projects include expansion of waterworks to connect to an existing system, construction of storm water detention/retention ponds or tanks within an existing utility corridor or road allowance. This type of project is pre-approved, and the proponent may proceed without following the procedures set out in any other part of the Class EA process.

SCHEDULE A+ PROJECTS

Schedule A+ projects were introduced by MEA in 2007. Similar to Schedule A projects, these projects are also pre-approved. However, the main difference is that for Schedule A+ projects, the public must be advised of the undertaking before the project implementation. Examples of Schedule A+ projects include: the construction of localized operational improvements such as upgrades to a WTP up to its existing rated capacity where no land acquisition is required; and the establishment, extension or enlargement of a sewage collection system and all necessary works to connect the system to an existing sewage or natural

drainage outlet, provided all such facilities are in either an existing road allowance or an existing utility corridor, including the use of trenchless technology for water crossings.

SCHEDULE B PROJECTS

Schedule B projects generally include improvements and minor expansions to existing facilities where there is potential for some adverse environmental impacts. These projects require screening of alternatives for their environmental impacts and completion of Phases 1 and 2 of the Class EA planning process. If outstanding issues remain after the public review period, any party may request that the Minister of the Environment consider a Part II Order. Provided no significant impacts are identified and no requests for a Part II order to a Schedule C or Individual Environmental Assessment are received, Schedule B projects are approved and may proceed directly to implementation. Examples include construction of new water storage facilities and water/wastewater conveyance facilities (pumping stations).

SCHEDULE C PROJECTS

Schedule C projects generally include the construction of new facilities and major expansions to existing facilities. These projects are typically more complex and have the potential for significant environmental effects. As a result, they proceed under full planning and documentation procedures and satisfy all five phases of the Class EA planning process. Phase 3 involves the assessment of alternative methods of carrying out the project, as well as public consultation on the preferred conceptual design. Phase 4 includes the preparation of an Environmental Study Report which is filed for public review – Phase 4 only applies to Schedule C projects. Provided no significant adverse impacts are identified, and no requests for Part II Order or elevating to an Individual Environmental Assessment are received, Schedule C projects are then approved and may proceed to Phase 5 (implementation). Some examples of Schedule C projects are as follows: construction of a new storm water management facility with provisions for chemical or biological treatment, and the construction of a new water system including water supply and distribution system.

1.2.3.1 MASTER PLAN PROCESS

Master Plans are conducted under the structure of the MEA Class EA process. They are long range plans that identify infrastructure requirements for existing and future land use within a larger Study area, through the application of EA principals. At a minimum, a Master Plan must follow the process for a Schedule A project, that is, to address Phase 1 and 2 of the Municipal Class EA Process (i.e. following Approach 1 as defined in the MEA Class EA document). An alternative to using Approach 1 would be to use Approach 2 as defined in the MEA document, which includes completing the full evaluation for sizing and siting a Schedule B project or to use Approach 3 which includes completing the full evaluation for sizing and siting Schedule B and C projects.

The current Master Plan has been completed using Approach 1 as defined within the MEA document. That is, it will identify the overall water and wastewater system's needs, proposing general locations for future infrastructure to support the City's development plans until 2036. If infrastructure requirements classified as Schedule B and/or C projects are identified within the Master Plan, additional project specific Class EA's will be required after the Master Plan is complete to identify the sites for the proposed future infrastructure. Conversely, all Schedule A and A+ projects identified in the Master Plan can be implemented upon the finalization of the Study. The Master Plan can be referenced in order to justify undertaking the infrastructure project at the Class EA level.

It is generally recommended that Master Plans be reviewed every 5 years, to reassess any natural, social or technical conditions that may change what infrastructure works are required within a given servicing system. Some factors to be considered during the review period include: changes to design assumptions, significant new environmental effects and significant changes in the community`s population growth plan.

Where the acquisition of provincially owned lands is required, the proponent will need to comply with the requirements of Infrastructure Ontario (IO), which involves the application of the Ministry of Infrastructure (MOI) Public Work Class EA (amended October 2012) process. Should the MOI Public Work Class EA process be required, compliance can be achieved in a straightforward manner utilizing the results from the Utilities Kingston Water and Wastewater Master Plans. If an MOI/OI process is required, it will fall under Category B since the project is the acquisition of land. The Category B process requires completion of a Consultation and Documentation (C&D) report. While this can be undertaken concurrently with the Municipal Class EA, the C&D report is specific to IO and is generally completed separately. The work and consultation activities completed for the Municipal Class EA process will provide sufficient information to complete the C&D report.

1.2.4 CANADIAN ENVIRONMENTAL ASSESSMENT ACT COMPLIANCE

On July 6, 2012, the federal government released a revised Canadian Environmental Assessment Act (CEAA). Under the previous CEAA, there were triggers that would have required the need to conduct an EA to meet the CEAA. However since July 2012 the requirement is that there needs to be a physical activity (project) that falls under the “Regulations Designating Physical Activities” and specifically is in the “Schedule for Physical Activities”.

In a review of the Schedule for Physical Activities, there is no physical activity that matches the work proposed for construction of the watermains or sanitary sewers proposed in this Master Plan Study. This means that since it is not one of the Physical Activities in the Schedule, it is not a designated project and meeting the requirements of the CEAA will not be necessary for the projects identified herein.

Section 14 (2) of the CEAA does provide the Minister with the power, by order, to designate a physical activity that is not prescribed by regulations if, in the Minister’s opinion, either carrying out of that physical activity may cause adverse environmental effects or public concerns related to those effects may warrant the designation. This is not the case for this project so meeting the CEAA will not be required.

1.3 PROBLEM DEFINITION

1.3.1 STUDY AREA

The Study area being considered for this Master Plan Update includes the water and wastewater servicing within the City of Kingston’s urban area and within the satellite community of Cana. The Study Area is illustrated in Figure 1-2.

Figure 1-2 Study Area

For the purpose of the Master Plan updates, the Study Area will be referred to in three separate regions, Kingston East, Kingston Central and Kingston West regions. The Official Plan permits no additional growth within the serviced area of the Cana Subdivision and therefore no evaluation is required in this Master Plan update.

1.3.2 PROJECT CLASS EA SCHEDULES

The Water and Wastewater Master Plan Updates have been undertaken as per the Municipal Class EA process using Approach 1 as defined in the MEA Class EA document. By using this approach, the Master Plans will not require approval under the EA Act. The Study will complete Phases 1 and 2 of the Class EA process, notably the identification of the problem/opportunity and the evaluation of system servicing alternatives. All Schedule A and A+ projects identified in the Master Plan can be implemented upon the finalization of the Study, whereas Schedule B and C projects will require the completion of additional project-specific Class EA Studies prior to their implementation.

Phase 1 of this Study identifies the need for the Master Plan Updates as well as the definition of the problem or opportunity related to the water and wastewater servicing strategies available for the projected growth of the Study Area. Phase 2 identifies and evaluates the water and wastewater alternative solutions as a system related to this problem or opportunity definition. The Phase 2 work included the following:

- Identification of System Servicing Alternatives (Water and Wastewater);
- Establishment of Evaluation Criteria;
- Evaluation of Alternatives;
- Public Consultation; and
- Selection of Preferred Solutions.

1.3.3 DEFINITION OF PROBLEM OR OPPORTUNITY

This Master Plan Study provides updates to the former Water and Wastewater Master Plans which were originally completed in 2007 and 2010, respectively. This update is warranted given the revised population projections to 2036 and the infrastructure projects that have been implemented since the completion of the previous Master Plans which will impact the level of service being provided by the infrastructure.

The Problem/Opportunity for the Utilities Kingston Water and Wastewater Master Plan Updates Class EA is defined as follows:

To plan for water and wastewater integrated infrastructure and pollution control to safely and reliably service the existing and projected residential and employment population, with a focus on intensification within the current urban and serviced boundary, while minimizing impacts on the natural, cultural and social features to ensure service excellence in the City of Kingston.

1.4 PROCESS FOR THE EVALUATION OF ALTERNATIVES

1.4.1 APPROACH TO EVALUATION OF ALTERNATIVES

The water and wastewater systems servicing alternatives were evaluated using natural, social and cultural, technical and economic criteria to determine the preferred servicing alternative. The criteria are included in an evaluation matrix to objectively assess the impacts and determine the preferred solution. Comparative assessments of the alternative water and wastewater servicing options were conducted to determine which solution has the least overall impact.

The evaluation approach used to determine the preferred water and wastewater servicing solutions for this Master Plan is explained below:

- **Step 1: Determine Evaluation Criteria** – Criteria must be defined upon which the alternatives will be evaluated. As mentioned above, evaluation criteria for this project will include (1) impact on the natural environment, (2) impact on the social and cultural environments, (3) technical and operational merit, and (4) financial and economic impact. The individual impacts will typically fit into these four general categories. A breakdown of the impacts included under each criterion is defined in Section 1.4.3 of this report.
- **Step 2: Create an Evaluation System** – An evaluation system was required to evaluate each of the alternatives. In order to be impartial, this system was developed prior to determining the potential impacts associated with each alternative. During the evaluation, each of the alternatives was assigned a colour rating: green for “preferred”, yellow for “less preferred” and orange for “least preferred”, for each of the evaluation criterion. The colour rating reflected how the alternative performs with respect to that criterion. The four evaluation criteria categories were assigned equal weighting as they were considered to have equal importance in this evaluation.
- **Step 3: Document Potential Impacts** - The individual impacts associated with each alternative were determined and documented. These impacts were categorized under one of the four categories of evaluation criteria described above, based on whether they impact the natural environment, social and cultural environment, technical and operational merit, or financial and economic environment. Separate matrices for evaluating the water system alternatives and the wastewater system alternatives were created to document the impacts, weigh the alternatives qualitatively, and ultimately determine the preferred solutions.
- **Step 4: Evaluate the Alternatives** - Each of the alternatives was assigned a colour rating for each of the four evaluation criteria using the methodology established in Step 2. The evaluation was based

on a qualitative assessment of the individual impacts documented in the table created during Step 3. The colour green rating indicates that the alternative had a low impact (most preferred) with respect to that particular criterion. A yellow colour will indicate moderate impact (less preferred). An orange colour indicates that the alternative had a high impact (least preferred) with respect to that particular criterion.

- **Step 5: Determine the Preferred Alternative** - The servicing alternative with the least overall impact was recommended for implementation.

1.4.2 EVALUATION METHODOLOGY

In order to qualitatively evaluate the water and wastewater servicing alternatives, each of the criteria presented in Section 1.4.3 were assessed in a descriptive manner rather than a quantitative manner. In place of having a numerical or weighted ranking system, the evaluation focuses instead on the strengths and weaknesses of each servicing alternative to identify the preferred alternative. For each evaluation criterion and each system alternative, the potential effects on the environment were identified and evaluated relative to the other alternatives as being most preferred, less preferred and least preferred. The evaluation is based on the relative advantages and disadvantages of the potential environmental effects of each system alternative.

1.4.3 EVALUATION CRITERIA

As explained above, the evaluation approach involves the assessment of the impacts to the environment associated with implementing the water and wastewater system servicing alternatives. A more detailed breakdown of the specific criteria under each category is listed below:

NATURAL ENVIRONMENT CONSIDERATIONS

- Natural Features
- Watercourses and Aquatic Habitat
- Natural Heritage Areas
- Areas of Natural and Scientific Interest (ANSI)
- Designated Natural Areas

SOCIAL AND CULTURAL ENVIRONMENT CONSIDERATIONS

- Proximity of Facilities to Residences, Businesses, and Institutions
- Public health
- Archaeological and Cultural Features
- Designated Heritage Features
- Wells or Wellhead Protection Areas
- Consistency with Land Use Designations, Approved Development Plans, and Proposed Land Use Changes

TECHNICAL SUITABILITY AND OPERATIONAL SUITABILITY

- Design and Constructability
- Maintaining or Enhancing Drinking Water Quality
- Security of System
- Ease of Connection to Existing Infrastructure & Ease of Modifications Required to Existing Infrastructure
- Operations and Maintenance Requirements

FINANCIAL AND ECONOMIC CONSIDERATIONS

- Operations and Maintenance Costs
- Total Capital Costs

1.5 EXISTING CONDITIONS

1.5.1 DESCRIPTION OF EXISTING COMMUNITY

The City of Kingston is part of eastern Ontario and is home to approximately 127,000 residents – 85% of which live within the urban boundary and are serviced by Utilities Kingston water and sewer infrastructure. The historical City is located where Lake Ontario meets the St. Lawrence River at the south end of the Rideau Canal, which is a UNESCO World Heritage site.

The urban area is where the majority of the water and wastewater infrastructure and facilities are located. Kingston's urban area is largely made up of residential, business park, commercial, and institutional land uses with the future development bordering these land uses. The outskirts of the urban boundary are mainly comprised of rural, open space and environmental protection land uses.

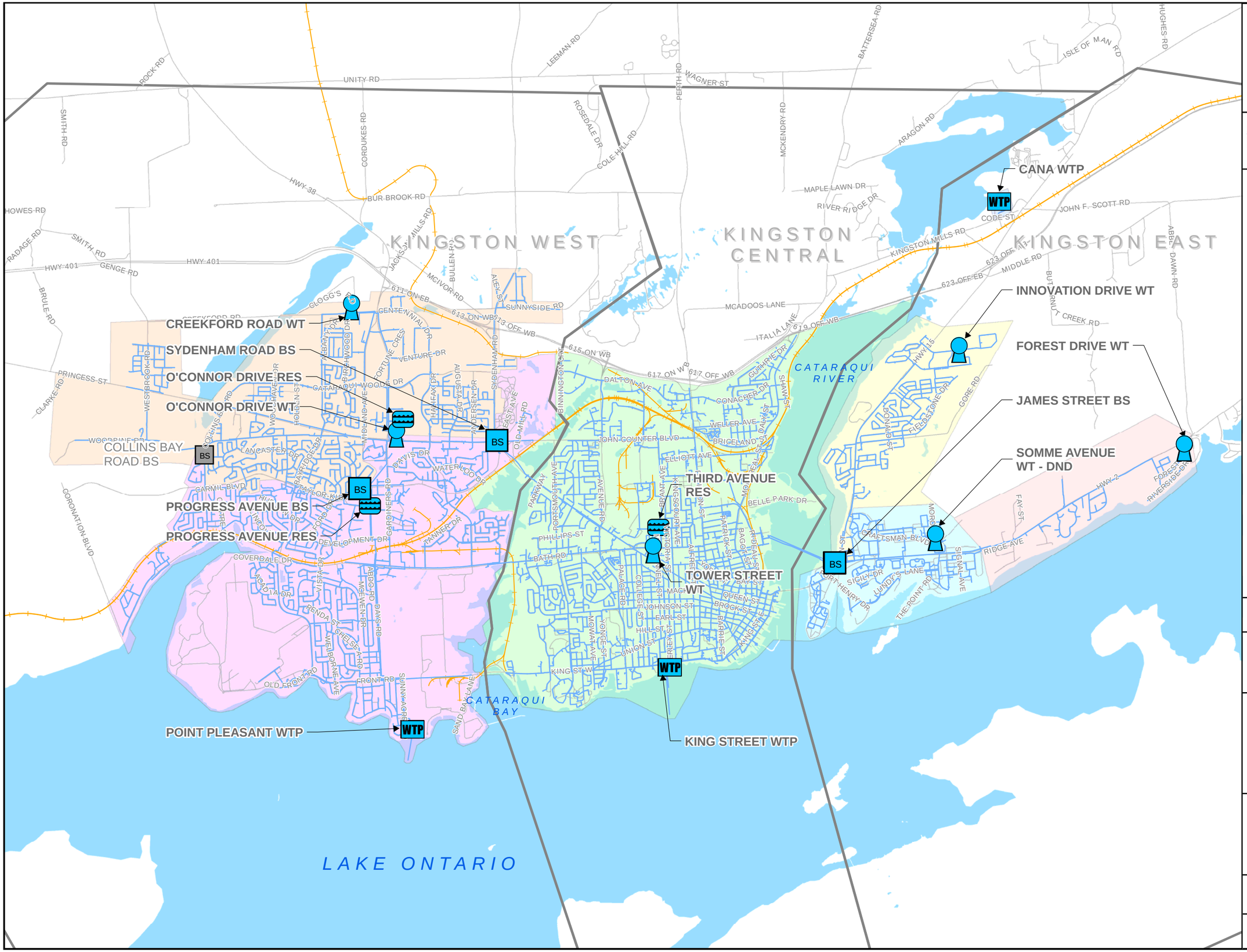
The land uses within the City of Kingston and surrounding areas provide an understanding of the potential future growth and implementation of development needs for the City.

1.5.2 EXISTING WATER SERVICING SYSTEM

The City of Kingston water supply and distribution system covers an area of approximately 8,300 ha. It is generally bordered by Westbrook Road to the west, Macdonald-Cartier Freeway to the north, Abbey Dawn Road to the east and Lake Ontario to the south. It is split between three (3) regions:

- Kingston West (50,793 POP)
- Kingston Central (54,711 POP)
- Kingston East (9,836 POP)

The City of Kingston water distribution system has 6 different pressure zones. Kingston West encompasses pressure zones 1A and 2. Kingston Central encompasses pressure zone 1B, and Kingston East encompasses zones 3A, 3B, and 3C.



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Legend

- WATER RESERVOIR
- BOOSTER STATION
- BOOSTER STATION (NOT ACTIVE)
- ELEVATED STORAGE TANK
- WATER TREATMENT PLANT
- WATER PIPE
- WATERBODY

PRESSURE ZONE

- 1A
- 1B
- 2
- 3A
- 3B
- 3C
- CANA

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale:
0 375 750 1,500 Meters
1:64,000

N W E S

Project:

Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:

WATER SYSTEM OVERVIEW

Project No.:	Date:		
151-02944-00	JANUARY 2017		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	MP	1-3

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\4.0 Class EA\Master Plan Report\Maps\151-02944-00 Fig1-3.mxd

1.5.2.1 WATER TREATMENT PLANTS

Raw water from Lake Ontario passes through two (2) main water treatment plants (WTP) that supply the majority of the Kingston water distribution system. A smaller scale water treatment plant serves the Cana subdivision north of Macdonald-Cartier Freeway (Hwy 401) drawing raw water from groundwater.

Currently, the Kingston West water distribution system is serviced by water supplied from:

→ Point Pleasant Water Treatment Plant (currently being upgraded)

The Kingston Central and East water distribution is serviced by water supplied from:

→ King Street Water Treatment Plant

The Cana subdivision is serviced by water supplied from:

→ Cana Water Treatment Plant

A summary of the WTP capacity and treatment/disinfection objectives can be seen below in Table 1-2.

Table 1-2 Water Treatment Plant Summary

	PLANT RATED CAPACITY (ML/D)	PLANT "FUNCTIONAL" CAPACITY (ML/D)	MAX DAY DEMAND (ML/D)	SOURCE WATER	TREATMENT/DISINFECTION	
Point Pleasant WTP (Ex.)	45.5	41	30.20	**Surface**	Direction Filtration	2-log removal/inactivation of Giardia Cysts
Point Pleasant WTP (New)	90	80	30.20		Chlorine Disinfection	1-log removal/inactivation of Giardia Cysts
King St. WTP	118	95	72.14	**Surface**	Conventional Filtration	2.5-log removal/inactivation of Giardia Cysts
					Chlorine Disinfection	0.5-log removal/inactivation of Giardia Cysts
City of Kingston Total (Ex.)	163.5	136	102.34			
City of Kingston Total (New)	208	175	102.34			
Cana WTP	0.11	0.10	0.04	**GUDI**	Cartridge Filtration	2-log removal/inactivation of Giardia Cysts
					Chlorine Disinfection	1-log removal/inactivation of Giardia Cysts

1.5.2.2 PRESSURE ZONES

Water systems are typically divided into separate hydraulic regions also known as pressure zones. This is to maintain adequate pressure in the system regardless of topography. Pressure zones are usually divided by valves (i.e. pressure sustaining valve) or pumps (i.e. booster station).

The existing City of Kingston water distribution system currently has six different pressure zones. Kingston West is separated from Kingston Central by the Little Cataraqui Creek, while Kingston Central is separated from Kingston East by the Great Cataraqui River. Water is supplied to the Point Pleasant WTP from Lake Ontario and currently supplies Kingston West. Water is supplied to the King Street WTP from Lake Ontario and pumped to service Kingston Central and to the James Street Booster Station which services Kingston East. Kingston West encompasses pressure zones 1A and 2, Kingston Central encompasses Zone 1B, and Kingston East encompasses Zones 3A, 3B, and 3C.

As part of the previous Master Plan, it was recommended that the West and Central zones be interconnected. There are currently two existing interconnections, one on Bath Road, and another on Princess Street. Two additional interconnections are scheduled to be completed by 2021. One on John Counter Boulevard and another on Front Road / King Street W. As some of two of these connections have been constructed and are open, an interconnected system has been considered in the subsequent sections.

1.5.2.3 BOOSTER STATIONS/ RESERVOIRS

There are three booster stations, three combined reservoir/booster stations and high lift pumps located at both treatment plants which supply pressure to the Kingston water distribution system.

The Kingston West water distribution system includes:

- Sydenham Road BS
- Old Colony Road BS
- Progress Avenue Reservoir/ BS
- O'Connor Drive Reservoir/ BS

The Kingston Central water distribution system includes:

- Third Avenue Reservoir/ BS

The Kingston East water distribution system includes:

- James Street BS

The following table provides the boosting capacity of the various components in the distribution system:

Table 1-3 Water Boosting Capacity

STATION	Total Capacity	Firm Capacity	Stand-by Capacity	Comments
	Units: ML/day			
Kingston West - Zone 1				
Point Pleasant WTP (Existing) HLPS	45.50	41.00	41.00	
Point Pleasant WTP (New) HLPS	90.00	80.00	80.00	Note 1
Progress Ave. Reservoir BS	19.01	10.89	8.12	
Sub-Total (Ex.)	**114.35**	**51.89**	**49.12**	Note 4
Sub -Total (new)	**109.01**	**90.89**	**88.12**	Note 5
Kingston West - Zone 2				
O'Connor Dr. Reservoir & BS	53.14	35.42	35.42	
Old Colony Rd. BS	6.39	3.20	0	Note 2
Sydenham Rd. BS	0.81	0.41	0	
Collins Bay BS	~~4.49~~	~~2.25~~	~~0~~	Note 3
Sub-Total	**60.34**	**39.03**	**35.42**	
Kingston Central – Zone 1B				
King St. WTP HLPS	118.00	95.00	91.07	
Third Ave. Reservoir & BS	63.40	31.60	31.80	
Sub-Total	**181.40**	**126.60**	**122.87**	
Kingston East – Zone 3				
James St. BS	49.77	33.18	33.18	
Sub-Total (Ex.)	**49.77**	**33.18**	**33.18**	
Sub-Total (New)	**27.65**	**14.69**	**14.69**	Note 6

Note 1: The indicated Total and Firm Capacity are based on plant capacity and not pump capacities as it is the limiting factor
Note 2: Capacities indicated based on VFD set point (i.e. capacity limited to 37 L/s), pump capacity is 7.08ML/day (82 L/s)
Note 3: Station not currently in use and therefore capacity not included in totals.
Note 4: Excludes Point Pleasant WTP (New) HLPS
Note 5: Excludes Point Pleasant WTP (Existing) HLPS
Note 6: Capacity is based on upgrades currently under construction

1.5.2.4 WATER STORAGE

There are five elevated storage tanks (EST), three reservoirs, one standpipe and storage at both treatment plants that supply water (domestic and fire flow) to the Kingston water distribution system.

The Kingston West water distribution system includes:

- O'Connor Drive EST
- Creekford Road EST
- O'Connor Dr. Reservoir
- Progress Ave. Reservoir

The Kingston Central water distribution system includes:

- Tower Street EST
- Third Ave. Reservoir

The Kingston East water distribution system includes:

- Innovation Drive EST
- Somme Avenue EST (CFB Kingston)
- Forrest Drive Standpipe

The following table provides the storage capacity of the various components in the distribution system:

Table 1-4 Existing Water Storage Capacity

STATION	Total	Functional	Typical Water Level	
	m^3	m^3	m	m
Kingston West - Zone 1				
Point Pleasant WTP (Existing)	6,560	1,750	3.25	3.75
Point Pleasant WTP (New)	~~12,960~~	~~6,550~~	~~4.5~~	~~1.5~~
Progress Ave. Reservoir	6,600	2,900	4.5	2.5
O'Connor Dr. EST	1,100	500	9.0	6.0
Sub-Total[1]	**14,260**	**5,150**		
Kingston West - Zone 2				
O'Connor Dr. Reservoir	8,044	4,000	11.75	5.25
Creekford Dr. EST	6,800	3,100	12.0	7.0
Sub-Total	**14,844**	**7,100**		
Kingston Central – Zone 1B				
King St. WTP	500	0	0	0
Third Ave. Reservoir	22,700	13,000	5.6	2.2
Tower St. EST	3,400	1,600	6.5	3.0
Sub-Total	**26,600**	**14,600**		
Kingston East – Zone 3				
Innovation Dr. EST	6,300	1,500	9.5	6.9
CFB Kingston EST	2,270	900	7.0	4.3
Forest Dr. Stand Pipe	1,770	200	6.0	0.5
Sub-Total	**10,340**	**2,600**		
Cana				
Cana WTP	45	16	2.5	1.75
Sub-Total	**45**	**16**		

1 - Point Pleasant WTP (New) is not included in the total.

1.5.2.5 DISTRIBUTION SYSTEM

The City of Kingston main water distribution system is comprised of Kingston West, Kingston Central and Kingston East. The Cana subdivision has a very small distribution system to service a small residential community. Furthermore, there are a couple of areas outside the urban boundary that are serviced by the municipal system (north of Hwy 401 near Sydenham Road, east along Hwy 2, to the west along Westbrook Road) servicing approximately 1,360 people.

The diameter of watermains in the existing system vary from 25 mm to 1200 mm, with the majority of pipes falling in the range of 150 mm to 300 mm. Kingston's distribution watermains are made from cast iron (CI), cured in place pipe (CIPP), concrete pressure pipe (CPP), copper (CU), ductile iron (DI), high density polyethylene (HDPE) and polyvinyl chloride (PVC). The West and East distribution systems are mainly constructed with PVC; the Central is primarily CI.

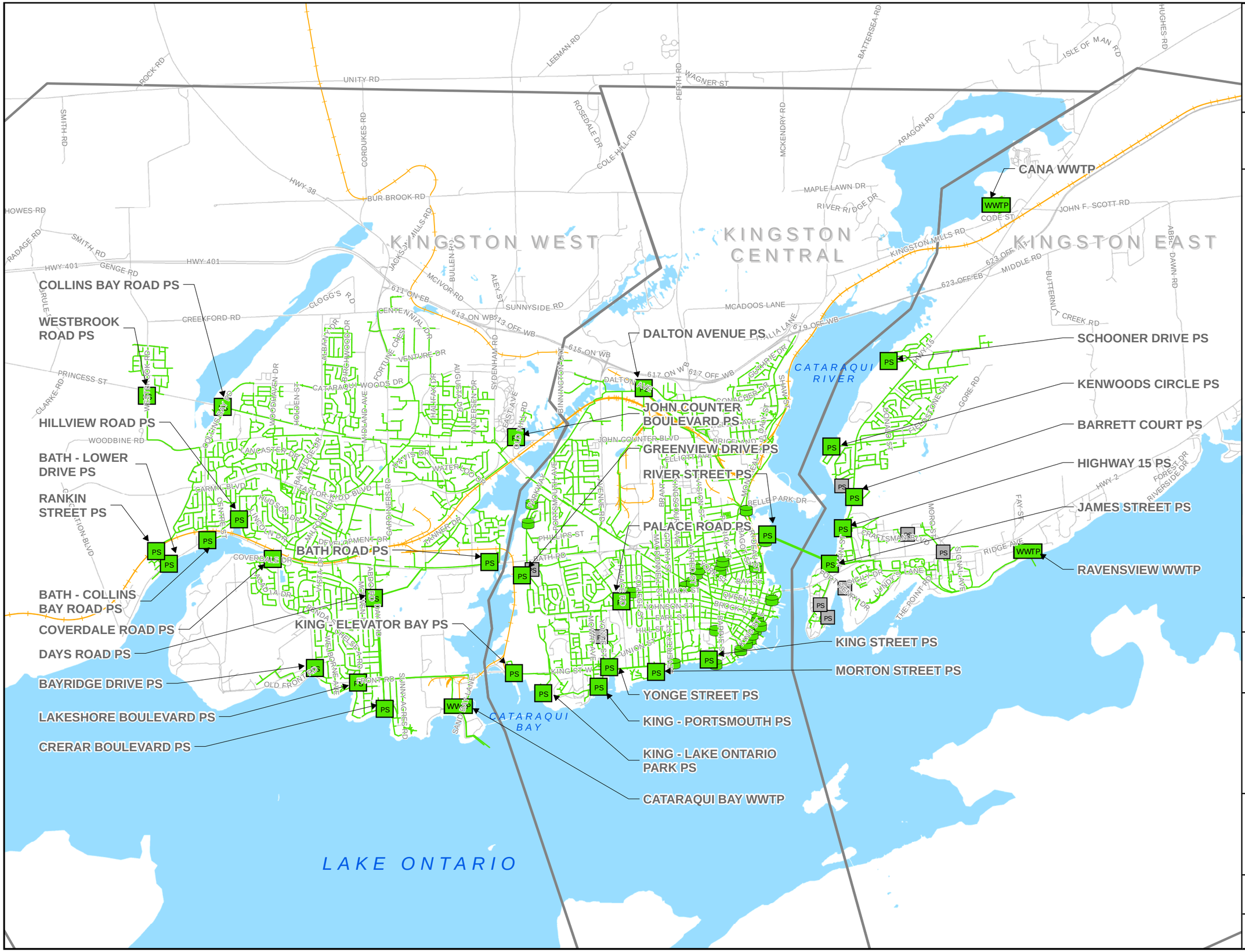
A more detailed description of the existing system can be found in the "*Baseline Review Report - Water.*"

1.5.3 EXISTING WASTEWATER SERVICING SYSTEM

The City of Kingston wastewater collection system services an area of approximately 8,300 ha. It is generally bordered by Westbrook Road to the west, Macdonald-Cartier Freeway to the north, Ravensview WWTP access road to the east and Lake Ontario to the south. It is split between three regions:

- Kingston West (50,151 POP)
- Kingston Central (54,711 POP)
- Kingston East (9,118 POP)

Kingston West is separated from Kingston Central by the Little Cataraqui Creek, while Kingston Central is separated from Kingston East by the Great Cataraqui River. The collection system consists of separated, partially separated and combined sewers. The sewers in the City of Kingston were built between 1900 to present.



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Legend

- PS — SANITARY PUMPING STATION
- WWTP — WASTEWATER TREATMENT PLANT
- OVERFLOW FACILITY
- PS — PUMPING STATION (NOT MODELLED)
- SANITARY SEWER
- WATERBODY

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale:
0 375 750 1,500 Meters
1:64,000

N W E S

Project:

Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:

WASTEWATER SYSTEM OVERVIEW

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1.5.3.1 COLLECTION SYSTEM

Wastewater flow from Kingston West is conveyed via gravity and pumping stations to the Cataraqui Bay WWTP. Wastewater and combined sewer flow collected from Kingston Central and East are conveyed via gravity and pumping stations to the Ravensview WWTP. The Cana WWTP located north of the Macdonald-Cartier Freeway services the Cana subdivision.

The collection systems in the City of Kingston are comprised of three different classifications of sewers: Combined Sewers; Partially Separated Sewers; and Separated Sewers. Combined sewers are conveyance systems that collect and carry both sanitary and storm water runoff. They are predominantly located in the older areas of the City, installed before wastewater treatment was widely used by municipalities. During large rainfall events these sewers may by-pass untreated wastewater into the environment (Combined Sewer Overflow). Partially separated sewers are sanitary sewers that also collect and convey storm water from roof leaders, downspouts, subdrains and building sump pumps. The City does not permit storm water connection to the sanitary system, however there are many areas of the City where this occurs. Accurate and complete records of these areas are not available. Separated sanitary sewers convey only sanitary wastewater, however are still subject to infiltration and inflow (I/I). All new development is serviced with separate sanitary and storm sewers. The Central system is the only collection area with combined sewers and combined sewer overflows.

1.5.3.2 COMBINED SEWER OVERFLOW AND BYPASS CHAMBERS

Portions of the central collection system are still serviced by combined sewers. Utilities Kingston has previously implemented various capital projects to reduce the risk to property owners and the environment through the implementation of storage, monitoring and overflow weirs.

There are currently 34 active overflows in the City of Kingston that range from manholes with weirs to elaborate multi-chamber tanks. The purpose of these overflows is to divert flow from combination sewers to sanitary sewers under regular conditions and to storm outlets during high flow conditions (wet-weather). The infrastructure includes 13 combined sewer overflows (CSO), 3 sanitary sewer overflows (SSO), 16 pumping station overflows, 2 tank overflows, 6 inline storage tanks and three CSO storage tanks. The figure below illustrates the Combined Sewer infrastructure in the City. It should be noted that the number and type of overflows outlined above are based on the systems configuration at the initiation of the project and Utilities Kingston has continued with temporary and permanent plugging based on recommendations from previous studies during the development of the Master Plan.

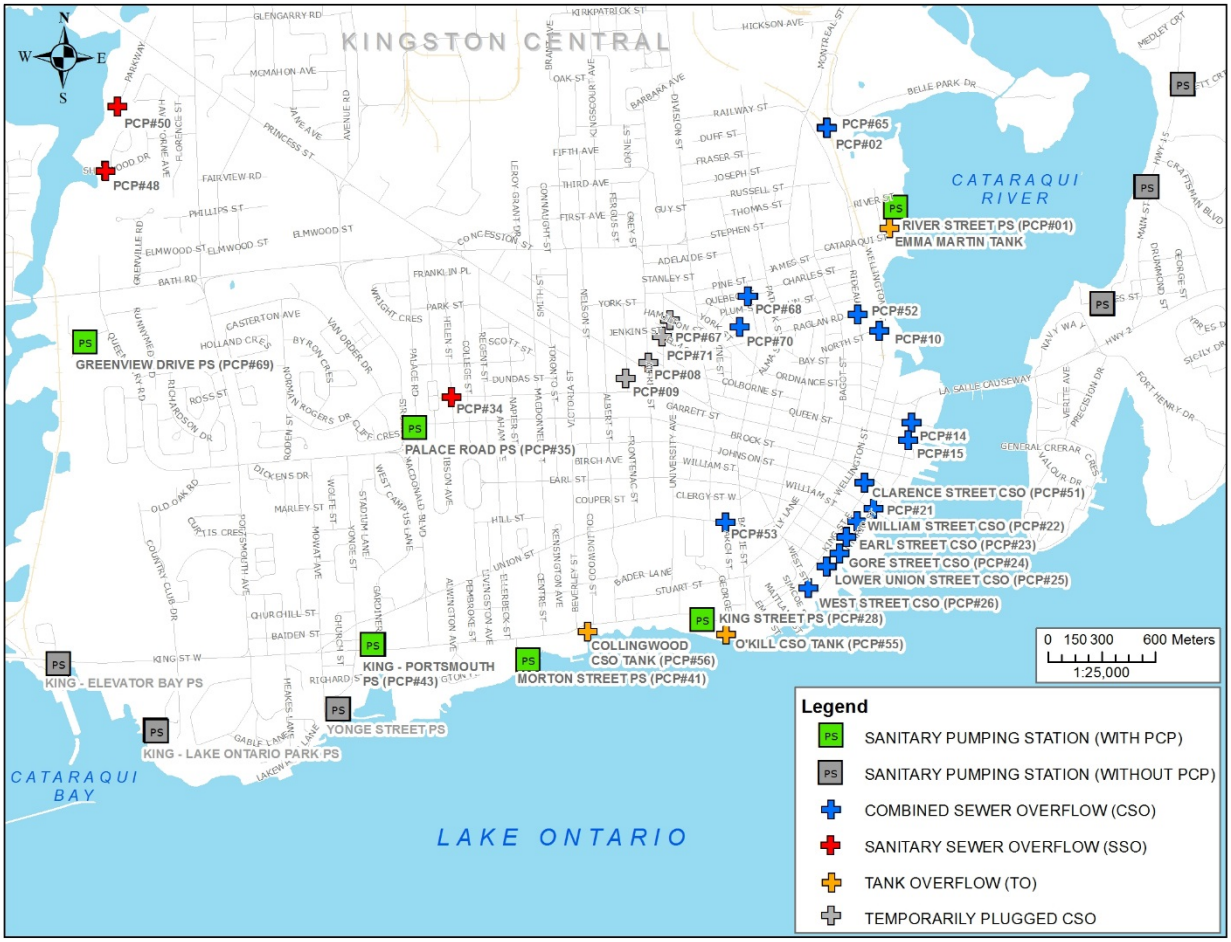


Figure 1-5 Combined Sewer Overflows and By-Pass

1.5.3.3 PUMPING STATIONS

Pumping Stations provide a method to convey collected wastewater flow which cannot be conveyed by gravity due to topography or other system characteristics. Pumping stations generally pump the flow through a forcemain to a location of higher elevation where it discharges into the gravity system further downstream. The Kingston West collection system has 13 pump stations, the Kingston Central collection system has 12 pump stations, and the Kingston East collection system has 5 pump stations. The figures provide flow diagrams of the pump station network in Kingston West and Central/East respectively.

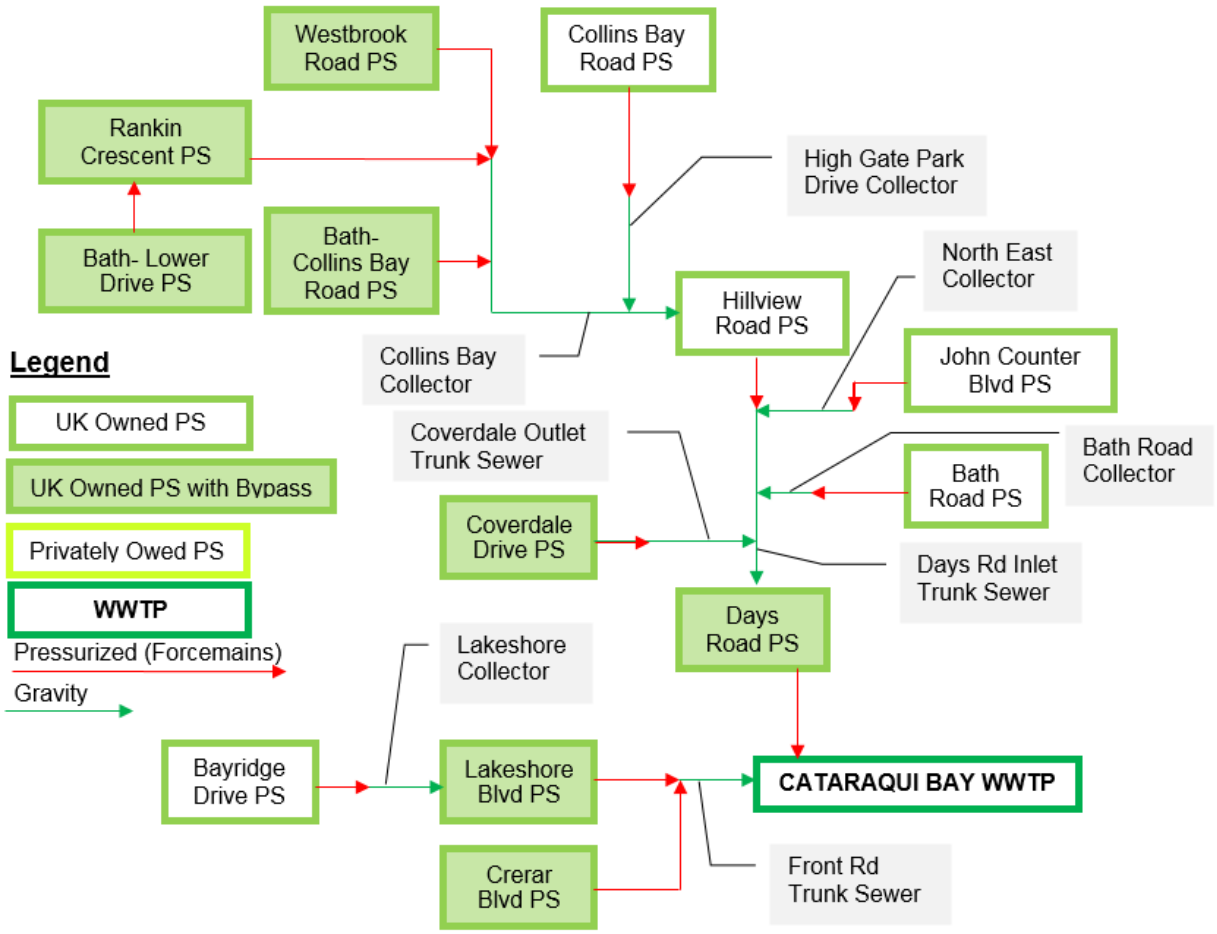


Figure 1-6 Kingston West Collection System Flow Diagram

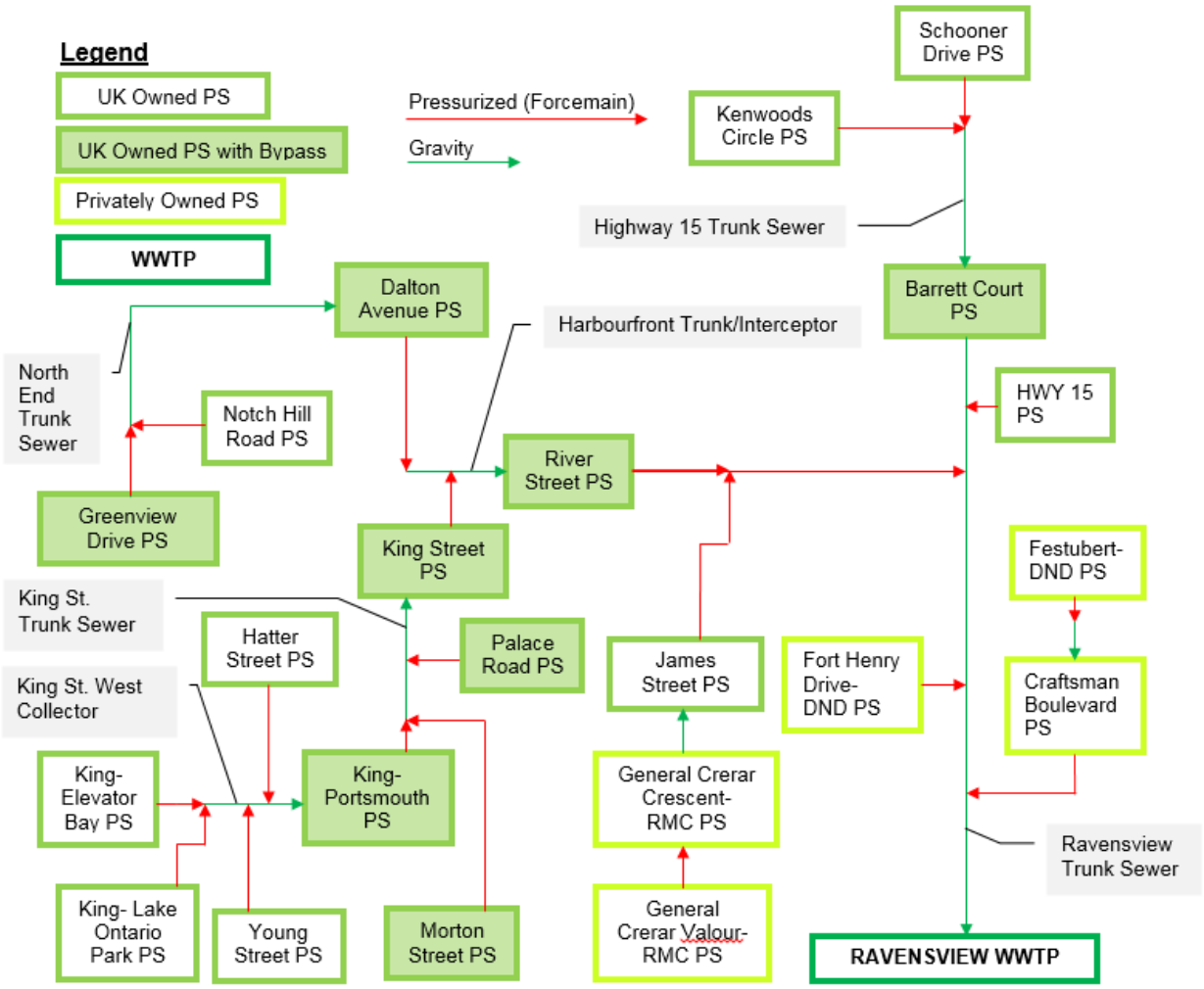


Figure 1-7 Kingston Central / East Collection System Flow Diagram

A summary of the pumping station capacities follows in Table 1-5.

Table 1-5 Wastewater Pumping Station Summary

Pumping Station	Collection Area	Forcemain Length	Forcemain Dia.	Capacity	
				Firm	Peak[1]
Bath Rd.	West	558 m	200 mm	51.4 L/s	87.4 L/s
Bath – Collins Bay	West	171 m	150 mm	16.0 L/s	32.0 L/s
Bath – Lower	West	98 m	100 mm	6.0 L/s	11.6 L/s
Bayridge Dr.	West	79 m	150 mm	19.0 L/s	36.9 L/s
Collins Bay Rd.	West	819 m	150 mm	20.0 L/s	23.8 L/s
Coverdale Dr.	West	733 m	200 mm	78.0 L/s	132.6 L/s
Crerar Blvd.	West	566 m	200 mm 150 mm	57.0 L/s	96.9 L/s
Days Rd.	West	5,367 m	900 mm 600 mm	900.0 L/s	1102.0 L/s
Hillview Rd.	West	557 m	350 mm	141.0 L/s	239.7 L/s
John Counter Blvd.	West	332 m	250 mm	50.6 L/s	86.0 L/s
Lakeshore Blvd.	West	435 m	400 mm	117.0 L/s	210.6 L/s
Rankin Cres.	West	561 m	150 mm	19.0 L/s	32.3 L/s
Westbrook Rd.	West	1,812 m	150 mm	14.0 L/s	18.0 L/s
Dalton Ave.	Central/East	1,550 m	600 mm 450 mm	990.0 L/s	1225.0 L/s
Greenview Dr.	Central/East	60 m	250 mm	47.3 L/s	85.1 L/s
King St.	Central/East	282 m	600 mm	576.0 L/s	731.0 L/s

Pumping Station	Collection Area	Forcemain Length	Forcemain Dia.	Capacity	
				Firm	Peak[1]
King – Elevator Bay	Central/East	697 m	250 mm	88.0 L/s	149.6 L/s
King – Lake Ontario	Central/East	456 m	150 mm	12.0 L/s	21.6 L/s
King - Portsmouth	Central/East	478 m	450 mm	285.0 L/s	405.0 L/s
Morton St.	Central/East	144 m	150 mm	18.0 L/s	32.4 L/s
Palace Rd.	Central/East	234 m	200 mm	22.0 L/s	22.0 L/s
River St.	Central/East	3,182 m	1067 mm 1067 mm	1700.0 L/s	2130.0 L/s
Yonge St.	Central/East	23 m	75 mm	4.0 L/s	9.9 L/s
Barrett Ct.	Central/East	608 m	300 mm	188.0 L/s	277.0 L/s
Highway 15	Central/East	555 m	250 mm	86.5 L/s	147.1 L/s
James St.	Central/East	128 m	150 mm	67.0 L/s	115.2 L/s
Kenwoods Cir.	Central/East	458 m	200 mm	48.0 L/s	95.4 L/s
Schooner Dr.	Central/East	556 m	150 mm	10.0 L/s	19.6 L/s

1 - Peak Capacity is estimated based on forcemain length and diameter. Refer to the "*Gap Analysis – Wastewater*" report for calculation details.

1.5.3.4 WASTEWATER TREATMENT PLANTS

The Ravensview WWTP treats flow originating in the Central and East collection systems. The facility is a secondary treatment plant which uses biological aerated filters (BAF) to achieve its effluent objectives.

The Cataraqui Bay WWTP is presently a conventional activated sludge plant which is currently undergoing a treatment and capacity upgrade. When complete, the plant will also employ BAF to achieve its effluent objectives.

Table 1-6 Wastewater Treatment Plant Capacity

WASTEWATER PLANT	RATED CAPACITY (M^3/DAY)		
	Peak Flow Rate (Primary)	Peak Flow Rate (Secondary)	Average Daily Flow Rate
Ravensview	193,000	193,000	95,000
Cataraqui Bay (existing)	134,400	69,200	38,800
Cataraqui Bay (new)	173,200	-	55,000

1.5.4 NATURAL ENVIRONMENT

The existing natural environment within the City of Kingston and surrounding areas is largely located outside of the urban boundary and in between the Kingston East, Kingston Central and Kingston West regions. These natural areas are largely composed of wetlands, valley lands, woodlands, and waterbodies. One of the larger waterbody corridors is the Inner Harbour that leads to the Great Cataraqui River. This corridor is an Environmental Protection Area of submerged vegetation. Some of the other natural landscape areas within the Study Area include agricultural land, areas of natural and scientific interest and natural constraints such as natural hazard areas and groundwater sensitivity areas.

1.5.5 SOCIO-CULTURAL ENVIRONMENT

The socio-cultural environment within the City of Kingston is comprised of heritage areas, sites, corridors and districts including UNESCO World Heritage Sites as well as institutions, woodlands, wetlands and valley lands. The heritage areas generally include Market Square, Barriefield, Old Sydenham, Lower Princess Street, Portsmouth Village, St. Lawrence Ward, Alamein Drive, Cataraqui Village, Village of Westbrook, Fort Henry, and Fort Frederick. The institutional areas include religious facilities, schools, penitentiaries, retirement homes, hospitals, military facilities, Kingston Fire and Rescue, and community centers.

1.6 FUTURE SERVICE REQUIREMENTS

1.6.1 GROWTH SCENARIOS

Fundamental to the development of the Master Plan was to analyze and consolidate the anticipated growth in the City of Kingston from the background reports and develop growth scenarios for the evaluation of the infrastructure. Through discussions with Utilities Kingston, the City of Kingston Planning Department, and review of previous Master Plans and available reports, one existing condition scenario and five growth scenarios were developed.

Table 1-7 Development Growth Scenario Description

SCENARIO	DESCRIPTION
2015	Existing Conditions
2021	Based on Committed and Pending Development Applications plus associated industrial, commercial and institutional growth estimates
2026	Based on remaining Committed and Pending Development Applications (“Committed Conditions”) plus associated industrial, commercial and institutional growth estimates
2036	Based on Future Known Potential Developments plus associated industrial, commercial and institutional growth estimates
Full Build-Out	Based on Undeveloped and Under-Developed Land as of 2036 with their anticipated development density (based on Official Plan) plus associated industrial, commercial and institutional growth estimates
Ultimate	Full Build-Out plus specific urban boundary extensions

The primary purpose of the 2021-2036 scenarios was to help evaluate the impacts of growth and development on the infrastructure and plan future upgrades. The full build-out and ultimate scenarios serve to provide a check and balance for the recommended upgrades in the 2021-2036 scenarios. For example, if a pipe is recommended to be upgraded to a certain size in one time step and the size required for the same pipe in the full build-out is only incrementally larger, the cost for the two options can be evaluated; given the relatively long life span of linear infrastructure and added flexibility for future development, the additional cost for a larger pipe may be justified. 2036 will be used as the primary scenario for planned improvements, and the other scenarios will provide timing and urgency requirements.

The full build-out and ultimate scenarios are not based on a specific development year but instead on development milestones. As the ultimate scenario is looking at only certain 'what if' scenarios commercial, industrial and institutional growth is not projected.

1.6.2 RESIDENTIAL

Estimating the number of residential units required for each growth scenario was completed using the City of Kingston And Kingston CMA Population, Housing and Employment Projections (Updated October 2013) - prepared by Meridian Planning and C4SE "CMA Report". The highest probability scenario, High Case, from the CMA was used for further analysis in the Water and Wastewater Master Plan Update.

In review of the CMA report and through discussions with Utilities Kingston the High Case projection was used for the analysis related to the Water and Wastewater Master Plan Update for the following reasons:

- The CMA report assigned a higher probability to the High Case projection, with reasonable justification;
- The High Case represents a marginal population increase from the Base Case Scenario over the analysis period, with increases ranging from 1% to 6% between 2021 and 2036; and
- Using the High Case provides flexibility for intensification and development within the City.

The CMA Report evaluated the entire census metropolitan area (CMA) and was also further broken down into several smaller areas. The analysis for the Master Plan used data exclusively for the area constrained by the City Boundary. It should be noted that the existing Urban Boundary does not service the entire area within the City Boundary. The City of Kingston Planning Department estimates that 96% of residents live within the Urban Boundary and the remaining 4% live in rural areas of the City. For the purpose of estimating residential development, it is assumed that this ratio will remain unchanged during the analysis period. The number of new development units required in Kingston were discounted by 4% in each time step to represent the number of units being developed in rural areas of the City.

Residential development was allocated to an analysis year based on demand generated by population growth. Submitted development applications, both committed and pending were given priority followed by anticipated development. Development applications were provided by the City of Kingston planning department; these applications included the total number of residential units and the development location. Anticipated development is comprised of publicly known developments that are in the news, before council, or part of reports commissioned by the City. Development applications that were provided by the planning department have sufficient residential units identified to satisfy the forecasted residential demand in 2021 and 2026. Anticipated development is used to fulfil the 2036 demand.

Table 1-8 Urban Residential Projections

	2015	2021	2026	2036
Population	126,645	137,220	145,690	156,640
Population per Unit	2.36	2.33	2.33	2.31
Existing Units (from previous time step)	53,759	53,759	58,893	62,528
Total # of Required Units (Population/ Pop. per Unit)	0	58,893	62,528	67,810
Required # of New Units (Existing - Total Req.)	0	5,133	3,635	5,282
Required # of New Units Rural (4% of New Units)	0	205	145	211
Required # of New Units Urban (96% of New Units)	**0**	**4,928**	**3,490**	**5,070**

1.6.3 INDUSTRIAL & COMMERCIAL

Estimating the industrial growth scenarios was based on the Employment Land Strategy Review report authored by Watson & Associates Economists Ltd. in association with Dillon Consulting Limited. The report developed a long-term vision and plan for industrial growth within the City of Kingston and served as the basis for the industrial growth and development assumptions in this Master Plan.

Commercial development projections are based on the square footage warrant outlined in the Commercial Inventory and Market Analysis City of Kingston, ON 2008 by Urban Metrics Inc. The Commercial Inventory Analysis projected commercial development warrants for the 2021 and 2026 scenarios. The warrant for the 2036 scenario was extrapolated by assuming that the current average of 10 square feet of retail space per person is maintained.

Table 1-9 Industrial and Commercial Growth Projections

YEAR	2015	2021	2026	2036	FULL BUILD-OUT	ULTIMATE
Industrial Growth (incl. Business Park)	0	80.4	126.4	171.9	197.9	-
Commercial Growth	0	16.3	18.5	24.3	27.9	-

*Cumulative

1.6.4 INSTITUTIONAL

Kingston is home to several large institutions such as Correctional Services Canada (CSC), Canadian Forces Base (CFB) Kingston, Royal Military College of Canada (RMC), Queen's University (Queen's), and St. Lawrence College (SLC) among others. Forecasting growth for the various institutions in Kingston is challenging. There are many factors that influence how and when these institutions will grow. Some of the institutions have their own public Master Plans while others are less formalized.

FEDERAL INSTITUTIONS

Federal institutions that have a large presence in Kingston include CSC and CFB Kingston. These institutions do not have formal plans available that forecast their anticipated growth. Growth rates used for the various analysis years were based on the assumptions made in the CMA report to predict the population. The high case scenario in the CMA report assumed that the City would maintain its current 1% share of federal jobs and that federal jobs will grow by 41% over 29 years, resulting in an average annual growth of 1.41%. The report estimated that the Federal Government currently employs 5,800 people in

Kingston, assuming a 29.6% growth (average of 1.41% annually 2015-2036); this would add 1,717 federal employees.

Kingston Penitentiary is an exception to these assumptions; the site was not operational during the existing analysis period. As a result, the demand at the site would be very minimal resulting in an under estimate of future requirements at the site. This site is relatively high profile and is anticipated to be redeveloped in the near future. It is anticipated that the entire 8.5 ha site will be redeveloped by 2036. The phasing of development on this site has been estimated at 25% by 2021, 50% by 2026 and 100% by 2036.

Table 1-10 Federal Institution Growth Projections

INSTITUTION	2021 GROWTH	2026 GROWTH	2036 GROWTH
CSC	8%	16%	30%
CFB Kingston	8%	16%	30%

ACADEMIC INSTITUTIONS

There are three large academic institutions in Kingston: Queen's, SLC and RMC. These institutions all have varying forecasts for their future growth.

QUEEN'S UNIVERSITY

The CMA report estimated that students enrolled in undergraduate and graduate studies in Ontario will increase by 31% between 2014 and 2041, resulting in an average annualized growth rate of 1.16%. The report indicates that it is estimated that Queen's will maintain its current share of post-secondary students.

In discussion with Queen's University Planning department and their projected 3 year enrollment numbers, Queen's is estimated to grow by 7.89% between 2014/2015 and 2017/2018 and then hold fairly stable for at least another projected planning cycle (3 years). Based on this information the average annualized growth rate for the next 6 years is estimated at approximately 1.31% (7.89% / 6yrs); that is in line with the CMA growth rate (1.16%).

Student residences are not included in this category and are included below in 'Student Population'.

ST. LAWRENCE COLLEGE

St. Lawrence College does not have a formal Master Plan for the campus. The growth assumptions for SLC were obtained by consulting with their Associate Director of Capital Planning and Sustainability. It was indicated that SLC anticipates to experience growth of approximately 30% over the next 20-25 years. Assuming this all occurs during the analysis period (2015-2036) results in an average growth of 1.5% per year that is in line with the CMA report estimate growth (1.16%).

Student residences are not included in this category and are included below in 'Student Population'.

ROYAL MILITARY COLLEGE

RMC was consulted during the Kinston East Master Plan Update regarding their anticipated growth. It was concluded that RMC does not expect to experience any growth and this assumption has been carried forward herein.

STUDENT POPULATION

Queen's and SLC are anticipated to grow by 24% and 30% respectively over the analysis period. Although the CMA considered growth of these institutions in terms of employment and permanent residents, it did not include consideration for temporary residents (students) resulting from the growth of the academic institutions.

In 2014, Queen's had a student population of 21,649 and residences for 4,089 of those students with an additional 550 residences becoming available starting in 2015. Based on these figures approximately 20% of students are currently accommodated in on-campus residences, with the remainder living in student housing in the university district. Queen's anticipates increasing residence capacity on West Campus. The increase in capacity will be generated through increasing the density in one residence building to accommodate an additional 700 students and building a new residential cluster with 1,360 units (4 – 340 unit buildings) for a total increase of 2,060 residence units.

In 2014 SLC had a student population of 4,729 and residences to accommodate 600 of those students. Based on these figures approximately 13% of students are currently accommodated in on-campus residences, with the remainder living in student housing in the community around the college. It is assumed that in 2026 an additional residence will be constructed to accommodate an additional 300 students on campus to maintain the approximate percent of on-campus students.

Table 1-11 Student Population Growth Projections

	2015	2021	2026	2036
Total Students	26,378	28,272	29,858	33,079
Student Population Increase	-	1,894	3,480	6,701
Increase on Campus (Residence) Capacity	-	700	1,680	2,360
Increase Living Off Campus	-	1,194	1,800	4,341

Accommodations for students living off campus are assumed to be provided through student housing located in the academic intensification area located between Queen's and SLC. The increase in residential units is assumed to be accommodated through the conversion of existing residential units to multi-unit student housing, increased density in existing buildings or conversions of single family homes to student housing. The distribution of these units is assumed to be relatively even across the academic intensification area.

OTHER INSTITUTIONS

Additional institutions within the City include fire, police, hospitals, elementary and high schools, among other public and municipal services. It is assumed that these institutions will continue to grow proportionally to the population that they serve. These services are assumed to remain in their current locations with intensification accommodating the growth.

Table 1-12 Other Institutional Growth Projections

INSTITUTION	2021 GROWTH	2026 GROWTH	2036 GROWTH
Hospitals	8%	15%	24%
Police + Fire	8%	15%	24%
Schools	8%	15%	24%
Public and Municipal Services	8%	15%	24%

1.7 ALLOCATION OF GROWTH AND DEVELOPMENT

1.7.1 RESIDENTIAL

Development applications were used to spatially distribute residential growth. Some of the applications represent large subdivisions that are partially constructed. These applications were revised to represent only the remaining unbuilt units at the time of the analysis. Depending on the stage of the development application it was categorized as either 'Closed', 'Committed' or 'Pending'. 'Closed' applications were omitted as these developments are currently complete and are included in the existing condition scenario. The remaining applications were used to distribute the development over the analysis periods. It was assumed that residential units will be developed to satisfy demand based on the following priority:

1. Application Status Committed; and
2. Application Status Pending.

The Cataraqui West Secondary Plan was not assumed to follow the above priority. Given the size and nature of this application, it is assumed that it will take time before all the remaining applications and permits are approved. Approximately half of the remaining units were deferred from 2021 to 2026.

Based on the assumptions above, there were adequate units identified in development applications to satisfy growth up to 2026 with 81 surplus units. The surplus units are included in the 2026 scenario as it provides a growth scenario where all the existing development applications (prior to Jan 1, 2015) are being serviced (i.e. committed). The increase of 60 units is expected to have negligible impact to the 2026 scenario.

Growth and development for the full build-out scenario is based on the development of vacant land and underutilized parcels in Kingston. The City of Kingston Planning Department provided a list of vacant land and underutilized parcels along with their anticipated development density. These anticipated units were included in the full build-out scenario. In addition to the anticipated units described above any remaining units part of an identified development that were not included in a previous growth scenario are included in the full build-out. The full build-out scenario added an additional 10,213 units, representing a population increase of approximately 23,590 people or 15%.

The ultimate scenario builds on the full build-out scenario, it assumes that all land within the Urban Boundary is developed with no remaining vacant parcels and that the various proposed expansions to the urban boundary are developed. The proposed expansions are based on areas identified through consultation with the planning department. The areas of expansion are assumed to be fully developed at their proposed density and land use. This scenario results in the population growing by 45%, adding approximately 70,704 people or 30,608 units to the full build-out scenario. No formal development year is assigned to this scenario as it is intended to be used as a tool for infrastructure planning and cost benefit analysis.

1.7.2 INDUSTRIAL, COMMERCIAL AND INSTITUTIONAL

INDUSTRIAL

The Employment Land Strategy report suggested that it is likely industrial development would absorb parcels with easy access to Highway 401 first and that Business Park development would absorb newer parcels located nearer to other service amenities such as food, banking, and health care. These preferences were taken into consideration by reviewing parcel location and existing development in the surrounding areas while assigning development for the 2021-2036 analysis scenarios.

The industrial development required to satisfy the demand for the full build-out was based on residential growth rate. It is assumed that industrial growth will be proportional to the residential growth, with both experiencing a 15% increase from the 2036 scenario. The Employment Land Strategy review highlighted that many of the existing industrial areas had land available for intensification. For this reason the specific location of industrial growth was not identified, instead existing industrial areas are assumed to intensify to accommodate the increased demand. There was one exception to this assumption which was Cloggs Rd/ORC Land. This parcel of land has been identified by the City as a potential area for future business park which is not currently serviced.

COMMERCIAL

The spatial distribution of the commercial development was completed by assigning growth to the commercial nodes identified by the Inventory Analysis. The Inventory Analysis report identified that a 4% vacancy is indicative of a healthy market. As such, the vacancy at each node was iteratively reduced to approximately 4% over the analysis period until the commercial demand was obtained. Growth was then assigned to undeveloped land, which was assumed to develop with a lot coverage of 25%. The commercial inventory analysis identified this level of coverage as typical for commercial development in Kingston.

INSTITUTIONAL

It is anticipated that the large institutions will intensify their operations on existing property and not acquire new land given their large existing land inventory in the area.

1.8 DESIGN CRITERIA

1.8.1 WATER DEMAND RATES

This section outlines the water demand generation criteria that will be applied to the growth projections and during the analysis and planning of infrastructure in the City of Kingston.

Water demand patterns vary between municipalities. The variations are primarily influenced by the habits and characteristics of system users. Volume as well as diurnal patterns will tend to fluctuate depending on servicing requirements, such as the size of the serviced population, type, and amount of industry present as well as condition of the infrastructure.

The Ministry of Environment Design Guidelines for Water Works (MOE, 2008) have attempted to account for variations in flow demand by permitting acceptable ranges for design calculations. As a result of this flexibility, many municipalities in Ontario have set standard flow demand criteria for their jurisdiction. The set design flow is typically within the MOE's accepted range; however, it is often based on the historical flows observed by the municipality.

Where variations in parameters or guidelines are permitted, a review of applicable standards and municipalities of similar size has been completed to ensure that values used in this Master Plan are reasonable and consistent with other jurisdictions and past work in Kingston.

Water Demand

Table 1-13 below outlines the water demand rates applied during the analysis and planning of water infrastructure. The recommended criteria is based on a review of historic flow data and municipalities of similar size.

Table 1-13 Water Demand Unit Rates for Residential, Industrial, Commercial and Institutional Land Use

LAND USE	AVERAGE DAY FLOW	MAXIMUM DAY FACTOR	PEAK HOUR FACTOR
Residential	350 L/cap/day	1.50	2.25 (1.5 times diurnal peak)
Medium Density Residential	350 L/cap/day		
Industrial	35 m^3/ha/day		
Commercial	28 m^3/ha/day		
Institutional	Varying scaling based on growth		

Fire Flows

A land use based fire flow approach for identifying Level of Service (LOS) was applied. Using zoning information from the City of Kingston Official Plan and the calculated fire flows for a representative sample of buildings within each land use type, the following fire flow LOS targets were used:

Table 1-14 Recommended Fire Flow Rate Based on Land Use

LAND USE TYPE	Fire Flow @ 139kPa (20psi)	
	L/min	L/s
Industrial	16,300	270
Institutional	10,600	175
Medium/High Density Residential	14,600	245
Commercial	14,400	240
Residential	6,500	110

It should be noted that the above noted targets are applied within the water model (most stringent target applied for multi-zoned nodes) to determine if there is a difference or gaps between the available capacity and the above noted targets. Some targets may not be achieved due to limitations of the existing system.

WASTEWATER FLOW GENERATION RATES

The following section outlines the flow generation criteria that will be applied during the analysis and planning of infrastructure in the City of Kingston for this Master Plan.

Wastewater generation patterns vary between municipalities. The variations are primarily influenced by the habits and characteristics of system users. Volume as well as diurnal patterns will tend to fluctuate depending on servicing requirements. Examples of these requirements include the size of the serviced population, type, and amount of industry present as well as condition of the infrastructure.

The MOE Design Guidelines for Sewage Works (MOE, 2008) have accounted for variations in flow generation by permitting acceptable ranges for design calculations. As a result of this flexibility, many municipalities in Ontario have set standard flow generation criteria for their jurisdiction. The set design flow is typically within the MOECC's accepted range, however, it is often based on the historical flows observed by the municipality.

A review of applicable regulations and design guidelines was completed. Where variations in parameters or guidelines are permitted, a review of design and servicing standards for municipalities of similar size has been completed.

Table 1-15 below outlines the technical design criteria used and the LOS applied during the analysis and planning of wastewater infrastructure in the City of Kingston for this Master Plan. It should be noted that the values presented in the table have been adjusted when loaded into the hydraulic model depending on land use type to better account for the fraction that makes it into the sewer. Details regarding the discount factor can be found in the Wastewater Hydraulic Modeling report.

Table 1-15 Wastewater Generation Unit Rates for Residential, Industrial, Commercial and Institutional Land Use

LAND USE	AVERAGE DAY FLOW	PEAKING FACTOR
Residential	350 L/cap/day	Adjusted during model validation and calibration to match observed field data
Commercial	28 m^3/ha/day	
Industrial	35 m^3/ha/day	
Business Park Industrial	49 L/employee/day	
Institutional	Case by case basis	

1.9 FLOW DEMAND/GENERATION

The anticipated development and growth in the City of Kingston was detailed in the "*Growth Scenario Report.*" This report used existing development applications along with background reports to estimate the amount and location of anticipated growth. These projections were used in conjunction with the recommended unit flow generation criteria outlined in the Design Criteria.

Table 1-16 Summary of Projected Development Units/Area

Note that the values in the table are incremental for each analysis year.

Land Use	Unit	2021	2026	2036	Full Build-out	Ultimate
Residential	Residential Units	4,928[1]	3,490[1]	5,070[1]	10,213[2]	30,608[3]
Off Campus Student Residential Growth	Students	1,194[4]	1,800[4]	4,341[4]	Scaled proportional to population increase.	
Industrial	Hectares	32.7[5]	49.9[5]	66.3[5]		
Industrial Business Park	Hectares	47.7[5]	76.5[5]	105.6[5]		
Commercial	Hectares	16.3[6]	18.5[6]	24.3[6]		
Institutional	Historic flow is scaled based on anticipated growth by institution[7]					

Notes:
1 – Table 3-1 Growth Scenario Report
2 – Table 3-5 Growth Scenario Report
3 – Table 3-6 Growth Scenario Report
4 – Table 6-6 Growth Scenario Report
5 – Table 4-1 Growth Scenario Report
6 – Table 5-1 Growth Scenario Report (converted to *ha* assuming 25% lot coverage Commercial Inventory and Market Analysis City of Kingston, ON 2008)
7 – Section 6 Growth Scenario Report details the demand per unit of development.

1.9.1 PROJECTED WATER DEMAND

Table 1-17 details the water flow demand per unit of development. The data presented in these tables is incremental and not cumulative.

Table 1-17 Projected Water Demand Increase

Note that the values in the table are incremental for each analysis year.

Land Use	Unit Flow Demand	2021 Flow (L/s)	2026 Flow (L/s)	2036 Flow (L/s)	Full Build-out Flow (L/s)	Ultimate Flow (L/s)
Residential	350 L/cap/day	46.53[1]	33.69[1]	47.45[1]	95.50	286.42
Off Campus Student Residential Growth	350 L/cap/day	7.67	6.42	13.05	0	0
Industrial	35 m^3/ha/day	13.27	6.97	7.13	5.71	0
Industrial Business Park	49 L/cap/day	0.49[2]	0.29[2]	0.30[2]		0
Commercial	28 m^3/ha/day	5.27	6.01	7.89	11.86	0
Institutional	Scaled Historical Flow	11.86	14.89	16.55	17.49	0
Total	**L/s**	**85.09**	**68.27**	**92.37**	**130.56**	**286.42**
	m^3/day	**7,352**	**5,899**	**7,981**	**11,280**	**24,747**

Notes:
1 – Residential densities of 2.36, 2.33, 2.33, 2.31, 2.31, 2.31 people per unit were used, respectively, over the scenarios
2 – 18 employees per ha of business park industrial (from Employment Land Strategy Review, Watson & Associates 2015)

Using the information presented in the table above along with the recommended demand multipliers, historic meter data, and development projections, the following is a summary of the anticipated total demand in each zone:

Table 1-18 Total Water Demand Projections

	EXISTING	2021	2026	2036	FULL BUILD-OUT	ULTIMATE
	(M^3/D)					
Kingston West- Total						
Future ICI+ Residential ADD [1]	0	3,722	2,446	1,856	7,241	11,886
Total Average Day Flow	**20,135**	**23,857**	**26,303**	**28,158**	**35,399**	**47,285**
Total Max Day Flow	30,202	35,785	39,454	42,238	53,099	70,928
Total Peak Hour Flow	45,303	53,678	59,181	63,357	79,649	106,392
Kingston West & Central - Zone 1						
Future ICI+ Residential ADD [1]	0	4,063	2,969	6,649	9,501	0

	EXISTING	2021	2026	2036	FULL BUILD-OUT	ULTIMATE
	(M^3/D)					
Total Average Day Flow	**55,020**	**59,083**	**62,051**	**68,700**	**78,201**	**78,201**
Total Max Day Flow	82,530	88,624	93,077	103,050	117,301	117,301
Total Peak Hour Flow	123,795	132,936	139,615	154,575	175,952	175,952
Kingston West - Zone 2						
Future ICI+ Residential ADD [1]	0	2,787	2,124	602	1,294	11,886
Total Average Day Flow	**7,778**	**10,565**	**12,688**	**13,291**	**14,584**	**26,470**
Total Max Day Flow	11,667	15,847	19,033	19,936	21,876	39,705
Total Peak Hour Flow	17,500	23,771	28,549	29,904	32,814	59,557
Kingston East - Zone 3						
Future ICI+ Residential ADD [1]	0	529	830	730	487	12,861
Total Average Day Flow	**5,434**	**5,962**	**6,792**	**7,522**	**8,009**	**20,869**
Total Max Day Flow	8,150	8,944	10,188	11,283	12,013	31,304
Total Peak Hour Flow	12,225	13,415	15,283	16,924	18,020	46,956
City of Kingston						
Future ICI+ Residential ADD [1]	0	7,379	5,922	7,981	11,281	24,746
Total Average Day Flow	**68,231**	**75,609**	**81,531**	**89,512**	**100,793**	**125,539**
Total Max Day Flow	102,346	113,414	122,297	134,268	151,190	188,309
Total Peak Hour Flow	153,519	170,121	183,446	201,402	226,784	282,464

1 – Values are incremental
2 - Future ICI + Residential flow vary slightly from calculated flows due to loading and rounding procedures - within 0.4%.

1.9.2 WASTEWATER PROJECTED FLOW GENERATION

Table 1-19 details the wastewater flow generation per unit of development. The data presented in these tables is incremental and not cumulative. It is assumed that not all water demand (from water meter data) discharges directly into the sanitary sewer. A demand adjustment factor was used to account for this assumption. It may be assumed that in general a range of around 60-80% of the total drinking water volume distributed and used by consumer's transfers to sanitary sewers. This accounts for the difference between water flow generation and wastewater flow generation.

Table 1-19 Projected Wastewater Generation Increase

Land Use	Unit Flow Generation	2021 Flow (L/s)	2026 Flow (L/s)	2036 Flow (L/s)	Full Build-out Flow (L/s)	Ultimate Flow (L/s)
Residential	350 L/cap/day	36.73[1]	26.01[1]	38.28[1]	78.36	229.14
Off Campus Student Residential Growth	350 L/cap/day	6.14	5.14	10.44	0	0
Industrial	35 m3/ha/day	11.27	6.97	8.13	4.77	0
Industrial Business Park	49 L/cap/day	0.36[2]	0.22[2]	0.23[2]		0
Commercial	28 m3/ha/day	4.21	4.81	6.31	9.48	0
Institutional	Scaled Historical Flow	9.49	11.89	13.24	20.41	0
Infiltration	Applied to development parcels > 2ha	45.31	46.33	39.2	44.05	174.66
Total	**L/s**	**113.61**	**101.37**	**116.13**	**157.07**	**403.80**
	m3/day	**9,816**	**8,758**	**10,034**	**13,571**	**34,888**

Notes:
1 – Residential densities of 2.36, 2.33, 2.33, 2.31 people per unit were used, respectively, over the scenarios
2 – 18 employees per ha of business park industrial (from Employment Land Strategy Review, Watson & Associates 2015)

Table 1-20 Wastewater Flow Generation Projections

Land Use	Unit Flow Generation	2021 Flow (L/s)	2026 Flow (L/s)	2036 Flow (L/s)	Full Build-out Flow (L/s)	Ultimate Flow (L/s)
Kingston West Cataraqui Bay WWTP	Development Flow[1]	42.74	32.52	19.45	64.03	110.06
	Base Infiltration[1&2]	36.75	37.41	31.14	37.81	70.37
Sub-Total	**L/s[3]**	**79.49**	**149.42**	**200.01**	**301.85**	**482.28**
Kingston Central East Ravensview WWTP	Development Flow[1]	25.09	22.18	56.29	44.29	119.08
	Base Infiltration[1&2]	9.03	9.26	9.25	10.94	104.29
Sub-Total	**L/s[3]**	**34.12**	**65.56**	**131.1**	**186.33**	**409.7**
Total	**L/s[3]**	**113.61**	**214.98**	**331.11**	**488.18**	**891.98**
	m^3/day [3]	**9,816**	**18,574**	**28,608**	**42,179**	**77,067**

Notes:
1 - Values are incremental
2 – Applied to development parcels > 2ha
3 – Values are cumulative

2 VOLUME 2 – WATER GAP ANALYSIS AND ALTERNATIVE SOLUTIONS

2.1 FORWARD

The following chapter details the condition assessment, gap analysis and alternatives analysis and review for the water system in the City of Kingston. The intent of Volume 2 – Water Gap Analysis and Alternative Solutions is to provide a consolidation of the work completed for the *"Condition Assessment Report – Water," "Gap Analysis – Water,*" and "*Alternative Analysis and Review – Water.*" Refer to the previously mentioned reports for further details.

2.2 CONDITION ASSESSMENT

An integral part of Water Master Plan was to conduct a condition assessment to give an overview of all Utilities Kingston owned and operated facilities. The objective of the condition assessment was to gain an understanding of the facilities that form part of the City's water system and evaluate each facilities importance to the system, its overall condition and establish a reliability rating for each facility.

2.2.1.1 FIELD ASSESSMENT

A high-level Field Assessment was completed for all of the facilities. Each facility was divided into the following asset categories.

- Civil / Site Conditions
- Structural
- Process Piping and Equipment
- Instrumentation
- Process and Building Electrical
- Building Mechanical

The categories were populated with all of the major components that make up the facility. The field assessment included a high-level visual inspection of these components as well as recording information provided by Utilities Kingston operators regarding daily facility operation and historic maintenance issues. Each major component was scored on its Risk Level, Effective Life, and Condition Rating.

2.2.1.2 RELIABILITY RATING

The "Reliability Rating" provides a concise indicator identifying the overall condition and criticality of the different facilities. The indicator helps determine repair, rehabilitation and replacement needs of the facilities to develop a proper strategy for the phasing of the expenditures. An understanding of the risk of facility failure and its impact to the systems operation will facilitate scheduling prioritization and optimize capital expenditures based on risk.

A formula based approach using background information and data gathered during field work was used to calculate the Reliability Rating for each facility:

Reliability Rating = Total Facility Risk (A) x Total Equipment Risk (B) x Total Condition Rating (C)

- The Facility Risk (A) involved a review of each facility – the type of customer, the quantity of customers and the outcome if any that a failure could cause to customers' health, property, and safety as well as to the environment of the surrounding area. The evaluation was split into 4 categories: Customer Type, Number of Customers, Risk to Public, and Environmental Impact.
- The Equipment Risk (B) is the risk of failure of the equipment at each facility. The evaluation was split into 4 categories, considering: the Criticality of the Equipment, the Probability of Failure, the Overall Risk and the Effective Life remaining of each asset.
- The Condition Rating (C) was established and recorded for each asset during the Field Assessments. The Condition Rating was scored between 1 (Poor) and 5 (Excellent), for the condition of the component as deemed by the WSP engineer taking into account any comments made by Utilities Kingston staff. These findings were used to calculate the Total Condition Rating.

Once all data was recorded in the Risk Assessment sheet the Reliability Rating was calculated for all facilities. The Reliability Rating allows all facilities to be compared with the Overall Rating (A, B, C, D, E) established. Table 2-1 below outlines the Overall Rating used to determine the timeframe for any recommended intervention.

Table 2-1 Description of Overall Rating and Reliability Rating Scores

Overall Rating	Reliability Rating	Description
A	**0 - 5**	No action required.
B	**6 – 10**	Minor repairs may be required to non-critical components. Review required, but no work required immediately.
C	**11 - 40**	Certain Assets/Equipment may need replacing in the future. Review and plan maintenance.
D	**41 – 99**	Certain Assets/Equipment may need replacing in the immediate future, and review is required to outline maintenance.
E	**100 – 125**	Immediate action required to prevent failure and minimize impact to customers.

2.2.2 RESULTS

Table 2-2 below summarizes the Total Condition Rating, Total Facility, Equipment Risk and Overall Rating for the Water Facilities.

Table 2-2 Total Facility Risk, Total Equipment Risk, Total Condition Rating and Overall Rating for Water Infrastructure

Pumping Station Name	Total Facility Risk - A	Total Equipment Risk - B	Total Condition Rating - C	Overall Rating
Innovation Dr. EST	3.4	1.8	1.0	**B**
O'Connor Dr. Res/BS	3.7	1.8	1.0	**B**

Pumping Station Name	Total Facility Risk - A	Total Equipment Risk - B	Total Condition Rating - C	Overall Rating
Forest Dr. Standpipe	2.4	2.2	1.3	**B**
Creekford Rd. EST	3.8	1.8	1.0	**B**
Progress Ave. Res/BS	2.9	2.7	1.5	**C**
Old Colony Rd. BS	3.7	2.2	1.4	**C**
Purdy's BS (Sydenham Rd)	2.9	2.4	1.7	**C**
O'Connor Drive EST	3.8	2.4	1.5	**C**
James St BS	3.7	2.4	1.7	**C**
Third Ave. Res/BS	2.9	3.0	2.3	**C**
Tower St. EST	3.8	2.7	2.1	**C**
Collins Bay Rd. BS	2.2	PS currently not in use - See comments under section 7.3.1 of Condition Assessment Report - Water		

Legend

Total Facility Risk	1.0 - 2.0	2.1 - 3.5	3.6 - 5.0
Total Equipment Risk	1.0 - 2.0	2.1 - 3.5	3.6 - 5.0
Total Condition Rating	1.0 - 2.0	2.1 - 3.5	3.6 - 5.0
Overall Rating	A	B /C	D

Refer to the "*Condition Assessment Report – Water*," for further details the Condition Assessment methodology and results.

2.3 GAP ANALYSIS – WATER

Following the Condition Assessment, the operation of the existing system was analyzed through the application of a Hydraulic Model. The analysis applied the six development scenarios and the resulting increase in water demand. The hydraulic model included all of the existing infrastructure as well as select upgrades based on Imminent projects. Imminent projects are those which Utilities Kingston is currently in the process of implementing and are assumed to come online during various development scenarios. The table below provides a summary of the anticipated projects and identifies what scenario year they are assumed to be online. The results from the hydraulic model were compared to a desired level of service (LOS) which was developed by reviewing relevant standards and regulations as well as municipalities of similar size. The desired level of service is summarized in the table below. Full details regarding the development of the level of service can be found in the *"Gap Analysis – Water."*

Table 2-3 Planned Capital Projects and Infrastructure Upgrades (Water)

Scenario	Description
2015 (Interconnected)	→ Point Pleasant WTP Upgrades → Interconnection at Bath Rd. and Princess St. open. → Cataraqui Woods Dr. from Princess St. to Bayridge Dr.

Scenario	Description
2021	→ Front Rd. Watermain Interconnection (1050 mm) → CFB Kingston EST decommissioning → James St. Booster Station Phase 1 Upgrades Gatwick Ave. from Kendal Ave. to Creekford Rd. (300 mm) → Centennial Dr. to Resource Rd. (400 mm) → Cataraqui Woods Dr. from Centennial Dr. to Sydenham Rd.(400 mm) → Augusta Dr. from Atkinson to Cataraqui Woods Dr. (400 mm) → John Counter Blvd. from Indian Rd. to Princess St. (400 mm) → Pipe/Junction Additions for New Developments
2026	→ Pipe/Junction Additions for New Developments
2036	→ Pipe/Junction Additions for New Developments
Full Build-Out	→ Pipe/Junction Additions for New Developments
Ultimate	→ Pipe/Junction Additions for New Developments

2.3.1 MODELING

An all-pipe model of the system including pipes, key hydrants, storage tanks and system water sources was developed using INFOWATER hydraulic modeling software. This model was updated based on information provided by Utilities Kingston to reflect current system conditions. The construction, loading, and calibration of this model are documented separately in the: "*Hydraulic Modeling Report – Water.*"

2.3.2 FACILITY GAPS

2.3.2.1 WATER TREATMENT

The City of Kingston is supplied by three water treatment plants, King Street, Point Pleasant and Cana WTP. It has been indicated that the Cana WTP has no plans for growth; however, there is significant growth planned within the main distribution system, and therefore the treatment capacity has not been reviewed for the future scenarios. Beyond 2015, the west and central zones are interconnected. For this reason, the WTPs are not reviewed individually as the water can flow freely from one side to the other and are instead reviewed from a City-wide perspective. Water supply data from 2010 to 2014 was reviewed to determine historic water demands in the system. The west, central and east represent approximately 29%, 64% and 7% respectively (ADD) of the total City demand.

To meet the required LOS, Water Treatment Plants require that the capacity of the WTP should be greater or equal to the maximum day demand with an allowance for the required water for the treatment process. Additionally, WTPs should be designed for a minimum of 10 years (20 years preferred based on the MOE Guidelines). As such, the projected maximum day demands were compared to the rated capacity and the estimated functional capacity of the King St and Point Pleasant WTP to evaluate the LOS, as summarized in Table 2-4.

Table 2-4 Future Max Day Demand vs. Plant Capacity

	PLANT RATED CAPACITY (ML/D)	PLANT "FUNCTIONAL" CAPACITY (ML/D)	MDD (ML/D)	% OF "FUNCTIONAL" CAPACITY	FUNCTIONAL CAPACITY SURPLUS (ML/D)	LOS CRITERIA MET
2015 (Existing)						
Point Pleasant WTP (Ext)	45.5	41	30.20	**73.7%**	10.80	☑
Point Pleasant WTP (New)	90	80	30.20	**37.8%**	49.80	☑
King St. WTP	118	95	72.14	**75.9%**	22.86	☑
City of Kingston (Ext)	163.5	136	102.35	**75.3%**	33.65	☑
City of Kingston (New)	208	175	102.35	**58.5%**	72.65	☑
Cana WTP	0.11	0.10	0.04	**40.0%**	0.06	☑
2015 (Interconnected)						
City of Kingston (New)	208	175	102.35	**58.5%**	72.65	☑
2021						
City of Kingston (New)	208	175	113.41	**64.8%**	61.59	☑
2026						
City of Kingston (New)	208	175	122.30	**69.9%**	52.70	☑
2036						
City of Kingston (New)	208	175	134.27	**76.7%**	40.73	☑
Full Build-out						
City of Kingston (New)	208	175	151.19	**86.4%**	23.81	☑
Ultimate						
City of Kingston (New)	208	175	188.31	**107.6%**	-13.31	☒

2.3.2.2 WATER STORAGE

Water Storage in a drinking water system is intended to provide a continuous supply of water to maintain system pressure and to reserve volume to meet critical water demands during fire flow and emergency conditions.

The MOE Drinking Water Guideline outlines the requirements of the required storage. The formula for calculating the required treated water storage in the distribution system is as follows:

$$Total\ Treated\ Water\ Storage\ Requirements = A + B + C$$

Where: A = Fire Storage
B = Functional Storage (25% of Max Day Demand)
C = Emergency Storage (25% of A+B)

Fire storage is the product of the maximum fire flow required in the system and the corresponding fire duration.

When the system can supply more than just the maximum day demand (but less than the peak demand), the fire storage requirements can be determined using the following formula:

$$A = (Peak\ Demand - Pumping\ Station\ Stand\ By\ Capacity) \times Fire\ Duration$$

Where: Peak demand is the greater of the peak hour demand and the maximum day plus fire demand.

Floating storage should be designed such that the elevation of the functional volume (B) is able to maintain a minimum pressure of 275 kPa (40 psi) in the system under peak hour flow conditions. The fire (A) and emergency (C) volumes should be at elevations that sustain 275 kPa (40 psi) during peak hour demand conditions, and 140 kPa (20 psi) under the maximum day plus fire flow condition (MOE, 2008).

The LOS for storage must satisfy the calculated storage for Fire (A), Functional (B) and Emergency (C) requirements. Where fire storage can be reduced by the firm pumping capacity in the zone; based on the greater of the Peak Hour Demand (PHD) and the Maximum Day Demand (MDD) plus fire flow as described in the MOE Design Guidelines.

The total storage requirements for the City of Kingston were compared to the total existing storage tank volumes (Table 2-5 below). Based on the current configuration there is sufficient total storage to meet the minimum requirements in all pressure zones. However, there is a deficiency of functional storage in the central zone. Once the system is interconnected and the Point Pleasant WTP upgrade is complete, there will be sufficient capacity to meet the minimum LOS required for both the total and functional storage.

The CFB Kingston EST is owned by the Department of National Defence (DND) and is located within their property. DND has indicated that due to life cycle age and maintenance, they would like the CFB Kingston EST decommissioned if it is no longer required. It has been indicated that the CFB Kingston EST will be decommissioned by 2021 and therefore this storage has been removed from the available storage. The storage requirements were compared to the revised storage capacities with CFB EST offline.

Table 2-5 2015 (Interconnected) Total Water Storage Surplus/Deficiency

		ZONE 1	ZONE 2	ZONE 3	TOTAL
Total Available Storage	m^3	47,260	14,844	8,170	70,274
Functional Storage	m^3	24,550	7,100	1,700	33,350
2021					
Total Required Storage	m^3	27,695	6,627	4,557	35,442
Required Functional Storage	m^3	22,156	3,962	2,236	28,354
Total Surplus	**m^3**	**19,565**	**8,217**	**3,613**	**34,832**
Functional Surplus	**m^3**	**2,394**	**3,138**	**(536)**	**4,996**
2026					
Total Required Storage	m^3	29,086	8,677	5,221	38,218
Required Functional Storage	m^3	23,269	4,758	2,547	30,574
Total Surplus	**m^3**	**18,174**	**6,167**	**2,949**	**32,056**
Functional Surplus	**m^3**	**1,281**	**2,342**	**(847)**	**2,776**
2036					
Total Required Storage	m^3	32,203	8,548	5,869	41,959
Required Functional Storage	m^3	25,762	4,984	2,821	33,567
Total Surplus	**m^3**	**15,057**	**6,296**	**2,301**	**28,315**
Functional Surplus	**m^3**	**(1,212)**	**2,116**	**(1,121)**	**(217)**
Full Build-out					
Total Required Storage	m^3	36,656	10,178	6,873	47,247
Required Functional Storage	m^3	29,325	5,469	3,003	37,798
Total Surplus	**m^3**	**10,604**	**4,666**	**1,297**	**23,027**
Functional Surplus	**m^3**	**(4,775)**	**1,631**	**(1,303)**	**(4,448)**
Ultimate					
Total Required Storage	m^3	36,656	22,826	19,124	62,367
Required Functional Storage	m^3	29,325	9,926	7,826	47,078
Total Surplus	**m^3**	**10,604**	**(7,982)**	**(10,954)**	**7,907**
Functional Surplus	**m^3**	**(4,775)**	**(2,826)**	**(6,126)**	**(13,727)**

It can be seen from the table above that there is a functional deficiency in the East system from 2021 continuing through 2026. There is also a functional deficiency in Zone 1, the East and the City as a whole starting in 2036 through to the Ultimate.

2.3.2.3 BOOSTER STATIONS

Booster stations must be able to meet the following criteria in order to satisfy the required LOS which is based on the available floating storage. It should be noted that high lift pumps are also considered in the booster station capacity as they also provide system capacity. Based on the MOE Guidelines the following criteria are applied:

- If Sufficient Floating Storage Exists
  - For each pressure district provide maximum day demands.
  - For each pressure district provide sufficient standby power for the pump capacity equal to the average day demand rate.
- If Insufficient Floating Storage Exists
  - For each pressure district provide peak hour or maximum day plus fire demands (whichever are greater).
  - For each pressure district provide full standby power.

The table below compares the firm and stand-by capacities to the MDD and ADD, respectively. Additionally, the existing and interconnected system are also compared based on the MDD and ADD.

Table 2-6 Future Max Day Demand vs. Boosting Capacity

	ADD (ML/D)	MDD (ML/D)	SUFFICIENT FLOATING STORAGE	FIRM CAPACITY	MDD OF FIRM CAPACITY	STAND-BY CAPACITY	ADD OF STAND-BY CAPACITY	LOS CRITERIA MET
2015 (Existing)								
Kingston West Zone 1A	12.36	18.54	☑	51.89	**35.72%**	49.12	**25.16%**	☑
Kingston West Zone 2	7.78	11.67	☑	39.03	**29.89%**	35.42	**21.96%**	☑
Kingston Central Zone 1B	42.66	63.99	☑	126.60	**50.55%**	122.87	**34.72%**	☑
Kingston East Zone 3	5.43	8.15	☑	33.18	**24.57%**	33.18	**16.38%**	☑
2015 (Interconnected)								
Kingston West & Central Zone 1	68.23	102.35	☑	217.49	**37.95%**	210.99	**26.08%**	☑
Kingston West Zone 2	7.78	11.67	☑	39.03	**29.89%**	35.42	**21.96%**	☑
Kingston East Zone 3	5.43	8.15	☑	33.18	**24.57%**	33.18	**16.38%**	☑
2021								
Kingston West & Central Zone 1	59.08	88.62	☑	217.49	**40.75%**	210.99	**28.00%**	☑
Kingston West Zone 2	10.56	15.85	☑	39.03	**40.61%**	35.42	**29.82%**	☑

	ADD (ML/D)	MDD (ML/D)	SUFFICIENT FLOATING STORAGE	FIRM CAPACITY	MDD OF FIRM CAPACITY	STAND-BY CAPACITY	ADD OF STAND-BY CAPACITY	LOS CRITERIA MET
Kingston East Zone 3	5.96	8.94	☑	14.69	**60.89%**	14.69	**40.59%**	☑
2026								
Kingston West & Central Zone 1	62.05	93.08	☑	217.49	**42.80%**	210.99	**29.41%**	☑
Kingston West Zone 2	12.69	19.03	☑	39.03	**48.77%**	35.42	**35.82%**	☑
Kingston East Zone 3	6.79	10.19	☑	14.69	**69.37%**	14.69	**46.24%**	☑
2036								
Kingston West & Central Zone 1	68.70	103.05	☑	217.49	**47.38%**	210.99	**32.56%**	☑
Kingston West Zone 2	13.29	19.94	☑	39.03	**51.08%**	35.42	**37.52%**	☑
Kingston East Zone 3	7.52	11.28	☑	14.69	**76.82%**	14.69	**51.21%**	☑
Full Build-out								
Kingston West & Central Zone 1	78.20	117.30	☑	217.49	**53.93%**	210.99	**37.06%**	☑
Kingston West Zone 2	14.58	21.88	☑	39.03	**56.05%**	35.42	**41.17%**	☑
Kingston East Zone 3	8.01	12.01	☑	14.69	**81.79%**	14.69	**54.53%**	☑
Ultimate								
Kingston West & Central Zone 1	78.20	117.30	☑	217.49	**53.93%**	210.99	**37.06%**	☑
Kingston West Zone 2	26.47	39.70	☑	39.03	**101.74%**	35.42	**74.72%**	☒
Kingston East Zone 3	20.87	31.30	☑	14.69	**213.13%**	14.69	**142.08%**	☒

It can be seen from the table above that the LOS for each of the pressure zones has been met under all scenarios except the Ultimate scenario. The Ultimate scenario is primarily used for contrast to the 2015 - 2036 with regards to potential upgrades. Therefore, as the 2015 – 2036 scenarios meet the pumping and boosting LOS, boosting capacity upgrades are not needed at this time.

2.3.3 DISTRIBUTION GAPS

2.3.3.1 PRESSURES

The minimum and maximum pressures in the distribution system were observed under minimum day, average day and peak hour demand for each scenario. Based on the system modeling, maps showing pressures at nodes are presented in the *"Gap Analysis – Water."*

Pressures throughout the system are generally within the range prescribed (40 – 100 psi). Some areas of exceptions have been noted in the different scenarios and demand alternatives and are reviewed below:

- An area near the Third Avenue Reservoir and Tower Street Tower experiences pressures between 37 and 39 psi. The available pressure improves between the 2015 existing condition and the 2015 interconnection and then marginally decreases between 2015 interconnect and 2036. These low pressures are due to the higher elevations in the area which correspond to pressures of about 39 psi during static (zero-flow) conditions with the Tower St. Tower at overflow elevations (i.e. it is not possible to achieve a 40 psi service pressure based on operating levels).
- An area near the O'Connor Reservoir and O'Conner St. experiences some pressures slightly below 40 psi. The 2015 interconnect had some marginal effect on the area, and the remaining scenarios also had little change. Some of this area is a reservoir fill line without service connections which can be left as is.
- An area near the intersection of Bayridge Drive and Taylor Kidd Boulevard in Zone 1 experiences some pressures below 40 psi (33 – 39 psi). This area had little variation between the 2015 interconnect scenario and ultimate.
- An area south-west of the intersection of Montreal Street and Highway 401 also saw some pressures below 40 psi in each scenario. This area is at the highest-elevation and farthest reach of Zone 1. The pressures are only a few psi below 40.
- Some high pressures (<105 psi) were observed in the Bayridge area near Mona Dr. and Malvern Tr., largely due to the topography of the area (low-lying). This was consistent throughout the scenarios.
- Some high pressures (<109 psi) were observed around the James Street Booster Station largely due to the topography of the area (low-lying). This was relatively consistent throughout the scenarios and demand alternatives.
- During the 2021 scenario, the control parameters change due to the removal of the CFB Tower and therefore James Street Booster Station is controlled by the Innovation Drive Tower. Due to this change and in order to fill the tower, pressures above 100psi are seen along the Highway15 corridor and diminish as the demand increases between demand alternatives and scenarios.

2.3.3.2 FIRE FLOWS

An assessment of the available fire flows was conducted using the hydraulic model. The model revealed that flows meet current fire flow standards in most areas within the City of Kingston, except along some small diameter watermains, in poorly looped areas and other isolated districts throughout the system. Older watermains smaller than 150 mm often do not have capacity to deliver fire flows to meet current standards. These watermains were designed and constructed using standards that are different than those applied today. There are also small areas throughout the distribution system in each scenario that do not meet current fire flow standards. The identified gaps include the following areas: Westbrook area, Princess Street between Woodhaven Drive and Bayridge Drive, an area near Elmwood, Sydenham Road north of Hwy 401, Dalton Avenue, Balsam Grove and Calvin Park.

2.3.3.3 LEAKAGE

The City of Kingston has been performing a comprehensive water balance study for many years. The tables below provide a summary of the water balance results for the City of Kingston system as a whole, and for three subsystems, West, Central and East in year the 2014. The tables are a snapshot of the water balance details.

Table 2-7 City of Kingston 2014 Water Balance Summary

KINGSTON DRINKING WATER SYSTEM WATER BALANCE 2014 (m3)					Dec-2014
Net Water to System 24,904,204 100%	Authorized Consumption 13,808,565 55.45%	Billed Authorized Consumption 13,808,565 54.83%	Billed Metered Consumption 13,655,690 54.83%		Revenue Water 13,655,690 54.83%
			Billed Unmetered Consumption Unknown		
		Unbilled Authorized Consumption 152,875 0.61%	Unbilled Metered Consumption		Non-Revenue Water 11,248,514 45.17%
			Mains New & Relined (Utilities Kingston)	49,531	
			Watchdog Meters (Non-System)	19	
			Unbilled Unmetered Consumption		
			Water Facility Equipment	6,031	
			Fire Department	1984	
			Flow Testing	36,932	
			Flushing	52,678	
			Hydrant Maintenance	3,457	
			Mains New & Relined (Utilities Kingston)	0	
			New Mains (Development)	1,014	
			Private Hydrants	1,229	
			152,875	0.61%	
	Total Water Loses 11,095,639 44.55%	Apparent Losses 560,693.19 2.25%	Unauthorized Consumption	62,261	
			Meter Inaccuracies	464,293	
			Data Handling Errors	34,139	
			560,693.19	2.25%	
		Known Real Losses 4,706,338 18.90%	Estimated Loss - Known Main Breaks 3,813,416	15.31%	
			Estimated Loss - Known Service Leaks 892,921	3.59%	
		Unknown Losses 5,828,608 23.40%	5,828,608	23.40%	

While there is no specific design criteria or LOS to meet, a strategic analysis of the leakage based on other municipalities' leakage rates can potentially help improve the amount of water currently lost to leakage.

2.3.3.4 ENERGY EFFICIENCY

Energy efficiency includes the pumps' electrical and hydraulic (combined) efficiency; number of pump starts per day, time-of-use electrical rates (night-time pumping); the piping system's head losses (including facility and yard piping) and what fraction of water storage is elevated or in-ground (requiring re-pumping). As long as the LOS is met, optimization of the system can be revised to maximize efficiency to lower operating costs. Specific energy efficiency measures from the simulations have been discussed in the "Hydraulic Modeling Report - Water", and the "Alternatives Analysis and Review -Water" report since energy reviews are a 'check' on the proposed alternative.

2.3.3.5 RELIABILITY AND RESILIENCY

Reliability refers to the system's ability to handle routine upsets such as pipe breaks or planned maintenance to pumps or storages, for example. Resiliency refers to the ability to recover from major upsets such as the loss of components with long replacement lead times (e.g. rail or river crossings) or the upset of complex processes such as water quality that may take days or a week to fully restore (e.g. boil water advisory).

2.4 ALTERNATIVE SOLUTIONS

Water distribution networks are complex and intricately connected systems. In many cases, changes, operational or physical, can have an influence on system performance out to the furthest reaches of the distribution system. Alternatives have been developed based on the infrastructure deficiencies identified in the "*Gap Analysis Report - Water*." Results from the 2036 scenario were used as the primary scenario for planned improvements and upgrades for the infrastructure, with the full build-out scenario serving as a check and balance for the recommended upgrades. The results from the 2021 and 2026 scenarios were used to identify the timing and urgency of the upgrades. The ultimate scenario has been primarily used to develop an overall strategy to help guide the servicing of these development areas with the analysis identifying high-level servicing recommendations. Infrastructure that provides a source of energy and volume to the system is used as a starting point for the evaluation; this infrastructure includes booster stations and storage tanks. Pressure, flow, headloss, leakage and available fire flow in the distribution phase are then reviewed. Discussions regarding the developed alternatives has been divided up into the various pressure zones which make up the distribution network:

1. Zone 1
2. Zone 2
3. Zone 3, 3a and 3b

Refer to Figure 1-3: Existing Water Servicing System

2.5 EVALUATION OF ALTERNATIVES OF WATER INFRASTRUCTURE

The evaluation of alternatives to resolve the identified gaps in the infrastructure was completed using the approach outlined in the "*Alternative Analysis and Review – Water*," and Section 1.4 of this report. As previously detailed rather than using a numerical or weighted ranking system, the evaluation focuses instead on the strengths and weaknesses of each servicing alternative to identify the preferred alternative. For each evaluation criterion and for each system alternative, the potential impact to the natural, social,

cultural, technical and economic criteria was identified and evaluated relative to the other alternatives as being most preferred, less preferred and least preferred.

2.5.1 FACILITIES EAST ZONE (PRESSURE ZONE 3A, 3B AND 3C)

In the East system, the primary deficiency that was observed was a functional storage deficiency developing in 2021 which occurs once the CFB Kingston EST is taken offline. By 2036 the functional storage deficiency is projected to reach 1,121 m^3 increasing from 536 m^3 and 847 m^3 in 2021 and 2026 respectively. The observed storage deficiency is partially a result of the operation of the system. Innovation Dr. EST has an elevation which does not permit its full use based on the tanks construction and the topography of the pressure zone. In order to avoid over pressurizing the system to fill the EST, the maximum fill level in the EST is reduced. If the full storage capacity in Innovation EST is used, it is suspected that the functional storage deficiency can be corrected. However, increasing the hydraulic grade line (HGL) will likely result in a high pressure south of Gore Road where the topography is lower and higher pressures are currently observed. In addition to the storage deficiency, Utilities Kingston staff have also noted operational issues with Forest Drive stand pipe which includes water quality issues and freezing. Several alternatives to correct these issues have been evaluated and are listed below. In addition to these three alternatives, consideration was given to installing a new watermain across the proposed Third Crossing (Alternative 2). This alternative was not short listed due to required increase in complexity to the system as well as the additional infrastructure which would otherwise not be required.

ALTERNATIVE 1 – OPTIMIZE INNOVATION DRIVE ELEVATED STORAGE AND FOREST DRIVE STAND PIPE HYDRAULIC GRADE LINE

This alternative involves adjusting the water level in Innovation Dr. EST and Forest Dr. stand pipe to maximize the available storage in Zone 3 while ensuring that high pressures do not develop in low-lying areas. Some of the service areas have elevations as low as 81.00m. It is undesirable to have pressures exceeding 100 psi at nodes in the distribution system. Under static conditions, this would permit the elevation in the tower to have a maximum HGL of 151.28m without causing over pressure in the system. However, this does not account for the head loss that needs to be overcome in order to fill the tower.

From the results, described in "*Alternative Analysis and Review – Water,"* it can be concluded that Innovation Dr. EST, when used to its full potential can address the functional storage deficiency projected for 2036 of 1,121m^3. However, filling the EST to this elevation does cause areas of concern due to high-pressure west of Highway 15 between Medley Court and Gore Road.

ALTERNATIVE 2 – NEW PRESSURE ZONE AT GORE ROAD

Alternative 2 involves isolating the area north of Gore Road into a new pressure zone (Zone 4). A new booster station would be required to pump the water into Zone 4 either from Zone 3 or from a new feed across the proposed Third Crossing (from Zone 1). Innovation EST would serve as the storage for this zone and would be isolated from Zone 3. In this configuration, Innovation EST would be significantly oversized for the population and business served in Zone 4. This isolation would also create a larger storage deficiency in Zone 3, resulting in the requirement for a new storage tank to be added to Zone 3. With the addition of storage in Zone 3, the functional storage deficiency can be addressed, and the system can be operated similarly to its current operation with the CFB Kingston EST. Adding a pressure zone, a booster station, and an EST would result in increased complexity to the system as well as significant capital and operational cost. Based on the above this alternative was not reviewed further as it did not provide a reasonable solution to address the problem.

ALTERNATIVE 3 – NEW SUBZONE NEAR GORE ROAD

Alternative 3 builds on observations made during the analysis of Alternative 1. Alternative 3 involves increasing the HGL in Innovation Dr. EST to make full use of its available storage and creating a subzone to isolate the identified high-pressure area in the existing pressure zone. This area will be isolated with the use of three PRVs and by isolating several local connections. In addition to the PRVs, a new 500 mm watermain will be required to extend through the subzone along Highway 15, starting north of Wellington Street extending north to Gore Road. This new main will by-pass the subzone to continue providing flow and pressure to the area north of Gore Road. Adjusting the operational levels in Innovation Dr. EST increases the functional storage to 3,177 m^3 which resolves the projected deficiency in 2036. The hydraulic model was used to evaluate the impacts of the increased HGL on the pressure zone and sub-zone. The increased HGL does increase the overall pressure in the zone. However, through the implementation of the new subzone, the available pressure in the low-lying area south of Gore Road is restricted to levels consistent with the MOE guidelines. Flows and pressures during Average Day, Min Day, Peak Hour and Fire Flow are all within the desired level of service.

Recommendation

Based on the evaluation in "Alternative Analysis and Review – Water" it is recommended that Alternative 3 be implemented. The other two alternatives fail to satisfy the technical requirements. Alternative 3 provides the best long-term solution to ensure a satisfactory level of service. Additionally, with the City of Kingston currently in the planning stages to complete a widening along a significant section of the watermain alignment proposed in Alternative 3, there is potential for significant cost savings to implement this project if the two projects can be completed concurrently.

ALTERNATIVE 4 – DECOMMISSION FOREST DRIVE STAND PIPE

Alternative 4 considers the decommissioning of Forest Drive standpipe with the implementation of Alternative 3. Forest Drive stand pipe is an older storage facility built in 1981 which currently has operational limitations, including water quality issues and ice damage due to its configuration. Forest Drive currently provides 200 m^3 of functional storage and 1,770 m^3 of total storage. Innovation Dr. EST has sufficient storage to replace the operational volume lost through decommissioning Forest Drive and there is also sufficient surplus total storage to permit its decommissioning based on required storage volumes in 2036.

The hydraulic model was used to evaluate the impact of decommissioning Forest Drive stand pipe on the hydraulic performance of the distribution system. It was found that there were limited changes to LOS during Average Day, Peak Hour and Min Hour upon decommissioning of Forest Drive. However, there was a notable change in the available fire flow at the far eastern extent of the distribution system as well as various other locations in the east system.

Forest Drive was concluded to provide other benefits to the system aside from storage. The facility is located near the eastern extent of the distribution system which is serviced by a single feed along Highway 2. Currently in the event of a pipe break on the single feed, water can still be supplied from Forest Drive stand pipe. If it were decommissioned this redundancy and reliability would be lost and the eastern extent of the system would be without pressure and water. Overall decommissioning the Forest Dr. stand pipe would result in a reduced level of service for users and was not recommended.

2.5.2 FACILITIES CENTRAL & WEST ZONE (PRESSURE ZONE 1)

There were two observations made for the central zone in the Gap Report. The first being that there is an excess of total storage and boosting capacity in the zone and the second being that a functional storage deficiency develops by 2036. Reducing the amount of excess storage can have benefits to the system by

reducing operational and maintenance costs, however, it can also reduce the operational flexibility for the zone. The alternatives presented below aim to reduce the excess total storage and increase the functional storage in the pressure zones. One or more alternatives may be selected to optimize the operation and available storage in the zone.

ALTERNATIVE 1 – ADJUST OPERATIONAL LEVELS IN THIRD AVENUE RESERVOIR

Growth and development are projected to cause a short fall of 1,212 m^3 of functional storage in Zone 1 by 2036. Third Avenue Reservoir has a capacity of 22,700 m^3 and is currently operated with a functional storage of 13,000 m^3. The reservoir has an approximate cross-sectional area of 3,900 m^2. Typical operational levels in the reservoir range from 2.2 m to 5.6 m. By increasing the range of operation by 0.5 m the functional storage deficiency in Zone 1 can be corrected. The typical operating range would be revised to 1.7 m - 5.6 m increasing the functional storage by approximately 2,000 m^3 to a total of 15,000 m^3. This alternative is able to correct the deficiency with virtually no external impact and was not reviewed further for this reason. Revising the operational levels is the preferred solution to correct the functional storage deficiency.

ALTERNATIVE 2 – DECOMMISSION SYDENHAM RD BOOSTER STATION AND OLD COLONY BOOSTER STATION TO REDUCE THE AMOUNT OF EXCESS BOOSTING CAPACITY

As a result of the excess boosting capacity that exists in Zone 2, alternatives to reduce the amount of boosting capacity were considered. Sydenham Rd. and Old Colony Booster Station were identified in the last Master Plan to be eliminated. Utilities Kingston has also indicated that these two stations are not suspected of providing significant benefit to the system. Eliminating these booster stations would reduce excess boosting capacity as well as operation and maintenance costs for the system.

Booster stations and storage are interconnected. Reducing the amount of boosting capacity reduces the excess storage and reducing the amount of storage reduces the amount of excess boosting capacity.

Overall, it was concluded that Old Colony and Purdy's Court booster stations provide minimal improvement to the redundancy and reliability of the system and corresponding pressure zone. There is ample storage and boosting capacity, and the overall service improvement provided to users is not significant. Eliminating these facilities will result in energy savings as well as operational and maintenance costs without negative impact to the level of service. The external impacts as a result of decommissioning these two facilities is minimal. It is recommended that this alternative be implemented.

Based on the observed system operation during the hydraulic simulations both of these facilities can be taken offline at any point to provide operational savings. Once they are taken offline, they can be decommissioned. It is recommended that this work be completed by 2021.

ALTERNATIVE 3 – REDUCE EXCESS STORAGE IN ZONE 1

Similar to Alternative 2, pressure Zone 1 has excess storage and boosting capacity. O'Connor EST and Progress Avenue Reservoir are two facilities which require capital improvements and present operational challenges. Alternative 3 was separated into "Alternative 3A - Decommission O'Conner Tower to Reduce the Volume of Excess Storage" and "Alternative 3B Decommission Progress Avenue to reduce the volume of excess storage."

O'Connor EST is a relatively small elevated storage tower; it has been reported that it does not meet current seismic standards and needs other upgrades. Utilities Kingston has noted that the tank fills and drains very quickly, making it difficult to operate. It is also prone to emptying during large breaks. Alternative 3A

considers decommissioning this tower to reduce operational and maintenance costs as well as reduce excess storage in the pressure zone.

Progress Avenue Reservoir has been identified by Utilities Kingston as a facility which has had structural issues. It currently requires roof repairs and structural crack repairs. Additionally, reservoirs are not the most efficient storage method with water being pumped up to the location/elevation of the reservoir and then all the energy is lost when it is dumped into the tank for storage.

Recommendation

Alternative 1, 2 and 3A were identified as the preferred alternatives to resolve the identified deficiencies. Old Colony and Sydenham Rd booster stations were identified to provide minimal benefit to the system and are also recommended to be decommissioned- which will provide operational cost savings. O'Connor EST is to be decommissioned, and a new PRV/PSV is to be installed at the former site of Old Colony Booster Station. This alternative makes the most efficient use of existing infrastructure and provides the most operational flexibility.

Based on the observed system operation during the hydraulic simulations, it is recommended that the PRV/PSV be installed at Old Colony Booster Station prior to the interconnection along Front Road. The interconnection is anticipated to be commissioned by 2018. The PRV/PSV can be commissioned once installed and will provide benefit to the system. Once the interconnection along Front Road is complete, O'Connor EST can be turned off and then decommissioned. Point Pleasant WTP should be re-configured to operate based on the elevation at Tower Street once O'Conner EST is turned off.

2.5.3 DISTRIBUTION SYSTEM (ALL ZONES)

2.5.3.1 IDENTIFIED HIGH AND LOW-PRESSURE ZONES

HIGH-PRESSURE SOUTH OF GORE ROAD

High pressures were noted between James Street Booster Station and south of Gore Road. The high-pressure condition currently exists and is suspected to be primarily a result of the lower topography in the area. This high-pressure issue is corrected through the creation of a subzone which was a previously evaluated alternative.

THIRD AVENUE RESERVOIR

The nodes in the low-pressure area around Third Avenue Reservoir was found to have pressures slightly below 40 psi under various demand scenarios. These results were supported by reviewing available hydrant tests in the area which had static results in a similar range. Although the current operating pressures in the area are lower than desired, there have not been any recorded complaints from users regarding pressure. The ground elevation in this area is higher than the surrounding area in the pressure zone which reduces the amount of available pressure based on the HGL of the pressure zone. Operating pressures below 40 psi are outside of the operating range recommended by the MOE. However, the design guidelines do recognize that there are cases where operating pressures may be dictated by system size and/or topography.

As there have not been complaints from systems users regarding pressure and the fire flows are currently within the desired level of service, the capital cost and the increased complexity of the system required currently outweigh the benefits of correcting the deficiency.

PRINCESS STREET AND FUTURES GATE – LOW PRESSURE

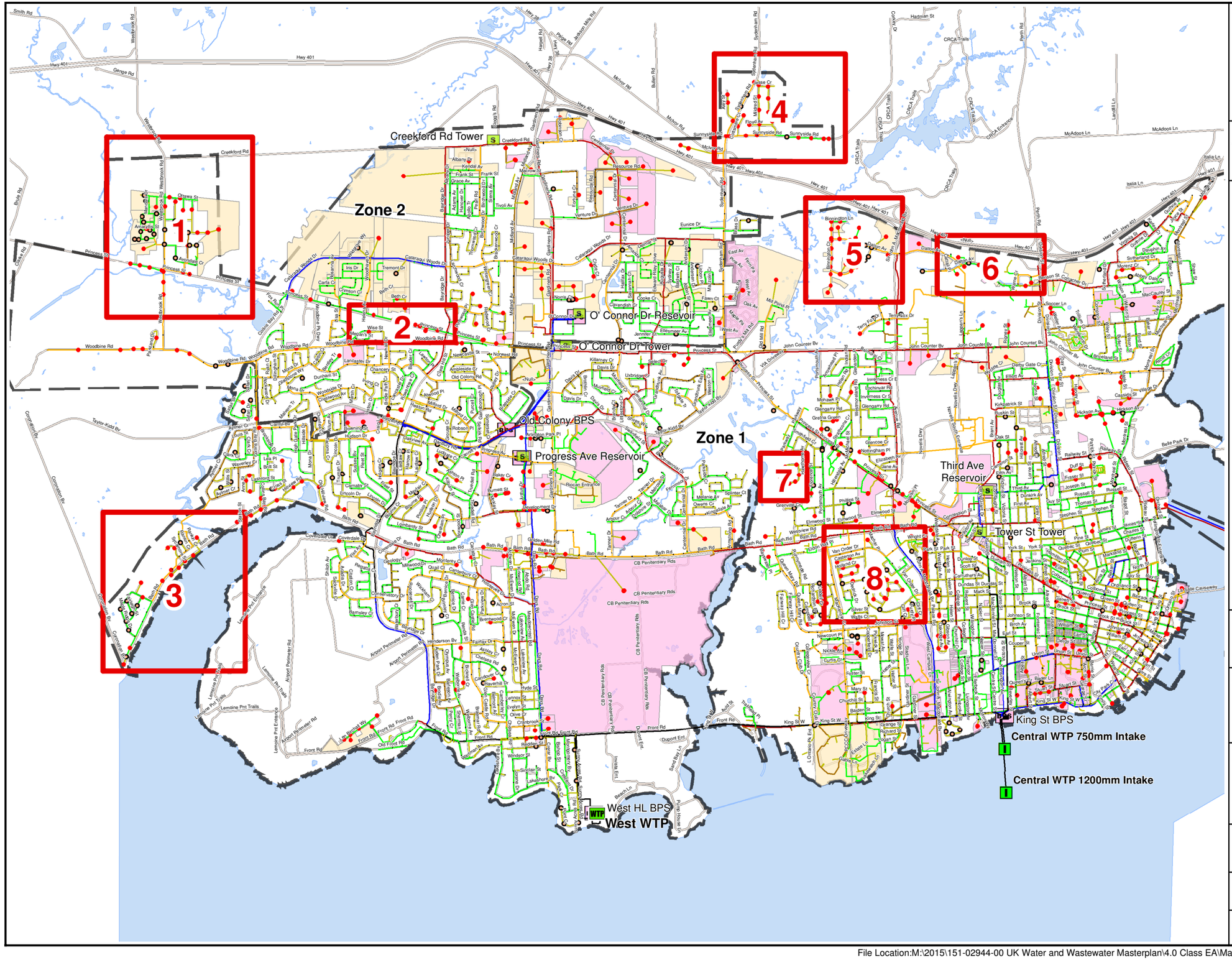
A low-pressure area was observed to develop near the intersection of Futures Gate and Princess Street extending south towards Uxbridge Crescent. This low-pressure area is resolved through the implementation of the PRV/PSV at the former Old Colony Road Booster Station upon its decommissioning.

BAYRIDGE AND TAYLOR KIDD – LOW PRESSURE

A low-pressure area was observed in the south-west corner of the intersection of Bayridge Drive and Taylor Kidd Boulevard. This low-pressure area is generally above the required 40 psi and generally only drops slightly below this threshold during peak times in the distribution system. Due to the proximity of this area to the Zone 2 boundary, it was considered to reconfigure the pipes to service this area from Zone 2. Modifying the existing watermain configuration would increase the pressure to this area, but would reduce the reliability and resiliency. Correcting isolated pressure deficiencies that occur only during isolated periods is less preferred than maintaining the current level of redundancy to the area.

2.5.3.2 IDENTIFIED FIRE FLOW GAPS AND ALTERNATIVES

There are various locations identified throughout the distribution system where fire flow can be improved. Some nodes which experience available fire flow below the desired level of service may be restricted by their elevation or the service configuration in that area of the distribution system. As detailed by the MOECC guidelines, water distribution systems should be designed to provide a balance between hydraulic water supply needs and water quality. In some instances, upgrades to improve fire flow may result in a decrease in water quality as a result of increased retention time and water age. Alternatives for fire flow improvements have been selected based on the density of nodes which do not meet the desired LOS for fire flows. Eight areas of interest were identified where alternatives for improvements were developed as shown on Figure 2-2



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Legend

- WTP — Water Treatment Plant (WTP)
- S — Storage Tank
- BPS — Booster Pumping Station (BPS)
- I — Raw Water Intake
- PressureZone
- Road
- Waterbody
- 2021-2026 Future Development
- 2036 Future Development

Fire Flow (Available) (L/s)

- <= 80 (Res) or 230 (ICI)
- < 100 (Res) or 270 (ICI)
- >= 100 (Res) or 270 (ICI)

Pipe: Diameter (mm)

- <= 150
- <= 200
- <= 250
- <= 300
- <= 450
- <= 600
- > 600

Scale: 0 500 1,000 1,500 m — 1:42,500

Project:
Water and Wastewater Master Plan
City of Kingston, Ontario

Title:
KINGSTON WATER SYSTEM-FIRE FLOW AVAILABILITY (ZONES 1 & 2)

Scenario:
2036 FUTURE (MDD+FF)

Project No.:	Date:
151-02944-00	DECEMBER 2016

Drawn By:	Checked By:	Code:	Figure No.:
HC	JLD	MP	2-1

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\4.0 Class EA\Master Plan Report\Maps\151-02944-00_Fig2-1.mxd

WESTBROOK (AREA 1)

Westbrook is an area which can benefit significantly from either of the following two alternatives:

- Alternative 1 – New feed along Princess Street.
- Alternative 2 – New feed along Creekford Road.

The hydraulic results from both scenarios are quite similar. Alternative 1 would involve extending a new watermain along Princess Street from Cataraqui Woods Drive west to Westbrook Road. This route is along a main arterial road and crosses an environmentally protected area. Alternative 2 involves extending a new watermain from Bayridge Drive west along Creekford Road to Westbrook Road. This route is significantly longer than the Princess Street route but needs to cross a smaller environmentally protected area. The evaluation of these two alternatives can be found in "*Alternative Analysis and Review – Water."*

Based on the evaluation, the preferred alternative is to provide servicing along Creekford Road. Although the capital cost is expected to be slightly higher, this alternative provides the least construction risk, the lowest impact to the natural and social environment and the most flexible servicing alternatives for future development. Given the improvement to fire flow, as well as the impact to reliability and resiliency, it is recommended that this project be completed by 2026.

PRINCESS STREET BETWEEN WOODHAVEN DRIVE AND BAYRIDGE DRIVE (AREA 2)

Two alternatives were considered to correct this area; one upsized the main along Princess Street while the other considered looping Holden with Cataraqui Woods Drive. Holden is a new development which is in the process of being built out. Looping through Holden Street with a 300 mm watermain is a technically suitable alternative which has no external impact to implement and improves looping of the system. The alternative to increase the size along Princess Street is not considered further. This work should be completed concurrently with the development of the residential subdivision.

ELMWOOD (AREA 3)

Extending a new 300 mm watermain along Bath Road was the first alternative considered to improve fire flow in this area. Based on the results of the hydraulic simulation this improvement will provide very minimal improvement to the area and would be difficult to construct. The second improvement that was considered was to loop Lower Drive to Bath Road with a 150 mm watermain approximately 70m long. This looping provided significant improvement to the available fire flow along Lower Drive and is recommended to be implemented. Given the short length of the watermain and relatively low capital cost, it is recommended to be implemented by 2021.

SYDENHAM ROAD NORTH OF HIGHWAY 401 (AREA 4)

The alternative considered to improve fire flow to this area was to twin the existing 300 mm watermain. Additional crossings of Highway 401 are cost prohibitive, technically difficult and have associated construction risk. The model results for the simulated alternative indicate that twinning this pipe will have very minimal impact to fire flows in the area. Based on the lack of performance improvement it is not recommended to be implemented. There are limited opportunities for flow improvement in this area without providing significantly upsized distribution pipes which can have a negative impact on water age/quality as a result of the increased volume stored in the distribution mains.

DALTON AVENUE (AREA 5)

Two alternatives were considered to improve the fire flows to this area; one involved twinning the feed and the other involved increasing the pipe size along Dalton Avenue between Sir John A. MacDonald Boulevard and Grant Timmins Drive. Both alternatives have similar technical results improving the fire flow to this area. Twinning the feed would be the preferred alternative for two reasons, it improves the redundancy and reliability to this area which is currently only serviced by one watermain, and the existing pipe is relatively new with no history of breaks. Given the age of the industrial park and the relative benefit, it is recommended that this be implemented by 2036.

DALTON AVENUE (AREA 6)

The existing 200 mm watermain which extends from Division Street to Don Street on Dalton Avenue was suspected to be the cause of the low fire flows in the area. Fire Flow was re-evaluated with this section watermain replaced with a 300 mm pipe. Replacing this pipe provided a notable improvement to the fire flows in the area. Replacement of the pipe is preferred to twinning as the pipe is old and has a significant history of breaks. As a result of the poor condition of the watermain and its improvement of fire flows, it is recommended that this pipe be replaced. Given the age of the industrial park and the relative benefit, it is recommended that this be implemented by 2026.

BALSAM GROVE (AREA 7)

Balsam Grove is a residential area serviced by a single watermain and experiences low fire flows. To the west, there is an unopened Right-of-Way which has a sanitary sewer extending through it. A new watermain was extended along this ROW south to Queen Mary Road to see if this would improve the fire flows. Extending a new pipe along the ROW is preferred to twinning or upsizing the feed into the subdivision as it improves redundancy and reliability, there is a sewer project which is required through the same corridor, and there is no history of breaks on the existing watermain. From the hydraulic simulation, it was concluded that this would improve the fire flow and is recommended to be implemented. Given the area of improvement and the scale of the capital project, it is recommended to be implemented prior to 2036.

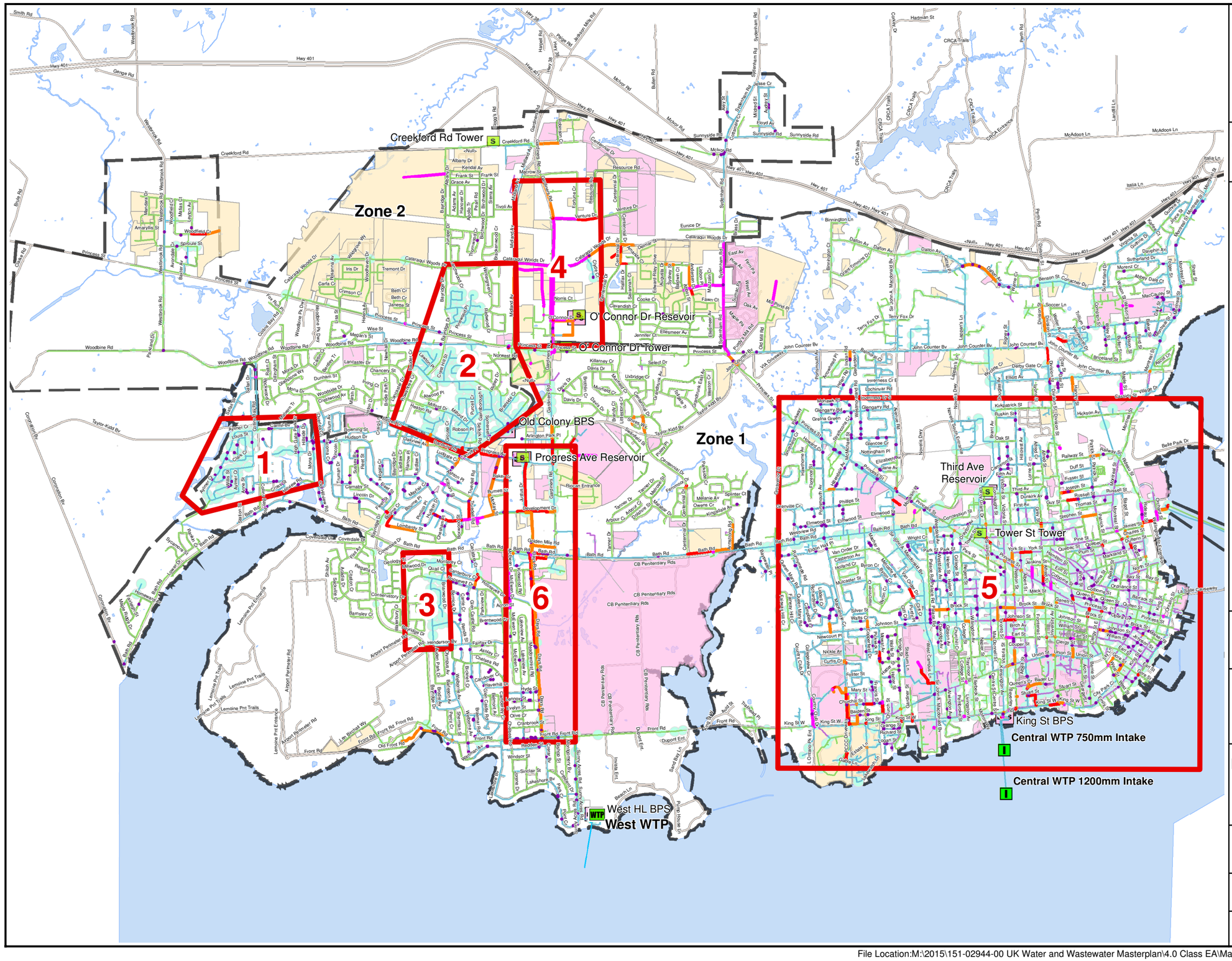
CALVIN PARK (AREA 8)

Calvin Park is another residential area with fire flows lower than the desired level of service. The improvements considered to improve the fire flow in this area included upsizing the watermain along Norman Rogers Drive to a 300 mm dia. as well as looping through three easements to Norman Rogers. The three loops are located at Herchmer Drive, Holland Crescent out to Norman Rogers Drive, Michael Grass Crescent to Van Order Drive. Norman Rogers is recommended to be upsized as it was recently lined in 2009 and is still suspected to be restricting available fire flow. The results from the hydraulic simulation indicate that these improvements will provide a notable improvement to the fire flow in the area and are recommended to be implemented. Given the short length of the watermain and relatively low capital cost, it is recommended that the looping to be implemented by 2021. The upsize along Norman Rogers Drive is recommended to be implemented by 2026.

2.5.3.3 LEAKAGE AND HEAD LOSS IMPROVEMENTS

Maintaining a reasonable amount of head loss in the distribution system is a balance between managing the amount of required energy input into the system, the energy gradient across the pressure zone and ensuring the resulting volume stored in the distribution pipes does not cause water quality/age issues. The figure on the following page illustrates pipe age, leakage and pipe head loss throughout the distribution system. The map emphasizes leakage rates above the average in the distribution system and head loss which exceeds 3m/ km of pipe. In various locations in the distribution system it can be observed that leakage

is suspected to be an issue while the head loss has not been flagged. These areas would be good candidates for rehabilitation methods. There are other areas which have significant leakage and various pipes flagged due to head loss. In these areas ‘C’ factors should be confirmed, and a pipe size increases may be warranted depending on the findings. These areas can been see below in Figure 2-2.



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Legend

- WTP Water Treatment Plant (WTP)
- S Storage Tank
- BPS Booster Pumping Station (BPS)
- I Raw Water Intake
- PressureZone
- Road
- Waterbody
- 2021-2026 Future Development
- 2036 Future Development
- Water Main Breaks

Pipe: Headloss Gradient (m/km)

- 0.000000 - 2.000000
- 2.000001 - 3.000000
- 3.000001 - 5.000000
- 5.000001 - 100.000000

Pipe Age

- 1900-1940
- 1941-1980
- 1981-2015

Leakage

- > 0.066 L/s
- > 0.044 L/s
- > 0.022 L/s
- >= 0 L/s

Scale:
0 500 1,000 1,500 m
1:42,500

Project:
Water and Wastewater Master Plan
City of Kingston, Ontario

Title:
KINGSTON WATER SYSTEM - PIPE HEADLOSS AND LEAKAGE (ZONES 1 & 2)

Scenario:
2036 FUTURE (PEAK HOUR)

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
Drawn By:	Checked By:	Code:	Map No.:
STR	MS	MP	2-2

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LAWRENCE AND BALMORAL PARK (AREA 1)

Pipes in this area were installed in the 1970's, are suspected to be experiencing leakage above the average and have experienced a number of breaks in the past. This area does not have any pipes identified with high head loss. This area would be a good candidate for rehabilitation as it is not anticipated that pipe size will need to be increased. It is recommended that leakage studies be completed in this area to confirm leakage rates prior to rehabilitation.

OLD COLONY PARK (AREA 2)

Area 2 has pipes installed in the 1980's, has conditions similar to Area 1, high leakage, older pipes and no pipes with high head loss, however, there has been significantly fewer pipe breaks. Given the observations, this area would be a good candidate for rehabilitation in an attempt to remedy leakage. It is recommended that leakage studies be completed in this area to confirm leakage rates prior to rehabilitation.

HENDERSON PLACE (AREA 3)

Pipes in area 3 were installed in the 1970's and are suspected to be experiencing significant leakage. There are no pipes which are experiencing significant head loss, however, there has been a number of pipe breaks in the area. This area is not expected to require pipe size increases and would be a good candidate for rehabilitation. It is recommended that leakage studies be completed in this area to confirm leakage rates prior to rehabilitation.

GARDINERS ROAD (AREA 4)

There are two 400 mm pipes extending north of O'Connor Reservoir on Gardiners Road to Cataraqui Woods Drive and a single feed extending north beyond Cataraqui Woods Drive to Venture Drive. These pipes experience head loss in excess of 5m/ km during periods of peak demand. The pipe on the west side of Gardiners Road was installed in 2009, and the pipe on the east which extends up to Venture Drive was installed in 1978. As these pipes are experiencing high head loss, it is recommended that the older pipe be replaced. Increasing the east pipe to a 600 mm from a 400 mm will re-distribute the flow to permit both of the pipes to experience less than 2m/ km of head loss during peak periods. It is recommended that this pipe upsize extend along Gardiners Road up to Venture Drive.

At Venture Drive there is a pipe extending east to Fortune Crescent which experiences head loss in excess of 5m/ km. This is a short section of pipe which feeds an area that is relatively well looped. Increasing this pipe size would result in limited improvement to the distribution system while the costs to upsize the pipe would be significant as it would require reconstruction of the road. Based on the limited impact this pipe has on the area; should the street be reconstructed it may be worthwhile to upsize the pipe. However it is not worth reconstructing the street to upsize the pipe for the limited benefit.

The main on Cataraqui Woods Drive between Clyde Court and Midland Avenue experiences significant head loss, upsizing this pipe to a 500 mm through these limits would reduce the head loss experienced during periods of peak demand and permit this watermain to operate below 2m/ km of head loss. It is recommended that this section of watermain be replaced.

DOWNTOWN (AREA 5)

In Area 5 it can be observed that there is significant leakage throughout with high head loss being observed at various locations in the area. The pipes in the area vary in age with some expected to be in excess of 100yrs. As this is the oldest part of the City and there is significant social and cultural effects to completing this work, no specific areas have been identified, but additional investigation can be completed and then work

can be coordinated with other projects in these areas. Some of these pipes may be good candidates for rehabilitation while others should be upsized. In the area, it is recommended that testing be completed to verify pipe roughness and a pipe size increase should be considered based on the results of the testing. It is also recommended that leakage studies be completed in this area to confirm leakage rates prior to rehabilitation or replacement.

DAYS ROAD (AREA 6)

There are two pipes of interest in this area. One is a 600 mm dia. transmission main providing large volumes of water to the distribution system and 250 mm pipe which provides local distribution to the adjacent subdivision. The 250 mm pipe has been recently lined. Updating this pipe to have a roughness coefficient which is more consistent with a lined pipe the head loss drops below 2 m/ km during peak periods making this pipe no longer a concern. Reviewing the head loss experienced by the 600 mm pipe over the course of the day reveals that the majority of the time the pipe is operating below the 2m/ km which is within an acceptable range for a transmission main. No further recommendations are suggested for this area.

HIGHWAY 15 (AREA 7)

The watermain which extends through this area along Highway 15 experiences high head loss, however, based on the recommended alternative above there will be an additional 500 mm pipe extending though this area which will relieve the high head loss experienced by this pipe. No further upgrade is required.

The table below summarizes the findings of the seven areas discussed above and the associated timing recommendations.

Table 2-8 Recommended Leakage and Headloss Improvements

AREA	YEAR OBSERVED	UPGRADE RECOMMENDED	OBJECTIVE
Lawrence and Balmoral Park (Area 1)	2015	Leakage Study	Reduce Leakage
Old Colony Park (Area 2)	2015	Leakage Study	Reduce Leakage
Henderson Place (Area 3)	2015	Leakage Study	Reduce Leakage
Gardiners Road (Area 4)	2015	Pipe replacement. Recommended to be completed prior to 2036.	Reduce Head loss
Downtown (Area 5)	2015	Leakage Study/ Condition / Coefficient Testing	Reduce Head loss / Reduce Leakage
Days Road (Area 6)	2036	Do Nothing	-

Highway 15 (Area 7)	2021	Addressed through implementation of the new subzone in Zone 3.	Reduce Head loss

2.6 RELIABILITY AND RESILIENCY

Reliability refers to the system's ability to handle routine upsets such as pipe breaks or planned maintenance to pumps or storage. Resiliency refers to the ability to recover from major upsets such as the loss of components with long replacement lead times or the upset of complex processes. The level of redundancy becomes progressively more important as the complexity of the equipment, and the quantity of water handled increases. The following sections review to guidance with respect to resiliency and reliability improvements.

2.6.1 DISTRIBUTION NETWORK LOOPING

In a pressurized system, one of the most important aspects to maximize reliability and resiliency is to provide looping of the distribution network. Looping provides multiple flow paths which can improve the hydraulic efficiency of the system particularly during fire flows as well as permit sections of the network to be isolated during a pipe break or other failure, minimizing service outages to users.

There are several areas of the distribution system which are currently serviced by a single pipe. Some examples include:

- Westbrook Road
- Southwest limit of water system along Bath Road
- Sunnyside Road (north of Highway 401 on Sydenham Road)
- East of CFB Kingston
- Highway 15 north of Gore Road

Westbrook Road and Highway 15 north of Gore Road will be corrected upon implementation of the preferred alternatives (New watermain along Creekford Rd and New Subzone in Zone 3) to other deficiencies noted in the system. Others were reviewed to identify improvements to fire flow. If redundancy is desired to be increased, a second distribution main is generally the most cost effective strategy compared to providing storage in the area.

2.6.2 STORAGE LOCATIONS & BACKFEEDING ZONES

Providing flow and pressure from multiple locations helps maintain the desired level of service in the distribution system during periods of high demand or facility failures. By not relying on one source of flow and pressure it significantly reduces the likelihood that a large pipe break or failure at a storage facility will cause a catastrophic deficiency in the system. Configuring the system to allow pressure zones to backfeed into zones of lower HGL is an effective way to accomplish this. This is commonly achieved by installing a combination pressure reducing and pressure sustaining valve at the boundary of the pressure zone. This valve is configured to maintain a constant downstream pressure and maintain a minimum upstream pressure regardless of demand. During periods of normal pressure the valve would be closed, when a decrease in

downstream pressure is detected the valve opens providing flow and pressure from the higher HGL to overcome the deficiency.

As indicated above a PRV/PSV is recommended to be installed to allow Zone 2 to backfeed Zone 1. This recommendation provides increased reliability to Zone 1. Completing this work between Zone 3 and Zone 1 could be completed but based on the increased reliability to Zone 1 and the configuration of Zone 1 to Zone 3 (i.e. 2 feeds) it is not recommended to install a PRV/PSV from Zone 3 to Zone 1.

2.7 SUMMARY OF RECOMMENDATIONS

The table below provides a brief summary of the recommended alternatives for the Kingston Water System.

Table 2-9 Summary of Recommended Water System Alternatives

INFRASTRUCTURE	OBSERVED GAP	RECOMMENDED ALTERNATIVE
East Storage	By 2026 1,121m^3 of functional storage is required to be added.	Install 3 PRV Chambers, 2 km of 500 mm Watermain, Isolation Valves to create a subzone in Zone 3 south of Gore Rd. (No reconstruction cost included - assumed to be coordinated with Hwy 15 widening). Adjust operational levels in Innovation Dr. EST once new subzone in Zone 3 is implemented.
Central Storage	By 2036 1,212m^3 of functional storage is required to be added.	Adjust operational levels in Third Ave. Reservoir to maximize its functional storage capacity.
Excess Total Storage in Zone 1	There is an excess of total storage available in Zone 1 once Zone 1 and 2 are interconnected.	Decommission Sydenham Rd. and Old Colony booster stations. Install a PRV/PSV at the former Old Colony BS. Decommission O'Connor EST once the Front Rd. interconnect is operational.
Low Pressure - Around Third Ave. Reservoir	The area near the Third Ave. Reservoir and Tower St. Tower had some pressures between 37 and 39 psi.	Continue to monitor
Low Pressure – Near Princess St. and Futures Gate	Low pressure is observed near the intersection of Princess St. and Futures Gate.	Corrected with PRV/PSV at former Sydenham BS
Low Pressure - Bayridge Dr. and Taylor Kidd Blvd	Pressure below 40psi is observed (33 – 39psi).	Continue to Monitor
High Pressure – Near James St. Booster Station	High pressures (<109psi) were seen around the James St. Booster Station largely due to the topography of the area.	Corrected though creation of subzone. See East Storage above.
Low Fire Flows in Westbrook Area	There are a cluster of nodes where the available fire flow is less than the required LOS.	Install 3.6 km of 300 mm watermain along Creekford Rd. to Westbrook Rd.
Low Fire Flows – Princess St. between Woodhaven Dr. and Bayridge Dr.	There are a cluster of nodes where the available fire flow is less than the required LOS.	Install 420m of 300 mm watermain to extend along Holden From Beth Cres. To Cataraqui Woods Dr.

INFRASTRUCTURE	OBSERVED GAP	RECOMMENDED ALTERNATIVE
Low Fire Flows - Area near Coronation Blvd.	There are a cluster of nodes where the available fire flow is less than the required LOS.	Install 70m of 200 mm dia. Watermain to loop between Lower Dr. and Bath Rd.
Low Fire Flows - Sydenham Rd. North of 401.	There are a cluster of nodes where the available fire flow is less than the required LOS.	Continue to monitor
Low Fire Flows - Dalton Ave. West of Sir. John A. Blvd.	There are a cluster of nodes where the available fire flow is less than the required LOS.	Twin watermain along Dalton Ave. between Sir John A. MacDonald Blvd. and Grant Timmins Dr. 300m.
Low Fire Flows - Dalton Ave. West of Division St.	There are a cluster of nodes where the available fire flow is less than the required LOS.	Replace 1 km of 300 mm Watermain on Dalton Ave. between Division St. to Don St.
Low Fire Flows - Balsam Grove	There are a cluster of nodes where the available fire flow is less than the required LOS.	Install 500m of 200 mm Watermain to loop Balsam Grove. Extend from Queen Mary Rd. to Sherwood Dr.
Low Fire Flows - Calvin Park	There are a cluster of nodes where the available fire flow is less than the required LOS.	New 150 mm watermain through easements to Norman Rogers Dr. located at Herchmer Dr. (75m), Holland Cr. (96m) out to Norman Rogers Dr., Michael Grass Cres. to Van Order Dr. (85m), Replace 1 km of 300 mm dia. watermain on Norman Rogers Dr. and Roden Rd. between Van Order Dr. and Johnson St.
Head loss above 3m/ km – Various locations	There are various pipes in the distribution system which experience high head loss.	Upsize Gardiners Rd. watermain (east) to a 500 mm - 1.2 km from O'Connor Reservoir to Fortune Cres. Upsize Cataraqui Woods Dr. watermain between Clyde Ct. and Midland Ave. to a 450 mm (900m). Conduct studies to verify pipe roughness.
Leakage – Various Locations	Leakage is experienced in various locations throughout the distribution system.	Conduct studies to verify leakage.
Reliability – Various locations	There are various areas in the distribution system serviced by a single feed.	Reliability was considered as an objective when evaluating alternatives. There were no critical reliability issues noted.

3 VOLUME 3 – WASTEWATER GAP ANALYSIS AND ALTERNATIVE SOLUTIONS

3.1 FORWARD

The following chapter details the condition assessment, gap analysis and alternatives analysis and review for the wastewater system in the City of Kingston. The intent of Volume 3 – Wastewater is to provide a consolidation of the work completed for the Condition Assessment Report, Gap Analysis Report, and Alternative Analysis and Review Report. Refer to the previously mentioned reports for further details.

3.2 CONDITION ASSESSMENT

An integral part of the Wastewater Master Plan Update was to conduct a condition assessment to give an overview of all Utilities Kingston owned and operated facilities. The objective of the Condition Assessment was to gain an understanding of the facilities that form part of the City's Wastewater system and evaluate each facilities importance to the system, its overall condition and establish a reliability rating for each facility.

3.2.1 FIELD ASSESSMENT

A high-level Field Assessment was completed for all of the facilities. Each facility was divided into the following asset categories.

- Civil / Site Conditions
- Structural
- Process Piping and Equipment
- Instrumentation
- Process and Building Electrical
- Building Mechanical

The categories were populated with all of the major components that make up the facility. The field assessment included a high-level visual inspection of these components as well as recording information provided by Utilities Kingston operators regarding daily facility operation and historic maintenance issues. Each major component was scored on its Risk Level, Equipment Risk, and Condition Rating.

The "Reliability Rating" provides a concise indicator identifying the overall condition and criticality of the different facilities. This indicator helps determine repair, rehabilitation and replacement needs of the facilities to develop a proper strategy for the phasing the work. An understanding of the risk of facility failure and its impact system to the system operation will facilitate scheduling prioritization and optimize capital expenditures based on risk.

A formula based approach using background information and data gathered during field work was used to calculate the Reliability Rating for each facility:

Reliability Rating = Total Facility Risk (A) x Total Equipment Risk (B) x Total Condition Rating (C)

- The Facility Risk (A) involved a review of each facility – the type of customer, the quantity of customers and the outcome if any that a failure could cause to customers' health, property, and safety as well as to the environment of the surrounding area. The evaluation was split into the 4 categories: Customer Type, Number of Customers, Risk to Public, and Environmental Impact.
- The Equipment Risk (B) is the risk of failure of the equipment at each facility. The evaluation was split into the 4 categories, considering: the Criticality of the Equipment, the Probability of Failure, the Overall Risk and the Effective Life remaining of each asset.
- The Condition Rating (C) was established and recorded for each asset during the Field Assessments. The Condition Rating was scored between 1 (Poor) and 5 (Excellent), for the condition of the component based on visual inspections taking into account any comments related to maintenance made by Utilities Kingston staff. These findings were used to calculate the Total Condition Rating.

Once all data was recorded in the Risk Assessment sheet the Reliability Rating was calculated for all facilities. The Reliability Rating allows all facilities to be compared with the Overall Rating (A, B, C, D, E) established. Table 3-1 below outlines the Overall Rating used to determine the timeframe for any recommended intervention.

Table 3-1 Description of Overall Rating and Reliability Rating Scores

OVERALL RATING	RELIABILITY RATING	DESCRIPTION
A	0 - 5	No action required
B	6 – 10	Minor repairs may be required to non-critical components. Review required, but no work required immediately.
C	11 - 40	Certain Assets/Equipment may need replacing in the future. Review and plan maintenance.
D	41 – 99	Certain Assets/Equipment may need replacing in the immediate future, and review is required to outline maintenance.
E	100 – 125	Immediate action required to prevent failure and minimize impact to customers.

3.2.2 RESULTS

Table 3-2 below provides a visual representation of how the Total Condition Rating, Total Facility and Equipment Risk influence the Overall Rating and shows where the capital budget should be prioritized to improve the system as a whole.

Table 3-2 Total Facility Risk, Total Equipment Risk, Total Condition Rating and Overall Rating for Wastewater Infrastructure

Pumping Station Name	Total Facility Risk - A	Total Equipment Risk - B	Total Condition Rating - C	Overall Rating
King-Lake Ontario Park PS	1.8	1.4	1.5	**A**
John Counter Boulevard PS	2.0	1.6	1.2	**A**
Hatter Street PS	1.8	1.5	1.6	**A**
Notch Hill Road PS	1.8	1.5	1.8	**A**
Morton Street PS	2.8	1.5	1.2	**A**
Coverdale PS	2.1	1.9	1.4	**B**
Bath Road PS	2.8	1.7	1.2	**B**
Yonge Street PS	1.9	1.7	1.8	**B**
King-Elevator Bay PS	2.0	1.9	1.6	**B**
Crerar Boulevard PS	2.9	1.5	1.4	**B**
King-Portsmouth PS	2.0	1.9	1.6	**B**
Kenwoods Circle PS	2.0	1.9	1.7	**B**
Bath-Lower PS	1.9	1.7	2.1	**B**
Westbrook PS	2.0	1.9	1.7	**B**
Palace Road PS	2.0	2.0	1.7	**B**
Rankin Crescent PS	2.0	2.2	1.6	**B**
Schooner Drive PS	2.0	2.0	1.8	**B**
Lakeshore Boulevard PS	2.5	1.9	1.6	**B**
Collins Bay PS	2.5	2.2	1.4	**B**
Bayridge PS	3.0	2.1	1.4	**B**
River Street PS	3.8	1.9	1.3	**B**
Highway 15	2.9	2.0	1.7	**B**
James Street PS	3.3	1.8	1.6	**B**
Bath-Collins Bay PS	2.8	2.1	1.7	**B**
Hillview Road PS	3.5	2.3	1.5	**C**
King Street PS	3.8	2.6	1.5	**C**
Dalton Avenue PS	4.3	2.3	1.5	**C**
Barrett Court PS	3.3	3.4	1.8	**C**
Days Road PS	4.8	3.8	2.5	**D**
Greenview Drive PS	2.1	PS currently being upgraded		

Legend

Total Facility Risk	1.0 - 2.0	2.1 - 3.5	3.6 - 5.0
Total Equipment Risk	1.0 - 2.0	2.1 - 3.5	3.6 - 5.0
Total Condition Rating	1.0 - 2.0	2.1 - 3.5	3.6 - 5.0
Overall Rating	A	B /C	D

The "*Condition Assessment Report – Wastewater,*" further discusses the condition assessment methodology and results.

3.3 GAP ANALYSIS - WASTEWATER

Following the Condition Assessment, the operation of the existing system was analyzed through the application of a hydraulic model. The analysis applied the six development scenarios and the estimated increase in wastewater generation to the existing system. The hydraulic model included all of the existing infrastructure as well as select upgrades based on Imminent projects. Imminent projects are those which Utilities Kingston is currently in the process of implementing and are assumed to come online during various development scenarios. The table below provides a summary of the anticipated projects and identifies what scenario year they are assumed to be online. The results from the hydraulic model were compared to a desired level of service (LOS) which was developed by reviewing relevant standards and regulations as well as municipalities of similar size. The desired level of service is summarized with the respective analysis below. Full details regarding the development of the LOS can be found in the Wastewater Gap Report.

Table 3-3 Planned Capital Projects and Infrastructure Upgrades (Wastewater)

Scenario	
2015	▪ West St. bypass (PCP#26) weir adjustment to 75.5m ▪ Permanent plugging of: → Queen St. CSO (PCP#15) → North/Wellington CSO (PCP#10) → Brock St. CSO (PCP#19, replace temporary plug with permanent) → Johnson St. CSO (PCP#21) → Lower Albert St. CSO (PCP#31) ▪ New weir across 900 mm overflow pipe on PCP#53 at Union/Division. Elevation TBD, approx. 88.0m
2021	▪ Portsmouth pumping station upgrades and forcemain redirected to Cataraqui Bay WWTP ▪ Pipe/junctions added for new developments ▪ Yonge St. sewer upsize (Johnson St. to Portsmouth PS) ▪ River St. PS forcemain twinning ▪ Alfred/Elm sewer upsize: sewer upsize (375 mm to 450 mm) on Alfred St. (Princess St. to Elm St.) and Elm St. (Alfred St. to Chatham St.) ▪ Hwy 15 trunk sewer upsize Gore Rd. to Grenadier Dr (0633-030 to 0631-030, to 450 mm) to be completed along with Hwy 15 widening ▪ Hwy 15 trunk sewer upsize to 525 mm (approx. 225m) from Wellington St. to Hwy 2 (12010-010 to 12051-010) ▪ Greenview PS upgrades ▪ Schooner Drive PS will be replaced with a new "Riverview PS" located in the quarry property. New 'Riverview PS' forcemain, from new pump station location near waterfront to Hwy15 trunk sewer roughly at 0636-010 ▪ Westbrook PS upgrades ▪ Combined sewer area reductions
2026 (*Committed)*	

Scenario	
	▪ Pipe/junction additions for new developments ▪ Combined sewer area reductions
2036	▪ Pipe/junction additions for new developments ▪ Combined sewer area reductions
Full Build-out	▪ Pipe/junction additions for new developments ▪ Combined sewer area reductions
Ultimate	▪ Pipe/junction additions for new developments ▪ Combined sewer area reductions

3.3.1 MODELING

A trunk model of the sanitary system including pipes, forcemains, maintenance holes, key pumping stations and other system infrastructure was developed using InfoSWMM hydraulic modeling software. This model was updated based on information provided by the City and Utilities Kingston to reflect current system conditions. The construction, loading and calibration of this model are documented separately in the: "*Hydraulic Modeling Report – Wastewater.*"

Simulations conducted in the gap analysis include dry-weather and wet-weather design storm analysis (for 1:2, 1:5, 1:10, 1:25, 1:50 and 1:100 year design storm events for Kingston). An extended-period CSO analysis was completed for a typical year of rainfall (2014 rainfall) and a wetter-then-average year of rainfall (2008 rainfall) was simulated for the months of April-October. The design storm analysis is used to evaluate the firm/peak capacities of pumping stations and the capacities of pipes including gravity sewers and forcemains. The CSO analysis is carried out to determine the severity of CSO's and SSO's as well as the total volumes of by-passes, the number of by-pass events and the duration of by-pass events.

3.3.2 LEVEL OF SERVICE

Table 3-4, summarizes the criteria used in evaluating the Level of Service for wastewater infrastructure. The LOS criteria was developed by reviewing relevant standards and regulations as well as design criteria for municipalities of similar size. The results from the hydraulic model were compared to this desired LOS. Full details regarding the development of the LOS can be found in the Wastewater Gap Report.

Table 3-4 Wastewater Level of Service

Gravity Sanitary Sewers	
Good	→ Hydraulic grade line (HGL) from the 100yr storm is more than 2m below the finished ground → Dry weather flow is less than the sewer capacity
Review	→ Hydraulic grade line (HGL) from the 25yr storm flows and larger, is within 2m of the finished ground → HGL from the 10yr storm flows and larger, is between 0.3m of the obvert of the pipe and 2m of the finished ground → Dry weather flows > 85% of the sewer capacity but < 99% of the sewer capacity
Gap	→ HGL from the 10yr storm flows and smaller, is within 2m of the finished ground → Cannot convey the dry weather flows without surcharging.
Pumping Facilities	

Good	→	Dry weather flows & 10yr storm flows are less than the pumping station's firm capacity[1]
Review	→	10yr storm flows are greater than the firm but less than the peak capacity[2]
Gap	→	10yr storm flows are greater than the pumping station peak capacity[2]
Forcemain Sanitary Sewers		
Good	→	Velocity in pipe is less than 2m/s
Review	→	Velocity in pipe is greater than 2m/s and less than 3m/s
Gap	→	Velocity in pipe is greater than 3m/s
Combined Sewer Overflow		
Gap	→	During a 7 month period starting within 15 days of April 1st, capture and treat 90% wet-weather volume (for an average year) above the dry weather flow. → Controlling over flow to not more than 2 events per season (June 1 – September 30) for an average year. → Combined total duration of CSO events at any one CSO location shall not exceed 48hrs. → An additional overflow event may be permitted provided that the PWQO for E.coli based on a geometric mean at beaches is not exceeded for 95% of the four month season between (June 1 – September 30).
Wastewater Treatment		
Good	→	Wastewater treatment plants rated average daily flow capacity ≥ average daily flows → Wastewater treatment plants rated peak flow capacity ≥ 10yr storm flows
Gap	→	The average daily flow capacity or peak flow capacity is exceeded

1. Firm Capacity – Largest Pump Out of Service
2. Peak Capacity – All Pumps in Operation

3.3.3 WASTEWATER SYSTEM GAPS

Using the results from the hydraulic model, gaps in the infrastructure were identified based on the required level of service. The infrastructure being analyzed includes gravity sewers, pumping facilities, forcemains, combined sewer overflows and wastewater treatment plants.

3.3.3.1 GRAVITY SEWERS

Table 3-5 illustrates the resulting LOS for each flow scenario with the resulting gaps identified with the hydraulic modeling results displayed. The level of service provided is displayed as follows: Green – Good, Yellow – Review, and Red – Gap. The text represents the condition that resulted in a change from a 'Good' LOS to a 'Review' LOS. For example, a cell that is yellow in colour with a '25-yr' indicates that the sewer has a 'Review' LOS and the last scenario that the LOS was 'Good' was during the 25yr storm condition.

Table 3-5 Wastewater Gravity Sewer Level of Service

	Catchment Properties			HGL Existing Conditions	HGL 2021 Conditions	HGL 2026 Conditions	HGL 2036 Conditions	HGL Build-out Conditions	HGL Ultimate Conditions
	Development in Catchment Area	Under influence of Combined Sewers	Known Issues	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS
North Harbourfront	YES	YES	NO	2-yr	2-yr	2-yr	5-yr	25-yr	25-yr
Harbourfront Trunk	YES	YES	NO	Dry	Dry	Dry	Dry	5-yr	5-yr
Harbourfront Trunk Twin	YES	YES	NO	Dry	Dry	Dry	Dry	2-yr	2-yr
King St. Trunk	YES	YES	NO	2-yr	5-yr	5-yr	5-yr	100-yr	100-yr
Charles St. Collector	YES	YES	NO	2-yr	10-yr	10-yr	50-yr	100-yr	100-yr
Collingwood Collector	YES	YES	YES	50-yr	50-yr	50-yr	50-yr	50-yr	50-yr
George Collector	YES	YES	YES	100-yr	100-yr	100-yr	100-yr	100-yr	100-yr
Rideau St. Collector	YES	YES	NO	10-yr	10-yr	10-yr	10-yr	100-yr	100-yr
Rideau Heights	YES	Yes	NO	2-yr	5-yr	10-yr	10-yr	25-yr	25-yr
North End Outlet	YES	YES	NO	50-yr	50-yr	50-yr	50-yr	50-yr	50-yr
North End Trunk	YES	NO	YES	10-yr	10-yr	10-yr	10-yr	10-yr	10-yr
King St. West Collector	YES	NO	NO	50-yr	50-yr	50-yr	50-yr	50-yr	50-yr

	Catchment Properties			HGL Existing Conditions	HGL 2021 Conditions	HGL 2026 Conditions	HGL 2036 Conditions	HGL Build-out Conditions	HGL Ultimate Conditions
	Development in Catchment Area	Under influence of Combined Sewers	Known Issues	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS
Coverdale Outlet Trunk Sewer	NO	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Days Rd Inlet Trunk	YES	NO	YES	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Front Rd Trunk	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Bath Rd Collector	YES	NO	NO	**25-yr**	**25-yr**	**25-yr**	**25-yr**	**5-yr**	**5-yr**
Collins Bay Collector	YES	NO	NO	**100-yr**	**100-yr**	**10-yr**	**10-yr**	**10-yr**	**Dry**
Crerar Collector	NO	NO	YES	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Crossfield Ave Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Halifax Dr Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
High Gate Park Dr Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Lakeshore Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
McEwen Dr Collector	YES	NO	YES	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
McEwen Dr Collector Diversion	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**

	Catchment Properties			HGL Existing Conditions	HGL 2021 Conditions	HGL 2026 Conditions	HGL 2036 Conditions	HGL Build-out Conditions	HGL Ultimate Conditions
	Development in Catchment Area	Under influence of Combined Sewers	Known Issues	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS	Sewer LOS
McKay St. Diversion	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Midland Ave Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
North Central Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
North East Collector	YES	NO	YES	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
North West Collector	YES	NO	NO	**50-yr**	**25-yr**	**10-yr**	**10-yr**	**10-yr**	**10-yr**
Princess-Bayridge Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Redwood Cres Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**
Sprucewood Cres Collector	YES	NO	NO	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**	**100-yr**

The following observations can be made from the tables presented above:

- The central collection system experiences significant gaps during wet-weather events larger than the 2 year return storm. These gaps are often a result of the large combined sewer areas which form part of the central collection system. It should be noted that these gaps are a result of an effort to minimize combined sewer overflows by maximizing storage in the system.
- Sewers that experience an improvement in the LOS is a result of the continued separation of combined sewers.

It is noted that there may be other areas of concern that will be reviewed in the alternatives as a result of bottlenecks or backwater effects being eliminated.

3.3.3.2 PUMPING FACILITY GAPS

Table 3-6 illustrates the resulting level of service for each flow scenario with the resulting gaps identified with the hydraulic modeling results displayed. The level of service provided is displayed as follows: Green – Good, Yellow – Review, and Red – Gap. The text represents the condition that resulted in a change from a 'Good' LOS to a 'Review' LOS. For example, a cell that is yellow in colour with a '25-yr' indicates that the PS has a 'Review' LOS and the last scenario that the LOS was 'Good' was during the 25yr storm condition.

Table 3-6 Wastewater Pumping Facility Level of Service

	Catchment Properties			Existing	2021	2026	2036	Full Build-out	Ultimate
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Station LOS	Station LOS	Station LOS	Station LOS	Station LOS	Station LOS
King St.[2]	YES	YES	YES	DRY	DRY	DRY	DRY	DRY	DRY
River St.[3]	YES	YES	YES	DRY	DRY	DRY	DRY	DRY	DRY
Bath Rd.	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Bath – Collins Bay[+]	NO	NO	NO	2-YR	2-YR	2-YR	2-YR	2-YR	2-YR
Bath – Lower	NO	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Bayridge Dr.	YES	NO	NO	100-YR	50-YR	50-YR	50-YR	10-YR	10-YR
Collins Bay Rd.	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Coverdale Dr.	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Crerar Blvd.	NO	NO	YES	DRY	2-YR	5-YR	5-YR	5-YR	5-YR
Days Rd.	YES	NO	YES	10-YR	5-YR	2-YR	2-YR	2-YR	DRY
Hillview Rd.	YES	NO	NO	2-YR	2-YR	2-YR	2-YR	2-YR	DRY
John Counter Blvd.	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Lakeshore Blvd.	YES	NO	YES	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Rankin Cres.	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	<DRY
Westbrook Rd.[4]	YES	NO	NO	5-YR	100-YR	10-YR	10-YR	10-YR	<DRY

	Catchment Properties			Existing	2021	2026	2036	Full Build-out	Ultimate
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Station LOS	Station LOS	Station LOS	Station LOS	Station LOS	Station LOS
Dalton Ave.	YES	NO	YES	10-YR	10-YR	10-YR	10-YR	10-YR	10-YR
Greenview Dr.	NO	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
King – Elevator Bay+	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
King – Lake Ontario	NO	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
King – Portsmouth[1]	YES	NO	NO	5-YR	100-YR	50-YR	50-YR	50-YR	50-YR
Morton St.	NO	NO	NO	10-YR	10-YR	10-YR	10-YR	10-YR	10-YR
Palace Rd[3]	YES	NO	YES	10-YR	10-YR	10-YR	10-YR	10-YR	10-YR
Yonge St.	NO	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Barrett Ct.+	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Highway 15+	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
James St.+	YES	NO	NO	100-YR	100-YR	100-YR	100-YR	<DRY	<DRY
Kenwoods Cir.	NO	NO	NO	100-YR	100-YR	100-YR	100-YR	100-YR	100-YR
Schooner Dr.	YES	NO	NO	DRY	DRY	DRY	DRY	DRY	DRY

+ Peak and firm flow based on drawdown test (Firm= lowest rated pump(s) & Peak = all pumps total rated flow)
[1] After 2021 Scenario all Flows Pump to Cataraqui Bay WWTP and PS is upgraded
[2] King Street and River Street PS have dynamic inflow based on a relationship with King Street and Emma Martin CSO tanks respectively. Total inflow fluctuates per scenario
[3] Pumping station cannot run 2 pumps at any time
[4] Westbrook pumping station is upgraded by 2021.

The following observations can be made from the tables presented above:

- A few of the pump stations are currently receiving flow exceeding their firm capacity during wet-weather events smaller than the 10yr design storm. The flow generally does not exceed the station's peak capacity, and in most cases, Utilities Kingston has not indicated capacity concerns with these facilities.
- King Street and River Street pump stations currently exceed their peak capacity during wet-weather events with a 2yr return period or larger. It should be noted that both of these pump stations service large combined sewer areas.
- It should be noted that Bath-Collins Bay PS, Hillview PS and Schooner PS are stations which do not have flow data or the data is limited. Utilities Kingston has also indicated that they have not had operational issues with these stations.

3.3.3.3 FORCEMAINS

The majority of the forcemains are adequate to convey the flow for all analysis periods based strictly on the observed velocity. Where velocities exceed 2 m/s additional investigation may be warranted. At higher velocities, energy loss can become significant, and hydraulic conditions may start to have adverse effects on the forcemain and its operation. The majority of forcemains were rated “Good” for their level of service, indicating that the velocity did not exceed 2 m/s up to and including the 100 year design storm. The forcemains that were rated “Gap” are presented in Table 3-7. The development scenario and design storm which first triggered the “Gap” level of service are also presented.

Table 3-7 Forcemain Gaps and Level of Service

FORCEMAIN	DEVELOPMENT SCENARIO (WHICH CAUSES LOS = GAP)	DESIGN STORM (WHICH CAUSES LOS = GAP)
Crerar Blvd	Existing Conditions	2-Year
Days Rd.	Existing Conditions	10-Year
Dalton Ave.	Existing Conditions	2-Year
King St.	Existing Conditions	2-Year

3.3.3.4 COMBINED SEWER OVERFLOW GAPS (GUIDELINE F-5-5)

Table 3-8 details the result of the wet-weather CSO analysis for an Average Year while Table 3-9 details the results for the wetter than average year which is based on 2008 rainfall data. Both analyses were completed using the April – November period required by Guideline F-5-5.

Table 3-8 Combined Sewer Overflow Gaps –Average Year

	2015	2021	2023	2036	BUILD-OUT	ULTIMATE
Total Treated Volume (1000m^3)	**11,483**	**10,927**	**11,413**	**12,752**	**13,752**	**17,288**
Total Treated Dry Weather Volume at Ravensview WWTP (1000m^3)	**9,538**	**9,621**	**10,211**	**11,455**	**13,752**	**16,550**
Total Treated Wet-weather Volume at Ravensview WWTP (1000m^3)	**1,945**	**1,305**	**1,202**	**1,296**	**1,350**	**738**
Total Bypass (1000m^3)	**77.0**	**8.2**	**7.8**	**3.6**	**0.2**	**0.2**

Ratio (Wet-weather Volume Treated / Captured Wet-weather)	**96%**	**99%**	**99%**	**99%**	**99%**	**99%**
Meets Frequency Requirements	X	X	X	X	✓	X
Meets Duration Requirements	X	X	X	✓	✓	X

Table 3-9 Combined Sewer Overflow Gaps – Wetter than Average Year

	2015	**2021**	**2023**	**2036**	**BUILD-OUT**	**ULTIMATE**
Total Treated Volume (1000m^3)	**12,017**	**11,283**	**11,762**	**13,059**	**15,534**	**17,770**
Total Treated Dry Weather Volume at Ravensview WWTP (1000m^3)	**9,538**	**9,621**	**10,211**	**11,455**	**12,402**	**16,550**
Total Treated Wet-weather Volume at Ravensview WWTP (1000m^3)	**2,479**	**1,662**	**1,551**	**1,603**	**3,132**	**1,220**
Total Bypass (1000m^3)	**169.6**	**38.6**	**33.9**	**20.4**	**1.1**	**1.1**
Ratio (Wet-weather Volume Treated / Captured Wet-weather)	**93%**	**97%**	**97%**	**98%**	**99%**	**99%**
Meets Frequency Requirements	X	X	X	X	✓	X
Meets Duration Requirements	X	X	X	X	✓	X
Virtual Elimination	X	X	X	X	X	X

From the tables above the following observations can be made:

- The system does not currently meet F-5-5 based on the duration and frequency of events.
- The system does meet F-5-5 based on the volume required to be treated and continues to improve into the future under all development scenarios.
- There is a notable decrease in bypass volume between 2015 and 2021. This is due to Portsmouth PS being redirected and various sewer separation projects assumed (as per Utilities Kingston projection) to be completed during this analysis period.
- By the 2036 development scenario both the volume and duration are within limits prescribed by F-5-5 during the average year.
- The increase in by-pass during the ultimate scenario is primarily due to Rankin and Westbrook PS being over capacity and experiencing local by-passing.

3.3.3.5 WASTEWATER TREATMENT PLANTS

The LOS for the for treatment plants is to provide full treatment for all average daily flow and provide primary treatment (minimum) up to and including the 10 year design storm. Table 3-6 illustrates the resulting level of service for each flow scenario with the resulting gaps identified.

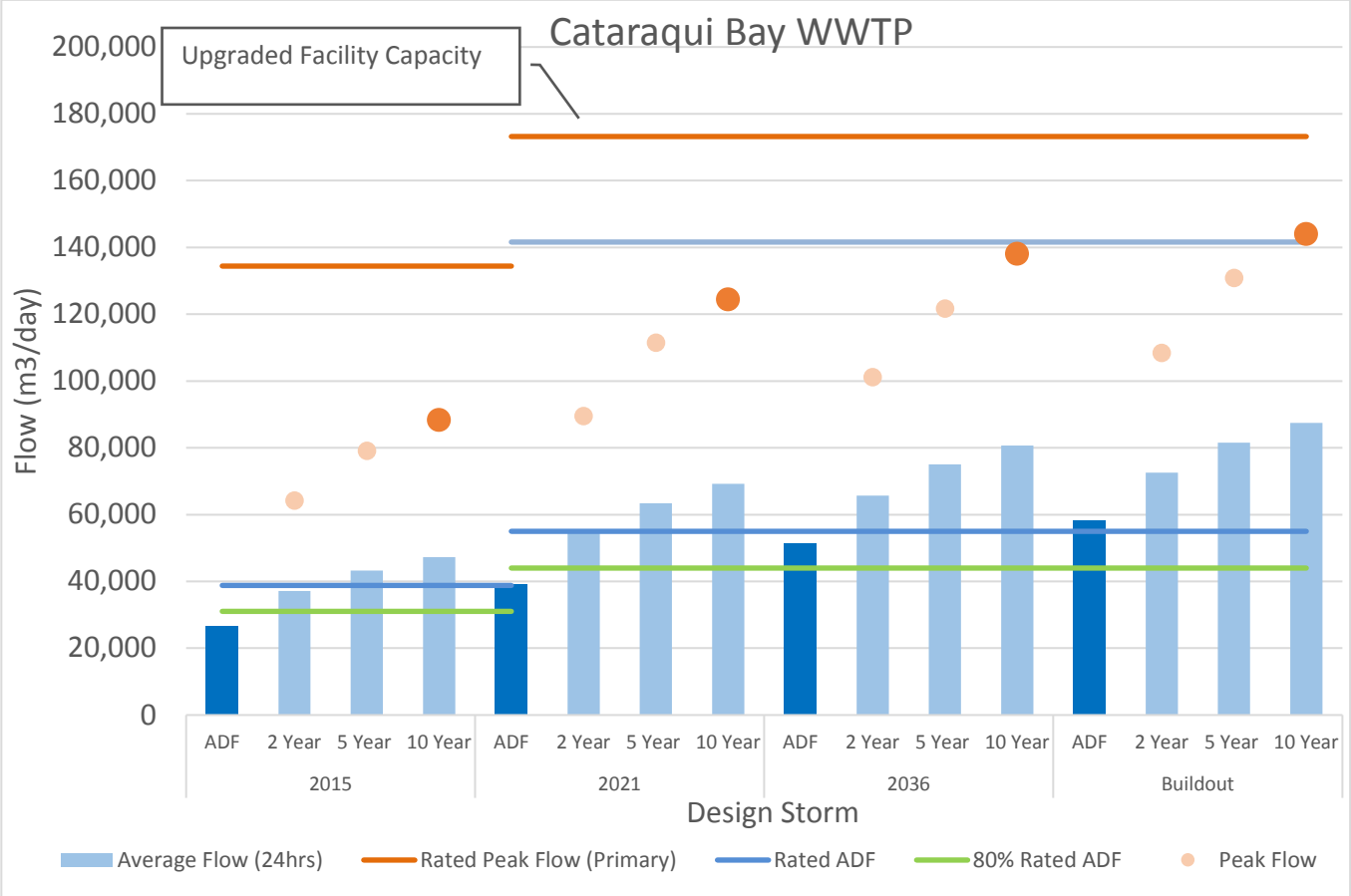


Figure 3-1 Cataraqui Bay WWTP Flows

As can be seen in the figure above, Cataraqui Bay upgrade is online by 2021 increasing its capacity. Cataraqui Bay has adequate capacity to treat the 10yr storm in all development scenarios to 2036. The ADF at Cataraqui Bay just exceeds the 80% of rated capacity by 2026.

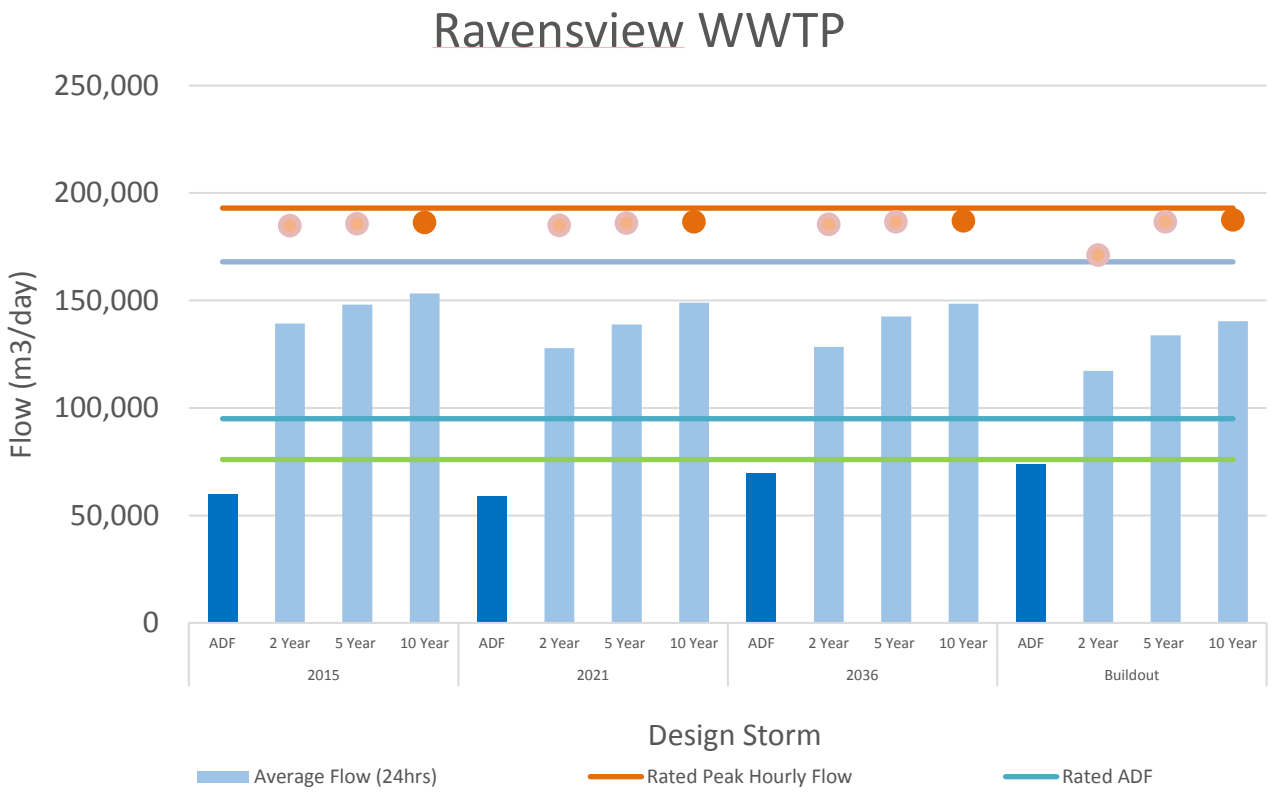


Figure 3-2 Ravensview WWTP Flows

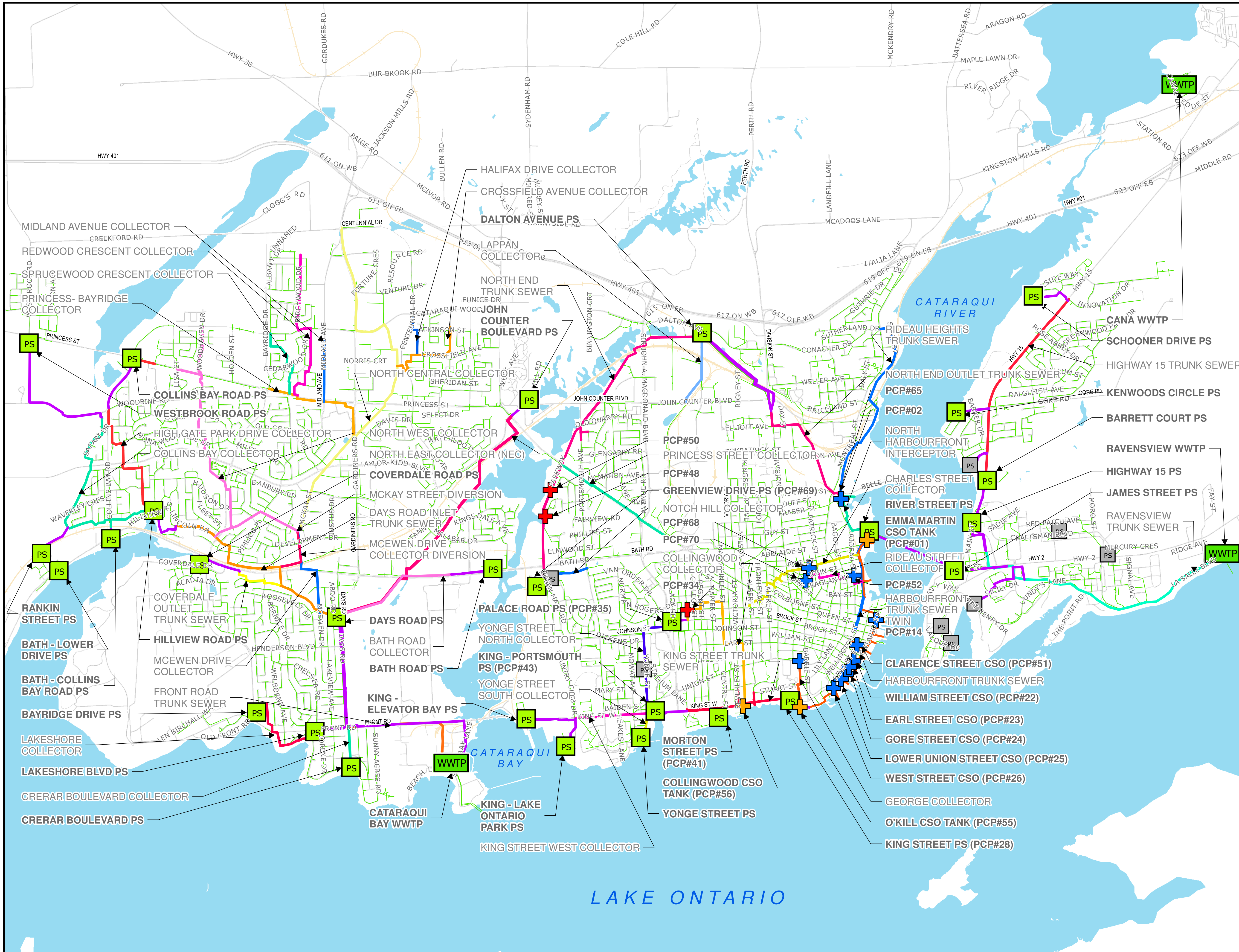
As seen in the figure above, wet-weather flow at Ravensview peaks in the 2026 scenario and then begins to decline due to assumptions regarding sewer separation. It is assumed that sewers are completely separated by the full build-out scenario where a notable drop in wet-weather flow is observed. Ravensview has adequate capacity to accommodate dry weather flow and wet-weather flow beyond 2036.

3.4 ALTERNATIVE SOLUTIONS

Alternatives have been developed based on the infrastructure deficiencies identified in the "*Gap Analysis Report - Wastewater*." Results from the 2036 scenario were used as the primary scenario for planned improvements and upgrades for the infrastructure, with the full build-out scenario serving as a check and balance for the recommended upgrades. The results from the 2021 and 2026 scenarios were used to identify the timing and urgency of the upgrades. The ultimate scenario has been primarily used to develop an overall strategy to help guide the servicing of these development areas with the analysis identifying high-level servicing recommendations.

The wastewater system was reviewed starting with the upstream branches of the system, working downstream. Discussions regarding the developed alternatives has been divided into the three main collection systems:

1. West Collection System
2. Central Collection System
3. East Collection System



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Legend

- WWTP — WASTEWATER TREATMENT PLANT
- PS — SANITARY PUMPING STATION
- PS — SANITARY PUMPING STATION (NOT MODELLED)
- COMBINED SEWER OVERFLOW (CSO)
- TANK OVERFLOW (TO)
- SANITARY SEWER OVERFLOW (SSO)
- FORCEMAIN
- SANITARY SEWER
- WATERBODY

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale: 0 300 600 1,200 Meters

1:47,500

Project:

Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:

WASTEWATER COLLECTION SYSTEM OVERVIEW MAP

Project No.:	Date:
151-02944-00	DECEMBER, 2016

Drawn By:	Checked By:	Code:	Figure No.:
CM	MM	MP	3-3

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\4.0 Class EA\Master Plan Report\Maps\151-02944-00_FIG3-3_WW_System_Overview.mxd

3.4.1 EVALUATION OF ALTERNATIVES OF WASTEWATER INFRASTRUCTURE

The evaluation of alternatives to resolve the identified gaps in the infrastructure was completed using the approach outlined in the "*Alternative Analysis and Review – Wastewater.*" As previously detailed, rather than using a numerical or weighted ranking system, the evaluation focuses instead on the strengths and weaknesses of each servicing alternative to identify the preferred alternative. For each evaluation criteria and for each system alternative, the potential impact to the natural, social, cultural, technical and economic criteria was identified and evaluated relative to the other alternatives as being most preferred, less preferred and least preferred.

In the development of alternative solutions the main principle considered was to determine if the infrastructure will be able to adequately convey projected development and design storm flows to meet the desired level of service for the 2036 scenario and meet the F-5-5 criteria for the CSOs. Table 3-10 details the LOS criteria for the system.

Table 3-10 Level of Service to be met for Evaluated Alternative Solutions

COLLECTION SYSTEM TYPE	SEWERS LOS	PUMPING STATION LOS	WWTP LOS
Wastewater System	100yr Design Storm Flows	10yr Design Storm Flows	10yr Design Storm Flows

The evaluation of the infrastructure alternatives were subdivided into seven categories.

1. Sewer Conveyance and Capacity
2. Pumping Station Conveyance and Capacity
3. Combined Sewer Area Collection System (Central Collection System Only)
4. Wastewater Treatment Plant Capacity
5. Condition and Reliability
6. I/I Reduction by Area
7. Ultimate Scenario Servicing

3.4.2 WEST COLLECTION SYSTEM ALTERNATIVE SOLUTION ANALYSIS

3.4.2.1 SEWER CONVEYANCE AND CAPACITY ANALYSIS

BATH ROAD COLLECTOR

The Bath Road collector receives flow from the Bath Road Pumping Station and runs along Bath Road and through a R.O.W. across CSC property (Collins Bay Institution). Surcharging was observed during model simulation and appears to have a high wet-weather influence, supported by the wet-weather modeling results.

ALTERNATIVE 1

Alternative 1 involves upsizing of the sewers along Bath Road from Centennial Drive to east of Tanner Drive (between manholes 763-030 to 764-030) from 250 mm to 300 mm (±500m) and Tanner Drive to Days Road (between manholes 764-020 to 346-020) from 450 mm to 600 mm (±1,100m). This would provide adequate capacity to meet the required 100yr storm LOS.

ALTERNATIVE 2

This alternative involves redirecting the flows from Bath Road Collector to the North East Collector at Bath Road and Tanner Drive where the sewers cross.

Recommendation

By connecting the Bath Road Collector to the North East Collector at the intersection of Bath Road and Tanner Drive, surcharging is eliminated. There is minimal work required to complete this connection as the two sewers cross near this location. There is sufficient fall to allow the flow to be directed to the North East Collector. As this has been identified as a current issue in 2015, and progressively gets worse through the analysis period, it is recommended to complete this work by 2021.

COLLINS BAY COLLECTOR

The Collins Bay Collector was observed to experience surcharging during major storm events for the 2036 scenario simulations. The surcharging was observed at various locations along the length of the sewer and is largely due to the upgrades to the Westbrook Road PS.

ALTERNATIVE 1

Alternative 1 involves upsizing the Collins Bay Collector along Beaver Crescent to the south side of Taylor Kidd Boulevard (between manholes 34166-020 to 34026-061) from 250 mm to 300 mm (±900m). It also involves increasing the 375/400 mm section along Aylmer Crescent from Waverley Crescent to the west side of Collins Bay Road (between manholes 34024-010 to 33492-030) to 450 mm (±950m).

ALTERNATIVE 2

This alternative involves redirecting the flow from Westbrook Road PS that currently discharges into the Collins Bay Collector at Beaver Crescent by extending the forcemain approximately 100m across Collins Bay Road to connect into the High Gate Park Drive Collector.

Recommendation

Alternative 2 is the preferred solution. By installing a short section of forcemain, a significant length gravity sewer upsizing can be avoided. Additionally, as the Westbrook pumping station is currently in the process of being upgraded, there would be minimal cost to revise the pumps to account for changes to the forcemain. It is recommended that a new section of forcemain be installed to redirect the flow to High Gate Collector. A valve should also be installed to permit the flexibility to discharge into either sewer; providing flexibility in the event the flow along the High Gate Park Drive Collector needs to be reduced.

NORTH WEST COLLECTOR

The section located just upstream of the McKay Street Diversion on the North West Collector was observed through model simulations to experience surcharging during major storms in the 2036 scenario.

Recommendation

Based on a review of the simulation results for the North West Collector, a section of sewer should be upsized to meet the LOS for the 1:100yr storm. This upsizing should be completed along Bayridge Drive from Lincoln Drive to Mayfair Crescent to just east of Pembridge Crescent and Truedell Road (between manholes 33306-010 & 33022-031) from 450 mm to 600 mm, approximately 1,300m.

CRERAR BOULEVARD COLLECTOR

The Crerar Boulevard collector which is tributary to the Crerar Boulevard Pumping Station has been documented in the past of having sewer back-ups and basement flooding. The results of hydraulic modeling do not support a capacity issue in the service area. Based on flow data collected for this Master Plan study this has not been observed.

Recommendation

Prior to conducting any sewer upsizing, it is recommended that flow monitoring continue for this service area to confirm reports and to update flow data when available. This analysis should be completed by 2021 and re-evaluated during the next Master Plan update.

MCEWEN DRIVE COLLECTOR

The McEwen Drive collector which is tributary to the Days Road Pumping Station has been documented of having sewer back-up and basement flooding. The model results do not currently indicate a capacity issue in the service area. Based on flow data collected for this Master Plan study this has not been observed.

Recommendation

It is recommended that flow monitoring be completed for this service area at the pumping station to confirm reports prior to completing any sewer upsizing.

3.4.2.2 PUMPING STATION CONVEYANCE AND CAPACITY ANALYSIS

CRERAR BOULEVARD PUMPING STATION

The Crerar Blvd PS results for the 2036 scenario showed an exceedance of firm capacity during the 10Yr storm. Both the lead and lag pump were simulated to be in operation during peak conditions. To meet the LOS for the 2036 scenario, the firm capacity of the pumping station should be upgraded from 77 L/s to 90 L/s.

Recommendation

As the observed firm capacity of this station is lower than the ECA firm capacity, and the ECA capacity is close to the 2036 peak flow for the 1:10yr storm, it is recommended that a hydraulic review be completed to determine the cause of the capacity reduction at the pumping station. Additionally, once the effluent from the Point Pleasant process is removed, the flow should continue to be monitored to determine its true impact on the station. If it is determined that flows are still consistent with previous data and the firm capacity cannot be increased by eliminating the hydraulic restriction, then an upgrade would be recommended. This analysis should be completed by 2021 and re-evaluated during the next Master Plan update.

HILLVIEW ROAD PUMPING STATION

The Hillview Road PS results for the 2036 scenario show a firm capacity (141 L/s) exceedance during the 1:10yr storm. However, only one pump was observed to be in operation during these conditions in the model. This suggests that the wet well is able to provide sufficient storage for the instantaneous peak flow long enough for the firm capacity to transfer the flow.

This pumping station receives additional flow from development upstream of the station and modifications to the High Gate Park Drive Collector further increase the peak flows. Before the upstream upgrades, the station was experiencing a peak flow of approximately 175 L/s and with the upgrades the 1:10yr peak flow was approximately 180 L/s.

In addition to the exceedance of firm capacity it was also observed that a short section of forcemain experiences velocities above the recommended levels (>3m/s). This would only be the case for a short (10m) 200 mm section of the forcemain leaving the pumping station before the size increases to 350 mm for the remaining length.

The full build-out scenario was also reviewed and if the upstream upgrades were completed the station would experience approximately 185 L/s.

Recommendation

To optimize the current configuration of the PS and to meet the 2036 LOS it is recommended that the firm capacity be increased to approximately 185 L/s. Increasing the capacity beyond 185 L/s will cause downstream surcharging. It is recommended that this be achieved by replacing the smaller forcemain to a 300 mm from just outside the wet well to the existing 350 mm forcemain. Another option would be to install a 350 mm pipe and throttle the flow with a valve. This configuration poses operational risks due to the possibility of the valve being in advertantly opened; resulting in flooding downstream as well as maintenace issues with a partially open valve. Using a reduced pipe size is the preferred alternative, in the event of a future capacity increase this short section of smaller diameter pipe (higher headloss) can be overcome though pump selection. By completing this upgrade, the full build-out flow should also be able to be accommodated. It is recommended that the upgrades be completed by 2021.

DAYS ROAD PUMPING STATION

Days Road PS is a primary station located in the west collection system. The station receives a large amount of inflow from upstream sources. During the 2036 scenario, major storm events were observed to cause peak flows of approximately 1,077 L/s to the station; exceeding the reported 990 L/s firm capacity. The modeled storm events caused all 4 pumps to run, indicating that the peak flow lasted long enough to negate any impact resulting from wet well storage volume. After simulating alternative upgrades for infrastructure upstream of the station the peak flows were simulated to increase to approximately 1,100 L/s.

Recommendation

Based on the results from model simulations, and the importance of this station to the system, it is recommended that the firm capacity be increased to approximately 1,200 L/s to meet the full build-out LOS (representing a modest increase from the 2036 scenario). Days Road pumping station is in poor condition and is projected to reach its firm capacity by 2021. It is recommended that Days Road PS be upgraded by 2021.

BATH COLLINS BAY ROAD PUMPING STATION

The Bath-Collins Bay Road PS is a small station which outlets into the Collins Bay Collector, it services a small area in the west sewer collection system. In the 2036 model simulation of the 10yr storm there were observed firm capacity exceedances and cases when both of the pumping station pumps were in operation. While this was observed in the model simulations, there have been no reports of basement flooding or sewer back-up.

Recommendation

It is recommended that flow monitoring at Bath-Collins Bay PS including Rankin Street PS and Bath-Lower Drive PS be implemented to verify the results before upgrades are recommended. If the results are verified, it is recommended to increase the firm capacity to 22 L/s. This analysis should be completed by 2021 and re-evaluated during the next Master Plan update.

LAKESHORE BOULEVARD PUMPING STATION

The Lakeshore Boulevard PS was not observed to exceed 2036 LOS during model scenario simulations for dry and wet-weather conditions. The pumps were observed to be operating in a lead/lag configuration. There have been reported issues of basement flooding in service the area during major storm events, however, based on the information provided for model calibration, results do not support this observation and could be a result of equipment failure or other operational malfunction.

Recommendation

It is recommended that flow monitoring at Lakeshore Boulevard continue. This analysis should be completed by 2021 and re-evaluated during the next Master Plan update.

3.4.2.3 WASTEWATER TREATMENT PLANT CAPACITY ANALYSIS

During model simulations, the Cataraqui Bay Wastewater Treatment Plant was not observed to exceed the upgraded plant capacity for the 1:10 year storm or the ADF by 2036. Exceedance of 80% of the rated ADF by 2026 was observed. This indicates the trigger point for initiating the planning and design stages for future required upgrades to ensure that they are in place by the time they are needed.

Recommendation

The Class EA for the Cataraqui Bay WWTP upgrades recommended two upgrade Phases for this WWTP. Phase 1 increases the average day plant capacity to 55,000 m^3/day and Phase 2 increases it to 68,000 m^3/day. As planning for the next upgrade has already been completed allowances have been made in the Phase 1 design for the future upgrades, it is recommended that the planning and design for Phase 2 commence by 2026. This timing will permit implementing the upgrades by 2036. Additionally, as the 2036 flows are not currently expected to exceed the Phase 1 upgraded plant capacity, the observed ADF should be carefully tracked and used to fine tune the timing of the commencement of the next planning phase.

3.4.3 CENTRAL COLLECTION SYSTEM ALTERNATIVE SOLUTION ANALYSIS

3.4.3.1 SEWER CONVEYANCE AND CAPACITY ANALYSIS

NOTCH HILL COLLECTOR

The hydraulic modeling shows that the Notch Hill Collector experiences surcharging during major design storms. This collector is simulated with large amounts of wet-weather influence as calibrated from flow monitors. The North End Trunk Sewer (NETS) surcharging influences sections of the Notch Hill Collector that experience surcharging. The lower section of surcharging appears to be directly correlated the NETS, surcharging in this section of the Notch Hill Collector only occurs when the NETS is surcharged.

By eliminating the issues in the NETS, the lower section of Notch Hill Collector is alleviated. However, there is still a section that is surcharged.

To correct the remaining sewer, upsizing of the sewers along Notch Hill Road from Portsmouth to Runnymede Rd (between manholes 9716-010 to 3942-030) from 450 mm to 600 mm, for an approximate length of 350m would be required to meet 100yr design storm LOS.

Recommendation

To ensure that conveyance capacity is not restricted, the Notch Hill Collector should be upgraded between Portsmouth Avenue and Runnymede Road to a 600 mm sewer. In order to complete the upgrade, the downstream sewers need to be able to handle additional flows. For this reason, it is recommended that this section be completed by 2026 after the correction of NETS (refer to NETS section below). It should be noted that this collector appears to have a significant response to wet-weather. If an I&I reduction can be achieved, the upgrade should be re-evaluated.

PRINCESS STREET COLLECTOR

Surcharging along the length of the Princess Street Collector was observed during major design storm events in the 2036 scenario. The Princess Street Collector runs north-west along Princess Street and is tributary to the North End Trunk Sewer (NETS). This collector is a separated sewer that has no direct combined sewers. The collector is projected to receive a large amount of development growth by 2036.

To correct the surcharging, upsizing of the sewers along Princess Street from just west of Concession Street to Parkway (between manholes 0823-020 to 2284-020) from 375/300/375 mm to 450/525 mm, for an approximate length of 1,800 m would be required to meet the 100yr storm LOS.

Recommendation

The severity of the surcharging in the Princess Street Collector increases between the 2015 and 2036 scenarios, with the most significant surcharging occurring in 2036. During the 2015 and 2021 scenarios, there is a short section of the collector that experiences minor surcharging in the 1:10yr storm. By 2026, the surcharging at the location identified above becomes more severe, and minor surcharging is observed upstream and downstream of this location. As this is a long length of sewer, it is recommended the upgrades be divided into 3 phases as follows:

- Phase 1 - Indian Road to Parkway (manholes 0826-010 to 2284-020) from 375/300/375 mm to 525 mm for an approximate length of 550m by 2021.

- Phase 2 - West of Sir John A MacDonald Blvd to Indian Road (manholes 0825-070 to 0826-010) from 375 mm to 525 mm (manholes 0825-040 to 0826-010) and 450 mm (manholes 0825-040 to 0825-070) for an approximate length of ±750m by 2026.
- Phase 3 - East of Mooalim Pl to west of Sir John A MacDonald Blvd (manholes 0823-020 to 0825-070) from 375 mm to a 450 mm for an approximate length of 500m by 2036.

NORTH END TRUNK SEWER

The North End Trunk Sewer or NETS services a large area of separated sewer located in the central collection system that has undergone previous upgrades including sewer twinning and I/I reduction programs. This sewer has two SSOs (PCP#48 & 50) which currently have documented history of overflows during major storm events. Model simulations for the 2036 scenario show that surcharging occurs during wet-weather.

To correct the surcharging in the NETS, twinning of the sewers would be required in three separate sections. Section 1 extends along Queen Mary Road heading north from Greenview Drive to Sherwood Crescent (from manhole 9341-010 to 2284-131), approximately 900 m; section 2, from manhole 2284-010 to 509081 (from Princess Street heading north to Portsmouth Avenue), approximately 700 m; and Section 3 from John Counter heading north to Dalton Avenue (manhole 614091 to 1760-010), approximately 1,900 m. The NETS has been twinned at several locations along its length. By completing the remaining three sections identified above sewer surcharging can be eliminated in the 2036 scenario during wet-weather.

Additionally, by completing the identified twinning, it would eliminate sanitary sewer overflows (SSO) that occur on this trunk sewer.

Recommendation

To ensure that capacity conveyance is not restricted, the remaining single pipe sections of the NETS should be twinned. Once this is complete, the SSO can be eliminated. The severity of the surcharging increases between 2015 and 2036, with 2036 seeing the majority of the sewer surcharging. 2015 to 2036 sees two small sections, located at either end, which experience minor surcharging in the 1:10yr design storm. Moderate to severe surcharging is observed throughout the scenarios during the 1:100yr storm. As this is a long length of sewer it is recommended to phase the twinning of this sewer into 2 phases as follows:

- Phase 1 - Twinning of sewer from Greenview Drive to Sherwood Crescent & Section 2 - Princess Street to Portsmouth – by 2021
- Phase 2 - Twinning of sewer from John Counter Blvd to Dalton Ave – by 2036

The SSOs should be monitored once the first sections are twinned to ensure that overflows are no longer occurring before permanently plugging these SSOs.

KING STREET WEST COLLECTOR

The King Street West Collector located upstream of the King-Portsmouth PS is a separated sewer that was observed to surcharge in the 2036 scenario during wet-weather simulations. King-Lake Ontario Park PS & King-Elevator Bay PS are two smaller PS that contribute to the collector. In addition to these PS the collector also receives additional flow in the 2036 scenario from projected development.

To correct the surcharging in the sewer, upsizing would be required along King Street West just east of County Club Drive to McDonald Avenue (from manhole 0054-030 to 0051-104) from a 400/350 mm to a 450 mm (550m). The upsize would provide a 1:100yr storm LOS.

Recommendation

To ensure that conveyance capacity is not restricted, the King Street West Collector should be upgraded between County Club Dr. and McDonald Ave to a 450 mm sewer. As some of the development in this service area is scheduled to be online by 2021, it is recommended to complete this work by 2021. This work could be coordinated with the Portsmouth redirection project that has been indicated as an Imminent project.

COLLINGWOOD STREET COLLECTOR

The Collingwood Street Collector is a partially separated sanitary sewer that is projected to become fully separated by 2036. It is located upstream of the King Street Trunk Sewer. During the 1:100yr storm analysis surcharging was observed in the sewer, causing a SSO at PCP#34. This overflow is a control structure located at the intersection of Helen and Mack streets. There have been documented sewer overflows at this location from Utilities Kingston's flow monitoring program.

ALTERNATIVE 1

This alternative involves upsizing of the sewer along Helen Street to Mack Street, along Mack Street to Regent Street and along Regent Street to Dundas Street (from manhole 0423-010 to 04511-020) from 300 mm to 375 mm, approximately 400m that would provide 1:100yr storm LOS. This would also allow the SSO (PCP#34) to be plugged.

ALTERNATIVE 2

This alternative involves redirecting the flow from Palace Road which currently discharges into the Collingwood Collector at Helen Street and Brock Street to a location in the Collingwood Collector further downstream. The forcemain is required to be extended by approximately 210 m and is proposed to extend along Palace Road and Johnston Street discharge into a local sewer at Oakridge Ave and Johnston Street. The local sewer is 225 mm and upsizes to 450 mm at the connection to the Collingwood Collector. The proposed connection location is downstream of the observed surcharging. The Collingwood Collector was analyzed with the redirected forcemain, and no further surcharging was observed. The local sewer was not reviewed and may require upsizing to accept the flows.

Recommendation

The section of Collingwood Collector that is surcharging is scheduled for rehabilitation. The incremental cost to upsize a pipe that is scheduled to be replaced is minimal when compared to installing a new forcemain. For these reasons the upsizing of the sewers was the preferred option (Alternative 1). The pipes along Helen, Mack and Regent Street, are recommended to be upsized to 375 mm to provide 1:100yr storm LOS. This would also allow the removal of PCP#34. As Utilities Kingston has identified that the elimination of SSOs are a priority, it is recommended that this be completed by 2021.

CHARLES STREET COLLECTOR

The Charles Street Collector is currently being upgraded as part of an Imminent project. This project includes the installation of upsized pipes along Alfred and Elm Streets. Prior to this work Utilities Kingston temporarily plugged four CSO control locations (PCP# 08,09,67,71). The CSOs were identified as no longer required due to significant reductions in combined sewer areas that have been achieved in this area through sewer separation and source control. There is one remaining CSO on the Charles Street Collector at Quebec & Barrie Street (PCP#68). Provided there are no changes to the sewer separation strategy included with the imminent projects, by 2036 combined sewers tributary to this sewer will be completely separated.

Recommendation

A flow monitoring program should be completed to confirm the model simulation results. Upon confirmation, the temporarily plugged overflows and PCP#68 can be eliminated. The remaining overflow (PCP#68) should be plugged by 2036 once all remaining combined sewer areas are eliminated.

3.4.3.2 PUMPING STATION CONVEYANCE AND CAPACITY ANALYSIS

DALTON AVENUE PUMPING STATION

The Dalton Ave PS located at the downstream end of the NETS and is a large capacity pumping station. It was observed to meet the desired LOS for the 2036 model scenario for dry and wet-weather conditions. However, there have been reported issues of basement flooding in the service area during major storm events. Based on the information provided for flow and level at the PS, there are no model results to support this observation. Additional information regarding this station was provided that indicated potential issues with the pump size and/or operation of the station. Utilities Kingston is currently undertaking a study to determine the cause of the issue with the station.

Recommendation

It is recommended that Utilities Kingston continue with the study and flow monitoring.

KING-PORTSMOUTH PUMPING STATION

The King-Portsmouth PS is currently located in the Central Collection System. However, in the 2021 and future scenarios the PS is modeled to convey flow via a new forcemain directly to the Cataraqui Bay WWTP with and upgraded capacity (Imminent project). The upgraded pumping station firm capacity is able to convey flows to meet the 2036 LOS. Historically, there have been documented cases of basement flooding sewer back-ups upstream of the PS. Yonge Street is currently being reconstructed, and the service area is undergoing an I/I reduction program to alleviate dry-weather/wet-weather effects. The projects identified above along with the pumping station upgrades are anticipated to resolve the flooding and back-ups.

Recommendation

It is recommended that Utilities Kingston continue with Portsmouth Redirection and I&I reduction program.

PALACE ROAD PUMPING STATION

The Palace Road PS located upstream of the Collingwood Street Collector. It is a small PS that currently is simulated to run a single pump with a firm capacity of 22 L/s. During model simulations for the 2036 scenario, the PS is able to meet the LOS. This PS has reports of sewer back-ups upstream in its service area. These backups have been attributed to power outages.

The PS forcemain was reported to have a high gradient loss and described by operators to cause operating restrictions when using two pumps. Currently, the PS is configured to only run a single pump under normal conditions.

Recommendation

It is recommended that Utilities Kingston continues to monitor the issues. If power outages are a regular occurrence, consider permanent backup power at this location.

3.4.3.3 COMBINED SEWER AREA COLLECTION SYSTEM ANALYSIS

COMBINED SEWER ANALYSIS

The combined sewer system was analyzed separately from the rest of the central system; there are controls and parameters in place which cause all the components to act as a single system. Pump stations, sewers, storage chambers and outfalls all function together to maximize storage in the system while providing an outlet to mitigate risk to property and human health. Therefore, to ensure that all aspects of the combined sewer system are evaluated, the system component were analyzed concurrently. The following infrastructure was identified to be included in the combined sewer system:

- North Harbourfront Interceptor, Rideau Heights Trunk, Rideau Street Collector, Harbourfront Trunk, King Street Trunk, Hwy 15 Trunk and Ravensview Trunk Sewers
- King Street and River Street Pumping Station and Forcemains
- Collingwood, King St, and Emma Martin Tank
- CSO/SSO Control Structures

COMBINED SEWER SEPARATION STRATEGY

One of the larger overall capital projects that the City is undertaking is the reduction of combined sewer areas. In 2006, the Combined Sewer Critical Evaluation was completed with the purpose of developing a guiding policy for the rehabilitation of combined sewer areas. The study concluded that the preferred option was to separate sewers and not replace the combined sewers. As a result of this evaluation, the City of Kingston Council has adopted a policy that incorporates local sewer separation as the primary approach to reduce CSOs.

However, as policies and regulations change, it was determined that the effectiveness of these types of projects should be re-evaluated. A high level analysis of the sewer separation plan was completed to ensure that this objective was still the most effective and appropriate for the City of Kingston. High-level alternatives were developed to complete an evaluation of sewer separation strategies. The alternatives were grouped into three main categories:

- **Source Controls** – the method of removing storm water that may be directed to the sanitary system by water conservation or lot level methods (i.e. sewer separation)
- **Conveyance Control** - the method of transferring the flows through the sanitary system to the treatment facility
- **End of Pipe Controls** – the method of containing the flows within the conveyance system or at the outfalls. These typically include some form of storage or treatment.

Based on these categories, the following alternatives were developed with the goal to virtually eliminate CSOs in the central system:

Alternative 1 Do nothing: Status quo or to stop any further upgrades in the central system.

Alternative 2 Source Control: Eliminate all combined sewers in the central system

Alternative 3 Conveyance Control: Upsize or upgrade the sewers and pumping station within the central system

Alternative 4 End of Pipe Control: Increase or add storage facilities within the central system to contain the flows

Alternative 5 Conveyance & End of Pipe Control: A combination of Alternative 3 and 4

Recommendation

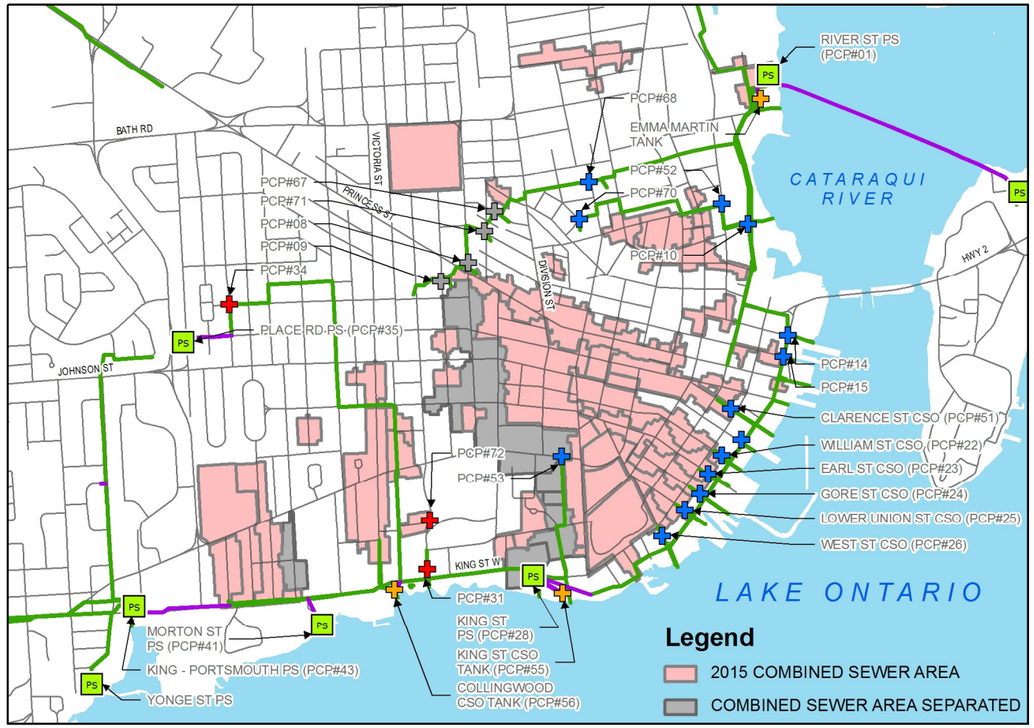
It was concluded from the evaluation that the sewer separation alternative is still the best option for reducing the CSO volumes. It is the best option as it reduces the amount of flow within the sanitary sewer as well as having the lowest overall capital and operational costs.

DEVELOPMENT OF CSO REDUCTION STRATEGIES AND ALTERNATIVES

A CSO reduction plan was developed to project how, when and where the source control measures would be implemented. This reduction plan was developed to estimate the pace and location of future sewer separation work for the purposes of the master plan. The estimation is based on an approach consistent with that used during the development of last eight years of capital reconstruction plans. This takes into consideration such things as infrastructure age, priority separation areas and risk assessment based on the condition of all features within the right-of-way, including road and other utilities. This reduction plan projections were used to identify initial gaps in the system as it was the current strategy for the City. Based on the re-evaluation of the combined sewer separation, combined sewer reduction is still the preferred method for reducing combined sewer volumes.

Figure 3-4 shows an overview of the combined sewer area projections by scenario in the central collection system and existing overflow locations.

One of the difficulties with developing a long-term reduction plan is that the longer the time horizon of the plan the greater the uncertainty. Policy and priorities of a City can change based on many factors and criteria that may not be evident today. Therefore, to provide additional understanding of the impacts of variations in the reduction plan, two analyses were completed. One reviewed the current sewer separation plan to determine the results if a slower or faster separation rate was completed. This analysis reviewed five alternatives and quantified the impacts of a varied sewer separation rate. The second analysis was a sensitivity analysis to determine the most effective remaining areas for separation for two purpose; (1) to provide guidance for development of a reduction plan beyond 2036 and (2) to provide further information if the current reduction plan is desired to be accelerated. Both of these analysis were completed by applying two criteria, (1) To meet F-5-5 and (2) to “virtually eliminate” CSO’s under a wetter than average year. The CSOs were analyzed using the average rainfall year (2014) and wet rainfall year (2008).



1 / 3-1 2015 COMBINED SEWER AREA
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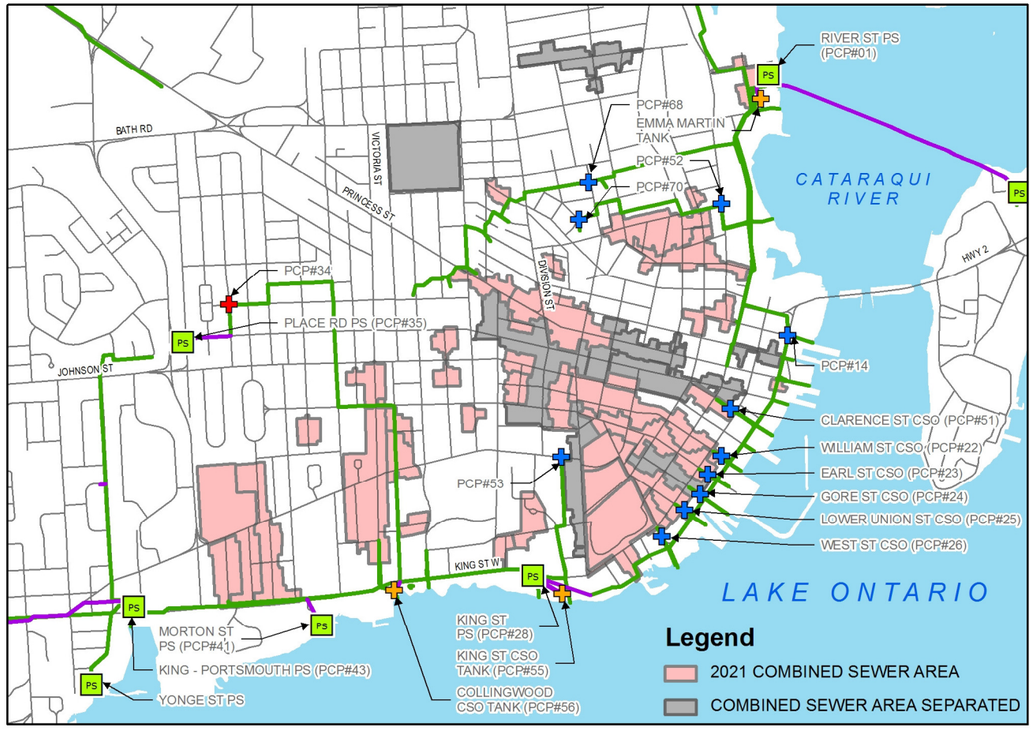

2 / 3-1 2021 COMBINED SEWER AREA
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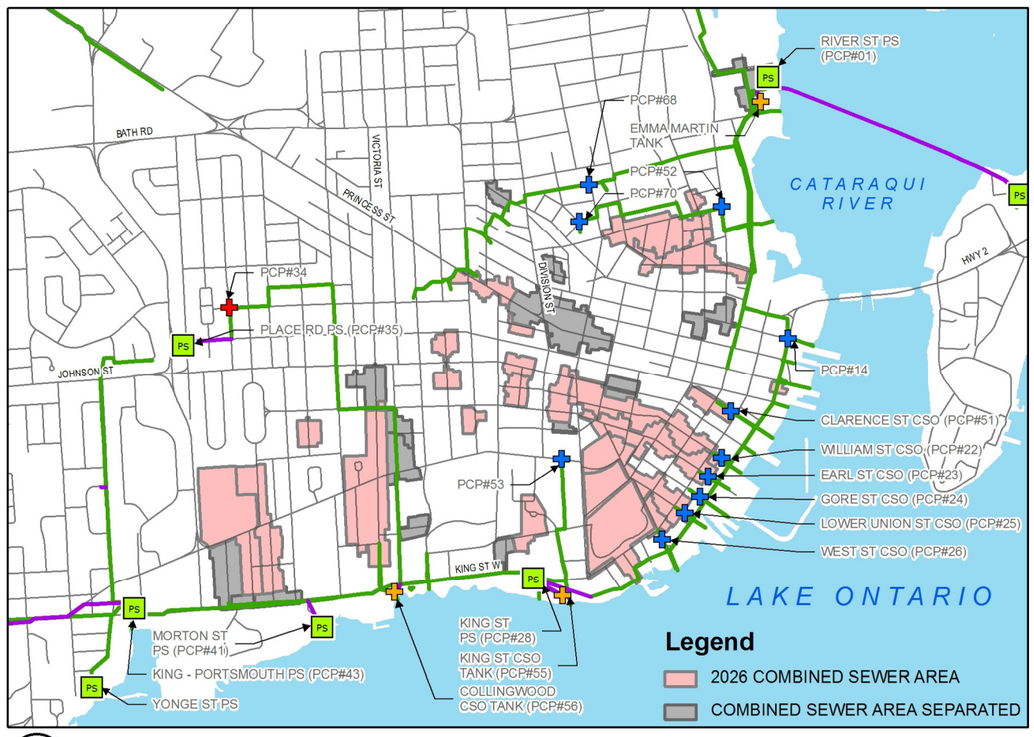
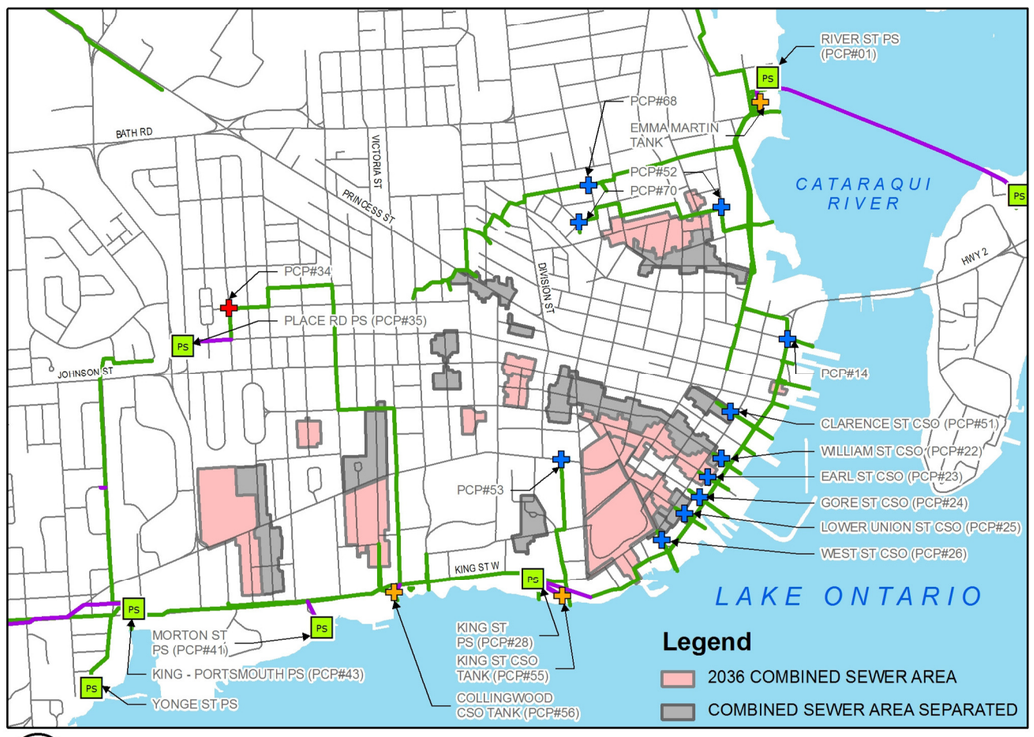


3 / 3-1 2026 COMBINED SEWER AREA
1:27,500



4 / 3-1 2036 COMBINED SEWER AREA
1:27,500

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K7L 4X7

Legend

- SANITARY PUMPING STATION
- COMBINED SEWER OVERFLOW (CSO)
- TANK OVERFLOW (TO)
- SANITARY SEWER OVERFLOW (SSO)
- PLUGGED CSO
- SANITARY SEWER (MODELLED)
- FORCEMAIN
- ROAD

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale:
0 200 400 800 Meters
1:27,500

Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
COMBINED SEWER OVERVIEW

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	MP	3-4

VARIED SEWER SEPARATION RATE

The alternatives considered in the first analysis included:

Scenario 1 No additional sewer separation between 2015 and 2036 with 2036 growth (Base Case)

Scenario 2 2026 projected sewer separation with 2036 growth (Slower Case)

Scenario 3 2026 projected sewer separation + 50% of projected sewer separation between 2026 and 2036 with 2036 growth (Slow Case)

Scenario 4 2036 projected sewer separation with 2036 growth (Projected Case)

Scenario 5 All combined sewers separated with 2036 growth (Faster Case)

The table below summarizes the CSO analysis under the typical rainfall year for the different scenarios. The analysis was completed for each individual CSO for duration, time and volume. However, accumulative totals for duration and time have been shown in the table and the results have been flagged if any of the individual CSO locations do not meet the F-5-5 criteria (orange) or if all of the CSO locations are meeting the F-5-5 criteria (green). The F-5-5 criteria for duration and time are that the combined total duration of CSO events at any one CSO location shall not exceed 48hrs and controlling overflows to not more than 2 events per season. The volume criteria is a system wide requirement that 90% of the Wet-weather Volume of the system (for an Average Year) above the dry weather flow shall be treated.

Table 3-11 Reduction Plan Scenarios - Average Year

	SCENARIO 1 BASE CASE 2036 GROWTH WITH NO SEPARATION	SCENARIO 2 SLOWER CASE 2036 GROWTH WITH 2026 SEPARATION PROJECTIONS	SCENARIO 3 SLOW CASE 2036 GROWTH WITH 2026 + 50% OF 2036 SEPARATION PROJECTIONS	SCENARIO 4 PROJECTED CASE 2036 GROWTH WITH 2036 SEPARATION PROJECTIONS	SCENARIO 5 FASTER CASE 2036 GROWTH WITH ALL SEWER SEPARATED
Approximately Combined Sewer Area Remaining (ha)	174	90	72	54	0
% of Remaining Combined Area relative to Base Case	-	51.7%	41.4%	31.0%	0.00%
Total Cumulative Duration Bypass (hrs)	348.5	238.5	227.5	73.5	25.0
% Reduction relative to Base Case	-	31.6%	34.7%	78.9%	92.8%
Total Number of Bypass Events	37	24	23	14	2
% Reduction relative to Base Case	-	35.1%	37.8%	62.2%	94.6%
Total By-Pass Volume(m^3)	29,173	8,205	5,816	3,565	266
% Reduction relative to Base Case	-	71.9%	80.0%	87.8%	99.1%
Total Wet-weather Volume at Ravensview (m^3)	1,310,602	913,797	860,949	819,183	794,965
% Reduction relative to Base Case	-	30.3%	34.3%	37.5%	39.3%
Wet-weather Capture (Bypass / Wet-weather) (m^3)	97.8%	99.1%	99.3%	99.6%	99.9%

Similarly, the following table presents the results for a wetter than average year for the different alternatives.

Table 3-12 CSO Reduction Plan Scenarios - Wetter than Average Year

	SCENARIO 1 BASE CASE 2036 GROWTH WITH NO SEPARATION	SCENARIO 2 SLOWER CASE 2036 GROWTH WITH 2026 SEPARATION PROJECTIONS	SCENARIO 3 SLOW CASE 2036 GROWTH WITH 2026 + 50% OF 2036 SEPARATION PROJECTIONS	SCENARIO 4 PROJECTED CASE 2036 GROWTH WITH 2036 SEPARATION PROJECTIONS	SCENARIO 5 FASTER CASE 2036 GROWTH WITH ALL SEWER SEPARATED
Approximately Combined Sewer Area Remaining (Ha)	174	90	72	54	0
% of Remaining Combined Area relative to Base Case	-	51.7%	41.4%	31.0%	0.00%
Total Cumulative Duration Bypass (Hrs)	750.0	634.0	624.0	92.5	5.0
% Reduction relative to Base Case	-	15.5%	16.8%	87.7%	99.3%
Total Number of Bypass Events	63.0	41.0	39.0	24.0	1.0
% Reduction relative to Base Case	-	34.9%	38.0%	61.9%	98.4%
Total By-Pass Volume(m^3)	82,538	36,480	30,441	20,449	1,050
% Reduction relative to Base Case	-	55.8%	63.1%	75.2%	98.7%
Total Wet-weather Volume at Ravensview (m^3)	1,800,624	1,212,304	1,137,885	1,080,651	795,749
% Reduction relative to Base Case	-	32.7%	36.8%	40.0%	55.8%
Wet-weather Capture (Bypass / Wet-weather) (m^3)	95.4%	97.00%	97.3%	98.1%	99.9%

The analysis concluded that by continuing with the projected sewer separation plan, significant treatment volume reduction can be achieved. This reduction in volume can have significant operational and

maintenance cost savings. Additionally, in both the average year and wetter than average year scenarios, there is a notable increase in the duration and number of events in the slow case compared to the projected case.

In consultation with the Ministry of Environment and Climate Control (MOECC) and the Cataraqui Region Conservation Authority (CRCA), while all criteria are important, the volume and duration criteria are typically the more important aspects with volume being the most important. All of the Alternatives meet the required MOECC F-5-5 volumetric criteria, with a notable reduction in volume with increased sewer separation. The duration and frequency are exceeded in all of the Alternatives with significant improvement as the area of separated sewers increases. Common to all of the alternatives was that West St. CSO was the most significant contributors to overflow volume, duration and frequency.

REMAINING COMBINED SEWER AREAS

Based on the projected combined sewer separation plan, by 2036 there are combined sewer areas which will remain. To compare the effectiveness of sewer separation for the remaining areas, the hydraulic model was used to simulate the 2036 sewer separation with increases in separation of areas to review the effectiveness of CSO reduction.

A sensitivity analysis was completed for the 2036 growth scenario by eliminating one of the four remaining areas as indicated in the figure below. Each area was 'separated' while the remaining areas were left 'unseparated.'

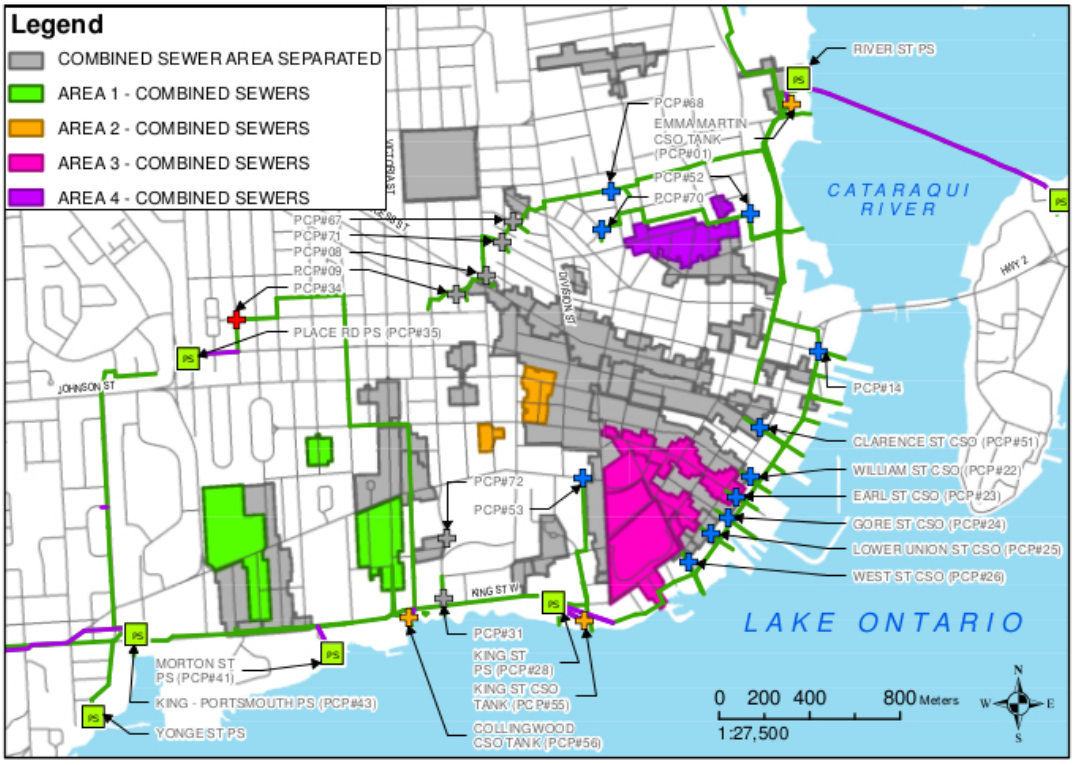

Figure 3-5 Remaining Combined Sewer Areas

The table below summarizes the totals from the CSO sensitivity analysis under the typical rainfall year. The same format and criteria that were used in the previous section were used to display the results in relation to F-5-5 guidelines.

Table 3-13 Average Year CSO By-pass Volume, Duration and Frequency Sensitivity Analysis (2036)

		2036 GROWTH WITH 2036 SEWER SEPARATION				
	BASE CASE NO ADDITIONAL SEWER SEPARATION	AREA 1: SEWER SEPARATION	AREA 2: SEWER SEPARATION	AREA 3: SEWER SEPARATION	AREA 4: SEWER SEPARATION	FULL SEWER SEPARATION
Approximately Combined Sewer Area Remaining (ha)	54	36	51	29	47	0
% of Remaining Combined Area relative to Base Case	-	70.6%	94.4%	53.7%	87.0%	0.0%
Total Cumulative Duration Bypass (hrs)	73.5	30.5	45.0	40.0	48.5	25.0
% Reduction relative to Base Case	-	58.5%	38.8%	45.6%	34.0%	66.0%
Total Number of Bypass Events	14.0	6.0	11.0	10.0	12.0	2.0
% Reduction relative to Base Case	-	57.1%	21.4%	28.6%	14.3%	85.7%
Total By-Pass Volume(m^3)	3,565	571	1,903	1,456	2,539	334
% Reduction relative to Base Case	-	84.0%	46.6%	59.2%	28.8%	90.6%
Total Wet-weather Volume at Ravensview (m^3)	819,183	720,356	743,151	720,968	730,943	695,033
% Reduction relative to Base Case	-	12.0%	9.3%	12.0 %	10.8%	15.1%
Wet-weather Capture (Bypass / Wet-weather) (m^3)	99.6%	99.9%	99.7%	99.8%	99.6%	99.9%
Rate of By-Pass Reduction (m3/ha)	-	166.3	554.0	66.5	146.6	61.1

The table below shows the results of the CSO during the wetter than average year.

Table 3-14 Wet Year CSO By-pass Volume, Duration and Frequency Sensitivity Analysis (2036)

	2036 GROWTH WITH 2036 SEWER SEPARATION					
	NO ADDITIONAL SEWER SEPARATION	AREA 1: SEWER SEPARATION	AREA 2: SEWER SEPARATION	AREA 3: SEWER SEPARATION	AREA 4: SEWER SEPARATION	FULL SEWER SEPARATION
Approximately Combined Sewer Area Remaining (ha)	54	36	51	29	47	0
% of Remaining Combined Area relative to Base Case	-	70.6%	94.4%	53.7%	87.0%	0.0%
Total Cumulative Duration Bypass (hrs)	92.5	30.5	86.5	67.5	81.0	5.0
% Reduction relative to Base Case	-	67.0%	6.5%	27.0%	12.4%	66.0%
Total Number of Bypass Events	24.0	10.0	22.0	16.0	21.0	1.0
% Reduction relative to Base Case	-	58.3%	8.3%	33.3%	12.5%	85.7%
Total By-Pass Volume(m^3)	20,449	6,193	18,170	14,595	17,426	1,050
% Reduction relative to Base Case	-	69.7%	11.1%	28.6%	14.8%	94.9%
Total Wet-weather Volume at Ravensview (m^3)	1,080,651	947,306	987,815	956,474	1,077,628	795,749
% Reduction relative to Base Case	-	12.3%	8.6%	11.5 %	0.3%	26.4%
Wet-weather Capture (Bypass / Wet-weather) (m^3)	98.1%	99.4%	98.2%	98.5%	98.4%	99.9%
Rate of By-Pass Reduction (m3/ha)	-	792.0	759.6	234.2	431.9	359.2

The findings from the CSO sensitivity analysis further supported the effectiveness of sewer separation. Area 1 was identified as the most effective area to reduce the total amount of by-pass while Area 2 is the most effective area from a reduction per hectare point of view (i.e. cost). The fully separated system demonstrated that a fully separated system would meet the F-5-5 criteria for all parameters. This supports that full separation of the system is an effective long-term goal to meet the F-5-5 criteria.

FUTURE SYSTEM

As demonstrated above, sewer separation is the most effective combined sewer overflow reduction plan. By implementing the combined sewer reduction plan, the sewer system begins to operate as a typical separated system. In order to understand what upgrades would be required for the system in the long term and help to with future planning, the combined system was compared to a similar LOS as the rest of the separated system. For both pumping stations and sewers a 1:10yr storm LOS was selected. The following alternatives were developed to provide an overall servicing strategy and to identify some common or reasonable upgrades that can be completed within the current Master Plan horizon in preparation for when the majority of combined sewers are separated.

Scenario 1 Sewer Separation as Planned

Scenario 2 Aggressive Sewer Separation

Scenario 3 Redirect Northern Central Flow to East

SCENARIO 1

In this scenario, there would be no more sewer separation beyond what is planned for the 2036 development scenario. This option is considered the do nothing or base case options.

ALTERNATIVE 2

In this scenario, the remaining combined sewer areas would be eliminated by 2036. This option would be an aggressive reduction program as it would be above what Utilities Kingston has deemed to be reasonable sewer separation to complete.

ALTERNATIVE 3

In this scenario, the sewer separation would continue as planned to 2036. The flows from the north portion of the City (North End Trunk Sewer, Dalton, North End Outlet Sewer and the Rideau Heights Trunk Sewer) would be re-directed away from the downtown combined sewer system to a new pumping station and forcemain. The facility would be located at the intersection of the North End Outlet sewer and the Rideau Height Trunk sewer; pumping across the Cataraqui River between John Counter Blvd. and Gore Road (i.e. Third Crossing) to the Highway 15 trunk sewer. This option was developed to provide and understanding of the upgrades to the downtown system if some flows were diverted away from River Street PS.

Recommendations

Based on the analysis, detailed in "*Alternative Analysis and Review – Wastewater*," there are some common infrastructure upgrades that would be required to service the central area in the future regardless of how sewer separation proceedes. The following infrastructure upgrades are recommended in the current Master Plan horizon to prepare for a separated system:

KING STREET FORCEMAIN TWINNING

It is recommended that the King Street PS forcemain be twinned. This will provide the additional capacity that is required in each of the servicing strategies as well as relieve the high velocities currently being experienced in the forcemain under peak conditions. Twinning will also provide redundancy to a critical pumping station. This upgrade should be completed by 2026.

RIVER STREET PS INLET SEWER TWINNING

There is a small section of sewer between Cataraqui Street and River Street pumping station that was not twinned when the section upstream (Harbourfront Trunk Sewer) was completed. It is recommended that this 250 m section be completed. This upgrade should be completed by 2036.

RIDEAU STREET COLLECTOR

There is a 250 m section of the sewer at the downstream end of the Rideau Collector before it connects to the Harbourfront Trunk Sewer that reduces from 600 mm to 375 mm. Replacing this section of the sewer with 600 mm will relieve this issue. Once this upgrade is complete, PCP#52 should be monitored for a period of time and if no overflows are experienced, it can be plugged. This upgrade should be completed by 2036.

RAVENSVIEW TRUNK SEWER

The trunk sewer conveys all of the flow from the central and east systems and transfers it to the Ravensview WWTP. By conveying more flow from the central area, the Ravensview trunk sewer is required to be twinned. The analysis further supports the Class EA that was previously completed for this project which recommended twinning of the sewer along Hwy 2. This upgrade should be completed by 2036.

3.4.4 EAST COLLECTION SYSTEM ALTERNATIVE SOLUTION ANALYSIS

3.4.4.1 SEWER CONVEYANCE AND CAPACITY ANALYSIS

There were no issues of note in the east collection system related to gravity capacity and conveyance.

3.4.4.2 PUMPING STATION CONVEYANCE AND CAPACITY ANALYSIS

The Schooner Drive PS is projected to exceed its current firm capacity by 2036. It has been reported by Utilities Kingston that Schooner Drive PS is scheduled to be decommissioned and a new PS (Riverview PS) is to be installed to service the existing service area as well as the new development.

Recommendations

It is recommended that Utilities Kingston continues with the replacement of Schooner Drive PS with new Riverview PS.

3.4.4.3 WASTEWATER TREATMENT PLANT ANALYSIS

Currently, the Ravensview wastewater treatment plant was not observed to exceed the plant capacity for the 1:10yr storm or the ADF by 2036. It did just reach the 80% of the rated ADF by full build-out. The 80% threshold was used to indicate the requirement to begin the planning and design of required upgrades to ensure they can be constructed in time. The figure below illustrates the projected flows at Ravensview.

Recommendations

The recommended upgrades to the central and east collection system increase the wastewater flow to the WWTP slightly (Refer to figure below). The ADF flows between 2021 and 2036 are below the 80% limit and reach the limit by full build-out. The 1:10yr peak flow does exceed the rated capacity by 1.5% in 2021, 2.2% by 2036 and by full build-out the peak flow reduced down to within less than 1% of the rated capacity. Based on this marginal exceedance of the peak flow and as the ADF is below the limit, an upgrade is not recommended at this time.

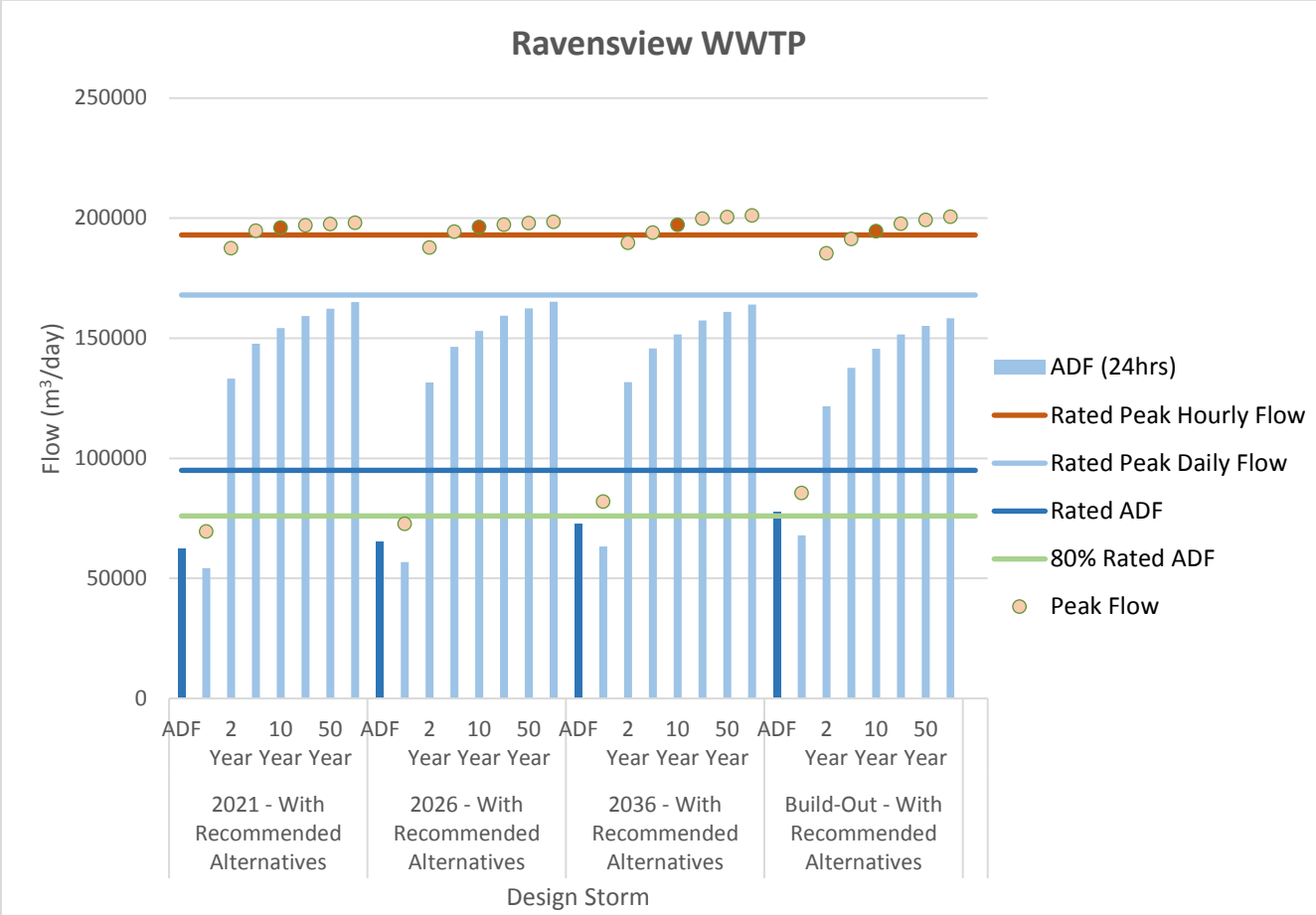

Figure 3-6 Ravensview WWTP Capacity with Alternatives

3.4.5 WET-WEATHER INFLOW REDUCTION

An important component of the future servicing needs is to reduce the amount of wet-weather inflow. Reducing wet-weather inflow also reduces maintenance and operational costs while making available capacity for future development. However, wet-weather inflow reduction targets are difficult to quantify, and results are typically not guaranteed.

A system has been developed to flag or prioritize catchment areas based on their wet-weather influence. This system was developed to consider two factors:

OVERALL BENEFIT

Some areas have significant wet-weather flow, while others do not. Therefore the overall potential reduction or wet-weather amount is a considered. Once this was determined, it was scored using the following criteria:

Table 3-15 I/I Ranking Based on Observed Wet-weather Flow

WET-WEATHER FLOW (L/S)	SCORE
0-10	1
11 -100	2
101 – 250	3
>250	4

INFLOW VERSUS AREA

To determine the scale of the potential repairs to the system, the wet-weather flow (2yr peak flow minus the dry peak flow) was compared to the catchment area. Once this was calculated, a scoring using the following ranges was used:

Table 3-16 I/I Ranking Based on Inflow Rate

INFLOW RATE (L/S/HA)	SCORE
0.0 – 0.15	1
0.16 – 0.45	2
0.46 – 1.0	3
>1.0	4

Based on these criteria the following table provides a summary of this analysis. Note that in order to focus on a specific catchment area, any catchment area draining into downstream catchment areas have been removed.

The modeling results for 2015 for the dry weather and a 2yr design storm were used to provide an indication of the wet-weather response of the system. The approach described above was applied, and summary of the evaluation can be seen below in Table 3-1.

Table 3-17 I&I Evaluation Summary Central Collection System

SYSTEM	CATCHMENT AREA	WET-WEATHER SCORE	INFLOW SCORE	I&I RATING
West	Bath Rd.	2	2	4
West	Bath – Collins Bay+	2	4	8
West	Bath – Lower	1	2	2
West	Bayridge Dr.	1	3	3
West	Collins Bay Rd.	1	1	1
West	Coverdale Dr.	1	1	1
West	Crerar Blvd.	2	3	6
West	Days Rd.	3	2	6
West	Hillview Rd.	2	2	4
West	John Counter Blvd.	1	4	4
West	Lakeshore Blvd.	2	1	2
West	Rankin Cres.	1	1	1
West	Westbrook Rd.*	1	1	1
Central	Dalton Ave.	4	3	12

SYSTEM	CATCHMENT AREA	WET-WEATHER SCORE	INFLOW SCORE	I&I RATING
Central	Greenview Dr.	2	4	8
Central	King St.3	4	4	16
Central	King – Elevator Bay+	1	4	4
Central	King – Lake Ontario	1	2	2
Central	King - Portsmouth2	3	3	9
Central	Morton St.	1	3	3
Central	Palace Rd.	2	2	4
Central	River St.3	4	2	8
Central	Yonge St.	1	3	3
East	Barrett Ct.+	2	1	2
East	Highway 15+	1	1	1
East	James St.+	1	1	1
East	Kenwoods Cir.	1	2	2
East	Schooner Dr.	1	2	2

Good	Moderate	High	Very High

As Days Rd PS had a high rating and based on the process of eliminating upstream drainage areas and the number of upstream drainage areas it was difficult to fully eliminate their influence based on the process used. Therefore, a separate analysis of the main tributary areas has been completed to provide additional information:

Table 3-18 I&I Evaluation Summary West Collection System

CATCHMENT AREA	WET-WEATHER	INFLOW	I&I RATING
Day Rd Inlet	2	2	4.00
Northwest Collector	2	2	4.00
Northcentral Collector	3	1	3.00
Northeast Collector	2	1	2.00
Remaining Area	3	3	9.00

Based on the results, the following is a summary of the conclusions:

- Complete additional flow monitoring for Bath-Collins Bay to verify the wet-weather influence.
- Complete additional flow monitoring for Crerar PS once Point Pleasant process effluent is removed to verify the wet-weather influence.
- Develop I&I strategy for the Days Road PS high wet-weather area.
- Develop I&I strategy for Greenview and Dalton PS.
- Continue with Portsmouth I&I reduction program.

It should be noted that I&I investigations do not always identify the sources and therefore do not always lead to a wet-weather reduction to the extent that a capacity increase could be avoided. Therefore the recommended upgrades to meet the indicated LOS should be implemented. If work is completed that reduces wet-weather influence, these results should be considered during the design of the upgrades.

3.5 RELIABILITY AND RESILIENCY

Reliability refers to the system's ability to handle routine upsets such as pipe breaks or planned maintenance. Resiliency refers to the ability to recover from major upsets such as the loss of components with long replacement lead times or the upset of complex processes. The amount of reliability is dependent on many factors and is ultimately up to the operating authority based on the level of risk they are willing to take. To provide some guidance a number of items were reviewed, and the following items were determined to be valuable to the overall system:

- Back-up power
- Forcemain redundancy
- Condition of facilities

In order to provide a framework for Utilities Kingston to improve reliability, these aspects were reviewed and improvements recommended.

3.5.1 BACKUP POWER

Backup power to a facility is an important aspect to provide reliability to that service area. Water supply is typically maintained during a power outage, and therefore sewage flows will continue. Additionally, power outages often occur during storms when the flows are their highest. Based on the analysis completed, the following stations had the highest facility risk and would benefit from backup power:

- River Street PS
- King Street PS
- Dalton Avenue PS
- Days Road PS

Of the four stations listed above, River Street PS and Dalton Avenue PS are the only stations full backup power. Backup power should be considered at King Street PS and Days Road PS. Backup power at these locations would increase the reliability and resiliency of the collection system given the large catchment areas they serve.

3.5.2 FORCEMAINS

Another important aspect of system reliability is the system's ability to continue to transfer wastewater to the WWTP during a repair or equipment failure.

The four highest risk stations are River St, King St, Dalton and Days Road PS. Each of these is reviewed below based on the noted criteria:

3.5.2.1 RIVER STREET PS

The River Street 1050 mm forcemain has recently been twinned its entire length. If there was an issue with one of the forcemains the flow could be directed to a single forcemain. In this scenario, the peak flow velocities would range from 0.77m/s to 2.25m/s for the dry weather flow and 1:10yr storm flow during the 2015 and 2036 scenarios. While these velocities are higher than typically desired, they would only be experienced during peak flow conditions and would not be destructive to the forcemain.

3.5.2.2 KING STREET PS

The King Street PS has a single 600 mm forcemain. This forcemain has been recommended to be twinned to provide addition capacity and reduce the overall velocity under normal conditions. If one of the forcemains were unavailable, the velocity would be higher than 3m/s under peak flow conditions. However, King PS has a dynamic pump system between the Harbourfront trunk sewer and the King St storage tank. This system could be used to reduce the flows maintaining velocities below 3m/s for short durations during normal operating conditions.

3.5.2.3 DALTON AVE PS

The Dalton Ave PS has a 600 mm and 450 mm forcemain. If all flows were directed to the 600 mm forcemain the velocities would range from 0.44m/s to 2.92m/s for the dry weather flow and the 1:10yr storm flow between 2015 and 2036. While these velocities are higher than typically desired, they would only be experienced during peak flow conditions and would not be destructive to the forcemain. Additionally, there have been no reported issues with the 600 mm forcemain.

If all flows were directed to the 450 mm forcemain the velocities would range from 0.78m/s to 5.19m/s for the dry weather flow and the 1:10yr storm flow during the 2015 and 2036 scenarios. Additionally under the 1:2yr storm event in all scenarios the velocities exceed 3m/s. Reports of leaks and breaks on the 450 mm forcemain have also been reported. Therefore, if there is a minor storm event occurred during the repair of the 600 mm forcemain, velocities in the main could adversely impact the forcemains integrity. The 450 mm forcemain could be replaced with a 600 mm forcemain to increase reliability.

3.5.2.4 DAYS ROAD PS

Day Road PS has a 900 mm and 600 mm forcemain. Flow through the 600 mm forcemain discharges back into the 900 mm forcemain downstream of the PS or can be re-directed to the gravity sewer on Front Rd, ultimately discharging to the WWTP. If all flows were directed to the 900 mm forcemain, the velocities would range from 0.35m/s to 1.69m/s for the dry weather flow and the 1:10yr storm flows between 2015 and 2036. These velocities are within an acceptable range for peak flow and would not be destructive to the forcemain. In discussions with Utilities Kingston operators, it was noted that there is currently no ability to isolate the 900 mm forcemain from the grit tank at the WWTP headworks. This should be reviewed to develop an isolation plan for this forcemain. No additional issues with the 900 mm forcemain have been reported.

Flows are not able to be isolated to the 600 mm forcemain as the influent pumping station at the WWTP is not adequate to handle the full flows from Days Rd. Therefore if there is a problem with the forcemain along the alignment after the flow has combined (into the 900 mm), there is no redundancy available. If reliability was desired to be increased, this should be reviewed in conjunction with the recommended Days Road PS upgrades to ensure the dynamic relationship between the pumps and forcemain are considered.

3.5.3 CONDITION

As detailed in the condition assessment (WSP, 2015) each facility was rated based on facility risk, equipment risk, and condition rating. Based on these, Days Road PS was the only facility that received a low rating. This station is recommended for an upgrade and renewal of the other equipment should be completed at that time. The remaining facilities have a moderate rating with minor improvements that should be completed to maintain their operation as recommended in the condition report.

3.6 ULTIMATE SCENARIO ANALYSIS

The ultimate servicing strategy is intended to provide general guidance and direction with how to best service the large development areas outside of the existing urban boundary. Given the scale of these areas, significant upgrades are required to service them when fully developed. Interim upgrades and/or phasing of the infrastructure should be evaluated when firm development plans begin to be submitted. The guidance with respect to this scenario is limited to major infrastructure, trunk sewers, pumping stations and treatment plants. The servicing for the areas for the ultimate developments were developed with the concept of using the existing servicing scheme where possible to minimize the additional infrastructure required.

Based on the location of these developments the following table outlines the upgrades that would be required:

Table 3-19 Ultimate Servicing Upgrades West and Central/East

INFRASTRUCTURE	UPGRADES TO SERVICE ULTIMATE SCENARIO
WEST COLLECTION SYSTEM	
Rankin St. PS	PS Firm Capacity Increase to 250 L/s Forcemain Upsizing to 600 mm (Approximately 560m)
Westbrook PS	PS Firm Capacity Increase by approximately 200% to 60 L/s Forcemain Twinning (Approximately 1,930m)
Hillview Ave. PS	PS Firm Capacity Increase to 420 L/s Forcemain Twinning (Approximately 575m)
Days Road PS	PS Firm Capacity Increase to 1,200 L/s
High Gate Park Dr. Collector	Sewer Upsizing to 600 mm between MH 33461-020 to 33383-020 (Approximately 100m)
Collins Bay Collector	Sewer Twinning and Upsizing to 450/600 mm between MH94024-030 to Hillview PS (Approximately 1,500m)
Days Road Inlet Trunk Sewer	Sewer Upsizing to 675 mm between MH 33310-010 to 33125-010 (Approximately 825m)
Cataraqui Bay WWTP	WWTP ADF Capacity Increase to 95,000m^3/day.
CENTRAL/EAST COLLECTION SYSTEM	
Barret Crt PS	PS Firm Capacity Increase to 200 L/s
HWY 15 Trunk Sewer	Sewer Twinning between MH 637056 and Barret Crt PS (Approximately 2,900m)
Ravensview WWTP	WWTP ADF Capacity Increase to 100,000m^3/day and a Peak Flow increase to 225,000m^3/day

3.7 SUMMARY OF RECOMMENDATIONS

The tables below provides a brief summary of the recommended alternatives and the gap which initially triggered the review.

Table 3-20 Summary of Sewer Recommendations: West Collection System

TRUNK / COLLECTOR SEWER	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Bath Road Collector	Some sewer surcharging throughout collector for major storm events	Connect to North East Collector at Bath Rd and Tanner Dr	Full Build-out 1:100yrs Storm	By 2021
Collins Bay Collector	Sewer surcharging throughout collector for major storm events after upgrading Westbrook PS.	Extend Westbrook PS forcemain 100m to the High Gate Park Drive Collector	Full Build-out 1:100yr Storm	By 2021
North West Collector	Sewer surcharging upstream of McKay Street Diversion	Upgrade sewer between manholes 33306-010 & 33022-031 from a 450 mm to 600 mm	Full Build-out 1:100yr Storm	By 2026
Crerar Collector	Basement flooding in service area documented	Continued Flow monitoring	Full Build-out 1:100yr Storm	By 2021
McEwen Dr. Collector	Basement flooding in service area documented	Continued Flow monitoring	1:100yr Storm	By 2021

Table 3-21 Summary of Pumping Station Recommendations: West Collection System

PUMPING STATION	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Crerar Blvd. PS	PS firm capacity exceedance during major storm events. Reported basement flooding in service area.	Hydraulic Review and Continued Flow Monitoring after WTP process water is removed	Full Build-out 1:5yr Storm	By 2021
Hillview Road PS	PS firm capacity exceedance during major storm events. FM velocity exceedance observed for 200 mm section. Condition rating of C	FM upsizing for Hillview PS (200 mm to 300 mm). Firm capacity increased to approximately 185 L/s by forcemain upgrades	Full Build-out 1:10yr Storm	By 2021

PUMPING STATION	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
	reported.			
Days Road PS	PS firm capacity exceedance during major storm events. Condition rating of D reported. Basement flooding in service area documented.	Firm capacity increase to 1,200 L/s	Full Build-out 1:10yr Storm	By 2021
Bath-Collins Bay Road PS	PS firm capacity exceedance during major storm events	Additional Flow monitoring	Full Build-out 1:2yr Storm	By 2021
Lakeshore Boulevard PS	Reported issues of basement flooding in service area	Continued Flow monitoring	Full Build-out 1:100yr	By 2021

Table 3-22 Summary of Sewer Recommendations: Central Collection System

TRUNK / COLLECTOR SEWER	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Notch Hill Collector	Surcharging within 2m of surface during storms larger than the 10yr storm	Upgrade the sewer between Portsmouth Ave and Runnymede Rd to a 600 mm sewer	Full Build-out 1:100yr Storm	2026
North End Trunk Sewer (NETS)	Surcharging within 2m of surface during storms larger than the 10yr storm Flooding in service area documented and overflows	Twin the following sections of sewers: Greenview Dr. to Sherwood Cres. Princess St. to Portsmouth Ave. John Counter Blvd to Dalton Ave. Confirm no SSO and Plug PCP #48 & #50	Full Build-out 1:100yr Storm	Phased completion by the following dates: Phase 1 by 2021 Phase 2 by 2036
Princess St. Collector	Surcharging within 2m of surface during storms larger than the 10yr storm	Upsize the following sections of sewers: Indian Rd to The Pkwy Rd to 525 mm West of Sir John A MacDonald Blvd to Indian Rd to 450/525 mm East of Mooalim Pl to west of Sir John A MacDonald to 450 mm	Full Build-out 1:100yr Storm	Phased completion by the following dates: Phase 1 by 2021 Phase 2by 2026 Phase 3 by 2036
King St. West Collector	Surcharging within 2m of surface during storms larger than the 50yr storm	Upgrade the sewers between County Club Dr. and McDonald	Full Build-out 1:100yr Storm	By 2021

TRUNK / COLLECTOR SEWER	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
		Ave to a 450 mm sewer	Full Build-out 1:100yr Storm	
Collingwood Collector	Surcharging within 2m of surface during storms larger than the 50yr storm Flooding in service area documented and overflows	Upsize the sewers between Helen and Regent St. to 375 mm	Full Build-out 1:100yr Storm	By 2021
Charles St. Collector	Surcharging within 2m of surface during storms large than the 2yr between 2015 and 2026	Confirm Local Sewer Capacity Plug PCP#68	Full Build-out 1:100yr Storm	By 2036

Table 3-23 Summary of Pumping Station Recommendations: Central Collection System

PUMPING STATION	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Dalton Road PS	Meets required LOS Basement flooding in service area documented	Continue with study and flow monitoring	Full Build-out 1:10yr Storm	N/A
King-Portsmouth PS	Meets required LOS after PS upgrade (Imminent project) Basement flooding in service area documented	Continue with Portsmouth Redirection and I&I reduction program.	Full Build-out 1:50yr Storm	N/A
Palace Road PS	Meets required LOS Flooding in service area documented and overflows	Continue to monitor and if power outages are a regular occurrence, consider permanent backup power at this location.	Full Build-out 1:10yr Storm	N/A

Table 3-24 Summary of Infrastructure Gaps for 2036 Level of Service: Central Combined Sewer System

INFRASTRUCTURE	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	TIMING
Combined Sewers	Combined Sewer Overflows	Continue with sewer separation plan	By 2036
King St. PS	Velocities in Forcemain above 3m/s	Twin forcemain	By 2026
River Street PS Inlet Sewer (End of Harbourfront Trunk Sewer)	Surcharging under all scenarios between the 1:2 to the 1:100yr storm	Twin sewer between Cataraqui St. to River St. PS (MH7114-030 to River St. PS) approximately 250m.	By 2036
Rideau St. Collector	Surcharging under all scenarios between the 1:2 to the 1:100yr storm	Upsizing of Sewer between Wellington St. to Raglan Rd	By 2036

		(MH7455-025 to 7106-020), approximately 350m Confirm no CSO and Plug PCP #70	
Ravensview Trunk Sewer	Capacity increase in central system cause surcharging	Twinning of Entire Length, Approximately 3400m	By 2036

Table 3-25 Summary of East Collection System Infrastructure Gaps

INFRASTRUCTURE	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	TIMING
Schooner Dr.	Firm capacity is exceeded during dry conditions by 2036	Replace PS	2036

3.8 POLLUTION CONTROL PLAN UPDATE

Pollution Prevention and Control Plans (PPCP) have been created for the City since 1992 and have evolved over the years to reflect updates to Policy, Environmental Regulations and Municipal Infrastructure. The PPCP outlines programs and strategies to be implemented with the intention of safeguarding public health & safety and to follow best practices prescribed by the Ministry of Environment and Climate Change (MOECC).

The PPCP update completed for this Master Plan includes considerations for the recommended alternatives and maintains the current objectives of 'virtual elimination' and meeting MOE Guideline F-5-5. Guideline F-5-5 is the guiding document for works regarding the development of PPCPs.

3.8.1 MOE GUIDELINE F-5-5

Procedure F-5-5 outlines the guidelines for the treatment of combined and partially separated sewers in municipal and private areas. The objectives of the procedure are as follows:

1. Eliminate the occurrence of dry-weather overflows
2. Minimize the potential for impacts on human health and aquatic life resulting from CSOs
3. Achieve as a minimum, compliance with body contact recreational water quality objectives (Provincial Water Quality Objectives (PWQO) for Escherichia coli (E.coli)) at beaches impacted by CSOs for at least 95% of the four-month period (June 1 to September 30) for an average year

The Ministry requires that the municipality/operating authority of the system satisfies the following:

1. Develop a Pollution Prevention and Control Plan (PPCP)
2. Meet minimum CSO controls
3. Provide additional controls
4. For beaches impaired by CSOs where water quality is not meeting the PQWO for E. coli
5. Where required by receiving water quality conditions as specified in Procedure B-1-1 *"Water Management – Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy, July 1994"*

3.8.2 SYSTEM MONITORING PROGRAM

Utilities Kingston currently operates and maintians a CSO monitoring program. The program has facilitated data collection for use in the study and is necessary for tracking of CSO event volumes, duration and frequency. Monitors are installed that gather information relating to level, flow and pressure at various locations in the collection system. This information is retrieved and analyzed to determine the volume, duration and frequency of overflows at the monitored location.

3.8.3 PPCP UPDATE OBJECTIVE

The objective of the PPCP update was to review available documentation, validate the recommendations made in the 2010 PPCP update, and recommend additional controls to support the City's goal towards 'virtual elimination' of all CSOs. Additionally, a review of existing policies and programs affecting pollution control measures related to the collection system was carried out. The InfoSWMM model was used to estimate resulting impacts and results were compared to the requirements of the MOECC Procedure F-5-5. Many of the recommendations are based on the Alternatives Solutions Report (WSP, 2016). The PPCP consolidates the evaluation and recommendations related to CSO infrastructure in the Central Area, and reduction of extraneous flows to the collections system.

3.8.4 SEWER SEPARATION PROGRAM

The projected sewer separation for the 2021, 2026 and 2036 scenarios was analyzed as part of the Master Plan (refer to Section 3.3.3.4). The results support sewer separation as the primary CSO reduction strategy. It was recommended that the projected sewer separation reduction rate continue, at a minimum, to continue reducing the volume, duration and frequency of combined sewer overflows. This strategy improves conformance with F-5-5 and reduces the scale of major infrastructure conveyance improvements required throughout the systems.

3.8.5 SITE SPECIFIC RECOMMENDATIONS

Based on the findings, each PCP location was reviewed for any site-specific recommendations to support the effort of reduction and 'virtual elimination' of overflows. Findings are summarized in Table 3-26 below. The long-term overflow reduction strategy effects were reviewed for each PCP location in conjunction with the primary servicing strategies and capital improvement recommendations that were identified. The table below provides a summary of all remaining PCPs and their site-specific recommendations.

Common among all locations is that overflow infrastructure should be maintained until demonstrated elimination of overflows is observed as evidenced from flow monitoring. These control structures themselves continue to provide an important service of protecting public safety with the reduction of sewer back-ups which in turn may cause basement flooding. The general overflow elimination priorities by type are listed below:

1. **Sanitary Sewer Overflows (SSO)** – SSOs are recommended to be plugged through capital works as these areas no longer receive direct runoff from combined sewers and form part of a separated sewer system. SSOs should only be plugged/removed if flow monitoring confirms that overflows no longer occur from historic data. SSO locations are currently required to provide emergency relief that prevents sewer back-up and basement flooding.
2. **Combined Sewer Overflows (CSO)** – Combined sewers should be reviewed on a case-by-case basis for CSOs located along local systems once combined sewers are removed upstream of them before considering plugging/elimination. CSOs located along trunk systems should be maintained until combined sewer areas are removed upstream and flow monitoring supports their elimination.

3. **Tank Overflows (TO)** – Tank overflows are recommended to remain for emergency overflow conditions.
4. **Pumping Station Overflows (PSO)** – Pumping station overflows are recommended to remain for emergency overflow conditions.

3.8.6 CSO MONITORING PROGRAM RECOMMENDATIONS

CSO monitoring is recommended to continue and be expanded to include CSOs not currently monitored, or those that are currently only monitored to indicate the occurrence of an overflow event. Monitoring systems that permit the source of flow (storm or sanitary), volume, duration, and frequency should be installed or updated to continue to support monitoring system performance. UK should continue to use MOECC Procedure F-5-5 criteria as the minimum objective for reducing sewer overflows. UK should also continue to use the monitoring program to work towards the goal of “virtual elimination”, where overflows only occur during major rainfall events or during unusually long periods of wet-weather as supported by a review of CSO flow monitoring data.

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Table 3-26 Summary of Site-Specific CSO Recommendations for PPCP

ID# (PCP#)	DESCRIPTION OF LOCATION	TYPE OF DISCHARGE	TRUNK, LOCAL OR OTHER	CURRENT OVERFLOW ACTIVITY	IMPACT FROM SEWER SEPARATION PROJECTION	IMPACT FROM PORTSMOUTH SERVICE AREA REDIRECTION	ADDITIONAL SITE-SPECIFIC RECOMMENDATIONS	COMMENTS
Combined Sewer Overflow (CSO)								
8	Princess St E of Frontenac	CSO	Local	N/A	HIGH	N/A	Permanently plug after completion of hydraulic review and removal of remaining combined sewers.	Temporarily Plugged in 2015. Work upstream and along the Charles St. Collector affects review of PCPs 8, 9, 67 and 71.
9	Frontenac St	CSO	Local	N/A	HIGH	N/A	Permanently plug after completion of hydraulic review and removal of remaining combined sewers.	Temporarily Plugged in 2015. Work upstream and along the Charles St. Collector affects review of PCPs 8, 9, 67 and 71.
52	Raglan and Rideau	CSO	Local	MODERATE	MODERATE	N/A	Complete Rideau St. collector upgrades. Plugging when work and flow monitoring is completed in conjunction with sewer separation work in the long-term	Review flow monitoring in conjunction with PCP#70.
67	Chatham St	CSO	Local	N/A	MODERATE	N/A	Permanently plug after completion of hydraulic review and removal of remaining combined sewers.	Temporarily Plugged in 2015. Work upstream and along the Charles St. Collector affects review of PCPs 8, 9, 67 and 71.
70	Carlisle & Chest Nut	CSO	Local	LOW	MODERATE	N/A	Recommend Rideau St. Collector upgrades. Plugging when work and flow monitoring is completed in conjunction with sewer separation work in the long-term.	Review flow monitoring in conjunction with PCP#52
71	Alfred St	CSO	Local	N/A	MODERATE	N/A	Permanently plug after completion of hydraulic review and removal of remaining combined sewers.	Temporarily Plugged in 2015. Work upstream and along the Charles St. Collector affects review of PCPs 8, 9, 67 and 71.
Pump Station Overflows (PSO)								
43	King-Portsmouth pump Station	PSO	Local	VERY LOW	N/A	N/A	PS to be upgraded. Continue to maintain for emergency overflow purposes and monitor.	PS overflow provides servicing for emergency conditions. New monitoring equipment is to be installed to track frequency, duration and volume of overflows in conjunction with PS upgrades. I&I study currently being completed in 2016
Sanitary Sewer Overflows (SSO)								
34	Helen and Mack	SSO	Local	MODERATE	LOW	N/A	Collingwood Collector upgrades to be completed. Permanently plug/remove after completion of this work	Work projected for completion. Upstream flows contributed by the Palace Road PS.
48	NETS at Sherwood	SSO	Trunk	LOW	N/A	N/A	NETS twinning upgrades to be completed. Plugging when work and flow monitoring is completed after hydraulic and Dalton Ave PS flow review.	This is a large trunk sewer with high I&I documented and is subject to overflows/basement flooding. Overflows to remain in place until works are completed and monitoring clearly illustrates a stop to overflow activity.
50	NETS at Parkway S	SSO	Trunk	VERY LOW	N/A	N/A	NETS twinning upgrades to be completed. Plugging when work and flow monitoring is completed after hydraulic and Dalton Ave PS flow review.	This is a large trunk sewer with high I&I documented and is subject to overflows/basement flooding. Overflows to remain in place until works are completed and monitoring clearly illustrates a stop to overflow activity.

4 VOLUME 4 – CAPITAL IMPROVEMENT PLAN

4.1 CAPITAL PROJECTS

4.1.1 FORWARD

This chapter includes a review and analysis of the capital projects and upgrades required to the wastewater and water infrastructure that services the City of Kingston. The "*Alternatives Analysis and Review*" reports for Water and Wastewater identified preferred capital projects to service future development and recommended timing based on technical merit. The "*Condition Assessment Report*" for Water and Wastewater identified various upgrades based on observed condition and age of existing facilities. The objective of this report is to phase the identified upgrades and capital projects to ensure an integrated plan where projects from both systems are coordinated, making efficient use of operational and capital budgets.

4.1.2 CAPITAL PROJECTS

The tables below provide a brief description of the capital upgrade and an opinion of probable cost in 2016 dollars. The opinion of probable cost is developed based on historic Utilities Kingston capital projects and WSP's experience with projects of similar scale and complexity. The year indicated in the table is when the upgrade is 'required' based on technical criteria identified in the "*Alternatives Analysis and Review*" reports for water and wastewater. Some of the capital projects have scheduling requirements based on other projects being completed or must be implemented in a certain sequence. The comments column identifies these restrictions as well as comments regarding the anticipated urgency of the project. Figures which map the required upgrades by analysis period follow the tables.

Table 4-1 Water Growth/ Development Projects

Water Growth/ Development Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Front Rd. - Interconnect	Install a 1050 mm watermain along Front Rd. between Point Pleasant WTP and Sir John A. Blvd.	'A', 'A+'	2018	$5.0M	Project to be coordinated with Portsmouth PS redirect.
CFB Kingston - Decommissioning	CFB Kingston EST decommissioning	'A', 'A+'	2021	-	Not completed by Utilities Kingston
James St. BS - Capacity Upgrade	James St. Booster Station Phase 1 Upgrade to 27.65 ML/day total and 14.69 ML/day stand-by capacity.	'B'	2021	$5.8M	Currently underway.
Decommission Old Colony & Sydenham BS	Decommission Sydenham Rd. and Old Colony booster stations. Install a PRV/PSV at former the Sydenham BS.	'A', 'A+'	2021	$600K	Project required to be completed before Front Rd. Interconnect is operational and O'Connor EST is taken offline.
New Zone 3 Subzone	Install 3 PRV Chambers, 2 km of 500 mm Watermain, Isolation Valves to create a subzone in Zone 3 south of Gore Rd. (No reconstruction cost included - assumed to be coordinated with HWY 15 widening).	'A', 'A+'	2021	$2.7M	Work to be coordinated with Highway 15 widening (2018) and be completed prior to decommissioning of CFB Tower.
Cataraqui Woods Dr. - New Watermain	Install a new 400 mm watermain along Cataraqui Woods Dr. from Centennial to Sydenham.	'A', 'A+'	2021	$690K	Work to be coordinated with the extension of Cataraqui Woods Dr.
Augusta Dr.- New Watermain	New 400 mm watermain along Augusta Dr. from Atkinson to Cataraqui Woods.	'A', 'A+'	2021	$450K	Work to be coordinated with new development.
Holden - New Watermain	Install 420m of 300 mm Watermain to extend along Holden From Beth Cres. To Cataraqui Woods Dr.	'A', 'A+'	2021	$450K	Work to be coordinated with new development.
O'Connor EST - Decommissioning	Decommission O'Connor EST once the Front Rd. interconnect is operational.	'A', 'A+'	2021	$1.4M	O'Connor EST is to be taken offline once Front Rd. Interconnect is operational. Removal can be deferred further if needed.
Centennial Drive – New Watermain	New Watermain extending between Centennial Dr. and Resource Rd.	'B'	2021	$700K	Design currently underway.
Adjust Operational Levels in Innovation Dr. EST	Adjust operational levels in Innovation Dr. EST once new subzone in Zone 3 is implemented	'A', 'A+'	2021	-	Adjustment to be completed once Zone 3 is operational.
Adjust Operational Levels in Third Ave.	Adjust operational levels in Third Ave. Reservoir	'A', 'A+'	2021	-	Adjustment to be completed once prior to 2021 to ensure functional storage.

Water Growth/ Development Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
John Counter Blvd- New Watermain	New 400 mm watermain along John Counter Blvd. from Indian Rd. to Princess St.	'A', 'A+'	2021	$410K	Work to be coordinated with John Counter Blvd. widening project.
Pearl Ave. - New Watermain	Install 300 mm Watermain Pearl Ave. from Kendal Ave. to Creekford Rd.	'A', 'A+'	2021	$690K	Work to be coordinated with new development.
Balsam Grove - Rideau Trail Watermain Looping	Install 500m of 200 mm watermain to loop Balsam Grove. Extend from Queen Mary Dr. to Sherwood Dr.	'A', 'A+'	2036	$350K	Coordinate with North End Trunk Sewer Twinning
Gardiners Rd. - Watermain Upsizing	Upsize Gardiners Rd. watermain (east) to a 500 mm - 1.2 km from O'Connor Reservoir to Fortune Cres.	'A', 'A+'	2036	$2.6M	Upgrade to address high head loss (important trunk main).
Cataraqui Woods - Watermain Upsizing	Upsize Cataraqui Woods Dr. watermain between Clyde Ct. and Midland Ave. to a 450 mm (900m).	'A', 'A+'	2036	$1.8M	Upgrade to address high head loss (important trunk main).

Table 4-2 Water Fire Flow / Reliability Projects

Water Fire Flow / Reliability Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Calvin Park Watermain Looping	New 150 mm watermain through easements to Norman Rogers Dr. located at Herchmer Dr. (75m), Holland Cr. (96m) out to Norman Rogers Dr., Michael Grass Cres. to Van Order Dr. (85m)	'A', 'A+'	2021	$250K	Upgrade primarily to improve fire flows.
Lower Dr. Watermain Looping	Install 70m of 200 mm dia. Watermain to loop between Lower Dr. and Bath Rd.	'A', 'A+'	2021	$50K	Upgrade primarily to improve fire flows.
Norman Rogers Dr. - Watermain Upsizing	Replace 1 km of 300 mm dia. watermain on Norman Rogers Dr. and Roden Rd. between Van Order Dr. and Johnson St.	'A', 'A+'	2026	$1.9M	Upgrade primarily to improve fire flows. Recently lined.
Dalton Ave. - Watermain Replacement	Replace 1 km of 300 mm Watermain on Dalton Ave. between Division St. to Don St.	'A', 'A+'	2026	$1.9M	Upgrade primarily to improve fire flows. Older pipe numerous breaks along this section.
Creekford Rd. - New Watermain	Install 3.6 km of 300 mm watermain along Creekford Rd. to Westbrook Rd.	'A', 'A+'	2026	$6.7M	Upgrade primarily to improve fire flows and improve redundancy.
Dalton Ave. – Watermain Twinning	Twin watermain along Dalton Ave. between Sir John A. MacDonald Blvd. and Grant Timmins Dr. 300m.	'A', 'A+'	2036	$770K	Upgrade primarily to improve fire flows.

Table 4-3 Water Condition / Age Projects

Water Condition / Age Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Cana WTP - Piping	Replace Insulation to Ensure Longevity of Pipework.	'A', 'A+'	2021	$10K	Work and can be deferred to later date but may cause longevity issue with piping.
King St. WTP - Condition Upgrade	Replace PLC, review process, review diesel pump, replace gaskets, pump outlet piping and header, replace hypochlorite tank due to age and condition.	'A', 'A+'	2021	$175K	Can be deferred to later date but additional maintenance would be required.
Third Ave. Reservoir - Condition Upgrade	Replace pumps; diesel motor for emergency pump and building electrical.	'A', 'A+'	2021	$550K	Can be deferred to later date but additional maintenance would be required
Third Ave. Reservoir - Condition Upgrade	Replace process mechanical (excluding pumps); instrumentation; building mechanical and building electrical due to condition and age.	'A', 'A+'	2026	$400K	Work can be deferred to later date but additional maintenance would be required.
King St. WTP - Condition Upgrade	Replace underground diesel tank, replace sludge tank baffles due to condition and age.	'A', 'A+'	2026	$50K	Can be deferred to later date but additional maintenance would be required
Progress Ave. Reservoir - Condition Upgrade	Replace Pump Control Panel due to condition and age.	'A', 'A+'	2026	$40K	Can be deferred to later date but additional maintenance would be required
Tower St. Tower - Condition Upgrade	Replace building mechanical, actuated valve and manual valves due to condition and age.	'A', 'A+'	2026	$250K	Can be deferred to later date but additional maintenance would be required
James St. BS	Replace Auxiliary Pipework and Generator. Have pumps serviced and reviewed to establish effective life expectancy.		2026		Will be completed with current upgrade
Forest Dr. Standpipe - Condition Upgrade	Replace auxiliary piping, instrumentation, process electrical, building mechanical and building electrical due to condition and age.	'A', 'A+'	2031	$250K	Can be deferred to later date but additional maintenance would be required
James St. BS	Replace pumps, process piping, instrumentation and building mechanical.		2031		Will be completed with current upgrade

Water Condition / Age Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Progress Ave. Reservoir - Condition Upgrade	Replace process mechanical; instrumentation (excluding pump control panel); process electrical; building mechanical and building electrical, roof replacement due to condition and age.	'A', 'A+'	2036	$286K	Can be deferred to later date but additional maintenance would be required
King St. WTP - Condition Upgrade	Repair/rebuild structural concrete ceiling supports due to condition and age.	'A', 'A+'	2036	$30K	Can be deferred to later date but additional maintenance would be required
Third Ave. Reservoir - Condition Upgrade	Roof replacement due to condition and age.	'A', 'A+'	2036	$6K	Can be deferred to later date but additional maintenance would be required
Tower St. Tower - Condition Upgrade	Replace instrumentation, process electrical and building electrical.	'A', 'A+'	2036	$150K	Can be deferred to later date but additional maintenance would be required
James St. BS – Condition Upgrade	Replace pump control panel, roof replacement due to condition and age.	'A', 'A+'	2036	$80K	Can be deferred to later date but additional maintenance would be required

Table 4-4 Wastewater Growth/ Development Projects

Wastewater Growth/ Development Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Alfred/Elm Sewer Upsize	Upsize sewer from 375 mm to 450 mm on Alfred (Princess to Elm) and Elm (Alfred to Chatham).	'A', 'A+'	2021	$450K	Alfred/Elm Sewer Upsize
Days Rd. PS Capacity Increase	Firm capacity be increase to approximately 1,200 L/s	'B'	2021	$9.2M	Days Rd. PS Capacity Increase
Hillview Road PS - Forcemain Upsize	Replace 10m of forcemain from just outside the wet well to the existing 350 mm forcemain with 300 mm pipe.	'A', 'A+'	2021	$190K	Hillview Road PS - Forcemain Upsize
Hwy 15 Trunk Sewer - Upsize	Upsize the Hwy 15 trunk sewer (from 0633-030 to 0631-030) to 450 mm. Work to be coordinated with Hwy 15 widening.	'A', 'A+'	2021	$700K	Hwy 15 Trunk Sewer - Upsize
King St. Collector - Upsize	Upsize King St. collector along King St. W just east of County Club Dr. to McDonald Ave. (manhole 0054-030 to 0051-104) from a 400/350 mm to a 450 mm, approximately 550m	'A', 'A+'	2021	$670K	King St. Collector - Upsize
Multiple Locations - Flow Monitoring	Conduct flow monitoring at Crerar Collector, McEwen Dr. collector, Bath-Collins Bay Road PS, Lakeshore Boulevard PS	'A', 'A+'	2021	$20K	Multiple Locations - Flow Monitoring
North End Trunk Sewer - Twinning Phase 1	Twining of the sewer along Queen Mary heading north from Greenview Dr. to Sherwood Cres (manhole 9341-010 to 2284-131), approx. 900m. Twin from Princess St. heading north to south of John Counter Blvd. (manhole 2284-010 to 509081) ,approximately 700m	'A', 'A+'	2021	$3.0M	North End Trunk Sewer - Twinning
Princess St. Collector – Phase 1	Indian Rd. to The Pkwy Rd. to a 525 mm	'A', 'A+'	2021	$1.2M	Princess St. Collector
Schooner Dr. PS Replacement	Replace Schooner Dr. PS with new Riverview PS.	'B'	2021	$2.0M	Schooner Dr. PS Replacement
Westbrook PS - Capacity Upgrades	Upgrade the capacity of Westbrook PS to 30 L/s firm capacity.	'A', 'A+'	2021	$500K	Westbrook PS - Capacity Upgrades

Wastewater Growth/ Development Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Westbrook PS - Flow Redirect	Redirecting the flows from Westbrook Rd. PS that currently discharge in the Collins Bay Collector at Beaver Cres by extending the forcemain approximately 100m across Collins Bay Rd. to connect into the High Gate Park Drive Collector	'A', 'A+'	2021	$230K	Westbrook PS - Flow Redirect
Cataraqui Bay WWTP - Design	Planning and design for the Phase 2 upgrade	'C'	2026	$1.0M	Cataraqui Bay WWTP - Design
Collingwood St. Collector - Upsize	Upsizing of the sewer along Helen St. to Mack, along Mack to Regent St. and along Regent St. to Dundas St. (manhole 0423-010 to 04511-020) from a 300 mm to a 375 mm, approximately 400m	'A', 'A+'	2026	$600K	Collingwood St. Collector - Upsize
North West Collector between Lincoln Dr. to Pembridge Cres	Upsize along Bayridge Dr. from Lincoln Dr. to Mayfair Cres to just east of Pembridge Cres and Truedell Rd. (between manholes 33306-010 & 33022-031) from a 450 mm to a 600 mm, approximately 1,300m.	'A', 'A+'	2026	$2.3M	North West Collector between Lincoln Dr. to Pembridge Cres
Notch Hill Collector - Upsize	Upsizing of the sewer along Notch Hill Rd. from Portsmouth to Runnymede Rd. (between manholes 9716-010 to 3942-030) from a 450 mm to a 600 mm, approximately 350m	'A', 'A+'	2026	$660K	Notch Hill Collector - Upsize. May be able to be deferred if I&I is reduced.
Princess St. Collector – Phase 2	West of Sir John A MacDonald Blvd. to Indian Rd. to a 450/525 mm	'A', 'A+'	2026	$1.9M	Princess St. Collector
Cataraqui Bay WWTP - Capacity Upgrade	Construction of Phase 2 upgrade.	'C'	2031	$20.0M	Cataraqui Bay WWTP - Capacity Upgrade
North End Trunk Sewer – Phase 2	Twin sewer along John Counter Blvd. heading north to Dalton Ave. (manhole 614091 to 1760-010), approximately 1900m.	'A', 'A+'	2036	$3.4M	North End Trunk Sewer
Palace Road PS - Back Up Power	Install permanent backup generator	'A', 'A+'	2036	$150K	Palace Road PS - Back Up Power
Princess St. Collector – Phase 3	East of Mooalim Pl to west of Sir John A MacDonald to a 450 mm	'A', 'A+'	2036	$1.2M	Princess St. Collector

Table 4-5 Wastewater CSO Projects

Wastewater CSO Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
West St. CSO - Weir Adjustment	West St. bypass (PCP#26) weir adjustment to 75.5m	'A', 'A+'	2015	$10K	West St. CSO - Weir Adjustment
Sewer Separation	Separate 45ha of combined sewers in the central collection area. Refer to CSO separation plan.	'A', 'A+'	2021	$23.1M	Sewer Separation
King-Portsmouth PS - Capacity Upgrade and Flow Redirect	Upgrade the capacity of King-Portsmouth PS to 425 L/s firm capacity and install a new forcemain to redirect flow to Cataraqui Bay WWTP	'B'	2021	$10.0M	King-Portsmouth PS - Capacity Upgrade and Flow Redirect (EA is complete)
Sewer Separation	Separate 36ha of combined sewers in the central collection area. Refer to CSO separation plan.	'A', 'A+'	2026	$14.1M	Sewer Separation
Sewer Separation	Separate 36ha of combined sewers in the central collection area. Refer to CSO separation plan.	'A', 'A+'	2036	$14.2M	Sewer Separation
King St. PS - Twin Forcemain	Twin 282m of 600 mm forcemain	'A', 'A+'	2026	$560K	King St. PS - Twin Forcemain
Harbour Front Trunk Sewer - Twinning	Twin 250m of sewer between Cataraqui St. and River St. pumping station	'A', 'A+'	2036	$1.1M	Harbour Front Trunk Sewer - Twinning
Rideau St. Collector - Upsize	Upsize a 250m section of the sewer at the downstream end before it connects in the Harbourfront Trunk sewer from a 375 to a 600 mm	'A', 'A+'	2036	$460K	Rideau St. Collector - Upsize
Ravensview Trunk Sewer - Twinning	Twinning Ravensview Trunk Sewer entire length, approximately 3400m	'B'	2036	$27.0M	Ravensview Trunk Sewer - Twinning. EA is complete.
Charles St. Collector - Capacity Investigation	Confirm Local Sewer Capacity, Plug PCP#68	'A', 'A+'	2036	$12K	Charles St. Collector - Capacity Investigation

Table 4-6 Wastewater Condition / Age Projects

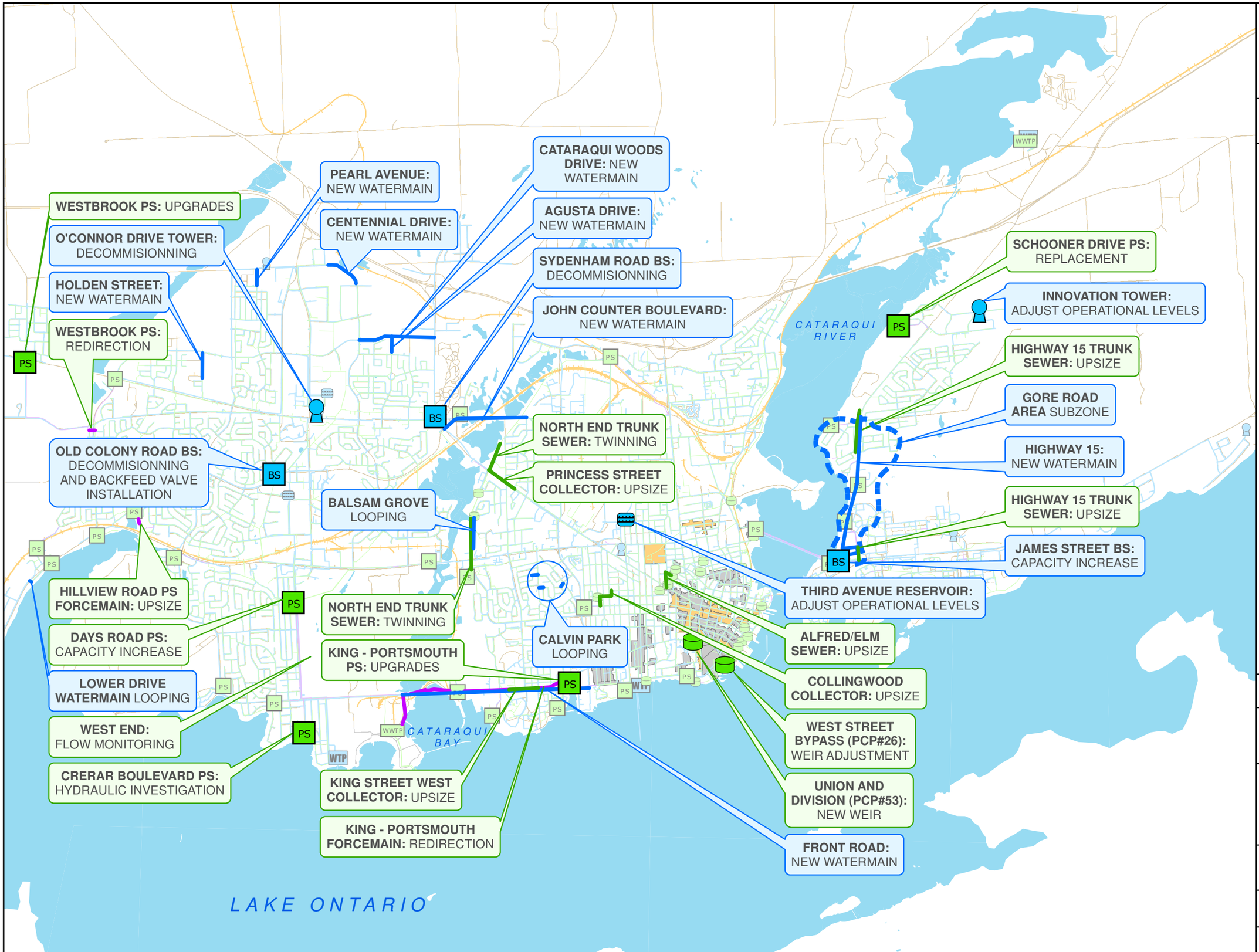
Wastewater Condition / Age Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Bath Lower PS - Condition Upgrade	Replace pump control panel, main breaker and sensors/transmitters due to condition and age.	'A', 'A+'	2021	$100K	Bath Lower PS - Condition Upgrade
Bayridge PS - Pump Control Panel and Pipe Supports	Replace Pipe supports and Pump Control Panel due to condition and age.	'A', 'A+'	2021	$95K	Bayridge PS - Pump Control Panel and Pipe Supports
Coverdale PS - Control Panel Replacement	Replace pump control panel due to condition and age.	'A', 'A+'	2021	$60K	Coverdale PS - Control Panel Replacement
Crerar PS - Hydraulic Investigation	Hydraulic investigation of Crerar PS to identify cause of discrepancy between ECA capacity and actual pumping capacity.	'A', 'A+'	2021	$8K	Crerar PS - Hydraulic Investigation
Dalton Ave. PS - Structural Review	Structural review to be completed - evidence of water ingress in dry well	'A', 'A+'	2021	$4K	Dalton Ave. PS - Structural Review
James St. PS - Control Panel	Replace pump control panel due to condition and age.	'A', 'A+'	2021	$40K	James St. PS - Control Panel
John Counter Blvd. PS - Driveway Repair	Repair damaged location in the driveway.	'A', 'A+'	2021	$3K	John Counter Blvd. PS - Driveway Repair
Kenwoods Circle PS - Valves and Piping	Replace pipework and valves due to condition and age	'A', 'A+'	2021	$150K	Kenwoods Circle PS - Valves and Piping
Lakeshore Blvd. PS - Condition Upgrade	Replace pump control panel, repair/replace flow meter, replace generator controller due to condition and age.	'A', 'A+'	2021	$105K	Lakeshore Blvd. PS - Condition Upgrade
Morton St. PS - Flow Meter	Repair / replace flow meter due to condition.	'A', 'A+'	2021	$10K	Morton St. PS - Flow Meter
Notch Hill PS - Condition Review	Complete condition review of facility	'A', 'A+'	2021	$4K	Notch Hill PS - Condition Review
Palace Rd. PS - Condition Review	Complete condition review of facility	'A', 'A+'	2021	$4K	Palace Rd. PS - Condition Review
Rankin PS - Valves and Pipework	Replace pipework and valves due to condition and age	'A', 'A+'	2021	$50K	Rankin PS - Valves and Pipework

Wastewater Condition / Age Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Ravensview WWTP - Condition/Age Upgrades	Change grit channel conveyor drive to soft start/vfd so power/torque is not immediate, portable actuator to open headworks sluice gate, verification of ventilation rates and gas detection system at headworks, steel sprockets are to be added and oilers added to keep chains lubricated on primary clarifiers/scum removal. Review hydraulics to determine if bypass chamber wall can be raised to prevent BAF effluent overflow during peak flows, replace roof on anaerobic digesters, install fabric hatches at locations along the centerline to permit operators taking measurements of bead depth, review Location of analyzer/probe in BAF.	'A', 'A+'	2021	$1.2M	Ravensview WWTP - Condition/Age Upgrades
Young St. PS - Condition Review	Complete condition review of facility	'A', 'A+'	2021	$4K	Young St. PS - Condition Review
Barret Ct. PS - Condition Upgrade	Replace pumps, pump control panel, sensors and transmitters, instrument panel, transformer, distribution panel, main breaker, generator and diesel tank due to condition and age.	'A', 'A+'	2026	$415K	Barret Ct. PS - Condition Upgrade
Bath Lower PS - Condition Upgrade1	Replace pipe work (add Isolation valves if not present) and instrument panel due to condition and age	'A', 'A+'	2026	$100K	Bath Lower PS - Condition Upgrade
Bath-Collins Bay - Pipework Replacement	Replace Pipework and Valves due to corrosion build up.	'A', 'A+'	2026	$50K	Bath-Collins Bay - Pipework Replacement
Collins Bay PS - Condition Upgrade	Replace pipework and valves; pump control panel; instrument panel and sensors/transmitters due to condition and age	'A', 'A+'	2026	$150K	Collins Bay PS - Condition Upgrade
Coverdale PS - Instrumentation Upgrade	Replace Instrument Panels and Sensors/Transmitters	'A', 'A+'	2026	$40K	Coverdale PS - Instrumentation Upgrade
Greenview PS	Condition Review	'A', 'A+'	2026	$4K	Greenview PS - Condition Review
Hillview PS - Condition Upgrade	Replace pipework, valves, sensors / transmitters and instrument panel.	'A', 'A+'	2026	$250K	Hillview PS - Condition Upgrade

Wastewater Condition / Age Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
James St. PS - Condition Upgrade	Replace pumps, sensors/transmitters, instrument panel and building mechanical due to condition and age.	'A', 'A+'	2026	$600K	James St. PS - Condition Upgrade
Kenwoods Circle PS - Condition Upgrade	Replace pump control panel, instrument panel, sensors/transmitters, transformer due to condition and age	'A', 'A+'	2026	$400K	Kenwoods Circle PS - Condition Upgrade
King St. PS - Instrumentation Upgrade	Replace Instrument Panel and Sensors/Transmitters due to condition and age.	'A', 'A+'	2026	$160K	King St. PS - Instrumentation Upgrade
King-Elevator Bay PS	Replace Pipework, Valves, Instrument Panel and Sensor/Transmitter.	'A', 'A+'	2026	$200K	King-Elevator Bay PS
King-Lake Ontario Park PS - Control Panel	Upgrade pump control panel due to condition and age	'A', 'A+'	2026	$30K	King-Lake Ontario Park PS - Control Panel
Lakeshore Blvd. PS - Condition Upgrade1	Replace instrument panel, sensors/transmitters, pipework and valves due to condition and age.	'A', 'A+'	2026	$250K	Lakeshore Blvd. PS - Condition Upgrade
Ravensview WWTP - Condition/Age	Upgrade heat exchanger due to corrosion, evaluate pumping system for effluent water	'A', 'A+'	2026	$300K	Ravensview WWTP - Condition/Age Upgrades
Barret Ct. PS - Condition Upgrade	Replace pipework, valves and instrumentation; HVAC & heaters due to age and condition.	'A', 'A+'	2031	$150K	Barret Ct. PS - Condition Upgrade
Bath-Collins Bay	Replace instrument panel and sensors / transmitters due to age and condition	'A', 'A+'	2031	$60K	Bath-Collins Bay
Bayridge PS - Condition Upgrade	Replace pump discharge pipework and valves; instrument panel and sensors/transmitters due to age and condition.	'A', 'A+'	2031	$175K	Bayridge PS - Condition Upgrade
Crerar Blvd. PS - Condition Upgrade	Replace pump control panel, instrument panels and sensors/transmitters due to age and condition	'A', 'A+'	2031	$100K	Crerar Blvd. PS - Condition Upgrade
Dalton Ave. PS - Condition Upgrade	Pipework, valves and instrumentation age and condition.	'A', 'A+'	2031	$400K	Dalton Ave. PS - Condition Upgrade
Highway 15 PS - Condition Upgrade	Replace pumps, pipework, valves, instrumentation, transformer, generator, diesel tank, process electrical and building mechanical.	'A', 'A+'	2031	$800K	Highway 15 PS - Condition Upgrade

Wastewater Condition / Age Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Kenwoods Circle PS - Condition Upgrade	Replace all process electrical and building mechanical due to condition and age.	'A', 'A+'	2031	$100K	Kenwoods Circle PS - Condition Upgrade
King St. PS - Condition Upgrade	Replace pump control panel, process electrical (excluding generator) and building mechanical due to condition and age.	'A', 'A+'	2031	$600K	King St. PS - Condition Upgrade
King-Elevator Bay PS - Condition Upgrade	Replace pump control panel, pumps, flowmeter, diesel generator and tank due to age and condition.	'A', 'A+'	2031	$500K	King-Elevator Bay PS - Condition Upgrade
Morton St. PS - Instrumentation Upgrade	Replace instrument panels and sensors/transmitters due to condition and age.	'A', 'A+'	2031	$75K	Morton St. PS - Instrumentation Upgrade
Notch Hill PS - Condition Upgrade	Pump control panel and sensors/transmitters due to age and condition.	'A', 'A+'	2031	$40K	Notch Hill PS - Condition Upgrade
Palace Rd. PS - Condition Upgrade	Replace pipework, valves and Instrumentation due to age and condition	'A', 'A+'	2031	$325K	Palace Rd. PS - Condition Upgrade
Rankin PS - Instrumentation Upgrade	Replace instrumentation due to age and condition	'A', 'A+'	2031	$75K	Rankin PS - Instrumentation Upgrade
Ravensview WWTP - Concrete Repairs	Review concrete decay and leaks in tunnels under primary clarifiers.	'A', 'A+'	2031	$30K	Ravensview WWTP - Concrete Repairs
River St. PS - Condition Review	Condition Review	'A', 'A+'	2031	$8K	River St. PS - Condition Review
Young St. PS - Condition Upgrade	Pump control panel and sensors/transmitters due to age and condition.	'A', 'A+'	2031	$40K	Young St. PS - Condition Upgrade
Bath Rd. PS - Condition Upgrade	Replace pipework, valves, and instrumentation due to age and condition.	'A', 'A+'	2036	$250K	Bath Rd. PS - Condition Upgrade
Collins Bay PS - Electrical Upgrade	Main Breaker replacement due to age and condition.	'A', 'A+'	2036	$5K	Collins Bay PS - Electrical Upgrade

Wastewater Condition / Age Projects	Description	EA Schedule	Timing	Cost 2016 $	Comments
Coverdale PS - Pipework	Pipework and valves to be replaced due to condition and age.	'A', 'A+'	2036	$85K	Coverdale PS - Pipework
John Counter Blvd. PS - Instrumentation Upgrade	Replace instrumentation due to age and condition	'A', 'A+'	2036	$100K	John Counter Blvd. PS - Instrumentation Upgrade
Morton St. PS - Condition Upgrade	Replace pipework, valves and pump control panel condition and age.	'A', 'A+'	2036	$150K	Morton St. PS - Condition Upgrade
Ravensview WWTP - Condition Upgrade	Replace corroded piping under the primary tanks.	'A', 'A+'	2036	$250K	Ravensview WWTP - Condition Upgrade



WSP
1224 GARDINERS RD, SUITE 201
KINGSTON, ONTARIO,
CANADA, K7P 0G2
WWW.WSPGROUP.COM

Utilities Kingston
UTILITIES KINGSTON,
P.O. BOX 790,
KINGSTON, ONTARIO,
K7L 4X7

Legend

- WASTEWATER PUMPING STATION
- WASTEWATER TREATMENT PLANT
- COMBINED SEWER OVERFLOW FACILITY
- WATER TREATMENT PLANT
- WATER STORAGE TANK
- WATER RESERVOIR
- BOOSTER PUMPING STATION
- WASTEWATER PIPE
- FORCEMAIN
- WATER PIPE
- COMBINED SEWER AREA REMOVED
- COMBINED SEWER AREA REMAINING
- WATERBODY

CAPITAL PROJECTS

- WASTEWATER PUMPING STATION
- COMBINED SEWER OVERFLOW FACILITY
- BOOSTER PUMPING STATION
- WATER STORAGE TANK
- WATER RESERVOIR
- WASTEWATER PIPE
- FORCEMAIN
- WATER PIPE
- NEW SUBZONE

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale:
0 350 700 1,400 Meters
1:55,000

N W E S

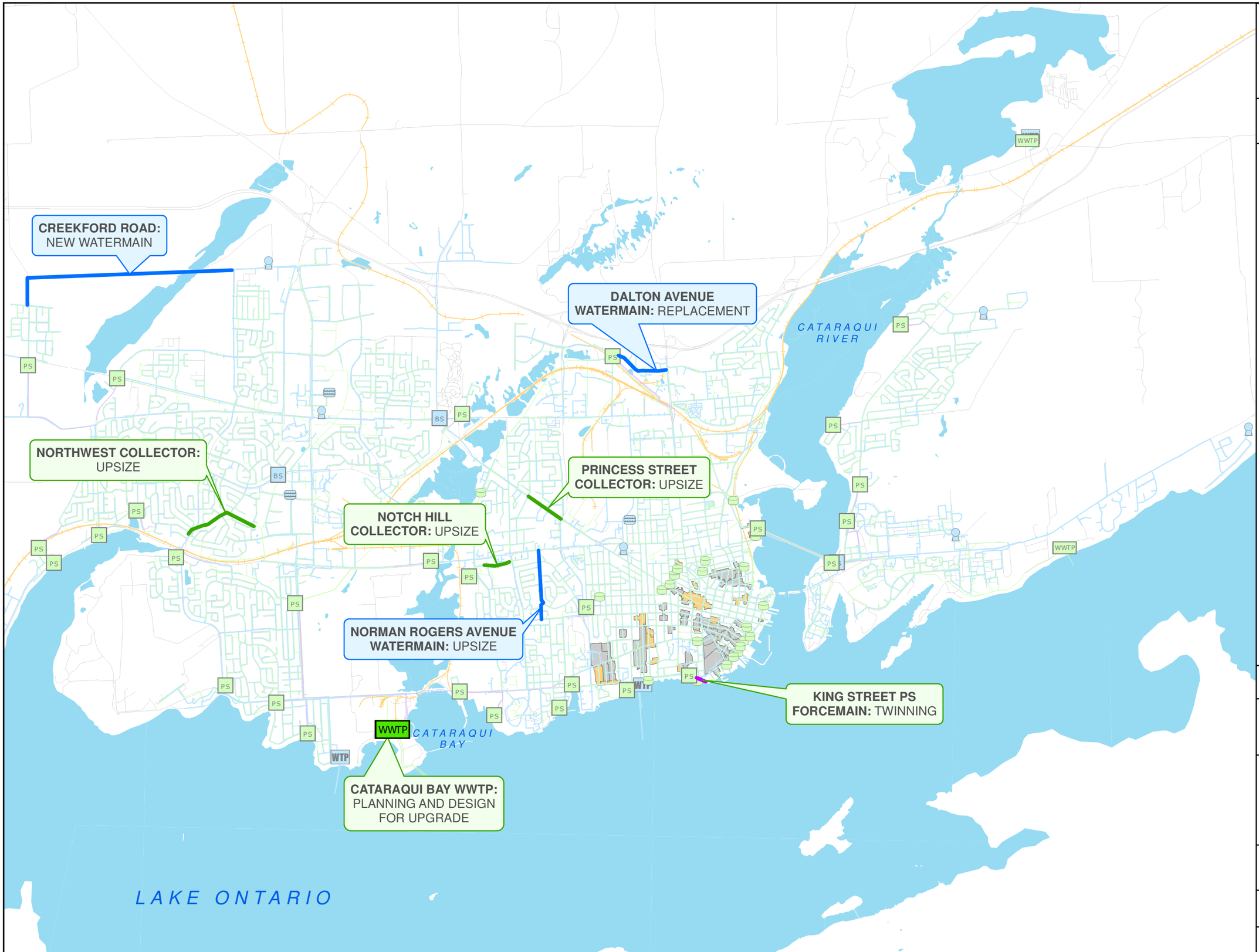
Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
CAPITAL PROJECTS 2021

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MS	MP	4-1

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\4.0 Class EA\Master Plan Report\Maps\151-02944-00_CIP_Fig4-1_CapitalProjects2021.mxd



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Utilities Kingston
UTILITIES KINGSTON,
P.O. BOX 790,
KINGSTON, ONTARIO,
K7L 4X7

Legend

- PS — WASTEWATER PUMPING STATION
- WWTP — WASTEWATER TREATMENT PLANT
- COMBINED SEWER OVERFLOW FACILITY
- WTP — WATER TREATMENT PLANT
- WATER STORAGE TANK
- WATER RESERVOIR
- BS — BOOSTER PUMPING STATION
- WASTEWATER PIPE
- FORCEMAIN
- WATER PIPE
- COMBINED SEWER AREA REMOVED
- COMBINED SEWER AREA REMAINING
- WATERBODY

CAPITAL PROJECTS

- WWTP — WASTEWATER TREATMENT PLANT
- WASTEWATER PIPE
- FORCEMAIN
- WATER PIPE

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale:
0 350 700 1,400 Meters
1:55,000

N W E S

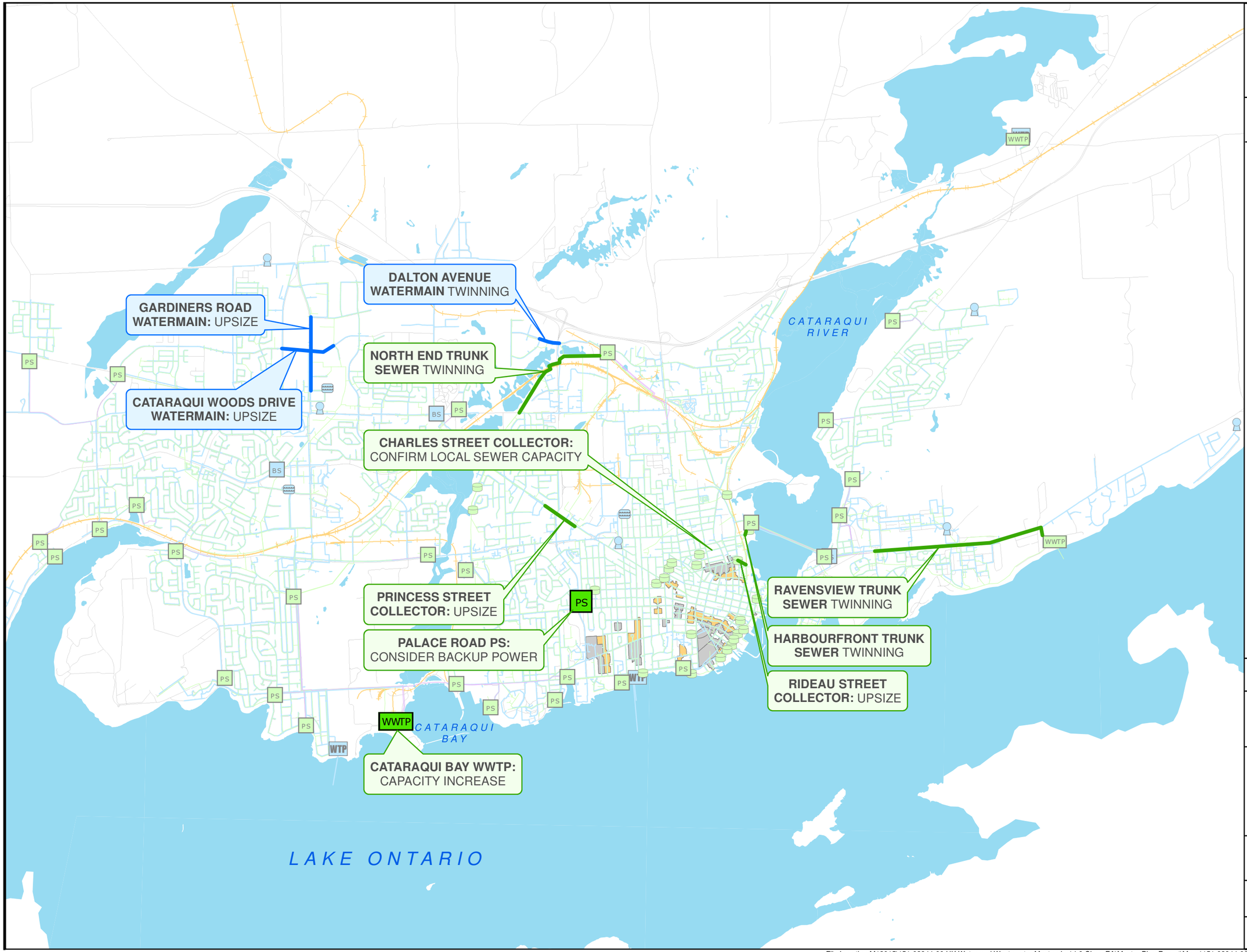
Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
CAPITAL PROJECTS 2026

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MS	MP	4-1

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\4.0 Class EA\Master Plan Report\Maps\151-02944-00_CIP_Fig4-2_CapitalProjects2026.mxd



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Utilities Kingston
UTILITIES KINGSTON,
P.O. BOX 790,
KINGSTON, ONTARIO,
K7L 4X7

Legend

- WASTEWATER PUMPING STATION
- WASTEWATER TREATMENT PLANT
- COMBINED SEWER OVERFLOW FACILITY
- WATER TREATMENT PLANT
- WATER STORAGE TANK
- WATER RESERVOIR
- BOOSTER PUMPING STATION
- WASTEWATER PIPE
- FORCEMAIN
- WATER PIPE
- COMBINED SEWER AREA REMOVED
- COMBINED SEWER AREA REMAINING
- WATERBODY

CAPITAL PROJECTS

- WASTEWATER PUMPING STATION
- WASTEWATER TREATMENT PLANT
- COMBINED SEWER OVERFLOW FACILITY
- WASTEWATER PIPE
- WATER PIPE

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale:
0 350 700 1,400 Meters
1:55,000

N W E S

Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
CAPITAL PROJECTS 2036

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MS	MP	4-3

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\4.0 Class EA\Master Plan Report\Maps\151-02944-00_CIP_Fig4-3_CapitalProjects2036.mxd

4.2 SCHEDULE

The proposed capital projects and renewal schedule has been developed with the goal of ensuring projects are coordinated to optimize costs while maintaining a balanced spending rate where possible. The schedule should be considered flexible, with the ability to advance or defer projects based on available funding and/or updated observations regarding the reasoning for the upgrade. A detailed version of the charts and figures below can be found in the "*Capital Improvement Plan*" for water and wastewater respectively.

4.2.1 WATER CAPITAL PROJECTS

The figure below illustrates the proposed annual capital expenditures for the wastewater system.

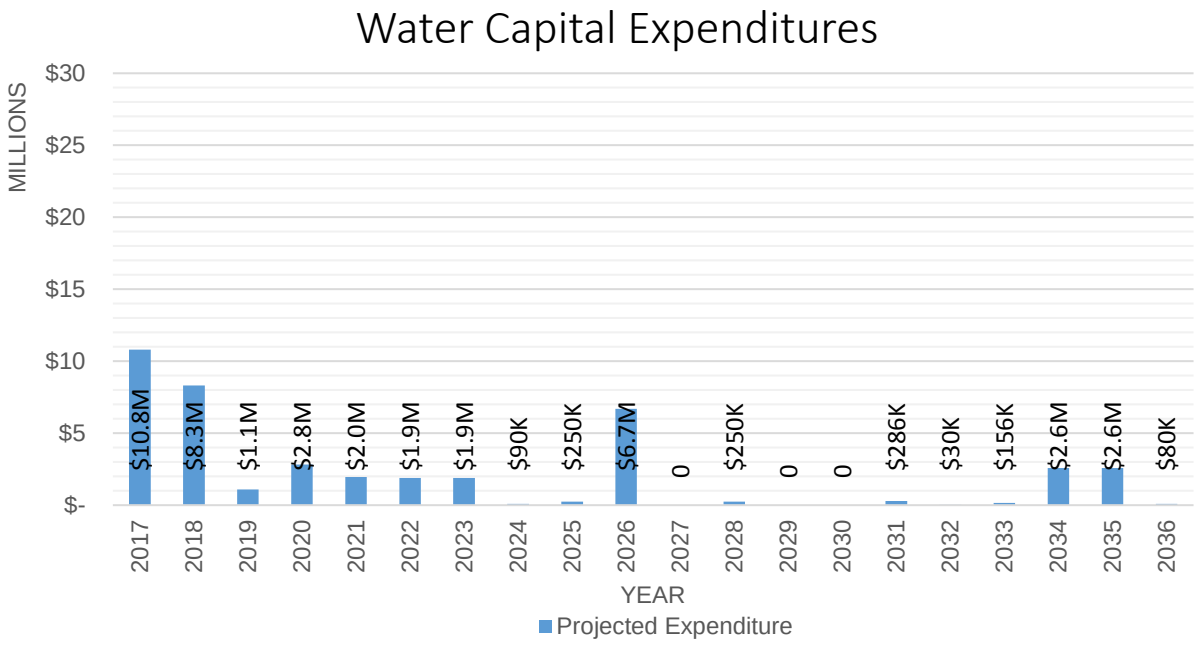

Figure 4-4 Water Capital Expenditures

Table 4-7 Water Capital Expenditures

Prior to 2021	Prior to 2026	Prior to 2036
2017	**2022**	**2028**
Front Rd. – Interconnect	Norman Roger's Ave. – Watermain Upsizing	Forest Dr. Standpipe – Condition Upgrade
James St. BS – Capacity Upgrade	**$1.9M**	**$250K**
$10.8M	**2023**	**2031**
2018	Dalton Ave. – Watermain Replacement	Progress Ave. Reservoir – Condition Upgrade
Cana WTP – Piping	**$1.9M**	**$286K**
Decommission Old Colony & Sydenham BS	**2024**	**2032**

- Front Rd. – Interconnect
- New Zone 3 Subzone

$8.3M

2019

- Cataraqui Woods – New Watermain
- Third Ave. Reservoir – Condition Upgrade

$1.1M

2020

- Augusta Dr.- New Watermain
- Balsam Grove – Rideau Trail Watermain Looping
- Holden – New Watermain
- King St. WTP – Condition Upgrade
- O'Connor EST – Decommissioning

$2.8M

2021

- Adjust Operational Levels in Innovation Dr. EST
- Adjust Operational Levels in Third Ave.
- Calvin Park Watermain Looping
- CFB Kingston – Decomissioning
- John Counter – New Watermain
- Lower Dr. Watermain Looping
- Pearl Ave. – New Watermain
- Third Ave. Reservoir – Condition Upgrade

$2.0M

- King St. WTP – Condition Upgrade
- Progress Ave. Reservoir – Condition Upgrade

$90K

2025

- Tower St. Tower – Condition Upgrade

$250K

2026

- Creekford Rd. – New Watermain

$6.7M

- King St. WTP – Condition Upgrade

$30K

2033

- Third Ave. Reservoir – Condition Upgrade
- Tower St. Tower – Condition Upgrade

$156K

2034

- Gardiners Rd. – Watermain Upsizing

$2.6M

2035

- Cataraqui Woods – Watermain Upsizing
- Dalton Ave. – Watermain Twinning

$2.6M

2036

- James St. BS – Condition Upgrade

$80K

4.2.2 WASTEWATER CAPITAL PROJECTS

The figure below illustrates the proposed annual capital expenditures for the wastewater system. The historic capital expenditures have been plotted for reference. It should be noted that these values have been obtained from Utilities Kingston Annual Report and may contain other capital expenses that are not captured through the analysis completed for the Master Plan.

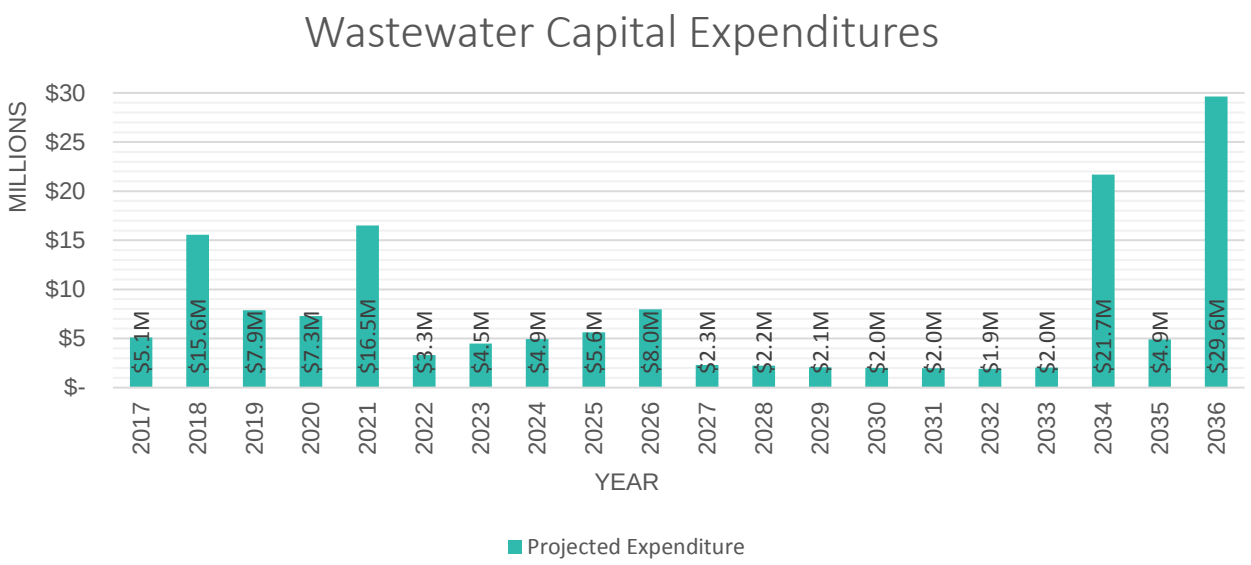

Figure 4-5 Wastewater Capital Expenditures

Table 4-8 Timing of Capital Expenditures

	Prior to 2021	Prior to 2026	Prior to 2036
2017	Westbrook PS – Capacity Upgrades		
	Sewer Separation		
	$5.1M		
2018	West St. CSO – Weir Adjustment		
	Westbrook PS – Flow Redirect		
	Dalton Ave. PS – Structural Review		
	John Counter Blvd. PS – Driveway Repair		
	King-Portsmouth PS – Capacity Upgrade and Flow Redirect		
	Hwy 15 Trunk Sewer – Upsize		
	Sewer Separation		
	$15.6M		
2019	Multiple Locations – Flow Monitoring		
	Crerar PS – Hydraulic Investigation		
	King St. Collector – Upsize		
	Bayridge PS – Pump Control Panel and Pipe Supports		
	Morton St. PS – Flow Meter		
	Alfred/Elm Sewer Upsize		
	Schooner Dr. PS Replacement		
2022		Barret Ct. PS – Condition Upgrade	
		Coverdale PS – Instrumentation Upgrade	
		King-Lake Ontario Park PS – Control Panel	
		Sewer Separation	
		$3.3M	
2023		North End Trunk Sewer – Twinning	
		Bath-Collins Bay – Pipework Replacement	
		Greenview PS – Condition Review	
		Kenwoods Circle PS – Condition Upgrade	
		Sewer Separation	
		$4.5M	
2024		Notch Hill Collector – Upsize	
		King St. PS – Twin Forcemain	
		Ravensview WWTP – Condition/Age Upgrades	
		Collins Bay PS – Condition Upgrade	
		Hillview PS – Condition Upgrade	
		King-Elevator Bay PS	
		Sewer Separation	
2027			Highway 15 PS – Condition Upgrade
			Morton St. PS – Instrumentation Upgrade
			Sewer Separation
			$2.3M
2028			Ravensview WWTP – Concrete Repairs
			Kenwoods Circle PS – Condition Upgrade
			King St. PS – Condition Upgrade
			Rankin PS – Instrumentation Upgrade
			Sewer Separation
			$2.2M
2029			Bath-Collins Bay
			Crerar Blvd. PS – Condition Upgrade
			King-Elevator Bay PS – Condition Upgrade
			Sewer Separation
			$2.1M
2030			Barret Ct. PS – Condition Upgrade
			Dalton Ave. PS – Condition Upgrade
			Young St. PS – Condition Upgrade

	Prior to 2021
	Sewer Separation
	$7.9M
2020	Hillview Road PS – Forcemain Upsize
	North End Trunk Sewer – Twinning
	James St. PS – Forcemain Upsize
	Coverdale PS – Control Panel Replacement
	Lakeshore Blvd. PS – Condition Upgrade
	Rankin PS – Valves and Pipework
	Sewer Separation
	$7.3M
2021	Days Rd. PS Capacity Increase
	Ravensview WWTP – Condition/Age Upgrades
	Bath Lower PS – Condition Upgrade
	James St. PS – Control Panel
	Kenwoods Circle PS – Valves and Piping
	Notch Hill PS – Condition Review
	Palace Rd. PS – Condition Review
	Young St. PS – Condition Review
	Sewer Separation
	Princess St. Collector
	$16.5M

	Prior to 2026
	$4.9M
2025	North West Collector between Lincoln Dr. to Pembridge Cres
	Bath Lower PS – Condition Upgrade
	King St. PS – Instrumentation Upgrade
	Lakeshore Blvd. PS – Condition Upgrade
	Sewer Separation
	$5.6M
2026	Cataraqui Bay WWTP – Design
	Harbourfront Trunk Sewer – Twinning
	James St. PS – Condition Upgrade
	Sewer Separation
	Collingwood St. Collector – Upsize
	Princess St. Collector
	$8.0M

	Prior to 2036
	Sewer Separation
	$2.0M
2031	Bayridge PS – Condition Upgrade
	Notch Hill PS – Condition Upgrade
	Palace Rd. PS – Condition Upgrade
	River St. PS – Condition Review
	Sewer Separation
	$2.0M
2032	Palace Road PS – Back Up Power
	Ravensview WWTP – Condition Upgrade
	Coverdale PS – Pipework
	Sewer Separation
	$1.9M
2033	Rideau St. Collector – Upsize
	Morton St. PS – Condition Upgrade
	Sewer Separation
	$2.0M
2034	Cataraqui Bay WWTP – Capacity Upgrade
	Bath Rd. PS – Condition Upgrade
	Sewer Separation
	$21.7M
2035	North End Trunk Sewer
	John Counter Blvd. PS – Instrumentation Upgrade
	Sewer Separation
	$4.9M
2036	Charles St. Collector – Capacity Investigation
	Ravensview Trunk Sewer – Twinning
	Collins Bay PS – Electrical Upgrade
	Sewer Separation
	Princess St. Collector
	$29.6M

5 VOLUME 5 – MITIGATION MEASURES

5.1 MITIGATION MEASURES

This section will outline the general mitigation measures that should be carried out during the planning and construction associated with the preferred alternatives outlined in Volume 2 and Volume 3.

Further site specific measures for the water and wastewater projects should be analyzed in preliminary and detailed design. During construction of the alternatives there are potential impacts to the natural environment as well as social, cultural, economic and other impacts.

5.2 NATURAL ENVIRONMENT IMPACTS

There are anticipated impacts to the natural environment during construction. These shall be minimized where possible through the use of mitigation measures or avoidance alternatives. The potential impacts relate to vegetation, wildlife & wildlife habitats, and aquatic habitats & communities. Table 5-1 outlines the anticipated construction activities and potential impacts that may result from these activities. In addition, there are mitigation measures to minimize these potential impacts with a description of the residual effect that may remain.

Table 5-1 Natural Environment Impacts, Mitigation Measures, and Residual Effects

Potential Activity	Potential Effect/Impact	Mitigation Measure or Avoidance Alternative	Residual Effect
Vegetation Clearing/Grubbing Removal of ground cover vegetation and trees may be necessary.	▪ Reduced bank stability ▪ Increased erosion/runoff entering watercourse, waterbody and wetland. ▪ Alteration to existing aquatic and terrestrial habitats ▪ See Construction Timing	▪ Secure work area with erosion control fencing prior to vegetation removal. Fencing should be inspected regularly. ▪ Re-vegetate disturbed area with native planting, during appropriate periods. Erosion control fencing should remain in-place until plantings are established. ▪ A minimum 1:1 native tree planting compensation plan to be employed. ▪ Trees not proposed for removal, occurring within 30 m of the proposed development areas should be protected with tree protection fencing. ▪ Stabilize banks to pre-disturbance condition.	▪ Areas cleared of vegetation can be restored to pre-disturbance condition. ▪ No negative residual impact is anticipated.
Excavation Terrestrial excavation necessary for	▪ Increased erosion potential ▪ Loss of vegetation	▪ See Vegetation Clearing/Grubbing ▪ Stockpiling of material on site should occur a minimum of 30 m away for a watercourse,	▪ Area will be restored to pre-disturbance condition.

Potential Activity	Potential Effect/Impact	Mitigation Measure or Avoidance Alternative	Residual Effect
placement of infrastructure, resulting in exposed soils.		waterbody, wetland or other sensitive area.	▪ No negative residual impact is anticipated.
Placement of Material Placement of foreign materials in aquatic and/or terrestrial environments may be necessary to support design criteria.	▪ Change in channel morphology ▪ Barrier to fish passage ▪ Disturbance to sensitive habitats ▪ Increased erosion potential & sedimentation ▪ Alteration of flow conditions ▪ Change in habitat structure ▪ Introduction of invasive species ▪ Introduction of contaminants	▪ See Vegetation Clearing/Grubbing ▪ See Excavation ▪ See Construction Timing ▪ Only material free of invasive species shall be brought on site. ▪ Only clean material shall be brought on site.	▪ Material brought on site will not negatively alter the form or function of the aquatic or terrestrial environments. ▪ No negative residual impact is anticipated.
Use of Industrial Equipment Industrial equipment may be necessary to carry out excavation, vegetation clearing or construction activities.	▪ Increased erosion potential & sedimentation ▪ Disturb or kill local fauna ▪ Potential for oil, grease or fuel leaks	▪ See Vegetation Clearing/Grubbing ▪ See Excavation ▪ See Construction Timing ▪ Prepare a spill management plan for on-site activities. ▪ Ensure equipment is regularly maintained (i.e. free of leaks, clean). ▪ Refuel equipment a minimum of 30 m from all watercourses, waterbodies, wetlands or other sensitive areas.	▪ Application of mitigation measures will result in no change to the form and function of the aquatic and terrestrial environments. ▪ No negative residual impact is anticipated.
Flow Management Dewatering may alter flow conditions.	▪ Change in migration/access to habitats ▪ Change in habitat structure and cover	▪ Contain and dewater in-water work areas as per a work-specific isolation/containment plan. ▪ Pumps should be outfitted with fish screens ▪ Transfer fish captured from isolated areas, downstream	▪ Application of mitigation measures will result in no change to the form and function of the aquatic and terrestrial environments.

Potential Activity	Potential Effect/Impact	Mitigation Measure or Avoidance Alternative	Residual Effect
	▪ Increased erosion potential and sedimentation ▪ Change in water temperature, contaminant and nutrient concentrations	▪ See Construction Timing.	▪ No negative residual impact is anticipated.
Water Extraction Water extraction (e.g. dewatering, placement of material) may be necessary to undertake construction works.	▪ Change in flow conditions ▪ Disturbing or killing fish ▪	▪ See Placement of Material	▪ Alteration to natural flow will be temporary. ▪ No negative residual impact is anticipated.
Construction Timing Construction work may occur during one or more consecutive seasons.	▪ Impact to nesting birds ▪ Impact to migration stopover site ▪ Impact to Species at Risk (e.g. Barn Swallow) ▪ Impact to spawning fish ▪ Impact to nesting or overwintering turtles ▪ Impacts to affect use of migration corridors or linkage areas	▪ See Species at Risk ▪ In-water work should adhere to the warmwater timing window, whereby work is not permitted between April 1st and June 30th of any given year. ▪ No vegetation removal (e.g. ground cover, shrubs or trees) between May 1st and July 31st of any given year. Where vegetation removal is necessary within this period, a qualified biologist must first confirm vegetation is free of nesting birds and eggs. ▪ Pre-construction inspection for turtles and snakes should be carried out. Construction activities should not occur during the turtle nesting season (i.e. May 15 to June 30). No in-water works should occur between October 15th and April 15th of any given year. ▪ Exclusionary fencing should be erected in areas where turtles may be impacted. The fencing should extend 10-50 m beyond the endpoint and be angled to	▪ Adherence to the construction timing windows will limit potential impact to species during critical life stages. ▪ No negative residual impact is anticipated.

Potential Activity	Potential Effect/Impact	Mitigation Measure or Avoidance Alternative	Residual Effect
		deter turtles from crossing the road.	
Species at Risk Species at Risk may be encountered during construction activities.	▪ Disturb or kill Species at Risk	▪ See Construction Timing ▪ Where a Species at Risk is encountered on site, activities should stop immediately. The individual(s) must not be handled. The Ministry of Natural Resources should be contacted for further direction. ▪ Pre-construction inspection for nesting fauna and eggs should be carried out prior to construction. ▪ Where a Barn Swallow nest is observed, all construction activities should be restricted to April 15 to August 15 of any given year. Where construction in or surrounding a nest is necessary, structures (e.g. bridges) should be blocked with screen or tarps prior to April 15. ▪ Exclusionary fencing should be placed along the perimeter of the site no later than the September prior to construction. The fencing should prevent turtles from accessing the area for overwintering or nesting.	▪ Application of mitigation measures will result in no change to the form and function of the aquatic and terrestrial environments. ▪ No negative residual impact is anticipated.

5.3 SOCIAL, CULTURAL AND ECONOMIC IMPACTS

5.3.1 TRAFFIC

Construction projects for the preferred water and wastewater alternatives have the potential to impact traffic within the City of Kingston. Traffic management plans should be developed with the City of Kingston Traffic Department. These plans may involve one (two-way) lane staying open at all times and being controlled by temporary traffic signals and/or flagmen control over the length of the work area. The impacts to traffic should be minimized as much as possible during construction. The main impact to traffic will could be lane closures and the increase in construction traffic for delivery of material and equipment and haulage of spoils. Construction signage should be posted outside the construction zone to make motorists aware of the construction and allow them to take alternate routes.

5.3.2 LAND USE

Temporary disruption of the business within construction areas is possible. Signage should be posted to inform detouring motorist that businesses are still open and accessible. Larger destinations within the affected areas should have major alternate routes available to minimize affect.

5.3.3 ARCHAEOLOGY AND HERITAGE FEATURES

Within the City of Kingston there is often a potential that construction areas will be in proximity to designated heritage structures or overlap with areas in the municipality that have known archaeological sites, areas with potential for archaeological resources, and more specific locations with sensitive cultural remains such as cemeteries often labeled as sensitive archaeological areas. If this is the case, an Archaeological Investigation Report (Stages 1 and 2) should be completed to ensure there are no archaeological areas of interest within construction zones. In the event of an archaeological find during construction, all works will be suspended, and the authorities contacted to investigate the site.

If the area to be physically impacted by the proposed activities has already been disturbed by road construction, sewer, and infrastructure development, it is unlikely there will be a concern. However, depending on the proximity of the work to designated heritage structures, a statement of potential impacts and mitigation measures is required to satisfy the Ontario Heritage Act requirements.

- Design and locate new infrastructure required along routes with the largest setback from heritage buildings (center of ROW within roadway) and along the least compact streetscapes wherever possible;
- Prior to construction, the contractor must become familiar with the locations of all known built heritage resources and cultural heritage landscapes adjacent to the area of the undertaking and, as outlined herein, take steps to prevent any impact to those heritage resources;
- Prior to construction, a vibration susceptibility analysis must be conducted to establish baseline data on identified built heritage resources. Should the analysis indicate that a resource will be unduly impacted, a building monitoring program must be implemented during construction;
- If during the process of development previously undetected built heritage resources or cultural heritage landscapes are identified, work in the area should cease and the developer or their agents should immediately notify the City of Kingston' heritage Planner; and
- During construction and after the completion of construction activities, the City of Kingston heritage planning staff will inspect the property to confirm that there are no unanticipated adverse impacts on the built heritage or cultural heritage landscapes. Should any damage be done to an existing structure, the City of Kingston's Policy on Masonry Restoration in Heritage Buildings is to be followed.

There is an amount of noise, dust, and vibration associated with construction projects that is unavoidable. The potential sources of noise, dust, and vibration are trunk traffic and regular construction activities. These impacts can generally be mitigated by doing the following:

- Excavated materials will be used on-site as much as possible in order to minimize trunk haulage to off-site disposal areas;
- The majority of construction activities, including trunk traffic and excavation equipment operation will be restricted pursuant to local municipal noise bylaws. The bylaw states that there will be no construction activity between 7pm and 7am (9am on Sundays) – Monday to Saturday and all day Sundays and Statutory Holidays;

- Dust control agents will be applied as necessary;
- Dry exposed soil will be sprayed with water to make it less susceptible to wind erosion and covered if left for extended periods of time;
- A building monitoring program will be implemented for buildings in close proximity to construction activities to assess effects from exposure; and
- Heavy equipment will be restricted to remain with the existing roadways R.O.W.

5.3.4 PUBLIC NOTIFICATION

Public notification for construction of the preferred water and wastewater alternatives should be facilitated through newspaper ads, construction signage and flyers to local residents and businesses. All emergency services (Police, Fire, EMS) will be contacted and notified of the project and specifically where construction is to impact access to public roads.

5.4 UTILITY IMPACTS

When construction activities occur within public road allowances, there is a potential to impact existing utilities. This includes existing watermains, sewers, gas mains, buried cable and telephone lines, and hydro lines and poles. During the design phase, preliminary drawings should be circulated to the utility companies to confirm the location of existing utilities and determine if any relocation will be required.

5.5 GENERAL MITIGATING MEASURES

The following Table 5-2, identifies general mitigation measures that should be carried out during construction of the preferred alternatives. These measures mitigate generally anticipated impacts that may occur during construction. A detailed review of the appropriate mitigating measures for all aspects of the construction of preferred alternatives should be carried out prior to construction.

Table 5-2 General Mitigation Measures

Effect	Mitigating Measures	Application Where/When
Terrestrial Vegetation and Wildlife		
Changes in vegetative composition as a result of loss of topsoil and subsoil mixing	▪ Restore site by replacing soils to preconstruction conditions	▪ Trenching or excavating
Removal or disturbance of significant trees and/or ground flora	▪ Review status of species ▪ Avoid these areas ▪ Employ tree protection measures in accordance with City of Kingston by-laws	▪ During site grading and construction phase of any project
Vegetation removal impacts and effects during construction on birds, nests and breeding	▪ Minimize vegetation removal and stabilize disturbed areas ▪ Vegetation removal should occur outside of core breeding period for birds in eastern Ontario	▪ During detailed design and construction phases ▪ Heavy construction activities should be done outside of May to end of July

Effect	Mitigating Measures	Application Where/When
Heritage Resources		
Unwanted increase in public access and potential vandalism	▪ Fence off area of concern ▪ Prevent public access	▪ Where appropriate with respect to significance of the heritage resource
Threatened viability of, or opportunity for, retention of sites having heritage value	▪ Avoid these areas ▪ Record or salvage information on features to be lost ▪ Relocate cultural resources when possible	▪ Where appropriate with respect to significance of the heritage resource
Unavoidable alteration to, or destruction of, heritage structures or archaeological sites	▪ Record or salvage information on features to be lost ▪ Relocate cultural resources when possible	▪ Where appropriate with respect to significance of the heritage resource
Disruption of quiet enjoyment	▪ Staging of construction to cause least disruption ▪ Employ noise and dust control measures	▪ As general practice
Land Uses		
Disruption of pedestrian movements between adjacent uses	▪ Maintain continuity of pedestrian walkway system as much as possible ▪ Provide walkway strips to adjacent residential areas	▪ As general practice ▪ Where possible
Facilities inconsistent with or which disrupt character of areas	▪ Preserve existing amenities as much as possible ▪ Design and site structures to blend with adjacent building forms and materials ▪ Site grading; utilize berms or other screening devices	▪ As general practice ▪ Where suitable
Temporary disruption during construction and/or inconvenience to users of adjacent properties and building	▪ Notify public agencies and adjacent owners of construction scheduling ▪ Prepare emergency program to ensure quick resolution of servicing problems ▪ Consult with public, agency and/or adjacent landowners regarding temporary access routes ▪ Schedule construction so as to minimize period of	▪ Where substantial inconvenience or disruption to adjacent uses would be experienced and where measures would substantially reduce effects ▪ As general practice

Effect	Mitigating Measures	Application Where/When
	disruption in proximity of adjacent uses and structures ▪ Ensure access for emergency response vehicles/personnel ▪ Apply noise and vibration control measures	
Traffic, noise and dust control	▪ Restrict working hours ▪ Apply dust control agent ▪ Scheduling of construction	▪ Where appropriate ▪ Where traffic impacts are substantial ▪ To protect heritage resources
Pre-construction earthmoving impacts on buildings	▪ Require that the earthworks contractor use the least destructive method available to complete the work. ▪ Complete an existing conditions survey prior to the project commencing	▪ Where appropriate ▪ Required for work adjacent to known and potential heritage resources
Outdoor Recreation		
Temporary disruption of open space activities during construction	▪ Employ noise and dust control measures ▪ Staging of construction to cause least disruption	▪ In areas within or adjacent to public open space
Public Health		
Exhaust emissions from construction equipment and vehicles	▪ Minimize operation on site, control location on site	▪ Where adjacent uses or natural vegetation could be adversely affected
Ground contamination	▪ Construction refueling precautions ▪ Precautions in operation and storage facilities	▪ On site generally

6 VOLUME 6 – PUBLIC CONSULTATION

6.1 PUBLIC AND AGENCY CONSULTATION

6.1.1 PUBLIC CONSULTATION

The following outlines the key aspects of the Public Consultation approach.

Consultation with the public (which includes stakeholders and interested parties) and government review agencies is a necessary and important component of the Municipal Class Environmental Assessment (EA) process. To meet the Class EA Phase 1 and Phase 2 consultation requirements, Utilities Kingston ensured that members of the public and government agencies were informed of the Study. They were given the opportunity to provide input (both written and verbal) on the review process of the problem or opportunity and alternative solutions.

The key aspects of the consultation approach are discussed in the following sections.

6.1.1.1 STAKEHOLDER CONTACT LIST

A stakeholder contact list was developed and is included the appendices. The public and all interested parties had the opportunity to add themselves to the list in order to be circulated on project notices. The public had the opportunity to hear about the Study through project notices published in local newspapers within the City as well as through Utilities Kingston's web-based communication tools such as their website, Facebook page, and Twitter account.

6.1.1.2 WEB BASED TOOLS

PROJECT WEBSITE

Utilities Kingston's website was used to inform the public of the progress of the Master Plan studies. As the studies progressed, updates were conveyed to the webmasters/administrators Utilities Kingston's website so that the information was uploaded to a web page designated for both studies. The site's existence was advertised for the duration of the Study through means of public notices. Project Notices and display materials presented at the PICs were made available for download on the website. Contact information for the key lead at Utilities Kingston and WSP were also included on the site. The page can be found at the following website: (https://utilitieskingston.com/Wastewater/Projects/MasterPlans2015)

SOCIAL MEDIA

To keep up with current information mediums used by the public, Utilities Kingston made use of their Facebook page and Twitter account to post updates regarding the status of the Study as well as to provide information regarding key consultation forums to which the public was invited to attend.

6.1.1.3 PUBLIC AND AGENCY CONSULTATION

The Study followed Approach 1 from the MEA Class EA process for the completion of Master Planning studies and therefore addressed Phase 1 and most of Phase 2 of the Municipal Class EA process. This Master Planning approach includes a broad level of assessment regarding the infrastructure requirements within a given municipality and therefore does not include the site specific analyses required for the

completion of Phase 2 for Schedule B and C (if applicable) projects. Implementation of all Schedule B and C projects will require additional site specific studies (e.g., evaluation of alternative sites or routes), consultation activities and the completion of a Project File. The Water and Wastewater Master Plan Updates required a total of two mandatory points of public consultation to satisfy the requirements of the MEA Class EA process; however, for this Master Plan, four key points of contact throughout the studies were undertaken, namely:

- Issue the Notice of Study Commencement;
- Hold a Public Information Centre (PIC) to present the problem statement and the servicing alternatives;
- Hold a Public Information Centre to present the preferred servicing alternative(s) and the 'road map' by which the recommended infrastructure should be implemented; and
- Issue the Notice of Study Completion.

More details regarding the notices and the PICs are included in the subsections below.

PROJECT NOTICES

The use of Project Notices was made to inform the Public, Agencies and other Stakeholders of the Commencement and Completion of the Studies as well as the timing and details regarding the two Public Information Centres (PICs). WSP sent Project Notices to persons on the Study's contact list, whereas Utilities Kingston arranged to publish the notice in the City's local newspapers. Notices for the PICs were mailed out at least 2 weeks prior to the PIC date and were advertised in the local newspaper within the same time frame.

PUBLIC INFORMATION CENTRES

Two PICs were held during the completion of the Water and Wastewater Master Plan Updates. Since both Master Plan updates were undertaken concurrently, it was fit to consult on the two studies in a single public forum. With projects of this nature, the public consultation process was most critical during the identification and evaluation of servicing alternatives. The first PIC that was held near the beginning of Phase 2 of the EA process introduced the Studies' purposes, the problem statement, the condition of the existing infrastructure and the evaluation approach and criteria. The second PIC was held near the end of Phase 2, with the purpose of presenting the preferred servicing alternatives for each system as well as the phasing plan for all the recommendations. The second PIC focused on what infrastructure is required and the implementation plan.

Interested stakeholders in attendance at either PIC were able to sign up for a Study mailing list so that they could be kept informed of studies' progress. This helped the team to meet special interest groups within the community and identify key areas where further consultation may have been necessary. In order to maximize the feedback from the public, stakeholders and agencies, the PIC materials presented at each PIC were also be made available on Utilities Kingston's website.

Questionnaires were developed and distributed at the PICs in order to solicit feedback from PIC attendees. The questionnaire was also be posted on the Utilities Kingston's website in case an attendee wanted to provide input into the process but was not able to attend the meeting or did not have a chance to pick up a questionnaire.

6.1.2 CONSULTATION WITH KEY STAKEHOLDERS AND AGENCIES

A summary of the comments and questions received from agencies and the public during the Class EA process are included below. Copies of the actual written correspondence received from agencies are provided in the appendices. The comments from key stakeholders are summarized in the following sections.

CITY OF KINGSTON

The City of Kingston Planning Department was consulted to provide input on the Class EA process. The Planning Department provided information on: growth, development projections, locations of developments and timing of developments. This information was reviewed and incorporated into the "*Growth Scenario Report*" and overarching Master Plan report.

The City of Kingston Fire Department was consulted to provide input and comments. The Fire Department provided input regarding the desired fire flow requirements by land use type. This information was incorporated into the master planning process.

KINGSTON CONSTRUCTION ASSOCIATION

The Kingston Constriction Association (KCA) was solicited for input in the master planning process. No comments were received from the KCA.

KINGSTON HOME BUILDERS ASSOCIATION

The Kingston Home Builders Association (KHBA) provided written responses following the first PIC. The KBHA, Altus Group Economic Consulting (Altus) and R.J. Burnside & Associates (Burnside) completed a preliminary review of the "Growth Scenario Report" and provided comments independently. The KBHA, Altus, and Burnside had two major concerns; (1) 2026-2036 growth scenario does not provide an appropriate full range and mix of housing types in conformance with the Provincial Policy and (2) we disagree with the base assumptions influencing the size and cost of the major infrastructure facilities (mainly; treatment plants and pump stations). Specifically the use of design flows versus actual flows and the utilization of only 80% of the rated plant capacity versus 100% when calculating post period benefits. Both of these assumptions lead to higher fees, plant expansions, capital expenditures, excess capacity and ongoing maintenance costs that could have been deferred lowering both water and waste water rates and development/impost charges.

The comments from the KBHA, Altus, and Burnside were reviewed and responded to by WSP and Utilities Kingston. The information was incorporated into revisions of the Master Plan where applicable.

MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE

The Ministry of the Environment and Climate Change (MOECC) was consulted as they are a key stakeholder in this process. The MOECC expressed their concerns with Combined Sewer Overflows specifically relating to the F-5-5 criteria.

CATARAQUI REGION CONSERVATION AUTHORITY

The Cataraqui Region Conservation Authority (CRCA) was solicited as a stakeholder in the Class EA process. The CRCA expressed specific interest in the Pollution Control Plan update and drinking water source protection. Information from the CRCA was reviewed and integrated into the Master Plan.

MINISTRY OF NATURAL RESOURCES AND FORESTRY

The Ministry of Natural Resources and Forestry (MNRF) was contacted to provide commentary on their interests in the master planning process. The MNRF provided general information about MNRF interests to be incorporated in the project. These interests include Significant Natural Heritage Features, Species at Risk, Fisheries, Significant Wildlife Habitat and relevant Acts and approvals. This information was reviewed concurrently with the Class EA process.

EDUCATIONAL INSTITUTIONS

The major educational institutions with the City of Kingston were contacted as key stakeholders as part of the Class EA process. These institutions include Queen's University (Queen's) and St. Lawrence College (SLC). Queen's provided information and commentary on project growth of the University. SLC provided a projection of growth for the next 25-30 years. The information provided was used in the development of the "*Growth Scenario Report*" and Master Plan document.

GENERAL PUBLIC

There were no comments were received from the general public following either of the PICs.

6.1.3 FIRST NATIONS CONSULTATION

First Nations and Métis were key stakeholder groups included in the consultation process. The following initiatives were undertaken to coordinate the engagement of Aboriginal peoples in the Class EA process:

- Developed a stakeholders list of First Nations and Métis communities with existing or asserted rights or claims within the Study Area;
- Reviewed the list with information received from the Ministry of Aboriginal Affairs to confirm aboriginal groups were not overlooked;
- Notified these communities of the Class EA that was underway as well as any consultation activities (e.g., Public Information Centres) that were being held regarding the Study; and
- Followed up with the community contacts to ensure that they had received the Notices regarding the Study