yongeTOmorrow Environmental Study Report
March 2021

Appendix M – yongeTOmorrow Existing and Future Conditions Assessment on Watermains, Sanitary, Storm and Combined Sewers

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Existing and Future Conditions Assessment Technical Memorandum

Watermains, Sanitary, Storm and Combined Sewers

Yonge Street Class EA Study
(Queen Street to College/Carlton Street)
City of Toronto

Prepared for Steer Davies Gleave
by IBI Group

IBI Project Number 131657 | 2017-0591

March 2021

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March 26, 2021
Reference 131657 | 2017-0591

Steer Davies Gleave
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Attention: Peter Piet, Project Manager

RE: Existing and Future Conditions Assessment Technical Memorandum for Watermains, Sanitary, Storm and Combined Sewers
Yonge Street Class EA Study – Queen Street to College / Carlton Street
City of Toronto

IBI Group is pleased to submit the technical memorandum for the wet utilities future conditions assessment for the above captioned project. The adequacy of the existing watermains, sanitary, combined, and storm sewers was analyzed with respect to their ability to support future development within the study area. Analysis was conducted using future population projections, assumptions, land cover conditions, as well as existing and planned wet utility infrastructure data supplied by the City of Toronto (the City). This technical memo highlights the modelling and assessment parameters used for analysis, along with the results of analysis, for potential future conditions. Existing conditions were analysed in the previous submission.

Yours sincerely,

IBI GROUP

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WRH/ad

Encls. Report

Document Control Page

CLIENT:	Steer Davies Gleave
PROJECT NAME:	Yonge Street Class EA Study – Queen Street to College / Carlton Street, City of Toronto
REPORT TITLE:	Watermains, Sanitary, Storm and Combined Sewers
IBI REFERENCE:	131657 | 2017-0591
VERSION:	Issued for 2nd Submission
DIGITAL MASTER:	P:\oak\2017\2017-0591\400_Tchncl\70_Rprts\03_Final ExistingFutureConditionTM\working\2017-0591_Yonge St EA Future conditions TM 20210326_FINAL.docx
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CIRCULATION LIST:	-
HISTORY:	Draft Technical Memorandum – May 27, 2020 For Submission
	Technical Memorandum – March 26, 2021 For Submission

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1 Introduction

IBI Group (IBI) was retained by Steer Davies Gleave (SDG - the Client) to provide technical support for the water distribution, wastewater collection and stormwater management components for the Yonge Street (Queen Street to Carlton / College Street) Environmental Assessment (EA) study.

As part of the study, existing and future conditions assessments have been completed for the watermains, sanitary, combined, and storm sewers within the area contributing to the Yonge Street Phase 1 Study Focus Area (College / Carlton Street to Queen Street corridor), as shown below in **Figure 1-1**. This technical memo outlines the work completed as part of the existing and future conditions assessments.

The scope of work of this EA study is to perform an Infrastructure Planning and Design Study to develop, evaluate and recommend design options for streetscape and public realm improvement for the Yonge Street public-right-of-way between Queen Street and College / Carlton Street within Phase 1 Focus Area.

The design options are intended to increase pedestrian space through a variety of means, including sidewalk widenings, a potential narrowing of the traffic lane widths, reduction in the number of traffic lanes and diversion of loading activities to adjacent public laneways and side streets, where possible. The accommodation of cycling facilities along this section of Yonge Street will be a key consideration of this study.

As shown in **Figure 1-1**, a Phase 2 EA for Yonge Street between College / Carlton Street to Davenport Road within Phase 2 Extended Focus Area will be undertaken. The Phase 2 EA will begin after the completion of Phase 1 EA and it is under a separate assignment by others.

In order to maximize the overall schedule for both the Phase 1 EA (Queen to College / Carlton Street) and Phase 2 EA (College / Carlton to Davenport), the data collection and analysis for completing Phase 2 EA will be performed as part of the Phase 1 EA. The results of the Phase 1 EA will be used for the Phase 2 EA (section of Yonge Street between College / Carlton and Davenport). **Figure 1-1** shows the suggested Study Area of data collection and analysis for water, sanitary, storm / combined system capacity assessment.

1.1 Scope of Assessment

The existing water system capacity analysis for the study area was completed. Fire hydrant flow testing within the study area was performed to collect data for model calibration. The City's GIS shapefile data for water system was reviewed and used to develop the water hydraulic network model using InfoWater modelling software. Subsequently, an updated water system model was provided by the City. **Appendix F-B** shows the schematic model layout for the future condition. The model water demand for the future condition assessments was updated using the projected population, as provided by the City– see **Appendix F-E**.

The condition assessment for the sanitary, combined, and storm sewer systems was completed congruently in a single integrated *InfoWorks ICM* sewer model. The City's shapefile data for landcover, property boundaries, sewers, manholes, catchbasins and laterals, building outlines, topographic data and other relevant data was obtained from the City to develop the existing conditions servicing model, which is provided digitally in **Appendix F-G**. Special structures such as weirs or overflows are included in the model. Flow generation is based on theoretical design standard calculation as no flow monitoring data was available to calibrate or confirm the modelling results for this study area.

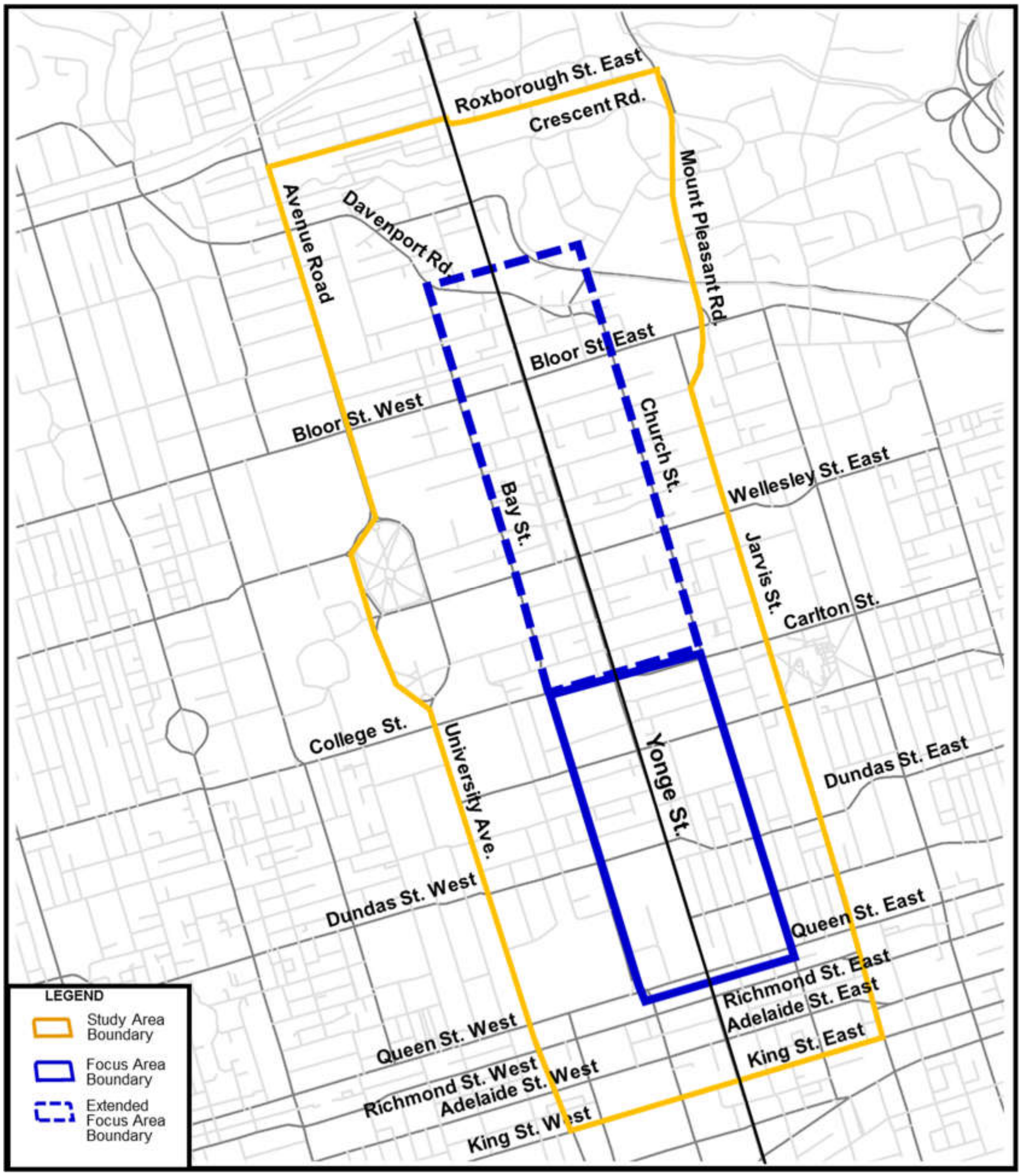

Figure 1-1 Yonge Street EA Study Area

1.2 Projected Future Population

The population and employment projections to 2041 for the study area were provided by the City. The projections were created at a traffic zone (TZ) level geography. The selected zones which best fit your study area include Zones 36 to 55 and 205. A key map to the zones and population is shown in **Appendix F-E**.

For a conservative design, the maximum Scenario for the residential (R2) and employment (E3) was selected for the future conditions assessment in this study – see **Table 1.1** and **Appendix F-E**.

1.2.1 Population Projections

Two growth plan scenarios are suggested: Scenario R1, the Growth Plan 2012 Scenario includes just sufficient potential housing to accommodate the forecasted growth per the Growth Plan as amended; and Scenario R2, the Maximum Scenario includes all residential potential under the unlikely situation that all of it were realized by 2041. In these projections, the population in collective dwellings is projected in each time period. The projected residential population for years 2031 and 2041 is shown in **Table 1.1**. The overview of the projected residential and employment population for year 2041 is shown in **Appendix F-E**.

1.2.2 Employment Projections

These employment projections are built with a completely different model and methodology than the population projections and uses a different regional forecast as control total. Three scenarios are provided: The nearest equivalent employment projection to the Base Population projection scenario is Scenario E1, Low No SmartTrack". The nearest equivalent employment projection to the Maximum Scenario for population that is Scenario E3, High with SmartTrack.

In the recent Transit Planning (March Executive Committee) report it was noted that 'City staff consider the Medium employment scenarios to be the most likely. The Low scenarios represent growth aligned with the Provincial Growth Plan forecasts for Toronto; while the High scenario represents an upper limit for growth in Toronto. The projected employment population for years 2031 and 2041 are shown in **Table 1.1**.

Table 1.1 Projected Future Population

Design	Residential		Employment		
	Growth Plan 2012 Scenario	Growth Plan Maximum Scenario	Low No SmartTrack	Medium with SmartTrack	High with SmartTrack
Scenario	R1	R2	E1	E2	E3
2031	114,336	128,800	233,785	249,775	252,615
2041	136,254	160,705	235,250	257,330	265,545

2 Water Distribution

The water systems for the Phase 1 Study Focus Area and Phase 2 Study Extended Focus Area are as follows:

- The Phase 1 Study Focus Area is located within the City’s Pressure District (PD) 1, which is supplied mainly from the John Street PD1 Pumping Station (PS). The existing Rosehill reservoir provides water storage and maintains system pressure for the PD1 water system in the vicinity of the Phase 1 Study Focus Area. The Rosehill reservoir is located at Rosehill Avenue and east of Yonge Street, a short distance north of the Study Area. The Rosehill reservoir water levels range between 133.5m (Low Water Level, LWL) and 141.1m (Top Water Level, TWL); and,
- The Phase 2 Study Extended Focus Area is located within the City’s Pressure District (PD) 2, which is supplied mainly from the High Level PD2 Pumping Station (PS). The existing St. Clair reservoir provides water storage and maintains system pressure for the PD2 water system in the vicinity of the Phase 2 Study Extended Focus Area. The St. Clair reservoir is located at St. Clair Avenue West and Spadina Road, a short distance northwest of the Study Area. The St. Clair reservoir water levels range between 151m (Low Water Level, LWL) and 158m (Top Water Level, TWL).

2.1 Data Collection

The GIS shapefiles data and the InfoWater model (provided by the City) for the water system in the vicinity of the study area was reviewed. Based on the review of the water system information, there are existing looping watermains within the study area. The existing distribution watermains in the Study Area consist of 150mm to 1200mm diameter.

In order to assess the available system pressures along Yonge Street, field testing was performed in the study area in late 2017. The monitoring data and fire hydrant test results are shown in **Appendices F-A**.

2.2 Modelling Methodology

A water distribution network InfoWater model was provided by the city. The St. Clair (for PD2) and Rosehill (for PD1) reservoirs were used as water supply source / boundary. A dummy reservoir represents water supply from John Street PD1 pumping station was used in model analysis. The future water demand was adjusted based the population as provided by the City.

2.3 Assessment Criteria

The adequacy of the existing hydraulic capacity for the watermain system was evaluated under the normal operating (e.g. peak hour) and fire flow conditions.

The City's 2009 Design Criteria for Sewers and Watermains provides the following system pressure and fire flow requirement for the assessment of the system capacity:

- System Pressure
  - Minimum pressure during peak hourly demand: 275kPa (40psi);
  - Minimum pressure during maximum day plus fire flow: 140kPa (20psi).
- Fire Flow: The Toronto 2009 Guideline was reviewed and established the required fire flow for the study area. Based on discussions with City staff, it is our understanding that the Fire Underwriters Survey (FUS, 1999) was accepted and selected for the fire flow calculation as a suitable alternative to the Toronto 2009 Guideline.
- Residential/employment water Demand: Average daily demand of 191L/cap/day.
- Peaking factors for various scenarios used in the subject site demand calculations were derived from the City's Design Standards, as summarized in **Table 2.1** below.

Table 2.1 Water Demand Peaking Factors

Demand Scenario	Population	Peaking Factor
Minimum Hour	Residential/Employment	0.84
Maximum Day	Residential	1.3
	Employment	1.1
Peak Hour	Residential	2.5
	Employment	1.2

2.4 Analysis and Results

The following sections provide the results and analysis for the hydrant flow tests and existing system capacity assessment.

2.4.1 Field Monitoring

Based on the above field monitoring and fire flow test results in later 2017 as shown in **Appendix F-A**., the system pressures range from 320kPa (45psi) to 600kPa (85psi) and they meet the City's recommended pressure ranges between 275kPa (40psi) and 700kPa (100psi) under the normal system operation.

2.4.2 Existing System Capacity Assessment

The following assumptions were made for hydraulic model analysis:

- **PD1 System:** it is assumed that water demand is supplied from St John PD1 Pumping Station and Rosehill PD1 reservoir. The system boundary head in the model was assumed to be 139m (approximately 75% of the full water level at Rosehill PD1 reservoir) during the high water demand period (e.g. maximum day plus fire and peak hour). The 75% full level is the approximate average under typical reservoir operations which ranges between 60% to 90% full levels; and

- **PD2 System:** it is assumed that High Level PD2 Pumping Station is off-line and water demand is only supplied from the St. Clair PD2 reservoir. The system boundary head in the model was assumed to be 156m (approximately 75% of full water level at the St. Clair PD2 reservoir) during the high water demand period (e.g. maximum day plus fire and peak hour).

Water modeling analysis was performed to assess the available system capacity along the existing watermain system near the study area. The model results under the existing system condition are summarized as follows:

- **System Pressure**: Except for a few local ground areas (outside study area) along the feedermains near Rosehill PD1 reservoir and St. Clair PD2 reservoir, the estimated minimum system pressure is approximately 290kPa (43psi) on both PD1 and PD2 systems under the normal operating condition (e.g. peak hour). The minimum pressure occurs at the local high ground area near Yonge Street and north of College Street (See **Appendix F-A** for details). The system pressure within the study area is higher than the City's pressure requirement of 275kPa (or 40psi); and,
- **Fire Flow Availability**: Except for a few local ground areas (outside study area) along the feedermains near Rosehill PD1 reservoir and St. Clair PD2 reservoir, the minimum available fire flow at pressure of 140kPa (22psi) is approximately 250L/s within the study area (e.g. at a critical location on Yonge Street and north of College Street – south boundary PD2 and further away from the St. Clair PD2 reservoir under the maximum day demand plus fire flow conditions, see **Appendix F-A** for details). The available system flow meets a typical fire flow requirement for a high-rise building and/or a commercial building.

2.4.3 Future System Capacity Assessment

The projected water demand and system pressure are discussed in the following sections

Future Water Demand

Based on the City's criteria for the proposed development areas, the estimated water demands for the subject site under the future 2041 high population condition. Refer to detailed calculation located in **Appendix F-B**. The estimated water demands for the traffic zone area near the subject site are approximately 942L/s, 1,108 and 1,597L/s for average day, maximum day, and peak hour conditions, respectively.

The City requires a fire flow of 317L/s for commercial over two (2) storeys and high-rise residential, and 378L/s for shopping centres. Based on the discussions with City staff, it is our understanding that the Fire Underwriters Survey (FUS, 1999) was accepted and selected for the fire flow calculation for details) as a suitable alternative to the City of Toronto 2009 Guideline.

Future System Pressure

The InfoWater hydraulic model was used to estimate the system pressures in the vicinity of the subject site under the proposed system condition. **Appendix F-B** shows the schematic watermain layouts in the hydraulic model.

As shown in the InfoWater model as provided by the City, a C-factor of 30 (representing aging of the watermain) was input to each of the (east and west) 300mm watermain along Yonge Street within the study area. The available fire flow is less than 200L/s at the critical location (along Yonge Street and north College Street) in the PD2 system under the future condition.

It is our understanding that both east-side and west-side mains with two (2) 300 mm mains along Yonge street within the study area will be replaced with two new watermains in the near future. The model simulation was re-assessed, and it was assumed that two existing watermains would be replaced by two new watermains along Yonge Street. The future system pressures are shown in **Appendix F-B** and summarized as follows:

System Pressure under Normal Operation

The system pressures for the areas within the subject site are between 275 and 700kPa (40 and 100 psi) under the Maximum Day and Peak Hour for the future condition. The anticipated system pressures within the subject site meet the City-suggested normal system operational pressures.

Minimum System Pressure under Fire Flow

The available fire flow was evaluated against the minimum pressure of 140kPa (20psi) at the existing and proposed hydrants in the vicinity of the site under the maximum day demand condition. **Appendix F-B** shows the critical fire flow locations along Yonge Street within study area.

Relatively large fire flow supply capacity and available system pressure (not less than 140kPa) can be maintained within the subject site under the fire flow condition.

The required fire flow of 250L/s (140kPa) for the future system was simulated and the minimum system pressure under maximum day plus fire flow conditions. The hydraulic model outputs under the maximum day plus fire flow condition are shown in **Appendix F-B**.

3 Sanitary, Storm, and Combined Sewer

The Yonge Street corridor within the Phase 1 Focus Area is serviced by a fully combined system with sewers ranging in diameter from 300mm to 1200mm. The sewers are generally circular shaped, made with a variety of pipe materials including: Brick, Reinforced Concrete, and Vitrified Clay. Along the Yonge Corridor within the Focus Area, the sewers were mostly constructed between 1945 and 1955, while the sewers in the contributing area range from 1876 to 2007. The contributing area is serviced by a combination of sanitary, storm and combined sewers. The combined sewers along Yonge St. are all local systems, with no major trunk systems running along it. The Yonge corridor is crossed by the 3050mm diameter Mid-Toronto Interceptor at Gerrard Street. The average depth of the combined sewers along Yonge is just over 4m, while the Interceptor is located approximately 25m underground.

The assessment of the capacity of the combined sewers within the focus area was performed using the InfoWorks ICM modelling software for both existing and potential future conditions. Analysis was focused on the capacity of the system within the focus area and any relevant downstream areas, however the upstream combined, sanitary, and storm systems contributing to the sewers on Yonge St. were all included in the model to account for any upstream flows being generated. The following sections outline the source of information, modelling methodology, assessment criteria, and model results.

3.1 Data Collection

The InfoWorks ICM model used for this analysis was created based on the model developed to analyse existing conditions in the study area, which in turn was developed based on the “Interceptor 2016 – Full Model” (the Interceptor Model) provided to IBI by the City. The physical network and subcatchments defined in this model were found to adequately represent the sewerage system within the study area. Stormwater flow generation was not represented in the Interceptor Model. Therefore, storm subcatchments and storm parameters were added to the model by IBI as part of the development of the existing conditions model (Yonge EA Cut Model 2016) and carried over into the 2041 Future Conditions Model (2041 Model). Please refer to the Existing Conditions Technical Memo in **Appendix F-A** for a full description of the data collection process for the existing conditions model.

Projections for both residential and employment populations for various future development scenarios were provided by the City in tabular format, distributed by traffic zone. A map of traffic zones around and containing the study area was provided, along with GIS shapefiles containing these traffic zone boundaries. Residential populations provided were taken from *Municipal Comprehensive Review Population Projections by Traffic Zone (2006 Geography)*, employment populations were taken from *SmartTrack Employment Projections by Traffic Zone (2006*

Geography). Both of these documents were prepared by prepared by the City of Toronto City Planning, Strategic Initiatives, Policy & Analysis, Research and Information department. See **Appendix F-E** for population projections.

Additionally, IBI was provided with a list of improvements and projects planned by Toronto Water. This list was reviewed to determine if any changes would need to be made to the model to reflect planned future conditions. This review determined that no changes to the modelled sewers would be necessary for this analysis.

3.2 Modelling Methodology

The methodology followed to create the 2041 Future Conditions Model using InfoWorks ICM v9.5 is summarized in **Table 3.1**. This model was developed based on the Yonge EA Cut model, which includes only areas and infrastructure contributing to the sewer network within the Yonge Street Corridor. Refer to **Appendix F-A** for information on the development of the Yonge EA Cut Model. It should be noted that only the most extreme population scenarios were considered in this analysis, on the basis that if the extreme scenarios were found to be feasible, all other scenarios would also be feasible. No calibration was performed during this process, as all future flows are theoretical. However, separate flow generation scenarios were defined, as described in **Table 3.1**.

Table 3.1 Summary of Methodology

Step	Description
1.0 Subcatchment Separation	All subcatchments containing population (i.e. non-road catchments) were duplicated in order to separately represent residential and employment populations. Each set of catchments was given the prefix “Res_” or “Emp_”, respectively.
2.0 Population Assignment	Projected populations were assigned to subcatchments based on the projected population density (in persons/ha) of the traffic zone containing the subcatchment.
3.0 Storm Subcatchments	No adjustment was made to the storm subcatchments developed for the existing conditions analysis.
4.0 Wastewater Flow	Wastewater flows were calculated based on the assigned residential and employment populations and per-capita generation rates. Two (2) flow scenarios were defined for this analysis: Flow Scenario 1: 240l/cap/day for residential populations, 250l/cap/day for employment populations. Flow Scenario 2: 450l/cap/day for all population.
5.0 Inflow & Infiltration	A constant I-I rate of 0.26L/s/ha was applied to all sanitary subcatchments in the model to represent design conditions.
6.0 Storm Flow	Storm subcatchments are made up of three (3) basic land surface types. The model parameters for each surface type are similar to the Toronto Basement Flooding EA Study guidelines. Storm flow is generated through the model by applying a given rainfall event.
7.0 Outlets / Boundary Conditions	Outlets from the Yonge EA Cut Model were either to combined sewer overflows, or to large Trunk Sewers. Each outlet was modelled as a “free outfall”. This methodology was retained for the 2041 Model.

Each step of the model build is explained in further detail in the following sections.

3.2.1 Populations Assignment

Population counts were assigned based on a population density calculated for each type of population (residential and employment) for each traffic zone. The traffic zone population density was calculated by using the total area of the traffic zone. The population to be included in the model was calculated based on the model’s total area coverage of each traffic zone (e.g. if model subcatchments cover 50% of a traffic zone, 50% of the traffic zone population would be distributed among those catchments). Populations were then further distributed based on “occupiable area” (i.e. non-road catchments), therefore no population was assigned to catchments representing roads. Maps of traffic zone populations and modelled population assignments can be found in **Appendix F-E**. Populations assigned were from the City’s “General Plan Maximum” scenario for residential, and “High with SmartTrack” scenario for Employment. These population counts are also tabulated in **Appendix F-E**.

3.2.2 Wastewater Flow Generation

Two (2) wastewater profiles were developed to represent residential and employment flows, respectively. The residential profile includes the typical residential wastewater pattern that was included with the 2016 Interceptor Model. This pattern is shown in **Figure 3-1**. No pattern was applied to employment wastewater flows (i.e. peaking factor = 1.0 for all timesteps). All Trade Flow values in the subcatchments were zeroed, as Trade Flow (i.e. employment wastewater flow) was represented using population, rather than hard-coded flows.

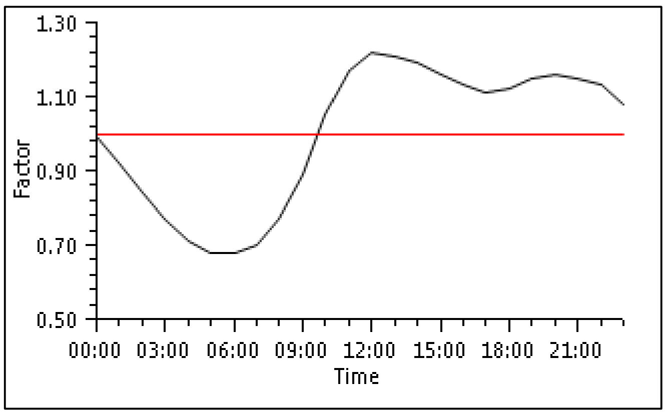

Figure 3-1 Residential Wastewater Generation Profile

Furthermore, two (2) flow scenarios were developed, as referenced in **Table 3.1**.

- **Flow Scenario 1** uses the City’s standard existing-system flow rates of 240l/cap/day for residential, and 250l/cap/day for employment; and,
- **Flow Scenario 2** uses the City’s design flow rate of 450l/cap/day for all population.

In both scenarios, the residential wastewater generation profile shown in **Figure 3-1** is applied to residential flows, and no peaking was applied to employment flows.

3.2.3 Inflow & Infiltration

The sanitary subcatchments within the Interceptor Model originally had a baseflow value equivalent to 0.05L/s/ha. This represents a typical groundwater infiltration value. This value was replaced with a constant flow rate of 0.26L/s/ha to represent design conditions. The baseflow does not get peaked, and is present during all analysis scenarios, regardless of rainfall.

3.2.4 Storm Flow

Model storm flow was generated using catchments of flow type “Storm” that were created as part of the existing conditions model development process. Storm catchments were assigned to the appropriate system (e.g. either storm or combined) based on the presence of servicing infrastructure, as well as the age of buildings compared to the age of sewer infrastructure. Road subcatchments on streets serviced by storm sewers were all connected to the storm system. Refer to **Appendix F-A** for complete details on storm catchment delineation.

During the previous analysis, Toronto's land cover raster was used to generate the pervious and impervious area percentages for each storm subcatchment. The raster included eight (8) different land cover / surface types. Each of these types were consolidated into one (1) of the following three (3) possible surface types and summed up within each subcatchment, presented in **Table 3.2**. Road subcatchments were assumed to be 100% Surface Type 1.

Table 3.2 Runoff Surface Types

#	Description	Raster Surface Types Included
1	Impervious Paved Surface	4 - Water 6 – Roads 7 – Other Paved Surfaces
2	Impervious Rooftop Surface	5 – Buildings
3	Pervious Surface	1 – Trees 2 – Grass / Shrubs 3 – Bare Earth 8 - Agriculture

The InfoWorks model parameters for the impervious and pervious surface types are presented in **Table 3.3** and

Table 3.4, respectively. Model parameters follow similar values to those suggested in the City's Basement Flooding Model Studies Guideline.

Table 3.3 Impervious Runoff Surface Model Parameters

Surface #	Surface Type	Runoff Routing Value	Runoff Volume Type	Ground Slope (m/m)	Initial Loss Value (m)	Fixed Runoff Coefficient
1	Pavement	0.013	Fixed	0.01	0.002	0.9
2	Flat Rooftop	0.015	Fixed	0.001	0.0	0.95

Table 3.4 Pervious Runoff Surface Model Parameters

Surface #	Surface Type	Runoff Routing Value	Runoff Volume Type	Ground Slope (m/m)	Horton Initial (mm/hr)	Horton Limiting (mm/hr)	Horton Decay (1/hour)	Horton Recovery (1/hour)
3	Pervious	0.410	Horton	0.01	100.00	10.0	2.0	2.0

3.3 Assessment Criteria

3.3.1 Capacity Level of Service

The combined system in the area was modelled under the following conditions to assess system performance with respect to capacity and surcharge protection:

1. **Dry Weather (Design Flow)**: The model was run using an I-I rate of 0.26L/s/ha, with no rainfall event applied. Both flow scenarios (as defined in **Table 3.1**) were considered; and,
2. **Wet Weather (Design + 2-year Flow)**: The model was run using an I-I rate of 0.26L/s/ha, and a 2-year 6-hour Chicago rainfall event for storm subcatchments. Both flow scenarios (as defined in **Table 3.1**) were considered.

It should be noted that the analysis was not completed using a dual drainage model and is limited in its functionality to assess rainfall events larger than a 2-year storm. Therefore the 100-year storm event (typically used for basement flooding studies) was not assessed.

Analysis of the level of service for a given system is based on the hydraulic grade line (HGL) and how it compares to the expected elevation of the bottom of connected basements (1.8m below grade). The difference between the ground elevation and the HGL in the sewer is known as the "freeboard". When assessing the model results, the freeboard at each node (manhole) is grouped into one (1) of three (3) possible levels:

1. **Sufficient Freeboard**: The HGL is either within the pipe (not surcharged), or more than 1.8m below the surface;
2. **Critical Surcharging**: The HGL is within 1.8m of the surface, but still below the surface; or,
3. **Surface Flooding**: The HGL is above the surface, therefore flooding to the street.

The assessment of each pipe is categorized into three (3) possible conditions:

1. **Freeflow**: The HGL is below the crown of the pipe. This identifies sewers with sufficient capacity;
2. **Surcharge (due to Backwater conditions)**: The pipe is surcharged and the slope of the HGL is flatter than the slope of the pipe, meaning the surcharging is due to an overloaded downstream pipe, or "backwater" conditions; and,
3. **Surcharge (over capacity)**: This condition is observed when the pipe is surcharged due to a lack of available capacity. The pipe does not have sufficient capacity to convey the flow. This highlights the bottlenecks of the system.

3.3.2 Combined Sewer Overflows and Ministry of the Environment Procedure F-5-5

The combined sewers within the study area were assessed under the following conditions to evaluate the risk of combined sewer overflows (CSO) and assess the level of compliance with the Ontario Ministry of the Environment (MOE) Procedure F-5-5:

1. **Dry Weather (Design Flow):** The model was run using a design I-I rate of 0.26l/s/ha with no rainfall event applied; and,
2. **Dry Weather (Best-Case):** The model was run without I-I baseflows to represent the best-case scenario for compliance with Procedure F-5-5.

Procedure F-5-5 prohibits CSO activity during dry weather, therefore the criterion for this portion of the assessment is that no CSO activity should occur during dry-weather conditions.

With regards to wet-weather conditions, it was noted in the existing conditions analysis that CSO activity did occur in the study area. Wet-weather CSO activity is permitted under Procedure F-5-5, subject to treatment and mitigation conditions. However, CSO volumes must not be allowed to increase above existing conditions. Determining the magnitude of any increases in wet-weather CSO volumes would require a typical-year continuous simulation using a calibrated model, and as such is beyond the scope of this analysis. It should also be noted that the model used for this analysis is not calibrated, so actual flows may differ from modelled flows.

3.4 Results and Analysis

3.4.1 Dry Weather Flow

The DWF model scenario was run to assess the flow in the system under design dry weather conditions. No Rainfall event is applied, and the flow within the system is made up of only wastewater flow and a design infiltration rate of 0.26L/s/ha.

Results of the analysis predict that all sanitary and combined sewers in the study area will operate under free-flow conditions, therefore operating within the expected level of service. The combined sewers within the Yonge Corridor of the Phase 1 EA are operating between 5% and 66% full under design dry-weather conditions in Flow Scenario 1. The sewers operate between 5% and 71% full in Flow Scenario 2.

In both flow scenarios, one (1) CSO will activate. This CSO is located just east of Yonge St., on Gloucester St. This CSO was active for the entire 24-hour modelling period. A visual overview of the analyzed pipes and their results with respect to the assessment criteria is provided in **Figure F-C.3** and **Figure F-C.4** in **Appendix F-C**.

3.4.2 Wet Weather Flow (2-year 6-hour Storm)

The WWF model scenario was run to assess the flow in the system during a 2-year rainfall event. The design storm used is a 2-year 6-hour Chicago storm. The flow within the system is made up of wastewater flow, an I/I rate of 0.26L/s/ha, and storm runoff.

Results of the analysis predict that at the peak of the 2-year storm event, the majority of sewers along the Yonge corridor will be operating under free flow conditions. Some pipes are expected to surcharge, however the HGL within the system is within the expected level of service (e.g. HGL more than 1.8m below grade). All CSOs in the area activate during the 2-year storm event. The analysis results for the 2-year storm is provided in **Figure F-C.5** and **Figure F-C.6** in **Appendix F-C**.

3.4.3 Combined Sewer Overflow Assessment

As mentioned in **Section 3.4.1**, one (1) CSO, near the intersection of Yonge and Gloucester St., is expected to activate during design dry-weather flow conditions for both flow scenarios, and remain active for the entire 24-hour simulation period.

This CSO was also activated when the simulation was run with no base flow as a hypothetical best-case scenario. See **Figure F-C.7** in **Appendix F-C** for a profile view of this condition. It should be noted that under existing conditions, the modelled water level on the upstream side of the weir was exactly equal to the weir crest elevation (106.429m AD) under design conditions. Therefore, simulations with lower population counts were not undertaken because this situation only occurs in one (1) location, and any growth resulting in increased dry-weather flow contribution to the combined sewers on Gloucester St. is likely to activate the weir in that area.

With regard to wet-weather CSO activity, all CSOs within the study area are expected to activate under the 2-year storm event, as discussed in **Section 3.4.2**. Dry-weather contribution to the combined sewers will increase as a result of the increase in population associated with re-development. Therefore, developers will have to ensure that storm outflow from re-development sites in the study area will not cause an increase in CSO volume. This can be accomplished either through on-site controls, or by diversion of storm flows away from combined sewers into fully separated storm systems, or by a combination of these approaches. While the feasibility of sewer separation on Yonge St. itself may be limited (see **Section 5** for further discussion), opportunities for diverting storm flows to existing fully separated storm sewers are present within the areas contributing to the combined sewers in on Yonge St.

4 Overland (Major) System

4.1 Data Collection

A Topographic Survey was completed and provided by the Client. The provided topographic data covers the public right-of-way along the Yonge Corridor and the local east-west streets connected to Yonge Street. The elevation data included in several AutoCAD files was used to assess drainage patterns. Private lands within the area are occupied predominantly by high-rise buildings and commercial properties with flat roofs, and therefore are not expected to have a significant impact on overland flow.

4.2 Overland Flow Analysis

Flow paths and directions were indicated on the overland flow figures for both the Phase 1 and Phase 2 EA focus areas, found in *Appendix C* of the Existing Conditions TM, provided in **Appendix F-A** of this document. Also indicated were some local low points, most located at corners of intersections. There were no major ponding locations identified in the Yonge corridor within either focus area. In general, the Yonge Corridor flows north to south, with most local connecting streets flowing west to east. As no significant changes in topography are expected as part of the growth along the Yonge Corridor, the existing overland flow analysis remains valid - see **Appendix F-D** for details.

5 Proposed Infrastructure Upgrades

Based on the above analysis, upgrades to the municipal watermains and storm sewers are likely not required. Some upgrades may be necessary to mitigate dry-weather CSO activity on Yonge St. Further discussion is provided in the following sections.

5.1 Watermains

The City requires as a minimum the replacement of both east-side and west-side mains with two (2) 300mm watermains along Yonge Street, between Queen St. and College St. (in PD1 system), irrespective of future needs. A few local 150mm watermains will be resized to 300mm outside the study area through other projects. The existing PD1 watermains near pressure district boundary between PD1 and PD2 will be looped as part of TTC College station works.

Based on the hydraulic analysis, it is recommended to replace both east-side and west-side watermains with two (2) 300mm watermain along Yonge Street, between College Street and Bloor Street in PD2 system to increase the capacity (e.g., increase available fire flow to 250L/s). In addition, it is recommended to provide a looped connection between these the two PD2 new watermains near College Street and Yonge Street; the existing/new 300mm watermain each is connected to a zone isolation valve at the pressure district boundary between PD1 and PD2 at this location – See Appendix F-B for Approximate location of the proposed PD2 looped watermain.

However, these may need to be relocated into the centre of the road to facilitate the placement of soil cells for street trees. Based on a review of subsurface profiles, it is believed that relocating the two (2) proposed watermains to the centre of the road is feasible. However, it may be challenging to achieve adequate clearance between the proposed watermains, utilities, and the subway box. The typical road cross sections along Yonge Street within the study areas are shown in **Appendix F-F**. It is recommended that detailed utility locates be performed to confirm the feasibility of the City's proposed watermain relocation.

5.2 Sanitary, Combined, and Storm Sewers

Based on the modelling work described in **Section 3**, there are no capacity constraints for storm and sanitary sewers along Yonge St. that will require remedial attention.

No critical capacity restrictions are present within the combined system, however model results indicate that the increase in population associated with growth in the area will trigger a constant combined sewer overflow during dry-weather conditions. This condition violates MOE Procedure F-5-5. The CSO in question is located on the east side of the intersection of Yonge and Gloucester St. The City has expressed a desire to pursue combined sewer separation along Yonge St. However, after a review of subsurface profiles, it was confirmed that full sewer separation is not feasible due to clearance constraints associated with the subway box and other buried infrastructure. The typical road cross sections along Yonge Street within the study areas are shown in **Appendix F-F**.

Therefore, the following options are proposed to mitigate the predicted dry-weather CSO event:

1. Raise the weir crest elevation from 106.429 m AD to 106.500 m AD. This action will incur the least amount of cost and effort and eliminates all CSO activity under the most conservative dry-weather scenario considered in this analysis (2041 maximum populations, 450l/cap/day wastewater allowance, 0.26l/s/ha design I-I flow). See **Figure F-C.8** in **Appendix F-C** for a profile view of the proposed configuration, with simulated HGL results.

2. Upsize and lower six (6) combined sewer pipes downstream of the weir, and one (1) pipe upstream of the weir. This solution will allow more flow to be conveyed below the weir crest elevation to the larger, deeper sewers further south on Yonge St. See **Figure F-C.9** in **Appendix F-C** for profile results for this solution.

It is important to note that neither of these scenarios will prevent wet-weather CSO activity. Wet-weather CSO activity will have to be addressed at the site level with on-site control or diversion of storm flows to separated storm sewers, as discussed in **Section 3.4.3**. Because of this, it is also recommended that a full CSO analysis be undertaken as part of future development plans for the Yonge St. corridor.

Additionally, due to the age and expected service life of the system, a condition assessment of the existing combined sewers is recommended to assess whether the existing pipes should be rehabilitated during the proposed watermain upgrade works.

6 Summary

Analysis of the water distribution and the sanitary/combined/storm sewer systems were completed as per the proposed future conditions.

6.1 Water Distribution

The available fire flow in the future water distribution system is reduced in comparison with the existing condition. It is recommended to replace both east-side and west-side watermains with two (2) 300mm watermain along Yonge Street, between College Street and Bloor Street (in PD2 system within Phase 2 extended focus area) to increase the capacity (e.g., increase available fire flow to 250L/s) to support future development. In addition, it is recommended to provide a loop connection between these two PD2 new watermains near College Street and Yonge Street; the existing/new 300mm watermain each is connected to a zone isolation valve at boundary between PD1 and PD2 at this location.

The existing PD1 watermains near pressure district boundary between PD1 and PD2 will be looped as part of TTC College station works.

Due to the service life, the City requires as a minimum the replacement of both east-side and west-side mains with a two 300mm mains along Yonge Street, between Queen Street and College Street (in PD1 system within Phase 1 focus area), irrespective of future needs.

Additionally, these may be relocated into the centre of the road to facilitate the placement of soil cells for street trees.

With proposed watermain infrastructure upgrades along Yonge Street, the available fire flow is 250L/s along Yonge Street within the study area. The required fire flow will be determined in accordance to the calculations from the FUS for the future. The fire-resistive construction and a complete automatic sprinkler protection are recommended and will be required to limit the fire flow requirement (e.g., fire flow less than 250/s) for the future development.

6.2 Sanitary Storm and Combined Sewers

The Yonge Street corridor within the focus area is serviced only by combined sewers. Areas upstream of the focus area are serviced by a combination of separate sanitary, storm and combined sewers. The modelling focuses on the performance of the sewers in the focus corridor but includes all upstream flows into the focus area. The three (3) sewer systems were modelled into one (1) integrated InfoWorks model to perform the assessment. The model includes wastewater flows, infiltration rates, and storm runoff to assess system performance. All model flows are based on theoretical values; no calibration was performed. The existing system was assessed under design dry weather, and 2-year design storm conditions.

During design dry weather conditions, the system performance is adequate with regard to capacity. The combined sewers within the Yonge Street corridor are expected to operate between 5% and

71% full, depending on flow conditions. However, one (1) combined sewer overflow is expected to activate under these conditions, violating MOE Procedure F-5-5. Two (2) potential mitigation strategies have been proposed. The first is to raise the crest elevation of the weir that allows the overflow. The second is to upsize and lower the combined sewer line from which sewage overflows. See **Section 5** for full discussion.

At the peak of a 2-year rainfall event, the majority of the system has adequate capacity; there is some minor surcharging occurring at select locations. No critical surcharging (e.g. water level within 1.8m of the surface) is expected. No major bottlenecks or system restraints are present. All twelve (12) combined sewer overflows in the area are expected to activate during the 2-year design storm.

6.3 Areas for Further Study

A detailed utilities location assessment is recommended to confirm the feasibility of the proposed watermain relocation. Due to the service life of the sewer system, a condition assessment of the existing combined sewers is recommended to assess whether rehabilitation works should be undertaken for the existing sewers at the time of the watermain upgrades and other works along the Yonge Street corridor. Finally, it is also recommended that a full CSO study be undertaken to assess the impacts of future population growth on CSO volumes within the study area.

Existing and Future Conditions Assessment Technical Memorandum

Watermains, Sanitary, Storm and Combined Sewers

Yonge Street Class EA Study
(Queen Street to College/Carlton Street)
City of Toronto

APPENDICES

Prepared for Steer Davies Gleave
by IBI Group
IBI Project Number 131657 | 2017-0591
March 2021

APPENDICES

Appendix F-A	Existing Condition Assessment Technical Memo
Appendix F-B	Future Water System Analysis F-B-1 - InfoWater Model Layout of Water System for Future Condition F-B-2 - Water System Pressure under Future Condition for Peak Hour Design Condition F-B-3 - Water System Pressure under Future Condition for Maximum Day plus Fire Flow F-B-4 - Water Demand Estimation
Appendix F-C	Future Combined Sewer Analysis
Appendix F-D	Future Overland (Major System) Analysis
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Appendix F-A

Existing Condition Assessment Technical Memo

Steer Davies Gleave

EXISTING CONDITIONS ASSESSMENT TECHNICAL MEMORANDUM FOR WATERMAINS, SANITARY, STORM AND COMBINED SEWERS

Yonge Street Class EA Study – Queen Street to College/Carlton Streets, Toronto, ON

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APRIL 2020

April 14, 2020
Our Ref: 2017-0591

Steer Davies Gleave
80 Richmond Street West, Unit #1502
Toronto ON, M5H 2A3

Attention: Peter Piet
Project Manager

Re: Existing Conditions Assessment Technical Memo for
Watermains, Sanitary, Storm and Combined Sewers
Yonge Street Class EA Study – Queen Street to College / Carlton Street
City of Toronto

Cole Engineering Group Ltd. (COLE) is pleased to submit the technical memorandum for the wet utilities existing conditions assessment for the above captioned project. As part of the existing conditions assessment, the adequacy of the existing capacity of the watermains, sanitary, combined, and storm sewers was analyzed. Analysis was conducted using existing population assumptions, land cover conditions, and wet utility infrastructure data supplied by the City of Toronto. This technical memo highlights the modelling and assessment parameters used for analysis, along with the results of analysis, for the existing system only. Future development, including existing approved development will be addressed in the future conditions assessment.

Yours sincerely,
COLE ENGINEERING GROUP LTD.

Will Heywood

William (Will) Heywood, P.Eng,
Team Lead, Stormwater Management Solutions / Water Resources

WRH/ad

Encls. Report

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Issues and Revisions Registry

Identification	Date	Description of issued and/or revision
Technical Memorandum	February 22, 2019	For client review
Technical Memorandum	February 27, 2019	For client review
Technical Memorandum	March 1, 2019	For submission
Technical Memorandum v2	April 6, 2020	Updated as per City Comments
Technical Memorandum v2	April 16, 2020	For submission

Statement of Conditions

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1 Introduction

Cole Engineering Group Ltd. (COLE) was retained by Steer Davies Gleave (SDG - the Client) to provide technical support for the water distribution, wastewater collection and stormwater management components for the Yonge Street (Queen Street to Carlton / College Street) Environmental Assessment (EA) study.

As part of the study, an existing conditions assessment has been completed for the watermains, sanitary, combined, and storm sewers within the contributing catchment the Yonge Street Phase 1 Study Focus Area (College / Carlton Street to Queen Street corridor), as shown below in **Figure 1-1**. This technical memo outlines the work completed, and results of the existing conditions assessment. The scope of work of this EA study is to perform an Infrastructure Planning and Design Study to develop, evaluate and recommend design options for streetscape and public realm improvement for the Yonge Street public-right-of-way between Queen Street and College / Carlton Street within Phase 1 Focus Area.

The design options are intended to increase pedestrian space through a variety of means, including: sidewalk widenings, a potential narrowing of the traffic lane widths, reduction in the number of traffic lanes and diversion of loading activities to adjacent public laneways and side streets, where possible. The accommodation of cycling facilities along this section of Yonge Street will be a key consideration of this study.

As shown in **Figure 1-1**, a Phase 2 EA for Yonge Street between College / Carlton Street to Davenport Road within Phase 2 Extended Focus Area will be undertaken. The Phase 2 EA will begin after the completion of Phase 1 EA and it is under a separate assignment by others.

In order to maximize the overall schedule for both the Phase 1 EA (Queen to College / Carlton Street) and Phase 2 EA (College / Carlton to Davenport), the data collection and analysis for completing Phase 2 EA will be performed as part of the Phase 1 EA. The results of the Phase 1 EA will be used for the Phase 2 EA (section of Yonge Street between College / Carlton and Davenport). **Figure 1-1** shows the suggested Study Area of data collection and analysis for water, sanitary, storm / combined system capacity assessment.

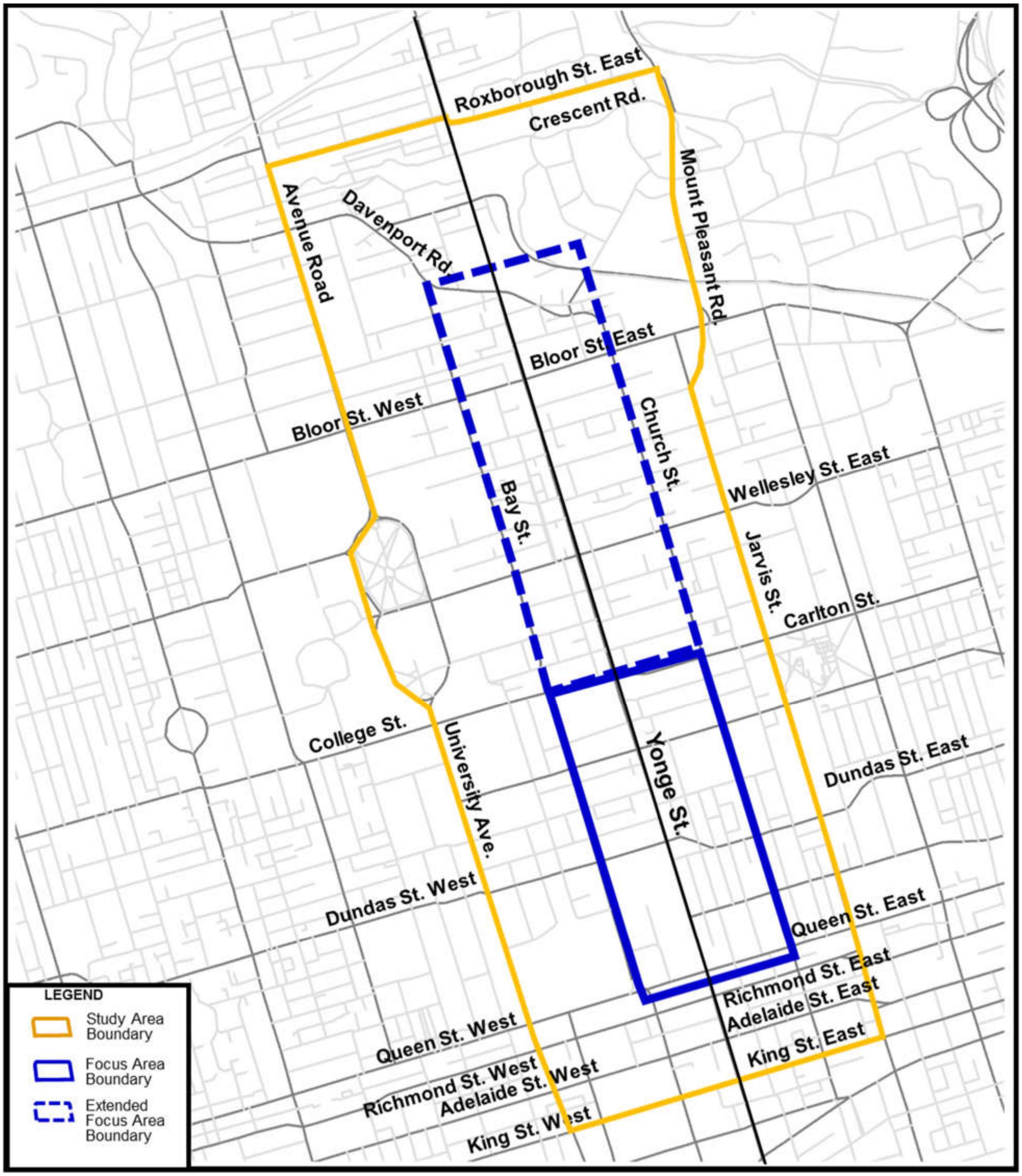


Figure 1-1 Yonge Street Study Area

1.1 Scope of Assessment

The existing water system capacity analysis for the study area was completed. Fire hydrant flow testing within the study area was performed to collect data for model calibration. The City's GIS shapefile data for water system was reviewed and used to develop the water hydraulic network model using InfoWater modelling software. **Appendix A-5** shows the schematic model layout for the existing condition. The calibrated water model was then utilized to estimate the available system heads (or pressures) at the watermain connections for the study area under the existing normal operating (e.g. peak hour) and fire flow conditions.

The condition assessment for the sanitary, combined, and storm sewer systems was completed congruently in a single integrated *InfoWorks ICM* sewer model. The City's shapefile data for landcover, property boundaries, sewers, manholes, catchbasins and laterals, building outlines, topographic data and other relevant data was obtained from the City to develop the existing conditions servicing model, which is provided digitally in **Appendix D**. Special structures such as weirs or overflows are included in the model. Flow generation is based on theoretical design standard calculation as no flow monitoring data was available to calibrate or confirm the modelling results for this study area.

2 Water Distribution

The water systems for the Phase 1 Study Focus Area and Phase 2 Study Extended Focus Area are as follows:

- The Phase 1 Study Focus Area is located within the City's Pressure District (PD) 1, which is supplied mainly from the John Street PD1 Pumping Station (PS). The existing Rosehill reservoir provides water storage and maintains system pressure for the PD1 water system in the vicinity of the Phase 1 Study Focus Area. The Rosehill reservoir is located at Rosehill Avenue and east of Yonge Street, a short distance north of the Study Area. The Rosehill reservoir water levels range between 133.5m (Low Water Level, LWL) and 141.1m (Top Water Level, TWL); and,
- The Phase 2 Study Extended Focus Area is located within the City's Pressure District (PD) 2, which is supplied mainly from the High Level PD2 Pumping Station (PS). The existing St. Clair reservoir provides water storage and maintains system pressure for the PD2 water system in the vicinity of the Phase 2 Study Extended Focus Area. The St. Clair reservoir is located at St. Clair Avenue West and Spadina Road, a short distance northwest of the Study Area. The St. Clair reservoir water levels range between 151m (Low Water Level, LWL) and 158m (Top Water Level, TWL).

2.1 Data Collection

The GIS shapefiles data (provided by the City) for the water system in the vicinity of the study area was reviewed. Based on the review of the water system information, there are existing looping watermains within the study area. The existing distribution watermains in the Study Area consist of 150mm to 1200mm diameter.

In order to assess the available system pressures along Yonge Street within the focused areas (within study area), four (4) fire hydrant flow testing / pressure monitoring points have been suggested at the hydrants along the existing Yonge Street watermains near the following streets: Bloor Street West, College Street and Queen Street West. The locations for the pressure gauges and flow tests are shown in **Appendix A-1**. Another two (2) pressure loggers were put outside the focus areas (within study area) during the monitoring period.

Prior to conducting the hydrant flow tests, six (6) pressure gauges will be installed on the designated hydrants to record the pressure for a duration of 24-hours, including the system pressure while the four (4) fire flow tests are carried out. The system pressures were recorded at the pressure logger location for a duration of over 24-hours on October 24 and 25, 2017.The monitoring data and fire hydrant test results are shown in **Appendices A-2 to A-4.**

2.2 Modelling Methodology

A water distribution network model, using InfoWater modelling software, was constructed to include the junctions and pipes in the vicinity of the study area based on the shapefile data (Pipe and Junction) and water demand for 2017 as provided by the City. The water demand represents the average day demand. A peak factor of 1.65 for maximum day and 2.48 for peak hour were used to estimate water demand for the analysis. The St. Clair (for PD2) and Rosehill (for PD1) reservoirs were used as water supply source / boundary. A dummy reservoir represents water supply from John Street PD1 pumping station was used in model analysis.

The field pressure and flow tests were used for the model calibration. Based on the flow test results, C-factors along the existing pipelines in the vicinity of the study area were refined. The 2017 water demand were lumped into 12 Dummy demand nodes and placed along the existing watermains within the study area to represent the local PD1 and PD2 water demand in the vicinity of the study area. The model parameters (e.g. C-factors) were adjusted until the best-fit between the simulated results and field testing data.

The “calibrated” water system model was then used to identify the available system heads (or pressures) along the existing system within the study area.

2.3 Assessment Criteria

The adequacy of the existing hydraulic capacity for the watermain system was evaluated under the normal operating (e.g. peak hour) and fire flow conditions.

The City’s 2009 Design Criteria for Sewers and Watermains provides the following system pressure and fire flow requirement for the assessment of the system capacity:

- System Pressure;
  - Minimum pressure during peak hourly demand: 275kPa (40psi);
  - Minimum pressure during maximum day plus fire flow: 140kPa (20psi); and,
- Fire Flow.

  The Toronto 2009 Guideline was reviewed and established the required fire flow for the study area. Based on discussions with City staff, it is our understanding that the Fire Underwriters Survey (FUS, 1999) was accepted and selected for the fire flow calculation as a suitable alternative to the Toronto 2009 Guideline.

2.4 Analysis and Results

The following sections provide the results and analysis for the hydrant flow tests, model calibration and existing system capacity assessment.

2.4.1 Field Monitoring

The field pressure data at the monitoring locations were analyzed and plotted as hydraulic grades / system head in **Appendices A-2** and **A-3.** The hydrant flow test data and results are shown in **Appendix A-4.** The test results and analysis are detailed as follows:

Test 1 (P1), Test 2 (P2 and P5 are within PD2 system: The system heads range from 145m to 162m (system pressure between 45psi to 80psi) at the three (3) locations within PD2. The average static system head for the PD1 system within the study area location is approximately 155m (approximately 55% full water level at the St. Clair reservoir).

- **Test 1 on Yonge Street and south of Bloor Street**: The detected static pressure at Test 1 location (elevation 113.8m) was approximately 410kPa (or 58psi). The static system head is approximately 158m (approximately 85% full water level at the St. Clair PD2 reservoir). The pressure / system head at Test 1 location dropped by approximately 4m (or 6psi) and the system head was reduced to 154m when the hydrant was flowing at average flow of 120L/s;
- **Test 2 on Yonge Street and north of College / Carlton Street**: The detected static pressure at Test 2 location (elevation 103m) was approximately 500kPa (or 73psi). The static system head is approximately 154m (approximately 50% full water level at the St. Clair PD2 reservoir). The pressure / system head at Test 2 location dropped by approximately 6m (or 8psi) and the system head was reduced to 148m when the hydrant was flowing at average flow of 114L/s; and,
- **P5 on 103 Crescent Road and South Dive**: The estimated system range from 151m to 162m.

Test 3 (P4), Test4 (P4) and P6 are within PD1 system: The system heads range from 135m to 146m (system pressure between 52psi to 82psi) at the three (3) locations within PD1. The average static system head for the PD1 system within the study area location is approximately 140m (approximately 85% full water level at the St. Clair reservoir).

- **Test 3 on Yonge Street and south of College / Carlton Street**: The detected static pressure at Test 3 location (Elevation 98.2m) was approximately 360kPa (or 52psi). The static system head is approximately 137m (approximately 55% full water level at the Rosehill PD1 reservoir). The pressure / system head at Test 3 location dropped by approximately 3m (or 4psi) and the system head was reduced to 134m when the hydrant was flowing at average flow of 107L/s;
- **Test 4 on Yonge Street and north of Queen Street**: The detected static pressure at Test 4 location (elevation 88.8m) was approximately 500kPa (or 73psi). The average static system head for the PD1 system within the study area location is approximately 140m (approximately 80% full water level at the Rosehill PD1 reservoir). The pressure / system head at Test 4 location dropped by approximately 4m (or 5psi) and the system head was reduced to 136m when the hydrant was flowing at average flow of 77L/s; and,
- **P6 on 119 York Street and Adelaide Street**: The estimated system range from 140m to 146m.

Based on the above field monitoring and fire flow test results, the system pressures range from 320kPa (45psi) to 600kPa (85psi) and they meet the City's recommended pressure ranges between 275kPa (40psi) and 700kPa (100psi) under the normal system operation.

2.4.2 Model Calibration

The water distribution network system model was conducted to simulate the fire flow test results (Tests 1 to 4). Modelling was completed assuming the water was supplied from John Street PD1 Pumping Station the Rosehill PD1 reservoir for the PD1 system and St. Clair PD2 reservoir was supplied water to PD2 system.

The field test results were used for model calibration, the system head difference between the field measurements and simulated results at each of the monitoring locations is approximately 1.5m (or around 2psi) for the Test location Tests 1 to 4 (including P5 and P6) and meet the general guideline for the model calibration.

2.4.3 Existing System Capacity Assessment

The following assumptions were made for hydraulic model analysis:

- PD1 system: it is assumed that water demand is supplied from St John PD1 Pumping Station and Rosehill PD1 reservoir. The system boundary head in the model was assumed to be 139m (approximately 75% of the full water level at Rosehill PD1 reservoir) during the high water demand period (e.g. maximum day plus fire and peak hour). The 75% full level is the approximate average under typical reservoir operations which ranges between 60% to 90% full levels; and
- PD2 system: it is assumed that High Level PD2 Pumping Station is off-line and water demand is only supplied from the St. Clair PD2 reservoir. The system boundary head in the model was assumed to be 156m (approximately 75% of full water level at the St. Clair PD2 reservoir) during the high water demand period (e.g. maximum day plus fire and peak hour).

Water modeling analysis was performed to assess the available system capacity along the existing watermain system near the study area. The model results under the existing system condition are summarized as follows:

- System Pressure: Except for a few local ground areas (outside study area) along the feedermains near Rosehill PD1 reservoir and St. Clair PD2 reservoir, the estimated minimum system pressure is approximately 290kPa (43psi) on both PD1 and PD2 systems under the normal operating condition (e.g. peak hour). The minimum pressure occurs at the local high ground area near Yonge Street and north of College Street (See **Appendix A-6** for details). The system pressure within the study area is higher than the City's pressure requirement of 275kPa (or 40psi); and,
- Fire Flow Availability: Except for a few local ground areas (outside study area) along the feedermains near Rosehill PD1 reservoir and St. Clair PD2 reservoir, the minimum available fire flow at pressure of 140kPa (22psi) is approximately 250L/s within the study area (e.g. at a critical location on Yonge Street and north of College Street – south boundary PD2 and further away from the St. Clair PD2 reservoir under the maximum day demand plus fire flow conditions, see **Appendix A-7** for details). The available system flow meets a typical fire flow requirement for a high-rise building and/or a commercial building.

3 Sanitary, Storm, and Combined Sewer

The Yonge Street corridor within the Phase 1 Focus Area is serviced by a fully combined system with sewers ranging in diameter from 300mm to 1200mm. The sewers are generally circular shaped, made with a variety of pipe materials including: Brick, Reinforced Concrete, and Vitrified Clay. Along the Yonge Corridor within the Focus Area, the sewers were mostly constructed between 1945 and 1955, while the sewers in the contributing area range from 1876 to 2007. The contributing area is serviced by a combination of sanitary, storm and combined sewers. The combined sewers along Yonge are all local systems, with no major trunk systems running along it. The Yonge corridor is crossed by the 3050mm diameter Mid-Toronto Interceptor at Gerrard Street. The average Depth of the combined sewers along Yonge is just over 4m, while the Interceptor is located approximately 25m underground.

The assessment of the capacity of the combined sewers within the focus area was performed using the InfoWorks ICM modelling software. Analysis was focused on the capacity of the system within the focus area and any relevant downstream areas, however the upstream combined, sanitary, and storm systems contributing to the sewers on Yonge were all included in the model to account for any upstream flows being generated. The following sections outline the source of information, modelling methodology, assessment criteria, and model results.

3.1 Data Collection

The City provided a City-wide InfoWorks ICM v9.5 model named the "Interceptor 2016 - Full Model" for use in this EA. The provided model is hereafter referred to as the Interceptor Model. The model provide is meant to represent appropriate conditions for the year 2016, and was considered in this study to represent the "Existing Conditions". It was confirmed with the City that there were no pipe construction or modification projects completed recently that would change the model properties.

The physical network within the Interceptor Model included pipes, manholes, weirs, orifices, and sluice gates. Also included in the Interceptor Model was sanitary subcatchments with populations and trade flow values. The definition of the subcatchment delineation was deemed to be suitable for the analysis of individual local pipes. No storm subcatchments or storm parameters were included in the model, and therefore had to be generated separately as a part of this analysis.

A QA / QC review was performed on the Interceptor Model physical network within the data collection area. Flow continuity checks were performed on the network within the Yonge Corridor to ensure there were no major data gaps or anomalies. Through the review, it was concluded that the received model physical network was adequate to perform the analysis without further adjustments. No checks against as-built drawings were performed.

The City also provided GIS Shapefiles of the sanitary, storm, and combined systems within the data collection area. The shapefiles provided additional useful information that was not included in the model including but not limited to: catch basin locations, infrastructure years of construction, more refined flow type details, and sewer drop pipe details.

Flow monitoring data was requisitioned from the City. Data for 12 nearby flow monitoring locations in **Figure 3-1** was provided. Through a review of the locations, it was determined that all locations were either outside of the Focus Area, or located on the interceptor sewer, and therefore could not be used in this analysis. No local monitoring data within the study area was provided. Open Data collected from the City's online data portal included streets, property boundaries, building outlines, and the 2007 land cover raster.

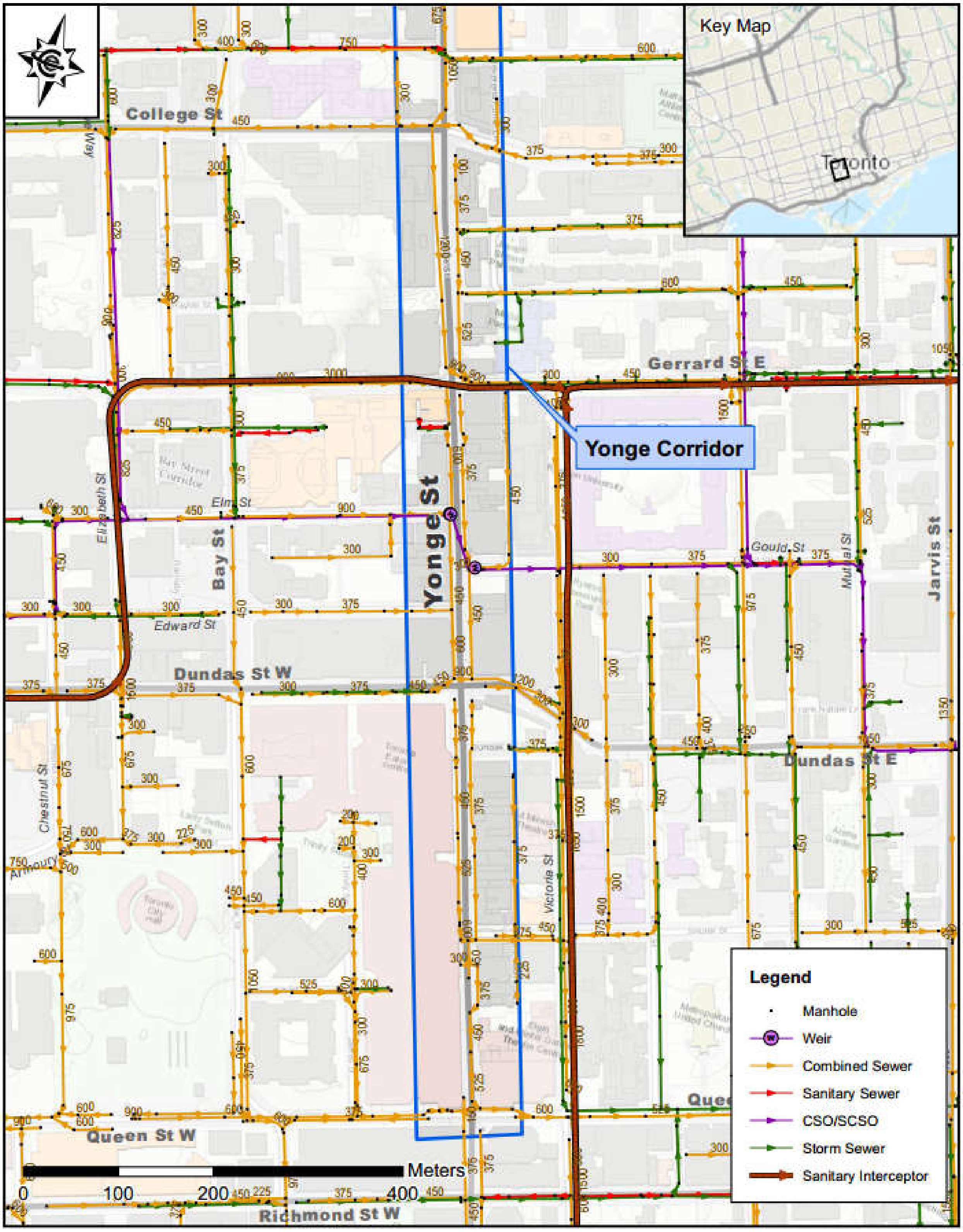


Figure 3-1 Yonge Corridor Existing Sewer Servicing

3.2 Modelling Methodology

The methodology followed to create the non-calibrated *InfoWorks* model is summarized in **Table 3.1**.

Table 3.1 Summary of Methodology

Step	Description
1.0 Initial Model Cut	The City-Wide Interceptor Model was cut to only include the network contributing to the study area. The “Yonge EA Cut Model” includes the sanitary, storm, and combined sewers and manholes in the area, as well as special structures such as Weirs and Sluice Gates.
2.0 Sanitary Subcatchments	Sanitary subcatchments were present in the Interceptor Model provided. All subcatchments contributing to the Yonge EA focus area were maintained in the “Cut Model”.
3.0 Storm Subcatchments	Storm subcatchments were generated by copying the sanitary subcatchments layer. Adjustments to boundaries were made as necessary based on estimated property connection locations. Subcatchments were assigned to either the combined or storm system based on the age of buildings in comparison to the age of storm infrastructure.
4.0 Wastewater Flow	Wastewater flows were calculated using the sanitary populations and trade flows present in the sanitary subcatchments. Populations were applied against a generic wastewater pattern provided in the Interceptor Model.
5.0 Inflow & Infiltration	A constant I-I rate of 0.26 L/s/ha was applied to all sanitary subcatchments in the model to represent design conditions.
6.0 Storm Flow	Storm subcatchments are made up of three (3) basic land surface types. The model parameters for each surface type are similar to the Toronto Basement Flooding EA Study guidelines. Storm flow is generated through the model by applying a given rainfall event.
7.0 Outlets / Boundary Conditions	Outlets from the Yonge EA Cut Model were either to combined sewer overflows, or to large Trunk Sewers. Each outlet was modelled as a “free outfall”.

Each step of the model build is explained in further detail in the following sections.

3.2.1 Interceptor Model Cut

The Interceptor Model was cut down to only include the Yonge EA sewers and contributing areas for ease of modelling, and to speed up model runs. The “Select Upstream” InfoWorks tool was used on all sewers within the Yonge EA focus corridor. The selection was refined to include all connected subcatchments, nodes, and special structures. A manual review was performed to ensure that there were no missing pieces or attributes from the Interceptor Model. All selected features were then exported out into a new model to create the “Yonge EA Cut Model”. **Figure 3-2** presents the Yonge EA Cut Model in relation to the full Interceptor Model.

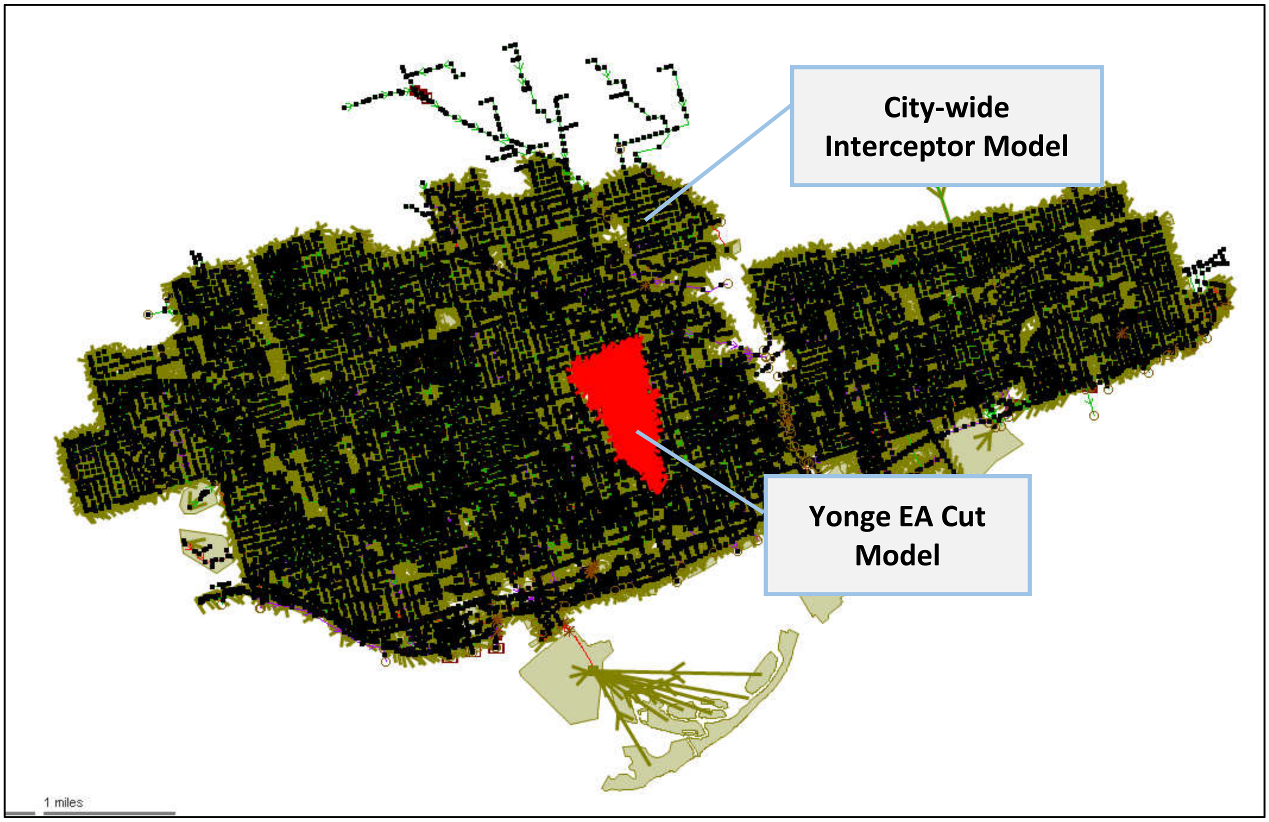


Figure 3-2 Yonge EA Cut Model

3.2.2 Wastewater Flow

Wastewater Flow in the model is generated from two (2) main components as outlined below:

Wastewater Flow = Peaked Residential Flow + ICI (Trade) Flow

Residential populations were provided in the Sanitary Subcatchments present in the Interceptor Model. A brief assessment was completed to identify if any data outliers were present. A typical residential flow pattern was included in the Interceptor Model and used for this analysis. The wastewater profile, labelled as "Waste water_Actual", uses the City's design standard residential flow generation rate of 240L/capita/day. The diurnal wastewater pattern used is presented in **Figure 3-3**.

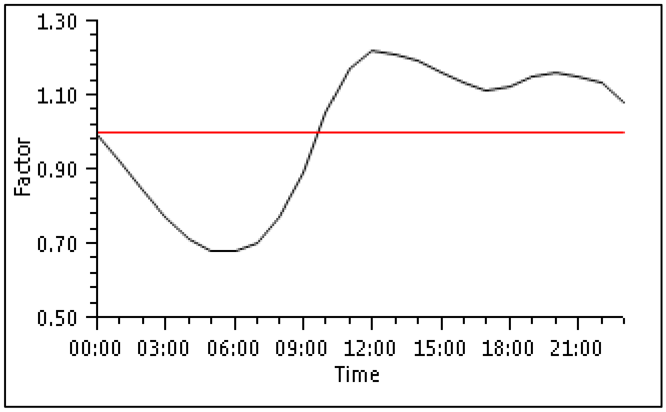


Figure 3-3 Residential Wastewater Generation Profile

ICI flow generation (e.g. Trade Flow) was provided in the Interceptor Model. An assessment of the values was conducted to identify if any outliers were present. No modifications were made to the trade flow values. Trade flows were applied against a "flat" pattern with a constant peaking factor of 1.

Since no flow monitoring data was available for the study area, no calibration was performed on the wastewater flow. The flows within the model therefore represent fully theoretical conditions.

3.2.3 Inflow & Infiltration

The sanitary subcatchments within the Interceptor Model originally had a baseflow value equivalent to 0.05L/s/ha. This represents a typical groundwater infiltration value. This value was replaced with a constant flow rate of 0.26 L/s/ha to represent design conditions. The baseflow does not get peaked, and is present during all analysis scenarios, regardless of rainfall.

3.2.4 Storm Flow

Subcatchments of flow type "Storm" were created to generate the storm water runoff for the model. Subcatchments were delineated based on an initial copy of the sanitary subcatchments. Refinements were made to the storm subcatchments to ensure full area coverage, and modifications made as necessary.

Each storm subcatchment was assigned to the appropriate system (e.g. either storm or combined) based on the presence of servicing infrastructure, as well as the age of buildings compared to the age of sewer infrastructure. The age of each building was compared against the year of construction for each storm sewer by reviewing historical aerial imagery available on the City's website[1]. Each subcatchment was assigned to the storm or combined system based on the four (4) rules outlined below:

1. Road subcatchments on streets serviced by storm sewers were all connected to the storm system;
2. Buildings and road subcatchments on streets where there is no storm sewers, were connected to the combined system;
3. Buildings constructed prior to the storm sewer servicing the street were assumed to be connected to the combined system; and,

[1] https://www.toronto.ca/city-government/accountability-operations-customer-service/access-city-information-or-records/city-of-toronto-archives/whats-online/maps/aerial-photographs/

4. Buildings built after the storm sewer servicing the street were assumed to be connected to the storm system.

It should be noted that in situations where storm subcatchments included buildings with varying conditions (e.g. old and new buildings), the subcatchment was cut into more refined subcatchments, and each part was assigned accordingly. Once expected discharge locations were assigned, subcatchments were manually connected to the most appropriate manhole location of the corresponding system type. Figure B.2 in **Appendix B** presents the system each subcatchment within the area is assigned to.

Toronto's land cover raster was used to generate the pervious and impervious area percentages for each storm subcatchment. The raster included eight (8) different land cover / surface types. Each of these types were consolidated into one (1) of the following three (3) possible surface types and summed up within each subcatchment, presented in **Table 3.2**. Road subcatchments were assumed to be 100% Surface Type 1.

Table 3.2 Runoff Surface Types

#	Description	Raster Surface Types Included
1	Impervious Paved Surface	4 - Water 6 – Roads 7 – Other Paved Surfaces
2	Impervious Rooftop Surface	5 – Buildings
3	Pervious Surface	1 – Trees 2 – Grass / Shrubs 3 – Bare Earth 8 - Agriculture

A visual comparison of the area and the land cover raster was performed. From the review it was determined that any water surface present in the raster would be ponded water on top of a paved surface, and therefore the water type was grouped together with the impervious paved surface category.

The InfoWorks model parameters for the impervious and pervious surface types are presented in **Table 3.3** and **Table 3.4** respectively. Model parameters follow similar values to those suggested in the City's Basement Flooding Model Studies Guideline.

Table 3.3 Impervious Runoff Surface Model Parameters

Surface #	Surface Type	Runoff Routing Value	Runoff Volume Type	Ground Slope (m/m)	Initial Loss Value (m)	Fixed Runoff Coefficient
1	Pavement	0.013	Fixed	0.01	0.002	0.9
2	Flat Rooftop	0.015	Fixed	0.001	0.0	0.95

Table 3.4 Pervious Runoff Surface Model Parameters

Surface #	Surface Type	Runoff Routing Value	Runoff Volume Type	Ground Slope (m/m)	Horton Initial (mm/hr)	Horton Limiting (mm/hr)	Horton Decay (1/hour)	Horton Recovery (1/hour)
3	Pervious	0.410	Horton	0.01	100.00	10.0	2.0	2.0

3.3 Assessment Criteria

The combined system in the area was modelled under the following conditions:

1. **Dry Weather (Design Flow)**: The model was run using an I-I rate of 0.26 L/s/ha, with no rainfall event applied; and,
2. **Wet Weather (Design + 2-year Flow)**: The model was run using an I-I rate of 0.26 L/s/ha, and a 2-year 6-hour Chicago rainfall event for storm subcatchments.

It should be noted that the analysis was not completed using a dual drainage model, and is limited in its functionality to assess rainfall events larger than a 2-year storm. Therefore the 100-year storm event (typically used for basement flooding studies) was not assessed.

Analysis of the level of service for a given system is based on the hydraulic grade line (HGL) and how it compares to the expected elevation of the bottom of connected basements (1.8m below grade). The difference between the ground elevation and the HGL in the sewer is known as the "freeboard". When assessing the model results, the freeboard at each node (manhole) is grouped into one (1) of three (3) possible levels:

1. **Sufficient Freeboard**: The HGL is either within the pipe (not surcharged), or more than 1.8m below the surface;
2. **Critical Surcharging**: The HGL is within 1.8m of the surface, but still below the surface; or,
3. **Surface Flooding**: The HGL is above the surface, therefore flooding to the street.

The assessment of each pipe is categorized into three (3) possible conditions:

1. **Freeflow**: The HGL is below the crown of the pipe. This identifies sewers with sufficient capacity;
2. **Surcharge (due to Backwater conditions)**: The pipe is surcharged and the slope of the HGL is flatter than the slope of the pipe, meaning the surcharging is due to an overloaded downstream pipe, or "backwater" conditions; and,
3. **Surcharge (over capacity)**: This condition is observed when the pipe is surcharged due to a lack of available capacity. The pipe does not have sufficient capacity to convey the flow. This highlights the bottlenecks of the system.

3.4 Analysis and Results

3.4.1 Dry Weather Flow

The DWF model scenario was run to assess the flow in the system under design dry weather conditions. No Rainfall event is applied, and the flow within the system is made up of only wastewater flow and a design infiltration rate of 0.26L/s/ha.

Results of the analysis show that all existing sanitary and combined sewers are operating under free-flow conditions, and therefore shows that the existing system is operating within the expected level of service. The combined sewers within the Yonge Corridor of the Phase 1 EA are operating between 5% and 30% full during typical dry weather. The combined sewer overflows (CSO's) are not active during dry weather. A visual overview of the analyzed pipes and their results with respect to the assessment criteria is provided in Figure B.3 in **Appendix B**.

3.4.2 Wet Weather Flow (2-year 6-hour Storm)

The WWF model scenario was run to assess the flow in the system during a 2-year rainfall event. The design storm used is a 2-year 6-hour Chicago storm. The flow within the system is made up of wastewater flow, an I/I rate of 0.26L/s/ha, and storm runoff.

Results of the analysis show that at the peak of the 2-year storm event, the majority of sewers along the Yonge corridor will be operating under free flow conditions. A few select pipes will be exhibiting some minor surcharging, however the HGL within the system is within the expected level of service (e.g. HGL more than 1.8m below grade). The combined sewer overflows within the area are all active during the 2-year storm event. The analysis results for the 2-year storm is provided in Figure B.4 in **Appendix B**.

4 Overland (Major) System

4.1 Data Collection

A Topographic Survey was completed and provided by the Client. The provided topographic data covers the public right-of-way along the Yonge Corridor and the local east-west streets connected to Yonge. The elevation data included in several AutoCAD files was used to assess drainage patterns. Private lands within the area are occupied predominantly by high-rise buildings and commercial properties with flat roofs, and therefore are not expected to have a significant impact on overland flow.

4.2 Overland Flow Analysis

Flow paths and directions were indicated on the overland flow figures for both the Phase 1 and Phase 2 EA focus areas, provided in **Appendix C**. Also indicated were some local low points, most located at corners of intersections. There were no major ponding locations identified in the Yonge corridor within either focus area. In general, the Yonge Corridor flows north to south, with most local connecting streets flowing west to east.

5 Summary

Analysis of the water distribution and the sanitary / combined / storm sewer systems were completed as per existing conditions.

5.1 Water Distribution

Based on the field tests and water modelling analysis, sufficient flow capacity is available along the existing system near the study area. The existing water distribution does not present a constraint and significant system upgrades are likely not required to support the proposed upgrades along Yonge Street.

5.2 Sanitary Storm and Combined Sewers

The Yonge Street corridor within the focus area is serviced only by combined sewers. Areas upstream of the focus area are serviced by a combination of separate sanitary, storm and combined sewers. The modelling focuses on the performance of the sewers in the focus corridor, but includes all upstream flows into the focus area. The three (3) sewer systems were modelled into one (1) integrated InfoWorks model to perform the assessment. The model includes wastewater flows, infiltration rates, and storm runoff to assess system performance. All model flows are based on theoretical values; no calibration was performed. The existing system was assessed under design dry weather, and 2-year design storm conditions.

During design dry weather conditions, the system has adequate capacity. All sewers within the area are free-flowing, and the sewers run between 5% and 30% full. At the peak of a 2-year rainfall event, the majority of the system has adequate capacity; there is some minor surcharging occurring at select locations. No critical surcharging (e.g. water level within 1.8m of the surface) is expected. No major bottlenecks or system restraints are present. Combined sewer overflows in the area are not active during dry weather; however they are active during the 2-year design storm.

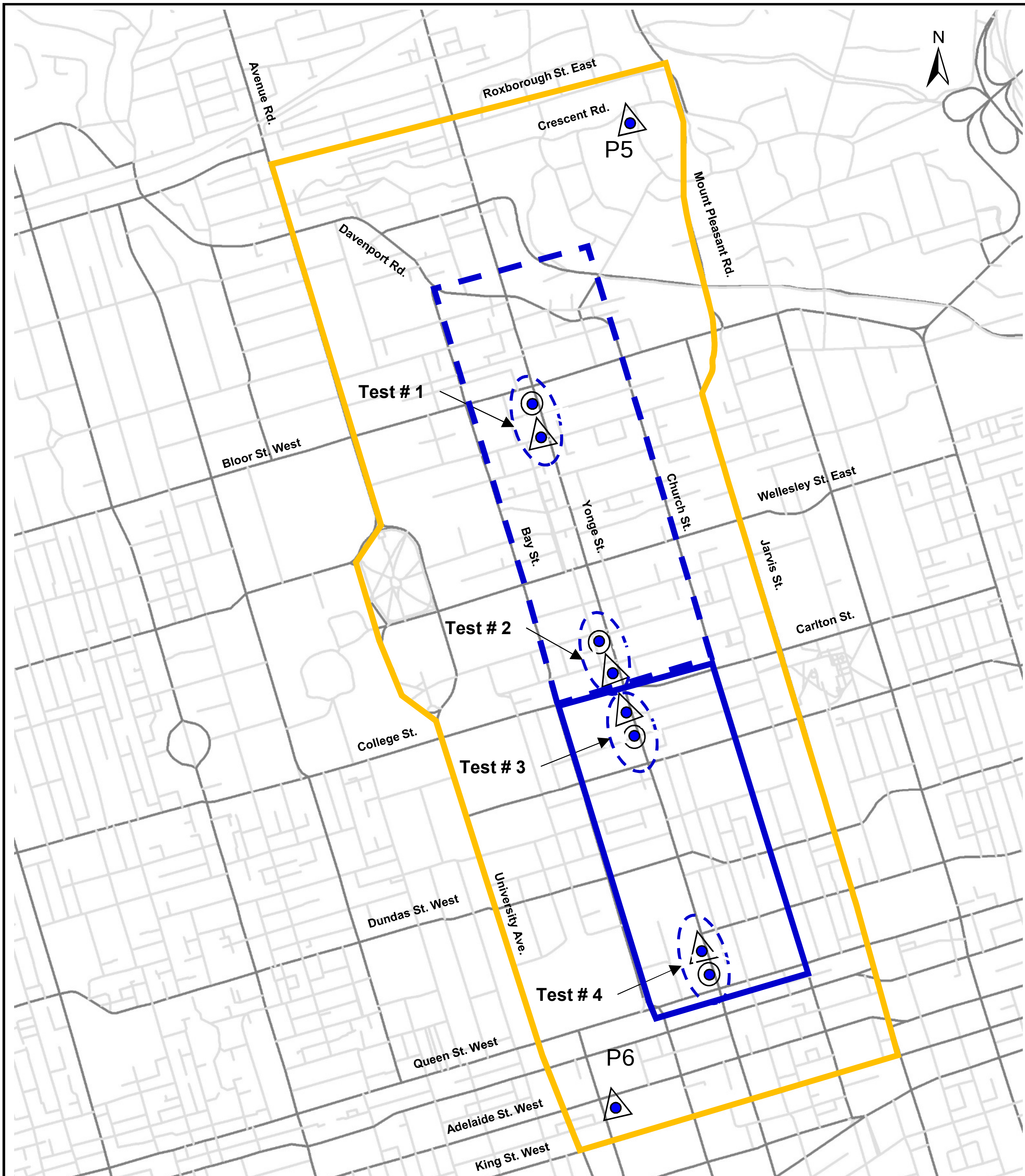
APPENDIX A

Water System Analysis

COLE

APPENDIX A-1

Flow Monitoring Locations



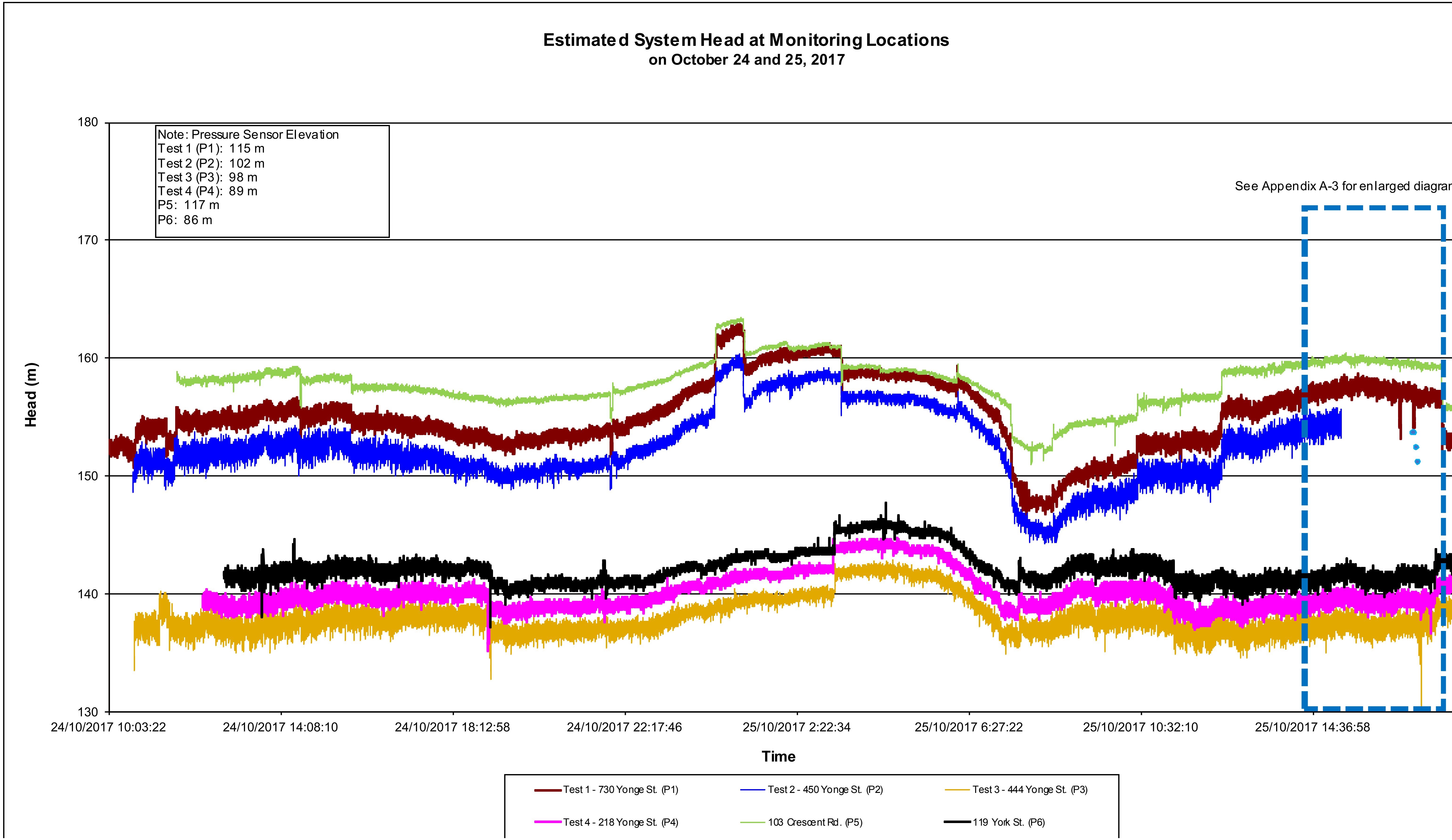
LEGEND

- Fire Hydrant
- Hydrant with Pressure Gauges
- Hydrant Flow Tests
- Study Area Boundary
- Focus Area Boundary
- Extended Focus Area Boundary

SCALE: NTS		Fire Hydrant Testing and Pressure Monitoring Locations		
COLE ENGINEERING	Yonge Street EA Study	DATE: February 2019	PROJ. No: 2017-0591	FIGURE No: Appendix A-1

APPENDIX A-2

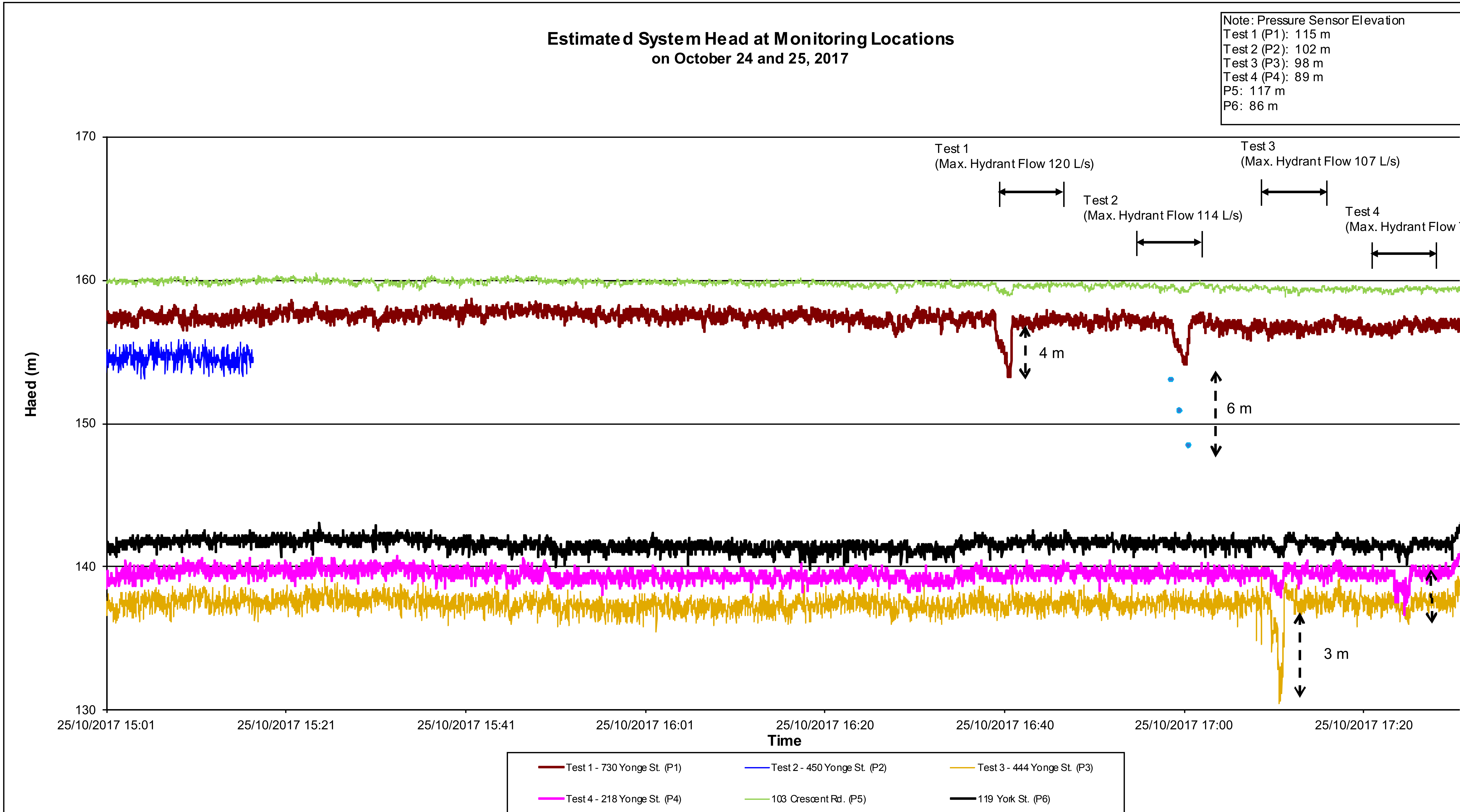
Estimated System Head at Monitoring Locations on October 24 and 25, 2017



Estimated System Head at Monitoring Locations
on October 24 and 25, 2017
Note: Pressure Sensor Elevation
Test 1 (P1): 115 m
Test 2 (P2): 102 m
Test 3 (P3): 98 m
Test 4 (P4): 89 m
P5: 117 m
P6: 86 m
See Appendix A-3 for enlarged diagram
Head (m)
180
170
160
150
140
130
24/10/2017 10:03:22
24/10/2017 14:08:10
24/10/2017 18:12:58
24/10/2017 22:17:46
25/10/2017 2:22:34
25/10/2017 6:27:22
25/10/2017 10:32:10
25/10/2017 14:36:58
Time
Test 1 - 730 Yonge St. (P1)
Test 2 - 450 Yonge St. (P2)
Test 3 - 444 Yonge St. (P3)
Test 4 - 218 Yonge St. (P4)
103 Crescent Rd. (P5)
119 York St. (P6)

APPENDIX A-3

Estimated System Head near
Monitoring Locations on
October 24 and 25, 2017


Estimated System Head at Monitoring Locations
on October 24 and 25, 2017
Note: Pressure Sensor Elevation
Test 1 (P1): 115 m
Test 2 (P2): 102 m
Test 3 (P3): 98 m
Test 4 (P4): 89 m
P5: 117 m
P6: 86 m
Test 1
(Max. Hydrant Flow 120 L/s)
Test 2
(Max. Hydrant Flow 114 L/s)
Test 3
(Max. Hydrant Flow 107 L/s)
Test 4
(Max. Hydrant Flow 73
4 m
6 m
3 m
4
Haed (m)
170
160
150
140
130
25/10/2017 15:01
25/10/2017 15:21
25/10/2017 15:41
25/10/2017 16:01
25/10/2017 16:20
25/10/2017 16:40
25/10/2017 17:00
25/10/2017 17:20
Time
Test 1 - 730 Yonge St. (P1)
Test 2 - 450 Yonge St. (P2)
Test 3 - 444 Yonge St. (P3)
Test 4 - 218 Yonge St. (P4)
103 Crescent Rd. (P5)
119 York St. (P6)

APPENDIX A-4

Hydrant Test Results

HYDRANT FLOW TEST FORM   Test # 1

COLE ENGINEERING
Experience Enhancing Excellence

Project No: 2017-0591 **Date:** October 25, 2017

Site Location: 730 Yonge St. Toronto, On. **Hydrants Opened by:** Toronto Water

Tested By: Gordon M, Shelley K.

1) Required photos:

- [✓] Site Id & Date
- [✓] Condition of Flow Hydrant
- [✓] Location Overview
- [✓] Condition of Residual Hydrant
- [✓] Other

2) Test Data

Time of Test: 1650

Location of Test: (Flow) In front of 696 Yonge St.

(Residual) In front of 730 Yonge St.

Main Size: —

Static Pressure: 58 psi

	Number of Outlets & Orifice Size	Pitot Pressure	Flow (USGPM)	Residual Pressure
1	1 × 2.5"	46	1150	56
2	2 × 2.5"	32	1900	52
3				
4				

3) Calculations

$Q = 29.83\, c d^2 \sqrt{p}$

Where c- cofficient of discharge (1 in smooth pipe)
d- pipe diameter (inches)
p- pitot reading (psi)
Q- flow (USGPM)

$Q_1 = (29.83)(0.9)(2.5")^2 \sqrt{46}$
$= 1138.03$

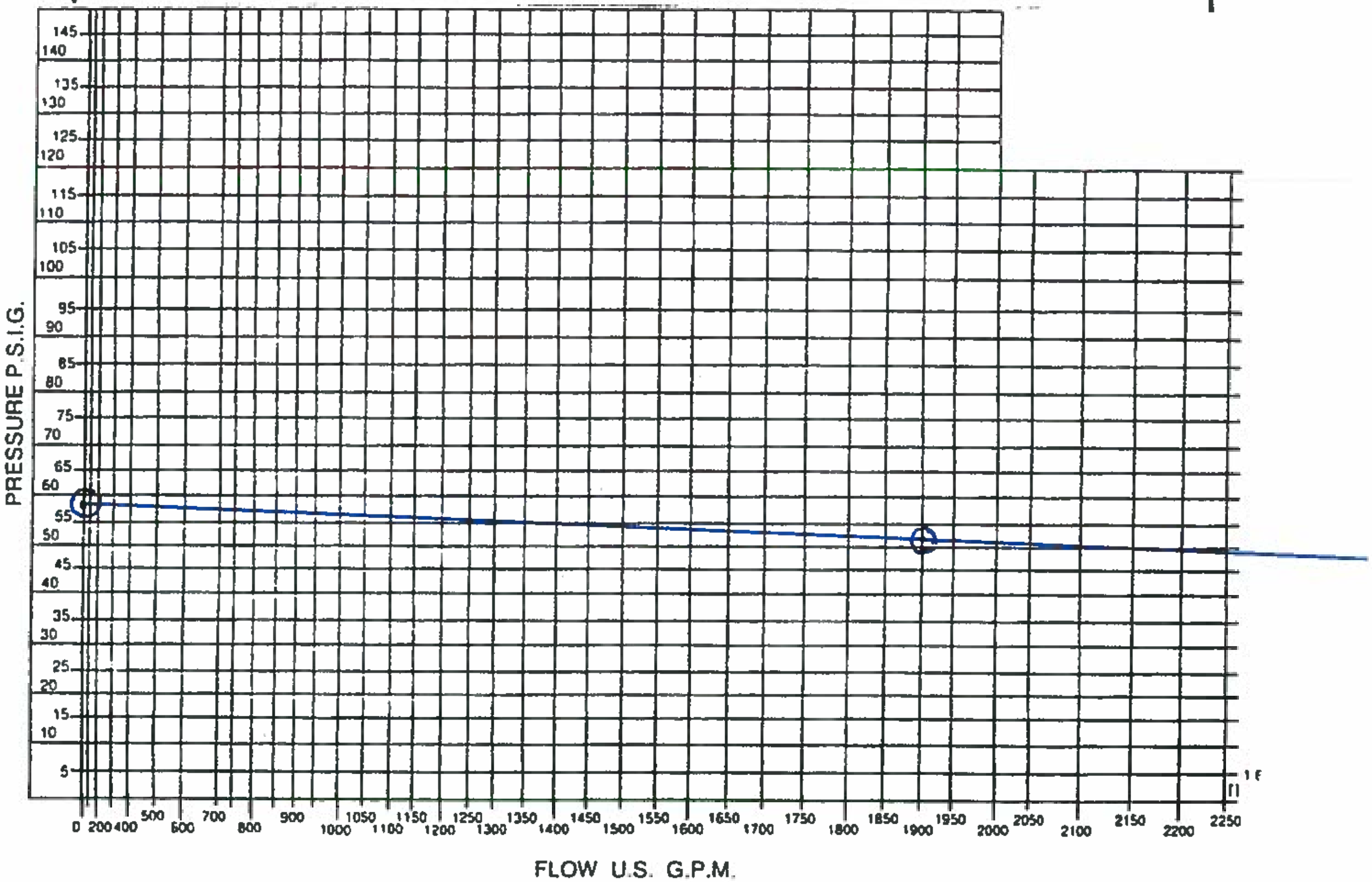
$Q_1 = \sim 1150$ USGPM

$Q_T = 2(29.83)(0.9)(2.5")^2 \sqrt{32}$
$= 1898.37$

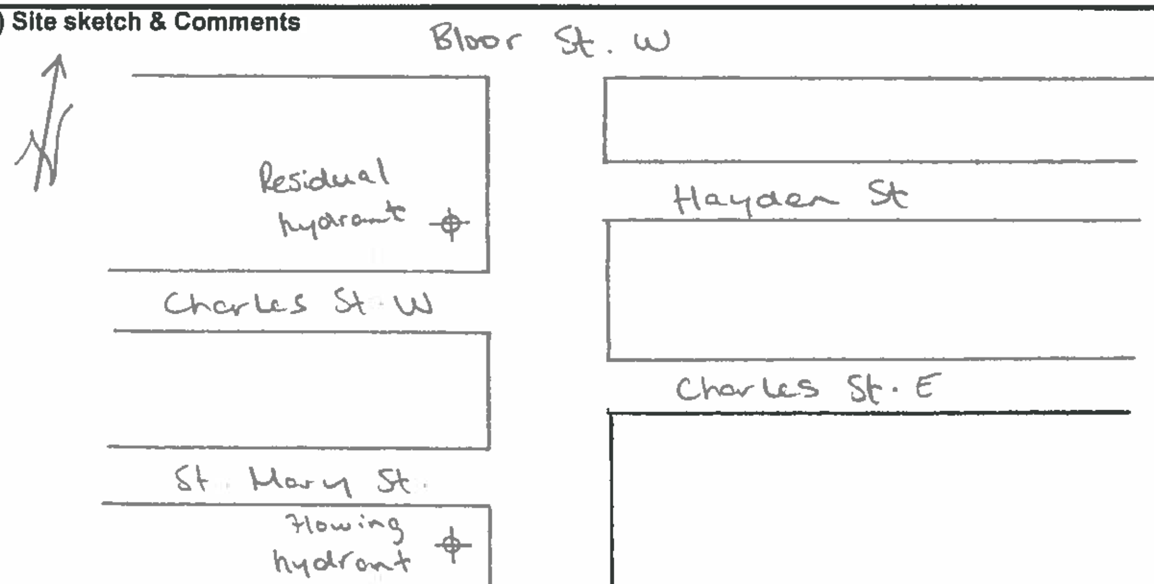
$Q_T = \sim 1900$ USGPM

Note: Hydrants tested according to NFPA 291: Recommended Practice for Fire Flow Testing and Marking of Hydrants

4) Plot



5) Site sketch & Comments



HYDRANT FLOW TEST FORM Test # 2

COLE ENGINEERING
Experience Enhancing Excellence

Project No: 2017-0591

Date: October 25, 2017

Site Location: 450 Yonge St. Toronto, On.

Hydrants Opened by: Toronto Water

Tested By: Gordon M, Shelley K.

1) Required photos:

- [x] Site Id & Date
- [x] Condition of Flow Hydrant
- [x] Location Overview
- [x] Condition of Residual Hydrant
- [x] Other

2) Test Data

Time of Test: 1700

Location of Test: (Flow) In front of 472 Yonge St.

(Residual) In front of 450 Yonge St.

Main Size: —

Static Pressure: 73 psi

	Number of Outlets & Orifice Size	Pitot Pressure	Flow (USGPM)	Residual Pressure
1	1 x 2.5"	50	1200	70
2	2 x 2.5"	28	1800	65
3				
4				

3) Calculations

$Q = 29.83\, cd^2\sqrt{p}$

Where c- cofficient of discharge (1 in smooth pipe)
d- pipe diameter (inches)
p- pitot reading (psi)
Q- flow (USGPM)

$Q_1 = (29.83)(0.9)(2.5")^2\sqrt{50}$

$= 1186.48$

$Q_1 = \sim 1200$ USGPM

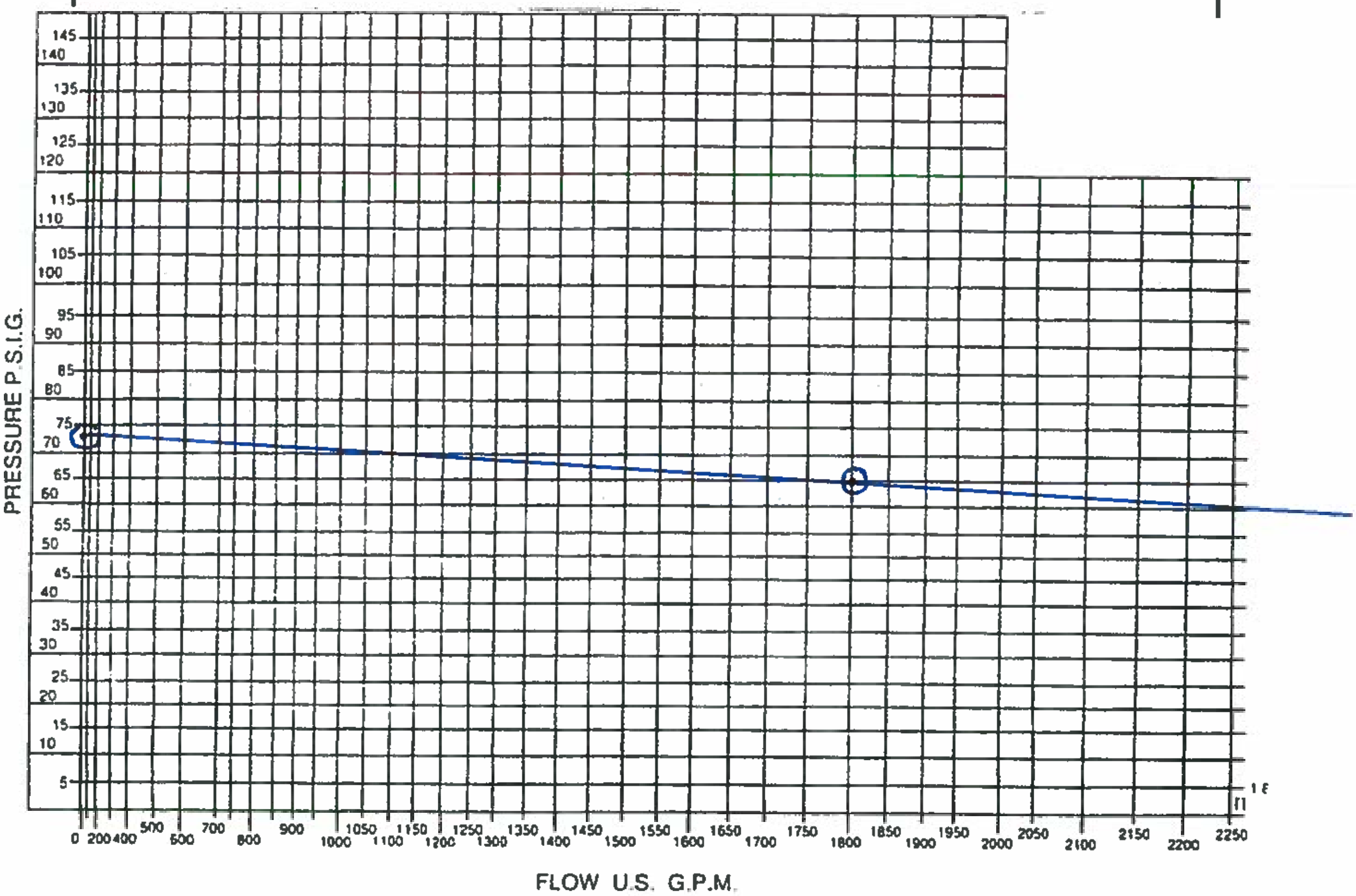
$Q_T = 2(29.83)(0.9)(2.5")^2\sqrt{28}$

$= 1775.76$

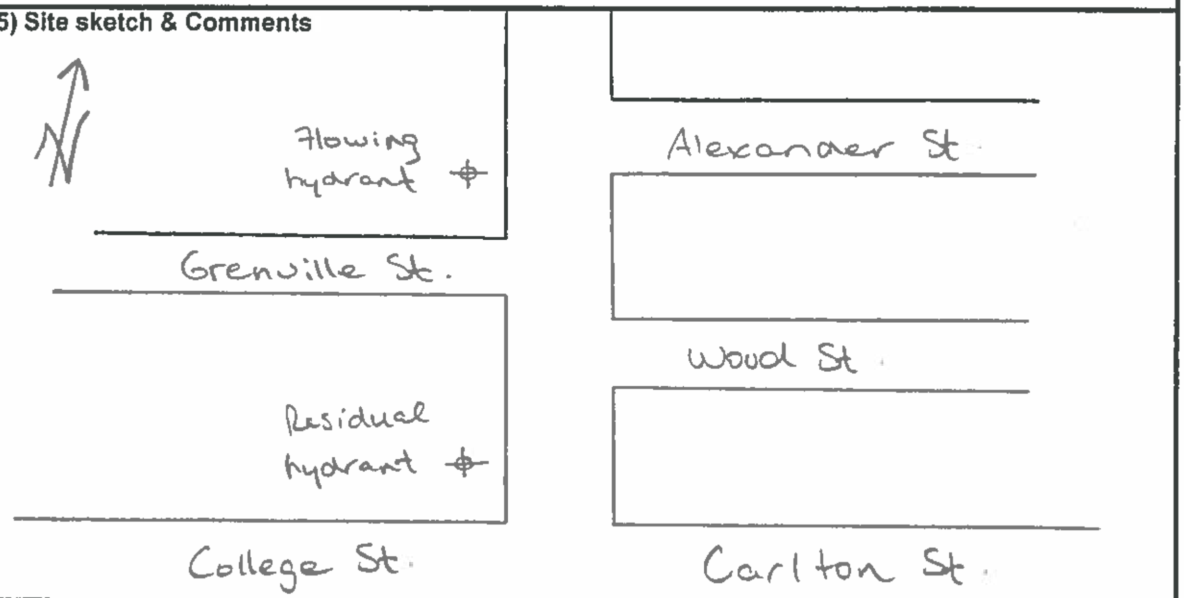
$Q_T = \sim 1800$ USGPM

Note: Hydrants tested according to NFPA 291: Recommended Practice for Fire Flow Testing and Marking of Hydrants

4) Plot



5) Site sketch & Comments



HYDRANT FLOW TEST FORM Test # 3

COLE ENGINEERING
Experience Enhancing Excellence

Project No: 2017-0591 **Date:** October 25, 2017

Site Location: 444 Yonge St. Toronto, On. **Hydrants Opened by:** Toronto Water

Tested By: Gordon M, Shelley K

1) Required photos:

- [x] Site Id & Date
- [x] Condition of Flow Hydrant
- [x] Location Overview
- [x] Condition of Residual Hydrant
- [x] Other

2) Test Data

Time of Test: 1710

Location of Test: (Flow) In front of 424 Yonge St.

(Residual) In front of 444 Yonge St.

Main Size: —

Static Pressure: 52 psi

	Number of Outlets & Orifice Size	Pitot Pressure	Flow (USGPM)	Residual Pressure
1	1 x 2.5"	42	1100	50
2	2 x 2.5"	26	1700	48
3				
4				

3) Calculations

$Q = 29.83\, cd^2\sqrt{p}$

Where c- cofficient of discharge (1 in smooth pipe)
d- pipe diameter (inches)
p- pitot reading (psi)
Q- flow (USGPM)

$Q_1 = (29.83)(0.9)(2.5")^2\sqrt{42}$

$= 1087.43$

$Q_1 = \sim 1100$ USGPM

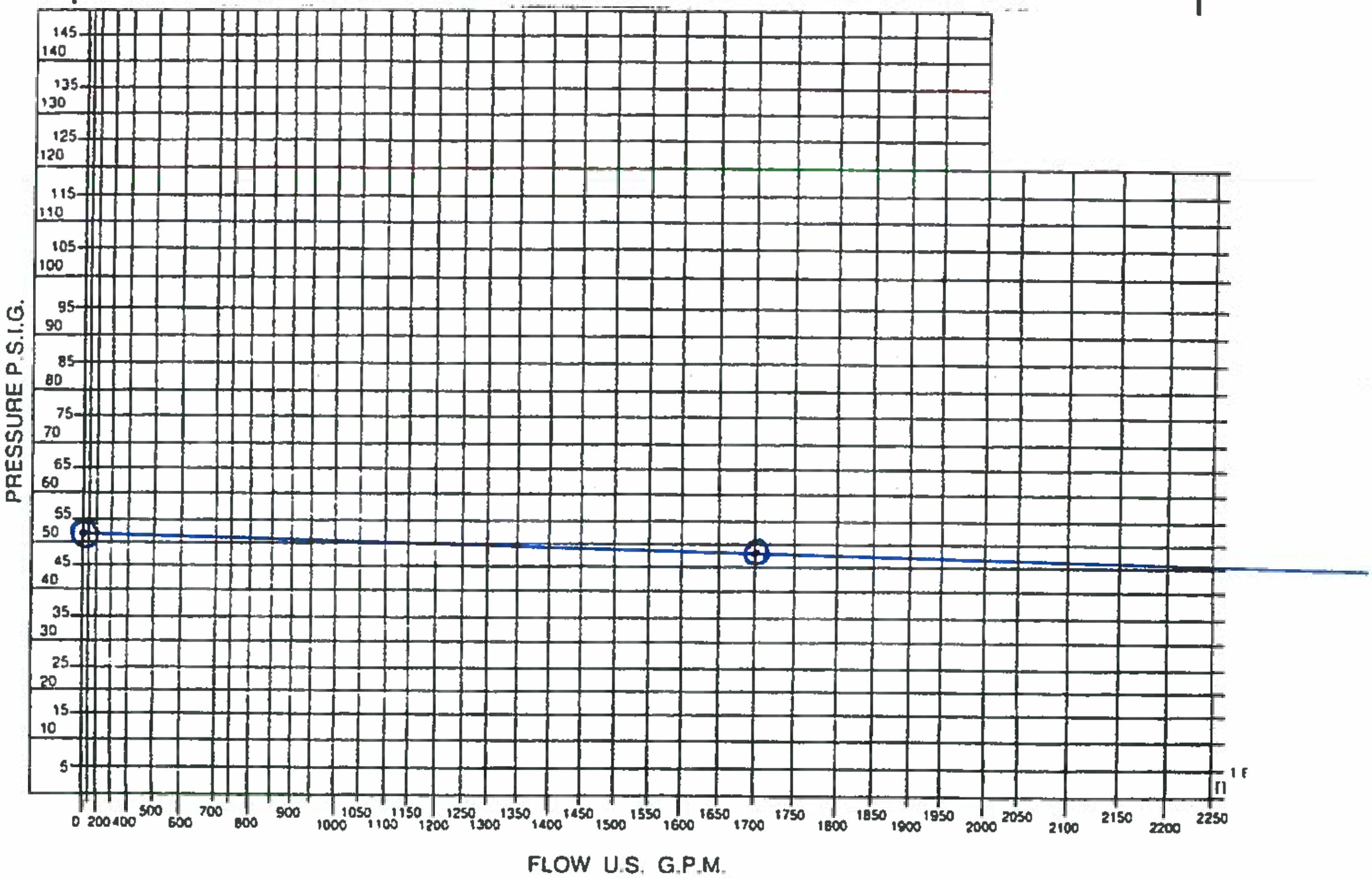
$Q_T = 2(29.83)(0.9)(2.5")^2\sqrt{26}$

$= 1711.17$

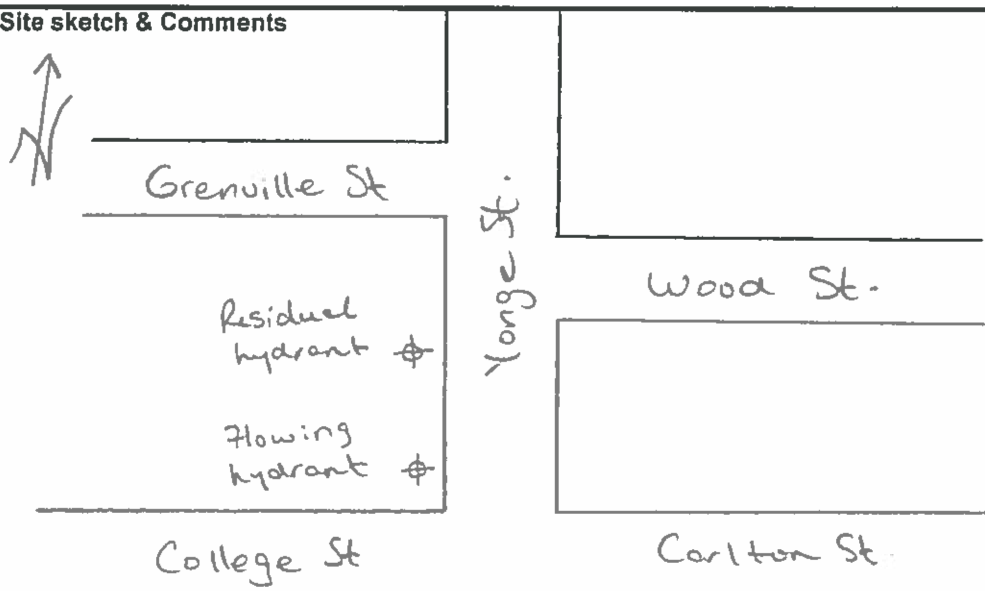
$Q_T = \sim 1700$ USGPM

Note: Hydrants tested according to NFPA 291: Recommended Practice for Fire Flow Testing and Marking of Hydrants

4) Plot



5) Site sketch & Comments



HYDRANT FLOW TEST FORM Test # 4

COLE ENGINEERING
Experience Enhancing Excellence

Project No: 2017 - 0591 **Date:** October 27, 2017

Site Location: 218 Yonge St. Toronto, On. **Hydrants Opened by:** Toronto Water

Tested By: Gordon M, Shelley K.

1) Required photos:

- [x] Site Id & Date
- [x] Condition of Flow Hydrant
- [x] Location Overview
- [x] Condition of Residual Hydrant
- [x] Other

2) Test Data

Time of Test: 1720

Location of Test: (Flow) In front of 190 Yonge St.

(Residual) In front of 218 Yonge St.

Main Size: —

Static Pressure: 73 psi

	Number of Outlets & Orifice Size	Pitot Pressure	Flow (USGPM)	Residual Pressure
1	1 x 2.5"	40	1050	71
2	2 x 2.5"	12	1150	68
3				
4				

3) Calculations

$Q = 29.83\, cd^2\sqrt{p}$

Where c- cofficient of discharge (1 in smooth pipe)
d- pipe diameter (inches)
p- pitot reading (psi)
Q- flow (USGPM)

$Q_1 = (29.83)(0.9)(2.5")^2\sqrt{40}$

$= 1061.22$

$Q_1 = \sim 1050$ USGPM

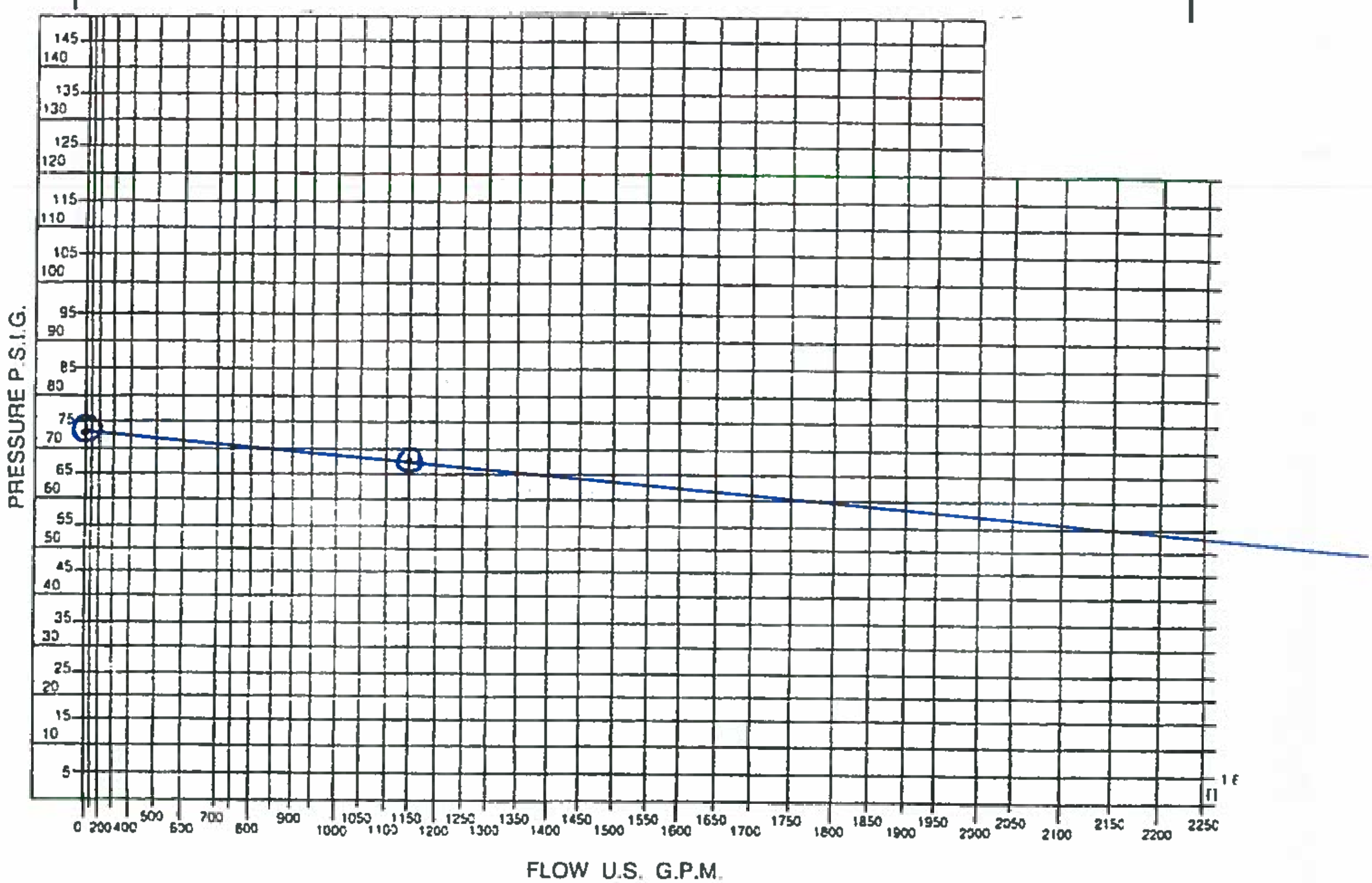
$Q_T = 2(29.83)(0.9)(2.5")^2\sqrt{12}$

$= 1162.51$

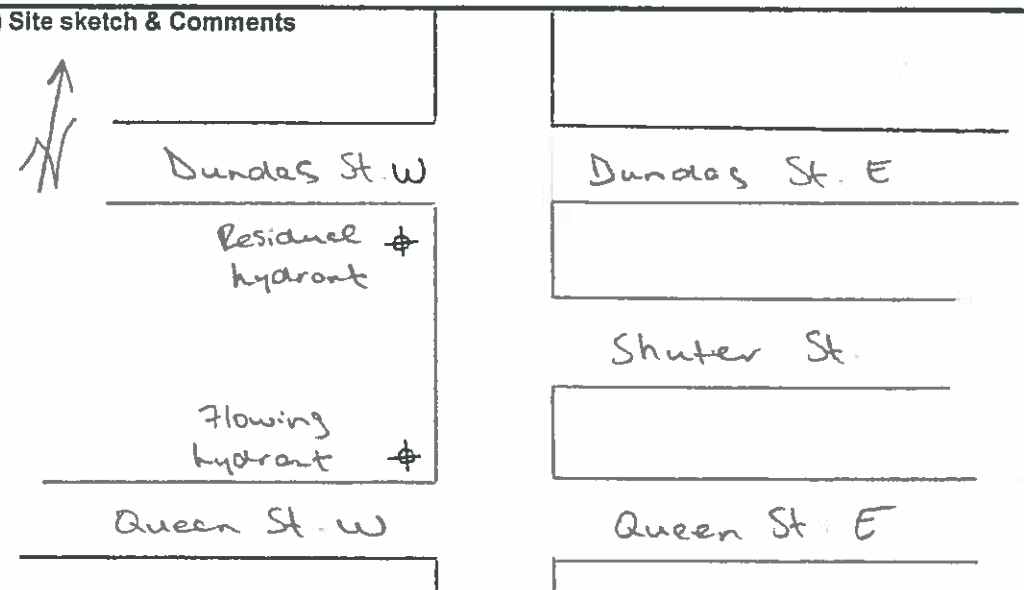
$Q_T = \sim 1150$ USGPM

Note: Hydrants tested according to NFPA 291: Recommended Practice for Fire Flow Testing and Marking of Hydrants

4) Plot

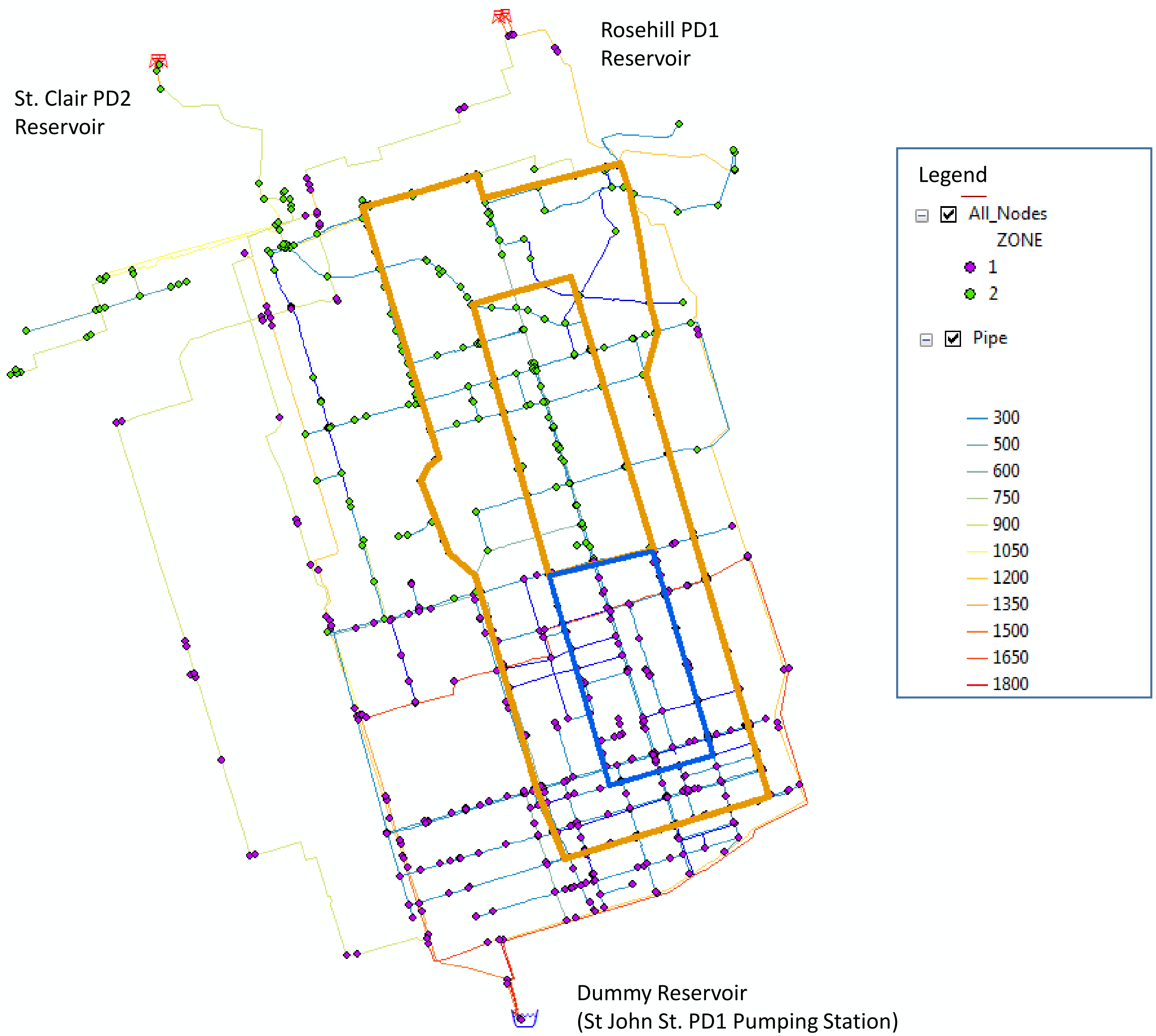


5) Site sketch & Comments



APPENDIX A-5

InfoWater Model Layout
of Water System

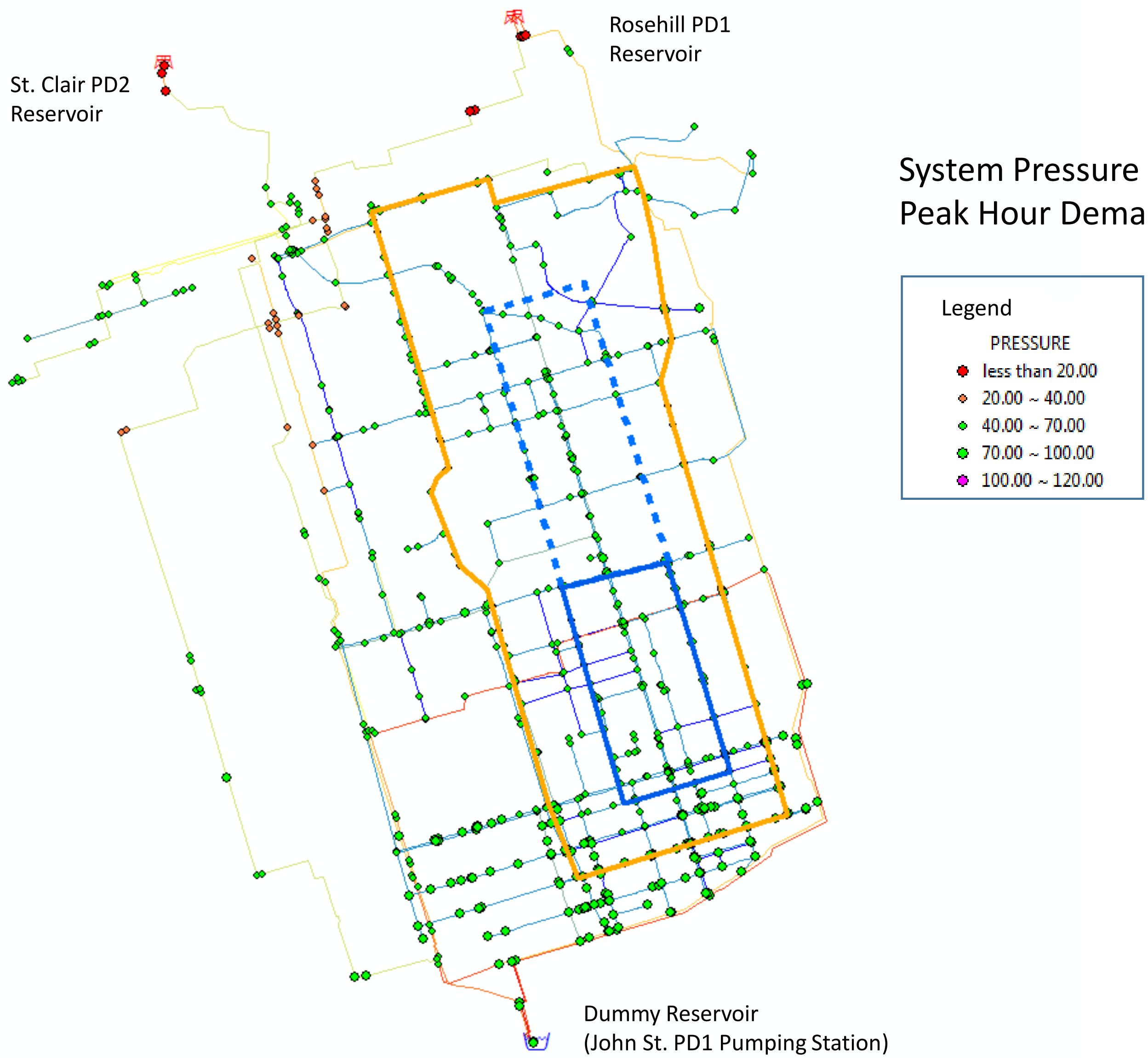


Rosehill PD1
Reservoir
St. Clair PD2
Reservoir
Dummy Reservoir
(St John St. PD1 Pumping Station)
Legend
All_Nodes
ZONE
1
2
Pipe
300
500
600
750
900
1050
1200
1350
1500
1650
1800

APPENDIX A-6

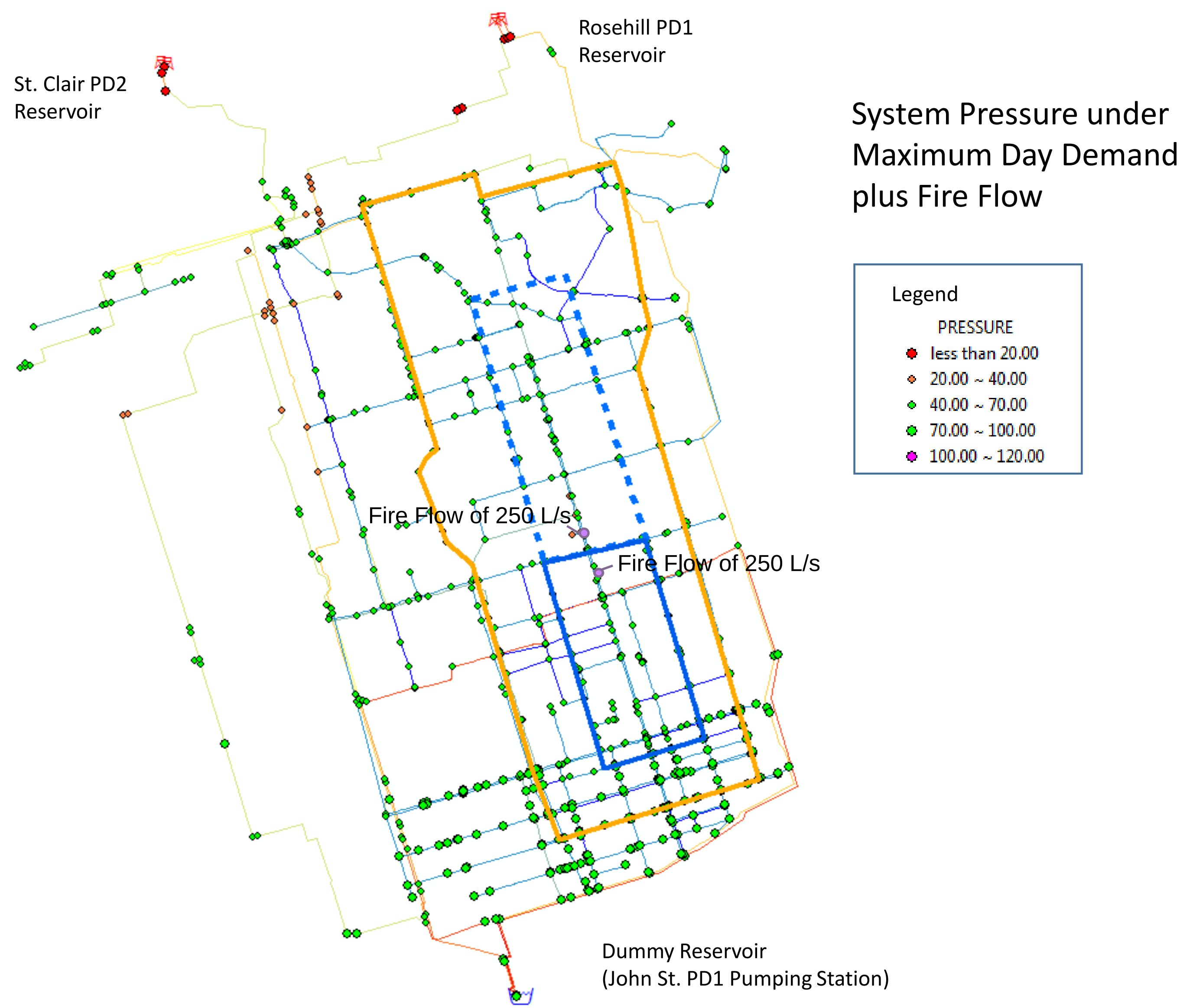
Water System Pressure Under Existing Condition for Peak Hour Design Condition

System Pressure under Peak Hour Demand



APPENDIX A-7

Water System Pressure Under Existing Condition for Maximum Day Plus Fire Flow

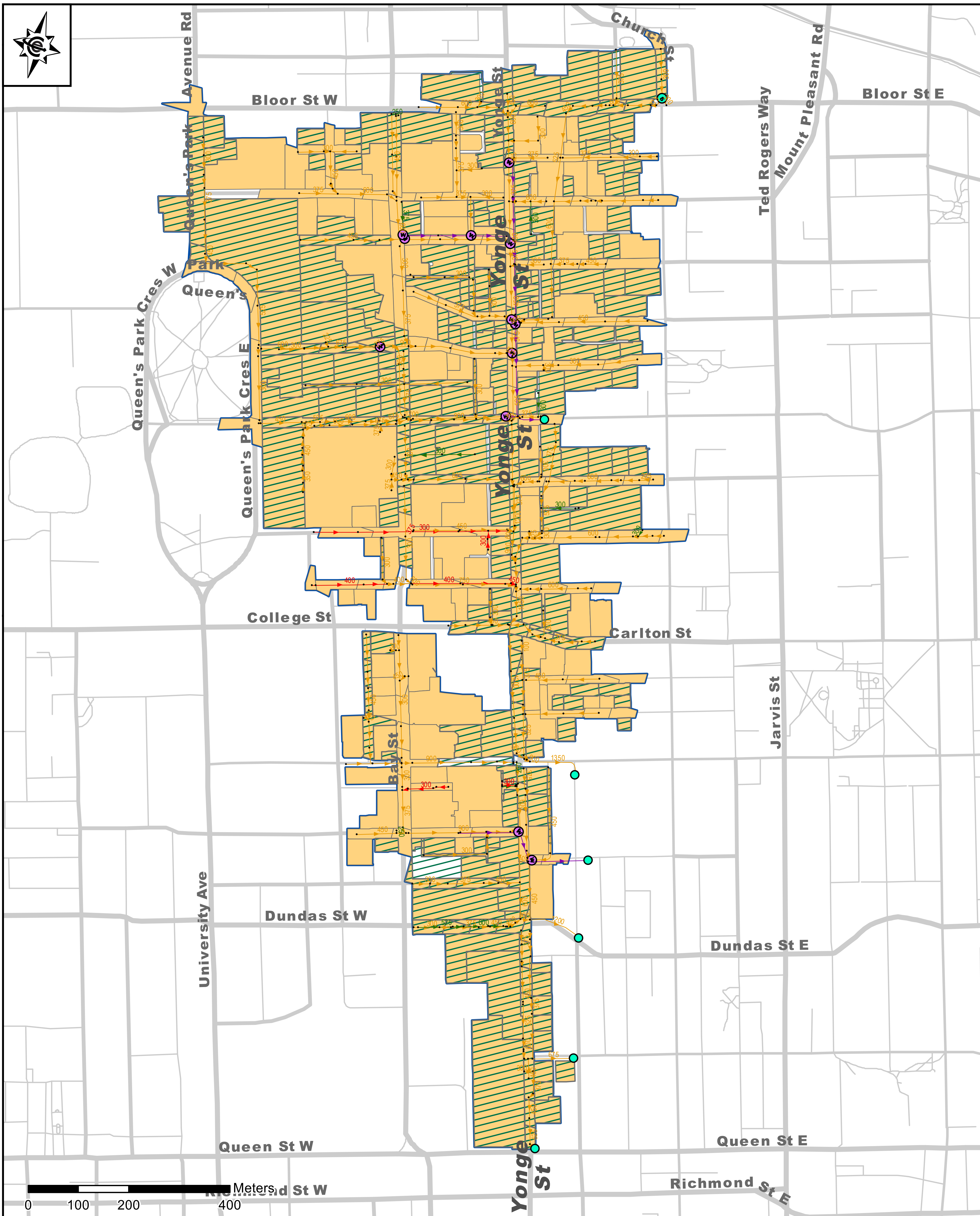


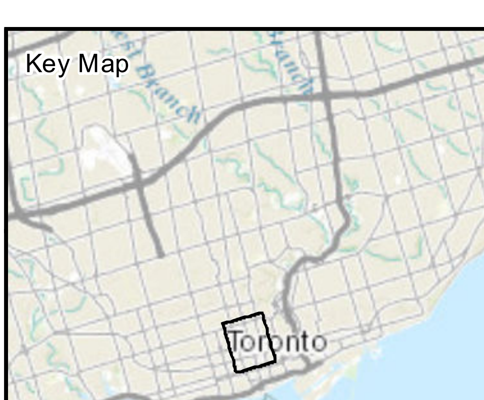
St. Clair PD2
Reservoir
Rosehill PD1
Reservoir
System Pressure under
Maximum Day Demand
plus Fire Flow
Legend
PRESSURE
less than 20.00
20.00 ~ 40.00
40.00 ~ 70.00
70.00 ~ 100.00
100.00 ~ 120.00
Fire Flow of 250 L/s
Fire Flow of 250 L/s
Dummy Reservoir
(John St. PD1 Pumping Station)

APPENDIX B

Combined Sewer Analysis

Figure B.1 - InfoWorks Model Overview





Legend

- Manhole
- Cut Model Outfall
- Weir
- Sluice Gate
- Combined Sewer
- Sanitary Sewer
- CSO/SCSO
- Storm Sewer
- Yonge EA Contributing Area

Contributing Subcatchments to Yonge Corridor

- Sanitary Subcatchment
- Storm Subcatchment

Sewer Capacity Assessment
Yonge TOronto EA
City of Toronto

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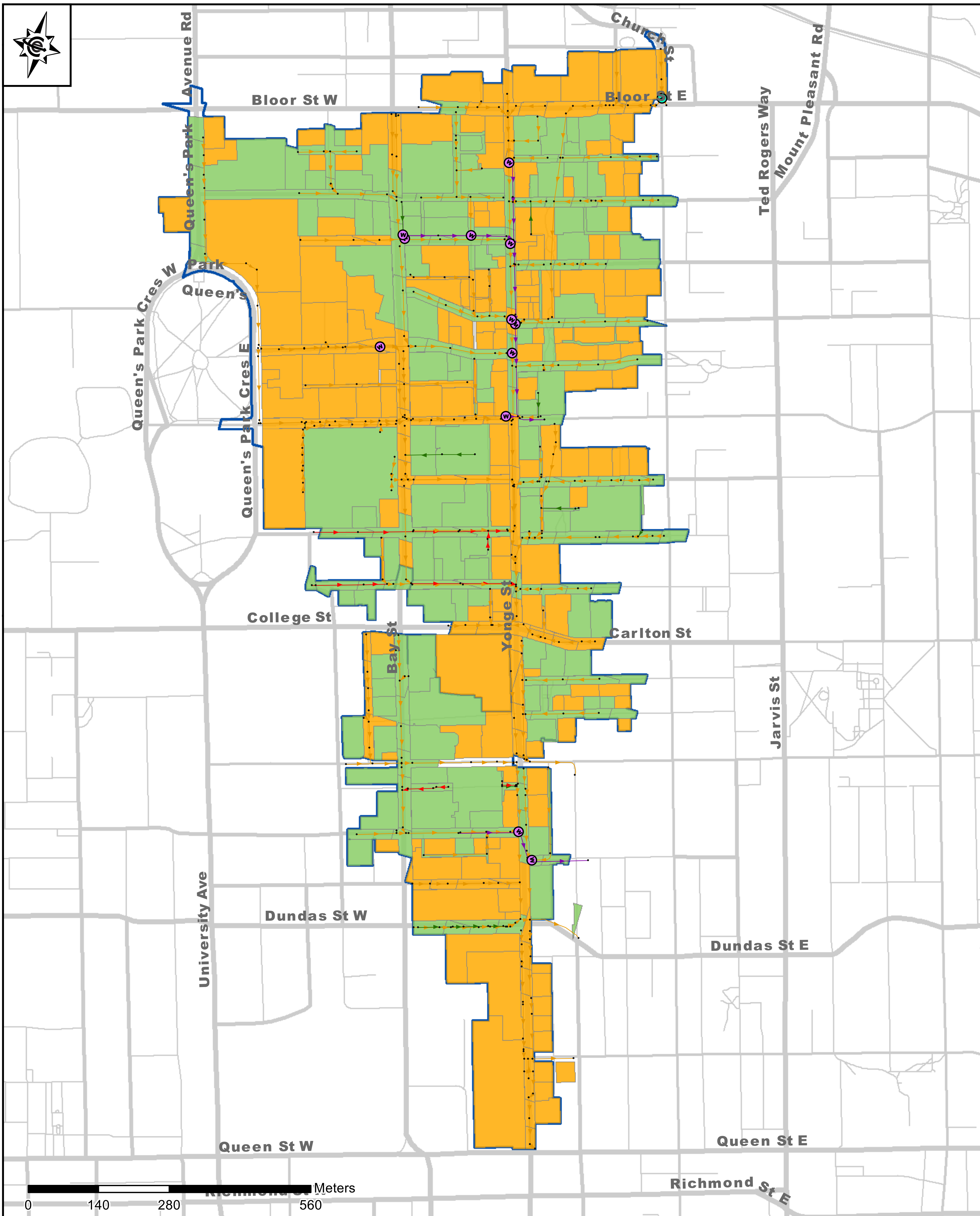
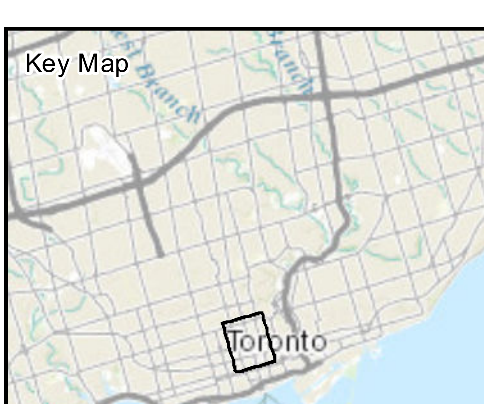
Figure B.2 - Storm Runoff System Assignment





Legend

- Weir
- Sluice Gate
- Combined Sewer
- Sanitary Sewer
- CSO/SCSO
- Storm Sewer
- Yonge EA Contributing Area

Subcatchments

- Connected to Combined Sewer
- Connected to Storm Sewer

Sewer Capacity Assessment
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City of Toronto

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Date: February 2019

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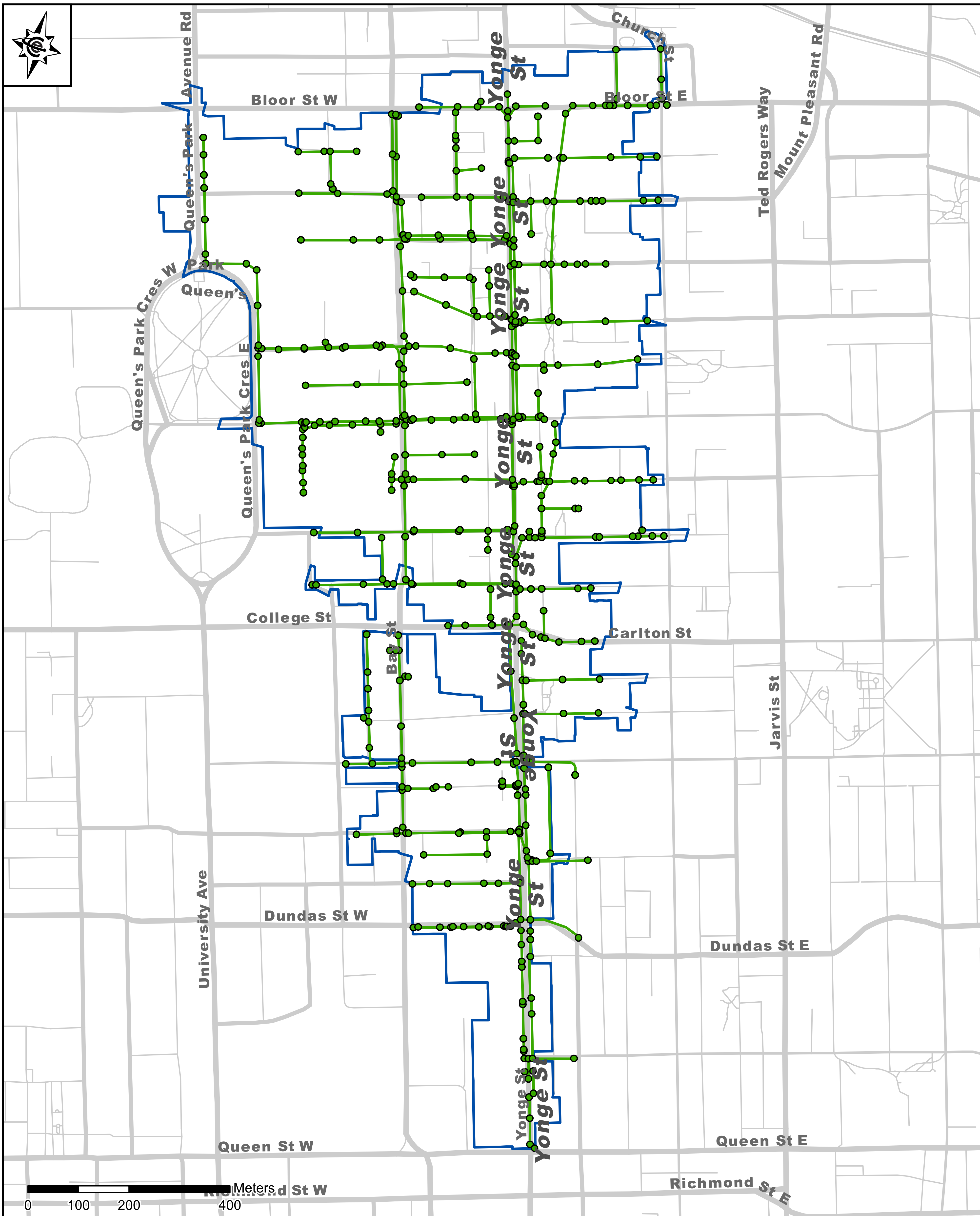
Figure B.3 - Dry Weather Flow Results



Legend

HGL Results at Nodes

- Freeflow, or Freeboard > 1.8 m

Sewer Capacity Results

- Free Flowing Sewer
- Surcharged Sewer (Backwater)
- Surcharged Sewer (Over Capacity)
- Yonge EA Contributing Area

Sewer Capacity Assessment
Yonge TOronto EA
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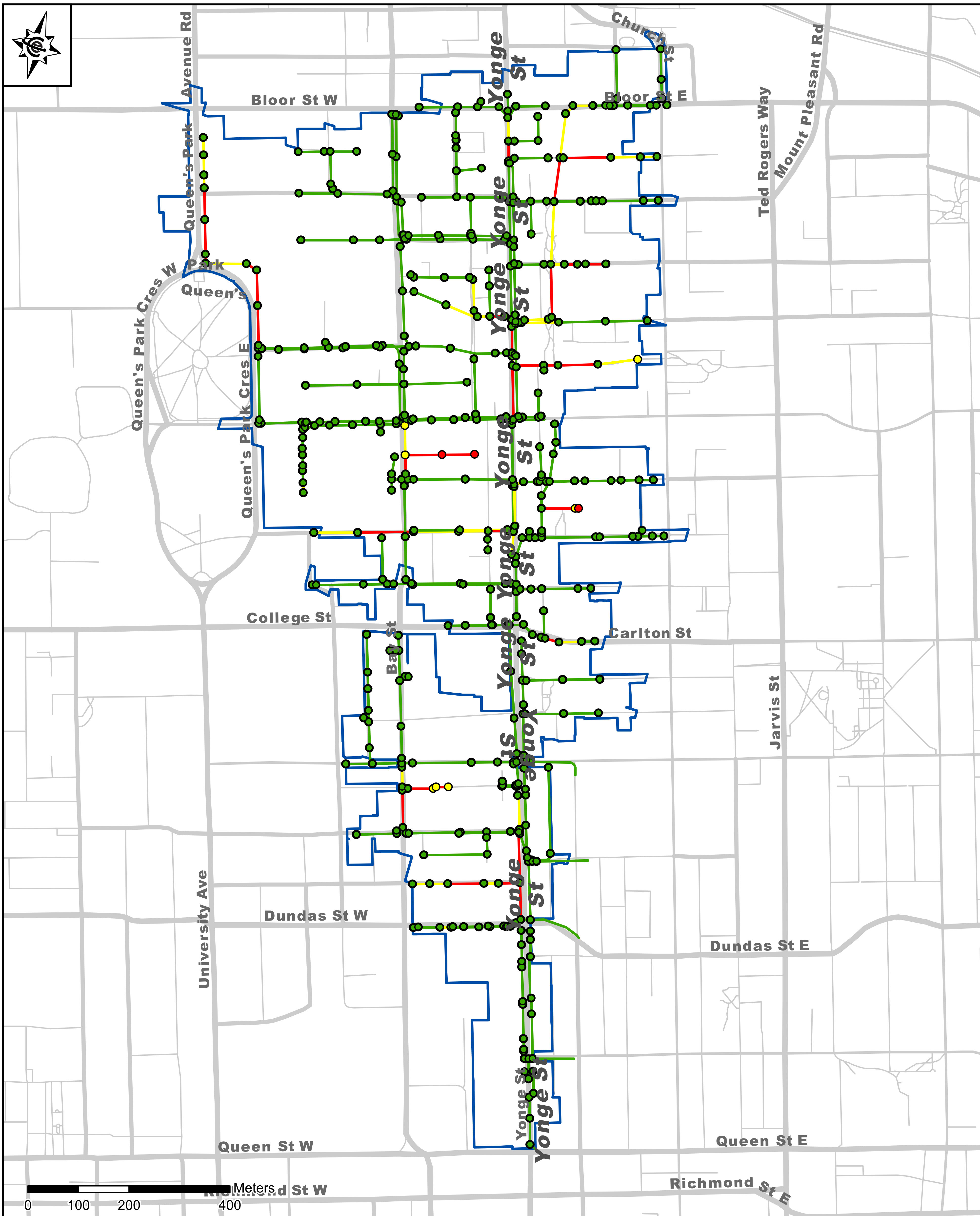
Figure B.4 - Design + 2-Year Storm Results



Legend

HGL Results at Nodes

- Freeflow, or Freeboard > 1.8 m
- Freeboard < 1.8 m
- Surface Flooding

Sewer Capacity Results

- Free Flowing Sewer
- Surcharged Sewer (Backwater)
- Surcharged Sewer (Over-Capacity)
- Yonge EA Contributing Area

Sewer Capacity Assessment
Yonge TOronto EA
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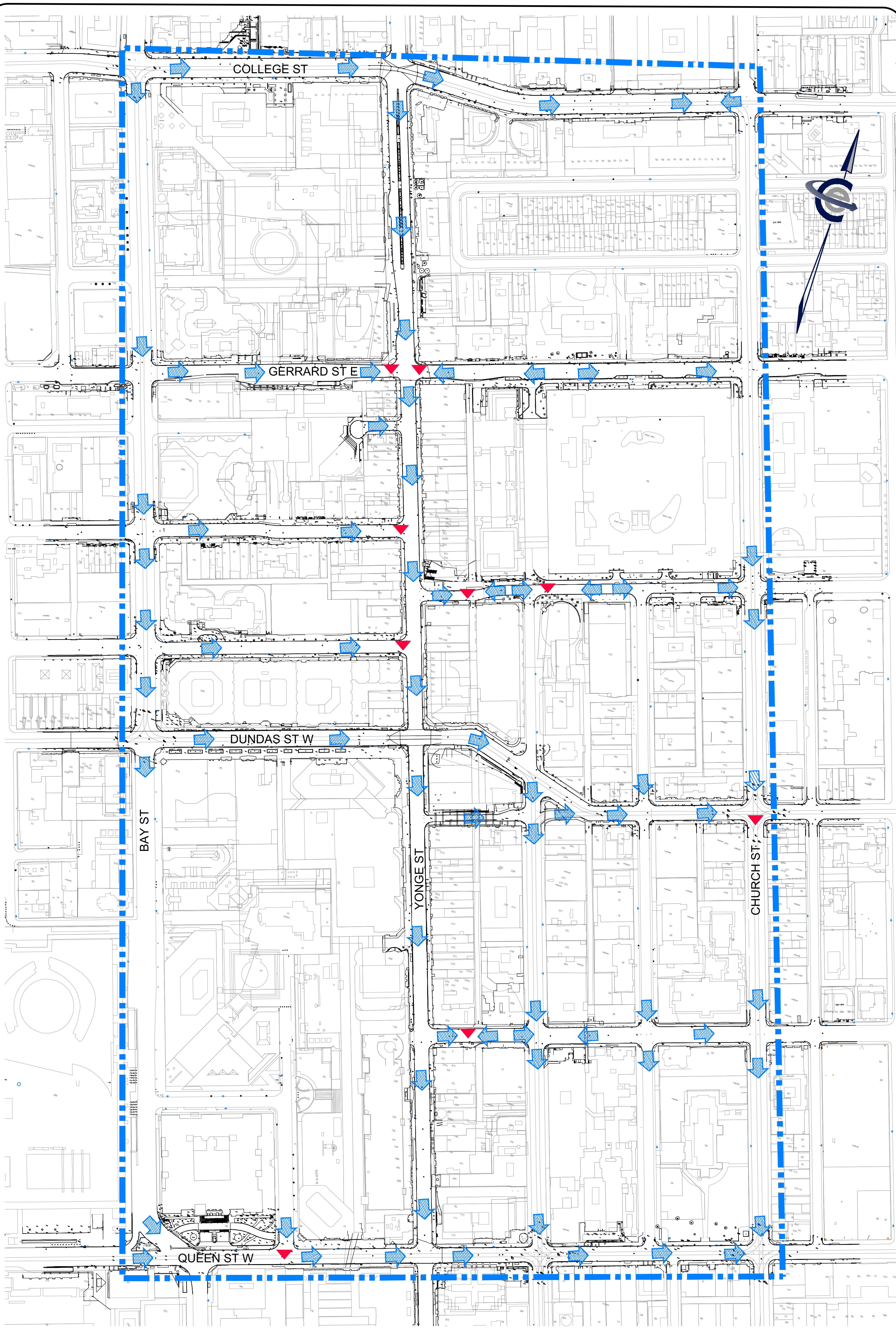
APPENDIX C

Overland (Major System) Analysis



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LEGEND

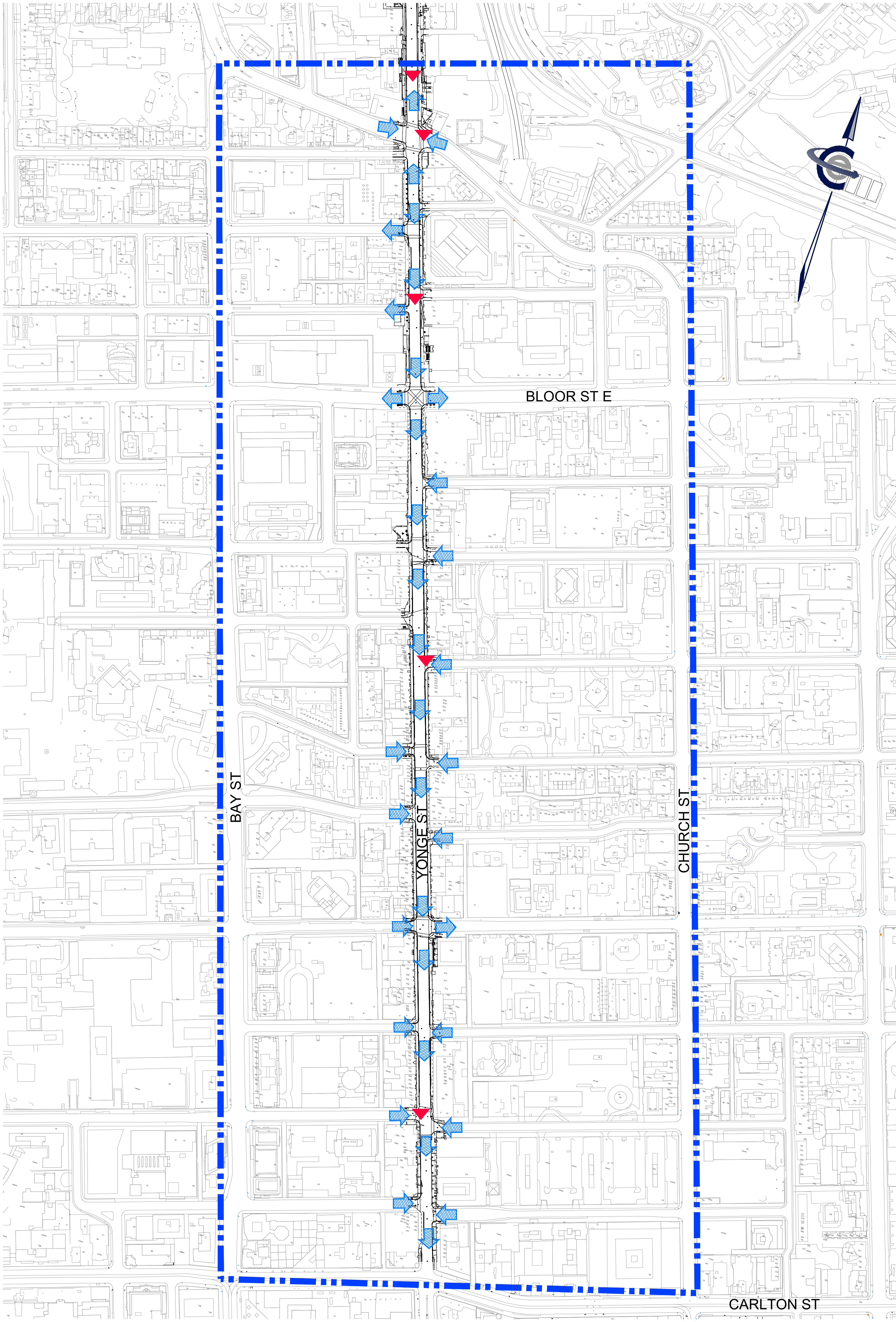
OVERLAND FLOW DIRECTION

FOCUS AREA

LOCAL LOW POINT

OVERLAND FLOW ROUTES
YONGE STREET EA STUDY
CITY OF TORONTO

DATE:	FEBRUARY 2019	PROJECT No.:	2017-0591
SCALE:	1:3000	FIGURE No.:	



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LEGEND

OVERLAND FLOW DIRECTION

EXTENDED FOCUS AREA BOUNDARY

LOCAL LOW POINT

OVERLAND FLOW ROUTES
YONGE STREET EA STUDY
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PROJECT No.:	2017-0591
FIGURE No.:	