TOWN OF WHITCHURCH-STOUFFVILLE

WATER AND WASTEWATER MASTER PLAN

APPENDIX D

Design Criteria and Level of Service Tech Memo

Design Criteria, and Level of Service Review

Town if Whitchurch-Stouffville

Water and Wastewater Master Study

Prepared by GM BluePlan

Town of Stouffville

Project No. 721067

March 2023

Glossary of Terms and Acronyms

The following table provides a summary of terms and acronyms that are commonly used throughout the report.

Term or Acronym	Definition
DWF	Dry Weather Flow
WWF	Wet Weather Flow
I/I	Inflow and Infiltration
SPS	Sewage Pumping Station
HGL	Hydraulic Grade Line
LOS	Level of Service
FUS	Fire Underwriters Survey
ADD	Average Day Demand
MDD	Maximum Day Demand
PHD	Peak Hour Demand
FF	Fire Flow

Table of Contents

1 Introduction

The purpose of this report is to review the Town's criteria and Level of Service assumptions used for infrastructure planning purposes and assess their applicability against available information and industry best practice. The review seeks to validate, confirm or amend, as appropriate, the criteria and assumptions that will be used for infrastructure planning for the Town's Water and Wastewater Master Plan and all subsequent long-term planning projects.

The report is sectioned into the two key areas of review; design criteria and level of service for both water and wastewater systems. The design criteria section presents the current criteria compared with industry best practice to recommend design criteria for linear assets and an approach for the implementation of the design criteria for proposed growth in hydraulic modelling.

The Level of Service (LOS) review aims to establish the governing criteria and targets that will be used to understand the performance of infrastructure and when upgrades and new infrastructure needs are triggered.

The last section of this report outlines the water and wastewater design criteria and level of service recommendations presented to and agreed on with the Town of Stouffville on June 8th, 2022.

2 Water Design Criteria

2.1 Existing Water Design Criteria

The Town of Stouffville's existing water design criteria is summarized as follows:

Table 1 – Existing Water Design Criteria

Parameter	Design Guidelines & Standard Drawings	2018 Master Plan Design Criteria
Average Day Domestic Demand	350 L/capita/day	350 L/capita/day
Average Day ICI Demands	Commercial /Industrial: 28 m^3/ha/day (80 person/ha population equivalent) Institutional: Unique values for hospitals, schools, etc.	350 L/capita/day
Max Day Demand Factor	2.0	2.0
Peak Hour Demand Factor	3.0	3.0
Fire Flow Demand / Requirement	- Commercial: 200L/s - Institutional: 175L/s - Industrial: 250L/s - Apartments: 150L/s - Townhouses: 125L/s - Single/Semi Detached: 117L/s	- Commercial: 200L/s - Institutional: 175L/s - Industrial: 250L/s - Apartments: 150L/s - Townhouses: 90L/s - Single/Semi Detached: 75L/s

Source: Town of Stouffville Design Guidelines (March 2021) and Town of Stouffville 2018 Water and Wastewater Master Plan

2.2 Assessment of Existing Water Design Criteria

The approach to determining water flows for both existing and future growth varies from municipality to municipality. However, in general, it is common practice to utilize an average day domestic demand with demand factors to establish the maximum day and peak hour demands, which are later used for various modelling scenarios.

In addition to domestic demand, fire flow demands must also be satisfied. The Town's minimum fire flow requirements have been set as a guide for the various land-use types. At their discretion, the Town may also require the developer to determine site specific requirements based on "Water Supply for Fire Protection" as prepared by the Fire Underwriters Survey (FUS).

In order to further assess the suitability of the existing design criteria an industry best practice review was undertaken.

2.3 Industry Review – Water Design Criteria

A review of other municipal design criteria was undertaken in order to compare industry standards against the existing Town of Stouffville criteria. Comparable municipalities include the other lower-tier municipalities contained within York Region, as well as similar fast-growing municipalities located within Southern Ontario. Table 2 summarizes the per capita domestic demand rates and peaking factors utilized by a sample of other municipalities from the Region of York and Ontario.

2.3.1 Average Daily (Per Capita) Water Demand

Figure 1 shows the Town of Stouffville's daily average residential water demand design criteria compared to other municipalities within York Region (shown in blue) and other municipalities with Ontario (shown in grey). The figure shows that Stouffville's current average daily water demand criteria of 350 L/cap/d does align closely with a number of other Local Area Municipalities in York. However, it is still higher than the typical average per capita demand in the comparable parts of the Greater Toronto Area. The average per capita domestic demand utilized for planning purposes in the sample of municipalities in Ontario is ~300 L/cap/d (ranging from ~190 – 390). There is a significant amount of variation in the numbers shown largely due to the intended purpose / uses of the values. For planning purposes, many municipalities have historically erred on the side of caution and kept high residential demand rates since at a localized level, these higher flows can occur. However, typically, when assessing actual billing data and water production trends, the per capita flow rates are much lower for an entire area/system. Figure 2 demonstrates similarly high variation in identified per capita rates for employment consumption, but overall a reduction from the Town's current criteria appears viable.

For the Town of Stouffville, a review of recent consumption data (flow balance using Region of York GIS) and historical billing data was completed to identify the actual water consumption trends in both Stouffville and Ballantrae systems. The following summarizes the outcomes of the review of recent 2020/2021 data:

- The average per capita flow rate in Stouffville (combined Z1/Z2/Z3) for all residential and employment is closer to ~200 Lpcd.
- The average per capita flow rate in Ballantrae for all residential and employment is closer to ~260 Lpcd.
- These above rates align much more closely with what the Region of York has identified in their recent Master Plans. Understanding that this rate does vary slightly from year to year depending on the weather conditions during the summer months, it is suggested that the per capita flow rate utilized for Stouffville and Ballantrae is reduced from the previous criteria, but while still leaving some "buffer" that acts as a safety factor.
    - It is important to note that the per capita flow rate will rarely have a significant impact on the sizing of local (Town) infrastructure. The vast majority of water infrastructure sizing needs are driven by the need to provide sufficient fire flow availability. This presents an opportunity to more closely align the Town's daily water demand rates with the Region of York's.

It should also be recognized that new growth (with new construction and appliance standards and public awareness) is experiencing lower water demand trends, which will likely continue to decrease typical domestic water demand rates further from current levels. Another significant contributing factor is the type of development; as development includes a higher mixture of apartments/townhouses, the per capita rate typically decreases because of the reduced need for outdoor irrigation.

Overall, for the average daily water consumption rate, there is an opportunity to further reduce the Town's standard moving forward, in particular for the larger growth area in Stouffville. Ultimately, a change in the average daily water consumption rate is not expected to have a significant impact on required infrastructure upgrades or sizing because most infrastructure upgrades locally are sized to ensure sufficient fire flow capacity is provided. Recommended and agreed to revised rates are:

- Stouffville Per Capita Water Demand Rate: 250 Lpcd (residential and employment)
- Ballantrae Per Capita Water Demand Rate: 300 Lpcd (residential and employment)

Figure 1: Comparison of Average Residential Water Demands

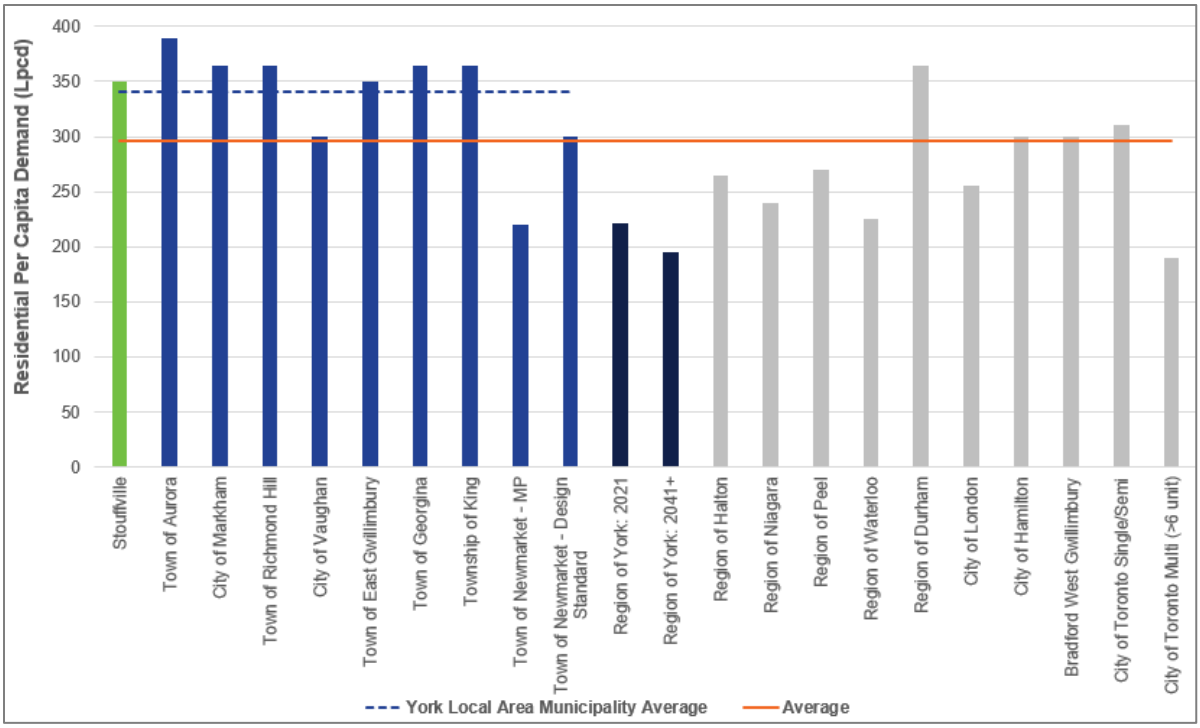
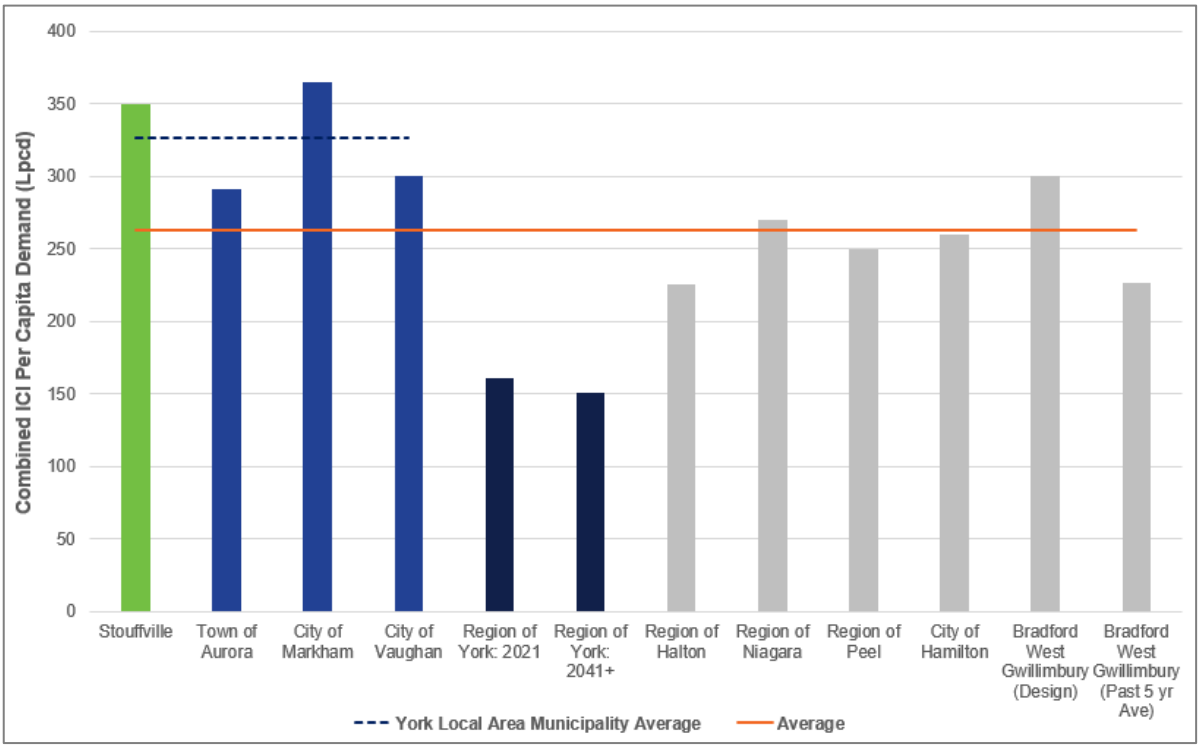


Figure 2: Comparison of Average Employment (Combined ICI) Water Demands



2.3.2 Peaking Factors

Based on a review of other lower-tier municipalities within York Region (shown in blue) and other municipalities in Ontario (shown in grey), the typical maximum day peaking factor ranges between 1.5 and 2. The typical peak hour demand peaking factor ranges between 2.5 and 3. Therefore, Stouffville's maximum day (2.0) and peak hour (3.0) factors are typical when compared to other municipalities.

For the Town of Stouffville, the review of recent daily consumption trends (flow balance using Region of York GIS) was completed to identify the typical peaking factors in both Stouffville and Ballantrae systems. The following summarizes the outcomes of the review of recent 2020/2021 data:

- The maximum day peaking factor for the Stouffville system was ~1.9 for Zone 1 and ~1.7 for Zone 2/3 in 2020/2021.
- The maximum day peaking factor for Ballantrae was ~2.7 in 2020/2021.
- These above peaking factors also align much more closely with what the Region of York has identified in their recent Master Plans (1.7 for Stouffville and the rest of the York Water System; ~3 for Ballantrae)
- Understanding that this rate does vary slightly from year to year depending on the weather conditions during the summer months, it is suggested that a degree of safety factor is maintained in the Master Plan criteria for peaking factors.

It is recommended that these values continue to be tracked over time using a system specific evidence-based approach by assessing actual daily production (flow balance) results each year.

It is also noted that the MOECC recommends that the peaking factor be adjusted based on the population of the service area. As the size/population of the study area increases, the peaking factor tends to decrease, so it would be expected for the Town's actual system peaking factor to gradually drop over time.

Overall, based on the industry trends and a review of recent historical peaking factors in Stouffville and Ballantrae, the following peaking factors are recommended:

- Stouffville
    - Maximum Day Peaking Factor: 2.0 x Average Day Demand
    - Peak Hour Factor: 3.0 x Average Day Demand (or 1.5 x Maximum Day Demand)
- Ballantrae
    - Maximum Day Peaking Factor: 2.8 x Average Day Demand
    - Peak Hour Factor: 4.2 x Average Day Demand (or 1.5 x Maximum Day Demand)

Figure 3: Comparison of Maximum Day Demand Peaking Factors

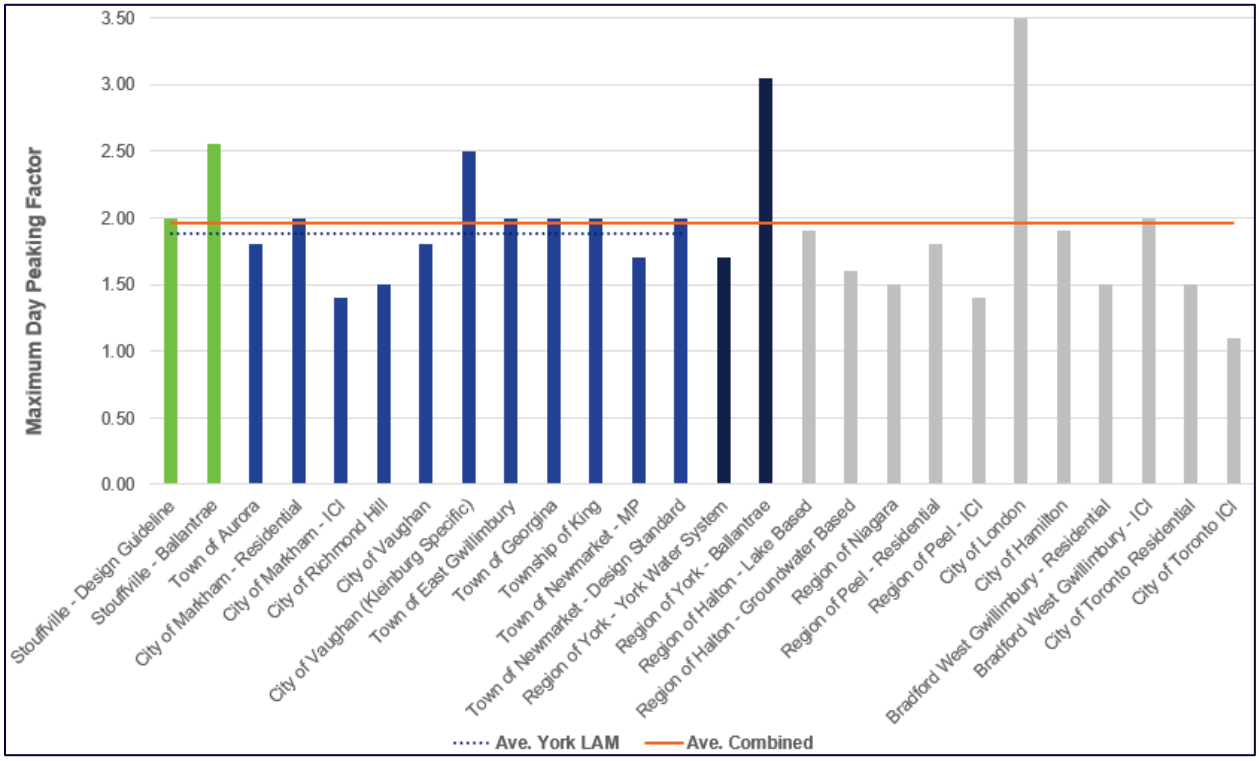


Table 2 – Summary of Water System Design Criteria

Municipality / Guideline	York Lower Tier?	Population[1]	Per Capita Demands (L/capita/day)					Peaking Factors		Acceptable Pressure Range (psi)		Fire Flow Criteria	
			Residential	Combined ICI	Industrial	Commercial	Institutional	Max Day	Peak Hour	Typical	Peak Hour	MDD+FF Pressure (PSI)	Target Available Fire Flow & Duration
MECP	No	-	Typical design range historically of 270-450	If reliable flow data is unavailable, then various rates by type identified as per MECP Table 3-2				Should be based on existing flow data where available. MDD: ~1.75 to 1.8 for 25k – 75k population PHD: ~2.62 to 2.7 for 25k – 75k population		40-100 psi		20	FUS should govern for individual sites. For storage sizing, recommended fire flows and duration are based on Table 8-1 below (varies by population of pressure district).
City of Hamilton	No	569,355	300	260	-	-	-	1.9	3	40-100 psi		20	**Varies by Type:** - Commercial: 150L/s - Industrial: 250L/s - Institutional: 150L/s - Small ICI (<1800m3): 100L/s - Residential >3 units: 150L/s - Residential 2-3 Units: 125L/s - Residential Single Detached: 75L/s - Residential Single - Dead-end: 50L/s
City of London	No	422,324	255	Not identified due to high variability. Designer to provide specific info or utilize MECP Table 3-2.				3.5	7.8	40-80 psi		20	FUS governs for design of individual sites. - Single Family Detached: 76L/s
City of Markham	**Yes**	338,503	365	Equivalent populations identified for various non-residential types (people/hectare); then residential rate is used.				Res: 2 ICI: 1.4	Res Max AM: 4.5 Res Max PM: 2 ICI Max AM: 0.8 ICI Max PM: 2.5	44-100 psi (PRVs where over 80psi)		20	FUS governs for design of individual sites. - Residential Minimum: 116.7L/s
City of Toronto	No	5,647,646	Single Family/Semi/Multi <6 units: 310 Multi-Unit (>6 units): 190	If reliable flow data is unavailable, then various rates should be utilized in line with the MECP Table 3-2. Other commercial should allow for 28m3/hectare/day				Residential: 1.5 Commercial: 1.1 Industrial: 1.1 Institutional: 1.1 Apartments: 1.3	Residential: 2.25 Commercial: 1.2 Industrial: 1.9 Institutional: 1.9 Apartments: 2.5	Preferred: 350-550 kPa (50-80 psi)	275-700kPa (40-100 psi) Up to 120psi with PRVs	20	**Varies by Type:** - Commercial (1-2 storeys): 189.3 L/s for 3 hrs - Commercial (3+ storeys): 316.7 L/s for 3 hrs - Industrial Park: 316.7 L/s for 3 hrs - Shopping Centre: 378.3 L/s for 3 hrs - High-rise Residential: 316.7 L/s for 3 hrs - Res. Multi (3+ storeys): 157.7 L/s for 3 hrs - Res. Multi (1-2 storeys): 126.2 L/s for 2 hrs - Res. Single Family: 63.3 L/s for 2 hrs
City of Vaughan	**Yes**	323,103	300 (Kleinburg = 347)	300	-	-	-	1.8 (Kleinburg = 2.5)	3.0 (Kleinburg = 4.0)	40-100 psi		20	**Varies by Type:** - Industrial/Commercial: 417L/s - Institutional: 250L/s - Multi-Unit Residential: 317L/s - Townhouses: 150L/s - Residential Single/Semi-Detached: 117L/s
Region of Durham	No	696,992	364	-	ADD: 45 m^3/ha/d MDD: 90 m^3/ha/d	86 persons per hectare	Various rates should be utilized in line with the MECP Table 3-2	-	-	40-100 psi (PRVs where over 80psi)		20	FUS governs for design of individual sites. - Single Family Detached: 75L/s
Region of Halton	No	596,637	265	225	295	175	220	Lake Based System:1.9 Groundwater System: 1.6	3.0	40-100 psi		20	FUS governs for design of individual sites. - Residential Minimum: 91.7L/s for 2 hours - Employment Minimum: 250L/s for 3 hours
Region of Niagara	No	477,941	240	270	-	-	-	1.5 x ADD (ADD based on past 5 years data)	Diurnal patterns established by PD based on data	40-100 psi		30 psi (on Regional transmission mains)	250 L/s for 3 hours
Region of Peel	No	1,515,556	270	250	-	-	-	Res: 1.8 ICI: 1.4	3.0	40-100 psi		20	FUS governs for design of individual sites. - PZ Storage: 378L/s for 6 hours
Region of Waterloo	No	587,165	225	-	-	-	-	MDD and diurnal patterns to be based on review of historical flow records		Preferred: 350-550 kPa (50-80 psi)	275-700kPa (40-100 psi) (PRVs where over 80psi)	20	FUS governs for design of individual sites.

Municipality / Guideline	York Lower Tier?	Population[1]	Per Capita Demands (L/capita/day)					Peaking Factors		Acceptable Pressure Range (psi)		Fire Flow Criteria	
			Residential	Combined ICI	Industrial	Commercial	Institutional	Max Day	Peak Hour	Typical	Peak Hour	MDD+FF Pressure (PSI)	Target Available Fire Flow & Duration
Region of York	**Upper Tier**	1,173,334	2021: 221 2041: 195 2016: 233	2021: 161 2041: 151 2016: 182	-	-	-	1.7	Diurnal patterns established by PD based on data	40-100 psi		20	Fire only identified for storage / transmission purposes: - Large PDs (ICI): 283.3 L/s for 3.5 hours - Small PDs (Res): 166.7 L/s for 2 hours
Town of Aurora	**Yes**	62,057	390	23.3 m^3/ha/d	-	-	-	1.8	5	Preferred: 350-550 kPa (50-80 psi)	275-700kPa (40-100 psi)	20	Varies by Type: - School: 250 L/s - Commercial: 167 L/s - Residential: 100 L/s
Town of Bradford West Gwillimbury	No	42,880	Design: 300 Past 5-yr Maximum: 227	Design: Bradford urban area: 5 m3/ gross ha/d Design: Future Hwy 400 employment area: 8 m3/ gross ha/d Past 5-yr maximum: 6.89 m3/ gross ha/d				Residential: 1.5 ICI: 2.0	1.8 x MDD	40-80 psi (when over 80psi, individual PRVs needed)		20	FUS governs for design of individual sites. - Residential Minimum: 116.7L/s
Town of East Gwillimbury	**Yes**	34,637	350	-	35m^3/ha/d	28m^3/ha/d	18m^3/ha/d	2	2.75	40-100 psi		20	FUS governs for design of individual sites. - Residential Minimum: 80L/s - Employment Minimum: 200L/s
Town of Georgina	**Yes**	47,642	365	-	Light: 35m^3/ha/d Heavy: 55m^3/ha/d	28m^3/ha/d	18m^3/ha/d	2	2.75	Preferred: 50-70 psi	50-100 psi	20	FUS governs for design of individual sites. - Residential Minimum: 116.7L/s
Township of King	**Yes**	27,333	370	-	28m^3/ha/d	28m^3/ha/d	18m^3/ha/d	2	2.75	40-100 psi		20	FUS governs for design of individual sites. - Residential Minimum: 116.7L/s
Town of Newmarket	**Yes**	87,942	Master Plan: 220 Design Standards: 300	-	21 m^3/ha/d	Retail/Office: 4 L/m^2/d Restaurant: 60 L/m^2/d	18 m^3/ha/d	Master Plan: 1.7 Design Standards: 2.0	Master Plan: 2.5 Design Standards: 3.0	Preferred: 350-550 kPa (50-80 psi)	275-700kPa (40-100 psi)	20	**Master Plan:** - Commercial/Institutional: 167L/s - Industrial: 265L/s - Apartments: 250L/s - Townhouses: 167L/s - Residential Single/Semi Detached: 90L/s **Design Standards:** - ICI: 265L/s - Apartments: 250L/s - Townhouses: 167L/s - Residential Single/Semi Detached: 117L/s
Town of Richmond Hill	**Yes**	202,022	365	-	Light industrial: 35m^3/ha/d Heavy industrial: 50m^3/ha/d	Shopping Centre: 4000 L/1000m^2/day Hospital: 1450 L/bed/day	Schools 110 L/student/day	Residential: 1.5	Residential: 2.5	40-100 psi		20	**Varies by Type:** - Commercial: 185-480L/s - Industrial: 72-190L/s - Institutional: 120-190L/s - Apartments: 72L/s - Townhouses: 68L/s - Single Family: 36 to 64L/s (varies by house separation distance)

3 Water Level of Service

3.1 Background

Many municipalities and cities use a range of level of service requirements to identify when the water system is no longer performing as designed. These level of service requirements can include exceedance of acceptable pressure and velocity ranges, as well as system leakages and water quality. This section will discuss the level of service the Town of Stouffville should be aiming to meet for the water system.

3.2 Distribution Capacity

The distribution system should be sized to convey the greater of peak hour flows or maximum day plus fire flows. Within each pressure zone in the distribution system, the range of acceptable pressures under normal conditions are approximately 50 psi (350 kPa) to 80 psi (550 kPa) for average day and maximum day analysis. The range of acceptable pressures for minimum hour and peak hour analysis is 40 psi (275 kPa) to 100 psi (690 kPa). Under fire flow conditions, it is acceptable for pressures to drop to 20 psi (140 kPa).

3.3 Fire Flow

The Town's existing Design Guidelines outlines the Town's standard fire flow requirements by land use type. These vary slightly compared to the prior Master Plan. The Design Guidelines are slightly more conservative for Townhouses and Single-Family Homes. The Design Guidelines targets do align closely with other municipality standards and should be targeted for all new developments / growth areas. For existing areas of the system that may currently be below the Design Guidelines target, it is desirable, where possible, to increase fire flow availability to reach the higher target. However, since looping or upsizing watermains in existing streets is not always viable, the 2018 Master Plan targets are suitable minimum targets for existing areas of the system.

Therefore, for the purposes of the Master Plan, the Master Plan fire flow demands by land use are suitable and should continue to be used to assess minimum system capacity needs in existing areas, but growth areas should target the Design Guideline standards. Table 3 summarizes each land use and the recommended fire flow demand.

It is noted that the fire flow demands do not necessarily have to be satisfied by a single hydrant location. For larger fire flows, it is typically not viable for a single hydrant to satisfy the requirement, so multiple hydrants within suitable distance of the building can be utilized to provide the combined requirement. There is also the potential to have additional fire suppression within a building in order to have a specific type of ICI property meet acceptable standards for fire flow protection.

Table 3 – Public Fire Protection Survey Services and Recommended Fire Flow Demands

Land use	Design Guidelines Fire Flow Demand (L/s)	2018 Master Plan Fire Flow Demand (L/s)
Single/Semi-detached family	117	75
Townhouses	125	90
Apartments	150	150
Institutional	175	175
Industrial	250	250

Commercial	200	200

3.4 Typical Watermain C-Factor Trends

Currently, the Town of Stouffville has two separate sets of C-Factor's established.

- C-Factors as established during the development of the 2018 Master Plan Model
  - Existing Cast Iron Watermains: C-Factors = 60 to 80
  - Existing Ductile Iron Watermains: C-Factors = 100 to 110
  - Existing PVC Watermains: C-Factors = 100 to 130
  - Proposed Watermains: C-Factors = 130
- C-Factors as identified in the Town's standard engineering guidelines (more conservative)
  - Watermains <150mm: C-Factor = 100
  - Watermains 200mm or 250mm: C-Factor = 100
  - Watermains 300mm: C-Factor = 120
  - Watermains >300mm: C-Factor = 130

Through development of the Town's Master Plan model, it was determined that the Town's Standard Guidelines are generally conservative compared to field observed c-factors. The current engineering guidelines are considered conservative, especially since the majority of new proposed watermains are PVC, which generally has a new C-Factor that exceeds 130 for any pipe size.

Having two separate guidelines for C-Factors has caused some challenges during development application reviews, where there is uncertainty over which guideline is most appropriate. Therefore, it is suggested that a single unified recommended C-Factor guideline is developed for future analyses.

The recently updated and calibrated model for Stouffville and Ballantrae has identified the following C-Factor trends by watermain type:

Ballantrae System:

- CPP = ~125 to 130 (Average ~127)
- PVC/HDPE (Plastics) = 100 to 150 (Average ~119)

Stouffville System

- CPP = 95 to 35 (Average ~105)
- Cast Iron = 60 to 80 (Average ~70)
- Ductile Iron = 90 to 130 (Average ~103)
- PVC/HDPE (Plastics) = 100 to 145 (Average 125)

Generally, the above calibrated C-Factors align well with industry standards for the various watermain materials and the range of vintages (age) of the watermains. Overall, the existing model C-Factors should be maintained as per the latest calibration. For any future watermains being proposed (either for development applications or as part of Master Plan upgrades), the C-Factor should be estimated as 130.

3.5 Water Recommendations

In general, the recommendations are to adjust the existing design criteria to be more in line with industry standards and recent consumption trends experienced in the Stouffville and Ballantrae systems.

Water Flow Projection Methodology

- Use existing demands for Baseline
- Existing demands based on water billing data / flow balance
- Growth demands applied to the Baseline using design criteria

Water Flow Criteria

- Use existing demands for Baseline
- Average Day Water Demand
    - Stouffville System: 250 Lpcd
    - Ballantrae System: 300 Lpcd
- Maximum Day Demand Peaking Factors
    - Stouffville System: 2.0 x Average Day Demand
    - Ballantrae System: 2.8 x Average Day Demand
- Peak Hour Demand Peaking Factors
    - Stouffville System: 3.0 x Average Day Demand (1.5 x Maximum Day Demand)
    - Ballantrae System: 4.2 x Average Day Demand (1.5 x Maximum Day Demand)

Water System Criteria

- Sizing water supply, transmission and storage facilities for Maximum Day Demand (MDD)
- Sizing water distribution system for peak hour demands (PHD) and Maximum Day Plus Fire Flow Demands (MDD + FF)

Water Level of Service

- Pressure Criteria - Peak/Minimum Hour
    - Existing System Areas: 40 - 100 psi
    - New Growth Areas and Pressure Zone Change Areas: 50 – 90 psi
    - Fire Flow Conditions: 20 psi
- Watermains - Velocities (excluding fire flow simulations)
    - Existing < 2 m/s
    - New < 1m/s
- Fire Flow
    - Existing System Areas: Fire flow targets based on land use as per the 2018 MP targets
    - New Growth Areas: Fire flow targets based on land use as per Design Guidelines

4 Wastewater Design Criteria

4.1 Existing Wastewater Design Criteria

The Town of Stouffville's existing wastewater design criteria is summarized as follows:

Table 4 – Existing Wastewater Design Criteria

Parameter	Design Guidelines & Standard Drawings	Master Plan Design Criteria
Residential Sewage Flows	350 L/capita/day	350 L/capita/day
Employment Sewage Flow	28 m3/ha/day (80 person/ha)	350 L/capita/day
Peaking Factor	Residential = Harmon (min 2, max 4) Industrial = 6.6604 x Area$^{-0.1992}$	Harmon Peaking Factor (min 1.5, max 4)
Infiltration	0.23 L/s/ha	0.23 L/s/ha

Source: Town of Stouffville Design Guidelines (March 2021) and Town of Stouffville 2018 Water and Wastewater Master Plan

4.2 Assessment of Existing Wastewater Design Criteria

The approach to determining wastewater flows for both existing and future growth varies from municipality to municipality. However, in general, it is common practice to utilize a per capita sanitary flow rate multiplied by a peaking factor (e.g., Harmon), to produce a peak sanitary flow. An extraneous flow component is then added, typically as an area-based unit I/I rate (e.g., L/s/ha) to produce a peak wet weather flow which is used to calculate design flows and plan for appropriate pipe sizing.

In order to further assess the suitability of the existing design criteria an industry best practice review was undertaken.

4.3 Industry Review – Wastewater Design Criteria

A review of other municipal design criteria was undertaken in order to compare industry standards against the existing Town of Stouffville criteria. Comparable municipalities include the other lower-tier municipalities contained within York Region, as well as similar fast growing municipalities located within Southern Ontario. Table 5 summarizes the per capita sanitary flow and extraneous flow rate allowances utilized by other municipalities within York Region and the Greater Toronto Area, and from select parts of Ontario.

4.3.1 Average Daily (Per Capita) Wastewater Flows

Figure 4 shows the Town of Stouffville's average residential wastewater flow design criteria compared to other municipalities within York Region (shown in blue) and other municipalities within Ontario (shown in grey). The figure shows that Stouffville's current average residential wastewater flow criteria of 350 L/cap/d does align closely with a number of other Local Area Municipalities in York, and it is lower than the York Region average of 369 L/cap/d. However, it is still higher than the typical average residential per capita flows in the sample of municipalities in the Greater Toronto Area. The average residential per capita wastewater flows utilized for planning purposes in the sample of municipalities in Ontario is ~337 L/cap/d (ranging from ~215 – 450).

Similarly, Figure 5 presents a comparison between the Town of Stouffville's average employment wastewater flow design criteria and other municipalities within York Region (shown in blue) and other

municipalities within Ontario (shown in grey). The figure shows that Stouffville's current average employment wastewater flow criteria of 350 L/cap/d does align closely with a number of other Local Area Municipalities in York, and it is lower than the York Region average of 374 L/cap/d. However, it is still higher than the typical average employment per capita flows in the sample of municipalities in the Greater Toronto Area. The average employment per capita wastewater flows utilized for planning purposes in the sample of municipalities in Ontario is ~322 L/cap/d (ranging from ~185 – 450).

For the Town of Stouffville, a recent review of flow monitoring data (from Q4-2021 to Q2-2022) was completed to identify per capita wastewater flow generation trends in the service area.

Figure 6 presents a summary of the flow monitoring analysis for per capita average dry weather flows for 16 monitors within the Community of Stouffville. The following summarizes the outcomes of the review:

- The average per capita wastewater flow rate in Stouffville for all residential and employment is ~264 Lpcd.
- Average per capita wastewater flow rates in Stouffville vary significantly from monitor to monitor ranging from 83 Lpcd to 457 Lpcd.
- Mora than 25% of the sample data points analyzed surpassed 300 Lpcd, while 8% of the data points surpassed the current Town criteria of 350 Lpcd.

It is important to know that per capita wastewater flow rate has a significant impact on the sizing of local wastewater infrastructure within the Town. Based on the industry review and analysis of flow monitoring data, it was recommended and agreed to maintain the wastewater design rate for Stouffville at 350 Lpcd for both residential and employment uses.

Lastly, it should be noted that York Region is currently undertaking a study for Reconciliation of Water & Wastewater Design Standards between York Region and Local Municipalities, which will offer another opportunity to integrate and revise design criteria at the municipal and regional level.

Figure 4: Comparison of Average Residential Wastewater Flow Rates

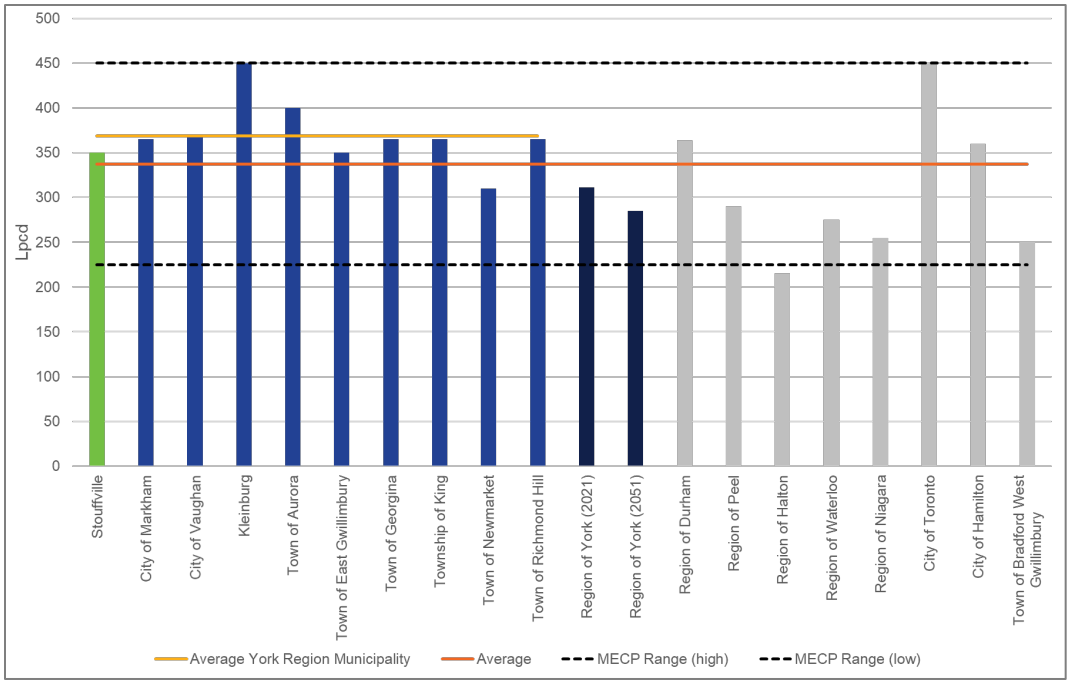


Figure 5: Comparison of Average Employment (Combined ICI) Wastewater Flow Rates

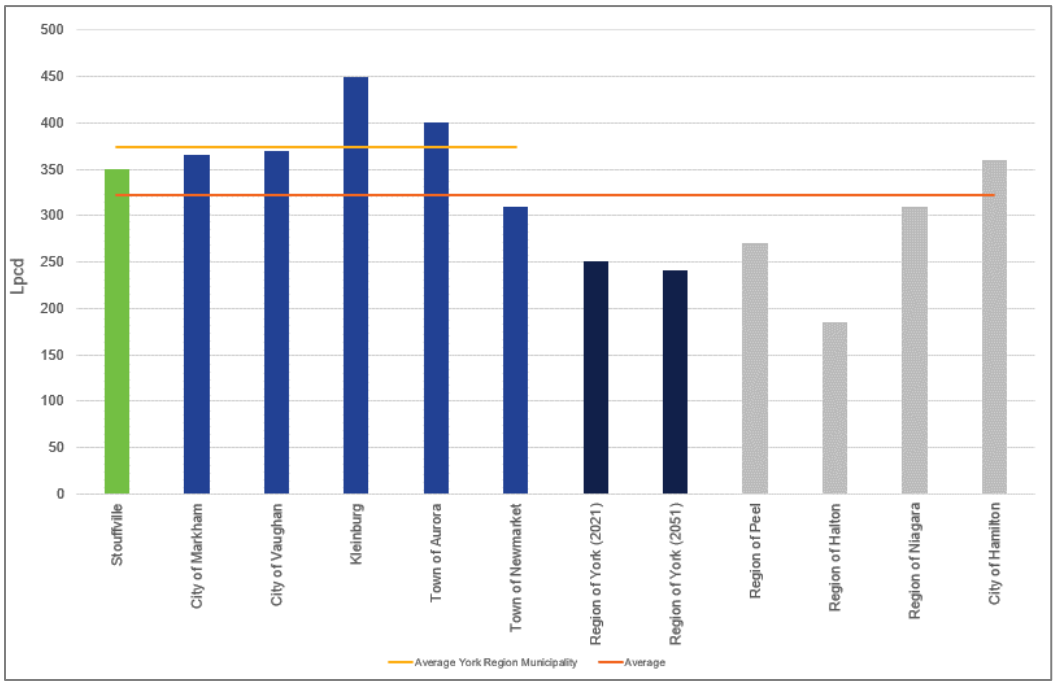
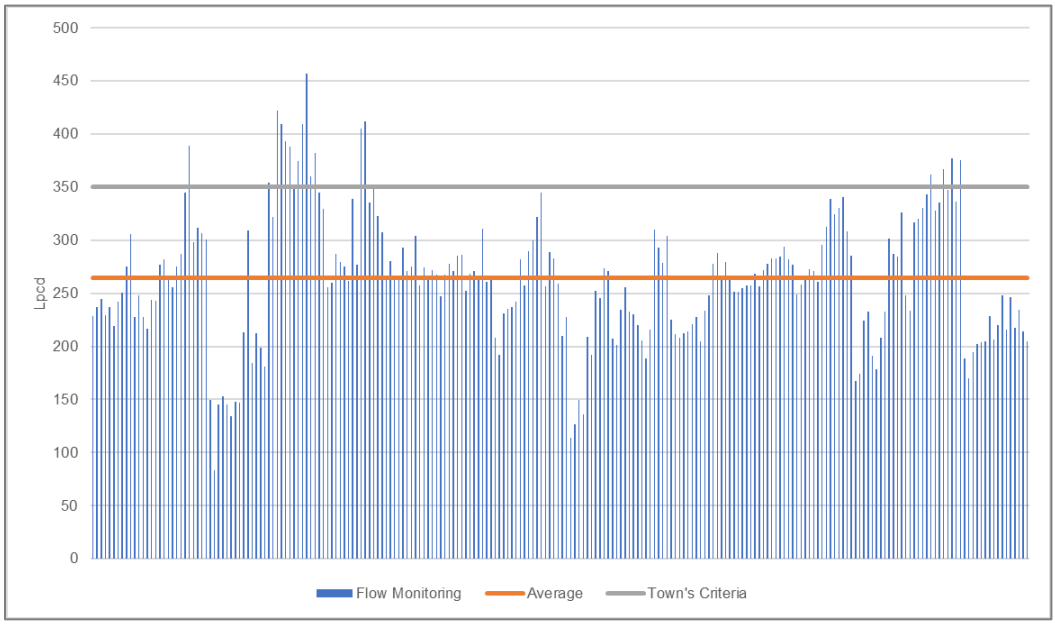


Figure 6: Flow Monitoring Analysis – Per Capita Average Dry Weather Flow



4.3.2 Inflow and Infiltration Allowance

Figure 7 shows the Town of Stouffville's design I/I rate compared to other municipalities within York Region (highlighted blue) and other municipalities within Ontario (shown in grey). The figure shows that Stouffville design I/I rate of 0.23 L/s/ha is slightly lower when compared to other municipalities in Ontario, as well as the York Region average of 0.26 L/s/ha. In terms of I/I rates the industry trend appears relatively stable although it is known that some municipalities are considering increasing their I/I allowance based on results from flow monitoring studies.

It should be recognized that new growth, due to new construction and appliance standards and public awareness, is experiencing decreasing water use trends, which will likely decrease typical domestic wastewater generation rates. Extraneous flow, however, is becoming the more critical variable when determining the size of linear wastewater infrastructure. It is not uncommon to have areas with I/I rates above the "design allowance". With the increases in wet weather event intensity and frequency attributable to climate change, rainfall-derived inflow and infiltration (RDII) will continue to place a significant strain on the capacity of the receiving sanitary sewer system.

Many Canadian municipalities are now prioritizing the reduction of I/I and have committed to undertaking a number of measures to address wet weather related issues. More recently in 2021, York Region has updated their inflow and infiltration reduction strategy to enhance and extends the Region's commitment to I/I reduction. The 2021 Update will guide implementation of I/I programs at the Region and local municipalities over the next five to ten years.

The prevalence of I/I issues in new subdivisions have become increasingly apparent to municipalities, evidenced through flow monitoring and inspections. As such, a reasonable design criteria allocation for I/I is considered good practice to maintain some flexibility for system capacity in the long-term planning of subcatchment areas. The 2022 Draft York Region Water and Wastewater Master Plan defines that for anticipated growth in future service areas wet weather flows are to be estimated based on the Region's inflow and infiltration flow hydrograph with a peak flow of 0.26 L/s/ha. Therefore, it was recommended and agreed with the Town that the I/I design allowance for Stouffville is increase from 0.23 L/s/ha to 0.26 L/s/ha to be in line with York Region.

Figure 7: Comparison of Ontario Municipalities Design I/I Allowance

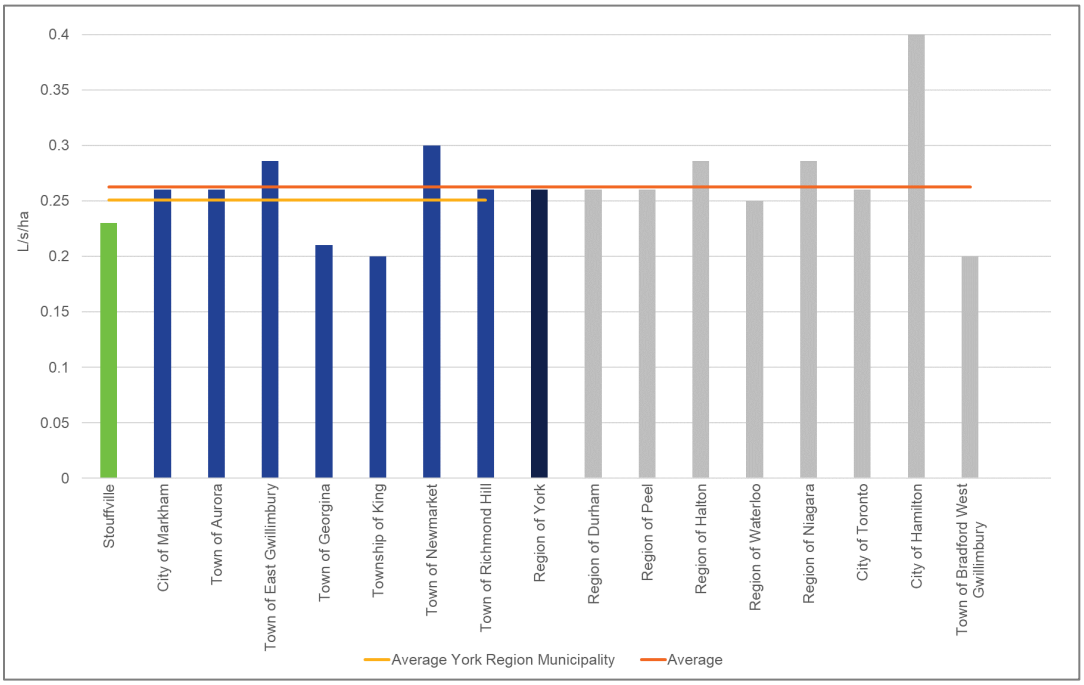


Table 5 – Summary of Wastewater Flow Rate Criteria Review

Municipality / Guideline	York Lower Tier Municipality?	Population	Per Capita Sanitary Flow Criteria (L/cap/d)					Peaking Factor Methodology	I/I Allowance (L/s/ha unless noted otherwise)	I/I Allowance Application
			Residential	Combined ICI	Industrial	Commercial	Institutional			
MECP	No	-	225 – 450		various	various (table 5-3) 28 m3/ha/day (minimum)	various (table 5-3) 70-140 L/d per student	Harmon & Babbitt	-	Currently, no explicit values of extraneous flow allowances are provided in the MECP Design Guidelines for Sewage Works (2008)
City of Hamilton	No	569,355	360	360	-	-	-	Babbit (min 2, max 5)	0.4-0.6	For areas where the weeping tiles of the dwelling are designed to be drained by gravity, or where a separate foundation drain collector sewer is proposed, the infiltration factor shall be 0.4 litres per second per hectare. For areas where there are no storm sewers, or shallow storm sewers which require the weeping tiles of the dwelling to be drained by sump pump, the infiltration factor shall be 0.6 litres per second per hectare
City of London	No	422,324	230	-	20000-25000 L/ha/day	230	230	Harmon Industrial = 0.8 x Harmon	0.10	I&I allowance. The Sewer Engineering Division may request an alternative infiltration allowance based on site conditions.
City of Markham	Yes	338,503	365	365	180000 litres/gross land area in ha/day	180000 litres/gross land area in ha/day	180000 litres/gross land area in ha/day	Harmon (min1.5, max 4)	0.26	Infiltration shall be calculated on the basis of 0.26 l/s/ha
City of Toronto	No	5,647,656	450		180000 L/floor ha/day	180000 L/floor ha/day	180000 L/floor ha/day	Harmon	0.26	Extraneous Flows –New Areas In computing the total peak flow rates for the design of new sanitary sewers, an allowance of 0.26 L/sec/gross ha will be applied, irrespective of land use classification to account for ground water infiltration and wet weather inflow into the pipes and maintenance holes.
City of Vaughan	Yes	323,103	370 (Kleinburg = 450)	370 (Kleinburg = 450)	-	-	-	Harmon (min 2, max 4)	0.26 (Kleinburg = 0.23)	An infiltration allowance is to be included in determining the design flow (based on gross service areas)
Region of Durham	No	696,992	364		180 m³/gross ha/day	180 m³/gross ha/day	112 m³/gross ha/day	Hamon (min 1.5, max 3.8)	0.26	residential infiltration allowance when foundation drain is not connected to the sanitary sewer
Region of Halton	No	596,637	215	185	240	145	180	Harmon	0.286	I&I design allowance
Region of Niagara	No	477,941	255	310	-	-	-	Harmon	0.286 for new development 0.4 for existing developments	Extraneous flow performance consideration - observed peak and total flows under 5 yr design storm
Region of Peel	No	1,515,556	290	270	-	-	-	Harmon (min 2, max 4)	0.26	Inflow & Infiltration allowance
Region of Waterloo	No	587,165	275	-	0.4 L/s/ha	core: 0.95 L/s/ha shopping mall: 0.3 L/s/ha general: 0.5 L/s/ha	institutional: 0.25 L/s/ha hospitals: 0.015 L/s/ha	Harmon (industrial peaking factor - use MECP guidelines for typical industry sewage flow peaking factors" commercial peaking factor: 2.5	0.25	Inflow and infiltration allowance. Use this or as directed by the municipality

Municipality / Guideline	York Lower Tier Municipality?	Population	Per Capita Sanitary Flow Criteria (L/cap/d)					Peaking Factor Methodology	I/I Allowance (L/s/ha unless noted otherwise)	I/I Allowance Application
			Residential	Combined ICI	Industrial	Commercial	Institutional			
Region of York	**Upper Tier**	1,173,334	2021: 311 Lpcd 2051: 285 Lpcd	2021: 251 Lpcd 2051: 241 Lpcd	-	-	-	Harmon	Existing Service Areas: Based on the 1:25 year storm return period Future Service Areas: 0.26	Maximum Infiltration: Based on 1:25 yr storm event from Region's model
Town of Aurora	Yes	62,057	400	400	-	-	-	Harmon (min 2, max 4)	0.26	An infiltration allowance of 0.26 L/s/ha is to be included in determining the design flow (based on gross service areas).
Town of Bradford West Gwillimbury	No	42,880	250	-	Light industrial 20 m3/ha/day Heavy industrial 35 m3/ha/day	28 m3/ha/day	19.8 m3/ha/day	Hamon (min 1.5 max 4)	0.2-0.5	Generally, areas serviced with sewers constructed prior to the year 2000 shall use an allowance of 0.5L/s/ha and areas serviced in 2000 and later shall use an allowance of 0.2L/s/ha
Town of East Gwillimbury	Yes	34,637	350	-	35,000 L/ha/d	28,000 L/ha/d	18,000 L/ha/d	Residential = Harmon (min 2, max 4) Industrial = 6.6604 x Area-0.1992	0.286	An infiltration allowance of 0.286 L/sec/ha shall be used in determining the design flows.
Town of Georgina	Yes	47,642	365	-	Light 35 m3/ha/d Heavy 55 m3/ha/d	28 m3/ha/day	18 m3/ha/day	Harmon (min 2, max 4)	0.21	An infiltration allowance shall be used in determining the design flows.
Township of King	Yes	27,333	365	-	Light: 35 m3/ha/day Heavy: 55 m3/ha/day	65 m3/ha/day	65 m3/ha/day	Residential = Harmon (min 2, max 4) Industrial = 6.6604 x Area-0.1992	0.2	Inflow & Infiltration allowance for Residential flows. ICI flow rates include allowances for infiltration.
Town of Newmarket	Yes	87,942	310	310	-	-	-	Harmon	0.3	An infiltration allowance for new development areas of 0.30 L/s/ha is recommended for use in the Town of Newmarket Water and Wastewater Master Plan. For existing developments, area specific infiltration allowances were developed based on historical flow monitoring data.
Town of Richmond Hill	Yes	202,022	365	-	180000 L/floor ha/day	180000 L/floor ha/day	180000 L/floor ha/day	Harmon (min 1.5 max 3.8)	0.26	Infiltration - Calculated on the number of gross hectares contributory to the sanitary sewers including parks and valley land, if they are tributary.
Stouffville	Yes	49,864	350	350	28 m3/ha/d	28 m3/ha/d	28 m3/ha/d	Harmon (min 1.5, max 4)	0.23	The design allowance for extraneous flows in the sanitary sewer system is 0.23 L/s/ha.
Acronyms: PDWF = Peak Dry Weather Flow; PWWF = Peak Wet Weather Flow; I/I = Peak Inflow and Infiltration; PF = Peak Factor										

5 Wastewater Level of Service

5.1 Background

Many municipalities and cities use a range of level of service requirements to identify when the wastewater system is no longer performing as designed. This level of service can range from depth and flow in the sewer network, to depth of hydraulic grade line (HGL) to ground level, and the number of overflows per annum at sewer overflows. This section will discuss the level of service the Town of Stouffville should be aiming to meet for the wastewater system.

5.2 Design Storm

Recognizing that wet weather events are different from region to region and vary with respect to the return period and duration, design storms should reflect the rainfall events experienced in that particular area. The development of a storm unique to the Stouffville area, and based on historical data, is the most suitable method to analyzing the existing sewer system and future growth scenarios.

5.2.1 Development of Design Storms

There are three major classifications of design storms. These are as follows:

- Design storms with an arbitrary temporal distribution, developed from local IDF curves. These storms suitable for smaller catchment areas as they represent high intensity rainfall that is generally associated with localized storms. They are easy to develop and can be adapted for larger catchments by using an areal reduction factor. Examples of this type of design storm are the Chicago and SCS design storms.
- Design storms based on observed data to replicate a temporal distribution. These storms are developed from IDF curves but are generally longer duration and lower intensity when compared to the Chicago and SCS design storms. These storms are more suitable for large catchment analysis. An example of this type of design storm is the AES design storm.
- Historic design storms. These are notable rainfall events that have occurred in the region. They are good for replicating worst case scenarios and planning for extreme conditions. They are not adapted to reflect different return periods. Examples of these are Hurricane Hazel and Hurricane Sandy.

Currently, the Town of Stouffville utilizes the Chicago storm as the design storm for infrastructure planning and system performance in the InfoWorks hydraulic model. This remains an appropriate design storm for a catchment area the size of the Stouffville system.

The Chicago storm has an areal reduction factor applied and it is run for a range of durations to find the critical duration. For example, the hydraulic model uses a 1 in 5 year return period design storm to assess sewer capacity and a 1 in 25 year return period level of service to assess basement flooding potential.

5.3 Capacity and Flood Risk

Municipalities typically use d/D analysis to assess the level of service for conveyance of flow in the sanitary sewer system. Ranges that have been used for assessing the LOS in sanitary sewer system are typically around 0.85 d/D. Some municipalities, such as York Region, have used 0.65 d/D for trunk sewer assessment and 0.85 d/D for the local collector assessment. Other municipalities have considered anything less than 1.0 d/D to meet the level of service requirement.

As sewer systems become increasingly under strain to meet these LOS requirements because of rapidly expanding growth or a greater frequency of extreme rainfall events, the approach to LOS for capacity is gradually adapting. Municipalities are now looking at sewers that exceed the traditional level of service requirements on an individual basis. If a sewer is surcharged but the sewer is in good condition and is not causing issues such as basement flooding, then the sewer is not triggered.

Basement flooding is a level of service requirement that has become more prominent in recent years. Typically, municipalities use a depth of 1.8m to trigger a basement flooding risk. This depth is the standard depth of a basement.

5.4 Wastewater Recommendations

In general, the recommendations are to adjust the existing I/I design criteria to be more in line with York Region and industry standards, maintain the current wastewater design criteria for both residential and employment. .

Wastewater Flow Projection Methodology

- Use existing flows for Baseline
- Existing flows based on flow monitoring data
- Growth flows applied to the Baseline using design criteria

Wastewater Flow Criteria for Growth

- Per Capita Wastewater Generation – 350 Lpcd
- I/I Allowance – 0.26 L/s/ha
- Peaking Factor – Harmon Peaking Factor with a range between 2 and 4

Wastewater System Criteria

- Sizing treatment facilities for Average Day Flows(ADF) (Region Only)
- Sizing of trunk sewers, pumping stations and collection system for Peak Wet Weather Flow (PWWF)
- SPS Firm Capacity based on largest pump out of service

Wastewater Level of Service

- Design Storm - Chicago Design Storm with Areal Reduction Factor
- Design Storm – 1 in 5 year Chicago Storm for sewer capacity; 1 in 25 Chicago Storm for basement flooding
- Sewer capacity - 85% d/D for sewer capacity
- Basement Flooding Risk – surcharge to within 1.8m below ground level

6 Summary of Recommendations

In general, the recommendations are to adjust the existing design criteria to be more in line with York region, industry standards and changing trends.

6.1 Water

Water Flow Projection Methodology

- Use existing demands for Baseline
- Existing demands based on water billing data / flow balance
- Growth demands applied to the Baseline using design criteria

Water Flow Criteria

- Use existing demands for Baseline
- Average Day Water Demand
    - Stouffville System: 250 Lpcd
    - Ballantrae System: 300 Lpcd
- Maximum Day Demand Peaking Factors
    - Stouffville System: 2.0 x Average Day Demand
    - Ballantrae System: 2.8 x Average Day Demand
- Peak Hour Demand Peaking Factors
    - Stouffville System: 3.0 x Average Day Demand (1.5 x Maximum Day Demand)
    - Ballantrae System: 4.2 x Average Day Demand (1.5 x Maximum Day Demand)

Water System Criteria

- Sizing water supply, transmission and storage facilities for Maximum Day Demand (MDD)
- Sizing water distribution system for peak hour demands (PHD) and Maximum Day Plus Fire Flow Demands (MDD + FF)

Water Level of Service

- Pressure Criteria - Peak/Minimum Hour
    - Existing System Areas: 40 - 100 psi
    - New Growth Areas and Pressure Zone Change Areas: 50 – 90 psi
    - Fire Flow Conditions: 20 psi
- Watermains - Velocities (excluding fire flow simulations)
    - Existing < 2 m/s
    - New < 1m/s
- Fire Flow
    - Existing System Areas: Fire flow targets based on land use as per the 2018 MP targets
    - New Growth Areas: Fire flow targets based on land use as per Design Guidelines
- Fire Flow
    - Single fire flow demand by land use (fire flow can be provided by multiple nearby hydrants)

Land use	Minimum Target for New Growth Areas (as per Design Guidelines) (L/s)	Minimum Target for Existing Service Areas (as per 2018 Master Plan) (L/s)
Single/Semi-detached family	117	75
Townhouses	125	90
Apartments	150	150
Institutional	175	175
Industrial	250	250
Commercial	200	200

6.2 Wastewater

Wastewater Flow Projection Methodology

- Use existing flows for Baseline
- Existing flows based on flow monitoring data
- Growth flows applied to the Baseline using design criteria

Wastewater Flow Criteria for Growth

- Per Capita Wastewater Generation – 350 Lpcd
- I/I Allowance – 0.26 L/s/ha
- Peaking Factor – Harmon Peaking Factor with a range between 2 and 4

Wastewater System Criteria

- Sizing treatment facilities for Average Day Flows(ADF) (Region Only)
- Sizing of trunk sewers, pumping stations and collection system for Peak Wet Weather Flow (PWWF)
- SPS Firm Capacity based on largest pump out of service

Wastewater Level of Service

- Design Storm - Chicago Design Storm with Areal Reduction Factor
- Design Storm – 1 in 5 year Chicago Storm for sewer capacity; 1 in 25 Chicago Storm for basement flooding
- Sewer capacity - 85% d/D for sewer capacity
- Basement Flooding Risk – surcharge to within 1.8m below ground level

6.3 Closing Remarks

York Region develops separate design guidelines and standard for regional trunk infrastructure located within the Town as well as other municipalities within the Region. York Region is currently undertaking a study for Reconciliation of Water & Wastewater Design Standards between York Region and Local Municipalities, which will offer another opportunity to further review Stouffville's water and wastewater design criteria.