



City of Barrie Minor/Major Drainage System Models

IPAL ENGINEERS ASSOCIATION – WORKSHOP AND ANNUAL GENERAL MEETING 4955

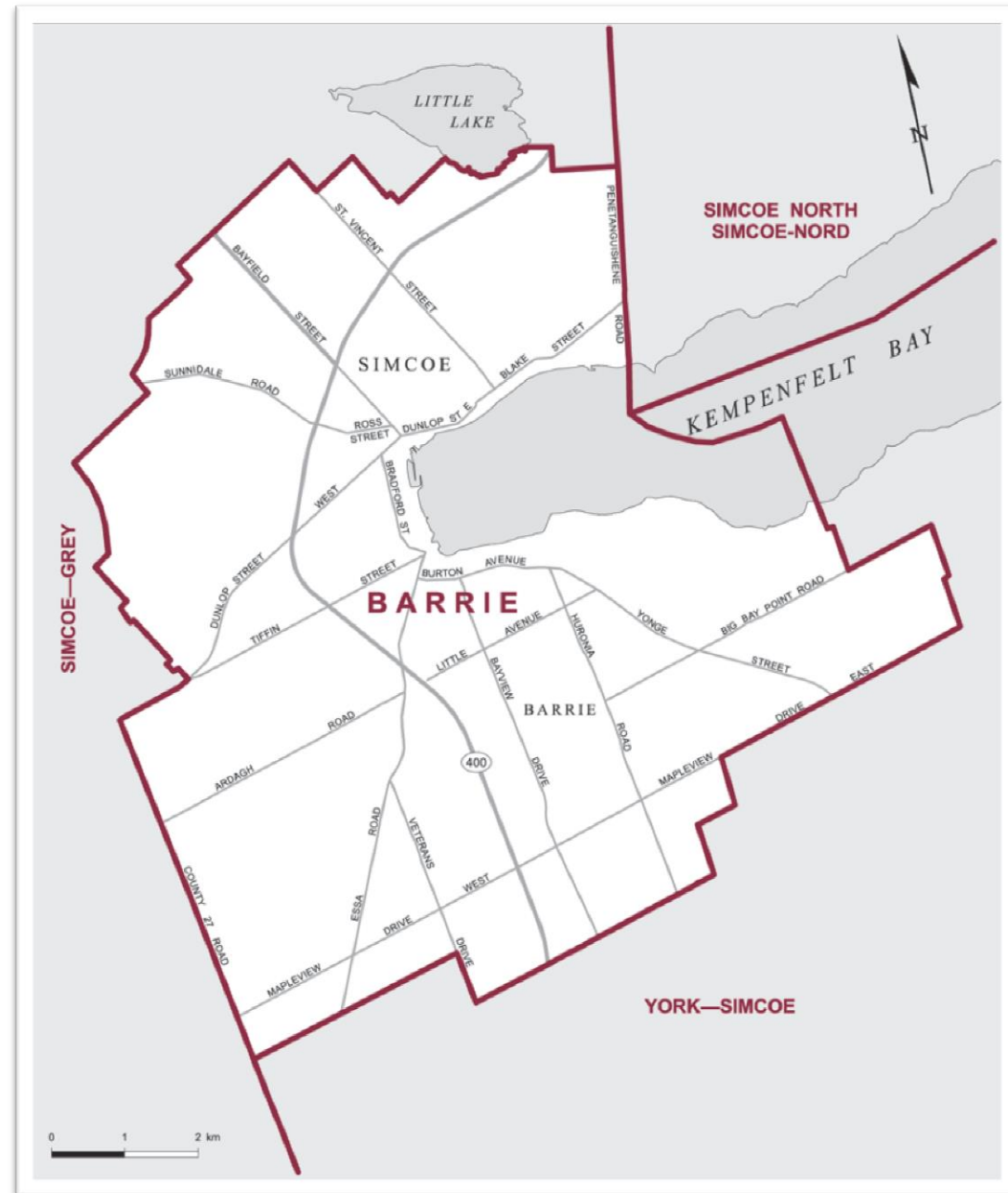
November 27, 2019

Tatham Engineering

- Mid-size civil engineering firm
- 30 years in operation
- Head office in Collingwood and branch offices in Barrie, Orillia, Bracebridge & Ottawa

City of Barrie

- Located on the shore of Lake Simcoe, approximately 1 hour east of the Blue Mountains and 1.5 hours north of Toronto
- Population of over 140,000 and area of 99 sq. km (9,900 ha)
- Barrie is composed of 25 watersheds/drainage areas containing:
 - 403 km of storm sewers and 7400 storm structures;
 - 181 stormwater management ponds; and
 - 13 significant watercourses.



Background

- Existing Drainage issues:
 - Deteriorating and undersized infrastructure;
 - Flooding of private and public property;
 - Municipal infrastructure located on private property;
 - Adverse water quality; and
 - Areas absent of formal drainage systems.
- Barrie identified the importance of careful planning and creative solutions to deal with stormwater
- The City's existing drainage systems had been modelled on a piecemeal basis
- Barrie chose to proactively address these issues by developing City-wide minor and major drainage system hydraulic and hydrologic models



Study Objectives

- Develop, calibrate and verify city-wide minor and major drainage system models allowing for:
 - A consistent modelling approach;
 - Identification of existing drainage deficiencies;
 - Development and evaluation of solutions;
 - Level of service and risk assessments;
 - Prioritization of the preferred solutions;
 - Assessment of climate change and land use impacts; and
 - Model sharing with agencies and consultants.

Model Selection

Background Information:

- Barrie compiled a comprehensive GIS database of its existing storm infrastructure
- Barrie obtained LiDAR data to provide an accurate digital elevation model of the entire City

Software Selection:

- Minor drainage system hydrologic and hydraulic model - PCSWMM
- Major drainage system hydrologic model – Visual OTTHYMO
- Major drainage system hydraulic model – HEC-RAS



Minor Drainage System Model Requirements

Hydrologic Model:

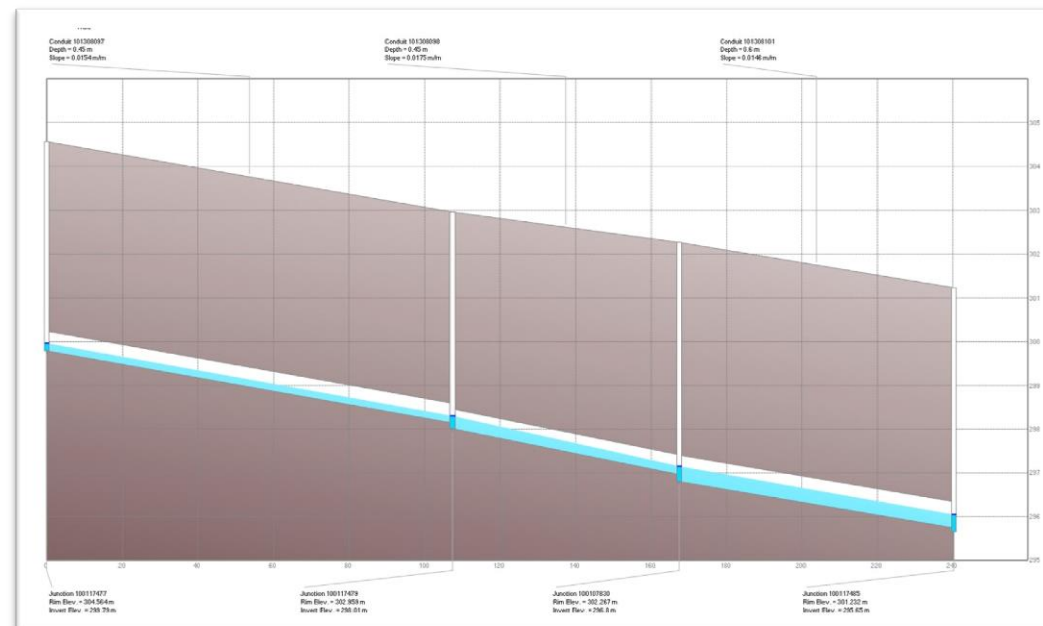
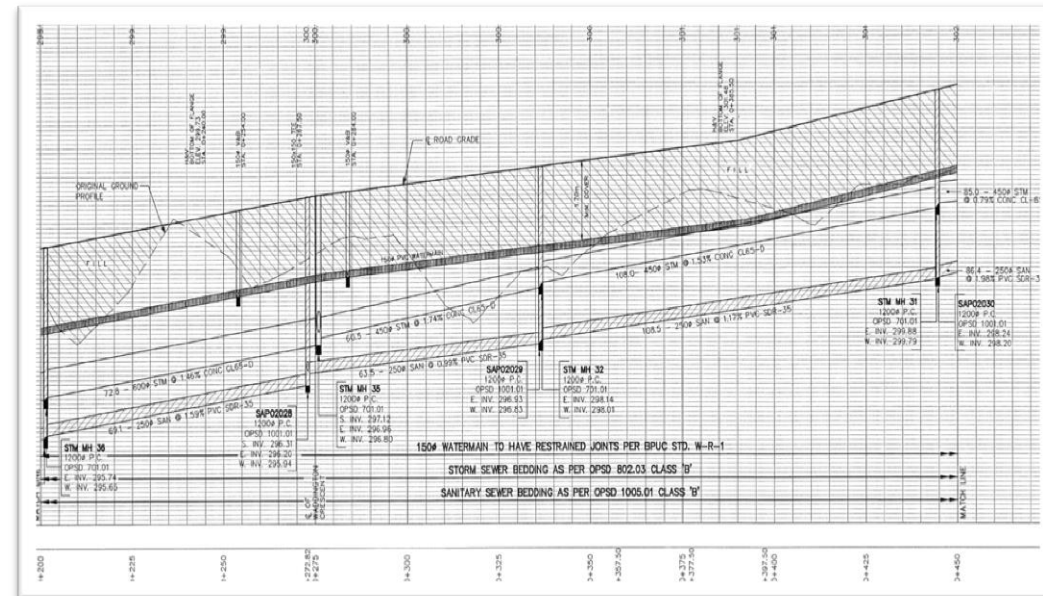
- Storm structure (junction) ID, co-ordinates and rim elevation
- Digital elevation model
- Soils and land use information
- SWMF stage-storage-discharge curves
- Rainfall data / streamflow data



Minor Drainage System Model Requirements

Hydraulic Model:

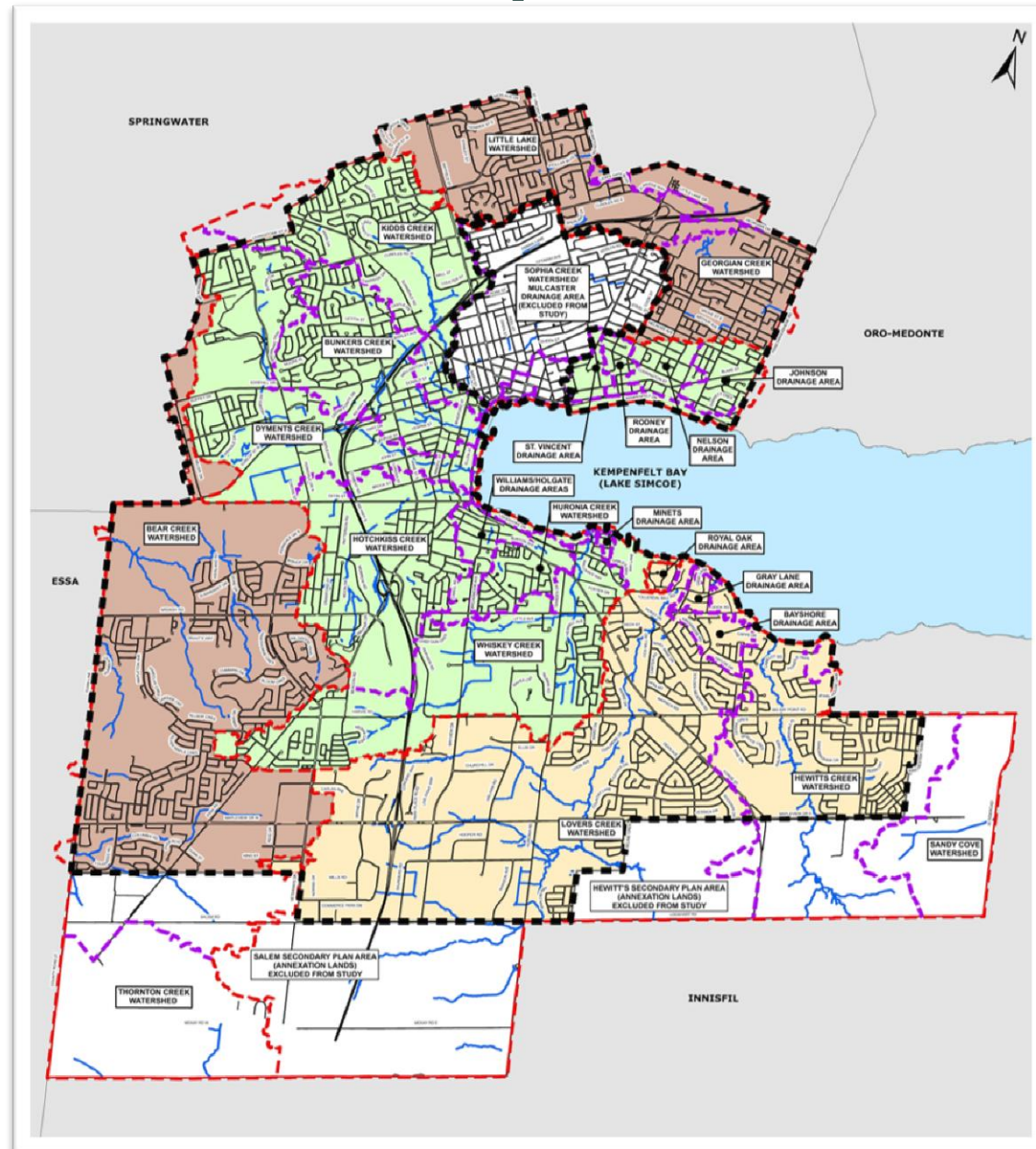
- Conduit (storm sewer) ID, co-ordinates, length, material, inverts, shape, and size
- Road geometry for dual drainage system
- SWMF stage-storage-discharge curves
- Major drainage system hydraulic model (HEC-RAS)
- Storm sewer outfall information



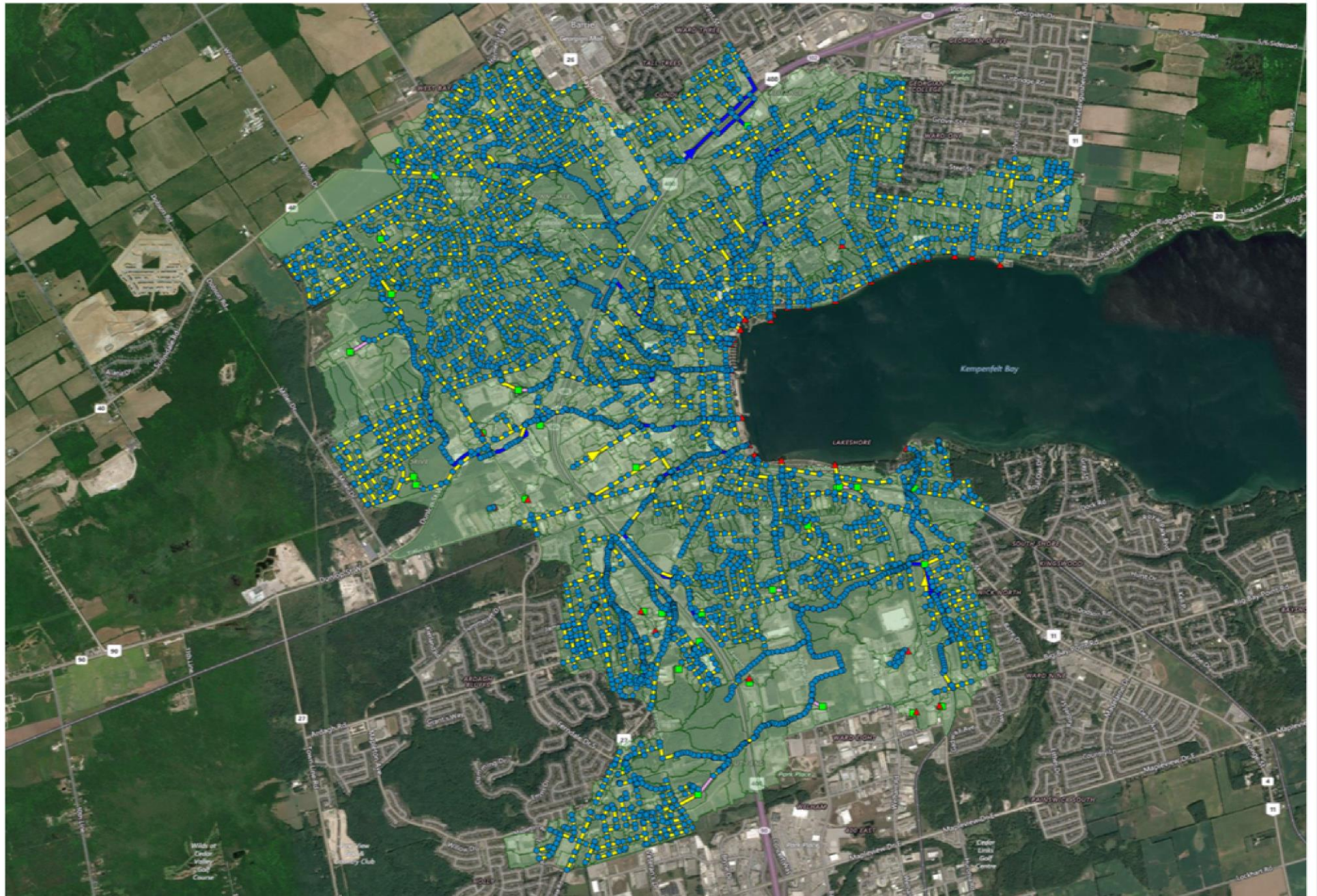
Major Drainage System Model Requirements

Hydrologic Model:

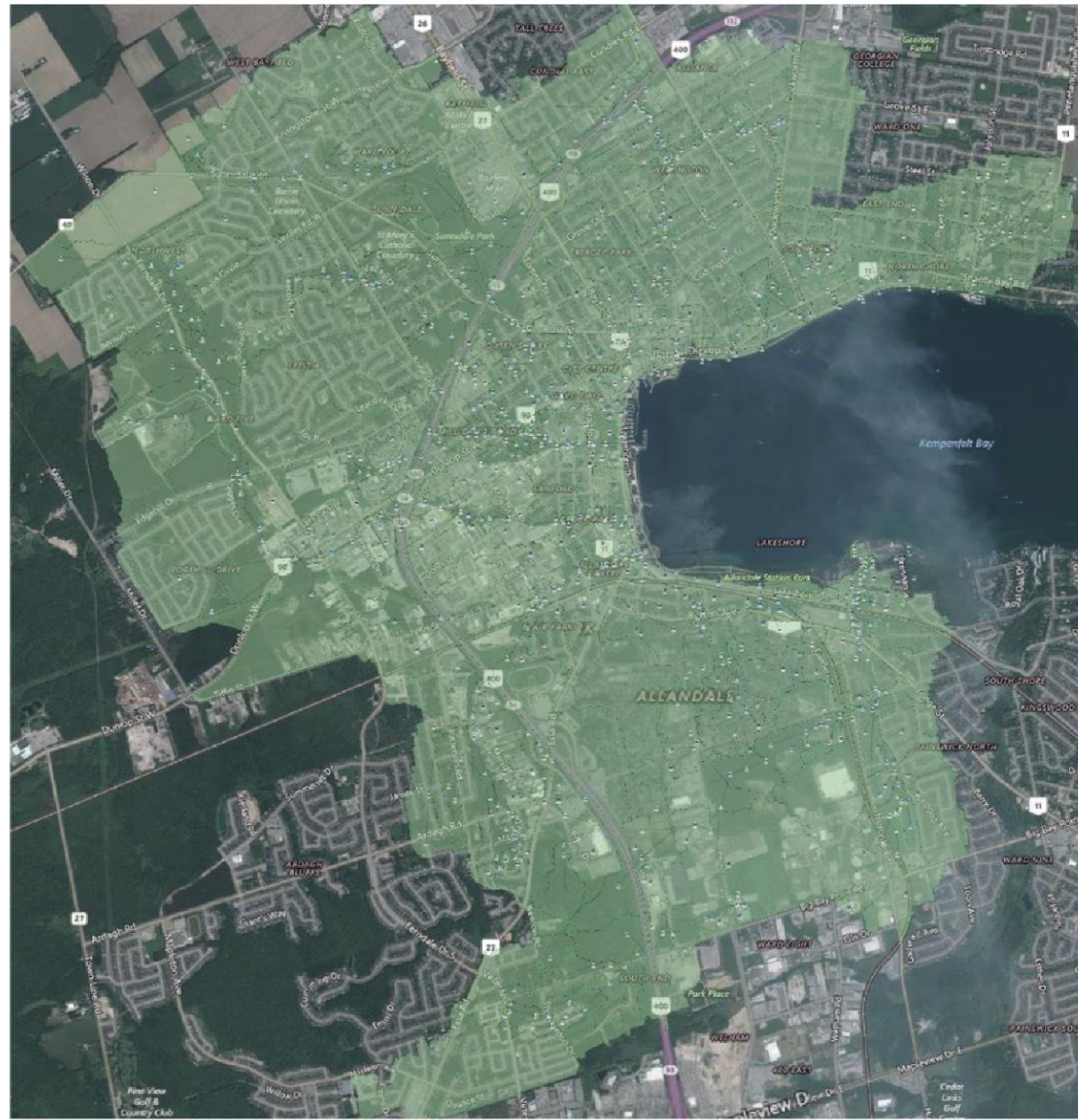
- Digital elevation model
- Soils and land use data
- SWMF stage-storage-discharge curves
- Watercourse, culvert and trunk storm sewer cross-section/shape, slope and length
- Rainfall data / streamflow data



Model Creation



Model Creation



Model Creation



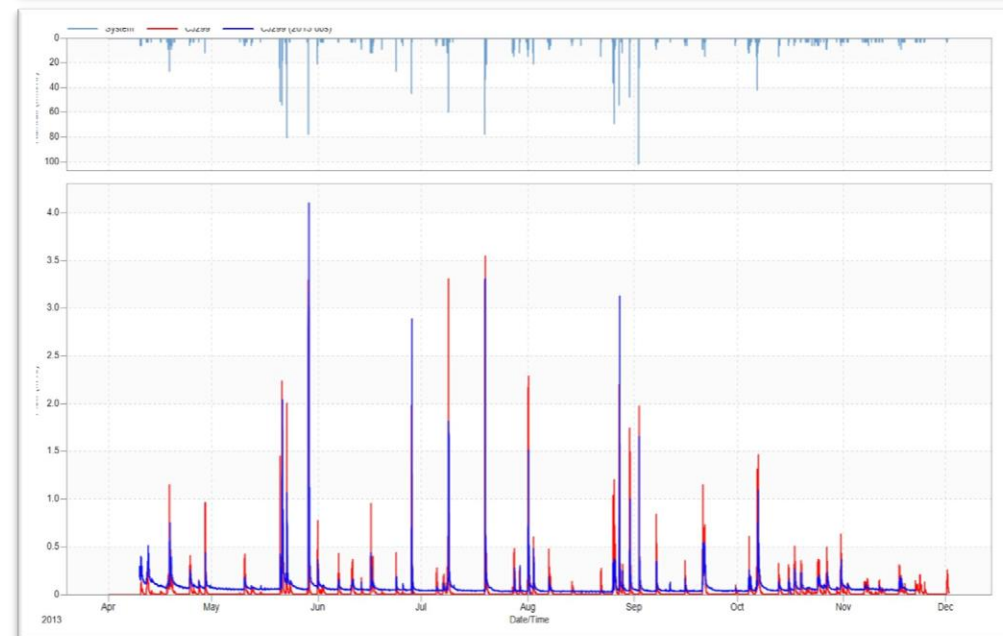
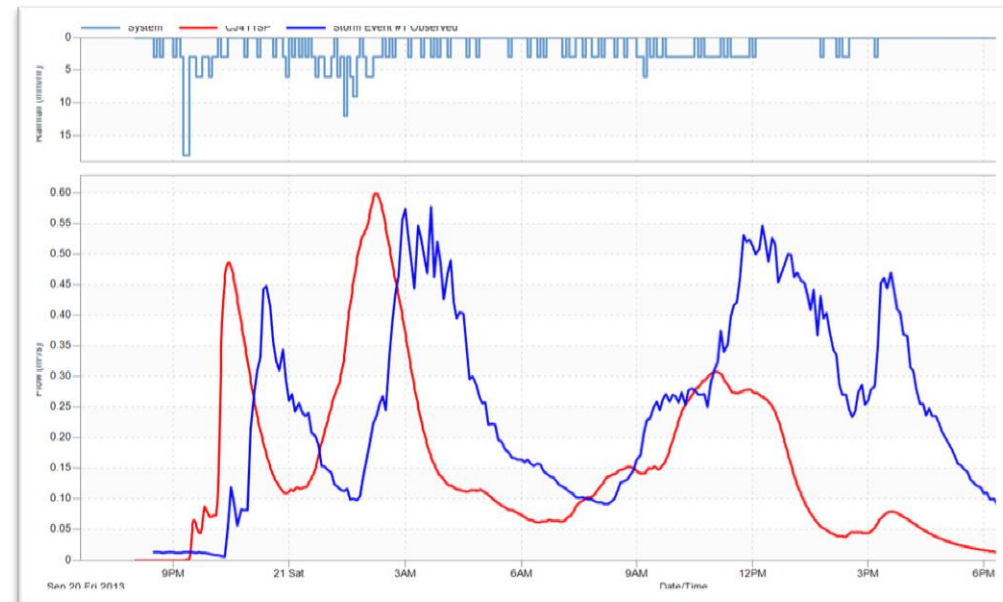
Model Calibration/Validation

Calibration:

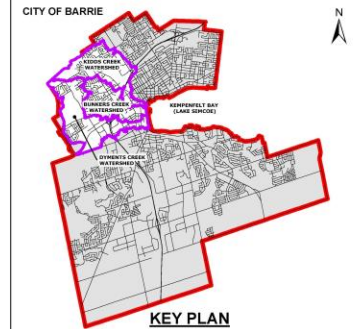
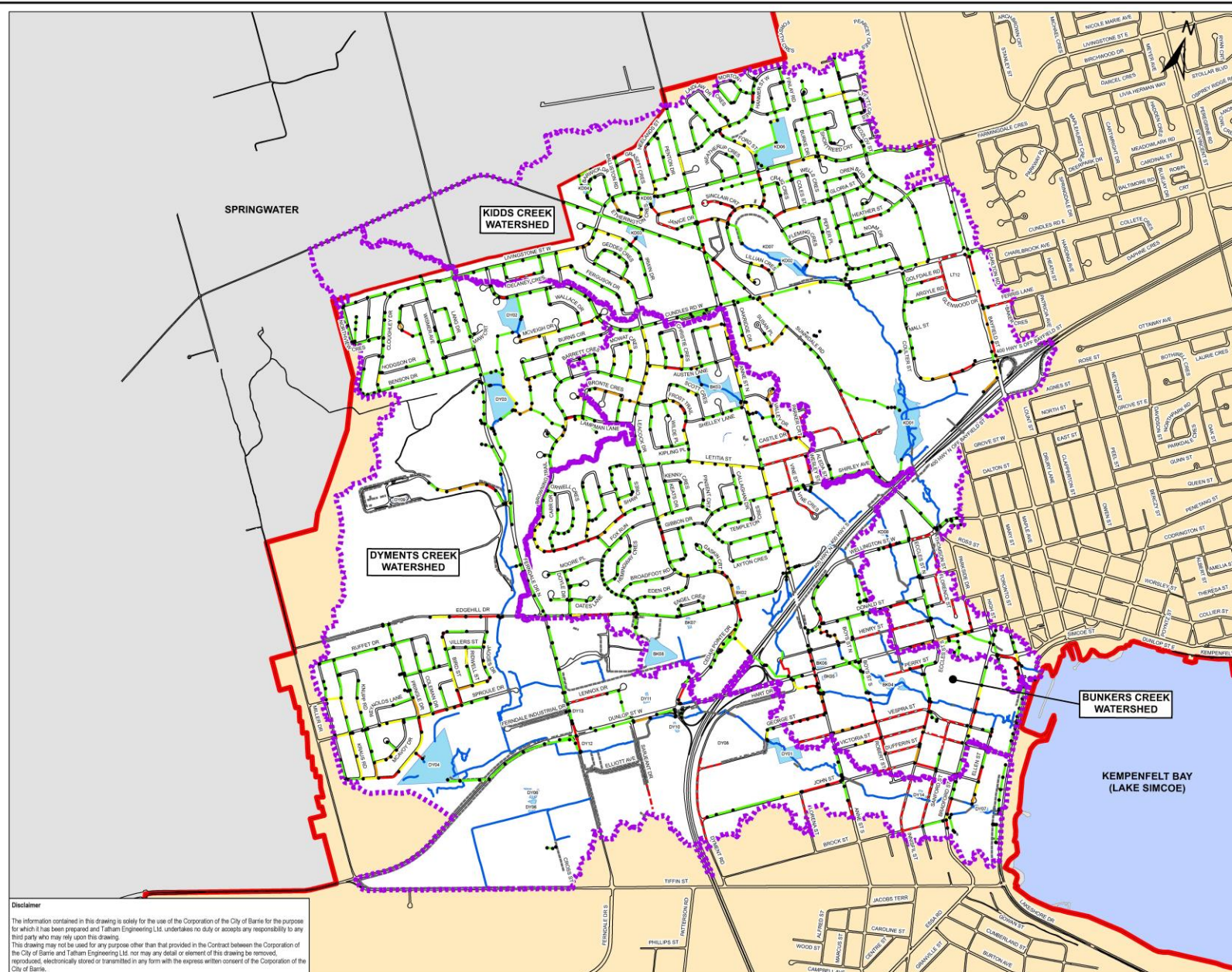
- Identified the subcatchment parameters with inherent uncertainty
- Sensitivity analysis
- Selected a series of calibration storm events
- Adjusted subcatchment parameters to fit model peak flow hydrographs to streamflow monitoring data

Validation:

- Continuous simulation for streamflow monitoring data period of record
- Comparison of the modelled hydrographs against the streamflow monitoring data



Model Results



LEGEND

- STORM DEVICES
- CULVERT
- DITCH
- WATERCOURSE
- STORM SEWER (QMAX/QFULL FLOW > 115%)
- STORM SEWER (QMAX/QFULL FLOW 101%-115%)
- STORM SEWER (QMAX/QFULL FLOW 85%-100%)
- STORM SEWER (QMAX/QFULL FLOW < 85%)
- ROADS
- ABSENT OF MINOR DRAINAGE SYSTEM
- SWMF
- WATERSHED/DRAINAGE AREA BOUNDARY
- MUNICIPAL BORDER



SCALE = 1:10,000
0 125 250 500 750 1,000 Meters

DRAINAGE MASTER PLAN

BUNKERS CREEK, DYMENTS CREEK
& KIDDS CREEK WATERSHEDS

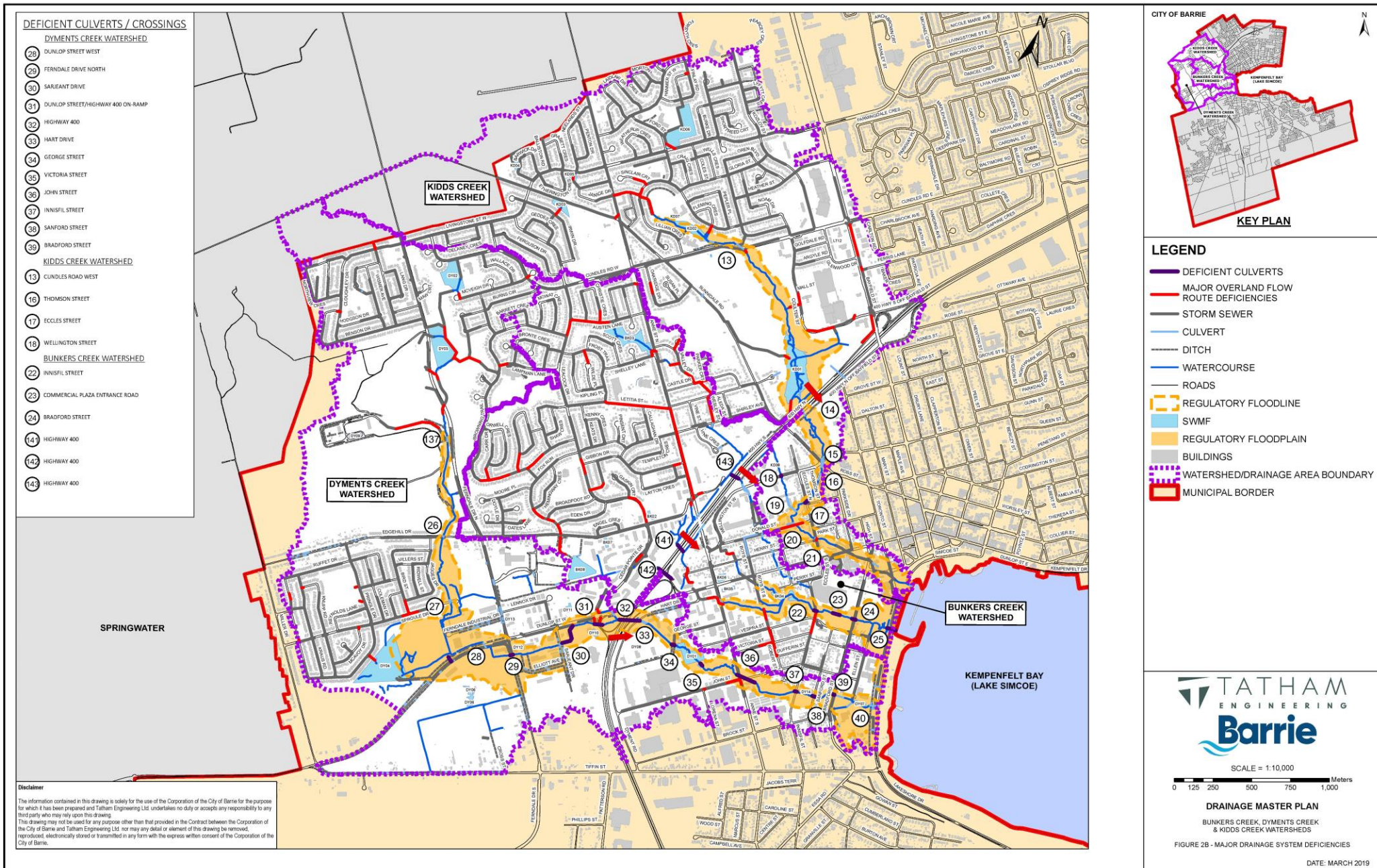
FIGURE 2A - MINOR DRAINAGE SYSTEM
DEFICIENCIES (5 YEAR STORM)

DATE: MARCH 2019

Disclaimer

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Model Results

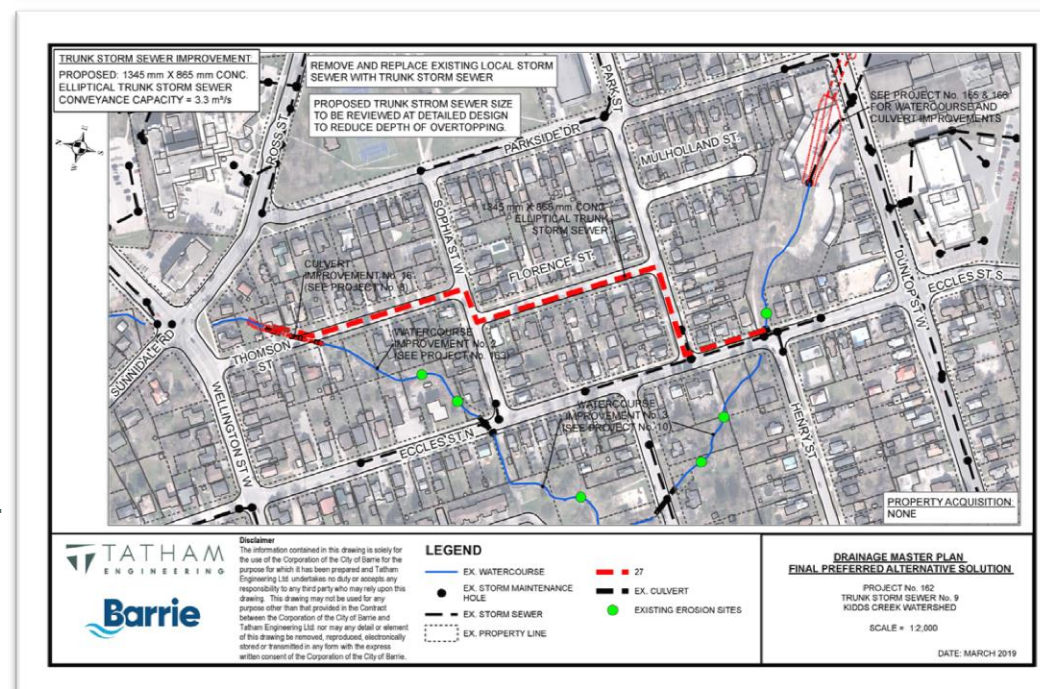


Summary

- Developed, calibrated and verified city-wide minor and major drainage system models using the following information:
 - Digital elevation model and topographic survey;
 - Storm sewer network GIS database;
 - Soil and land use data;
 - Watercourse, culvert, trunk storm sewer and SWMF information;
 - Rainfall and streamflow data; and
- The models have allowed for:
 - A consistent modelling approach;
 - Identification of existing drainage deficiencies;
 - Development and evaluation of solutions;
 - Level of service and risk assessments;
 - Prioritization of the preferred solutions;
 - Assessment of climate change and land use impacts; and
 - Model sharing with agencies and consultants.
- Evaluation of Low Impact Development measures

Ind Preferred Solutions Summary

Watercourse	Project No.	Opportunity (R)	Location	Description	Alternative	Property Acquisition	Project Cost	EA Schedule	EA Status
	1	SWMF Facility No. 11 (2006)	Livingstone St. W. and Ford St.	Controlled underground infiltration system for water quality treatment, erosion control and storm storage offset (SWMF #2006)	26	-	\$3,876,036	A+	Pre-Approved
	2	SWMF Facility No. 18 (2006)	Livingstone St. W. and Newcastle St.	Controlled underground infiltration system for water quality treatment and phosphorus removal. Greater major overland flow route to prevent private property	26	-	\$1,438,538	A+	Pre-Approved
	3	SWMF Facility No. 13 (2006)	Robson/Leith Dr. and Sunnyside Rd.	Controlled underground infiltration system for water quality treatment, phosphorus removal and storm storage offset (SWMF #2006)	26	-	\$1,660,080	A+	Pre-Approved
	4	Watercourse Improvement No. 1	Kidd's Creek between Leith Ave. and Curdies Rd. W. (Reaches 10-1 through 10-2)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion.	3A/20	-	\$1,564,864	B	New Project
	5	Culvert Improvement No. 12	Gordon Rd. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Potential Road - 100 Year design flood frequency).	30	-	\$1,080,797	A	Pre-Approved
	101	Watercourse Improvement No. 34	Kidd's Creek between Curdies Rd. and Highway 400 (Reaches 10-3 through 10-4)	Watercourse improvements on Kidd's Creek to stabilize existing bank erosion.	3A/20	-	\$1,768,862	B	New Project
	86	Culvert Improvement No. 16	Thameson St.	Culvert upgrades to satisfy 100 Year design flood frequency criteria (as per the recommendations of the Kidd's Creek MDP).	3A	27 Thameson St.	\$1,462,339	B	New Project
	102A	Trunk Storm Sewer No. 9	Thameson St., Sophia St. W., Florence St., Park St. and Eccles St. N.	Thameson St., Sophia St. W., Florence St., Park St. and Eccles St. N.	3A/20	-	\$1,761,467	B	New Project
	103	Watercourse Improvements No. 2	Kidd's Creek between Thameson St. and Eccles St. (Reaches 10-4)	Watercourse improvements along Kidd's Creek to stabilize existing bank failure/erosion.	3A/20	27 Thameson St. (portion of) 18 Thameson St. (portion of) 14 Thameson St. (portion of) 77 Eccles St. N. (portion of) 73 Eccles St. N. (portion of)	\$1,851,080	B	New Project
	9	Culvert Improvement No. 18	Waddington St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Potential Road - 100 Year design flood frequency).	30	-	\$178,464	A	Pre-Approved
	10	Watercourse Improvement No. 3	Kidd's Creek between Eccles St. and Henry St. (Reaches 10-5 through 10-10)	Watercourse improvements on Kidd's Creek to stabilize existing bank failure/erosion.	3A/20	Address Not Available (portion of) 19 Donald St. (portion of) 11 Donald St. (portion of) 38 Eccles St. N. (portion of) 10 Henry St. (portion of) 17 Eccles St. N.	\$1,761,157	B	New Project
	105	Watercourse Improvement No. 25	Kidd's Creek between Eccles St. and Dundas St. W. (Reaches 10-11)	Daylight watercourse through 100 Dundas St. W.	3A/20	100 Dundas St. W. (portion of)	\$2,428,671	B	New Project
	106	Culvert Improvement No. 140	Dundas St. W.	Culvert upgrades to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Potential Road - 100 Year design flood frequency).	30	100 Dundas St. W. (portion of)	\$4,333,868	B	New Project
	107	Watercourse Improvement No. 26	Kidd's Creek between Dundas St. W. and Bradford St.	Daylight watercourse through 100 Dundas St. W.	3A/20	-	\$887,618	B	New Project
	108	Trunk Storm Sewer No. 11	Bradford St.	Trunk storm sewer extension to satisfy City of Barrie Flow Design Guidelines for Road Crossings (Potential Road - 100 Year design flood frequency).	30	-	\$2,473,920	A+	Pre-Approved



Drainage Master Plan

CULVERT IMPROVEMENTS

5 CUNDLES ROAD	50 FERDALE DRIVE NORTH
8A THOMSON STREET	52 SARJEANT DRIVE
9 WELLINGTON STREET	53 HIGHWAY 400 E/W-S AND N-E/W RAMPS
38 HIGHWAY 400	54 HIGHWAY 400
37 HIGHWAY 400	57 GEORGE STREET
36 HIGHWAY 400	169B VICTORIA STREET
43 INNISFIL STREET	58B ANNE STREET SOUTH AND JOHN STREET
44 COMMERCIAL PLAZA ENTRANCE ROAD	60 INNISFIL STREET
45 BRADFORD STREET	61 SANFORD STREET
182 DUNLOP STREET WEST	62 BRADFORD STREET
166 DUNLOP STREET WEST	55 HART DRIVE

SWMF RETROFIT/CREATION

31 SWMF BK03	3 SWMF KD03
1 SWMF KD06	170B SWMF DY01
181 NEW SWMF	2 SWMF KD05
39 NEW SWMF	42 MILLIGAN'S POND

WATERCOURSE IMPROVEMENTS

4 REACH K1-1 THROUGH K1-2 (STABILIZE EXISTING BANK EROSION/FAILURE)
163 REACH K1-8A (STABILIZE EXISTING BANK EROSION/FAILURE)
10 REACH K1-10B THROUGH K1-10C (STABILIZE EXISTING BANK EROSION/FAILURE)
34 REACH Bu-3 (STABILIZE BED AND BANK EROSION)
35 REACH Bu-7 (STABILIZE BED AND BANK EROSION)
41 REACHES Bu-11 & Bu-15 (TOE TREATMENT TO STABILIZE BANK SCOUR)
183 REACH Dy-2A (WATERCOURSE REALIGNMENT)
51 REACH Dy-2B (WATERCOURSE RE-GRADING/SHAPING)
56 REACH Dy-3 (DAYLIGHT WATERCOURSE)
59 REACH Dy-5 (TOE TREATMENT TO STABILIZE BACK SCOUR)
165 REACHES K1-11 (DAYLIGHT WATERCOURSE)
167 REACHES K1-11 (DAYLIGHT WATERCOURSE)
46 REACH Bu-16 (WATERCOURSE RE-GRADING/SHAPING)
63 REACH Dy-6 (WATERCOURSE RE-GRADING/SHAPING)
49 REACH Dy-1 (WATERCOURSE REALIGNMENT)
161 REACH K1-4 THROUGH K1-8 (STABILIZE EXISTING BANK EROSION/FAILURE)

TRUNK STORM SEWER IMPROVEMENTS

32 ANNE ST. N. (FROM SWMF BK03 TO EDGEHILL DR.)
40B ANNE ST. S. (FROM DUNLOP ST. W. TO PERRY ST.)
162A THOMSON ST. SOPHIA ST. W. FLORENCE ST. AND ECCLES ST. (FROM THOMPSON ST. TO ECCLES ST.)
11A BRADFORD ST. (EXTENSION OF EXISTING TRUNK STORM SEWER)

50 YEAR DESIGN STORM CAPACITY

38 37 36
5 8 9 43 44 45 49 50 55
52 54 57 60 61 53 58B 166
62

100 YEAR DESIGN STORM CAPACITY

5 8 9 43 44 45 49 50 55
52 54 57 60 61 53 58B 166
62

REGULATORY FLOW CAPACITY

62

50 YEAR DESIGN STORM CAPACITY

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52 54 57 60 61 53 58B 166
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REGULATORY FLOW CAPACITY

62

SPRINGWATER

GENERAL RECOMMENDATIONS

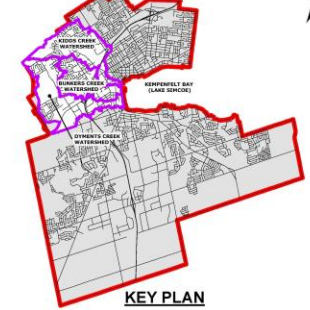
AS A GENERAL REQUIREMENT FOR ALL CAPITAL PROJECTS, IT IS RECOMMENDED THAT CONSIDERATION BE GIVEN TO UPSIZING LOCAL STORM SEWERS TO SATISFY CURRENT DESIGN STANDARDS AS PART OF FUTURE ROAD RECONSTRUCTION PROJECTS. SIMILARLY, RELOCATING STORM SEWER TO THE MUNICIPAL ROAD ALLOWANCE SHOULD ALSO BE CONSIDERED AS PART OF FUTURE ROAD RECONSTRUCTION PROJECTS. IT IS ALSO RECOMMENDED THAT THE STREETS IDENTIFIED AS BEING ABSENT OF A MINOR DRAINAGE SYSTEM THROUGHOUT THE STUDY AREA INCLUDE STORM SEWERS AS PART OF ROAD RECONSTRUCTION PROJECTS.

AS PART OF ROAD RECONSTRUCTION PROJECTS, MAJOR OVERLAND DEFICIENCIES ARE TO BE EVALUATED AND ADDRESSED WHERE FEASIBLE THROUGH OVERSIZING STORM SEWERS, ADJUSTING ROAD PROFILES/CROSS-SECTIONS OR OTHER MAJOR OVERLAND FLOW ROUTE IMPROVEMENTS.

IT IS RECOMMENDED THAT THE CITY PROACTIVELY ACQUIRE LANDS OR INTEREST THEREIN (EASEMENTS) OVER WATERCOURSES AND CULVERT CROSSINGS THROUGHOUT THE CITY WHERE IT IS IN THE CITY'S BEST INTEREST TO DO SO.

AS PART OF ROAD RECONSTRUCTION PROJECTS AND INTENSIFICATION PROJECTS ON LOCAL ROADS THROUGHOUT THE CITY, IT IS RECOMMENDED THAT THE CITY IMPLEMENT LINEAR LOW IMPACT DEVELOPMENT MEASURES SUCH AS PERFORATED PIPE SYSTEMS AND INFILTRATION TRENCHES TO PROMOTE INFILTRATION AND IMPROVE WATER QUALITY.

CITY OF BARRIE



KEY PLAN

LEGEND

- EXISTING STORM MAINTENANCE HOLE
- EXISTING STORM SEWER
- CULVERT
- DITCH
- WATERCOURSE
- ROADS
- RAILWAY
- PROPOSED TRUNK STORM SEWER IMPROVEMENTS
- PROPOSED WATERCOURSE IMPROVEMENTS
- PROPOSED CULVERT IMPROVEMENTS
- EXISTING SWMF
- PROPOSED SWMF RETROFIT/EXPANSION
- PARKLAND CONSIDERED FOR CENTRALIZED LID
- BUILDINGS
- WATERSHED/DRAINAGE AREA BOUNDARY
- MUNICIPAL BORDER
- EROSION SITE (BED AND BANK)
- PROJECT No.



SCALE = 1:10,000

0 125 250 500 750 1,000 Meters

DRAINAGE MASTER PLAN

BUNKERS CREEK, DYMENTS CREEK & KIDD'S CREEK WATERSHEDS

FIGURE 23 - FINAL PREFERRED ALTERNATIVE SOLUTIONS

DATE: MARCH 2019

Enhancing our communities