

# CITY OF KINGSTON WASTEWATER MASTER PLAN

GAP ANALYSIS - WASTEWATER



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GAP ANALYSIS - WASTEWATER  
**Utilities Kingston**

## **Type of document (version)**

Project no: 151-2944-00  
Date: January 30, 2017

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January 30<sup>th</sup>, 2017

Mr. Mike Fischer  
Utilities Kingston  
1211 John Counter Blvd  
Kingston, ON, K7L 4X7

Subject: City of Kingston Wastewater Master Plan

Dear Mr. Fischer:

We are pleased to provide the Wastewater System Gap Analysis for the City of Kingston service areas. The purpose of this report is to identify capacity constraints in the Kingston Wastewater System under the existing and future growth scenarios.

A system-wide evaluation of alternative solutions will be completed in a separate report as part of the Master Planning Process. Similarly, details pertaining to the hydraulic model construction and loading are documented separately in the Hydraulic Modeling Report.

We would be happy to discuss this report with you at your convenience.

Yours truly,

A handwritten signature in black ink, appearing to read 'Matt Morkem', written in a cursive style.

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



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# 1 INTRODUCTION

WSP was retained by Utilities Kingston to complete a Master Plan to establish servicing strategies for wastewater infrastructure for the next 20 years. The Master Plan will identify potential projects to address the servicing needs of planned growth and development within the Urban Boundary. The Master Plan is being conducted in accordance with the requirements set out in the Municipal Class Environmental Assessment (Class EA) document (Municipal Engineers Association, Amended 2011).

This report includes a review of the City's design criteria used for estimating sanitary flow and a review of the existing wastewater system. Gaps in the existing infrastructure related to the current and future scenarios are identified. The review is based on population growth projections established in the Growth Scenario Report (WSP, 2015) and projected wastewater generation developed in this report.

The outcome of these results will be the basis for the problem definition and evaluation of alternatives conducted as part of the Master Plan.

## 2 OVERVIEW OF EXISTING SYSTEM

### 2.1 WASTEWATER COLLECTION AND TREATMENT SYSTEMS

Utilities Kingston wastewater infrastructure services an area of approximately 8,258 ha. The system is comprised of 545 km of gravity sewer, 42 pumping facilities, 19 active CSO overflows, 4 CSO storage tanks and 3 wastewater treatment plants. The service area is bordered by Westbrook Road to the west, Macdonald-Cartier Freeway (HWY401) to the north, Ravensview WWTP access road to the east and Lake Ontario to the south. It is split into three zones:

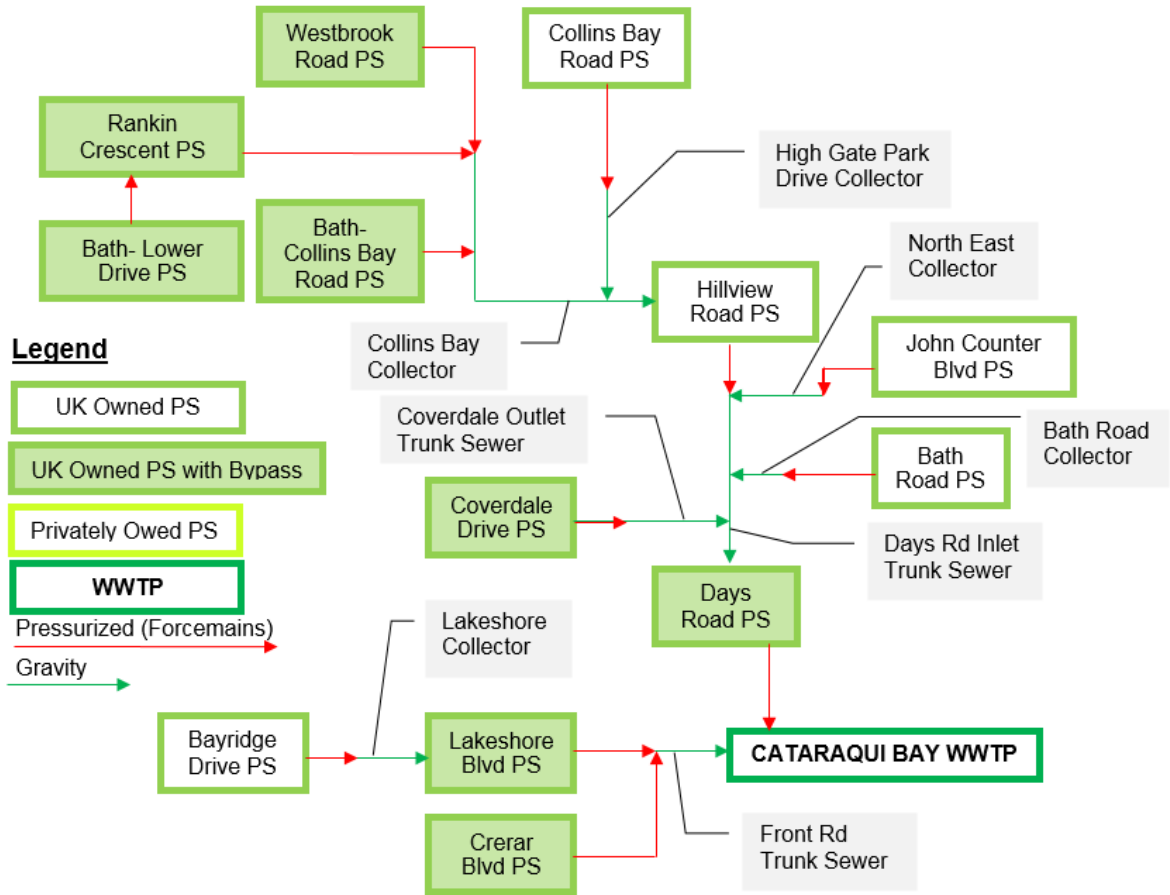
- Kingston West (3,953 ha)
- Kingston Central (2,919 ha)
- Kingston East (1,386 ha)

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. A more detailed description of the existing system can be found in the Baseline Report (WSP, 2015).

#### 2.1.1 KINGSTON WEST COLLECTION

Wastewater flow is collected from Kingston West and conveyed via gravity and pump stations to Cataraqui Bay Wastewater Treatment Plant. Figure 2-1 below illustrates the configuration of the collection system.

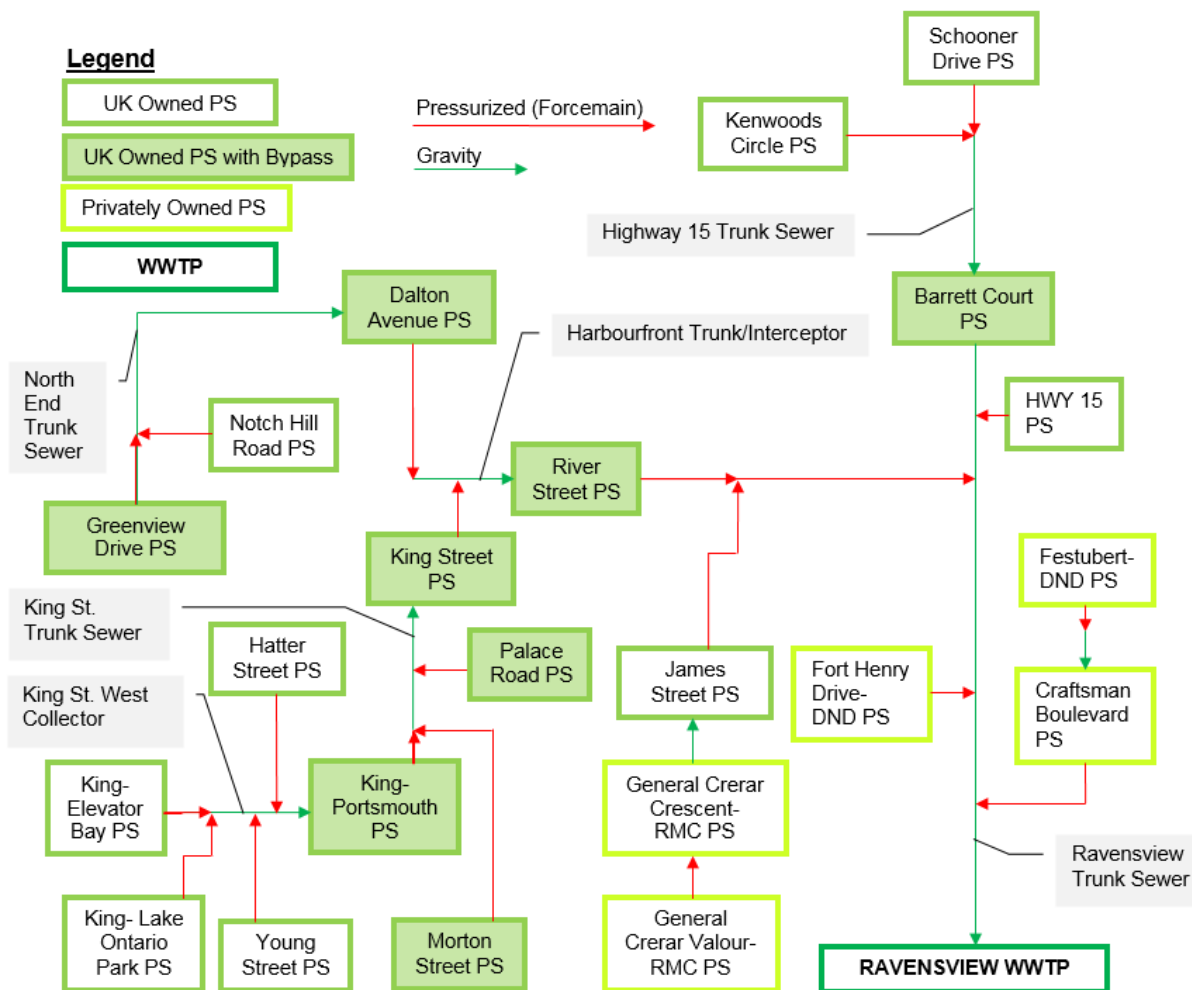
Figure 2-1 Kingston West Collection System



### 2.1.2 KINGSTON CENTRAL AND EAST COLLECTION

Wastewater and combined sewer flow collected from Kingston Central is conveyed via pump stations and gravity sewers to River Street Pumping Station where it is pumped into the gravity portion of the east collection system. This flow is eventually treated at the Ravensview Wastewater Treatment Plant. Figure 2-2 below illustrates the configuration of the collection system.

Figure 2-2 Kingston East and Central Collection System



### COMBINED SEWER OVERFLOW AND BYPASS CHAMBERS

There are currently 19 active combined sewer overflows (CSO) in the City of Kingston; all located in the Central Zone. They range from manholes with weirs to more complex multi-chamber tanks with storage capacity. The purpose of these CSOs is to divert flow from combination sewers to storm outlets during large wet weather flow events. CSO chambers with storage aim to equalize flow rates during wet weather, storing excess volume during periods of high flow. Once the flow subsides, the stored volume slowly returns into the collection system.

#### 2.1.3 TREATMENT FACILITIES

Utilities Kingston treatment facilities include three wastewater treatment plants (WWTP):

- Cataraqui Bay Wastewater Treatment Plant
- Ravensview Wastewater Treatment Plant
- Cana Wastewater Treatment Plant

Cataraqui Bay WWTP is a conventional activated sludge plant treating flow collected in the west collection system. Ravensview WWTP uses biological aerated filters (BAF) to treat flow collected in the central and east systems. The Cana WWTP is a small extended aeration plant treating flow generated in the Cana subdivision. There is no planned development in the Cana subdivision, and the plant is currently being replaced. Therefore this facility has not been evaluated.

## 3 SCENARIOS

### 3.1 DEVELOPMENT SCENARIOS

Based on discussions with Utilities Kingston, the City of Kingston Planning Department, review of previous Master Plans and available reports, five growth scenarios were developed. The development scenarios are further detailed in the Development Growth Criteria Report (WSP, 2015). These scenarios include:

**Table 3-1 Development Scenarios**

Scenario	Description
Existing	- Existing conditions
2021	- Based on Committed and Pending development applications
2026	- Based on remaining Committed and Pending Development applications (“Committed Conditions”)
2036	- Based on future known potential developments
Full Buildout	- Based on undeveloped and under-developed land as of 2036 with their anticipated development density (based on Official Plan)
Ultimate	- Full Buildout plus specific urban boundary extensions

### 3.2 IMMINENT PROJECTS

Utilities Kingston is currently in the process of implementing various infrastructure upgrades and capital projects which will come online during analysis periods. The table below provides a summary of the anticipated projects and identifies what scenario year they are assumed to be complete.

**Table 3-2 Planned Capital Projects and Infrastructure Upgrades**

Scenario	
2015	<ul style="list-style-type: none"> <li>▪ West St bypass (PCP#26) weir adjustment to 75.5m</li> <li>▪ Permanent plugging of:               <ul style="list-style-type: none"> <li>→ Queen St CSO (PCP#15)</li> <li>→ North/Wellington CSO (PCP#10)</li> </ul> </li> </ul>



Scenario	
	<ul style="list-style-type: none"> <li>→ Brock St (PCP#19, replace temp plug with permanent)</li> <li>→ Johnson St CSO (PCP#21)</li> <li>→ Lower Albert St CSO (PCP#31)</li> <li>▪ New weir across 900mm overflow pipe on PCP#53 at Union/Division. Elevation TBD, approx. 88.0m</li> </ul>
2021	<ul style="list-style-type: none"> <li>▪ Portsmouth pumping station upgrades and forcemain to redirected to Cataraqui Bay WWTP</li> <li>▪ Pipe/junctions added for new developments</li> <li>▪ Yonge St sewer upsize (Johnson to Portsmouth PS, currently underway, drawings can be provided)</li> <li>▪ River St PS forcemain twinning</li> <li>▪ Alfred/Elm sewer upsize: sewer upsize (375 to 450) on Alfred (Princess to Elm) and Elm (Alfred to Chatham)</li> <li>▪ Hwy 15 trunk sewer upsize (from 0633-030 to 0631-030, to 450mm) to be completed along with Hwy 15 widening</li> <li>▪ Hwy 15 trunk sewer upsize to 525mm</li> <li>▪ New 'Riverview PS' forcemain, from new pump station location near waterfront to Hwy15 trunk sewer roughly at 0636-010</li> <li>▪ Greenview PS upgrades</li> <li>▪ Schooner Drive PS will be replaced with a new "Riverview PS" located on the quarry property</li> <li>▪ Westbrook PS upgrades</li> <li>▪ Combined Sewer Area reductions</li> </ul>
2026 (Committed)	<ul style="list-style-type: none"> <li>▪ Pipe/junction additions for new developments</li> <li>▪ Combined Sewer Area reductions</li> </ul>
2036	<ul style="list-style-type: none"> <li>▪ Pipe/junction additions for new developments</li> <li>▪ Combined Sewer Area reductions</li> </ul>
Full Build-out	<ul style="list-style-type: none"> <li>▪ Pipe/junction additions for new developments</li> <li>▪ Combined Sewer Area reductions</li> </ul>
Ultimate	<ul style="list-style-type: none"> <li>▪ Pipe/junction additions for new developments</li> <li>▪ Combined Sewer Area reductions</li> </ul>

# 4 DESIGN CRITERIA AND LEVEL OF SERVICE

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

It should be noted that the Level of Service will be used for initial comparisons and more detailed reviews may be completed based on the resulting Level of Service of the infrastructure during existing or alternative scenarios.

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.

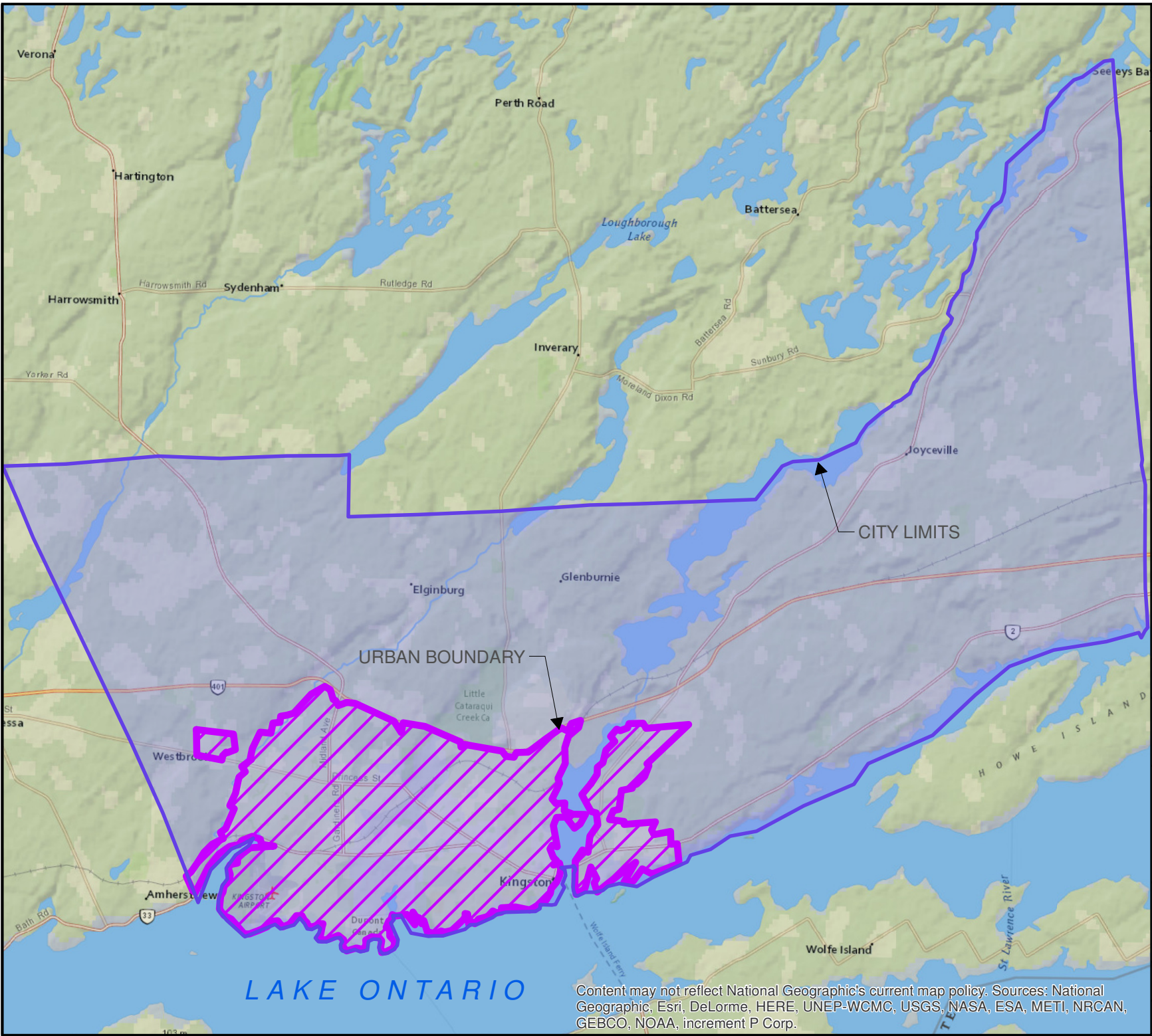
## 4.1 SERVICE AREA & POPULATION

The City of Kingston municipal wastewater service area is contained within the Urban Boundary. A census or survey to quantify the population and industry within the Urban Boundary has not been completed. Service boundaries and populations from previous studies and reports have been used to estimate the population within the Urban Boundary. The three boundaries used in this estimation include:

1. Kingston Census Metropolitan Area(CMA) - Figure 4-1
2. City of Kingston Limits & Urban Boundary - Figure 4-2
3. Urban and Rural Dissemination Area (Census Areas) - Figure 4-3

Figure 4-1 Kingston CMA





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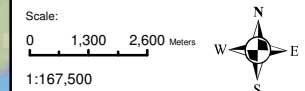


UTILITIES KINGSTON  
 P.O. BOX 790,  
 KINGSTON, ONTARIO,  
 K7L 4X7

**Legend**

- CITY LIMITS
- URBAN BOUNDARY

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



Project:  
**Water and Wastewater  
 Master Plan Updates**

City of Kingston, Ontario

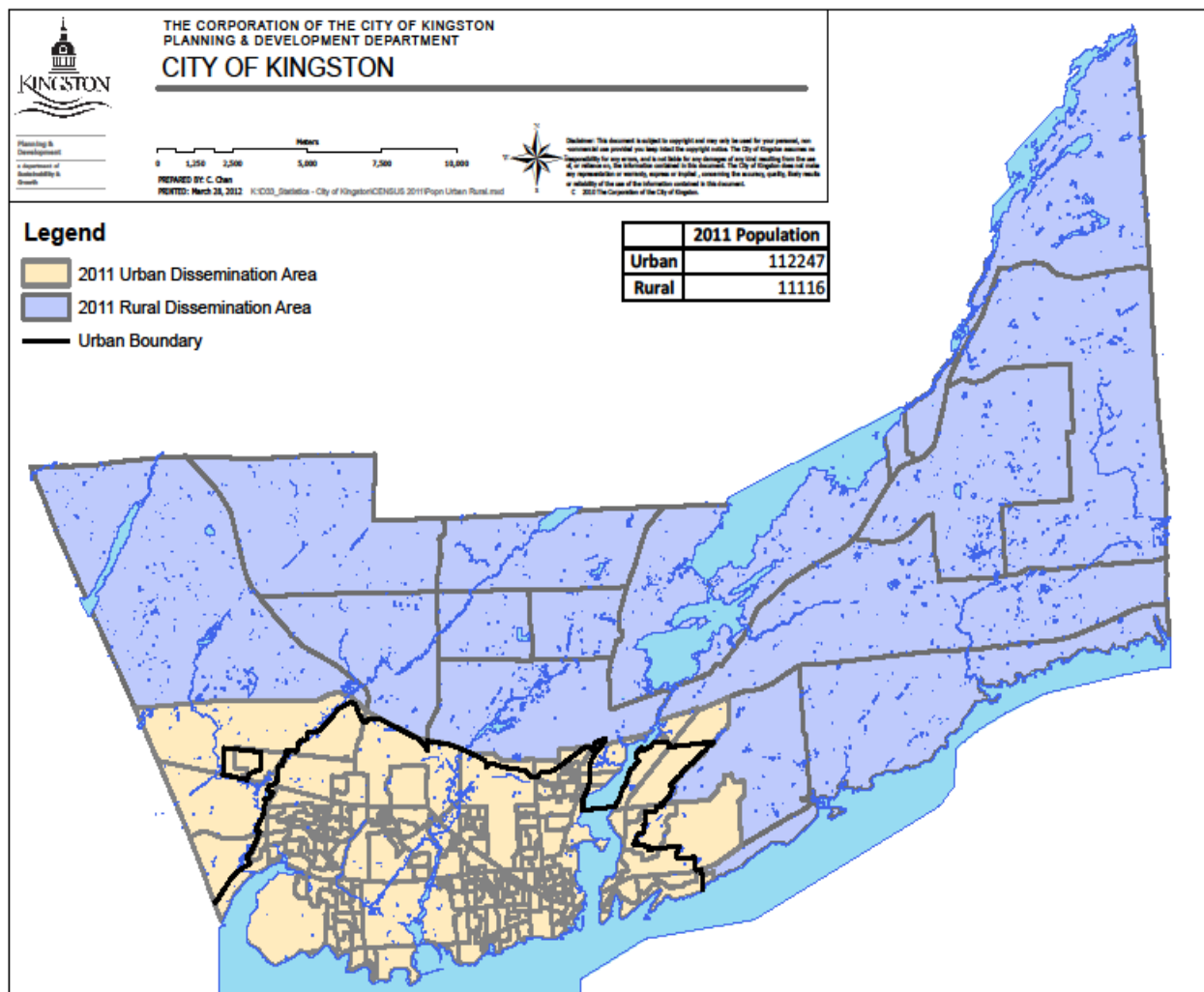
Title:  
**CITY OF KINGSTON  
 BOUNDARIES**

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MS	GS	FIG 4.2

Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Figure 4-3 Urban &amp; Rural Dissemination Area



As indicated in the Growth Report (WSP, 2015) the *City of Kingston and Kingston CMA population, housing and employment projections* (Meridian Planning/C4SE, 2013) or “CMA Report” was used to determine the base population for 2014. The CMA report divides the urban and rural areas by the dissemination areas (Figure 4-3). To determine the base population for the wastewater service areas, the following was completed. First, the population difference between the urban dissemination area and the urban boundary was identified. From the Census data, the dissemination areas and the GIS data provided (areas, densities) it was determined that approximately 90% of the population resided within the urban boundary in 2011. Segregating the areas into West, Central, and East the population distribution is approximately 44%, 48% & 8% respectively (based on GIS data).

The CMA report provided populations projections to 2041 for three scenarios: low, medium and high. The high case was determined to be the preferred population growth case (Development Growth Criteria Report, WSP 2015). The CMA report did not provide a population projection for 2014. However, populations for 2011 and 2016 were provided. As the relationship between the different time steps is not completely linear, an equation was developed based on the data provided to estimate the 2014 population. The population for 2014 is estimated at 126,645 within the Kingston

CMA. Using the urban to rural split indicated above the base population within the urban boundary is 113,980 (90% of 126,645).

Applying the growth projections completed in the Development Growth Criteria Report (WSP, 2015) and maintaining the approximate population divide (i.e. West, Central & East). Table 4-1 indicates the approximate population for each scenario. It should be noted that the Full Build Out and Ultimate scenarios are not associated with a specific year, an estimated population was developed based on the number of additional residential units and the density assumed for 2036 (2.31 cap/unit).

**Table 4-1 - Population Distribution**

AREA	POPULATION					
	2014	2021	2026	2036	FULL BUILDOUT	ULTIMATE
Wastewater Service Area	113,980	125,462	133,594	145,306	168,898	239,602
West (44%)	50,151	55,204	58,782	63,935	74,316	105,425
Central (48%)	54,711	60,222	64,125	69,747	81,071	115,009
East (8%)	9,118	10,036	10,687	11,624	13,511	19,168

## 4.2 DESIGN CRITERIA ANALYSIS

The analysis and review of the wastewater design criteria is an important step. This criterion provides the basis for wastewater flow calculations and is the starting point for the evaluation of existing system infrastructure, future infrastructure upgrades, and system-wide servicing strategies. This review will ensure that values used in this Master Plan are reasonable and consistent with other jurisdictions as well as past work in Kingston.

The table below summarizes the relative size of the municipalities used in the analysis.

**Table 4-2 Municipalities of Similar Size**

MUNICIPALITY	GEOGRAPHICAL AREA	POPULATION (2011 CENSUS)
Kingston (Urban)	82.9	123,363
Cambridge	112.8	126,748
Kitchener	136.9	219,153
Waterloo	64.0	98,780
Guelph	86.7	121,688
Barrie	77.0	135,711

### 4.3 WASTEWATER FLOW DESIGN CRITERIA

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 the condition of the infrastructure.

The MOECC Design guidelines (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.

#### 4.3.1 REVIEW OF STANDARDS AND FLOW DESIGN CRITERIA

A review of applicable design standards and design criteria used by provincial agencies, previous City of Kingston reports and other municipalities is summarized in the tables below.

**Table 4-3 Residential Flow Generation**

	ORGANIZATION	DESCRIPTION	ADF (L/CAP/D)
Residential Flow Generation	MOECC	Design Guidelines for Sewage Works 2008	270-450
	City of Kingston	Subdivision Guidelines, 2014	350
	City of Kingston	Wastewater Master Plan, 2010	350
	Region of Waterloo	Wastewater Treatment Master Plan, 2007	300
	City of Guelph	Wastewater Master Plan, 2008	300
	Region of Waterloo & City of Guelph	Design Guidelines	350
	City of Barrie	Wastewater Master Plan, 2013	225
	City of Barrie	Design Standards	225

Table 4-4 Industrial Flow Generation

	ORGANIZATION	DESCRIPTION	ADF (M <sup>3</sup> /HA/D)
Industrial Flow Generation	MOECC	Design Guidelines for Sewage Works 2008	35 (light Industry)
	City of Kingston	Subdivision Guidelines, 2014	To be considered on an individual basis
	City of Kingston	Wastewater Master Plan, 2010	45
	Region of Waterloo	Wastewater Treatment Master Plan, 2007	43.2
	City of Guelph	Wastewater Master Plan, 2008	N/A (converted using equivalent population)
	Region of Waterloo & City of Guelph	Design Guidelines	43.2
	City of Barrie	Wastewater Master Plan, 2013	35
	City of Barrie	Design Standards	35
	US EPA	Sanitary Sewer Design Standards	49 L/cap/day

Table 4-5 Commercial Flow Generation

	ORGANIZATION	DESCRIPTION	ADF
Commercial Flow Generation	MOECC	Design Guidelines for Sewage Works 2008	2.5-5.0 L/d/m <sup>2</sup>
	City of Kingston	Subdivision Guidelines, 2014	To be considered on an individual basis
	City of Kingston	Wastewater Master Plan, 2010	28m <sup>3</sup> /ha/day
	Region of Waterloo	Wastewater Treatment Master Plan, 2007	N/A (converted using equivalent population)
	City of Guelph	Wastewater Master Plan, 2008	N/A (converted using equivalent population)
	Region of Waterloo & City of Guelph	Design Guidelines	Core = 1.16l/s/ha; Shopping Mall = 0.3 l/s/ha; General = 0.6 l/s/ha
	City of Barrie	Wastewater Master Plan, 2013	28m <sup>3</sup> /ha/day
	City of Barrie	Design Standards	28m <sup>3</sup> /ha/day



Table 4-6 Institutional Flow Generation

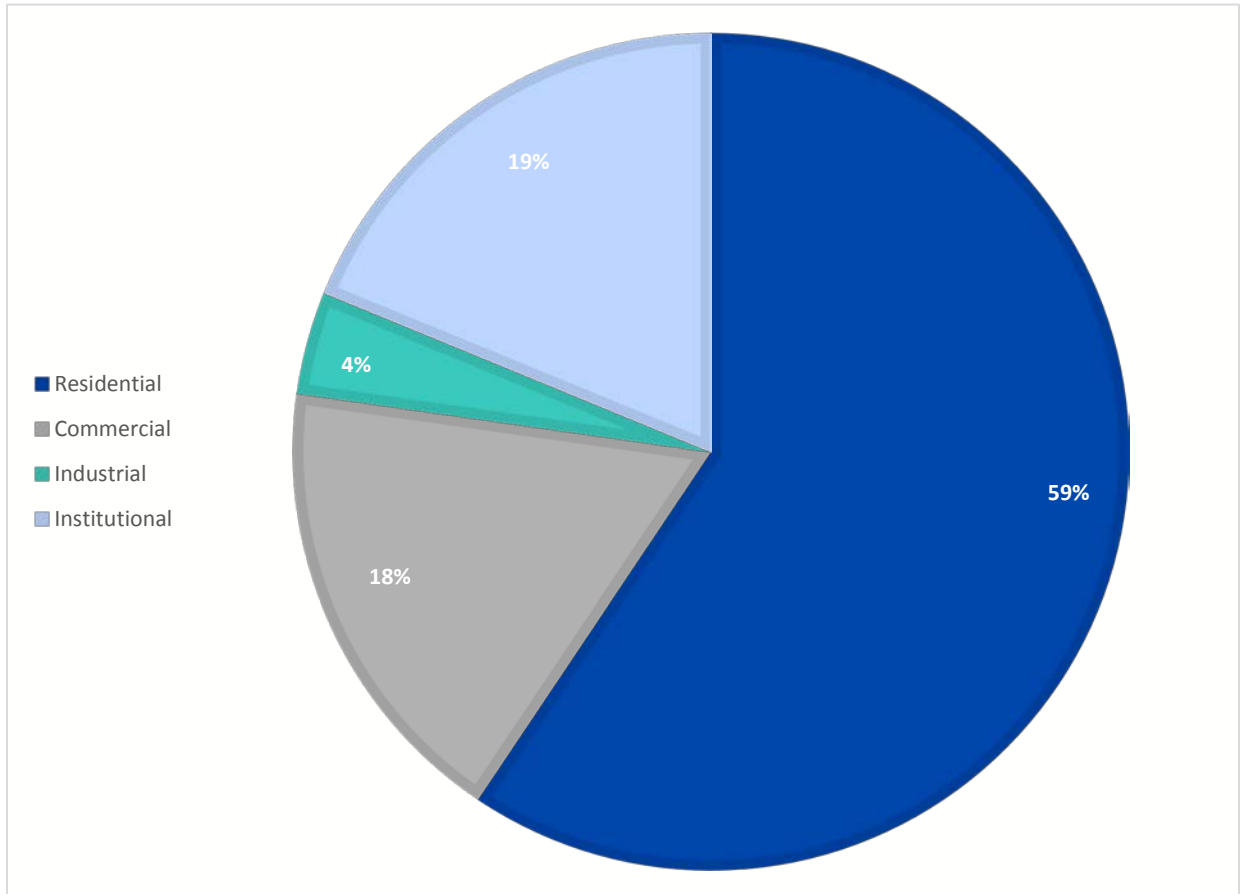
	ORGANIZATION	DESCRIPTION	ADF (M <sup>3</sup> /HA/D)
Institutional Flow Generation	MOECC	Design Guidelines for Sewage Works 2008	Individual case based on historical records.
	City of Kingston	Subdivision Guidelines, 2014	To be considered on an individual basis.
	City of Kingston	Wastewater Master Plan, 2010	28
	Region of Waterloo	Wastewater Treatment Master Plan, 2007	N/A (converted using equivalent population)
	City of Guelph	Wastewater Master Plan, 2008	N/A (converted using equivalent population)
	Region of Waterloo & City of Guelph	Design Guidelines	In accordance with MOECC Design Guidelines
	City of Barrie	Wastewater Master Plan, 2013	28
	City of Barrie	Design Standards	28

Table 4-3 through Table 4-6 outline a range of per capita design flows based on land use. The City of Kingston design guidelines fall within the recommended ranges stipulated by the MOECC and generally align with the municipalities selected for comparison.

#### 4.3.2 HISTORIC FLOW GENERATION

In order to evaluate the existing flow being generated by the City, the historic wastewater treatment flows were reviewed. Limited information was available regarding the breakdown of flow based on land use type. Historic potable water meter data was used to assign the proportion of flow being generated by each land use type. Figure 4-4 below illustrates the respective proportions.

Figure 4-4 2014 Water Consumption by Land Use Type



The calculated demand split was then applied to the historic dry weather flow observed at the wastewater plants. Dry weather flow was used as this provides a better representation of the actual flow generated by users without inflow and infiltration resulting from rain events.

Table 4-7 Dry Weather Wastewater Flow

Treatment Plant	Flow (L/s)	Flow (m <sup>3</sup> /d)
Average Daily Dry Weather Flow from Cataraqui Bay (L/s)	267	23,086
Average Daily Dry Weather Flow From Ravensview (L/s)	569	49,202
<b>Total Average Daily Dry Weather Flow (L/s)</b>	<b>837</b>	<b>72,288</b>

Table 4-8 Unit Wastewater Generation by Land Use Type

Land Use	Existing Flow (L/s)	Percent of Flow	Average Flow (L/s)	Existing Number of Units	Unit Flow Generation
Residential	837	59%	502	113,980 People	380 L/cap/day
Commercial		18%	151	795 ha	16 m <sup>3</sup> /ha/day
Institutional		4%	33		N/A
Industrial		19%	159	2666 ha	5 m <sup>3</sup> /ha/day

The historic flows suggest that the residential unit flow generation is very close to that being used in the design criteria. The calculated commercial and industrial flows are much lower. This low flow is thought to be due to the type of industry present in Kingston. The majority of the industrial uses are 'light' in nature and are not large consumers of water.

### 4.3.3 UNIT FLOW GENERATION RECOMMENDATIONS

A summary of the recommended flow generation criteria based on the review of historic demands, provincial agencies, previous City of Kingston previous report and municipalities of similar size.

Table 4-9 Recommended Unit Flow Generation

Land Use	Recommended
Residential	<b>350 l/cap/day</b> <i>Historic flows are within the design criteria parameters.</i>
Commercial	<b>28 m<sup>3</sup>/ha/day.</b> <i>Higher than historic flows, however, this will permit flexibility for varying requirements of future commercial development.</i>

Land Use	Recommended
<p><b>Industrial</b></p>	<p><b>35 m<sup>3</sup>/ha/day</b></p> <p><i>This is much higher than the observed historic flow. The historic flow is much lower than other municipalities and the MOECC guidelines. Using the historic value could limit future industrial development.</i></p>
<p><b>Business Park Industrial</b></p>	<p><b>49 L/employee/day</b></p> <p><i>Due to the amount of business park industrial anticipated and the historically low volume of sanitary flow generation from industrial areas, it is recommended that business park industrial be calculated separately from the rest of the industrial. The US EPA flow generation per employee is recommended.</i></p>
<p><b>Institutional</b></p>	<p><b>Case by case</b></p> <p><i>Review of historic flows on a case by case basis is recommended. Consistent with the design criteria.</i></p>

#### 4.4 DEMAND PATTERN

Wastewater flow generation typically follows a diurnal pattern. When estimating flow for design or analysis, it is important to consider the peaks in the pattern to account the period of highest demand. This peak flow occurs when a reasonable majority of the serviced population is generating flow at the same time. For residential areas, as population increases the probability of the entire serviced population generating flow at the same time decreases. To account for this, the MOECC recommends using the Harmon-Peaking Factor, which is a function of the serviced population. The MOECC also recommends an acceptable range with minimum and maximum values of 2 and 4 respectively. Peak factors used for industrial, commercial and institutional areas are based on the specific land use. Each land use type has a range of peaking factors. The MOECC recommends that although acceptable ranges are given for these types of land use, historic data or estimates based on the actual industrial process or activity taking place on the site should be used where available.

##### 4.4.1 REVIEW OF STANDARDS AND DESIGN CRITERIA

The table below provides a summary of the peaking factors being used by agencies, previous City of Kingston reports and other municipalities in Ontario.

Table 4-10 - Sanitary Flow Peaking Factors

	ORGANIZATION	DESCRIPTION	PEAKING FACTOR
Peaking Factors for Dry Weather Flow	MOECC	Design Guidelines for Sewage Works 2008	<ul style="list-style-type: none"> <li>→ Residential: Harmon Formula based on population</li> <li>→ Commercial: Design Guidelines for Drinking Water Systems</li> <li>→ Institutional: Design Guidelines for Drinking Water Systems</li> <li>→ Industrial: Monitor existing industry</li> </ul>
	City of Kingston	Subdivision Guidelines, 2014	<ul style="list-style-type: none"> <li>→ Residential: Range from 2.75 to 4.0 based on Harmon Formula.</li> <li>→ Refer to MOECC for other land uses</li> </ul>
	City of Kingston	Wastewater Master Plan, 2007	<ul style="list-style-type: none"> <li>→ Adjusted during model validation and calibration to match observed field data</li> </ul>
	Region of Waterloo	Wastewater Treatment Master Plan, 2007	<ul style="list-style-type: none"> <li>→ Residential: 3.3</li> <li>→ Commercial: N/A - Converted to equivalent population)</li> <li>→ Institutional: N/A - Converted to equivalent population)</li> <li>→ Industrial: Average 2.0</li> </ul>
	City of Guelph	Wastewater Master Plan, 2008	<ul style="list-style-type: none"> <li>→ Peak Factor of 1.8 for all land uses</li> </ul>
	Region of Waterloo & City of Guelph	Design Guidelines	<ul style="list-style-type: none"> <li>→ Residential: Harmon Formula based on population</li> <li>→ Commercial: 2.5</li> <li>→ Institutional: Refer to MOECC</li> <li>→ Industrial: Refer to MOECC</li> </ul>
	City of Barrie	Water Master Plan, 2013	<ul style="list-style-type: none"> <li>→ Harmon Formula based on population</li> </ul>
	City of Barrie	Design Guidelines	<ul style="list-style-type: none"> <li>→ Residential: Harmon Formula based on population</li> </ul>

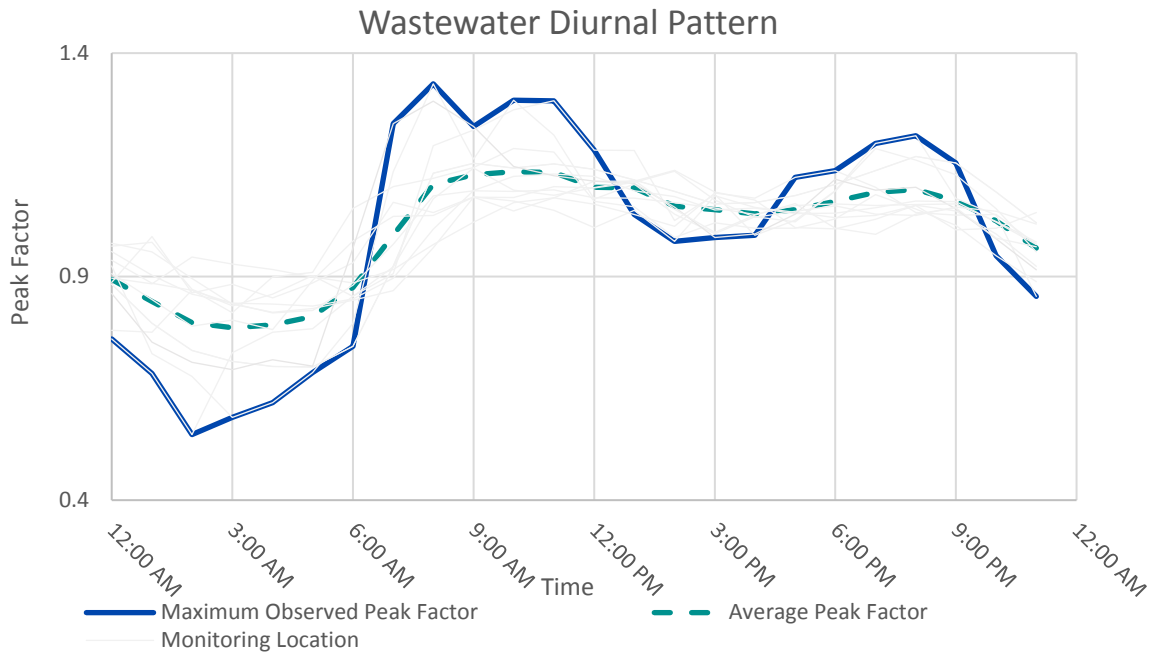
ORGANIZATION	DESCRIPTION	PEAKING FACTOR
		→ Commercial: Individual basis or 2.0
		→ Institutional: Individual basis or 2.0
		→ Industrial: Individual basis or 2.0-4.0

From the table above it can be concluded that there is limited variation with respect to the peaking factors being applied to sanitary flow for the various land use types.

#### 4.4.2 HISTORIC DEMAND PATTERN

Flow readings from monitoring locations around the City were used to generate daily diurnal patterns. The analysis focused only on dry weather flow in an attempt to capture the pattern resulting from system users minimizing the impact of inflow and infiltration.

Figure 4-5 Diurnal Wastewater Pattern



From Figure 4-5 it can be observed that the peak factor ranges from 0.55 to 1.33 over the course of a typical dry weather day. The average peak of the system is plotted along with the maximum observed peak factor (or minimum if below 1). The peak experienced by the system is lower than the range stipulated by the MOECC. The observed peak is lower than that recommended by the MOECC. This

is suspected to be due to various factors including, hydraulic dispersion taking place in the pipe, inflow, and infiltration as well as large contributing populations with varying time of use patterns. During a 'dry' day the system will still experience an inflow from ground water and other sources which will dampen the amplitude of user demand.

### 4.4.3 RECOMMENDATIONS

Due to the uncertainty of the impact that inflow and infiltration have on the diurnal pattern, no changes are recommended to the design criteria. The existing required design peaking factors are currently within the range of the values recommended by the MOECC and are consistent with other municipalities of similar size.

The recommended peaking factors are:

- Residential: 2.75 to 4.0 based on Harmon Formula.
- Commercial Industrial and Institutional, Refer to MOECC design guidelines

For the purpose of the master plan study, existing diurnal patterns will be used to approximate the sewage generation in Kingston. This same pattern will be applied to new development.

## 4.5 INFRASTRUCTURE LEVEL OF SERVICE

The level of service being provided by the infrastructure was evaluated for both dry and wet weather events. There are two considerations when assigning the overall level of service; the hydraulic condition occurring in the infrastructure and the scenario during which this hydraulic condition occurs. Hydraulic conditions experienced by the infrastructure were evaluated with consideration for the scenario during which they were experienced. Given the different flow characteristics during wet weather and dry weather as well as the corresponding probability of these events, they were evaluated against different benchmarks.

### 4.5.1 GRAVITY SEWERS

Sanitary sewer systems should be designed with the objective of conveying all the flows to be treated at the sewage treatment plant. Overflows within the sanitary sewer systems should be designed for emergency and unavoidable conditions only (MOECC, 2008). The MOECC also recommends that gravity sewers be designed to less than 100% full under normal conditions. During large rain events, trunk sewers may become surcharged. Allowing these sewers to surcharge provides storage capacity reducing the by-pass volume. However, this increase in the elevation of the hydraulic grade line in the sewer may have adverse effects depending on site-specific factors. The increase in the elevation of the hydraulic grade line is a result of capacity limitations resulting in bottlenecks and backup of the system. The two primary considerations are the amount of surcharging (elevation of hydraulic grade line) and the elevation of hydraulic grade line relative to adjacent basement elevations. The identified level of service below is based on satisfying MOECC's design guidelines for gravity sewers and maximizing storage capacity while minimizing the risk of basement flooding.

Table 4-11 Gravity Sewers Hydraulic Condition

HYDRAULIC CONDITION OF SEWERS			
FLOW CONDITION	FAIR	MODERATE	SEVERE
Dry Weather	Flow < 85% of pipe capacity	Flow > 85% of pipe capacity	Flow > 85% of pipe capacity
Wet Weather (up to and including 100yr return event)	HGL < 0.3m above pipe obvert and > 2 m below finished ground	HGL > 0.3 m above pipe obvert and > 2 m below finished ground	HGL within 2 m of finished ground

Table 4-12 Gravity Sewers Level of Service

LEVEL OF SERVICE OF SEWERS			
	GOOD	REVIEW	GAP
Facility Level of Service	Hydraulic grade line (HGL) from the 100yr storm is more than 2 m below the finished ground  Dry weather flow is less than the sewer capacity	Hydraulic grade line (HGL) from the 25yr storm flows and larger, is within 2 m 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	HGL from the 10yrs storm flows and smaller, is within 2 m of the finished ground  Cannot convey the dry weather flows without surcharging.

#### 4.5.2 PUMPING STATIONS AND FORCEMAINS

The MOECC requires that sanitary sewer systems be able to pump the design peak instantaneous flow. Pumping stations that service combined sewer systems are required to have a capacity sufficient to pump all of the dry weather flow plus 90% of the volume resulting from the design wet



weather flow for an average year flow. As the MOECC does not specify a specific design storm, a review of other Master Plans was completed.

**Table 4-13 Sanitary Pumping Station Design Storm Review**

MUNICIPALITY	DESIGN STORM
Kingston Master Plan (2007)	1:10yr
Cambridge	1:25yr
Region of Peel	1:5yr
Sudbury	1:2yr
Guelph	1:25yr

Based on this review the 10yr storm was selected as this is consistent with the previous Master Plan, recent upgrades completed in Kingston and is within the range used by other municipalities. Additionally, based on a typical year, the 10yr storm would be sufficient to satisfy the MOECC requirements regarding wet weather flows.

The flows experienced at sanitary pump stations and in the respective forcemains during both the existing and future flow conditions are evaluated. The purpose of this evaluation was to identify where capacity limitations are causing bottlenecks and backup of the system.

Multiple flow conditions were applied to each growth scenario using the hydraulic model. The flow conditions analyzed included the dry weather as well as multiple return periods for wet weather events ranging from the 2yr to 100yr design storm.

The recommended level of service is outlined in Table 4-14 below:

**Table 4-14 Sanitary Pump Stations Hydraulic Condition**

WEATHER SCENARIO	HYDRAULIC CONDITION OF PUMP STATION		
	FAIR	MODERATE	SEVERE
Dry Weather and Wet Weather (up to and including 10yr return event)	Measured flow < 85% of firm capacity	Measured flow > 85% of firm capacity and < 100% of firm capacity	Measured flow > 100% of firm capacity
Wet Weather (above 10yr up to 100yr return event)	Measured flow < peak capacity and no bypass at the station	Measured flow > peak capacity and bypass at the station	Measured flow > peak capacity and local flooding

Table 4-15 Pump Station Recommended Level of Service

LEVEL OF SERVICE OF PUMP STATION			
	GOOD	REVIEW	GAP
Facility Level of Service	Dry weather flows & 10yr storm flows are less than the pumping stations firm capacity	10yr storm flows are greater than the firm but less than the peak capacity	10yr storm flows are greater than the pumping station peak capacity

In addition to the pumping requirements, the MOECC also provides design standards for forcemains. At design pumping rates, a cleansing velocity of at least 0.6 m/s should be maintained. At peak flow, the maximum velocity should be limited to 3 m/s. Consideration also needs to be made for air/vacuum relief valves as well as the operating pressure in the forcemain.

The recommended criteria for evaluating the level of service was limited to the velocity in the forcemain. Considering operating pressures and requirements for air and vacuum relief valves require further hydraulic analysis beyond the scope of this assignment.

Table 4-16 Sanitary Forcemain Hydraulic Condition

HYDRAULIC CONDITION OF FORCEMAIN			
	FAIR	MODERATE	SEVERE
All Scenarios	Velocity < 3 m/s	Velocity > 2 m/s	Velocity > 3 m/s

Table 4-17 Sanitary Forcemain Level of Service

LEVEL OF SERVICE FORCEMAIN			
	GOOD	MONITOR	GAP
Forcemain Level of Service	Velocity in pipe is less than 2 m/s	Velocity in pipe is greater than 2 m/s and less than 3 m/s	Velocity in pipe is greater than 3 m/s

### 4.5.3 COMBINED SEWER OVERFLOW LOCATIONS AND BY-PASSES

Sections of the central sewer catchment area are still serviced by combined sewers. Utilities Kingston is currently working to eliminate these combined sewers through various capital projects. However, in the interim, sewer by-passes during large wet weather events are inevitable.

The MOECC has issued Procedure F-5-5 to regulate these by-pass events. Procedure F-5-5 provides a guideline regarding the quality, quantity, and frequency of overflows. Required mitigation measures are also identified to address the potential adverse effects of the sewer by-pass. Utilities Kingston has implemented a variety of control and monitoring measures that address the requirements of F-5-5, these include storage facilities, floatable control programs, monitoring instruments among others. These programs are described further in the PCP Update.

While Procedure F-5-5 applies to all CSOs, more stringent requirements are also prescribed for swimming and bathing beaches. The majority of Kingston's CSO locations are situated in areas that meet the guideline's definition of a beach area.

*Swimming and bathing beach is defined as a strip of shoreline with the physiographic, climatic, access and ownership attributes necessary to accommodate significant water contact and non-contact recreation under favourable aquatic conditions.*

With respect to volume, durations and frequency, Procedure F-5-5 requires the following:

- During a 7 month period starting within 15 days of April 1<sup>st</sup>, capture and treat 90% wet weather volume (for an average year) above the dry weather flow.
- Controlling overflow 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).

The minimum level of service for the CSOs is to satisfy these requirements and continue to reduce the volume of by-pass events during an average year. Additionally, based on discussions with UK, the long-term goal is to “virtually eliminate” combined sewer overflows based on a wetter than average year, which is intended to mean containment of all Combined Sewer Flows under a Wet Year Conditions, with overflows occurring only under less frequent storm events.

### 4.5.4 WASTEWATER TREATMENT

The MOECC requires that treatment process unit at wastewater plants be sized based on various design parameters. The table below details the process design basis required by the MOECC.

Table 4-18 MOECC WWTP Design Basis Requirements

Treatment Unit	Design Basis
Sewage Pumping Stations	Design Peak Instantaneous Flow
Screening	Design Peak Instantaneous Flow
Grit Removal	Design Peak Hourly Flow Peak Hourly Grit Loading
Primary Sedimentation	Design Peak Daily Flow
Aeration (without nitrification)	Average Daily BOD5 Loading (based on Design Average Daily Flow)
Aeration (with nitrification)	Average Daily BOD5 loading (Design Average Daily Flow) Peak Daily TKN Loading (Design Peak Daily Flow)
Secondary Sedimentation	Design Peak Hourly Flow Peak Daily Solids Loading
Sludge Return for Activated Sludge	50 to 200 % of Design Average Daily Flow
Disinfection	Design Peak Hourly Flow
Effluent Filtration	Design Peak Hourly Flow
Outfall Sewer	Design Peak Instantaneous Flow
Sludge Treatment (digestion and dewatering.)	Maximum Monthly Mass Loading and Flow Rates

From the table above it can be seen that all of the processes are based on either the average daily flow or a peak flow rate.

The MOECC indicates a sewage treatment plant should be able to treat the flows of sewage generated within buildings serviced by the sewer system exclusive of any extraneous flows (i.e. the average daily flow).

The guidelines (MOECC, 2008) also indicate that *“during wet weather, the minimum level of treatment required for flows above the dry weather flows from combined sewer system is primary treatment.”*

Therefore, based on the above the MOECC criteria, the recommended level of service for treatment plants is to provide full treatment to all average daily flow.

Additionally, based on the MOECC criteria indicated above, procedure F-5-5 (i.e. 90% of the wet weather flow) the level of service for wet weather flows is to provide primary treatment (min) up to and including the 10yr storm.

## 5 EXISTING FACILITIES

### 5.1 PUMPING STATIONS

Based on the recommended Level of Service for pumping stations and forcemains indicated above, the table on the following page identifies the flow observed at the various pump stations and forcemains (where available) that form part of the sanitary collection system.

Table 5-1 and Table 5-2 (Below) highlight several pumping stations and forcemains that appear to be stressed based on existing flows. Stations that show peak flows have been exceeded is most likely due to a high level above the typical operating range having been experienced, causing higher flow rates. The status of these stations will be further reviewed with the modeling results. It should be noted that in some cases a peak capacity was not able to be tested in the field. For these instances, consideration was given to the length of the forcemain to estimate how much the increased headloss during peak flow would impact the output of the pumps. The peak capacity was obtained by taking the sum of the pump output and applying the discount listed below:

- 0 -500m = 10%
- 501m – 1,500m = 15%
- 1,501m – 2,500m = 20%
- 2,501m – 3,500 = 25%
- >3,500m = 30%



Table 5-1 Existing Pump Station Flows

Pumping Station	Pump Capacity from ECA (CofA)	Pump Capacities From 2008 Stantec Report	Pump Capacity Information Reported by UK	Utilities Kingston Source	WSP Pump Capacity Draw Down Test	Forcemain Length	Peak Flow Discount	Recommended		Historic Flow Data (SCADA Records)			
								Firm	Peak	Average (2013)	Average (2014)	Peak (2013)	Peak (2014)
Bath Rd.	51.4 l/s	-	55.8 l/s	2011 1s flow data	None	558 m	15%	51.4 l/s	87.4 l/s	8.0 l/s	11.0 l/s	33.9 l/s	32.8 l/s
Bath – Collins Bay+	Unavailable	18 l/s & 25 l/s	-	-	19.6 l/s & 16.0 l/s	171 m	10%	16.0 l/s	32.0 l/s	-	-	-	-
Bath – Lower	6.3 l/s	9 l/s & 8 l/s	-	-	5.75 l/s & 7.2 l/s	98 m	10%	6.0 l/s	11.6 l/s	-	-	-	-
Bayridge Dr.	Unavailable	19 l/s & 22 l/s	-	-	None	79 m	10%	19.0 l/s	36.9 l/s	-	-	-	-
Collins Bay Rd.	22 l/s	8 l/s & 20 l/s	-	-	None	819 m	15%	20.0 l/s	23.8 l/s	-	-	-	-
Coverdale Dr.	52.6 l/s	71 l/s & 75 l/s	60-73 l/s	2011 1s flow data	79 l/s & 78 l/s	733 m	15%	78.0 l/s	132.6 l/s	49.0 l/s	52.0 l/s	131.8 l/s	132.5 l/s
Crerar Blvd.	77 l/s	-	57 l/s	2016 1s flow data	None	566 m	15%	57.0 l/s	96.9 l/s	15.0 l/s	19.0 l/s	59.0 l/s	55.0 l/s
Days Rd.	Unavailable	-	900 l/s firm 1,102 l/s peak	AECOM report	None	5,367 m	-	900.0 l/s	1,102.0 l/s	292.0 l/s	259.0 l/s	790.0 l/s	611.0 l/s
Hillview Rd.	192 l/s	141 l/s & 142 l/s	140-156 l/s	UK drawdown	None	557 m	15%	141.0 l/s	239.7 l/s	33.6 l/s	34.1 l/s	116.0 l/s	108.0 l/s
John Counter Blvd.	50.6 l/s	-	N/A	-	None	332 m	10%	50.6 l/s	86.0 l/s	-	-	-	-
Lakeshore Blvd.	126 l/s	112 l/s & 101 l/s	117 l/s	2016 1s Level Data	None	435 m	10%	117.0 l/s	210.6 l/s	12.0 l/s	14.0 l/s	108.0 l/s	155.7 l/s
Rankin Cres.	19.5 l/s	73 l/s & 61 l/s	18-19 l/s firm	UK drawdown	None	561 m	15%	19.0 l/s	32.3 l/s	-	-	-	-
Westbrook Rd.	14.6 l/s	14 l/s & 8 l/s	N/A	-	None	1,812 m	20%	14.0 l/s	18.0 l/s	-	-	-	-
Dalton Ave.	2@364 l/s & 2@386 l/s	-	990 l/s firm, 1,225 l/s theoretical peak	UK Report	None	1,550 m	-	990.0 l/s	1,225.0 l/s	169.0 l/s	154.0 l/s	929.0 l/s	957.0 l/s
Greenview Dr.**	47.3 l/s	39 l/s & 54 l/s	46.5 l/s firm	UK email	None	60 m	10%	47.3 l/s	85.1 l/s	23.0 l/s	28.0 l/s	106.0 l/s	85.8 l/s
King St.3	242 l/s	576-621 l/s firm & 731 l/s peak	-	-	None	282 m	-	576.0 l/s	731.0 l/s	255.0 l/s	283.0 l/s	755.0 l/s	771.0 l/s

Pumping Station	Pump Capacity from ECA (CofA)	Pump Capacities From 2008 Stantec Report	Pump Capacity Information Reported by UK	Utilities Kingston Source	WSP Pump Capacity Draw Down Test	Forcemain Length	Peak Flow Discount	Recommended		Historic Flow Data (SCADA Records)			
								Firm	Peak	Average (2013)	Average (2014)	Peak (2013)	Peak (2014)
<b>King – Elevator Bay+</b>	Unavailable	88 l/s & 91 l/s	-	-	92 l/s & 87 l/s	697 m	15%	88.0 l/s	149.6 l/s	-	-	-	-
<b>King – Lake Ontario</b>	Unavailable	-	12.6 l/s	UK PS info Excel Sheet	None	456 m	10%	12.0 l/s	21.6 l/s	-	-	-	-
<b>King - Portsmouth2</b>	285 l/s	-	-	-	None	478 m	10%	285.0 l/s	405.0 l/s	30.0 l/s	37.0 l/s	381.0 l/s	382.0 l/s
<b>Morton St.</b>	18 l/s	-	-	-	None	144 m	10%	18.0 l/s	32.4 l/s	7.0 l/s	5.5 l/s	35.7 l/s	-
<b>Palace Rd.</b>	51 l/s	-	-	-	22 l/s & 22 l/s	234 m	-	22.0 l/s	22.0 l/s*	-	-	-	-
<b>River St.3</b>	1,420 l/s	-	1,700 l/s firm 2,130 l/s peak	CH2MHill (twinning)	None	3,182 m	-	1,700.0 l/s	2,130.0 l/s	664.0 l/s	1,034.0 l/s	1,830.0 l/s	1,967.0 l/s
<b>Yonge St.</b>	Unavailable	7 l/s & 4 l/s	-	-	None	23 m	10%	4.0 l/s	9.9 l/s	-	-	-	-
<b>Barrett Ct.+</b>	Unavailable	103 l/s & 107 l/s & 98 l/s	277 l/s peak 188 l/s firm	2015 1s Flow Data 2016 1s Flow Data	89 l/s	608 m	-	188.0 l/s	277.0 l/s	-	-	-	-
<b>Highway 15+</b>	Unavailable	-	54,55 l/s 200l/s 86.5 l/s	UK PS Info Excel Sheet 2016 1s Flow Data 2016 1s Level Data	None	555 m	15%	86.5 l/s	147.1 l/s	12.0 l/s	11.0 l/s	143.0 l/s	144.0 l/s
<b>James St.+</b>	Unavailable	-	30 l/s,44 l/s, 54 l/s, 42.8 l/s	UK PS Info Excel Sheet 2016 1s Level Data	None	128 m	10%	67.0 l/s	115.2 l/s	30.0 l/s	37.0 l/s	105.0 l/s	108.0 l/s
<b>Kenwoods Cir.</b>	38 l/s	44 l/s & 20 l/s	-	-	48 l/s & 58 l/s	458 m	10%	48.0 l/s	95.4 l/s	-	-	-	-
<b>Schooner Dr.</b>	18 l/s	16 l/s & 15 l/s	-	-	10 l/s & 13 l/s	556 m	15%	10.0 l/s	19.6 l/s	-	-	-	-

\* - Noted by UK that only pump station is limited to one pump based on electrical capacity

\*\* - It has been noted by UK that SCADA data appear to be inaccurate.

Flow is above Firm Capacity	Flow is above Peak Capacity
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Table 5-2 Existing Forcemain Velocities

Pumping Station	Forcemain Length	Forcemain Dia.	Peak Flow Discount	Recommended		Forcemain Velocity (Flow in 1x FM)		Forcemain Velocity (Flow split in 2x FM)	
				Firm	Peak	@ Recommended Firm	@ Recommended Peak	@ Recommended Firm	@ Recommended Peak
Bath Rd.	558 m	200 mm	15%	51.4 l/s	87.4 l/s	1.6 m/s	2.8 m/s	N/A	N/A
Bath – Collins Bay	171 m	150 mm	10%	16.0 l/s	32.0 l/s	0.9 m/s	1.8 m/s	N/A	N/A
Bath – Lower	98 m	100 mm	10%	6.0 l/s	11.6 l/s	0.8 m/s	1.5 m/s	N/A	N/A
Bayridge Dr.	79 m	150 mm	10%	19.0 l/s	36.9 l/s	1.1 m/s	2.1 m/s	N/A	N/A
Collins Bay Rd.	819 m	150 mm	15%	20.0 l/s	23.8 l/s	1.1 m/s	1.3 m/s	N/A	N/A
Coverdale Dr.	733 m	200 mm	15%	78.0 l/s	132.6 l/s	2.5 m/s	4.2 m/s	N/A	N/A
Crerar Blvd.	566 m	200 mm	15%	57.0 l/s	96.9 l/s	1.8 m/s	3.1 m/s	1.2 m/s	2.1 m/s
		150 mm				3.2 m/s	5.5 m/s	2.2 m/s	3.7 m/s
Days Rd.	5,367 m	900 mm	-	900.0 l/s	1,102.0 l/s	1.4 m/s	1.7 m/s	1.0 m/s	1.2 m/s
		600 mm				3.2 m/s	3.9 m/s	2.2 m/s	2.7 m/s
Hillview Rd.	557 m	350 mm	15%	141.0 l/s	239.7 l/s	1.5 m/s	2.5 m/s	N/A	N/A
John Counter Blvd.	332 m	250 mm	10%	50.6 l/s	86.0 l/s	1.0 m/s	1.8 m/s	N/A	N/A
Lakeshore Blvd.	435 m	400 mm	10%	117.0 l/s	210.6 l/s	0.9 m/s	1.7 m/s	N/A	N/A
Rankin Cres.	561 m	150 mm	15%	19.0 l/s	32.3 l/s	1.1 m/s	1.8 m/s	N/A	N/A
Westbrook Rd.	1,812 m	150 mm	20%	14.0 l/s	18.0 l/s	0.8 m/s	1.0 m/s	N/A	N/A
Dalton Ave.	1,550 m	600 mm	-	990.0 l/s	1,225.0 l/s	3.5 m/s	4.3 m/s	2.4 m/s	2.9 m/s
		450 mm				6.2 m/s	7.7 m/s	4.2 m/s	5.2 m/s
Greenview Dr.	60 m	250 mm	10%	47.3 l/s	85.1 l/s	1.0 m/s	1.7 m/s	N/A	N/A
King St.3	282 m	600 mm	-	576.0 l/s	731.0 l/s	2.0 m/s	2.6 m/s	N/A	N/A

Pumping Station	Forcemain Length	Forcemain Dia.	Peak Flow Discount	Recommended		Forcemain Velocity (Flow in 1x FM)		Forcemain Velocity (Flow split in 2x FM)	
				Firm	Peak	@ Recommended Firm	@ Recommended Peak	@ Recommended Firm	@ Recommended Peak
King – Elevator Bay	697 m	250 mm	15%	88.0 l/s	149.6 l/s	1.8 m/s	3.0 m/s	N/A	N/A
King – Lake Ontario	456 m	150 mm	10%	12.0 l/s	21.6 l/s	0.7 m/s	1.2 m/s	N/A	N/A
King - Portsmouth	478 m	450 mm	10%	285.0 l/s	405.0 l/s	1.8 m/s	2.5 m/s	N/A	N/A
Morton St.	144 m	150 mm	10%	18.0 l/s	32.4 l/s	1.0 m/s	1.8 m/s	N/A	N/A
Palace Rd.	234 m	200 mm	-	22.0 l/s	22.0 l/s	0.7 m/s	0.7 m/s	N/A	N/A
River St.3	3,182 m	1067 mm 1067 mm	-	1,700.0 l/s	2,130.0 l/s	1.9 m/s 1.9 m/s	2.4 m/s 2.4 m/s	1.3 m/s 1.3 m/s	1.6 m/s 1.6 m/s
Yonge St.	23 m	75 mm	10%	4.0 l/s	9.9 l/s	0.9 m/s	2.2 m/s	N/A	N/A
Barrett Ct.	608 m	300 mm	-	188.0 l/s	277.0 l/s	2.7 m/s	3.9 m/s	N/A	N/A
Highway 15	555 m	250 mm	15%	86.5 l/s	147.1 l/s	1.8 m/s	3.0 m/s	N/A	N/A
James St.	128 m	150 mm	10%	67.0 l/s	115.2 l/s	2.1 m/s	3.7 m/s	N/A	N/A
Kenwoods Cir.	458 m	200 mm	10%	48.0 l/s	95.4 l/s	1.5 m/s	3.0 m/s	N/A	N/A
Schooner Dr.	556 m	150 mm	15%	10.0 l/s	19.6 l/s	0.6 m/s	1.1 m/s	N/A	N/A

Flow is above 2 m/s

Flow is above 3 m/s

## 5.2 TREATMENT PLANTS

The rated capacity of Ravensview WWTP and Cataraqui Bay WWTP are listed in the table below.

**Table 5-3 Rated Capacity**

Wastewater Plant	Rated Capacity (m <sup>3</sup> /day)		
	Peak Flow Rate (Primary)	Peak Flow Rate (Secondary)	Average Daily Flow Rate
Ravensview	193,000	193,000	95,000
Cataraqui Bay	134,400	69,200	38,800

The figures below illustrate the observed flow rates versus the rated capacities of the plants for 2013 and 2014.

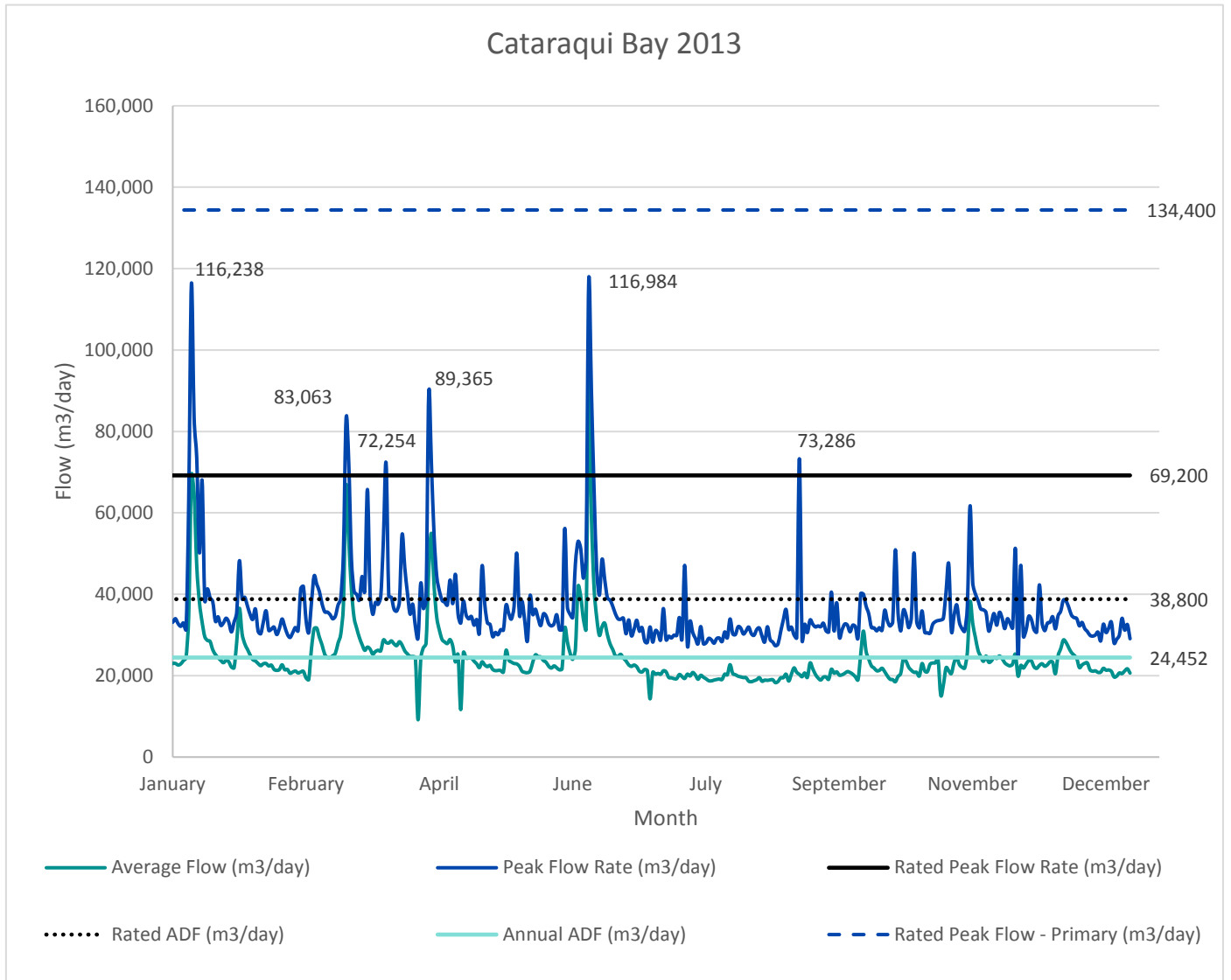


Figure 5-1 Cataraqui Bay Flows 2013

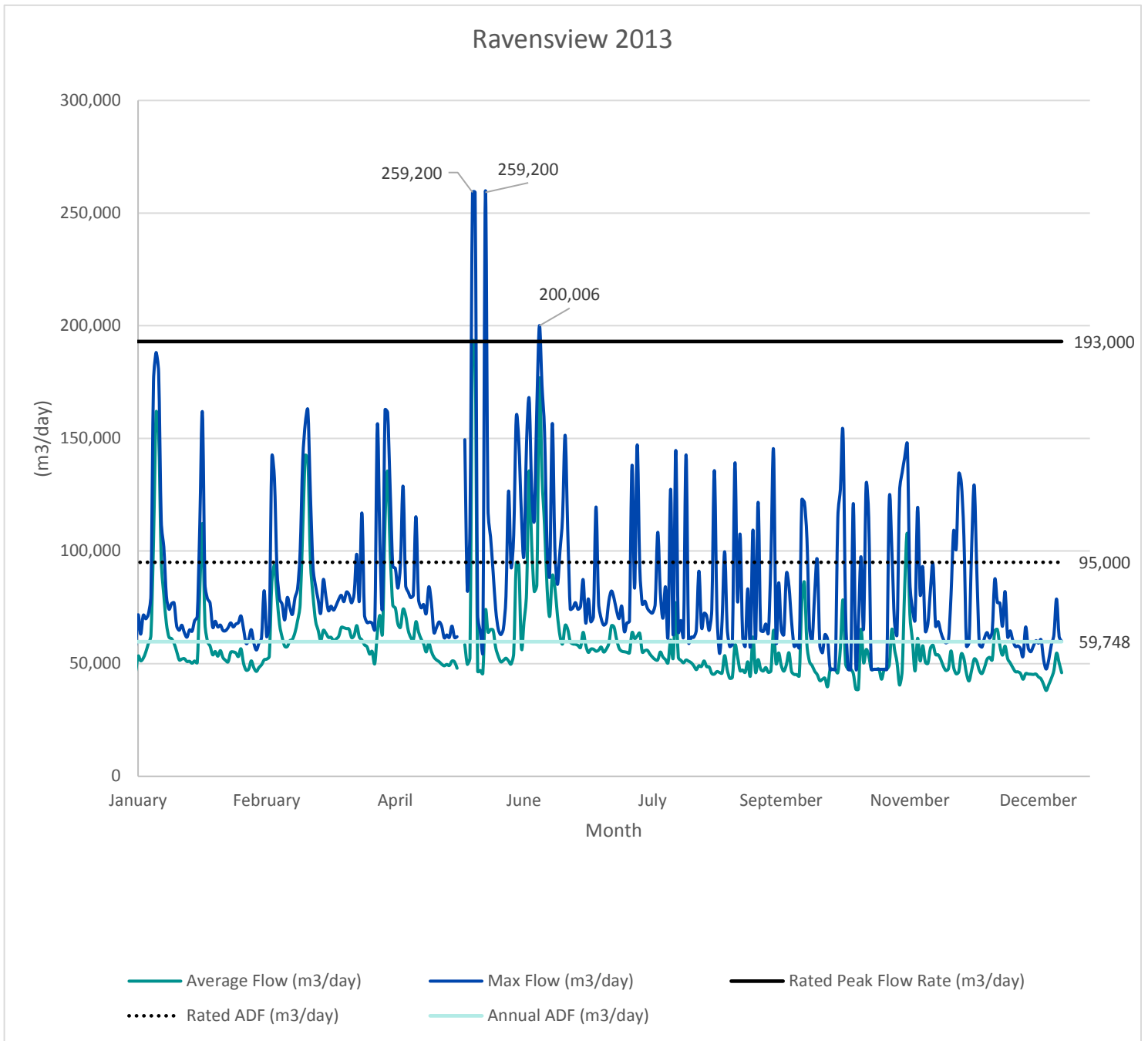


Figure 5-2 Ravensview Flows 2013

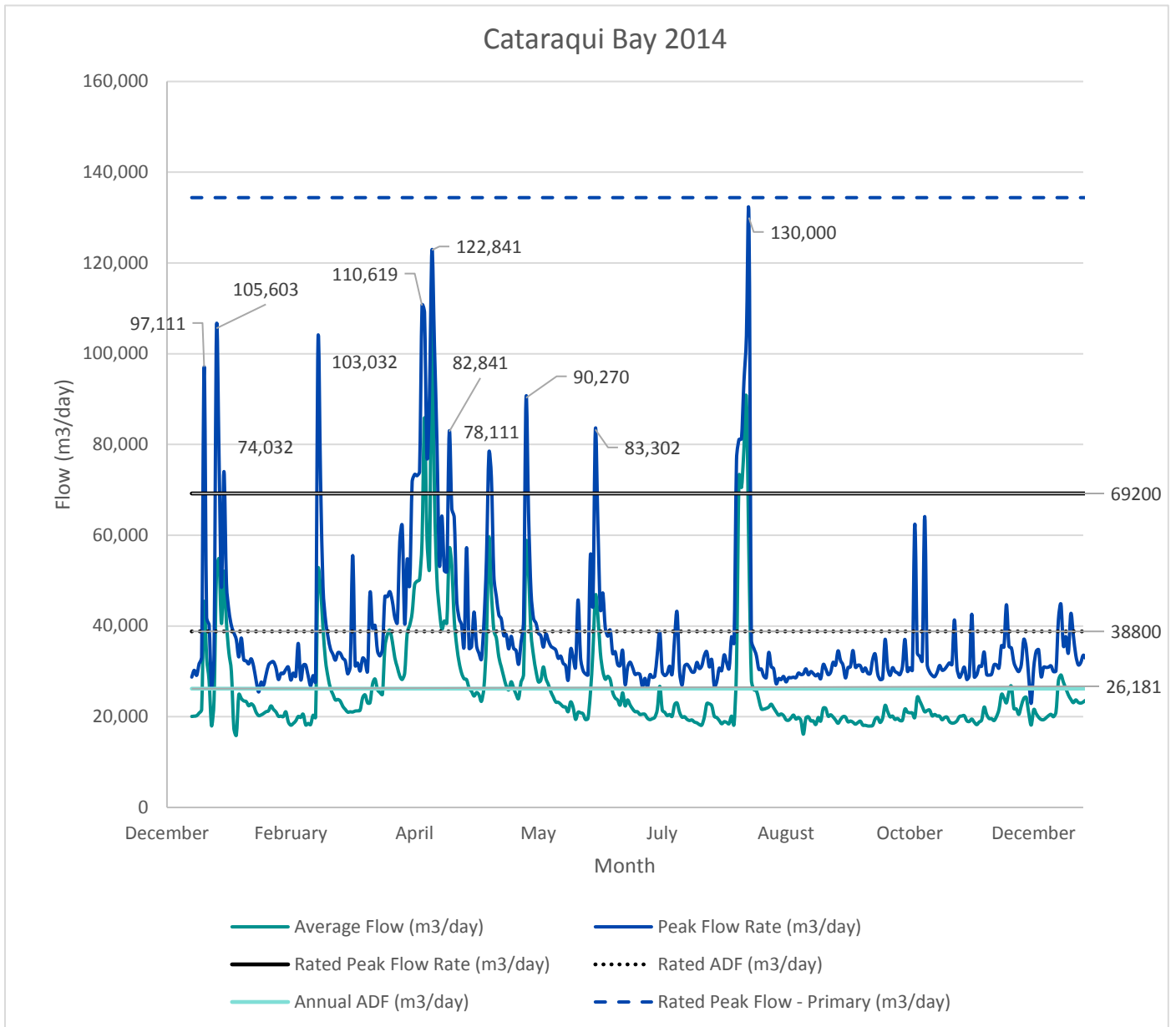
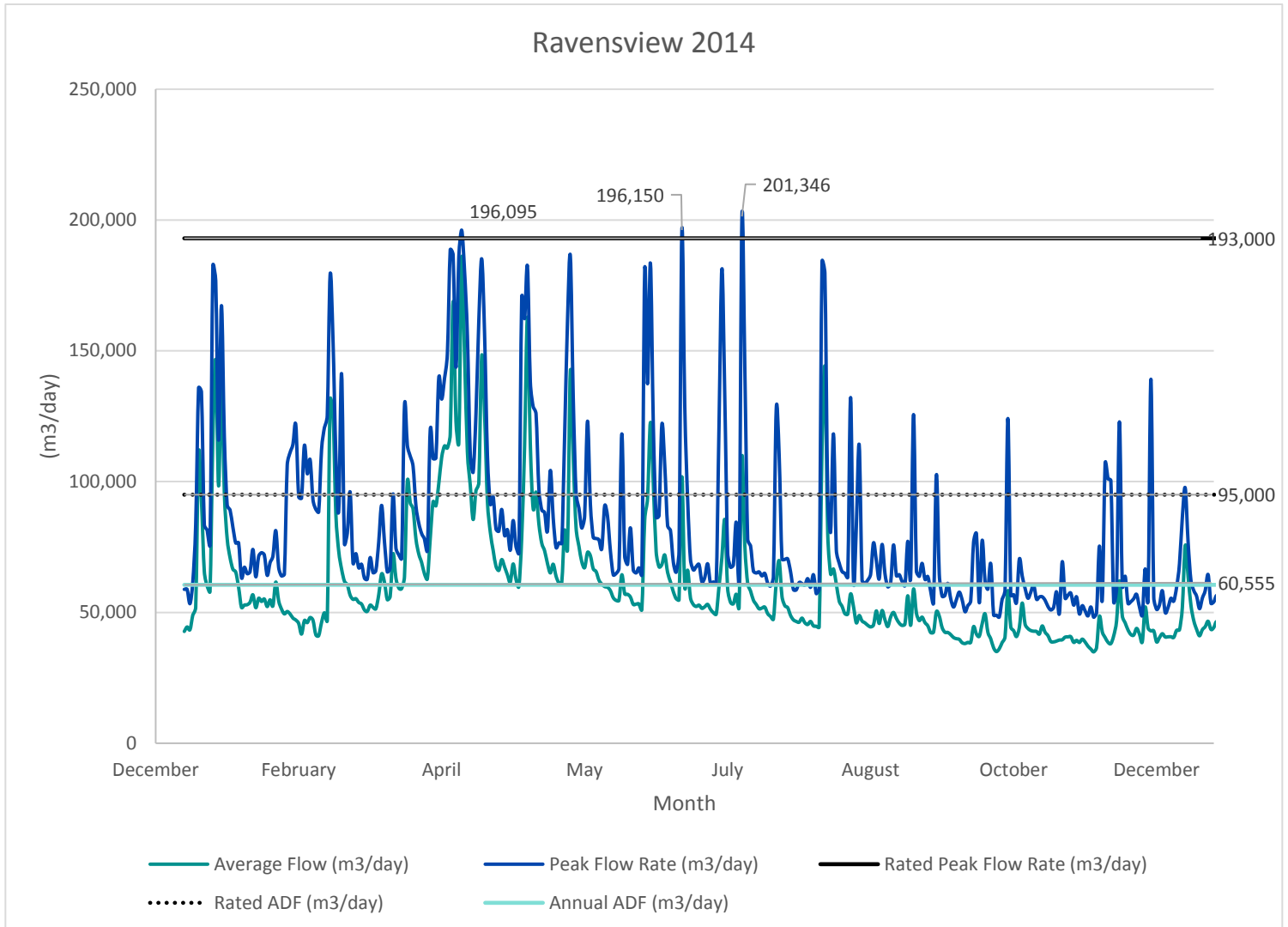


Figure 5-3 Cataraqui Bay Flows 2014



**Figure 5-4 Ravensview Flows 2014**

From the graphs above it can be concluded that both plants were below their rated annual average daily flow. Cataraqui Bay WWTP had a few max day exceedances but no peak flow exceedances. Ravensview WWTP only had some minor peak flow exceedances.

### 5.3 COMBINED SEWER OVERFLOW

Flow monitoring data from 2014 was reviewed to evaluate whether the existing system meets Procedure F-5-5 with respect to volume, duration, and frequency. Table 5-5 on the following page summarizes the evaluation; identifying frequency, duration and volume for each of the CSO locations.

Flow data from Ravensview was also evaluated to determine if the system was in compliance with F-5-5 based on volume treated vs. volume by-passed. As it is not possible to determine the exact amount of 'wet weather flow' collected by the system this was estimated as detailed below in Table 5-4.

Table 5-4 Wet weather flow volume at Ravensview WWTP

	2014 Average Flow (m <sup>3</sup> /day)	Average Dry Weather Flow (m <sup>3</sup> /day)	Average I/I Flow (m <sup>3</sup> /day)	# of Days	Total Monthly I/I Flow (m <sup>3</sup> )
Month	[1]	[2]	[1] – [2] = [3]	[4]	[3] x [4] = [5]
Apr.	99,594	60,431	39,163	30	1,174,903
May	80,653	60,430	20,223	31	626,917
Jun.	65,762	53,380	12,382	30	371,464
Jul.	58,199	50,687	7,512	31	232,867
Aug.	58,661	45,186	13,476	31	417,741
Sept.	46,004	41,157	4,848	30	145,428
Oct.	42,530	39,861	2,669	31	82,739
2014 F5-5-5 Period	<b>64,486</b>	<b>48,450</b>	<b>14,325</b>	<b>214</b>	<b>3,065,478</b>

Table 5-5 Sewer Overflow Events from 2014 Flow Monitoring

PCP # & Location	Cumulative Duration (hrs)	Number of Events	Total Volume (m <sup>3</sup> )	Comments
COMBINED SEWER OVERFLOW (CSO)				
8 Princess St E of Frontenac*	16.2	10	6,720	→ Connects to storm sewer and backflow effect may be occurring → CSO Plugged in 2015
9 Frontenac St S of Princess*	4.0	6	121	→ Connects to storm sewer and backflow effect may be occurring → CSO Plugged in 2015
14 Ontario and Barrack	0.5	3	121	
15 Queen and Ontario*	15.3	19	5,430	→ CSO Plugged in 2015
22 William St Vortex	N/A	N/A	N/A	
23 Earl d/s of vortex	386.8	14	33,191	
24 Gore St vortex	0.9	2	322	



	PCP # & Location	Cumulative Duration (hrs)	Number of Events	Total Volume (m <sup>3</sup> )	Comments
25	Lower Union d/s of vortex	4.0	8	949	
26	West and Ontario	66.0	8	41,770	
51	d/s of Clarence St in-line CSO	1.0	2	1,019	
52	Raglan and Rideau	1.3	7	2,354	
53	Division and Union	N/A	N/A	N/A	
65	Belle Park Local SA1200	2.4	6	18,978	
67	Chatham at Elm St	2.8	5	816	→ CSO Plugged in 2015
68	Quebec at Barrie St	2.9	3	82	
70	Carlisle & Chest Nut	N/A	N/A	N/A	
71	Alfred St, north of Princess	8.0	8	1,389	→ Connects to storm sewer and backflow effect may be occurring → CSO Plugged in 2015
PUMP STATION OVERFLOW (PSO)					
1	River Street Pump Station	0.0	0	0.0	
5	Dalton Pumping Station	0.0	0	0	
28	King St Pump Station	N/A	N/A	N/A	→ No monitoring currently installed → CSO Plugged in 2015
35	Palace Road pump station	34.3	8	N/A**	
41	Morton Street Pump Station	N/A	N/A	N/A	→ No monitoring currently installed

	PCP # & Location	Cumulative Duration (hrs)	Number of Events	Total Volume (m <sup>3</sup> )	Comments
43	King-Portsmouth Pump Station	0.0	0	0.0	
57	Crerar Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
58	Lakeshore Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
59	Coverdale Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
61	Bath-Collins Bay	N/A	N/A	N/A	→ No monitoring currently installed
62	Rankin Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
63	Bath Rd Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
69	Greenview Drive Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
73	Days Road Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
74	Barrett Court Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
75	Westbrook Pump Station	N/A	N/A	N/A	→ No monitoring currently installed
<b>SANITARY SEWER OVERFLOW (SSO)</b>					
2	Belle Park Chamber, Trunks	50.3	13	18,789	
31	Albert N of King	12.2	6	14,627	→ Connects to storm sewer and backflow effect may be occurring → CSO Plugged in 2015
34	Helen and Mack	48.3	10	719	→ Connects to storm sewer and backflow effect may be occurring

	PCP # & Location	Cumulative Duration (hrs)	Number of Events	Total Volume (m <sup>3</sup> )	Comments
48	NETS at Sherwood	214.1	12	59,710	
50	NETS at Parkway S	N/A	N/A	N/A	→ No monitoring currently installed
TANK OVERFLOW (TO)					
55	King St. CSO Tank	136.6	8	6,597	
56	Collingwood CSO Tank	144.1	11	92,607	
VOLUME ASSESSMENT					
<b>Total Overflow</b>				<b>306,311</b>	
<b>Total wet weather flow</b>				<b>3,065,478</b>	
<b>% By-passed</b>				<b>9.99%</b>	

Meets F-5-5	Exceeds F-5-5
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Based on the results, the following observations were made:

- The existing system currently meets F-5-5 volumetric criteria.
- Some instrument readings appear to be uncharacteristically high compared to annual by-pass volume and other events. This may be a result of inaccurate instrument readings. However, it could not be confirmed.
- Several of the CSO locations exceed the maximum number of two events required by F-5-5.
- Many of these events have a short duration with many lasting less than 60 min. Some of the short events may be a result of inaccurate instrument readings. However, this could not be confirmed.
- It has also been indicated by Utilities Kingston that there is suspected that backflow from the storm sewer is occurring. This would artificially increase the overflow volume. Currently, the volume is calculated based on the level at the overflow with no ability to identify the direction of flow in the sewer.

With respect to monitoring system performance and level of service, it is recommended that Utilities Kingston continue to use Procedure F-5-5 as the minimum objective for reducing sewer overflows. Utilities Kingston should also continue to work towards the goal of “virtual elimination,” where overflows only occur during extreme rainfall events or unusually long period of wet weather.

## 5.4 OPERATIONAL OBSERVATIONS

In addition to the observations highlighted by the historic flow monitoring data, Utilities Kingston has also provided a list of operational issues that have been observed at various locations in the collection system. A summary of these concerns is detailed in Table 5-6 and Table 5-7 below. These concerns will be reviewed in conjunction with the Level of Service results to help identify alternatives and upgrades to the various facilities.

**Table 5-6 Pump Station and Forcemain Reported Issues**

		Pump Station & Forcemain History of Issues	
		Known/Reported Issues: Pumping Stations	Known/Reported Issues: Forcemains
Kingston West	Bath Rd.	None	None
	Bath – Collins Bay	None	None
	Bath – Lower	None	None
	Bayridge Dr.	None	None
	Collins Bay Rd.	None	None
	Coverdale Dr.	None	None
	Crerar Blvd.	Basement flooding in service area documented	None
	Days Rd.	Basement flooding in service area documented	None
	Hillview Rd.	None	None
	John Counter Blvd.	None	None
	Lakeshore Blvd.	Basement flooding in service area documented	None
	Rankin Cres.	None	None
	Westbrook Rd.	None	None
Kingston Central	Dalton Ave.	Basement flooding in service area documented	Forcemain breakage on 450mm
	Greenview Dr.	None	None
	King St.	Bypassing	None
	King – Elevator Bay	None	None
	King – Lake Ontario	None	None
	King - Portsmouth	Basement flooding in service area documented	None
	Morton St.	None	None
	Palace Rd.	Flooding in service area documented and overflows. And, only 1 pump can run at a time	High headlosses noted
	River St.	Bypassing	None
Yonge St.	None	None	
Kingston East	Barrett Ct.	None	None
	Highway 15	None	None
	James St.	None	None
	Kenwoods Cir.	None	None
	Schooner Dr.	None	None

Table 5-7 Sewers Reported Issues

		Sewers History of Issues
		Known/Reported Issues
Kingston West	Coverdale Outlet Trunk Sewer	None
	Days Rd Inlet Trunk	Basement Flooding
	Front Rd Trunk	None
	Bath Rd Collector	None
	Collins Bay Collector	None
	Crerar Collector	None
	Crossfield Ave Collector	None
	Halifax Dr Collector	None
	High Gate Park Dr Collector	None
	Lakeshore Collector	None
	McEwen Dr Collector	Basement flooding in catchment area documented
	McEwen Dr Collector Diversion	None
	McKay St Diversion	None
	Midland Ave Collector	None
	North Central Collector	None
	North East Collector	Basement flooding in catchment area documented
	North West Collector	None
	Princess-Bayridge Collector	None
	Redwood Cres Collector	None
Sprucewood Cres Collector	None	
Kingston Central	North End Trunk	Widespread basement flooding and bypassing SSO
	North End Outlet	None
	North Harbourfront	CSO/SSO at Belle Park
	Harbourfront Trunk	None
	Harbourfront Trunk Twin	None
	King St Trunk	None
	Rideau Heights	None
	Charles St. Collector	None
	Collingwood Collector	None
	George Collector	Basement flooding before reconstruction
	King St West Collector	None
	Lappans Collector	None
	Notch Hill Collector	Basement flooding towards bottom end, of sewer more so affiliated with North End Trunk Sewer
	Princess St Collector	None
	Rideau St Collector	None
Yonge St N Collector	Basement flooding before reconstruction	
Yonge St S Collector	None	
Kingston East	Ravensview Trunk	None
	Highway 15	None

# 6 FLOW PROJECTIONS

## 6.1 DEVELOPMENT PROJECTIONS

The anticipated development and growth in the City of Kingston was detailed in the Development Growth Criteria Report (WSP 2015). 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

Table 4-8.

## 6.2 PROJECTED FLOWS

The tables below details the projected flows based on the anticipated development. Table 6-1 summarizes the identified development from the Growth Scenario Report and

Table 6-2 details the flow generation per unit of development. The data presented in these tables is incremental and not cumulative.

**Table 6-1 Projected Development**

Land Use	Unit	2021	2026	2036	Full Buildout	Ultimate
Residential	Residential Units	4,928 <sup>1</sup>	3,490 <sup>1</sup>	5,070 <sup>1</sup>	10,497 <sup>2</sup>	30,608 <sup>3</sup>
Off Campus Student Residential Growth	Students	1,194 <sup>4</sup>	1,800 <sup>4</sup>	4,341 <sup>4</sup>		
Industrial	Hectares	32.7 <sup>5</sup>	49.9 <sup>5</sup>	66.3 <sup>5</sup>	Scaled proportional to population increase.	
Industrial Business Park	Hectares	47.7 <sup>5</sup>	76.5 <sup>5</sup>	105.6 <sup>5</sup>		
Commercial	Hectares	16.3 <sup>6</sup>	18.5 <sup>6</sup>	24.3 <sup>6</sup>		
Institutional	Historic flow is scaled based on anticipated growth by institution <sup>7</sup>					

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



Table 6-2 Projected Flow Generation

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 <sup>1</sup>	26.01 <sup>1</sup>	38.28 <sup>1</sup>	78.36	229.14
Off Campus Student Residential Growth	350 L/cap/day	6.14	5.14	10.44	0	0
Industrial	35 m <sup>3</sup> /ha/day	11.27	6.97	8.13	4.77	0
Industrial Business Park	49 L/cap/day	0.36 <sup>2</sup>	0.22 <sup>2</sup>	0.23 <sup>2</sup>		0
Commercial	28 m <sup>3</sup> /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
<b>Total</b>	<b>L/s</b>	<b>113.61</b>	<b>101.37</b>	<b>116.13</b>	<b>157.07</b>	<b>403.80</b>
	<b>m<sup>3</sup>/day</b>	<b>9,816</b>	<b>8,758</b>	<b>10,034</b>	<b>13,571</b>	<b>34,888</b>

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 6-3 Flow Generation

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	Development Flow	42.74	32.52	19.45	64.03	110.06
Cataraqui Bay WWTP	Base Infiltration <sup>1</sup>	36.75	37.41	31.14	37.81	70.37
<b>Sub-Total</b>	<b>L/s</b>	<b>79.49</b>	<b>69.93</b>	<b>50.58</b>	<b>101.84</b>	<b>180.43</b>
Kingston Central East	Development Flow	25.09	22.18	56.29	44.29	119.08
Ravensview WWTP	Base Infiltration <sup>1</sup>	9.03	9.26	9.25	10.94	104.29
<b>Sub-Total</b>	<b>L/s</b>	<b>34.12</b>	<b>31.44</b>	<b>65.55</b>	<b>55.23</b>	<b>223.37</b>
<b>Total</b>	<b>L/s</b>	<b>113.61</b>	<b>101.37</b>	<b>116.13</b>	<b>157.07</b>	<b>403.80</b>
	<b>m<sup>3</sup>/day</b>	<b>9,816</b>	<b>8,758</b>	<b>10,034</b>	<b>13,571</b>	<b>34,888</b>

Notes:

- 1 – Applied to development parcels > 2ha

### 6.3 D-5-1

Procedure D-5-1 is used to ensure that sanitary flow generation from approved development applications will not exceed the design capacity of the sewage treatment plant(s). To ensure that capacity is not exceeded it is necessary to determine what uncommitted reserve capacity is available based on historic flows and existing development in conjunction with the model results. This calculation has been completed twice for Ravensview and Cataraqui Bay. It was completed once with

Portsmouth Pumping Station being treated at Cataraqui Bay and again with it in its current configuration (treated at Ravensview).

**Table 6-4 D-5-1 Calculation for Cataraqui Bay WWTP without Portsmouth Redirection**

<b>Cataraqui Bay WWTP (D-5-1) – Without Portsmouth Redirected</b>		
<b>Committed Capacity For Growth (2026)</b>		
Current 3-Yr ADF	26413	m <sup>3</sup> /d
ECA Design ADF	38800	m <sup>3</sup> /d
<b>Residential Growth Requirements</b>		
2015 Existing Served Population	50151	Persons
Current ADF per person	527	L/c/d
# of Committed Dwelling Units	5708	Dwellings
Population Density	2.36	Persons/Dwelling
Committed Residential Growth	13471	Persons
Committed Residential Capacity	7099	m <sup>3</sup> /d
<b>Commercial Growth Requirements</b>		
Committed Commercial Growth	8.9	Ha
Committed Institutional Growth	2.5	Ha
Total Committed C&I Area	11.4	Ha
Unit Flow (per MOECC)	28	m <sup>3</sup> /ha/d
Committed C&I Capacity	319	m <sup>3</sup> /d
<b>Industrial Growth Requirements</b>		
Committed Industrial Growth	70	Ha
Unit Flow (per MOECC)	35	m <sup>3</sup> /ha/d
Committed I Capacity	2461	m <sup>3</sup> /d
<b>Uncommitted Reserve Capacity</b>		
Hydraulic Reserve Capacity, Cr	12387	m <sup>3</sup> /d
Committed Residential Capacity	7099	m <sup>3</sup> /d
Committed I&C Capacity	319	m <sup>3</sup> /d
Committed I Capacity	2461	m <sup>3</sup> /d
Uncommitted Reserve Capacity	<b>2508</b>	m <sup>3</sup> /d
Average Annual Flow Increase	<b>988</b>	m <sup>3</sup> /d
Remaining Time at current Growth Rate beyond 2026	<b>2.5</b>	Years

Table 6-5 D-5-1 Calculation for Cataraqui Bay WWTP with Portsmouth Redirection

Cataraqui Bay WWTP (D-5-1) – With Portsmouth Redirected		
Committed Capacity For Growth (2026)		
Current 3-Yr ADF	32765	m <sup>3</sup> /d
ECA Design ADF	38800	m <sup>3</sup> /d
Residential Growth Requirements		
2015 Existing Serviced Population	54349	Persons
Current ADF per person	603	L/c/d
# of Committed Dwelling Units	6407	Dwellings
Population Density	2.36	Persons/Dwelling
Committed Residential Growth	15121	Persons
Committed Residential Capacity	9118	m <sup>3</sup> /d
Commercial Growth Requirements		
Committed Commercial Growth	8.9	Ha
Committed Institutional Growth	46.6	Ha
Total Committed C&I Area	55.5	Ha
Unit Flow (per MOECC)	28	m <sup>3</sup> /ha/d
Committed C&I Capacity	1555	m <sup>3</sup> /d
Industrial Growth Requirements		
Committed Industrial Growth	70	Ha
Unit Flow (per MOECC)	35	m <sup>3</sup> /ha/d
Committed I Capacity	2461	m <sup>3</sup> /d
Uncommitted Reserve Capacity		
Hydraulic Reserve Capacity, Cr	6035	m <sup>3</sup> /d
Committed Residential Capacity	9118	m <sup>3</sup> /d
Committed I&C Capacity	1555	m <sup>3</sup> /d
Committed I Capacity	2461	m <sup>3</sup> /d
Uncommitted Reserve Capacity	<b>-7098</b>	m <sup>3</sup> /d
Average Annual Flow Increase	<b>1313</b>	m <sup>3</sup> /d
Remaining Time at current Growth Rate beyond 2026	<b>0</b>	Years

Based on the D-5-1 calculation it can be concluded that Cataraqui Bay WWTP does not have adequate capacity to treat the resulting flow from the anticipated development up to 2026, assuming that Portsmouth is redirected. These results are reviewed in conjunction with the model results, presented in a subsequent section, to verify their accuracy. It should be noted that Utilities Kingston is currently in the process of upgrading this facility. Additionally, the Portsmouth pumping station is slated to be redirected to this plant only once the upgrades are completed.

Table 6-6 D-5-1 Calculation for Ravensview WWTP without Portsmouth Redirection

<b>Ravensview WWTP (D-5-1) – Without Portsmouth Redirection</b>	
<b>Committed Capacity For Growth (2026)</b>	
Current 3-Yr ADF	57,949 m <sup>3</sup> /d
ECA Design ADF	95,000 m <sup>3</sup> /d
<b>Residential Growth Requirements</b>	
2015 Existing Served Population	63,829 persons
Current ADF per person	908 L/c/d
# of Committed Dwelling Units	2,791 Dwellings
Population Density	2.36 Persons/Dwelling
Committed Residential Growth	6587 persons
Committed Residential Capacity	5,981 m <sup>3</sup> /d
<b>Commercial Growth Requirements</b>	
Committed Commercial Growth	26 Ha
Committed Institutional Growth	80 Ha
Total Committed C&I Area	106 Ha
Unit Flow (per MOECC)	28 m <sup>3</sup> /ha/d
Committed C&I Capacity	2968 m <sup>3</sup> /d
<b>Industrial Growth Requirements</b>	
Committed Industrial Growth	56 Ha
Unit Flow (per MOECC)	35 m <sup>3</sup> /ha/d
Committed I Capacity	1943 m <sup>3</sup> /d
<b>Uncommitted Reserve Capacity</b>	
Hydraulic Reserve Capacity, Cr	37,051 m <sup>3</sup> /d
Committed Residential Capacity	5,981 m <sup>3</sup> /d
Committed I&C Capacity	2,968 m <sup>3</sup> /d
Committed I Capacity	1,943 m <sup>3</sup> /d
Uncommitted Reserve Capacity	<b>26159 m<sup>3</sup>/d</b>
Average Annual Flow Increase	<b>1089 m<sup>3</sup>/d</b>
Remaining Time at current Growth Rate beyond 2026	<b>24 years</b>

Table 6-7 D-5-1 Calculation for Ravensview WWTP with Portsmouth Redirection

<b>Ravensview WWTP (D-5-1) – With Portsmouth Redirection</b>	
<b>Committed Capacity For Growth (2026)</b>	
Current 3-Yr ADF	51,598 m <sup>3</sup> /d
ECA Design ADF	95,000 m <sup>3</sup> /d
<b>Residential Growth Requirements</b>	
2015 Existing Served Population	59,631 persons
Current ADF per person	865 L/c/d
# of Committed Dwelling Units	2,092 Dwellings
Population Density	2.36 Persons/Dwelling
Committed Residential Growth	4,937 persons
Committed Residential Capacity	4,271 m <sup>3</sup> /d
<b>Commercial Growth Requirements</b>	
Committed Commercial Growth	26 ha
Committed Institutional Growth	36 ha
Total Committed C&I Area	62 ha
Unit Flow (per MOECC)	28 m <sup>3</sup> /ha/d
Committed C&I Capacity	1,733 m <sup>3</sup> /d
<b>Industrial Growth Requirements</b>	
Committed Industrial Growth	56 ha
Unit Flow (per MOECC)	35 m <sup>3</sup> /ha/d
Committed I Capacity	1,943 m <sup>3</sup> /d
<b>Uncommitted Reserve Capacity</b>	
Hydraulic Reserve Capacity, Cr	43,402 m <sup>3</sup> /d
Committed Residential Capacity	4,271 m <sup>3</sup> /d
Committed I&C Capacity	1,733 m <sup>3</sup> /d
Committed I Capacity	1,943 m <sup>3</sup> /d
Uncommitted Reserve Capacity	<b>35,457 m<sup>3</sup>/d</b>
Average Annual Flow Increase	<b>1,089 m<sup>3</sup>/d</b>
Remaining Time at current Growth Rate beyond 2026	<b>44 years</b>

From the table above it can be concluded that Ravensview has adequate capacity for identified development up to 2026 based on the D-5-1 calculation. These results are reviewed in conjunction with the model results, presented in a subsequent section, to verify their accuracy. It should be noted that the Portsmouth pumping station, that currently pumps to this plant is slated to be redirected to Cataraqui Bay WWTP.

# 7 MODELLING

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 Modelling Report – Wastewater.”

The wastewater model allows for simulations that can predict system responses to events under a wide range of conditions. Using hydraulic simulations, problems can be anticipated in proposed or existing systems, and solutions can be evaluated before time, money, and materials are invested in a real-world project. Simulations can either be for dry-weather or wet-weather conditions using an extended-period model analysis with the InfoSWMM software.

A dry-weather simulation represents an extended-period of time where no rainfall is observed to determine the operating behaviour of a system under normal conditions. This type of analysis can be useful in determining the effects of diurnal pattern peaking, dry-weather infiltration and inflow, and the dedicated servicing requirements of wastewater infrastructure under firm conditions. Wet-weather simulations are used to evaluate the response of the wastewater system under various rainfall or storm events where rain derived infiltration and inflow (RDII) is analyzed to evaluate the system performance over an extended-period. This type of analysis allows modeling of documented design storms, the review and analysis of CSO’s and SSO’s and the evaluation of pumping station peak capacities and their operating conditions and controls.

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) and an extended-period CSO simulation analysis where a typical year of rainfall (2014 rainfall) and wetter-than-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 these by-pass events.

## 7.1 WASTEWATER MODEL DEVELOPMENT

To model the scenarios used in the GAP analysis the following steps were taken:

- The InfoSWMM trunk model was updated using available as-built, GIS and pump station operation data to represent the 2014 existing condition of infrastructure.
- Total system dry-weather loading on an average day basis was determined for the existing conditions using demand adjusted 2013/2014 water consumption data.
- The dry-weather loading allocations assigned in the model were based on 2014 meter records and were assigned to each junction using sanitary sub-catchment areas and converted to L/s. Each meter record was assigned a representative diurnal pattern based on its land use zoning designation (e.g. Residential).
- A wastewater mass balance was conducted to pre-assign dry-weather infiltration to each junction in addition to loading from meter records. This rate was then manually adjusted to

calibrate the model for the dry-weather condition by comparing to in-flow monitors and SCADA data.

- Documented pipe materials and pipe age information were used to adjust the dry-weather infiltration of all junctions by location.
- Dry-weather calibration was finalized when observed monitoring data was simulated for peak flows/volumes and found to be within  $\pm 5$ -10% of observed monitored values. Further to this dry-weather calibration target being achieved, the timing of peak dry-weather flows was observed within 1 hour of the flow monitoring data.
- Wet-weather calibration was then conducted by simulating rain events for 2013/2014 and comparing model outputs with in-flow monitors and SCADA data.
- Rain-Derived Infiltration and Inflow (RDII) parameters were allocated to each model junction based on the representative sanitary sub-catchment areas using R-T-K Hydrographs. Combined sewer catchment areas were updated in the model using orthographic imagery and represented as storm water catchments in the model.
- RDII was then manually adjusted during calibration by catchment area size and location until existing conditions matched short, medium and long-term rainfall responses from runoff and infiltration.
- Wet-weather calibration was finalized when observed monitoring data was simulated for peak flows and found to be within -15-25%, and for peak, volumes when found to be within -10-20% of observed values.
- The model was then updated with future infrastructure for imminent projects including the redirection of the Portsmouth Pumping Station to the Cataraqui Bay Wastewater Treatment Plant. Each future scenario also included separation of combined sewers which was updated in the model by reducing the respective combined sewer catchment areas by year.

Documented pipe materials and pipe age information were used to adjust the dry-weather infiltration of all junctions by location.

# 8 WASTEWATER SYSTEM GAPS

Using the results flow the hydraulic model gaps in the infrastructure were identified based on the developed design criteria and required level of service.

## 8.1 GRAVITY SEWERS EVALUATION

Table 8-1, Table 8-2 illustrate the resulting level of service for each flow scenario with the resulting gaps identified. The results are also illustrated in the figures included in appendix A.



Table 8-1 - Hydraulic Gradeline Results Existing, 2021 and 2026

		Catchment Properties			HGL Existing Conditions								HGL 2021 Conditions								HGL 2026 Conditions (L/s)								
		Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	
Kingston West	Coverdale Outlet Trunk Sewer	NO	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Days Rd Inlet Trunk	YES	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Front Rd Trunk	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Bath Rd Collector	YES	NO	NO	✓	✓	✓	▲	▲	X	X	25-yr	✓	✓	✓	▲	▲	X	X	25-yr	✓	✓	✓	▲	▲	X	X	25-yr	
	Collins Bay Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	▲	▲	100-yr	✓	✓	✓	▲	▲	▲	X	50-yr	
	Crerar Collector	NO	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Crossfield Ave Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Halifax Dr Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	High Gate Park Dr Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Lakeshore Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	McEwen Dr Collector	YES	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	McEwen Dr Collector Diversion	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	McKay St Diversion	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Midland Ave Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	North Central Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	North East Collector	YES	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	North West Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	50-yr	✓	✓	✓	✓	✓	✓	X	X	25-yr	✓	✓	✓	▲	X	X	X	10-yr
	Princess-Bayridge Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Redwood Cres Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr
	Sprucewood Cres Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	▲	▲	▲	100-yr	

		Catchment Properties			HGL Existing Conditions								HGL 2021 Conditions								HGL 2026 Conditions (L/s)							
		Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS
Kingston Central	North End Trunk	YES	NO	YES	✓	✓	✓	▲	✗	✗	✗	10-yr	✓	✓	✓	▲	✗	✗	✗	10-yr	✓	✓	✓	▲	✗	✗	✗	10-yr
	North End Outlet	YES	NO	NO	✓	✓	✓	▲	▲	▲	✗	50-yr	✓	✓	✓	▲	▲	▲	✗	50-yr	✓	✓	✓	▲	▲	▲	✗	50-yr
	North Harbourfront	YES	YES	NO	✓	▲	✗	✗	✗	✗	✗	2-yr	✓	▲	✗	✗	✗	✗	✗	2-yr	✓	▲	✗	✗	✗	✗	✗	2-yr
	Harbourfront Trunk	YES	YES	NO	✓	✗	✗	✗!	✗!	✗!	✗!	Dry	✓	✗	✗	✗	✗	✗!	✗!	Dry	✓	✗	✗	✗	✗	✗!	✗!	Dry
	Harbourfront Trunk Twin	YES	YES	NO	✓	✗	✗	✗!	✗!	✗!	✗!	Dry	✓	✗	✗	✗	✗	✗!	✗!	Dry	✓	✗	✗	✗	✗	✗!	✗!	Dry
	King St Trunk	YES	YES	NO	✓	▲	✗	✗	✗	✗	✗	2-yr	✓	▲	▲	✗	✗	✗	✗	5-yr	✓	▲	▲	▲	✗	✗	✗	5-yr
	Rideau Heights	YES	NO	NO	✓	✓	✗	✗	✗	✗	✗	2-yr	✓	✓	▲	✗	✗	✗	✗	5-yr	✓	✓	✓	▲	✗	✗	✗	10-yr
	Charles St. Collector	YES	YES	NO	✓	✓	✗	✗	✗	✗	✗	2-yr	✓	✓	✓	▲	✗	✗	✗	10-yr	✓	✓	✓	▲	✗	✗	✗	10-yr
	Collingwood Collector	YES	YES	YES	✓	✓	✓	✓	✓	▲	✗	50-yr	✓	✓	✓	✓	✓	▲	✗	50-yr	✓	✓	✓	✓	✓	▲	✗	50-yr
	George Collector	YES	YES	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	King St West Collector	YES	NO	NO	✓	✓	✓	✓	✓	▲	✗	50-yr	✓	✓	✓	✓	▲	▲	✗	50-yr	✓	✓	✓	✓	▲	▲	✗	50-yr
	Lappans Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Notch Hill Collector	NO	NO	YES	✓	✓	▲	▲	✗	✗	✗	10-yr	✓	✓	▲	▲	✗	✗	✗	10-yr	✓	✓	▲	▲	✗	✗	✗	10-yr
	Princess St Collector	YES	NO	NO	✓	✓	✓	▲	✗	✗	✗	10-yr	✓	✓	✓	▲	✗	✗	✗	10-yr	✓	✓	✓	▲	✗	✗	✗	10-yr
	Rideau St Collector	YES	YES	NO	✓	✓	▲	▲	✗	✗	✗	10-yr	✓	✓	▲	▲	✗	✗	✗	10-yr	✓	✓	▲	▲	✗	✗	✗	10-yr
	Yonge St N Collector	YES	NO	YES	✓	✓	✓	✓	▲	▲	▲	100-yr	✓	✓	✓	✓	▲	▲	▲	100-yr	✓	✓	✓	✓	▲	▲	▲	100-yr
Yonge St S Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	
Kingston East	Ravensview Trunk	YES	NO	NO	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	
	Highway 15	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr

Legend:                      ✓ Good                      ▲ Review                      ✗ Gap                      ✗! Gap & Flooding at Surface Observed

Table 8-2 Hydraulic Gradeline Results 2036, Full Buildout and Ultimate

		Catchment Properties			HGL 2036 Conditions (L/s)							HGL Buildout Conditions							HGL Ultimate Conditions										
	Sewer	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	
					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kingston West	Coverdale Outlet Trunk Sewer	NO	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Days Rd Inlet Trunk	YES	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Front Rd Trunk	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Bath Rd Collector	YES	NO	NO	✓	✓	✓	▲	▲	X	X	25-yr	✓	✓	✓	X	X	X	X	X	5-yr	✓	✓	✓	X	X	X	X	5-yr
	Collins Bay Collector	YES	NO	NO	✓	✓	✓	▲	▲	X	X	25-yr	✓	✓	✓	▲	▲	X	X	X	25-yr	X	X	X	X	X	X	X	Dry
	Crerar Collector	NO	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Crossfield Ave Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Halifax Dr Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	High Gate Park Dr Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Lakeshore Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	McEwen Dr Collector	YES	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	McEwen Dr Collector Diversion	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	McKay St Diversion	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Midland Ave Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	North Central Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	North East Collector	YES	NO	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	North West Collector	YES	NO	NO	✓	✓	✓	▲	X	X	X	10-yr	✓	✓	✓	▲	X	X	X	X	10-yr	✓	✓	✓	▲	X	X	X	10-yr
	Princess-Bayridge Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Redwood Cres Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
Sprucewood Cres Collector	YES	NO	NO	✓	✓	✓	▲	▲	▲	▲	100-yr	✓	✓	✓	▲	▲	▲	▲	▲	100-yr	✓	✓	✓	▲	▲	▲	▲	100-yr	
Kingston Central	North End Trunk	YES	NO	YES	✓	✓	✓	▲	X	X	X	10-yr	✓	✓	✓	▲	X	X	X	10-yr	✓	✓	✓	▲	X	X	X	10-yr	
	North End Outlet	YES	NO	NO	✓	✓	✓	▲	▲	▲	X	50-yr	✓	✓	✓	▲	▲	▲	X	50-yr	✓	✓	✓	▲	▲	▲	X	50-yr	
	North Harbourfront	YES	YES	NO	✓	▲	▲	X	X	X	X	5-yr	✓	✓	▲	▲	▲	X	X	25-yr	✓	✓	▲	▲	▲	X	X	25-yr	

		Catchment Properties			HGL 2036 Conditions (L/s)							HGL Buildout Conditions							HGL Ultimate Conditions									
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	Dry	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Sewer LOS	
Kingston East	Harbourfront Trunk	YES	YES	NO	✓	X	X	X	X	X <sup>!</sup>	X <sup>!</sup>	Dry	✓	✓	▲	X	X	X	X	5-yr	✓	✓	▲	X	X	X	X	5-yr
	Harbourfront Trunk Twin	YES	YES	NO	✓	X	X	X	X	X <sup>!</sup>	X <sup>!</sup>	Dry	✓	▲	X	X	X	X	X	2-yr	✓	▲	X	X	X	X	X	2-yr
	King St Trunk	YES	YES	NO	✓	▲	▲	X	X	X	X	5-yr	✓	✓	✓	✓	▲	▲	▲	100-yr	✓	✓	✓	✓	▲	▲	▲	100-yr
	Rideau Heights	YES	NO	NO	✓	✓	✓	▲	X	X	X	10-yr	✓	✓	✓	▲	X	X	X	25-yr	✓	✓	✓	▲	X	X	X	25-yr
	Charles St. Collector	YES	YES	NO	✓	✓	✓	▲	▲	▲	▲	100-yr	✓	✓	✓	▲	▲	▲	▲	100-yr	✓	✓	✓	▲	▲	▲	▲	100-yr
	Collingwood Collector	YES	YES	YES	✓	✓	✓	✓	✓	▲	X	50-yr	✓	✓	✓	✓	✓	▲	X	50-yr	✓	✓	✓	✓	✓	▲	X	50-yr
	George Collector	YES	YES	YES	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	King St West Collector	YES	NO	NO	✓	✓	✓	✓	▲	▲	X	50-yr	✓	✓	✓	✓	▲	▲	X	50-yr	✓	✓	✓	✓	▲	▲	X	50-yr
	Lappans Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Notch Hill Collector	NO	NO	YES	✓	✓	▲	▲	X	X	X	10-yr	✓	✓	▲	▲	X	X	X	10-yr	✓	✓	▲	▲	X	X	X	10-yr
	Princess St Collector	YES	NO	NO	✓	✓	✓	▲	X	X	X	10-yr	✓	✓	✓	X	X	X	X	5-yr	✓	✓	✓	X	X	X	X	5-yr
	Rideau St Collector	YES	YES	NO	✓	✓	▲	▲	X	X	X	10-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
	Yonge St N Collector	YES	NO	YES	✓	✓	✓	✓	▲	▲	▲	100-yr	✓	✓	✓	✓	▲	▲	▲	100-yr	✓	✓	✓	✓	▲	▲	▲	100-yr
	Yonge St S Collector	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr
Ravensview Trunk	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	
Highway 15	YES	NO	NO	✓	✓	✓	✓	✓	✓	✓	100-yr	✓	✓	✓	✓	✓	✓	✓	100-yr	X	X	X	X <sup>!</sup>	X <sup>!</sup>	X <sup>!</sup>	X <sup>!</sup>	Dry	

Legend:

✓ Good

▲ Review

X Gap

X<sup>!</sup> Gap & Flooding at Surface Observed

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

- All gravity sewers meet the required level of service during the dry weather simulation for all analysis periods except the ultimate scenario.
- The east gravity collection system meets the required level of service up until the ultimate analysis period.
- The West gravity collection system generally meets the required level of service except for isolated locations in the collector sewers.
- The central collection system experiences significant gaps during wet weather events larger than the 2yr 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.
- Surface flooding may be experienced in the central system (isolated locations) during the 10yr return storm and larger.

It should also be noted that there may be further areas of concerns that will be reviewed further in the alternatives as a result of bottleneck or backwater effect being eliminated.

## **8.2 PUMPING FACILITY GAPS**

Table 8-3 through Table 8-7 illustrate the resulting level of service for each flow scenario with the resulting gaps identified. Further discussion of the results follows in the sections below.



Table 8-3 Pumping Station Flow Rates Existing and 2021

	Catchment Properties			Flow (L/s)		Peak Inflow Existing Conditions (L/s)								Peak Inflow 2021 Conditions (L/s)								
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Firm Capacity	Peak Capacity	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	
Kingston West	Bath Rd.	YES	NO	NO	51	87	4.5	15.1	19.1	21.8	25.1	27.7	30.2	100-YR	4.6	15.2	19.3	21.9	25.3	27.7	30.4	100-YR
	Bath – Collins Bay+	NO	NO	NO	16	39	1.6	14.2	19.0	22.2	26.2	29.1	32.0	2-YR	1.6	14.2	19.0	22.2	26.2	29.1	32.0	2-YR
	Bath – Lower <sup>5</sup>	NO	NO	NO	6	12	0.3	2.5	3.2	3.7	4.4	4.9	5.4	100-YR	0.3	2.5	3.2	3.7	4.4	4.9	5.4	100-YR
	Bayridge Dr.	YES	NO	NO	19	37	0.8	8.4	11.2	13.1	15.4	17.1	18.8	100-YR	1.8	9.8	12.7	14.7	17.1	18.9	20.7	50-YR
	Collins Bay Rd. <sup>5</sup>	YES	NO	NO	20	24	0.6	2.7	3.5	4.0	4.7	5.2	5.7	100-YR	1.8	4.6	5.6	6.3	7.2	8.0	8.7	100-YR
	Coverdale Dr.	YES	NO	NO	78	133	5.7	14.4	17.6	19.7	22.3	24.3	26.2	100-YR	5.7	14.4	17.6	19.7	22.3	24.3	26.2	100-YR
	Crerar Blvd.	NO	NO	YES	57	97	14.6	63.9	81.7	93.4	108.2	119.2	130.1	DRY	2.9	52.3	70.0	81.8	96.6	107.5	118.4	2-YR
	Days Rd.	YES	NO	YES	900	1102	221.0	623.3	780.4	873.7	1016.3	1102.8	1188.3	10-YR	297.5	705.8	867.9	990.7	1114.7	1201.9	1290.7	5-YR
	Hillview Rd. <sup>5</sup>	YES	NO	NO	141	240	53.0	118.2	143.7	162.8	185.6	202.8	212.5	2-YR	66.4	128.9	154.9	169.8	194.5	208.6	218.4	2-YR
	John Counter Blvd. <sup>5</sup>	YES	NO	NO	51	86	0.5	6.1	8.2	9.5	11.3	12.5	13.8	100-YR	12.2	18.5	21.0	22.6	24.6	26.2	27.7	100-YR
	Lakeshore Blvd.	YES	NO	YES	117	210	45.0	72.4	83.2	87.6	95.6	102.2	108.1	100-YR	45.6	72.9	83.3	88.4	96.6	102.6	108.4	100-YR
	Rankin Cres. <sup>5</sup>	YES	NO	NO	19	32	8.6	10.9	11.3	11.6	12.3	13.0	13.9	100-YR	8.6	10.9	11.3	11.6	12.3	13.0	13.9	100-YR
	Westbrook Rd.	YES	NO	NO	14	18	2.6	10.6	13.5	15.4	17.9	19.7	21.6	5-YR	7.8	15.9	19.0	21.1	23.5	26.4	27.4	
	Westbrook Rd.	YES	NO	NO	30	48	2.6	10.6	13.5	15.4	17.9	19.7	21.6		7.8	15.9	19.0	21.1	23.5	26.4	27.4	100-YR
Kingston Central	Dalton Ave.	YES	NO	YES	990	1225	124.6	588.5	776.9	821.7	1019.5	1067.5	1077.1	10-YR	137.3	627.0	795.9	823.5	1063.7	1074.2	1092.5	10-YR
	Greenview Dr.	NO	NO	NO	47	85	1.6	12.2	16.2	18.9	22.2	24.7	27.2	100-YR	1.6	12.2	16.2	18.9	22.2	24.7	27.2	100-YR
	King St. <sup>2</sup>	YES	YES	YES	576	731	329.5	859.1	869.2	934.4	1095.9	1122.9	1129.2	DRY	266.2	828.4	855.0	862.5	884.9	936.2	1040.3	DRY
	King – Elevator Bay+ <sup>5</sup>	YES	NO	NO	88	150	1.1	7.2	9.4	10.9	12.7	14.1	15.5	100-YR	1.1	7.2	9.4	10.9	12.7	14.1	15.5	100-YR
	King – Lake Ontario <sup>5</sup>	NO	NO	NO	12	22	0.6	3.0	3.9	4.5	5.2	5.7	6.3	100-YR	0.6	3.0	3.9	4.5	5.2	5.7	6.3	100-YR
	King – Portsmouth <sup>1</sup>	YES	NO	YES	285	405	70.2	206.8	250.8	291.8	334.3	361.0	398.4	5-YR	77.8	218.4	267.6	306.1	350.2	378.1	415.6	

	Catchment Properties	Flow (L/s)		Peak Inflow Existing Conditions (L/s)										Peak Inflow 2021 Conditions (L/s)								
		Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Firm Capacity	Peak Capacity	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS
Kingston West	King – Portsmouth <sup>1</sup>	YES	NO	NO	425	500	70.2	206.8	250.8	291.8	334.3	361.0	398.4		77.8	218.4	267.6	306.1	350.2	378.1	415.6	100-YR
	Morton St. <sup>5</sup>	NO	NO	NO	18	32	0.6	10.1	13.6	15.9	18.8	21.0	23.2	10-YR	0.6	10.1	13.6	15.9	18.8	21.0	23.2	10-YR
	Palace Rd. <sup>3</sup>	YES	NO	YES	22	22	1.7	12.9	17.0	19.8	23.2	25.8	28.4	10-YR	2.1	13.2	17.3	20.0	23.5	26.0	28.6	10-YR
	River St. <sup>3</sup>	YES	YES	YES	1700	2130	709.5	1978.6	2001.5	2032.4	2043.0	2049.2	2052.1	DRY	684.9	1978.8	1993.4	2003.5	2010.3	2021.8	2035.9	DRY
	Yonge St.	NO	NO	NO	4	10	0.6	1.3	1.5	1.7	1.9	2.1	2.3	100-YR	0.6	1.3	1.5	1.7	1.9	2.1	2.3	100-YR
Kingston East	Barrett Ct. <sup>5</sup>	YES	NO	NO	188	277	36.4	64.0	73.5	79.6	87.9	93.1	101.9	100-YR	47.9	75.5	86.3	91.1	100.1	108.7	115.0	100-YR
	Highway 15+	YES	NO	NO	87	147	3.5	11.9	15.3	17.6	20.4	22.6	24.7	100-YR	3.5	11.9	15.3	17.6	20.4	22.6	24.7	100-YR
	James St.+	YES	NO	NO	67	115	49.7	51.1	52.5	52.8	53.1	54.4	55.8	100-YR	52.1	54.2	55.1	55.8	55.9	56.1	57.3	100-YR
	Kenwoods Cir. <sup>5</sup>	NO	NO	NO	48	95	1.3	3.2	3.9	4.4	5.0	5.4	5.9	100-YR	1.3	3.2	3.9	4.4	5.0	5.4	5.9	100-YR
	Schooner Dr.	YES	NO	NO	10	20	1.9	10.1	13.2	15.2	16.8	19.7	21.6	DRY	3.5	11.9	14.9	16.8	19.2	21.0	22.8	DRY

Good	Review	Gap
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+ = 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 St. and River St. PS have dynamic inflow based on a relationship with King St. 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 has been shown with the upgrades capacity.

5=Model calibration based on limited SCADA data ranges and/only level monitoring data and/or anecdotal station data as available.



Table 8-4 Pumping Station Flow Rates 2026 and 2036

		Catchment Properties			Flow (L/s)		Peak Inflow 2026 Conditions (L/s)							Peak Inflow 2036 Conditions (L/s)								
		Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Firm Capacity	Peak Capacity	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS
Kingston West	Bath Rd.	YES	NO	NO	51	87	6.0	17.1	21.3	24.1	26.7	30.1	32.9	100-YR	6.0	17.1	21.3	24.1	27.5	30.1	32.9	100-YR
	Bath – Collins Bay+	NO	NO	NO	16	39	1.6	14.2	19.0	22.2	26.2	29.1	32.0	2-YR	1.6	14.2	19.0	22.2	26.2	29.1	32.0	2-YR
	Bath – Lower <sup>5</sup>	NO	NO	NO	6	12	0.3	2.5	3.2	3.7	4.4	4.9	5.4	100-YR	0.3	2.5	3.2	3.7	4.4	4.9	5.4	100-YR
	Bayridge Dr.	YES	NO	NO	19	37	1.8	9.8	12.7	14.6	17.1	18.9	20.7	50-YR	1.8	9.8	12.8	14.7	17.1	18.9	20.7	50-YR
	Collins Bay Rd. <sup>5</sup>	YES	NO	NO	20	24	4.4	7.6	8.9	9.7	10.7	11.5	12.2	100-YR	4.7	7.9	9.2	10.0	11.0	11.8	12.6	100-YR
	Coverdale Dr.	YES	NO	NO	78	133	5.7	14.4	17.6	19.7	22.3	24.3	26.2	100-YR	5.7	14.4	17.6	19.7	22.3	24.3	26.2	100-YR
	Crerar Blvd.	NO	NO	YES	77	97	2.9	52.3	70.0	81.8	96.6	107.5	118.4	5-YR	2.9	52.3	70.0	81.8	96.6	107.5	118.4	5-YR
	Days Rd.	YES	NO	YES	900	1102	352.6	759.7	911.2	1033.0	1159.5	1251.5	1346.7	2-YR	390.4	799.3	951.6	1076.2	1200.3	1295.6	1391.8	2-YR
	Hillview Rd. <sup>5</sup>	YES	NO	NO	141	240	67.1	131.9	159.6	178.5	200.6	214.2	225.2	2-YR	68.9	132.2	161.7	178.8	201.7	215.1	226.1	2-YR
	John Counter Blvd. <sup>5</sup>	YES	NO	NO	51	86	12.2	18.5	21.0	24.4	24.6	26.2	27.7	100-YR	12.2	18.5	21.0	22.6	24.6	26.2	27.7	100-YR
	Lakeshore Blvd.	YES	NO	YES	117	199	45.9	73.1	83.8	88.6	96.8	102.8	108.4	100-YR	45.9	73.1	83.8	88.6	96.8	102.8	108.4	100-YR
	Rankin Cres. <sup>5</sup>	YES	NO	NO	19	32	8.6	10.9	11.3	11.6	12.3	13.0	13.9	100-YR	8.6	10.9	11.6	11.9	12.2	13.0	13.8	100-YR
	Westbrook Rd.	YES	NO	NO	14	18	14.3	23.4	26.8	29.1	32.0	34.1	36.2		14.3	23.4	26.8	29.1	32.0	34.1	36.2	
	Westbrook Rd.	YES	NO	NO	30	48	14.3	23.4	26.8	29.1	32.0	34.1	36.2	10-YR	14.3	23.4	26.8	29.1	32.0	34.1	36.2	10-YR
Kingston Central	Dalton Ave.	YES	NO	YES	990	1225	146.1	652.9	798.0	824.8	1064.3	1074.4	1097.2	10-YR	155.4	654.0	818.7	826.0	1060.6	1077.6	1099.7	10-YR
	Greenview Dr.	NO	NO	NO	47	85	1.6	12.2	16.2	18.9	22.2	24.7	27.2	100-YR	1.6	12.2	16.2	18.9	22.2	24.7	27.2	100-YR
	King St. <sup>2</sup>	YES	YES	YES	576	731	278.8	812.0	836.5	855.2	946.1	924.6	1022.1	DRY	293.3	814.2	884.2	916.5	870.2	898.0	940.5	DRY
	King – Elevator Bay+ <sup>5</sup>	YES	NO	NO	88	150	1.1	7.2	9.4	10.9	12.7	14.1	15.5	100-YR	1.1	7.2	9.4	10.9	12.7	14.1	15.5	100-YR
	King – Lake Ontario <sup>5</sup>	NO	NO	NO	12	22	0.6	3.0	3.9	4.5	5.2	5.7	6.3	100-YR	0.6	3.0	3.9	4.5	5.2	5.7	6.3	100-YR
	King – Portsmouth <sup>1</sup>	YES	NO	YES	285	405	95.9	233.7	286.2	326.5	367.9	396.6	429.2		96.4	234.3	286.1	323.8	366.8	398.0	425.2	
King – Portsmouth <sup>1</sup>	YES	NO	NO	425	500	95.9	233.7	286.2	326.5	367.9	396.6	429.2	50-YR	96.4	234.3	286.1	323.8	366.8	398.0	425.2	50-YR	

		Catchment Properties			Flow (L/s)		Peak Inflow 2026 Conditions (L/s)							Peak Inflow 2036 Conditions (L/s)								
		Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Firm Capacity	Peak Capacity	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS
	Morton St. <sup>5</sup>	NO	NO	NO	18	32	0.6	10.1	13.6	15.9	18.8	21.0	23.2	10-YR	0.6	10.1	13.6	16.0	18.9	21.0	23.2	10-YR
	Palace Rd. <sup>3</sup>	YES	NO	YES	22	22	2.2	13.2	17.4	20.1	23.5	26.1	28.6	10-YR	2.9	13.7	17.7	20.5	23.9	26.4	29.0	10-YR
	River St. <sup>3</sup>	YES	YES	YES	1700	2130	703.6	1970.8	1995.7	2008.7	2009.3	2015.5	2020.9	DRY	779.3	1958.4	1989.5	2001.5	2002.7	2010.9	2020.3	DRY
	Yonge St.	NO	NO	NO	4	10	0.6	1.3	1.5	1.7	1.9	2.1	2.3	100-YR	0.6	1.3	1.5	1.7	1.9	2.1	2.3	100-YR
Kingston East	Barrett Ct. <sup>+</sup>	YES	NO	NO	188	277	58.4	84.6	97.3	104.5	114.6	120.0	128.8	100-YR	60.4	90.8	101.1	108.0	118.9	125.0	133.2	100-YR
	Highway 15+	YES	NO	NO	87	147	3.5	11.9	15.3	17.6	20.4	22.6	24.7	100-YR	3.5	11.9	15.3	17.6	20.5	22.6	24.7	100-YR
	James St.+	YES	NO	NO	67	115	56.9	57.1	57.6	57.9	58.4	58.7	59.0	100-YR	62.6	63.8	64.5	64.9	65.4	65.7	66.1	100-YR
	Kenwoods Cir. <sup>5</sup>	NO	NO	NO	48	95	1.3	3.2	3.9	4.4	5.0	5.4	5.9	100-YR	1.3	3.2	3.9	4.4	5.0	5.4	5.9	100-YR
	Schooner Dr.	YES	NO	NO	10	20	3.5	11.6	14.5	16.4	18.8	20.6	22.5	DRY	3.5	11.6	14.5	16.4	18.8	20.6	22.5	DRY

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- + = 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 & PS is upgraded
- 2= King St. and River St. PS have dynamic inflow based on a relationship with King St. 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 has been shown with the upgrades capacity.
- 5=Model calibration based on limited SCADA data ranges and/or level monitoring data and/or anecdotal station data as available

Table 8-5 Pumping Station Flow Rates Full Buildout and Ultimate

	Catchment Properties			Flow (L/s)		Peak Inflow Full Build-out Conditions (L/s)									Peak Inflow Ultimate Conditions (L/s)							
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Firm Capacity	Peak Capacity	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	
Kingston West	Bath Rd.	YES	NO	NO	51	87	8.3	17.1	23.4	26.2	29.7	32.3	34.8	100-YR	8.3	17.1	23.4	26.2	29.7	32.3	34.8	100-YR
	Bath – Collins Bay+	NO	NO	NO	16	39	1.6	14.2	19.0	22.2	26.2	29.1	32.0	2-YR	1.6	14.2	19.0	22.2	26.2	29.1	32.0	2-YR
	Bath – Lower <sup>5</sup>	NO	NO	NO	6	12	0.3	2.5	3.2	3.7	4.4	4.9	5.4	100-YR	0.3	2.5	3.2	3.7	4.4	4.9	5.4	100-YR
	Bayridge Dr.	YES	NO	NO	19	37	5.7	13.7	16.7	18.6	21.1	22.9	24.7	10-YR	5.7	13.7	16.7	18.6	21.1	22.9	24.7	10-YR
	Collins Bay Rd. <sup>5</sup>	YES	NO	NO	20	24	4.7	8.0	9.8	10.0	11.0	11.8	12.6	100-YR	4.7	8.0	9.8	10.0	11.0	11.8	12.6	100-YR
	Coverdale Dr.	YES	NO	NO	78	133	5.7	14.4	17.6	19.7	22.3	24.3	26.2	100-YR	5.7	14.4	17.6	19.7	22.3	24.3	26.2	100-YR
	Crerar Blvd.	NO	NO	YES	77	97	2.9	52.3	70.0	81.8	96.6	107.5	118.4	5-YR	2.9	52.3	70.0	81.8	96.6	107.5	118.4	5-YR
	Days Rd.	YES	NO	YES	900	1102	487.5	897.0	1033.6	1151.0	1282.3	1369.5	1445.9	2-YR	539.9	907.3	1064.9	1163.4	1287.9	1374.9	1451.2	DRY
	Hillview Rd. <sup>5</sup>	YES	NO	NO	141	240	76.0	139.7	163.4	179.0	203.8	223.7	233.5	2-YR	124.0	171.9	190.9	202.0	238.0	232.6	238.8	DRY
	John Counter Blvd. <sup>5</sup>	YES	NO	NO	51	86	20.0	24.0	26.7	28.5	30.7	32.3	34.0	100-YR	17.3	24.0	26.7	28.5	30.7	32.3	34.0	100-YR
	Lakeshore Blvd.	YES	NO	YES	117	199	48.3	73.1	82.4	88.7	97.1	103.4	108.4	100-YR	48.3	73.1	82.4	88.7	97.1	103.4	108.4	100-YR
	Rankin Cres. <sup>5</sup>	YES	NO	NO	19	32	8.6	9.8	11.4	11.4	12.2	13.0	13.8	100-YR	178.9	199.4	208.7	213.8	221.0	225.6	230.3	<DRY
	Westbrook Rd.	YES	NO	NO	14	18	16.6	23.3	26.7	29.0	31.9	34.0	36.1		61.4	74.9	79.9	83.6	88.3	91.7	95.1	
	Westbrook Rd.	YES	NO	NO	30	48	16.6	23.3	26.7	29.0	31.9	34.0	36.1	10-YR	61.4	74.9	79.9	83.6	88.3	91.7	95.1	<DRY
Kingston Central	Dalton Ave.	YES	NO	YES	990	1225	184.4	659.8	832.6	977.9	1075.2	1079.7	1171.8	10-YR	184.4	659.7	832.6	977.9	1075.2	1079.7	1171.8	10-YR
	Greenview Dr.	NO	NO	NO	47	85	1.6	12.2	16.2	18.9	22.2	24.7	27.2	100-YR	1.6	12.2	16.2	18.9	22.2	24.7	27.2	100-YR
	King St. <sup>2</sup>	YES	YES	YES	576	731	308.6	632.1	663.6	668.1	792.7	806.3	820.7	DRY	308.6	632.1	663.6	668.1	792.7	806.3	820.7	DRY

	Catchment Properties			Flow (L/s)		Peak Inflow Full Build-out Conditions (L/s)								Peak Inflow Ultimate Conditions (L/s)								
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Firm Capacity	Peak Capacity	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	DRY	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	Station LOS	
Kingston West	King – Elevator Bay+ <sup>5</sup>	YES	NO	NO	88	150	1.3	7.7	10.9	11.6	13.6	15.1	16.6	100-YR	1.3	7.7	10.9	11.6	13.6	15.1	16.6	100-YR
	King – Lake Ontario <sup>5</sup>	NO	NO	NO	12	22	0.6	3.0	3.9	4.5	5.2	5.7	6.3	100-YR	0.6	3.0	3.9	4.5	5.2	5.7	6.3	100-YR
	King – Portsmouth <sup>1</sup>	YES	NO	YES	285	405	101.8	235.9	289.0	324.4	368.5	399.8	430.3	2-YR	101.8	235.9	289.1	324.4	338.5	399.8	430.3	2-YR
	King – Portsmouth <sup>1</sup>	YES	NO	NO	425	500	101.8	235.9	289.0	324.4	368.5	399.8	430.3	50-YR	101.8	235.9	289.1	324.4	338.5	399.8	430.3	50-YR
	Morton St. <sup>5</sup>	NO	NO	NO	18	32	0.6	10.1	13.7	16.0	18.9	21.1	23.2	10-YR	0.6	10.1	13.7	16.0	18.9	21.1	23.2	10-YR
	Palace Rd. <sup>3</sup>	YES	NO	YES	22	22	2.9	13.7	17.7	20.5	23.9	26.4	29.0	10-YR	2.9	13.7	17.7	20.5	23.9	26.4	29.0	10-YR
	River St. <sup>3</sup>	YES	YES	YES	1700	2130	825.5	1795.4	1987.1	1987.8	1992.7	2008.4	2019.0	DRY	825.5	1795.4	1987.1	1984.8	1992.7	2008.4	2019.0	DRY
	Yonge St.	NO	NO	NO	4	10	0.6	1.3	1.5	1.7	1.9	2.1	2.3	100-YR	0.6	1.3	1.5	1.7	1.9	2.1	2.3	100-YR
Kingston East	Barrett Ct.+ <sup>5</sup>	YES	NO	NO	1560	1890	62.1	91.1	102.9	109.1	119.2	125.0	135.5	100-YR	140.2	168.2	171.0	175.9	179.1	178.4	180.8	100-YR
	Highway 15+	YES	NO	NO	4	10	3.7	12.0	15.4	17.7	20.5	22.6	24.7	100-YR	3.7	12.0	15.4	17.7	20.6	22.6	24.7	100-YR
	James St.+	YES	NO	NO	188	277	71.5	73.0	73.5	73.9	74.4	74.7	75.0	<DRY	71.5	73.0	73.5	73.9	74.4	74.7	75.0	<DRY
	Kenwoods Cir. <sup>5</sup>	NO	NO	NO	87	147	1.3	3.2	3.9	4.4	5.0	5.4	5.9	100-YR	1.3	3.2	3.9	4.4	5.0	5.4	5.9	100-YR
	Schooner Dr.	YES	NO	NO	67	115	3.5	11.6	14.5	16.4	18.8	20.6	22.5	DRY	3.5	11.6	14.5	16.4	18.8	20.6	22.5	DRY

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+ = 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 & PS is upgraded

2= King St. and River St. PS have dynamic inflow based on a relationship with King St. 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 has been shown with the upgrades capacity.

5=Model calibration based on limited SCADA data ranges and/only level monitoring data and/or anecdotal station data as available

Table 8-6 Forcemain Velocities Existing, 2021 and 2026

	Catchment Properties			Pipe Properties					Forcemain Velocity - Existing Conditions (m/s)								Forcemain Velocity - 2021 Conditions (m/s)							Forcemain Velocity - 2026 Conditions (m/s)								
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Forcemain #1 (Diam. mm)	Forcemain #2 (Diam. mm)	Approx. Length (m)	Assumed Flow Split	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	
Kingston West	Bath Rd.	YES	NO	NO	200	N/A	558	-	0.14	0.48	0.61	0.69	0.80	0.88	0.96	100-YR	0.15	0.48	0.61	0.70	0.80	0.88	0.97	100-YR	0.19	0.54	0.68	0.77	0.85	0.96	1.05	100-YR
	Bath – Collins Bay	NO	NO	NO	150	N/A	171	-	0.09	0.80	1.08	1.25	1.48	1.65	1.81	100-YR	0.09	0.80	1.08	1.25	1.48	1.65	1.81	100-YR	0.09	0.80	1.08	1.25	1.48	1.65	1.81	100-YR
	Bath – Lower	NO	NO	NO	100	N/A	98	-	0.04	0.31	0.41	0.48	0.56	0.62	0.68	100-YR	0.04	0.31	0.41	0.48	0.56	0.62	0.68	100-YR	0.04	0.31	0.41	0.48	0.56	0.62	0.68	100-YR
	Bayridge Dr.	YES	NO	NO	150	N/A	79	-	0.05	0.48	0.64	0.74	0.87	0.97	1.07	100-YR	0.10	0.55	0.72	0.83	0.97	1.07	1.17	100-YR	0.10	0.55	0.72	0.83	0.97	1.07	1.17	100-YR
	Collins Bay Rd.	YES	NO	NO	150	N/A	819	-	0.03	0.15	0.20	0.23	0.27	0.29	0.32	100-YR	0.10	0.26	0.32	0.36	0.41	0.45	0.49	100-YR	0.25	0.43	0.50	0.55	0.61	0.65	0.69	100-YR
	Coverdale Dr.	NO	NO	NO	200	N/A	733	-	0.18	0.46	0.56	0.63	0.71	0.77	0.83	100-YR	0.18	0.46	0.56	0.63	0.71	0.77	0.83	100-YR	0.18	0.46	0.56	0.63	0.71	0.77	0.83	100-YR
	Crerar Blvd.	NO	NO	YES	200	-	566	68%	0.32	1.38	1.77	2.02	2.34	2.58	2.82	5-YR	0.06	1.13	1.52	1.77	2.09	2.33	2.56	10-YR	0.06	1.13	1.52	1.77	2.09	2.33	2.56	10-YR
					-	150		32%	0.26	1.16	1.48	1.69	1.96	2.16	2.36	25-YR	0.05	0.95	1.27	1.48	1.75	1.95	2.14	50-YR	0.05	0.95	1.27	1.48	1.75	1.95	2.14	50-YR
					200	-		100%	0.46	2.04	2.60	2.97	3.45	3.79	4.14	DRY	0.09	1.66	2.23	2.60	3.07	3.42	3.77	2-YR	0.09	1.66	2.23	2.60	3.07	3.42	3.77	2-YR
					-	150		100%	0.82	3.62	4.62	5.29	6.13	6.74	7.36	DRY	0.16	2.96	3.96	4.63	5.47	6.08	6.70	DRY	0.16	2.96	3.96	4.63	5.47	6.08	6.70	DRY
	Days Rd.	YES	NO	YES	900	-	3843	74%	0.26	0.73	0.91	1.02	1.18	1.28	1.38	100-YR	0.35	0.82	1.01	1.15	1.30	1.40	1.50	100-YR	0.41	0.88	1.06	1.20	1.35	1.46	1.57	100-YR
					-	600	1524	26%	0.20	0.57	0.72	0.80	0.93	1.01	1.09	100-YR	0.27	0.65	0.80	0.91	1.03	1.11	1.19	100-YR	0.32	0.70	0.84	0.95	1.07	1.15	1.24	100-YR
					900	-	3843	100%	0.35	0.98	1.23	1.37	1.60	1.73	1.87	100-YR	0.47	1.11	1.36	1.56	1.75	1.89	2.03	50-YR	0.55	1.19	1.43	1.62	1.82	1.97	2.12	50-YR
					-	600	1524	100%	0.78	2.20	2.76	3.09	3.59	3.90	4.20	DRY	1.05	2.50	3.07	3.50	3.94	4.25	4.56	DRY	1.25	2.69	3.22	3.65	4.10	4.43	4.76	DRY
	Hillview Rd.	YES	NO	NO	350	N/A	557	-	0.55	1.23	1.49	1.69	1.93	2.11	2.21	25-YR	0.69	1.34	1.61	1.76	2.02	2.17	2.27	10-YR	0.70	1.37	1.66	1.85	2.09	2.23	2.34	10-YR

	Catchment Properties			Pipe Properties				Forcemain Velocity - Existing Conditions (m/s)								Forcemain Velocity - 2021 Conditions (m/s)							Forcemain Velocity - 2026 Conditions (m/s)										
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Forcemain #1 (Diam. mm)	Forcemain #2 (Diam. mm)	Approx. Length (m)	Assumed Flow Split	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS		
				200		10	-	1.69	3.76	4.58	5.18	5.91	6.46	6.77	DRY	2.11	4.10	4.93	5.40	6.19	6.64	6.95	<DRY	2.13	4.20	5.08	5.68	6.39	6.82	7.17	<DRY		
	John Counter Blvd.	YES	NO	NO	250	N/A	332	-	0.01	0.12	0.17	0.19	0.23	0.25	0.28	100-YR	0.25	0.38	0.43	0.46	0.50	0.53	0.56	100-YR	0.25	0.38	0.43	0.50	0.50	0.53	0.56	100-YR	
	Lakeshore Blvd.	YES	NO	YES	400	N/A	435	-	0.36	0.58	0.66	0.70	0.76	0.81	0.86	100-YR	0.36	0.58	0.66	0.70	0.77	0.82	0.86	100-YR	0.37	0.58	0.67	0.71	0.77	0.82	0.86	100-YR	
	Rankin Cres.	YES	NO	NO	150	N/A	561	-	0.49	0.62	0.64	0.66	0.70	0.74	0.79	100-YR	0.49	0.62	0.64	0.66	0.70	0.74	0.79	100-YR	0.49	0.62	0.64	0.66	0.70	0.74	0.79	100-YR	
	Westbrook Rd.	YES	NO	NO	150	N/A	1812	-	0.15	0.60	0.76	0.87	1.01	1.12	1.22	100-YR	0.44	0.90	1.08	1.19	1.33	1.49	1.55	100-YR	0.81	1.32	1.52	1.65	1.81	1.93	2.05	50-YR	
Kingston Central	Dalton Ave.	YES	NO	YES	600	-	1550	68%	0.30	1.42	1.87	1.98	2.45	2.57	2.59	10-YR	0.33	1.51	1.91	1.98	2.56	2.58	2.63	10-YR	0.35	1.57	1.92	1.98	2.56	2.58	2.64	10-YR	
					-	450		32%	0.25	1.18	1.56	1.65	2.05	2.15	2.17	10-YR	0.28	1.26	1.60	1.66	2.14	2.16	2.20	10-YR	0.29	1.31	1.61	1.66	2.14	2.16	2.21	10-YR	
					600	-		100%	0.44	2.08	2.75	2.91	3.61	3.78	3.81	DRY	0.49	2.22	2.81	2.91	3.76	3.80	3.86	DRY	0.52	2.31	2.82	2.92	3.76	3.80	3.88	DRY	
					-	450		100%	0.78	3.70	4.88	5.17	6.41	6.71	6.77	DRY	0.86	3.94	5.00	5.18	6.69	6.75	6.87	DRY	0.92	4.10	5.02	5.19	6.69	6.76	6.90	DRY	
		Greenview Dr.	NO	NO	NO	250	N/A	60	-	0.03	0.25	0.33	0.38	0.45	0.50	0.55	100-YR	0.03	0.25	0.33	0.38	0.45	0.50	0.55	100-YR	0.03	0.25	0.33	0.38	0.45	0.50	0.55	100-YR
		King St.	YES	YES	NO	600	N/A	282	-	1.17	3.04	3.07	3.30	3.88	3.97	3.99	DRY	0.94	2.93	3.02	3.05	3.13	3.31	3.68	DRY	0.99	2.87	2.96	3.02	3.35	3.27	3.61	DRY
		King – Elevator Bay	YES	NO	NO	250	N/A	697	-	0.02	0.15	0.19	0.22	0.26	0.29	0.32	100-YR	0.02	0.15	0.19	0.22	0.26	0.29	0.32	100-YR	0.02	0.15	0.19	0.22	0.26	0.29	0.32	100-YR
		King – Lake Ontario	NO	NO	NO	150	N/A	456	-	0.04	0.17	0.22	0.25	0.29	0.33	0.36	100-YR	0.04	0.17	0.22	0.25	0.29	0.33	0.36	100-YR	0.04	0.17	0.22	0.25	0.29	0.33	0.36	100-YR
		King - Portsmouth <sup>1</sup>	YES	NO	YES	450	600	478	-	0.44	1.30	1.58	1.83	2.10	2.27	2.50	10-YR	0.49	1.37	1.68	1.92	2.20	2.38	2.61	10-YR	0.60	1.47	1.80	2.05	2.31	2.49	2.70	5-YR
		King - Portsmouth <sup>2</sup>	YES	NO	YES	600	-	3357	-	0.25	0.73	0.89	1.03	1.18	1.28	1.41	100-YR	0.28	0.77	0.95	1.08	1.24	1.34	1.47	100-YR	0.34	0.83	1.01	1.15	1.30	1.40	1.52	100-YR
		Morton St.	NO	NO	NO	150	N/A	144	-	0.03	0.57	0.77	0.90	1.07	1.19	1.31	100-YR	0.03	0.57	0.77	0.90	1.07	1.19	1.31	100-YR	0.03	0.57	0.77	0.90	1.07	1.19	1.31	100-YR
		Palace Rd.	YES	NO	YES	200	N/A	234	-	0.05	0.41	0.54	0.63	0.74	0.82	0.90	100-YR	0.07	0.42	0.55	0.64	0.75	0.83	0.91	100-YR	0.07	0.42	0.55	0.64	0.75	0.83	0.91	100-YR

	Catchment Properties			Pipe Properties				Forcemain Velocity - Existing Conditions (m/s)								Forcemain Velocity - 2021 Conditions (m/s)							Forcemain Velocity - 2026 Conditions (m/s)								
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Forcemain #1 (Diam. mm)	Forcemain #2 (Diam. mm)	Approx. Length (m)	Assumed Flow Split	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS
River St.	YES	YES	YES	1067	1067		50%	0.40	1.11	1.12	1.14	1.14	1.15	1.15	100-YR	0.38	1.11	1.11	1.12	1.12	1.13	1.14	100-YR	0.39	1.10	1.12	1.12	1.12	1.13	1.13	100-YR
				1067	1067		100%	0.79	2.21	2.24	2.27	2.28	2.29	2.29	DRY	0.77	2.21	2.23	2.24	2.25	2.26	2.28	DRY	0.79	2.20	2.23	2.25	2.25	2.25	2.26	DRY
Yonge St.	NO	NO	NO	75	N/A	23	-	0.13	0.29	0.35	0.39	0.44	0.47	0.51	100-YR	0.13	0.29	0.35	0.39	0.43	0.47	0.51	100-YR	0.13	0.29	0.35	0.39	0.44	0.47	0.51	100-YR
Barrett Ct.	YES	NO	NO	300	N/A	598	-	0.52	0.91	1.04	1.13	1.24	1.32	1.44	100-YR	0.68	1.07	1.22	1.29	1.42	1.54	1.63	100-YR	0.83	1.20	1.38	1.48	1.62	1.70	1.82	100-YR
				400	N/A	448	-	0.29	0.51	0.59	0.63	0.70	0.74	0.81	100-YR	0.38	0.60	0.69	0.73	0.80	0.87	0.92	100-YR	0.47	0.67	0.77	0.83	0.91	0.95	1.03	100-YR
Highway 15	YES	NO	NO	250	N/A	555	-	0.07	0.24	0.31	0.36	0.42	0.46	0.50	100-YR	0.07	0.24	0.31	0.36	0.42	0.46	0.50	100-YR	0.07	0.24	0.31	0.36	0.42	0.46	0.50	100-YR
James St.	YES	NO	NO	200	N/A	8	-	1.58	1.63	1.67	1.68	1.69	1.73	1.78	100-YR	1.66	1.72	1.75	1.78	1.78	1.79	1.82	100-YR	1.81	1.82	1.83	1.84	1.86	1.87	1.88	100-YR
Kenwoods Cir.	NO	NO	NO	200	N/A	458	-	0.04	0.10	0.12	0.14	0.16	0.17	0.19	100-YR	0.04	0.10	0.12	0.14	0.16	0.17	0.19	100-YR	0.04	0.10	0.12	0.14	0.16	0.17	0.19	100-YR
Schooner Dr.	YES	NO	NO	150	N/A	556	-	0.11	0.57	0.75	0.86	0.95	1.11	1.22	100-YR	0.20	0.68	0.84	0.95	1.09	1.19	1.29	100-YR	0.20	0.65	0.82	0.93	1.07	1.17	1.27	100-YR

Good	Monitor	Gap
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- 1 King- Portsmouth Flow directed to Kingston Central/East in 2015 scenario
- 2 King - Portsmouth flow directed to Kingston West after PS upgrades in 2021 scenario
- 3 Assumed flow split is based on equalizing the headloss through the multiple forcemains

Table 8-7 Forcemain Velocities 2036, Full Buildout and Ultimate

	Catchment Properties			Pipe Properties				Forcemain Velocity - 2036 Conditions (m/s)								Forcemain Velocity - Build-out Conditions (m/s)							Forcemain Velocity - Ultimate Conditions (m/s)									
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Forcemain #1 (Diam. mm)	Forcemain #2 (Diam. mm)	Approx. Length (m)	Assumed Flow Split	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	
Kingston West	Bath Rd.	YES	NO	NO	200	N/A	558	-	0.19	0.54	0.68	0.77	0.88	0.96	1.05	100-YR	0.26	0.54	0.75	0.83	0.94	1.03	1.11	100-YR	0.26	0.54	0.75	0.83	0.94	1.03	1.11	100-YR
	Bath – Collins Bay	NO	NO	NO	150	N/A	171	-	0.09	0.80	1.08	1.25	1.48	1.65	1.81	100-YR	0.09	0.80	1.08	1.25	1.48	1.65	1.81	100-YR	0.09	0.80	1.08	1.25	1.48	1.65	1.81	100-YR
	Bath – Lower	NO	NO	NO	100	N/A	98	-	0.04	0.31	0.41	0.48	0.56	0.62	0.68	100-YR	0.04	0.31	0.41	0.48	0.56	0.62	0.68	100-YR	0.04	0.31	0.41	0.48	0.56	0.62	0.68	100-YR
	Bayridge Dr.	YES	NO	NO	150	N/A	79	-	0.10	0.55	0.72	0.83	0.97	1.07	1.17	100-YR	0.32	0.78	0.94	1.05	1.19	1.30	1.40	100-YR	0.32	0.78	0.94	1.05	1.19	1.30	1.40	100-YR
	Collins Bay Rd.	YES	NO	NO	150	N/A	819	-	0.27	0.45	0.52	0.57	0.62	0.67	0.71	100-YR	0.27	0.45	0.55	0.57	0.63	0.67	0.71	100-YR	0.27	0.45	0.55	0.57	0.63	0.67	0.71	100-YR
	Coverdale Dr.	NO	NO	NO	200	N/A	733	-	0.18	0.46	0.56	0.63	0.71	0.77	0.83	100-YR	0.18	0.46	0.56	0.63	0.71	0.77	0.83	100-YR	0.18	0.46	0.56	0.63	0.71	0.77	0.83	100-YR
	Crerar Blvd.	NO	NO	YES	200	-	566	68%	0.06	1.13	1.52	1.77	2.09	2.33	2.56	10-YR	0.06	1.13	1.52	1.77	2.09	2.33	2.56	10-YR	0.06	1.13	1.52	1.77	2.09	2.33	2.56	10-YR
					-	150		32%	0.05	0.95	1.27	1.48	1.75	1.95	2.14	50-YR	0.05	0.95	1.27	1.48	1.75	1.95	2.14	50-YR	0.05	0.95	1.27	1.48	1.75	1.95	2.14	50-YR
					200	-		100%	0.09	1.66	2.23	2.60	3.07	3.42	3.77	2-YR	0.09	1.66	2.23	2.60	3.07	3.42	3.77	2-YR	0.09	1.66	2.23	2.60	3.07	3.42	3.77	2-YR
					-	150		100%	0.16	2.96	3.96	4.63	5.47	6.08	6.70	DRY	0.16	2.96	3.96	4.63	5.47	6.08	6.70	DRY	0.16	2.96	3.96	4.63	5.47	6.08	6.70	DRY
	Days Rd.	YES	NO	YES	900	-	3843	74%	0.45	0.93	1.11	1.25	1.40	1.51	1.62	100-YR	0.57	1.04	1.20	1.34	1.49	1.59	1.68	100-YR	0.63	1.06	1.24	1.35	1.50	1.60	1.69	100-YR
					-	600	1524	26%	0.36	0.74	0.88	0.99	1.10	1.19	1.28	100-YR	0.45	0.82	0.95	1.06	1.18	1.26	1.33	100-YR	0.50	0.83	0.98	1.07	1.18	1.26	1.33	100-YR
					900	-	3843	100%	0.61	1.26	1.50	1.69	1.89	2.04	2.19	25-YR	0.77	1.41	1.62	1.81	2.02	2.15	2.27	10-YR	0.85	1.43	1.67	1.83	2.02	2.16	2.28	10-YR
					-	600	1524	100%	1.38	2.83	3.37	3.81	4.25	4.58	4.92	DRY	1.72	3.17	3.66	4.07	4.54	4.84	5.11	DRY	1.91	3.21	3.77	4.11	4.56	4.86	5.13	DRY



	Catchment Properties			Pipe Properties				Forcemain Velocity - 2036 Conditions (m/s)									Forcemain Velocity - Build-out Conditions (m/s)									Forcemain Velocity - Ultimate Conditions (m/s)								
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Forcemain #1 (Diam. mm)	Forcemain #2 (Diam. mm)	Approx. Length (m)	Assumed Flow Split	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS			
Kingston Central	Hillview Rd.	YES	NO	NO	350	N/A	557	-	0.72	1.37	1.68	1.86	2.10	2.24	2.35	10-YR	0.79	1.45	1.70	1.86	2.12	2.33	2.43	10-YR	1.29	1.79	1.98	2.10	2.47	2.42	2.48	5-YR		
					200	N/A	10	-	2.19	4.21	5.15	5.69	6.42	6.85	7.20	<DRY	2.42	4.45	5.20	5.70	6.49	7.12	7.43	<DRY	3.95	5.47	6.08	6.43	7.58	7.40	7.60	<DRY		
	John Counter Blvd.	YES	NO	NO	250	N/A	332	-	0.25	0.38	0.43	0.46	0.50	0.53	0.56	100-YR	0.41	0.49	0.54	0.58	0.63	0.66	0.69	100-YR	0.35	0.49	0.54	0.58	0.63	0.66	0.69	100-YR		
	Lakeshore Blvd.	YES	NO	YES	400	N/A	435	-	0.37	0.58	0.67	0.71	0.77	0.82	0.86	100-YR	0.38	0.58	0.66	0.71	0.77	0.82	0.86	100-YR	0.38	0.58	0.66	0.71	0.77	0.82	0.86	100-YR		
	Rankin Cres.	YES	NO	NO	150	N/A	561	-	0.49	0.62	0.66	0.67	0.69	0.74	0.78	100-YR	0.49	0.56	0.65	0.65	0.69	0.74	0.78	100-YR	10.12	11.28	11.81	12.10	12.51	12.77	13.03	<DRY		
	Westbrook Rd.	YES	NO	NO	150	N/A	1812	-	0.81	1.32	1.52	1.65	1.81	1.93	2.05	50-YR	0.94	1.32	1.51	1.64	1.80	1.92	2.04	50-YR	3.47	4.24	4.52	4.73	5.00	5.19	5.38	<DRY		
Kingston Central	Dalton Ave.	YES	NO	YES	600	-	1550	68%	0.37	1.57	1.97	1.99	2.55	2.59	2.64	10-YR	0.44	1.59	2.00	2.35	2.59	2.60	2.82	2-YR	0.44	1.59	2.00	2.35	2.59	2.60	2.82	2-YR		
					-	450		32%	0.31	1.32	1.65	1.66	2.13	2.17	2.21	10-YR	0.37	1.33	1.68	1.97	2.16	2.17	2.36	10-YR	0.37	1.33	1.68	1.97	2.16	2.17	2.36	10-YR		
					600	-		100%	0.55	2.31	2.90	2.92	3.75	3.81	3.89	DRY	0.65	2.33	2.94	3.46	3.80	3.82	4.14	DRY	0.65	2.33	2.94	3.46	3.80	3.82	4.14	DRY		
					-	450		100%	0.98	4.11	5.15	5.19	6.67	6.78	6.91	DRY	1.16	4.15	5.24	6.15	6.76	6.79	7.37	DRY	1.16	4.15	5.24	6.15	6.76	6.79	7.37	DRY		
	Greenview Dr.	NO	NO	NO	250	N/A	60	-	0.03	0.25	0.33	0.38	0.45	0.50	0.55	100-YR	0.03	0.25	0.33	0.38	0.45	0.50	0.55	100-YR	0.03	0.25	0.33	0.38	0.45	0.50	0.55	100-YR		
	King St.	YES	YES	NO	600	N/A	282	-	1.04	2.88	3.13	3.24	3.08	3.18	3.33	DRY	1.09	2.24	2.35	2.36	2.80	2.85	2.90	DRY	1.09	2.24	2.35	2.36	2.80	2.85	2.90	DRY		
	King – Elevator Bay	YES	NO	NO	250	N/A	697	-	0.02	0.15	0.19	0.22	0.26	0.29	0.32	100-YR	0.03	0.16	0.22	0.24	0.28	0.31	0.34	100-YR	0.03	0.16	0.22	0.24	0.28	0.31	0.34	100-YR		
	King – Lake Ontario	NO	NO	NO	150	N/A	456	-	0.04	0.17	0.22	0.25	0.29	0.33	0.36	100-YR	0.04	0.17	0.22	0.25	0.29	0.33	0.36	100-YR	0.04	0.17	0.22	0.25	0.29	0.33	0.36	100-YR		
	King - Portsmouth <sup>1</sup>	YES	NO	YES	450	600	478	-	0.61	1.47	1.80	2.04	2.31	2.50	2.67	5-YR	0.64	1.48	1.82	2.04	2.32	2.51	2.71	5-YR	0.64	1.48	1.82	2.04	2.13	2.51	2.71	5-YR		

	Catchment Properties			Pipe Properties				Forcemain Velocity - 2036 Conditions (m/s)								Forcemain Velocity - Build-out Conditions (m/s)							Forcemain Velocity - Ultimate Conditions (m/s)									
	Development in Catchment Area	Combined Sewers in Catchment Area	Known Issues	Forcemain #1 (Diam. mm)	Forcemain #2 (Diam. mm)	Approx. Length (m)	Assumed Flow Split	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	Dry	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	LOS	
King - Portsmouth <sup>2</sup>	YES	NO	YES	600	-	3357	-	0.34	0.83	1.01	1.15	1.30	1.41	1.50	100-YR	0.36	0.83	1.02	1.15	1.30	1.41	1.52	100-YR	0.36	0.83	1.02	1.15	1.20	1.41	1.52	100-YR	
	Morton St.	NO	NO	NO	150	N/A	144	-	0.03	0.57	0.77	0.90	1.07	1.19	1.31	100-YR	0.03	0.57	0.77	0.90	1.07	1.19	1.31	100-YR	0.03	0.57	0.77	0.90	1.07	1.19	1.31	100-YR
	Palace Rd.	YES	NO	YES	200	N/A	234	-	0.09	0.44	0.56	0.65	0.76	0.84	0.92	100-YR	0.09	0.44	0.56	0.65	0.76	0.84	0.92	100-YR	0.09	0.44	0.56	0.65	0.76	0.84	0.92	100-YR
	River St.	YES	YES	YES	1067	1067		50%	0.44	1.10	1.11	1.12	1.12	1.12	1.13	100-YR	0.46	1.00	1.11	1.11	1.11	1.12	1.13	100-YR	0.46	1.00	1.11	1.11	1.11	1.12	1.13	100-YR
					1067	1067		100%	0.87	2.19	2.22	2.24	2.24	2.25	2.26	DRY	0.92	2.01	2.22	2.22	2.23	2.25	2.26	DRY	0.92	2.01	2.22	2.22	2.23	2.25	2.26	DRY
	Yonge St.	NO	NO	NO	75	N/A	23	-	0.13	0.29	0.35	0.39	0.44	0.47	0.51	100-YR	0.13	0.29	0.35	0.39	0.44	0.47	0.51	100-YR	0.13	0.29	0.35	0.39	0.44	0.47	0.51	100-YR
Kingston East	Barrett Ct.	YES	NO	NO	300	N/A	598	-	0.86	1.28	1.43	1.53	1.68	1.77	1.88	100-YR	0.88	1.29	1.46	1.54	1.69	1.77	1.92	100-YR	1.98	2.38	2.42	2.49	2.53	2.52	2.56	DRY
					400	N/A	448	-	0.48	0.72	0.80	0.86	0.95	0.99	1.06	100-YR	0.49	0.72	0.82	0.87	0.95	1.00	1.08	100-YR	1.12	1.34	1.36	1.40	1.42	1.42	1.44	100-YR
	Highway 15	YES	NO	NO	250	N/A	555	-	0.07	0.24	0.31	0.36	0.42	0.46	0.50	100-YR	0.08	0.24	0.31	0.36	0.42	0.46	0.50	100-YR	0.08	0.24	0.31	0.36	0.42	0.46	0.50	100-YR
	James St.	YES	NO	NO	200	N/A	8	-	1.99	2.03	2.05	2.07	2.08	2.09	2.10	DRY	2.28	2.32	2.34	2.35	2.37	2.38	2.39	<DRY	2.28	2.32	2.34	2.35	2.37	2.38	2.39	<DRY
	Kenwoods Cir.	NO	NO	NO	200	N/A	458	-	0.04	0.10	0.12	0.14	0.16	0.17	0.19	100-YR	0.04	0.10	0.12	0.14	0.16	0.17	0.19	100-YR	0.04	0.10	0.12	0.14	0.16	0.17	0.19	100-YR
	Schooner Dr.	YES	NO	NO	150	N/A	556	-	0.20	0.65	0.82	0.93	1.07	1.17	1.27	100-YR	0.20	0.65	0.82	0.93	1.07	1.17	1.27	100-YR	0.20	0.65	0.82	0.93	1.07	1.17	1.27	100-YR

Good	Monitor	Gap
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- 1 King- Portsmouth Flow directed to Kingston Central/East in 2015 scenario
- 2 King - Portsmouth flow directed to Kingston West after PS upgrades in 2021 scenario
- 3 Assumed flow split is based on equalizing the headloss through the multiple forcemains

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. 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 St. and River St. 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.
- Where upgrades are proposed the downstream infrastructure must be re-evaluated with the larger pumping capacity.
- Based strictly on velocity, the majority of the forcemains are adequate to convey the flow for all analysis periods. 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.

### **8.3 COMBINED SEWER OVERFLOW GAPS (F-5-5)**

Table 8-8, Table 8-9 and Table 8-10 detail the result of the wet weather CSO analysis for an Average Year while Table 8-11, Table 8-12 and Table 8-13 detail the results for the wetter than average year which is based on 2008 rainfall data. Observations are discussed below.



Table 8-8 Average Year CSO By-Pass Volume, Duration and Frequency (2015 &amp; 2021)

PCP#	Location	2015						2021							
		Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m³)	Total Volume at Ravensview (m³)	Total Dry Weather Volume at Ravensview (m³)	Total Wet Weather Volume at Ravensview (m³)	Ratio (Bypass / Wet Weather) (m³)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m³)	Total Volume (m³)	Total Dry Weather Volume at Ravensview (m³)	Total Wet Weather Volume at Ravensview (m³)	Ratio (Bypass / Wet Weather) (m³)
<b>COMBINED SEWER OVERFLOW (CSO)</b>															
14	Ontario and Barrack	6.0	1	750	11,482,615	9,537,777	1,944,838	0.04%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
22	William St Vortex	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
23	Earl d/s of vortex	5.5	2	176	11,482,615	9,537,777	1,944,838	0.01%	4.0	2	160	10,926,587	9,621,225	1,305,362	0.01%
24	Gore St vortex	5.0	2	44	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
25	Lower Union d/s of vortex	5.0	1	127	11,482,615	9,537,777	1,944,838	0.01%	1.0	1	13	10,926,587	9,621,225	1,305,362	0.00%
26	West and Ontario	52.5	6	30,296	11,482,615	9,537,777	1,944,838	1.56%	36.5	4	4,610	10,926,587	9,621,225	1,305,362	0.35%
51	d/s of Clarence St in-line CSO	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
52	Raglan and Rideau	10.5	4	61	11,482,615	9,537,777	1,944,838	0.00%	10.5	4	61	10,926,587	9,621,225	1,305,362	0.00%
53	Division and Union	17.5	2	367	11,482,615	9,537,777	1,944,838	0.02%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
65	Belle Park Local SA1200	18.0	4	1,710	11,482,615	9,537,777	1,944,838	0.09%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
68	Quebec at Barrie St	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
70	Carlisle & Chest Nut	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
<b>PUMP STATION OVERFLOW (PSO)</b>															
1	River Street Pump Station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
5	Dalton Pumping Station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
28	King St Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
35	Palace Road pump station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
41	Morton Street Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
57	Crerar Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
58	Lakeshore Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
59	Coverdale Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
61	Bath-Collins Bay**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
62	Rankin Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
63	Bath Rd Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
73	Days Road Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
74	Barrett Court Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
75	Westbrook Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
<b>SANITARY SEWER OVERFLOW (SSO)</b>															
2	Belle Park Chamber, Trunks	1.5	1	1,201	11,482,615	9,537,777	1,944,838	0.06%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
34	Helen and Mack	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
48	NETS at Sherwood**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
50	NETS at Parkway S**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	10,926,587	9,621,225	1,305,362	0.00%
<b>TANK OVERFLOW (TO)</b>															
55	King St. CSO Tank	209.0	9	2,116	11,482,615	9,537,777	1,944,838	0.11%	94.5	8	1,058	10,926,587	9,621,225	1,305,362	0.08%
56	Collingwood CSO Tank	71.5	12	39,136	11,482,615	9,537,777	1,944,838	2.01%	28.5	7	2,303	10,926,587	9,621,225	1,305,362	0.18%
<b>TOTAL OVERFLOW VOLUME</b>		<b>402.0</b>	<b>44.0</b>	<b>75,987</b>	<b>11,482,615</b>	<b>9,537,777</b>	<b>1,944,838</b>	<b>3.91%</b>	<b>175.0</b>	<b>26.0</b>	<b>8,205</b>	<b>10,926,587</b>	<b>9,621,225</b>	<b>1,305,362</b>	<b>0.63%</b>

\* = CSO Plugged in 2015

\*\* = No bypass observed at PCP# 48 and 50

\*\*\* = Rankin and Westbrook PS is over capacity in Ultimate scenario

+ = Part of Kingston West System

+\* = Part of Kingston West System in 2021, 2026, 2036, Buildout and Ultimate Scenarios

Table 8-9 Average Year CSO By-Pass Volume, Duration and Frequency (2026 &amp; 2036)

PCP#	Location	2026						2036							
		Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )
<b>COMBINED SEWER OVERFLOW (CSO)</b>															
14	Ontario and Barrack	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
22	William St Vortex	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
23	Earl d/s of vortex	4.0	2	160	11,413,431	10,211,217	1,202,214	0.01%	4	2	162	12,751,794	11,455,434	1,296,360	0.01%
24	Gore St vortex	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
25	Lower Union d/s of vortex	1.0	1	9	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
26	West and Ontario	36.0	4	4,054	11,413,431	10,211,217	1,202,214	0.34%	39	4	982	12,751,794	11,455,434	1,296,360	0.08%
51	d/s of Clarence St in-line CSO	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
52	Raglan and Rideau	0.5	1	17	11,413,431	10,211,217	1,202,214	0.00%	1	1	4	12,751,794	11,455,434	1,296,360	0.00%
53	Division and Union	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
65	Belle Park Local SA1200	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
68	Quebec at Barrie St	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
70	Carlisle & Chest Nut	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%
<b>PUMP STATION OVERFLOW (PSO)</b>															
1	River Street Pump Station	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
5	Dalton Pumping Station	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
28	King St Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
35	Palace Road pump station	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
41	Morton Street Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
57	Crerar Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
58	Lakeshore Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
59	Coverdale Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
61	Bath-Collins Bay**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
62	Rankin Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
63	Bath Rd Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
73	Days Road Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
74	Barrett Court Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
75	Westbrook Pump Station**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
<b>SANITARY SEWER OVERFLOW (SSO)</b>															
2	Belle Park Chamber, Trunks	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
34	Helen and Mack	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
48	NETS at Sherwood**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
50	NETS at Parkway S**	0.0	0	0	11,413,431	10,211,217	1,202,214	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
<b>TANK OVERFLOW (TO)</b>															
55	King St. CSO Tank	94.5	8	1,058	11,413,431	10,211,217	1,202,214	0.09%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%
56	Collingwood CSO Tank	28.5	7	2,526	11,413,431	10,211,217	1,202,214	0.21%	30.5	7	2,417	12,751,794	11,455,434	1,296,360	0.19%
<b>TOTAL OVERFLOW VOLUME</b>		<b>164.5</b>	<b>23.0</b>	<b>7,824.68</b>	<b>11,413,431</b>	<b>10,211,217</b>	<b>1,202,214</b>	<b>0.65%</b>	<b>73.5</b>	<b>14.0</b>	<b>3,565</b>	<b>12,751,794</b>	<b>11,455,434</b>	<b>1,296,360</b>	<b>0.28%</b>

\* = CSO Plugged in 2015

\*\* = No bypass observed at PCP# 48 and 50

\*\*\* = Rankin and Westbrook PS is over capacity in Ultimate scenario

† = Part of Kingston West System

†† = Part of Kingston West System in 2021, 2026, 2036, Buildout and Ultimate Scenarios

Table 8-10 Average Year CSO By-Pass Volume, Duration and Frequency (Full Buildout & Ultimate)

PCP#	Location	Build-out							Ultimate						
		Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )
<b>COMBINED SEWER OVERFLOW (CSO)</b>															
14	Ontario and Barrack	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
22	William St Vortex	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
23	Earl d/s of vortex	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
24	Gore St vortex	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
25	Lower Union d/s of vortex	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
26	West and Ontario	25.0	2	266	13,751,858	12,401,727	1,350,131	0.02%	25.0	2	266	17,287,592	16,549,788	737,804	0.04%
51	d/s of Clarence St in-line CSO	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
52	Raglan and Rideau	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
53	Division and Union	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
65	Belle Park Local SA1200	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
68	Quebec at Barrie St	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
70	Carlisle & Chest Nut	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
<b>PUMP STATION OVERFLOW (PSO)</b>															
1	River Street Pump Station	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
5	Dalton Pumping Station	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
28	King St Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
35	Palace Road pump station	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
41	Morton Street Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
57	Crerar Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
58	Lakeshore Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
59	Coverdale Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
61	Bath-Collins Bay**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
62	Rankin Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	***	***	***	17,287,592	16,549,788	737,804	***
63	Bath Rd Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
73	Days Road Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
74	Barrett Court Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
75	Westbrook Pump Station**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	***	***	***	17,287,592	16,549,788	737,804	***
<b>SANITARY SEWER OVERFLOW (SSO)</b>															
2	Belle Park Chamber, Trunks	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
34	Helen and Mack	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
48	NETS at Sherwood**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
50	NETS at Parkway S**	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
<b>TANK OVERFLOW (TO)</b>															
55	King St. CSO Tank	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
56	Collingwood CSO Tank	0.0	0	0	13,751,858	12,401,727	1,350,131	0.00%	0.0	0	0	17,287,592	16,549,788	737,804	0.00%
<b>TOTAL OVERFLOW VOLUME</b>		25.0	2.0	266	13,751,858	12,401,727	1,350,131	0.02%	25.0	2.0	266	17,287,592	16,549,788	737,804	0.04%

\* = CSO Plugged in 2015  
 \*\* = No bypass observed at PCP# 48 and 50  
 \*\*\* = Rankin and Westbrook PS is over capacity in Ultimate scenario  
 † = Part of Kingston West System  
 †† = Part of Kingston West System in 2021, 2026, 2036, Buildout and Ultimate Scenarios

Table 8-11 Wet Year CSO By-Pass Volume, Duration and Frequency (2015 &amp; 2021)

PCP#	Location	2015							2021						
		Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )
<b>COMBINED SEWER OVERFLOW (CSO)</b>															
14	Ontario and Barrack	17.0	3	4,401	12,016,549	9,537,777	2,478,772	0.18%	6.0	1	1,671	11,282,996	9,621,225	1,661,771	0.10%
22	William St Vortex	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
23	Earl d/s of vortex	15.0	4	1,870	12,016,549	9,537,777	2,478,772	0.08%	13.0	4	1,525	11,282,996	9,621,225	1,661,771	0.09%
24	Gore St vortex	17.0	5	1,529	12,016,549	9,537,777	2,478,772	0.06%	2.0	1	93	11,282,996	9,621,225	1,661,771	0.01%
25	Lower Union d/s of vortex	13.5	3	2,740	12,016,549	9,537,777	2,478,772	0.11%	8.0	2	1,581	11,282,996	9,621,225	1,661,771	0.10%
26	West and Ontario	56.0	9	62,198	12,016,549	9,537,777	2,478,772	2.51%	21.0	3	18,093	11,282,996	9,621,225	1,661,771	1.09%
51	d/s of Clarence St in-line CSO	7.0	3	708	12,016,549	9,537,777	2,478,772	0.03%	5.5	2	656	11,282,996	9,621,225	1,661,771	0.04%
52	Raglan and Rideau	19.0	5	1,281	12,016,549	9,537,777	2,478,772	0.05%	6.5	2	1,228	11,282,996	9,621,225	1,661,771	0.07%
53	Division and Union	33.0	5	2,184	12,016,549	9,537,777	2,478,772	0.09%	9.5	3	146	11,282,996	9,621,225	1,661,771	0.01%
65	Belle Park Local SA1200	29.5	7	10,824	12,016,549	9,537,777	2,478,772	0.44%	4.0	1	1,336	11,282,996	9,621,225	1,661,771	0.08%
68	Quebec at Barrie St	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
70	Carlisle & Chest Nut	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
<b>PUMP STATION OVERFLOW (PSO)</b>															
1	River Street Pump Station	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
5	Dalton Pumping Station	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
28	King St Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
35	Palace Road pump station	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
41	Morton Street Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
57	Crerar Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
58	Lakeshore Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
59	Coverdale Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
61	Bath-Collins Bay**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
62	Rankin Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
63	Bath Rd Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
73	Days Road Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
74	Barrett Court Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
75	Westbrook Pump Station**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
<b>SANITARY SEWER OVERFLOW (SSO)</b>															
2	Belle Park Chamber, Trunks	4.5	2	2,421	12,016,549	9,537,777	2,478,772	0.10%	2.5	1	616	11,282,996	9,621,225	1,661,771	0.04%
34	Helen and Mack	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
48	NETS at Sherwood**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
50	NETS at Parkway S**	0.0	0	0	12,016,549	9,537,777	2,478,772	0.00%	0.0	0	0	11,282,996	9,621,225	1,661,771	0.00%
<b>TANK OVERFLOW (TO)</b>															
55	King St. CSO Tank	893.0	16	5,922	12,016,549	9,537,777	2,478,772	0.24%	526.5	13	3,369	11,282,996	9,621,225	1,661,771	0.20%
56	Collingwood CSO Tank	118.0	13	71,562	12,016,549	9,537,777	2,478,772	2.89%	54.5	12	8,286	11,282,996	9,621,225	1,661,771	0.50%
<b>TOTAL OVERFLOW VOLUME</b>		1,222.5	75.0	167,640	12,016,549	9,537,777	2,478,772	6.76%	659.0	45.0	38,600	11,282,996	9,621,225	1,661,771	2.32%

\* = CSO Plugged in 2015

\*\* = No bypass observed at PCP# 48 and 50

\*\*\*= Rankin and Westbrook PS is over capacity in Ultimate scenario

\*= Part of Kingston West System

\*\*= Part of Kingston West System in 2021, 2026, 2036, Buildout and Ultimate Scenarios



Table 8-12 Wet Year CSO By-Pass Volume, Duration and Frequency (2026 &amp; 2036)

PCP #	Location	2026							2036						
		Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )
<b>COMBINED SEWER OVERFLOW (CSO)</b>															
14	Ontario and Barrack	4.5	1	1,133	11,762,440	10,211,217	1,551,223	0.07%	2.5	1	360	13,058,756	11,455,434	1,603,322	0.02%
22	William St Vortex	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
23	Earl d/s of vortex	13.0	4	1,488	11,762,440	10,211,217	1,551,223	0.10%	12.5	4	1,322	13,058,756	11,455,434	1,603,322	0.08%
24	Gore St vortex	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
25	Lower Union d/s of vortex	8.0	2	1,353	11,762,440	10,211,217	1,551,223	0.09%	7.0	2	616	13,058,756	11,455,434	1,603,322	0.04%
26	West and Ontario	27.5	4	16,006	11,762,440	10,211,217	1,551,223	1.03%	10.0	2	8,310	13,058,756	11,455,434	1,603,322	0.52%
51	d/s of Clarence St in-line CSO	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
52	Raglan and Rideau	6.5	2	1,228	11,762,440	10,211,217	1,551,223	0.08%	6.0	2	1,019	13,058,756	11,455,434	1,603,322	0.06%
53	Division and Union	2.5	2	5	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
65	Belle Park Local SA1200	3.5	1	1,175	11,762,440	10,211,217	1,551,223	0.08%	1.5	1	140	13,058,756	11,455,434	1,603,322	0.01%
68	Quebec at Barrie St	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
70	Carlisle & Chest Nut	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
<b>PUMP STATION OVERFLOW (PSO)</b>															
1	River Street Pump Station	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
5	Dalton Pumping Station	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
28	King St Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
35	Palace Road pump station	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
41	Morton Street Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
57	Crerar Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
58	Lakeshore Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
59	Coverdale Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
61	Bath-Collins Bay**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
62	Rankin Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
63	Bath Rd Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
73	Days Road Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
74	Barrett Court Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
75	Westbrook Pump Station**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
<b>SANITARY SEWER OVERFLOW (SSO)</b>															
2	Belle Park Chamber, Trunks	2.0	1	325	11,762,440	10,211,217	1,551,223	0.02%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
34	Helen and Mack	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
48	NETS at Sherwood**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
50	NETS at Parkway S**	0.0	0	0	11,762,440	10,211,217	1,551,223	0.00%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
<b>TANK OVERFLOW (TO)</b>															
55	King St. CSO Tank	526.5	13	3,369	11,762,440	10,211,217	1,551,223	0.22%	0.0	0	0	13,058,756	11,455,434	1,603,322	0.00%
56	Collingwood CSO Tank	51.5	12	7,819	11,762,440	10,211,217	1,551,223	0.50%	53.0	12	8,682	13,058,756	11,455,434	1,603,322	0.54%
<b>TOTAL OVERFLOW VOLUME</b>		<b>645.5</b>	<b>42.0</b>	<b>33,901</b>	<b>11,762,440</b>	<b>10,211,217</b>	<b>1,551,223</b>	<b>2.19%</b>	<b>92.5</b>	<b>24.0</b>	<b>20,449</b>	<b>13,058,756</b>	<b>11,455,434</b>	<b>1,603,322</b>	<b>1.28%</b>

\* = CSO Plugged in 2015

\*\* = No bypass observed at PCP# 48 and 50

\*\*\* = Rankin and Westbrook PS is over capacity in Ultimate scenario

\* = Part of Kingston West System

\*\* = Part of Kingston West System in 2021, 2026, 2036, Buildout and Ultimate Scenarios

Table 8-13 Wet Year CSO By-Pass Volume, Duration and Frequency (Full Buildout &amp; Ultimate)

PCP#	Location	Build-out							Ultimate						
		Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Total Dry Weather Volume at Ravensview (m <sup>3</sup> )	Total Wet Weather Volume at Ravensview (m <sup>3</sup> )	Ratio (Bypass / Wet Weather) (m <sup>3</sup> )
<b>COMBINED SEWER OVERFLOW (CSO)</b>															
14	Ontario and Barrack	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
22	William St Vortex	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
23	Earl d/s of vortex	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
24	Gore St vortex	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
25	Lower Union d/s of vortex	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
26	West and Ontario	5.0	1	1,050	15,534,187	12,401,727	3,132,460	0.03%	5.0	1	1,050	17,770,260	16,549,788	1,220,472	0.09%
51	d/s of Clarence St in-line CSO	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
52	Raglan and Rideau	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
53	Division and Union	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
65	Belle Park Local SA1200	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
68	Quebec at Barrie St	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
70	Carlisle & Chest Nut	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
<b>PUMP STATION OVERFLOW (PSO)</b>															
1	River Street Pump Station	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
5	Dalton Pumping Station	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
28	King St Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
35	Palace Road pump station	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
41	Morton Street Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
57	Crerar Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
58	Lakeshore Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
59	Coverdale Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
61	Bath-Collins Bay**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
62	Rankin Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	***	***	***	17,770,260	16,549,788	1,220,472	***
63	Bath Rd Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
73	Days Road Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
74	Barrett Court Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
75	Westbrook Pump Station**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	***	***	***	17,770,260	16,549,788	1,220,472	***
<b>SANITARY SEWER OVERFLOW (SSO)</b>															
2	Belle Park Chamber, Trunks	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
34	Helen and Mack	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
48	NETS at Sherwood**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
50	NETS at Parkway S**	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
<b>TANK OVERFLOW (TO)</b>															
55	King St. CSO Tank	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
56	Collingwood CSO Tank	0.0	0	0	15,534,187	12,401,727	3,132,460	0.00%	0.0	0	0	17,770,260	16,549,788	1,220,472	0.00%
<b>TOTAL OVERFLOW VOLUME</b>		<b>5.0</b>	<b>1.0</b>	<b>1,050</b>	<b>15,534,187</b>	<b>12,401,727</b>	<b>3,132,460</b>	<b>0.03%</b>	<b>5.0</b>	<b>1.0</b>	<b>1,050</b>	<b>17,770,260</b>	<b>16,549,788</b>	<b>1,220,472</b>	<b>0.09%</b>

\* = CSO Plugged in 2015

\*\* = No bypass observed at PCP# 48 and 50

\*\*\*= Rankin and Westbrook PS is over capacity in Ultimate scenario

\* = Part of Kingston West System

\*\*= Part of Kingston West System in 2021, 2026, 2036, Buildout and Ultimate Scenarios

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 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.
- West Street CSO is responsible for the bulk of the by-pass volume until 2036. At this point Collingwood CSO West Street by-pass similar volumes.
- Once all combined sewers are eliminated (full buildout development scenario) CSO events are anticipated to be virtually eliminated during both average year and the wetter than 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.

## 8.4 WASTEWATER TREATMENT PLANTS

As previously indicated the desired Level of Service for the for treatment plants is to provide full treatment for all average daily flow and provide primary treatment (min) up to and including the 10yr storm.

The figures and tables below illustrate the anticipated daily flow as a result of the various flow and development scenarios. In addition to the dry and wet weather scenarios, an ADF value has been calculated. Dry weather flow only considers base I/I and does not consider the effects extraneous flow as a result of rainfall in a typical year. The ADF value has been determined by comparing the observed ADF from 2014 to the modeled dry weather flow. The comparison results in approximately a 36% & 15% increase in flow as a result of normal annual rainfall at Cataraqi Bay WWTP and Ravensview WWTP, respectively. This increase is applied to the calculated dry weather flow to obtain the ADF. This increase corresponds to an average extraneous flow increase of 7,025 m<sup>3</sup>/day at Cataraqi Bay and 7,817 m<sup>3</sup>/day at Ravensview in the existing conditions and is scaled proportionally to the dry weather increase for each subsequent development scenario. The previous master plan reported increases as high as 31%.

Generally, capacity upgrades are triggered when a treatment facility reaches approximately 80% of the current functional or production capacity. This early identification allows time to accommodate the required planning and design between the anticipated need and the implementation of the upgrades.

When reviewing Table 8-14 and Table 8-15 along with Figure 8-1 and Figure 8-2 below the following should be noted:

- Dry weather flows and ADF are observed from the model output are compared to the Rated ADF of the Facility.

- Wet weather flows are instantaneous flows observed from the model output and are compared to the Rated Peak Flow.

The following observations can be made:

#### CATARAQUI BAY WWTP

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- Cataraqui Bay upgrade is online by 2021 increasing its capacity.
- Cataraqui Bay has adequate capacity to treat the 10yr storm in all development scenarios.
- The ADF at Cataraqui Bay just exceeds the 80% of rated capacity by 2026.
- The rated ADF capacity is exceeded by Full Buildout.

#### RAVENSVIEW WWTP

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- 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.
- Flow conveyed to Ravensview is limited by the capacity of River St. Pumping Station. This can be observed by the plateau in peak flow rates for wet weather.
- Once full sewer separation is implemented River Street is not pumping at peak capacity for the 2yr storm and smaller. This is observed by the drop in the resulting peak flow at Ravensview for the 2yr storm in the Full Buildout Scenario.
- Ravensview has adequate capacity to accommodate dry weather flow and wet weather flow beyond 2036.

Table 8-14 Catarauqui Bay WWTP Flows

Scenario	Analysis Period						
	Rated Capacity (m <sup>3</sup> /day)	Existing (m <sup>3</sup> /day)	2021 (m <sup>3</sup> /day)	2026 (m <sup>3</sup> /day)	2036 (m <sup>3</sup> /day)	Full Build-out (m <sup>3</sup> /day)	Ultimate (m <sup>3</sup> /day)
<b>ADF</b>	55,000	26,547	39,189	46,326	51,417	58,430	65,130
<b>DRY</b>	(ADF Capacity)	19,520	29,747	36,075	40,732	47,279	53,635
<b>2 Year</b>	173,200	64,195	89,461	96,109	101,140	108,343	112,552
<b>5 Year</b>		79,055	111,459	117,430	121,627	130,842	133,714
<b>10 Year</b>		88,288	124,336	131,127	138,017	143,964	148,206
<b>25 Year</b>		(Peak Capacity)	102,283	142,079	148,403	154,848	160,944
<b>50 Year</b>		108,592	152,813	158,196	164,413	173,383	175,347
<b>100 Year</b>		117,460	160,548	168,460	175,298	180,653	183,015
		Flow Exceeds Rated Capacity					

Table 8-15 Ravensview WWTP Flows

Scenario	Analysis Period						
	Rated Capacity (m <sup>3</sup> /day)	Existing (m <sup>3</sup> /day)	2021 (m <sup>3</sup> /day)	2026 (m <sup>3</sup> /day)	2036 (m <sup>3</sup> /day)	Full Build-out (m <sup>3</sup> /day)	Ultimate (m <sup>3</sup> /day)
<b>ADF</b>	95,000	59,951	58,788	61,537	69,419	73,720	93,661
<b>DRY</b>	(ADF Capacity)	52,132	51,123	53,515	60,517	64,410	82,938
<b>2 Year</b>	193,000	184,821	184,991	185,429	185,357	171,107	191,284
<b>5 Year</b>		185,700	186,033	186,402	186,614	186,577	204,964
<b>10 Year</b>		186,197	186,505	186,782	187,084	187,403	206,383
<b>25 Year</b>		(Peak Capacity)	186,786	187,069	187,242	187,614	188,099
<b>50 Year</b>		187,262	187,522	189,259	187,614	190,406	209,602
<b>100 Year</b>		187,701	187,955	189,892	190,484	191,267	210,110
		Flow Exceeds Rated Capacity					

Figure 8-1 Cataraqui Bay WWTP Flows

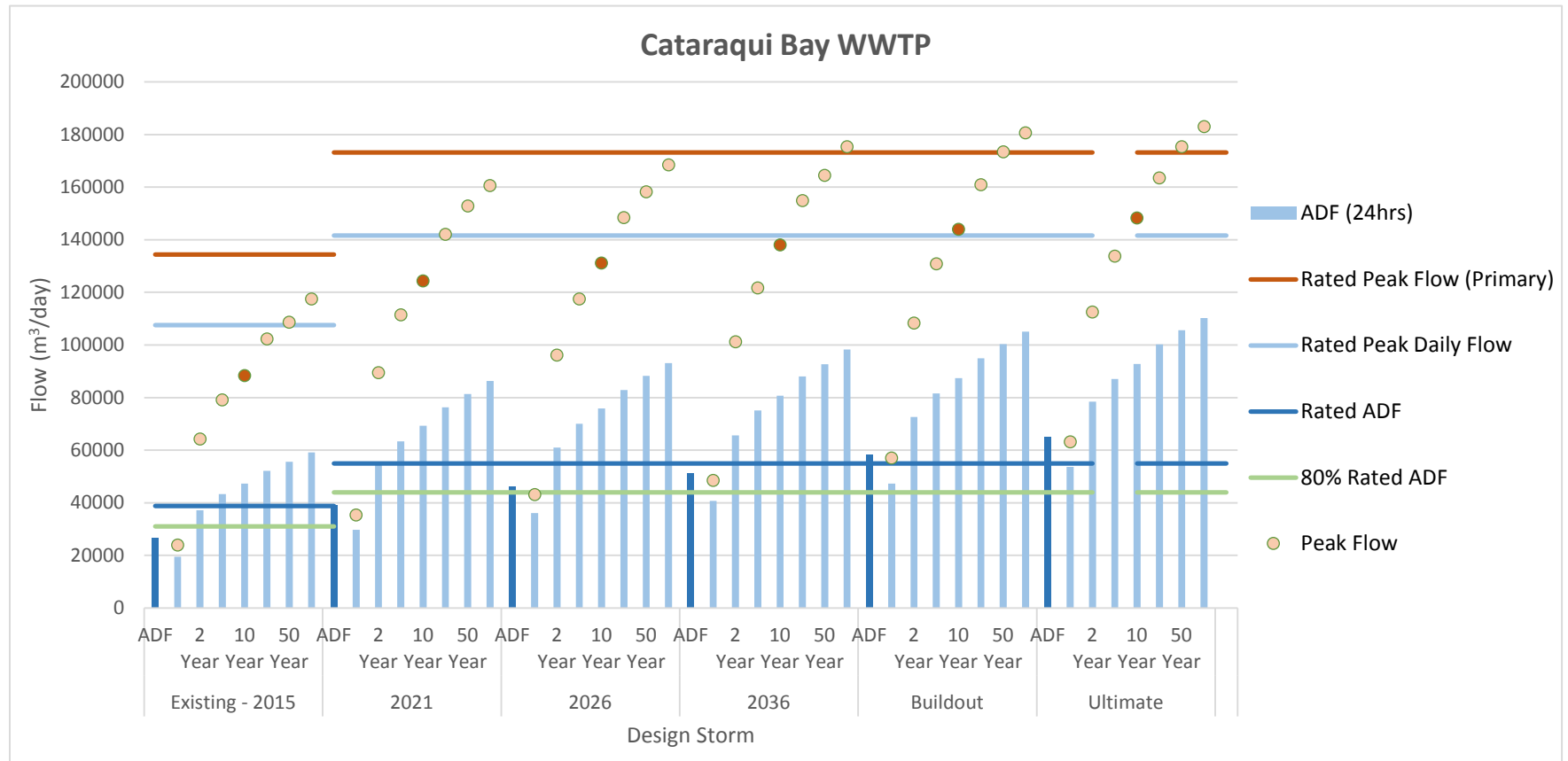
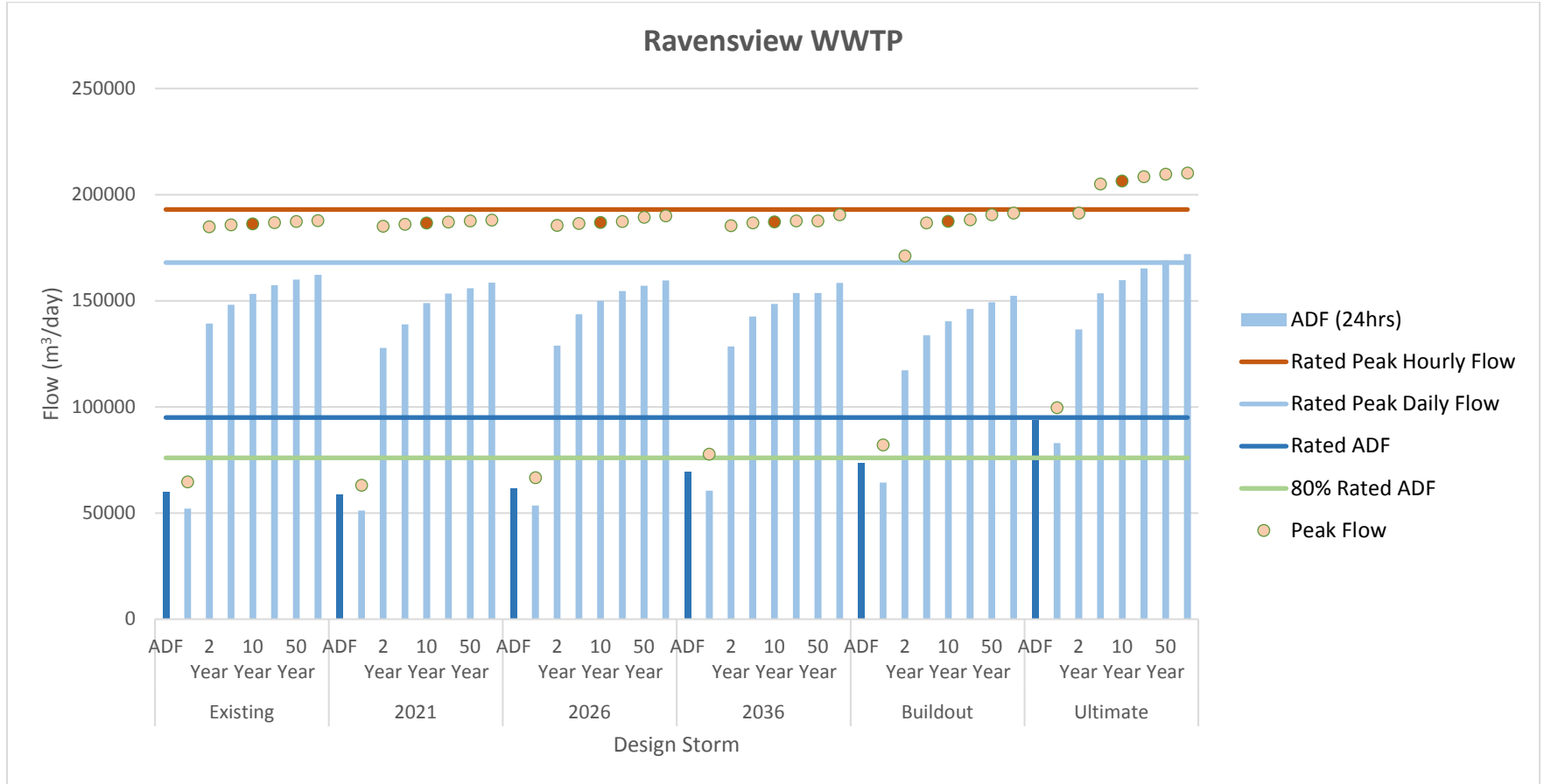


Figure 8-2 Ravensview WWTP Flows







# APPENDIX A

## DESIGN STORM ANALYSIS MAPS

Figure 1-1	Dry Weather Design Storm Analysis – Kingston West 2015
Figure 1-2	1:10 Year Design Storm Analysis – Kingston West 2015
Figure 1-3	1:100 Year Design Storm Analysis – Kingston West 2015
Figure 1-4	Dry Weather Design Storm Analysis – Kingston Central and East 2015
Figure 1-5	1:10 Year Design Storm Analysis – Kingston Central and East 2015
Figure 1-6	1:100 Year Design Storm Analysis – Kingston Central and East 2015
Figure 2-1	Dry Weather Design Storm Analysis – Kingston West 2021
Figure 2-2	1:10 Year Design Storm Analysis – Kingston West 2021
Figure 2-3	1:100 Year Design Storm Analysis – Kingston West 2021
Figure 2-4	Dry Weather Design Storm Analysis – Kingston Central and East 2021
Figure 2-5	1:10 Year Design Storm Analysis – Kingston Central and East 2021
Figure 2-6	1:100 Year Design Storm Analysis – Kingston Central and East 2021
Figure 3-1	Dry Weather Design Storm Analysis – Kingston West 2026
Figure 3-2	1:10 Year Design Storm Analysis – Kingston West 2026
Figure 3-3	1:100 Year Design Storm Analysis – Kingston West 2026
Figure 3-4	Dry Weather Design Storm Analysis – Kingston Central and East 2026
Figure 3-5	1:10 Year Design Storm Analysis – Kingston Central and East 2026
Figure 3-6	1:100 Year Design Storm Analysis – Kingston Central and East 2026
Figure 4-1	Dry Weather Design Storm Analysis – Kingston West 2036
Figure 4-2	1:10 Year Design Storm Analysis – Kingston West 2036
Figure 4-3	1:100 Year Design Storm Analysis – Kingston West 2036
Figure 4-4	Dry Weather Design Storm Analysis – Kingston Central and East 2036
Figure 4-5	1:10 Year Design Storm Analysis – Kingston Central and East 2036
Figure 4-6	1:100 Year Design Storm Analysis – Kingston Central and East 2036
Figure 5-1	Dry Weather Design Storm Analysis – Kingston West Full Buildout
Figure 5-2	1:10 Year Design Storm Analysis – Kingston West Full Buildout
Figure 5-3	1:100 Year Design Storm Analysis – Kingston West Full Buildout
Figure 5-4	Dry Weather Design Storm Analysis – Kingston Central and East Full Buildout
Figure 5-5	1:10 Year Design Storm Analysis – Kingston Central and East Full Buildout
Figure 5-6	1:100 Year Design Storm Analysis – Kingston Central and East Full Buildout
Figure 6-1	Dry Weather Year Design Storm Analysis – Kingston West Ultimate
Figure 6-2	1:10 Year Design Storm Analysis – Kingston West Ultimate
Figure 6-3	1:100 Year Design Storm Analysis – Kingston West Ultimate
Figure 6-4	Dry Weather Design Storm Analysis – Kingston Central and East Ultimate
Figure 6-5	1:10 Year Design Storm Analysis – Kingston Central and East Ultimate
Figure 6-6	1:100 Year Design Storm Analysis – Kingston Central and East Ultimate

## **LEVEL OF SERVICE MAPS**

Figure 7-1	Level of Service – Kingston West 2015
Figure 7-2	Level of Service – Kingston Central and East 2015
Figure 8-1	Level of Service – Kingston West 2021
Figure 8-2	Level of Service – Kingston Central and East 2021
Figure 9-1	Level of Service – Kingston West 2026
Figure 9-2	Level of Service – Kingston Central and East 2026
Figure 10-1	Level of Service – Kingston West 2036
Figure 10-2	Level of Service – Kingston Central and East 2036
Figure 11-1	Level of Service – Kingston West Full Buildout
Figure 11-2	Level of Service – Kingston Central and East Full Buildout
Figure 12-1	Level of Service – Kingston West Ultimate
Figure 12-2	Level of Service – Kingston Central and East Ultimate



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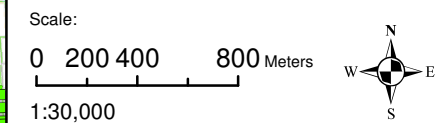


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**Legend**

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED
- GRAVITY SEWER CONDITION**
- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
- DRY WEATHER FLOW < 85% OF CAPACITY
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- ADF ≥ RATED ADF CAPACITY
- ADF ≥ 80% RATED ADF CAPACITY
- ADF ≤ 80% ADF CAPACITY

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

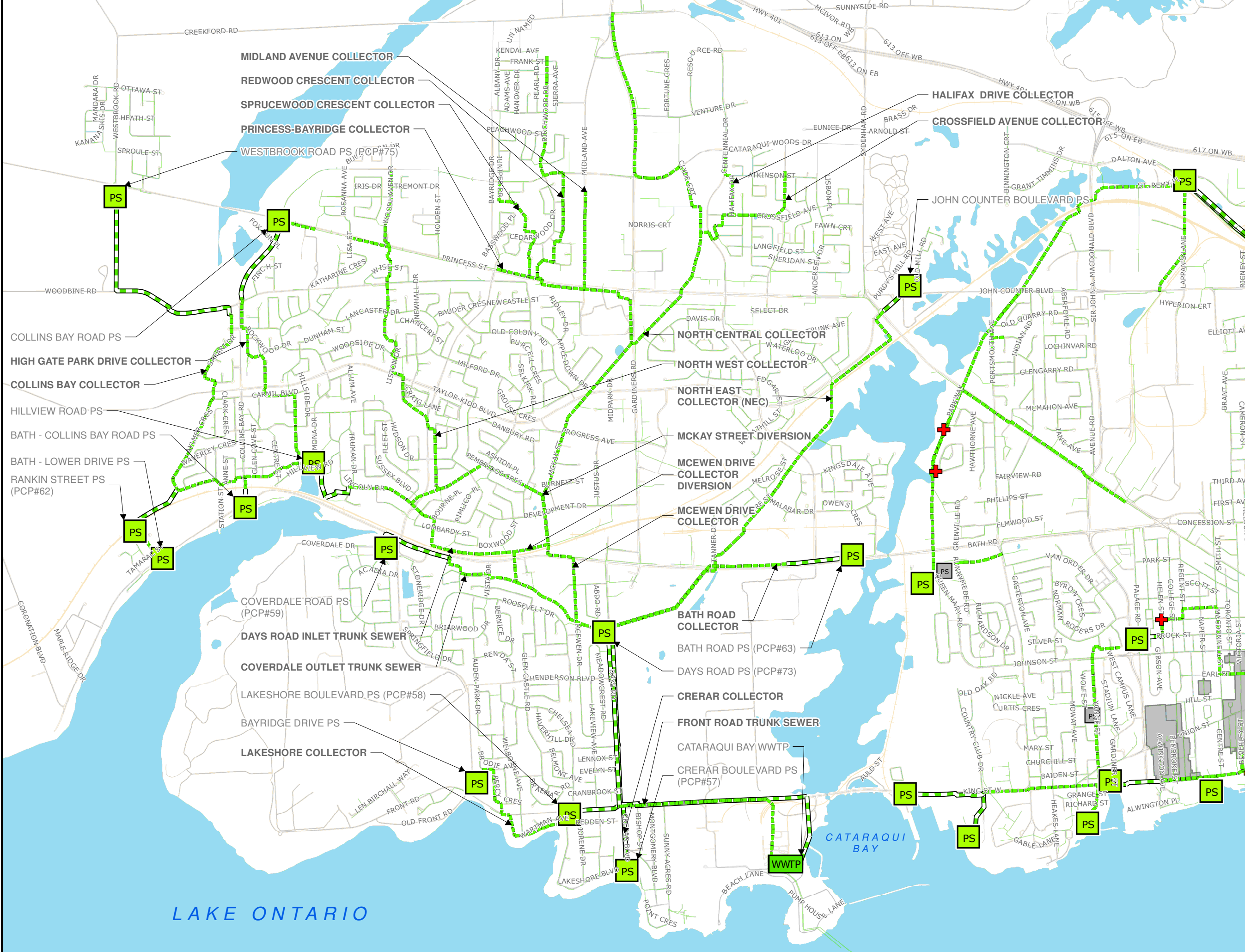


Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON WEST 2015**

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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

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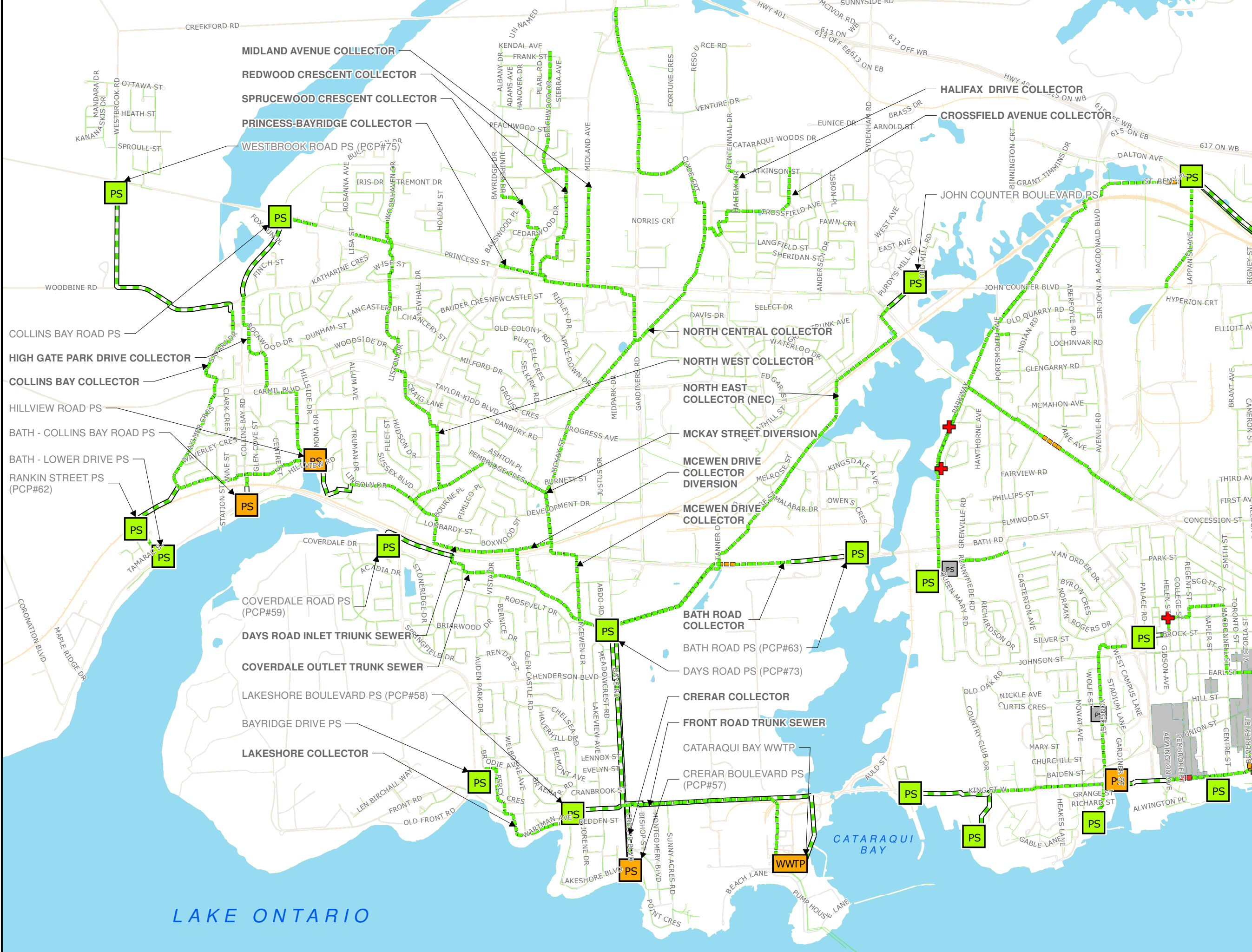
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- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
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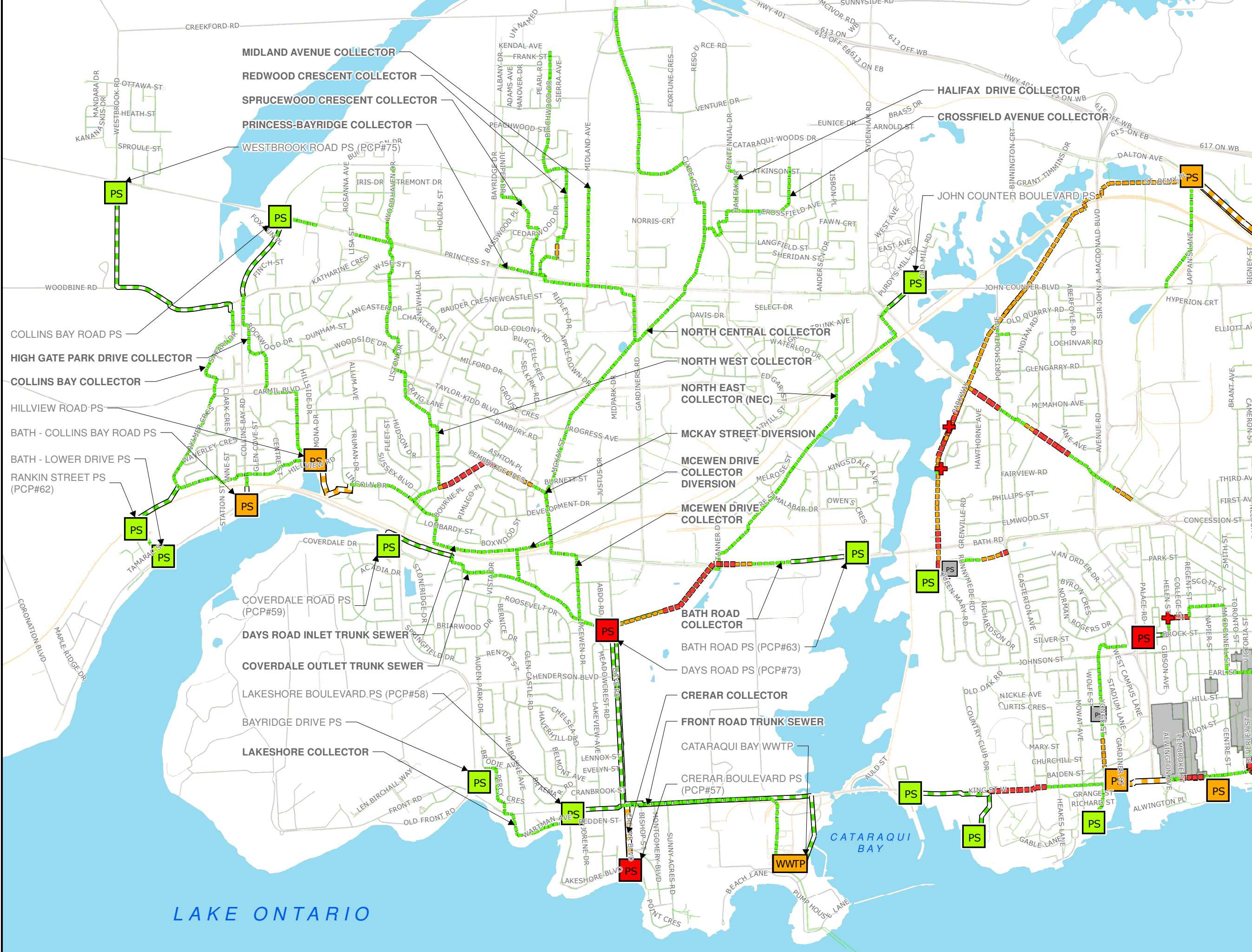
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- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA

### SANITARY PUMP STATION CONDITION

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED

### GRAVITY SEWER CONDITION

- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
- DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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

Scale:  
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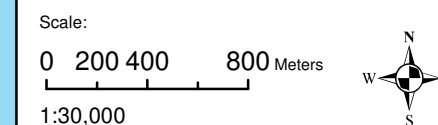


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- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
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Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013, Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.



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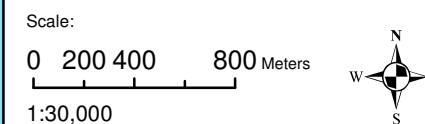


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### Legend

- COMBINED SEWER OVERFLOW
  - SANITARY SEWER OVERFLOW
  - TANK OVERFLOW
  - EXISTING SANITARY SEWER
  - COMBINED SEWER AREA
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
  - BETWEEN FIRM AND PEAK CAPACITY
  - BELOW FIRM CAPACITY
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Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.



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### Legend

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- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION CONDITION

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED

### GRAVITY SEWER CONDITION

- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
- DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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

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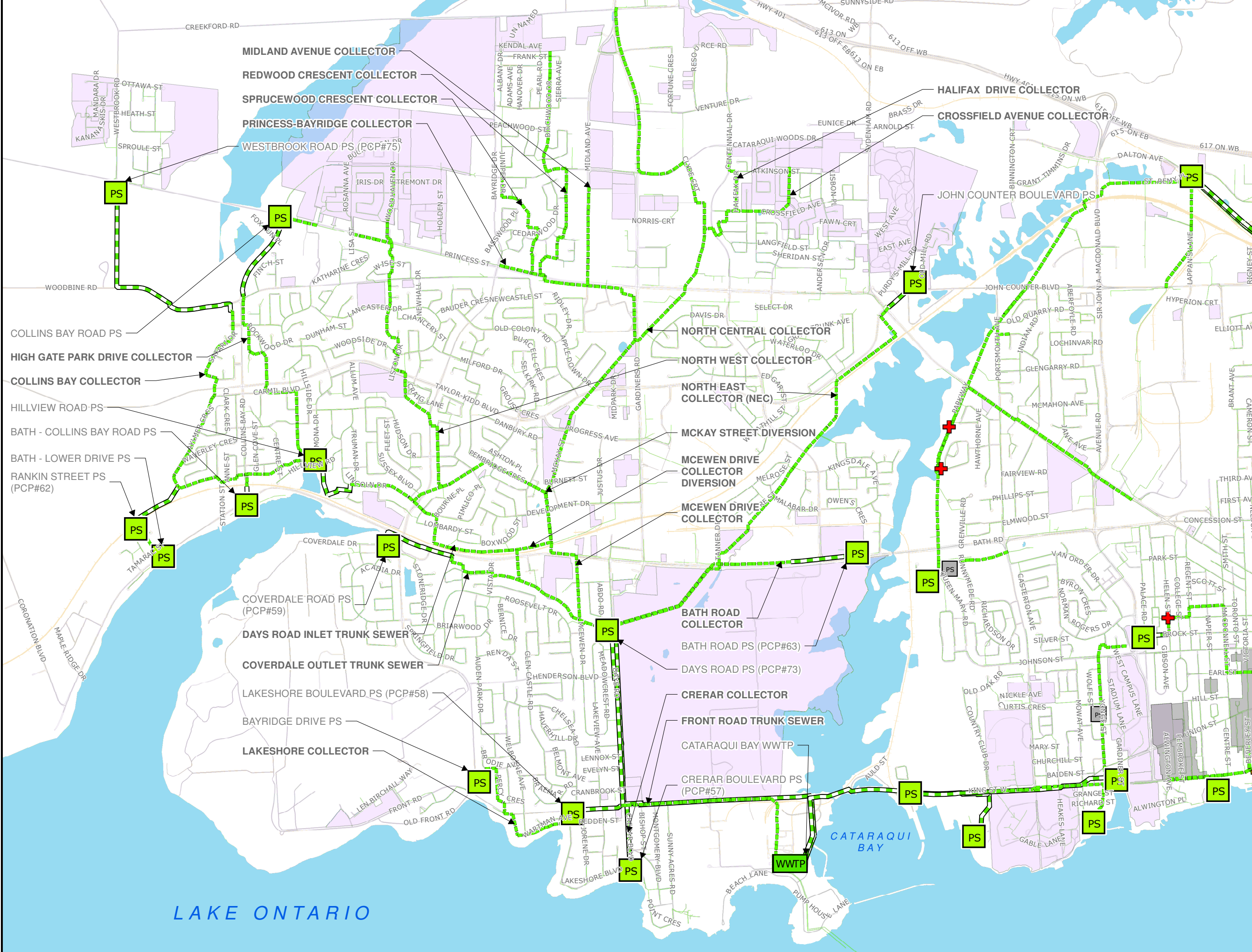
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON WEST 2021**

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	2-1









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UTILITIES KINGSTON  
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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

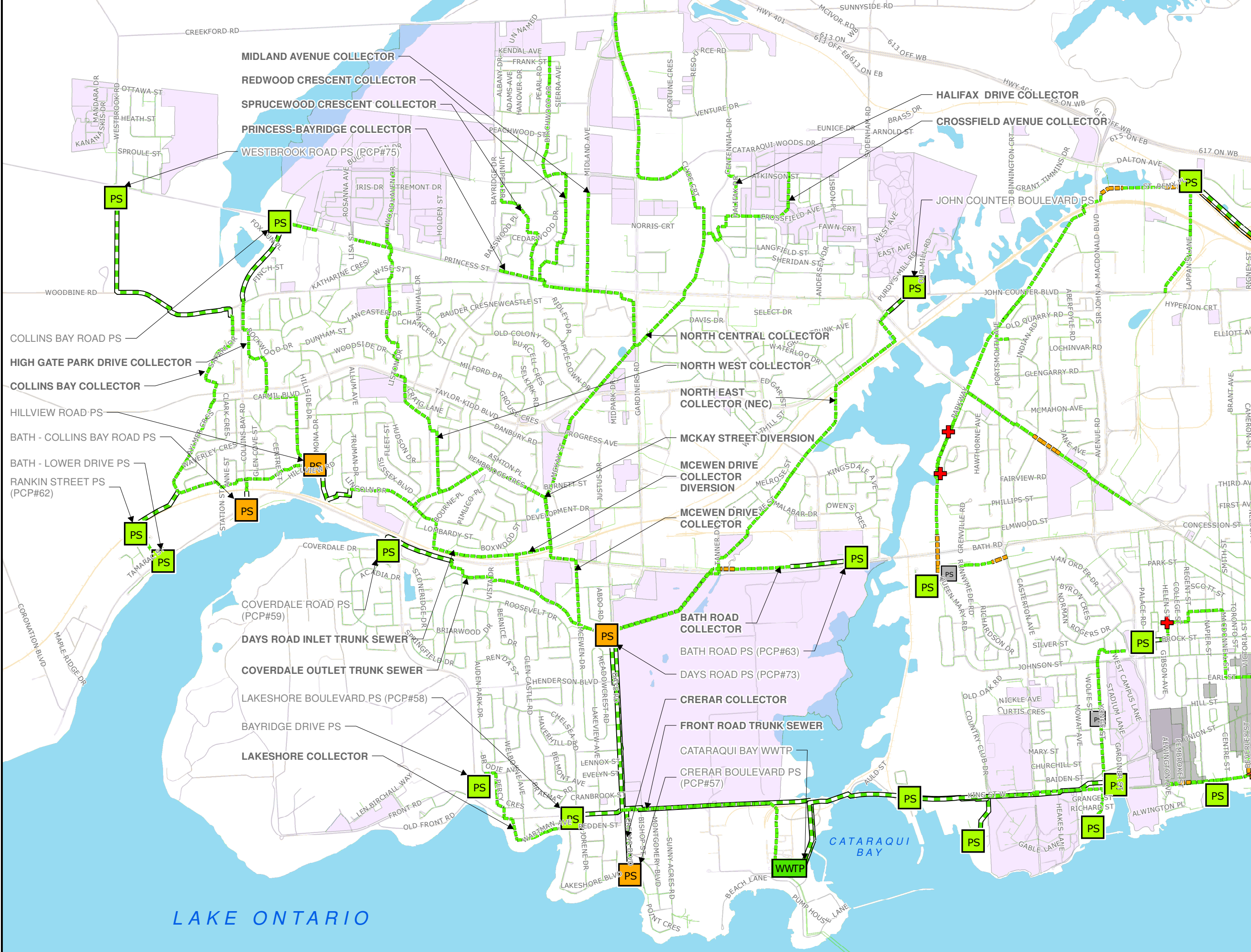
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Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST 2021**

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

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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

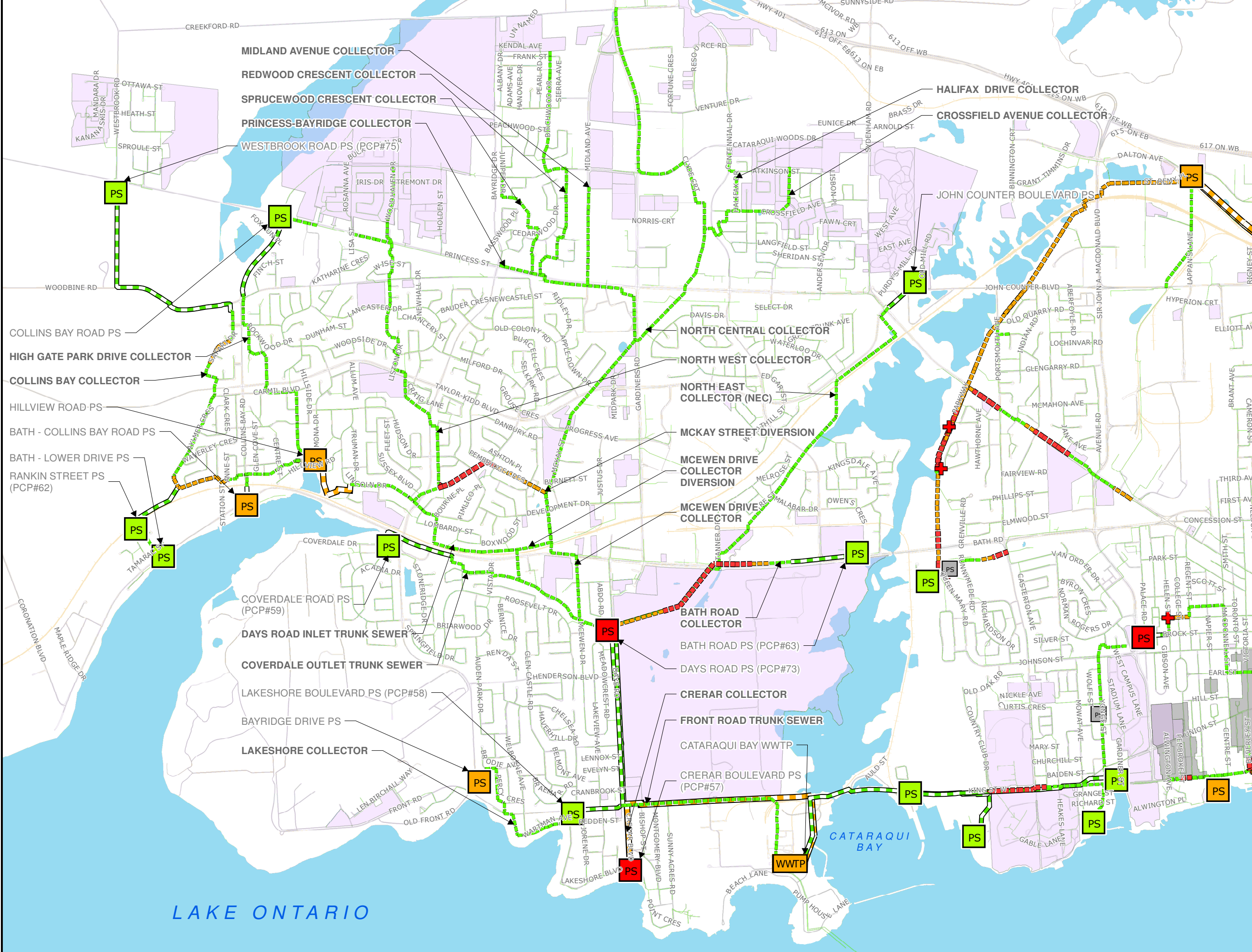
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Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST 2021**

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

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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION CONDITION

- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED

- ### GRAVITY SEWER CONDITION
- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99% OF CAPACITY
  - DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- ADF ≥ RATED ADF CAPACITY
- ADF ≥ 80% RATED ADF CAPACITY
- ADF ≤ 80% ADF CAPACITY

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

Scale:

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Project:

**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title: **DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST 2021**

Project No.:

151-02944-00

Date:

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Code:

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2-4







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**Legend**

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCE MAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

Scale:  
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1:30,000

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

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST 2021**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 2-5









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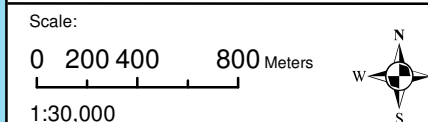


UTILITIES KINGSTON  
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KINGSTON, ONTARIO,  
K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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



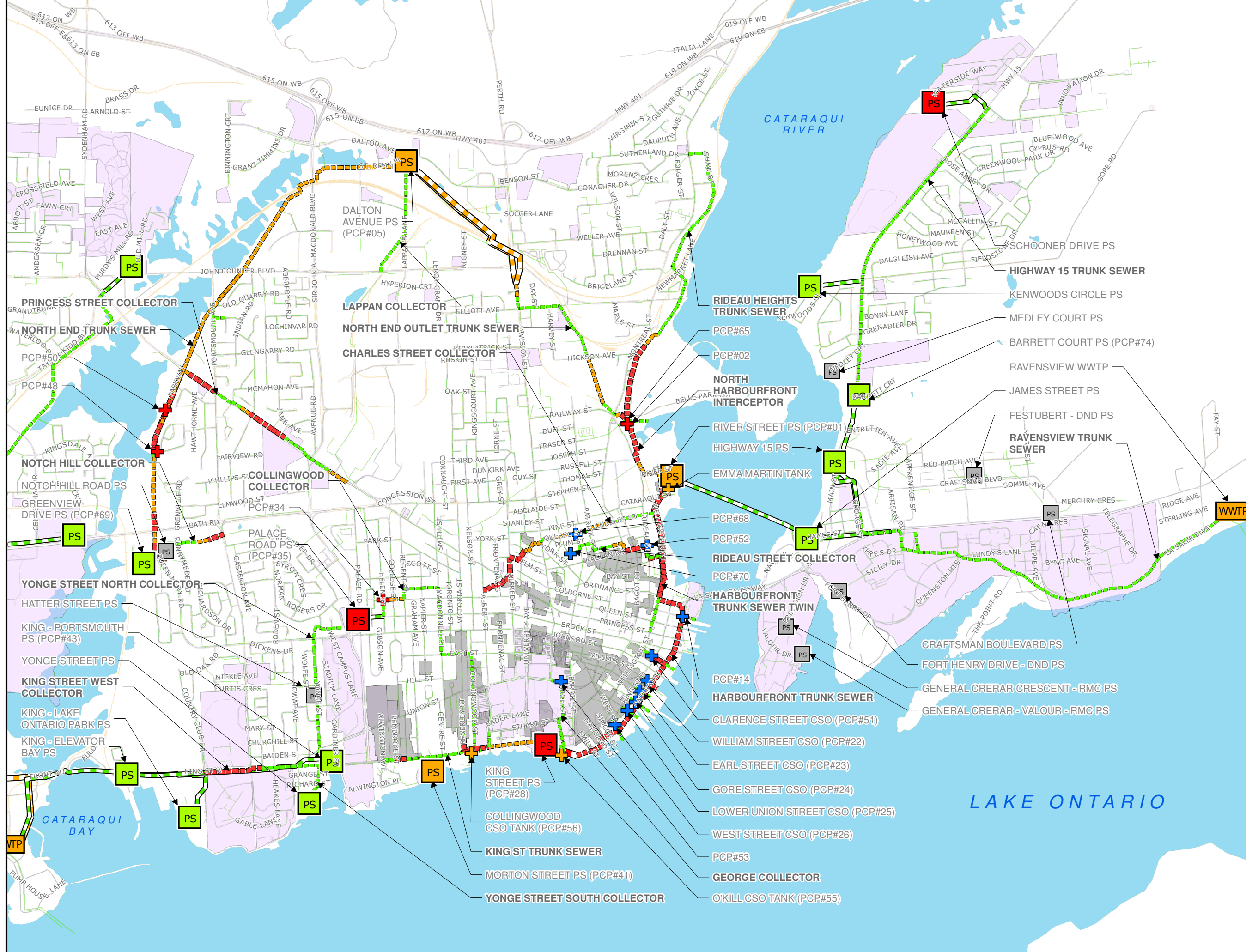
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST 2021**

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

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**Legend**

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

**SANITARY PUMP STATION CONDITION**

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED

- GRAVITY SEWER CONDITION**
- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
  - DRY WEATHER FLOW < 85% OF CAPACITY

**SANITARY FORCEMAIN CONDITION**

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

**WASTEWATER TREATMENT PLANT CONDITION**

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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

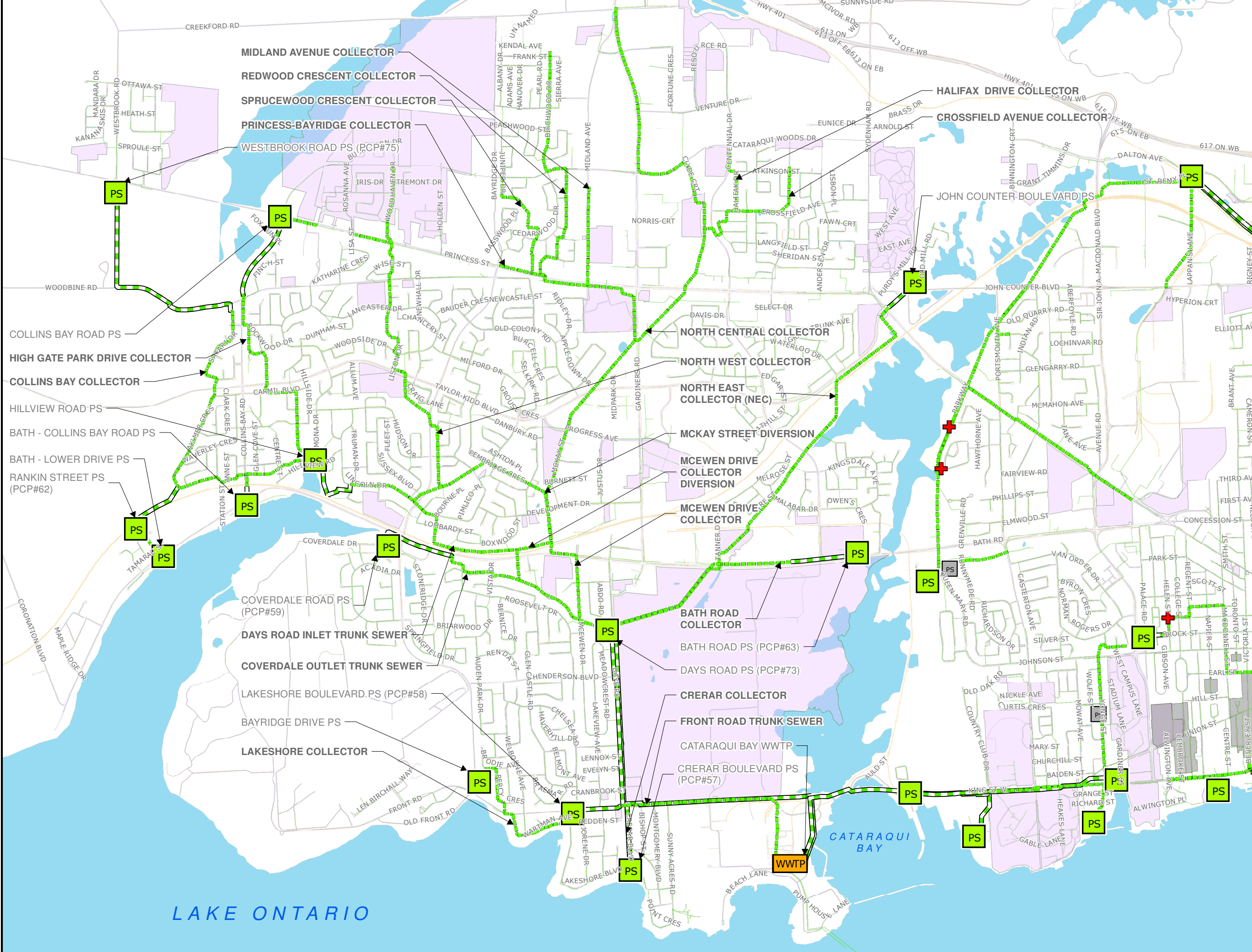
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Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON WEST 2026**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 3-1







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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

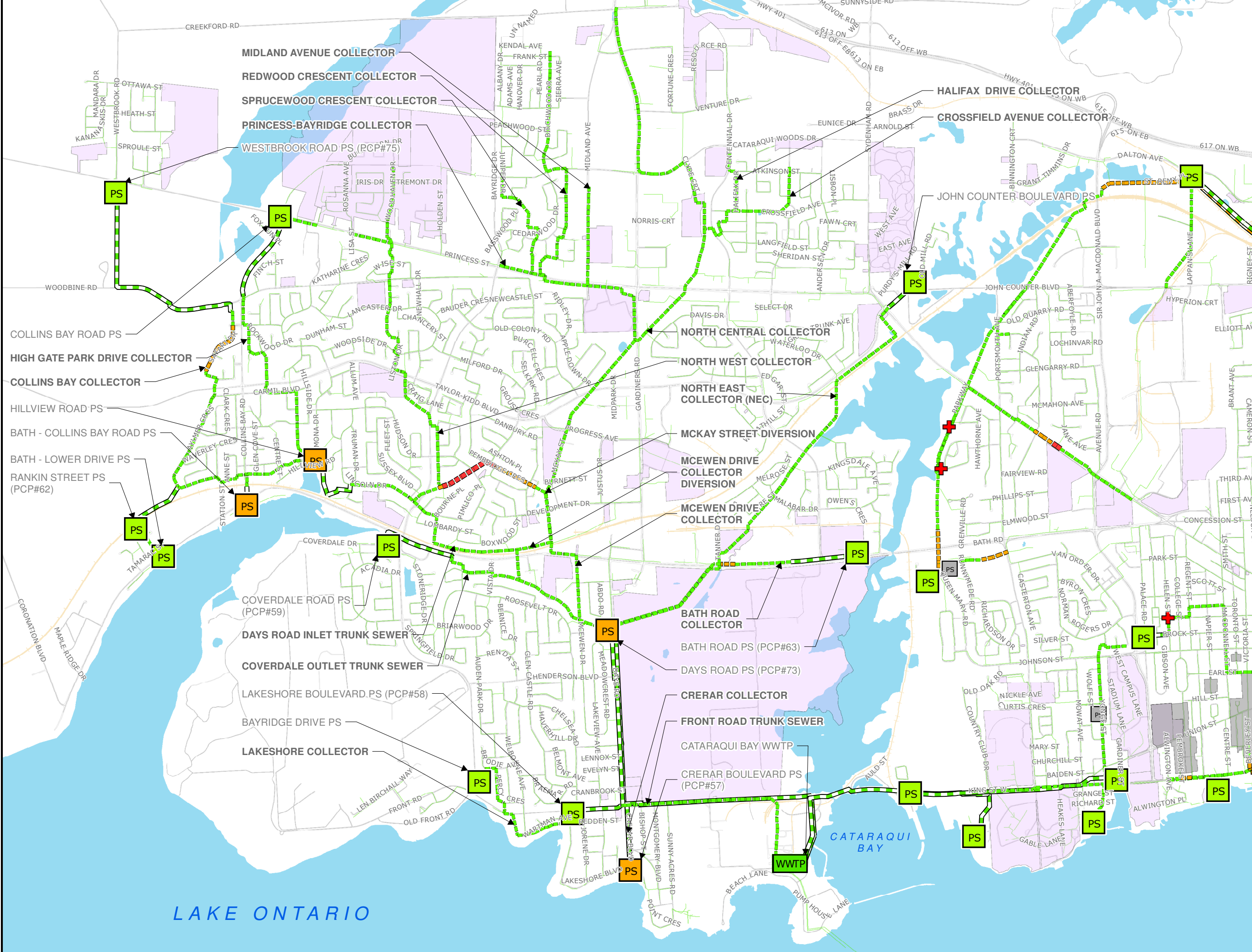
Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

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

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST 2026**

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	3-2







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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

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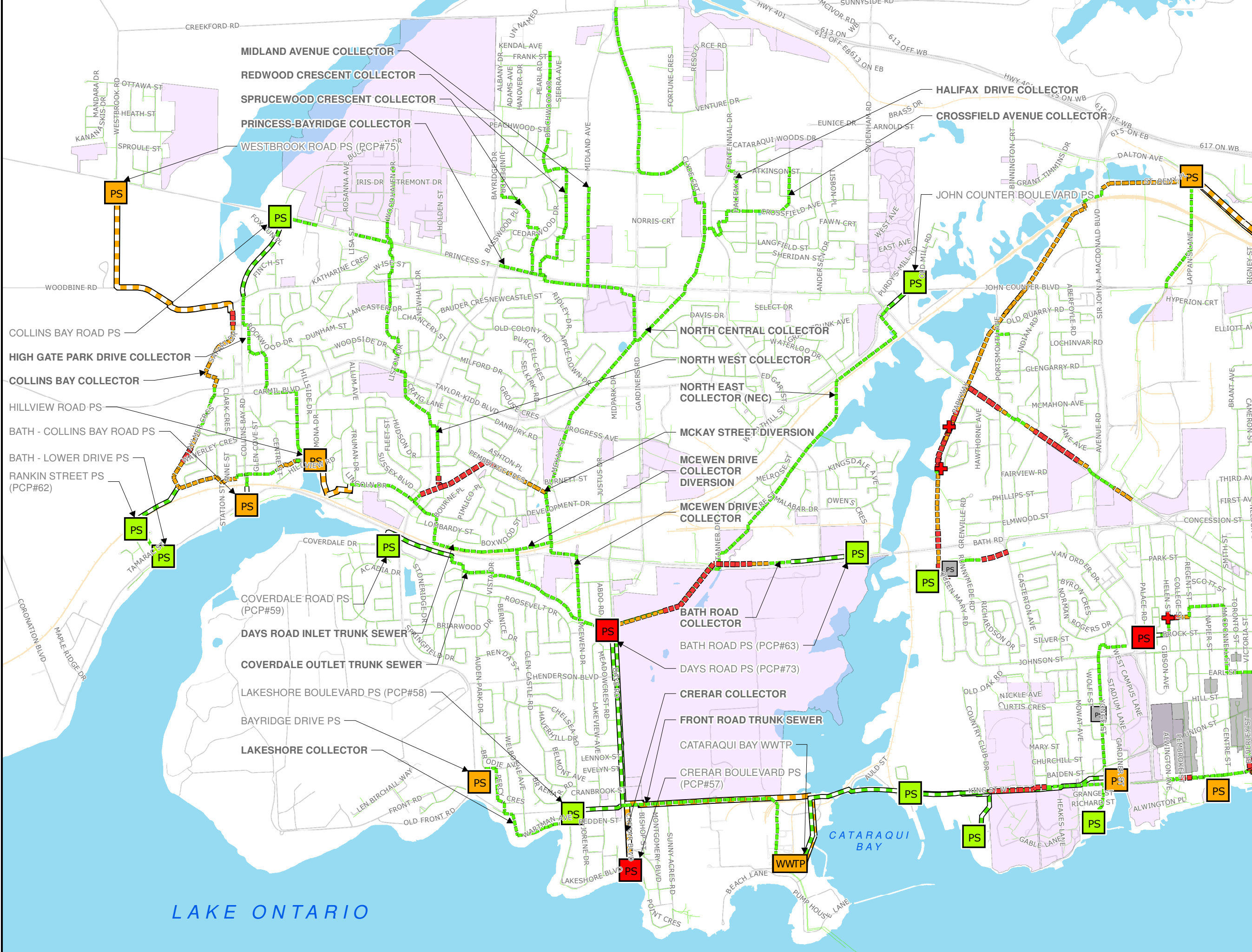
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST 2026**

Project No.:	Date:
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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION CONDITION

- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED

- ### GRAVITY SEWER CONDITION
- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
  - DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- ADF ≥ RATED ADF CAPACITY
- ADF ≥ 80% RATED ADF CAPACITY
- ADF ≤ 80% ADF CAPACITY

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

Scale:

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Project:

Water and Wastewater  
Master Plan Updates

City of Kingston, Ontario

Title: **DRY WEATHER DESIGN  
STORM ANALYSIS -  
KINGSTON CENTRAL  
AND EAST 2026**

Project No.:

151-02944-00

Date:

DECEMBER 2016

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Figure No.:

3-4







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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

Scale:  
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1:30,000

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

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST 2026**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 3-5







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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
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Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

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Project:

Water and Wastewater  
Master Plan Updates

City of Kingston, Ontario

Title:

1:100-YEAR DESIGN  
STORM ANALYSIS -  
KINGSTON CENTRAL  
AND EAST 2026

Project No.:

151-02944-00

Date:

DECEMBER 2016

Drawn By:

CM

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Code:

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Figure No.:

3-6







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KINGSTON, ONTARIO,  
K7L 4X7

**Legend**

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

**SANITARY PUMP STATION CONDITION**

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED

**GRAVITY SEWER CONDITION**

- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
- DRY WEATHER FLOW < 85% OF CAPACITY

**SANITARY FORCEMAIN CONDITION**

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

**WASTEWATER TREATMENT PLANT CONDITION**

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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

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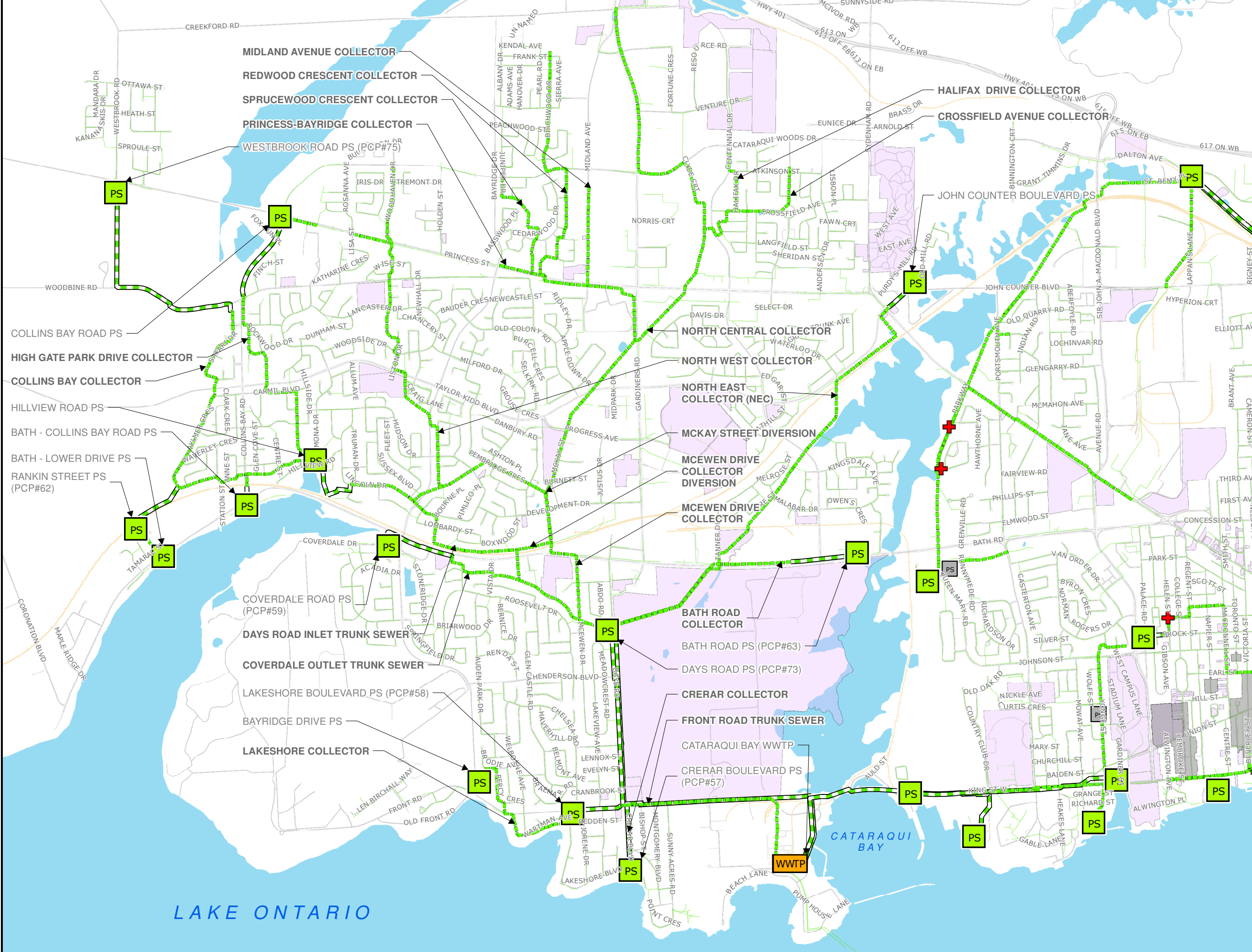
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON WEST 2036**

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

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UTILITIES KINGSTON  
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KINGSTON, ONTARIO,  
K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

Scale:

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Project:

Water and Wastewater  
Master Plan Updates

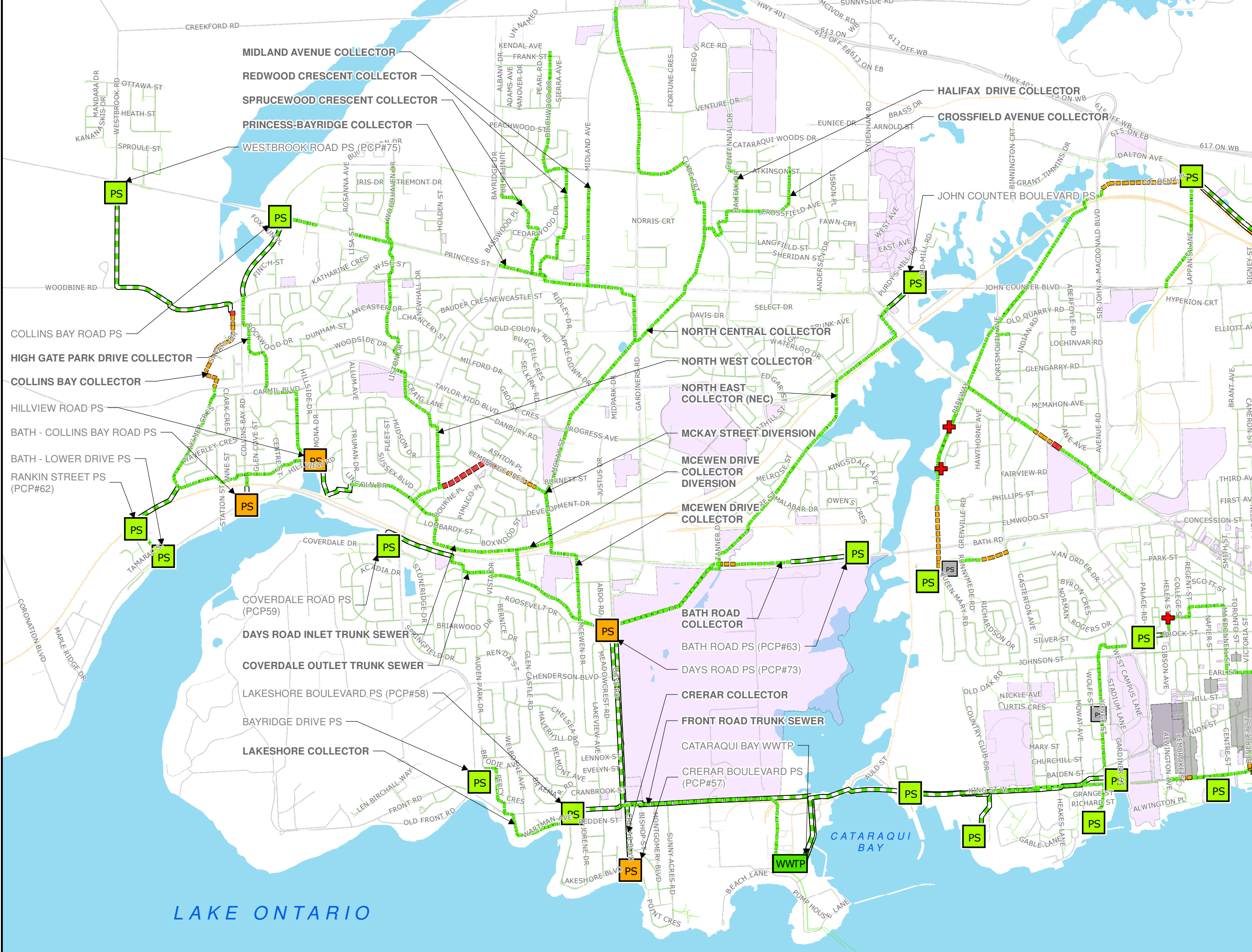
City of Kingston, Ontario

Title:

1:10-YEAR DESIGN  
STORM ANALYSIS -  
KINGSTON WEST 2036

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	4-2







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**Legend**

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

Scale:

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Project:

**Water and Wastewater Master Plan Updates**

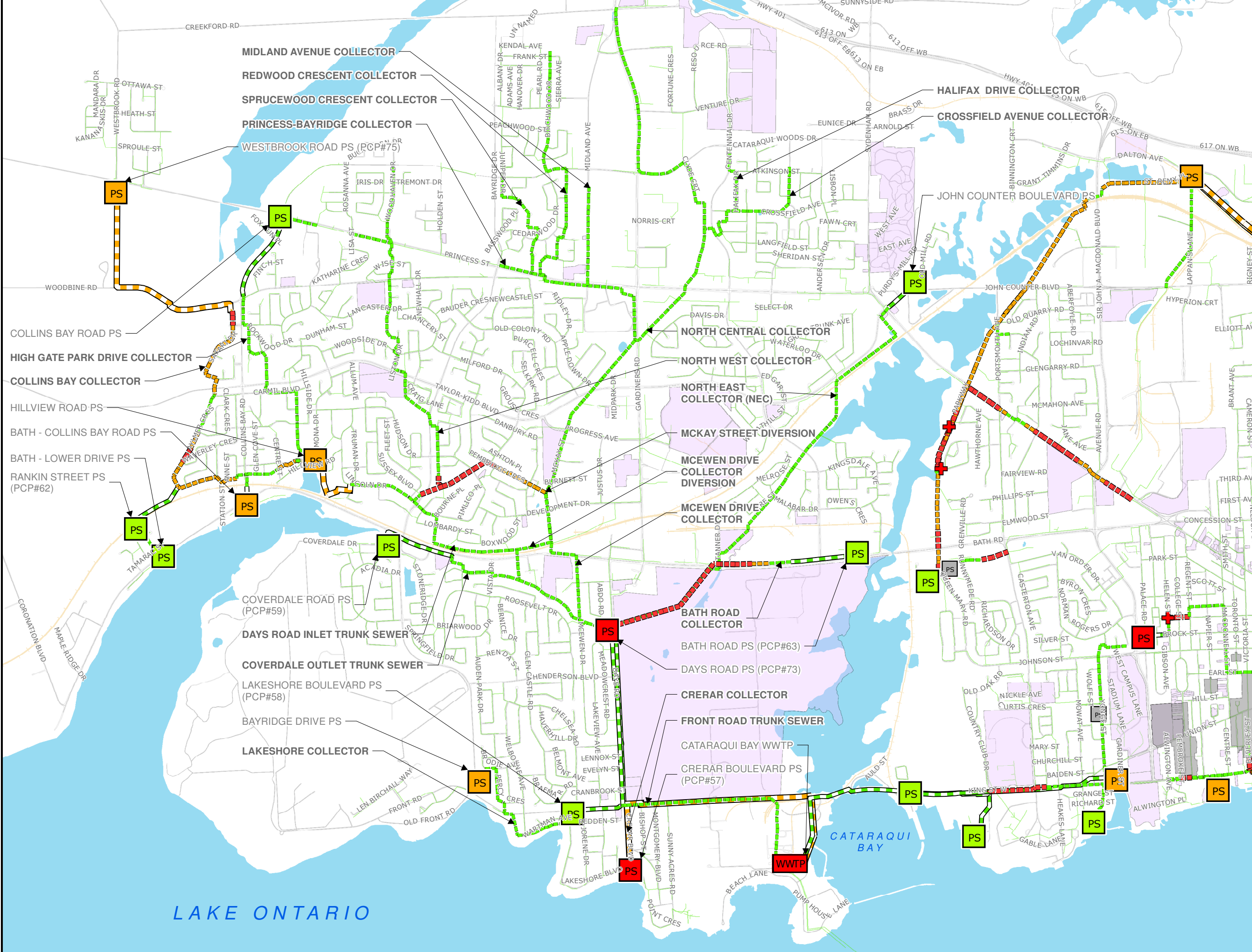
City of Kingston, Ontario

Title:

**1:100-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST 2036**

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

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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION CONDITION

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED

### GRAVITY SEWER CONDITION

- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
- DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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

Scale:  
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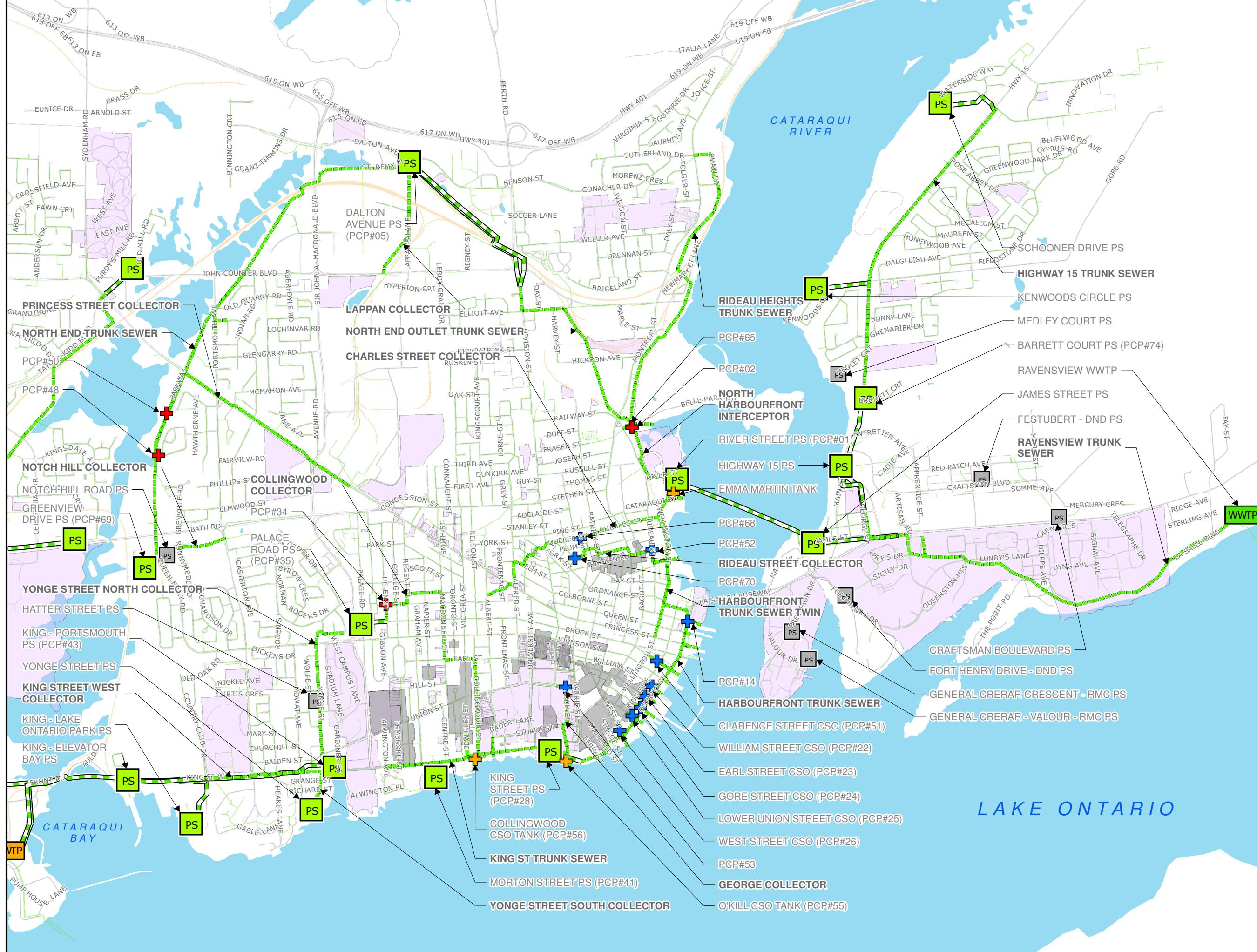
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title: **DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST 2036**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 4-4







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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

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

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST 2036**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 4-5









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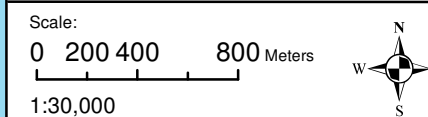


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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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



Project:  
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Master Plan Updates**  
  
City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN  
STORM ANALYSIS -  
KINGSTON CENTRAL  
AND EAST 2036**

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

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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION CONDITION

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED

- ### GRAVITY SEWER CONDITION
- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
  - DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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

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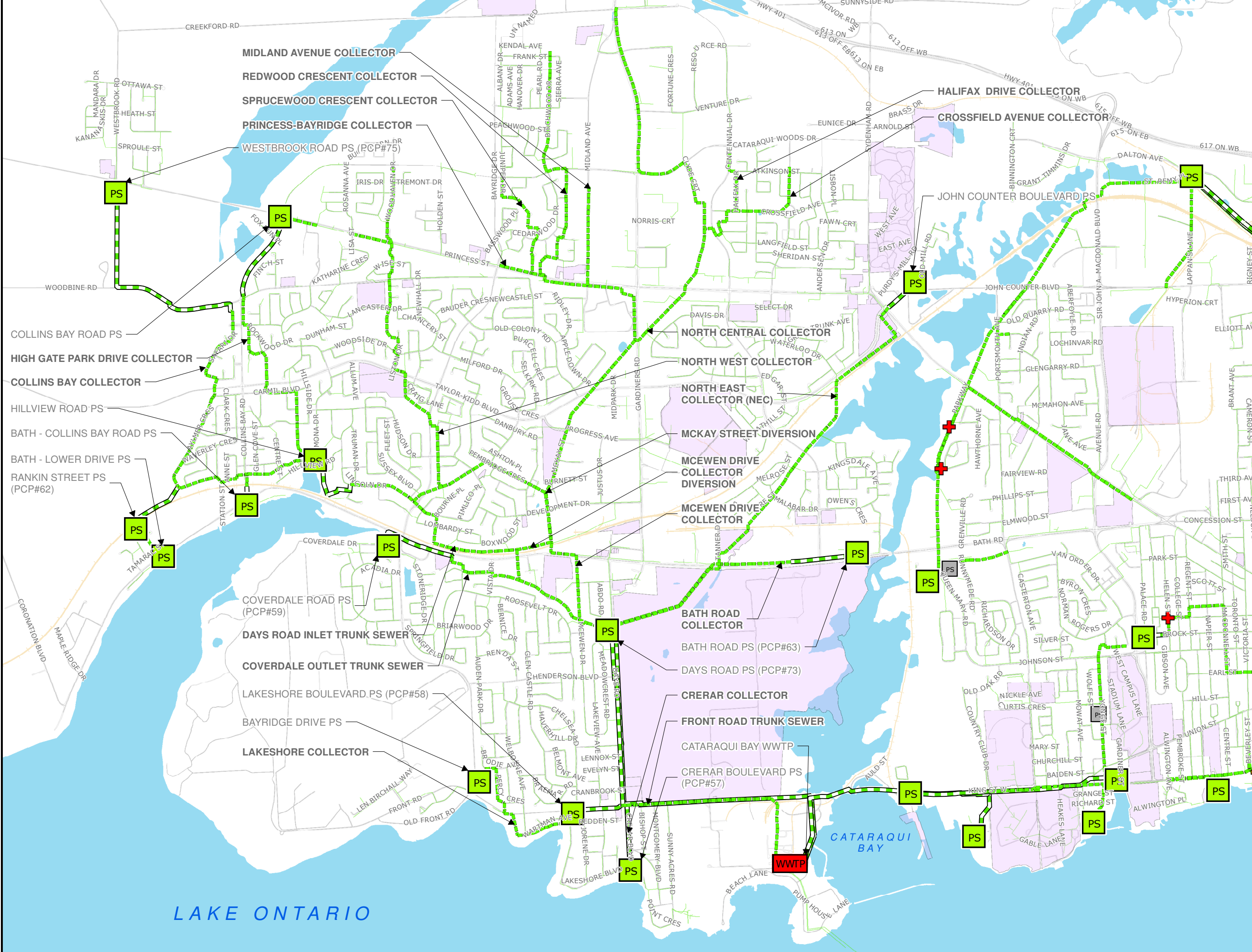
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON WEST FULL BUILDOUT**

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

Drawn By:	Checked By:	Code:	Figure No.:
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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

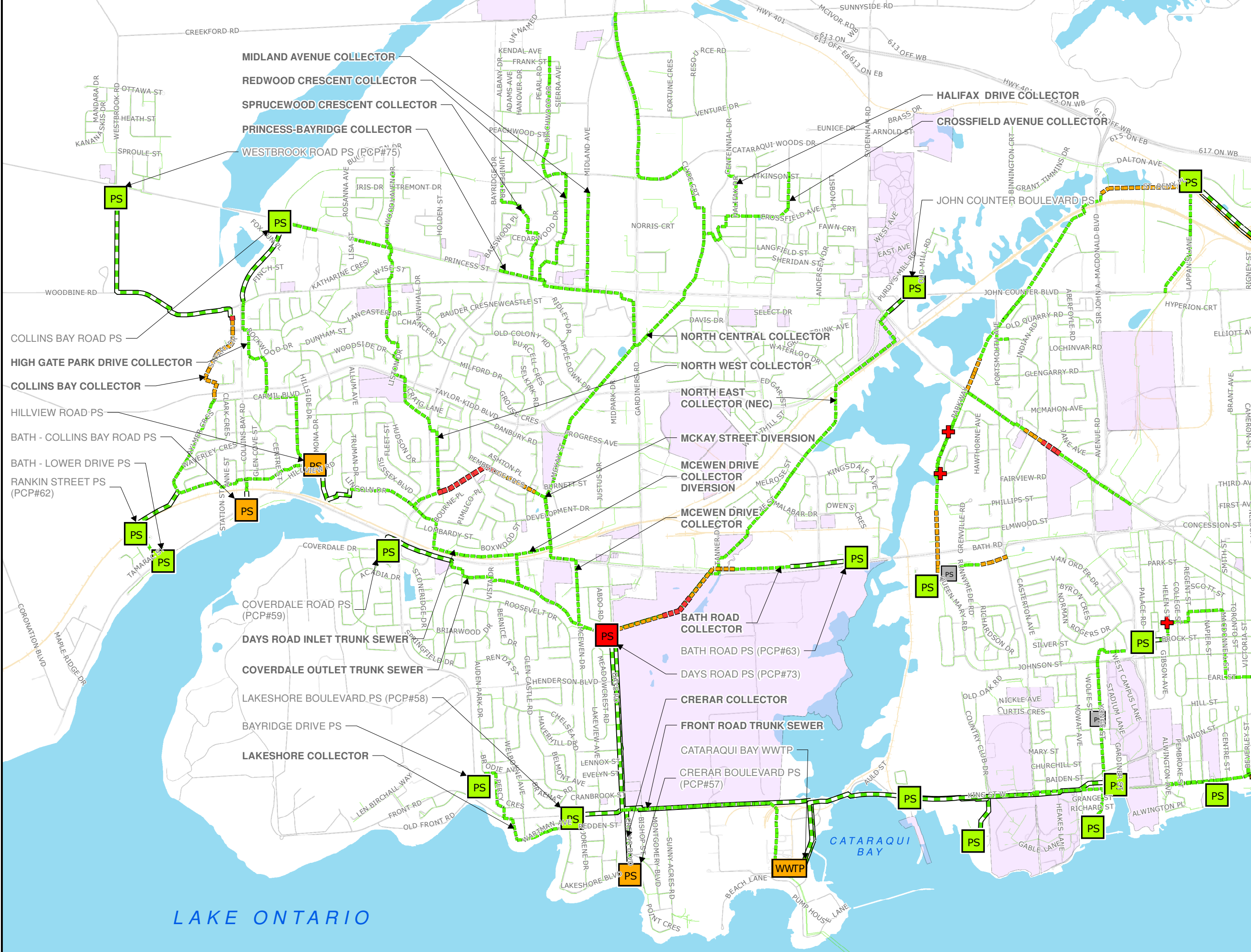
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Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST FULL BUILDOUT**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 5-2







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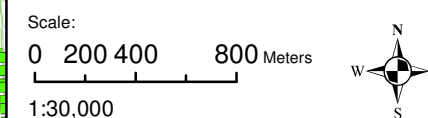


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### Legend

- COMBINED SEWER OVERFLOW
  - SANITARY SEWER OVERFLOW
  - TANK OVERFLOW
  - EXISTING SANITARY SEWER
  - COMBINED SEWER AREA
  - PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- ABOVE PEAK CAPACITY
  - BETWEEN FIRM AND PEAK CAPACITY
  - BELOW FIRM CAPACITY
  - NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
  - WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
  - WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
  - BETWEEN 2 M/S AND 3 M/S
  - BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- PEAK FLOW ≥ RATED PEAK HOURLY FLOW
  - PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
  - PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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



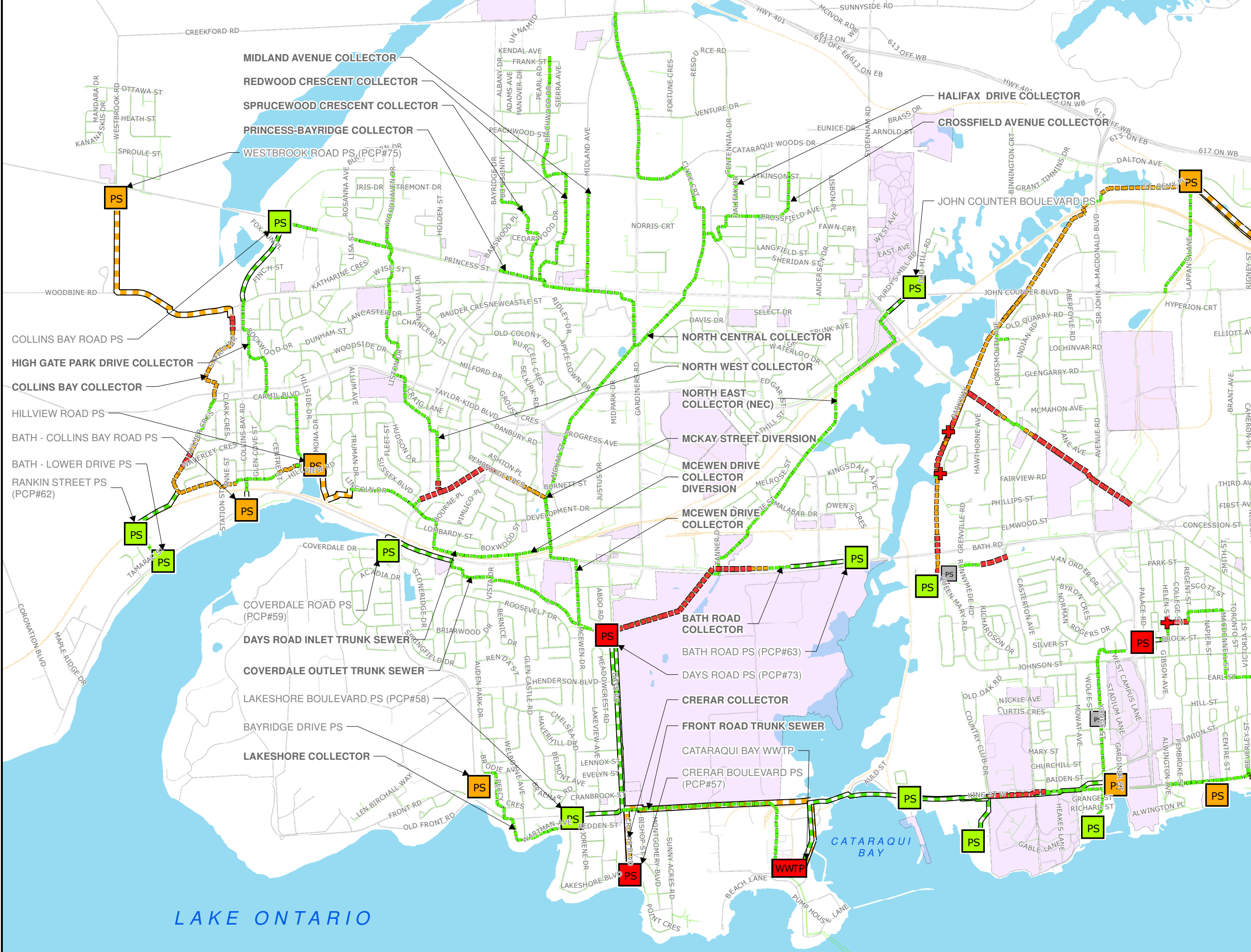
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST FULL BUILDOUT**

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

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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION CONDITION

- ABOVE PEAK CAPACITY
- BETWEEN FIRM AND PEAK CAPACITY
- BELOW FIRM CAPACITY
- NOT MODELLED

### GRAVITY SEWER CONDITION

- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
- DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- ADF ≥ RATED ADF CAPACITY
- ADF ≥ 80% RATED ADF CAPACITY
- ADF ≤ 80% ADF CAPACITY

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

Scale:  
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Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST FULL BUILDOUT**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 5-4







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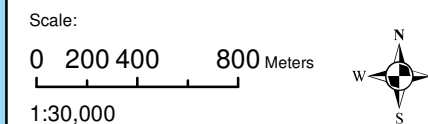


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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
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Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.



Project:  
**Water and Wastewater  
Master Plan Updates**

City of Kingston, Ontario

Title:  
**1:10-YEAR DESIGN  
STORM ANALYSIS -  
KINGSTON CENTRAL  
AND EAST FULL BUILDOUT**

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

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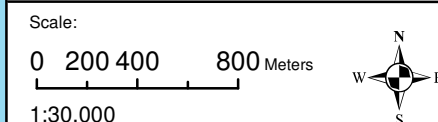


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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
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- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
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- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
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Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.



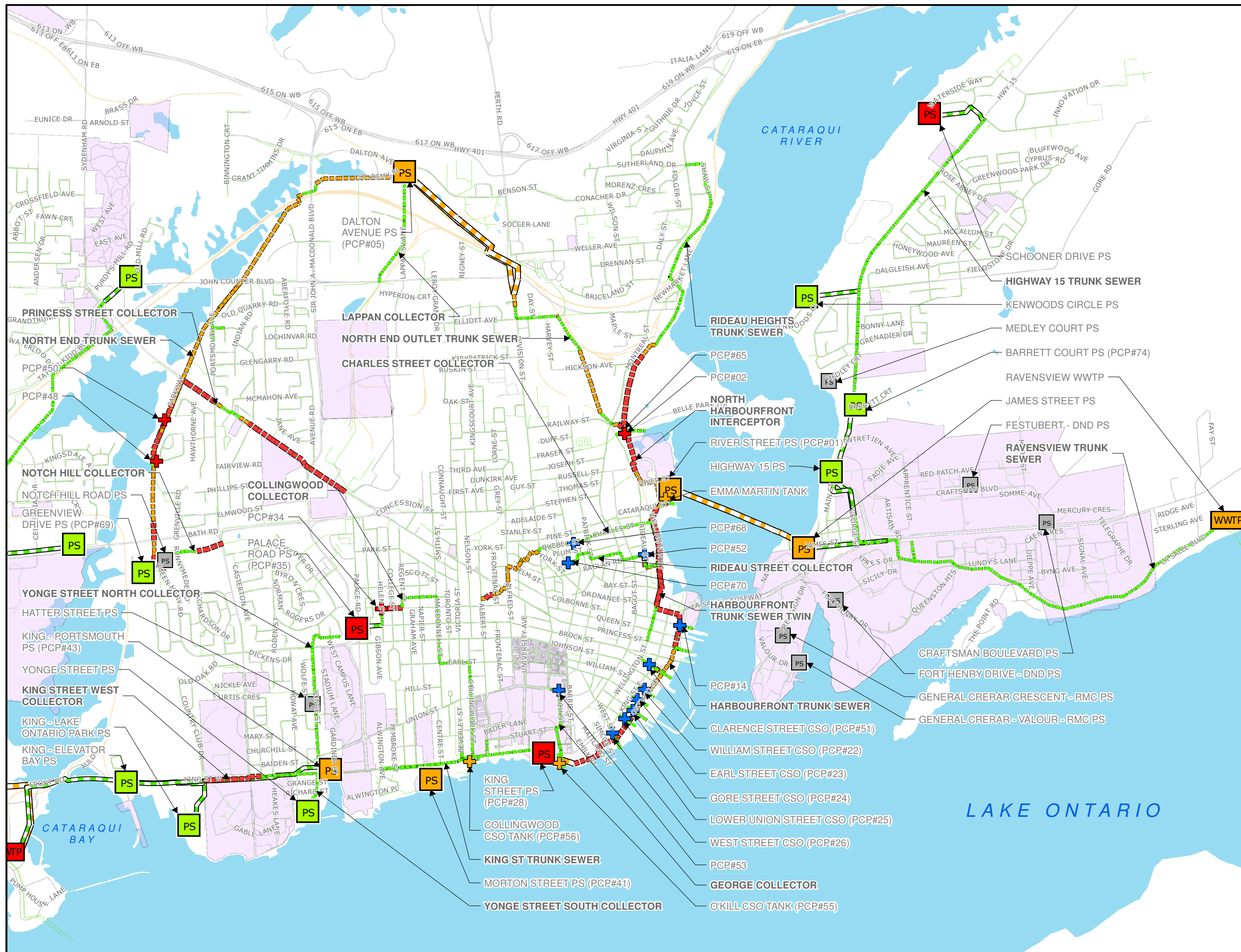
Project:  
**Water and Wastewater  
Master Plan Updates**

City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN  
STORM ANALYSIS -  
KINGSTON CENTRAL  
AND EAST FULL BUILDOUT**

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	5-6







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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
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### SANITARY PUMP STATION CONDITION

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
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  - DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99%
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### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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

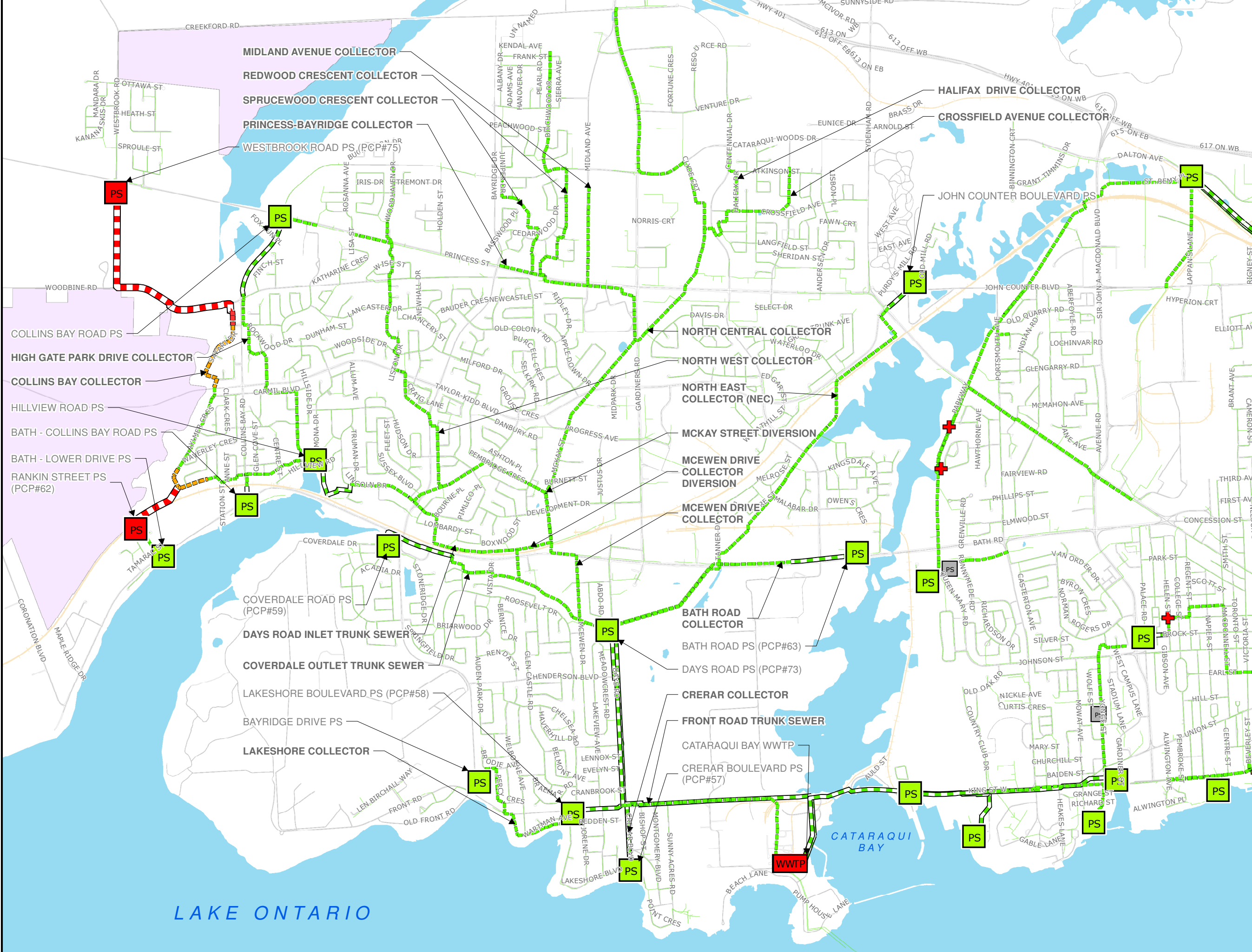
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Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN STORM ANALYSIS - KINGSTON WEST ULTIMATE**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 6-1









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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
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- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
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- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

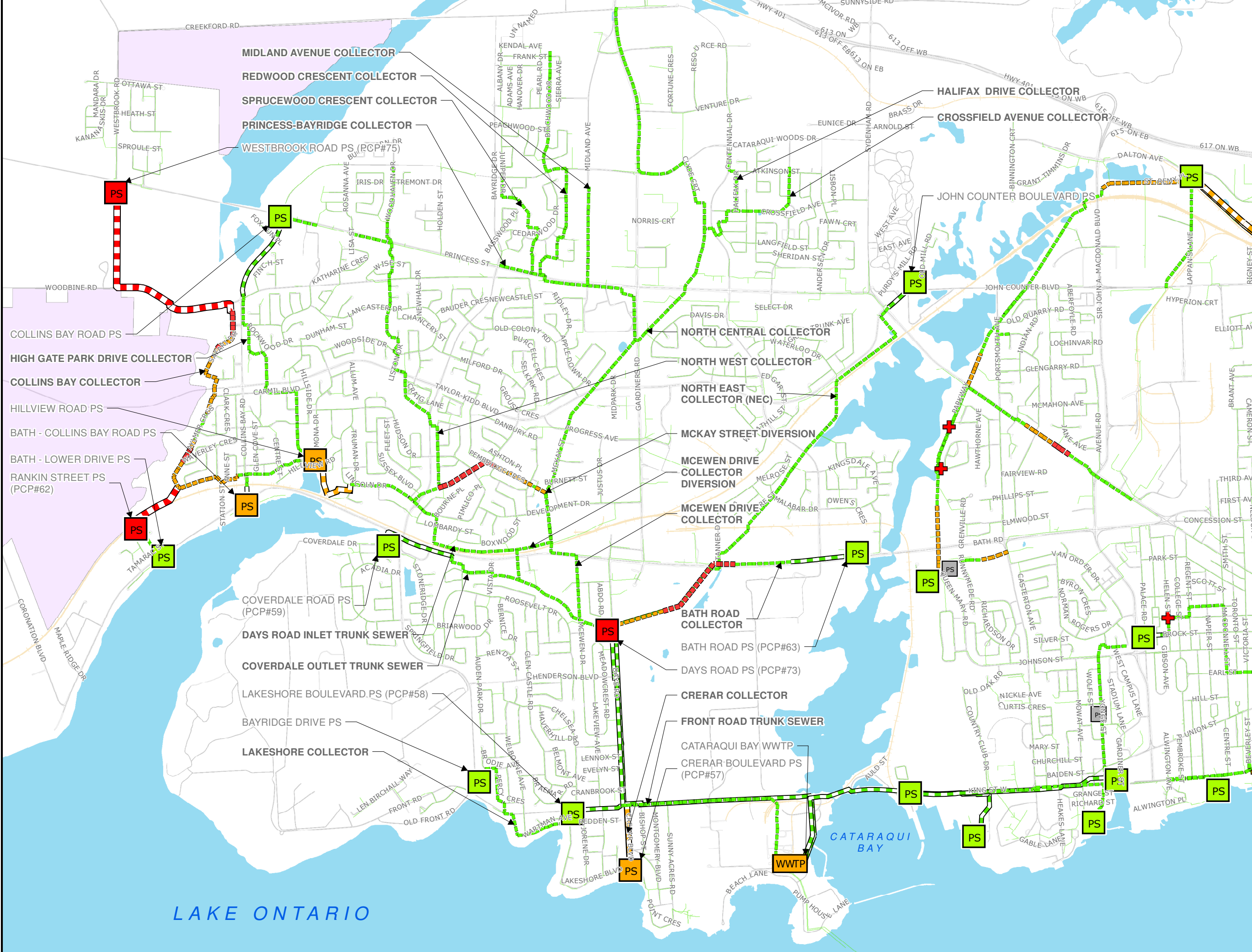
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Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST ULTIMATE**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 6-2







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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- FORCEMAIN
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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

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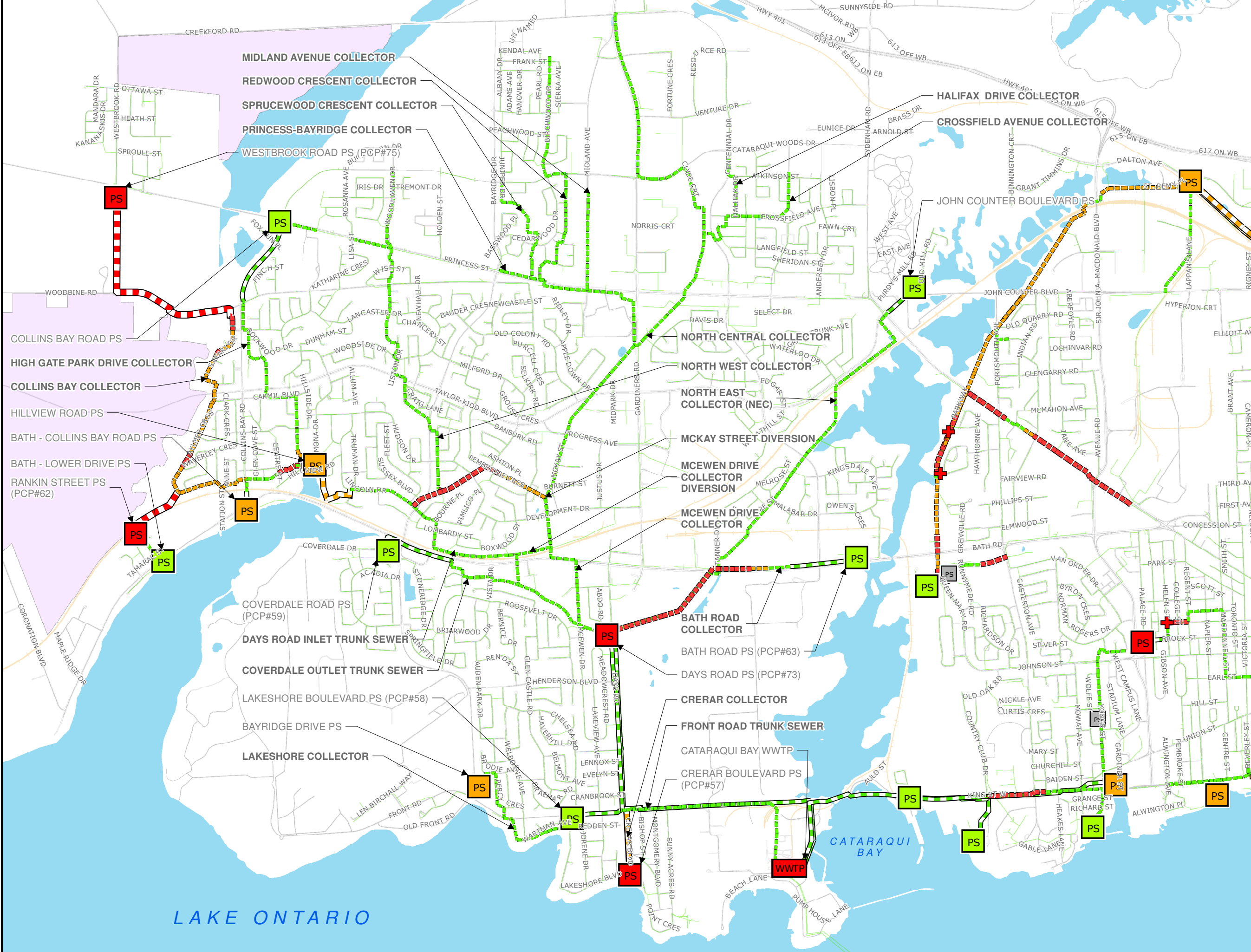
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Project:  
**Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN STORM ANALYSIS - KINGSTON WEST ULTIMATE**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 6-3



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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION CONDITION

- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED

- ### GRAVITY SEWER CONDITION
- CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - DRY WEATHER FLOW IS > 85% OF CAPACITY BUT < 99% OF CAPACITY
  - DRY WEATHER FLOW < 85% OF CAPACITY

### SANITARY FORCEMAIN CONDITION

- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S

### WASTEWATER TREATMENT PLANT CONDITION

- WWTP ADF ≥ RATED ADF CAPACITY
- WWTP ADF ≥ 80% RATED ADF CAPACITY
- WWTP ADF ≤ 80% ADF CAPACITY

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  
1:30,000



Project:  
**Water and Wastewater  
Master Plan Updates**

City of Kingston, Ontario

Title:  
**DRY WEATHER DESIGN  
STORM ANALYSIS -  
KINGSTON CENTRAL  
AND EAST ULTIMATE**

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	6-4







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### Legend

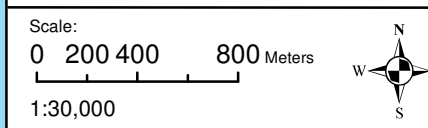
- COMBINED SEWER OVERFLOW
  - SANITARY SEWER OVERFLOW
  - TANK OVERFLOW
  - EXISTING SANITARY SEWER
  - COMBINED SEWER AREA
  - PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
  - PS BETWEEN FIRM AND PEAK CAPACITY
  - PS BELOW FIRM CAPACITY
  - PS NOT MODELLED

- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
  - WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
  - WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT

- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
  - BETWEEN 2 M/S AND 3 M/S
  - BELOW 2 M/S

- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
  - WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
  - WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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



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

Title:  
**1:10-YEAR DESIGN STORM ANALYSIS - KINGSTON CENTRAL AND EAST ULTIMATE**

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	6-5









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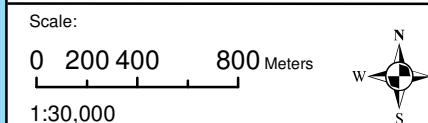


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K7L 4X7

### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT
- SANITARY PUMP STATION CONDITION**
- PS ABOVE PEAK CAPACITY
- PS BETWEEN FIRM AND PEAK CAPACITY
- PS BELOW FIRM CAPACITY
- PS NOT MODELLED
- GRAVITY SEWER CONDITION**
- HGL WITHIN 2M OF FINISHED GROUND AND > 0.3M ABOVE PIPE OBVERT
- WET WEATHER HGL > 0.3M ABOVE PIPE OBVERT AND > 2M BELOW FINISHED GROUND
- WET WEATHER HGL < 0.3M ABOVE PIPE OBVERT
- SANITARY FORCEMAIN CONDITION**
- ABOVE 3 M/S
- BETWEEN 2 M/S AND 3 M/S
- BELOW 2 M/S
- WASTEWATER TREATMENT PLANT CONDITION**
- WWTP PEAK FLOW ≥ RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≥ 80% RATED PEAK HOURLY FLOW
- WWTP PEAK FLOW ≤ 80% RATED PEAK HOURLY FLOW

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



Project:  
**Water and Wastewater  
Master Plan Updates**

City of Kingston, Ontario

Title:  
**1:100-YEAR DESIGN  
STORM ANALYSIS -  
KINGSTON CENTRAL  
AND EAST ULTIMATE**

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	6-6

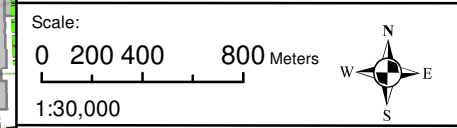




**Legend**

- COMBINED SEWER OVERFLOW
  - SANITARY SEWER OVERFLOW
  - TANK OVERFLOW
  - EXISTING SANITARY SEWER
  - COMBINED SEWER AREA
- SANITARY PUMP STATION LEVEL OF SERVICE**
- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
  - NOT MODELLED
- GRAVITY SEWER LEVEL OF SERVICE**
- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS
- SANITARY FORCEMAIN LEVEL OF SERVICE**
- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
  - VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
  - VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR
- WASTEWATER TREATMENT PLANT LEVEL OF SERVICE**
- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
  - ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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

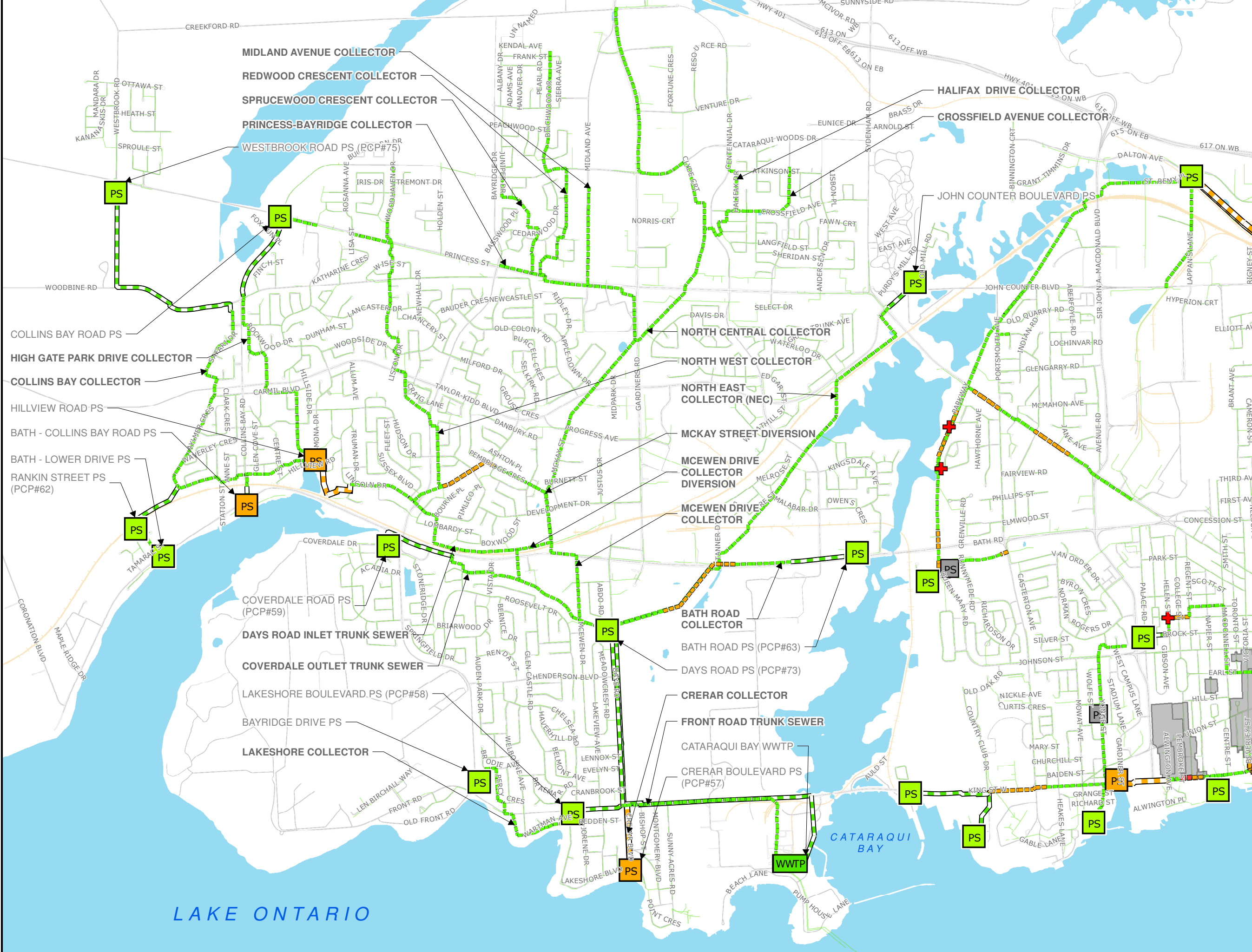


Project: **Water and Wastewater Master Plan Updates**  
City of Kingston, Ontario

Title: **LEVEL OF SERVICE - KINGSTON WEST 2015**

Project No.: 151-02944-00	Date: DECEMBER 2016
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Drawn By: CM	Checked By: MF	Code: GAP	Figure No.: 7-1
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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA

#### SANITARY PUMP STATION LEVEL OF SERVICE

- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- NOT MODELLED

#### GRAVITY SEWER LEVEL OF SERVICE

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

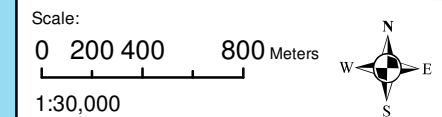
#### SANITARY FORCEMAIN LEVEL OF SERVICE

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

#### WASTEWATER TREATMENT PLANT LEVEL OF SERVICE

- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



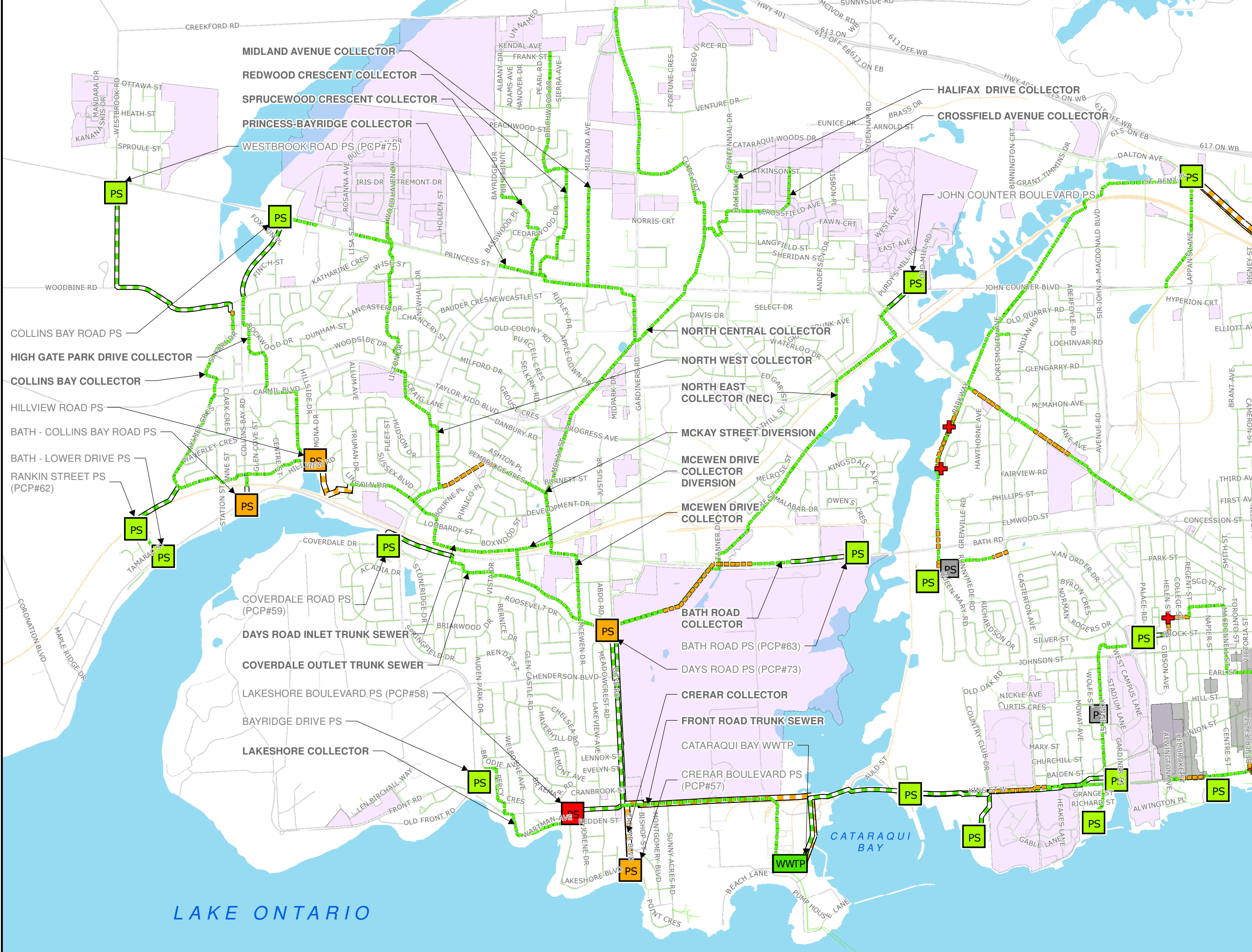
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**LEVEL OF SERVICE - KINGSTON CENTRAL AND EAST 2015**

Project No.: 151-02944-00		Date: DECEMBER 2016	
Drawn By: CM	Checked By: MF	Code: GAP	Figure No.: 7-2

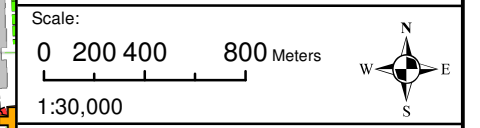




**Legend**

- COMBINED SEWER OVERFLOW
  - SANITARY SEWER OVERFLOW
  - TANK OVERFLOW
  - EXISTING SANITARY SEWER
  - COMBINED SEWER AREA
  - PROJECTED DEVELOPMENT
- SANITARY PUMP STATION**
- LEVEL OF SERVICE**
- PS DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
  - PS PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
  - PS PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
  - PS NOT MODELLED
- GRAVITY SEWER LEVEL OF SERVICE**
- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS
- SANITARY FORCEMAIN LEVEL OF SERVICE**
- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
  - VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
  - VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR
- WASTEWATER TREATMENT PLANT LEVEL OF SERVICE**
- WWTP 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
  - WWTP ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



Project: **Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title: **LEVEL OF SERVICE - KINGSTON WEST 2021**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 8-1





### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION

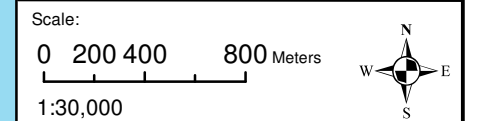
- LEVEL OF SERVICE**
- PS DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
  - PS PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
  - PS PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
  - PS NOT MODELLED

- GRAVITY SEWER LEVEL OF SERVICE**
- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

- SANITARY FORCEMAIN LEVEL OF SERVICE**
- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
  - VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
  - VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

- WASTEWATER TREATMENT PLANT LEVEL OF SERVICE**
- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
  - ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**LEVEL OF SERVICE - KINGSTON CENTRAL AND EAST 2021**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 8-2





### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION LEVEL OF SERVICE

- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- NOT MODELLED

### GRAVITY SEWER LEVEL OF SERVICE

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

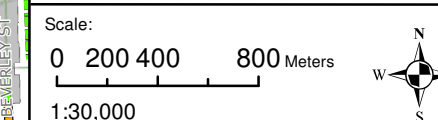
### SANITARY FORCEMAIN LEVEL OF SERVICE

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

### WASTEWATER TREATMENT PLANT LEVEL OF SERVICE

- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title: **LEVEL OF SERVICE - KINGSTON WEST 2026**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 9-1







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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION LEVEL OF SERVICE

- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- NOT MODELLED

### GRAVITY SEWER LEVEL OF SERVICE

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

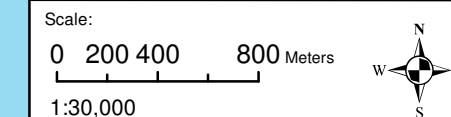
### SANITARY FORCEMAIN LEVEL OF SERVICE

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

### WASTEWATER TREATMENT PLANT LEVEL OF SERVICE

- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**LEVEL OF SERVICE - KINGSTON CENTRAL AND EAST 2026**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 9-2







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**Legend**

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

**SANITARY PUMP STATION**

**LEVEL OF SERVICE**

- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- NOT MODELLED

**GRAVITY SEWER LEVEL OF SERVICE**

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

**SANITARY FORCEMAIN LEVEL OF SERVICE**

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

**WASTEWATER TREATMENT PLANT LEVEL OF SERVICE**

- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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

Scale:  
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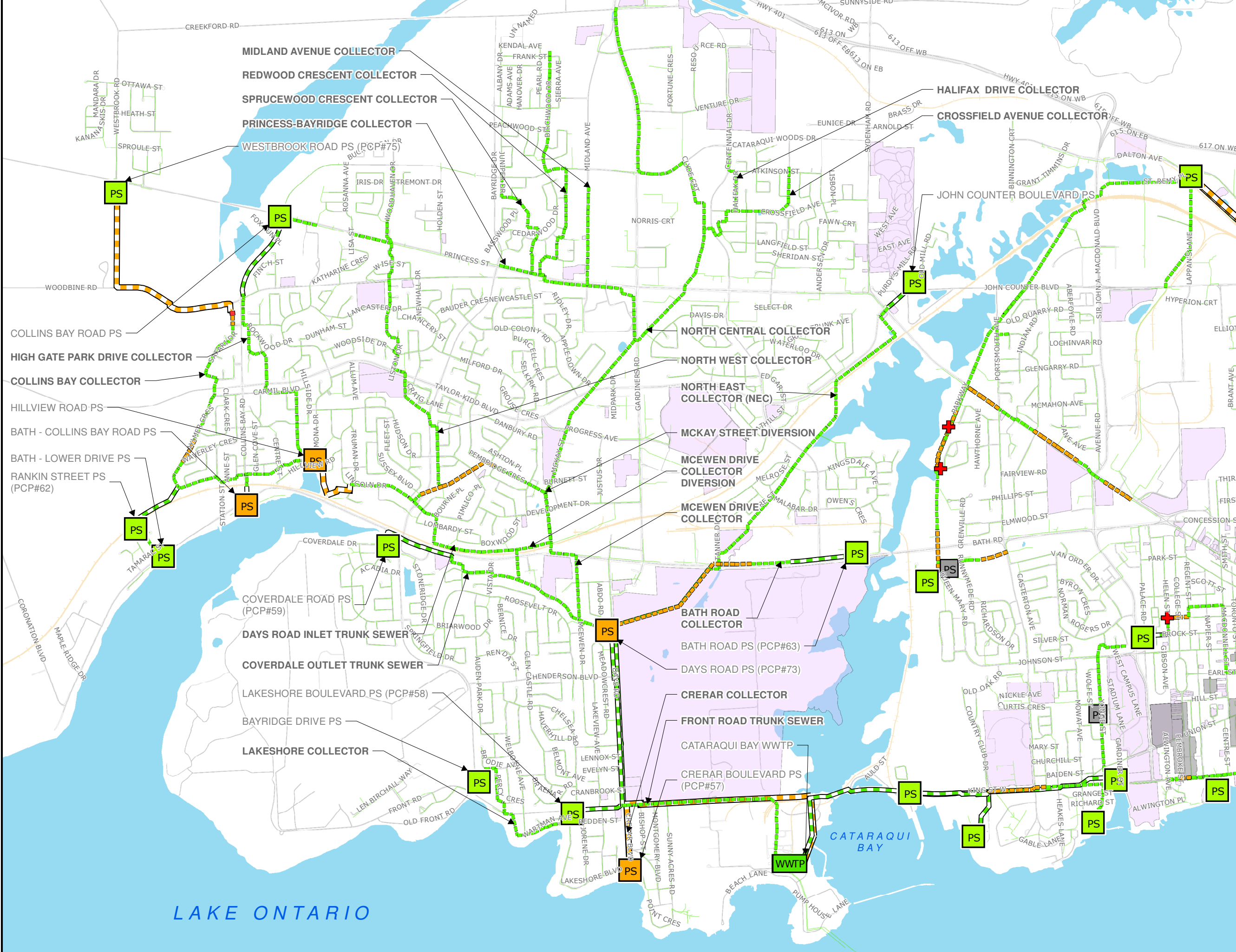
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**LEVEL OF SERVICE - KINGSTON WEST 2036**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 10-1







### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION LEVEL OF SERVICE

- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- NOT MODELLED

### GRAVITY SEWER LEVEL OF SERVICE

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

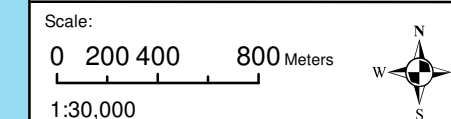
### SANITARY FORCEMAIN LEVEL OF SERVICE

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

### WASTEWATER TREATMENT PLANT LEVEL OF SERVICE

- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



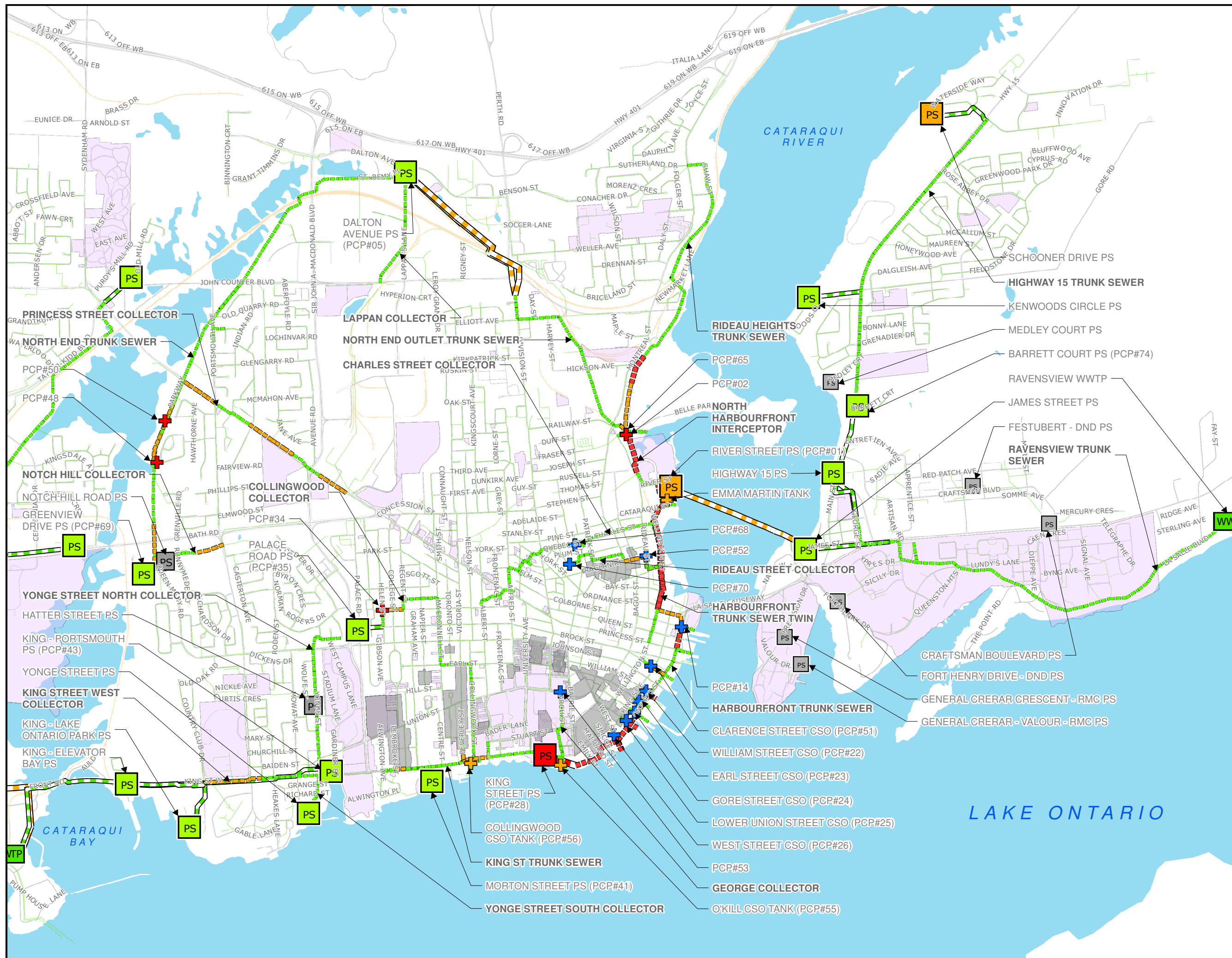
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**LEVEL OF SERVICE - KINGSTON CENTRAL AND EAST 2036**

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

Drawn By: CM Checked By: MF Code: GAP Figure No.: 10-2

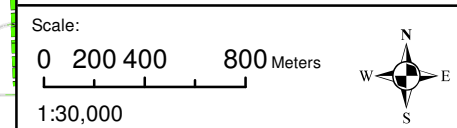




### Legend

- COMBINED SEWER OVERFLOW
  - SANITARY SEWER OVERFLOW
  - TANK OVERFLOW
  - EXISTING SANITARY SEWER
  - PROJECTED DEVELOPMENT
- SANITARY PUMP STATION**
- LEVEL OF SERVICE**
- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
  - NOT MODELLED
- GRAVITY SEWER LEVEL OF SERVICE**
- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS
- SANITARY FORCEMAIN LEVEL OF SERVICE**
- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
  - VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
  - VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR
- WASTEWATER TREATMENT PLANT LEVEL OF SERVICE**
- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
  - ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



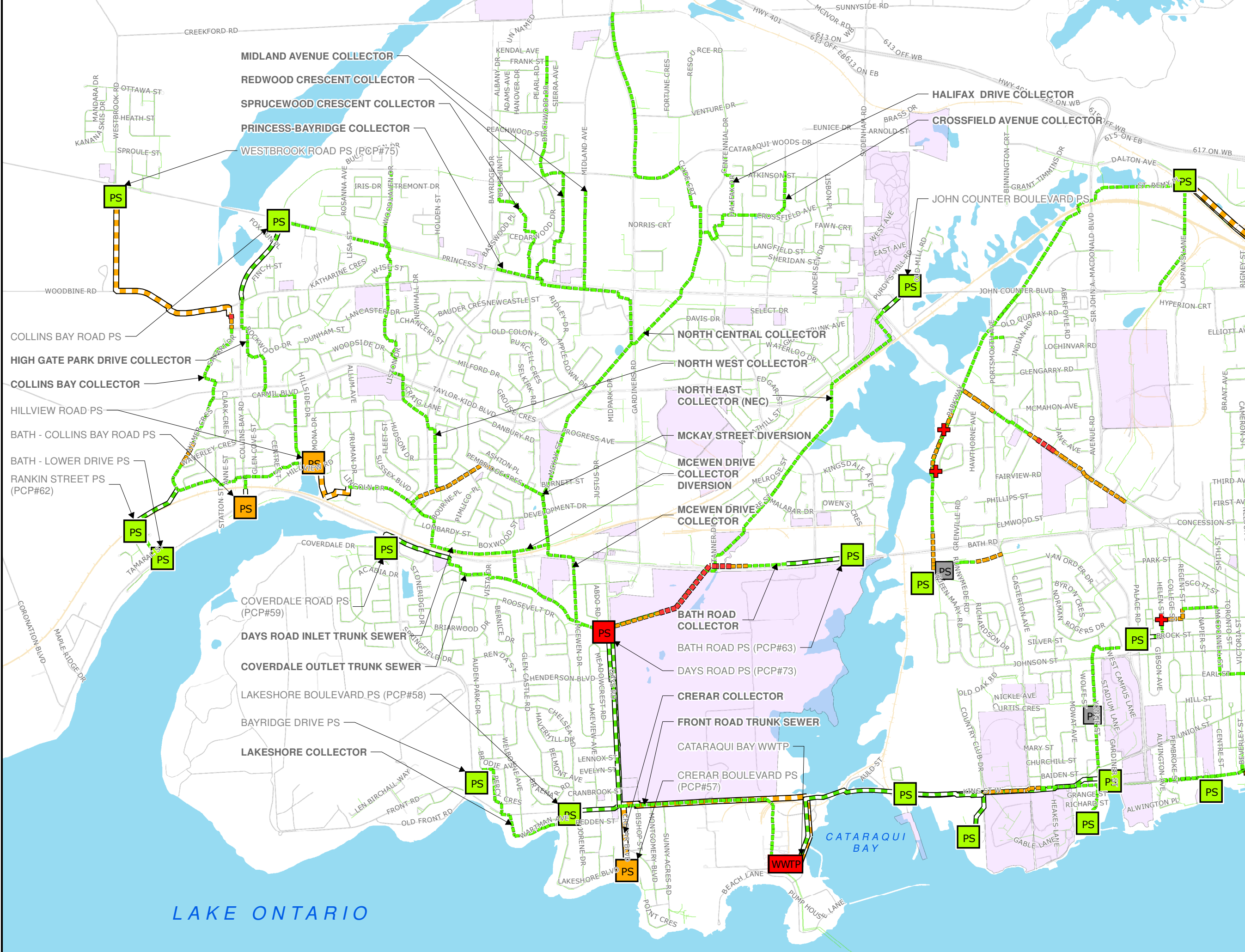
Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**LEVEL OF SERVICE - KINGSTON WEST FULL BUILDOUT**

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

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	GAP	11-1







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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- PROJECTED DEVELOPMENT

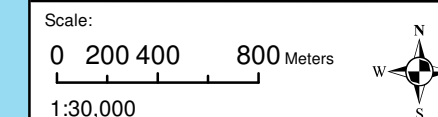
### SANITARY PUMP STATION

- #### LEVEL OF SERVICE
- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
  - NOT MODELLED

- #### GRAVITY SEWER LEVEL OF SERVICE
- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

- #### SANITARY FORCEMAIN LEVEL OF SERVICE
- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
  - VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
  - VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR
- #### WASTEWATER TREATMENT PLANT LEVEL OF SERVICE
- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
  - ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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



Project:  
**Water and Wastewater Master Plan Updates**

City of Kingston, Ontario

Title:  
**LEVEL OF SERVICE - KINGSTON CENTRAL AND EAST FULL BUILDOUT**

Project No.:	151-02944-00	Date:	DECEMBER 2016
Drawn By:	CM	Checked By:	MF
Code:	GAP	Figure No.:	11-2







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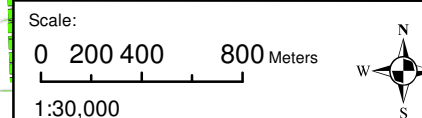


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**Legend**

- COMBINED SEWER OVERFLOW
  - SANITARY SEWER OVERFLOW
  - TANK OVERFLOW
  - EXISTING SANITARY SEWER
  - PROJECTED DEVELOPMENT
- SANITARY PUMP STATION**
- LEVEL OF SERVICE**
- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
  - PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
  - NOT MODELLED
- GRAVITY SEWER LEVEL OF SERVICE**
- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
  - SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS
  - YEAR STORM. NO SEVERE CONDITIONS
- SANITARY FORCEMAIN LEVEL OF SERVICE**
- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
  - VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
  - VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR
- WASTEWATER TREATMENT PLANT LEVEL OF SERVICE**
- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
  - ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

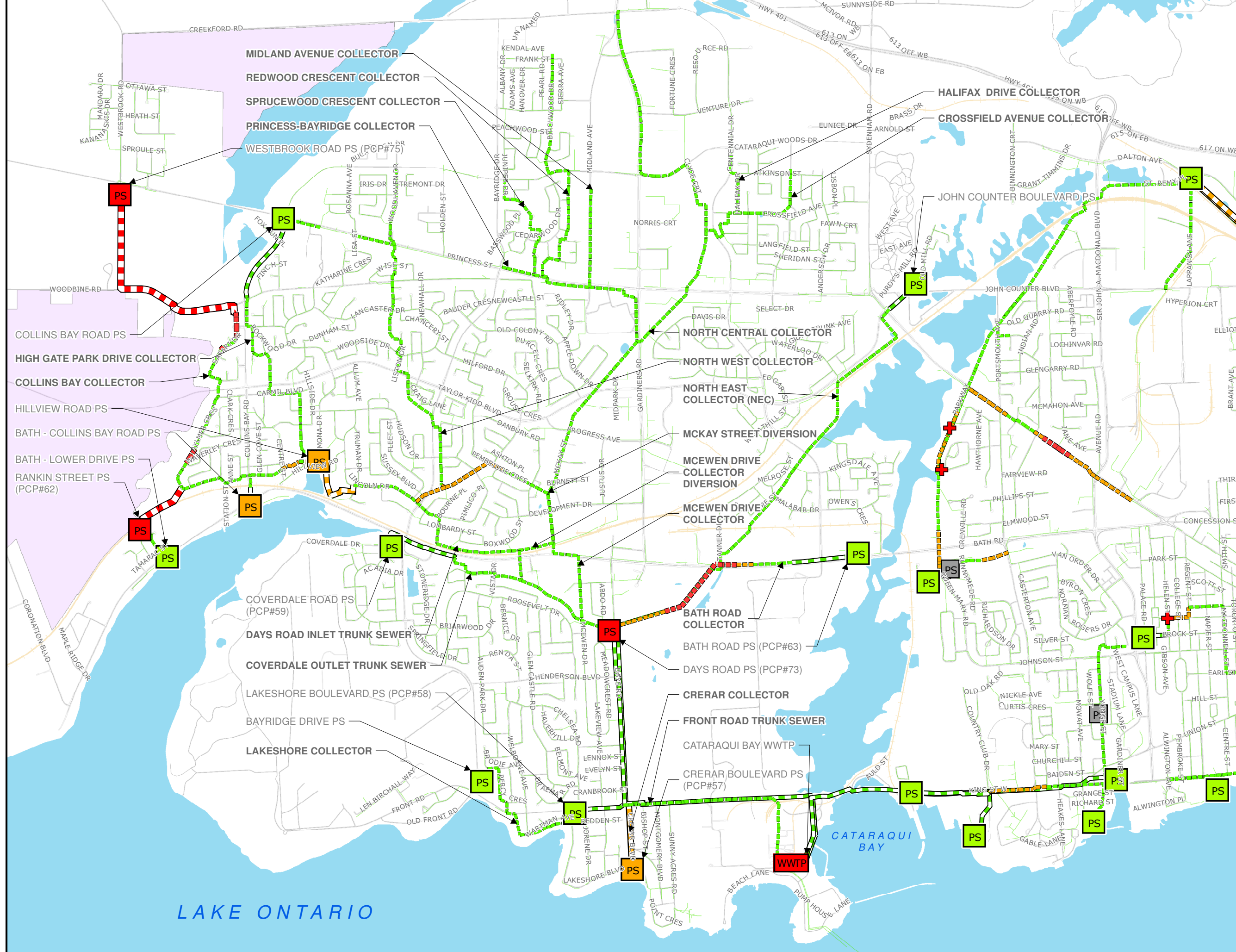
Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.



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

Title:  
**LEVEL OF SERVICE - KINGSTON WEST FULL ULTIMATE**

Project No.:	151-02944-00	Date:	DECEMBER 2016
Drawn By:	CM	Checked By:	MF
Code:	GAP	Figure No.:	12-1









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### Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- PROJECTED DEVELOPMENT

### SANITARY PUMP STATION

#### LEVEL OF SERVICE

- DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- NOT MODELLED

### GRAVITY SEWER LEVEL OF SERVICE

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

### SANITARY FORCEMAIN LEVEL OF SERVICE

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

### WASTEWATER TREATMENT PLANT

#### LEVEL OF SERVICE

- 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

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

1:30,000

Project:

Water and Wastewater  
Master Plan Updates

City of Kingston, Ontario

Title:

LEVEL OF SERVICE -  
KINGSTON CENTRAL  
AND EAST ULTIMATE

Project No.:  
151-02944-00

Date:  
DECEMBER 2016

Drawn By:  
CM

Checked By:  
MF

Code:  
GAP

Figure No.:  
12-2



