MUNICIPAL ENGINEERS ASSOCIATION
DEVELOPMENT ENGINEERING COMMITTEE
(MEA-DEC)
MEETING MINUTES

Date: **Thursday December 9, 2021**

Time: **10:05 am - 12:00 pm**

Location: **Video Conference via Zoom**

Attendees: **Listed at bottom of Minutes**

Prepared by: Patti Kennedy, Mike Pincivero

Item No.	Discussion Topics	
1	Opening Remarks: a) Welcome to the final DEC meeting for 2021. b) Introductions – click on "participants" in Zoom to see list for order of introductions, but the list order is different for each participant to introduce themselves and municipality… MP called everyone in order of his screen to introduce themselves c) Meeting structure: a. Please use "Reactions" at bottom of screen to raise hand or gestures, otherwise, just ask any questions at any time. b. Stop at 12 for hour lunch. d) P. Kennedy preparing meeting minutes.	Mike Pincivero Town of Wasaga Beach
2	Maximum # of lots permitted on single access road • In engineering standards or policies? • Guelph - a length of road 150 m requires an emergency access. Greater than 300 m a 2nd permanent access is required. • Collingwood – emergency services concerns-they utilize National Fire Protection Association -NFPA 1141 standard is utilized. Number of access routes based on number of households. Will share with Group. (see attached excerpts of NFPA 1141; also, access to purchase the document is here: https://catalog.nfpa.org/NFPA-1141-Standard-for-Fire-Protection-Infrastructure-for-Land-Development-in-Wildland-Rural-and-Suburban-Areas-P1411.aspx) • Whitby – 230 m max length of road, or the option to widen pavement at intersection to 12 m to provide added access. They will share their standard (see attached) • Halton – no specific standard; no more than 20 units on single service (based on water supply), limited by fire flow beyond 100 m. • Oshawa – 250 m from any single point of access; if greater than that distance, a secondary access is required. (see attached guidelines) • Ajax – site plans single cul-de-sac – units require sprinklers if exceeding a max length. • Richmond Hill – determined through conversations with planning and fire department during development application review. • T of WB – up to 40 units; beyond 40 units requires a secondary emergency access; up to 80 units with emergency access; over 80 units, a permanent second access road is required. • York Region – looking forward to receive NFPA documents to rely on. Find that each lower tier fire department has different criteria.	Mike Pincivero Town of Wasaga Beach

3	O.Reg 406/19 (Excess Soil) – how to deal with registered subdivision roads (already dedicated to Municipality and therefore, Mun is “owner”) • Oshawa - Should this be addressed in the Subdivision Agreements (S.A.)? • Regulation comes into full force and effective January 2022. • MP – suggest yes this should be outlined in the S.A.; it should be the developer’s responsibility • WB also has wording in Engineering Standards indicating developer must comply with O.Reg. 406/19 • Oshawa – can the municipality put the onus on the Developer? • The Regulation gives opportunity to place onus on contractor, but ultimately, the owner is responsible / liable. • Wolwich – the Regulation does give ability to put the onus on the developer/contractor. Shoring up S.A. to ensure wording covers off Reg. is recommended. Update Engineering Standards to reflect the legislation/Reg. Site Alteration By-laws should be updated before Jan. 2022. • Town of Grimsby – is there a mechanism to defer ownership of lands to the Town? Discussion with regard to how to not transfer lands to the Town at Registration of the M-Plan – Town does take ownership at time of registration. One option is to require pre-servicing prior to subdivision registration. Could make developer phase registration of M-Plan with pre-servicing / earthworks done prior to each phase of the M-plan being registered. • Whitby – focus on project leader, not owner of lands. If the developer is still the “project leader” municipality may not be responsible. Will share information with Group for legal information (see link: https://mcmillan.ca/insights/the-quick-and-dirty-on-ontarios-new-excess-soil-regulations/)	Chris Lato City of Oshawa
4	Site Plan permanent dewatering • Oshawa – addressed in Agreements? Who is responsible to monitor? Working on a “re-do” of Agreement and would appreciate wording. • Guelph – related to underground parking garage? Then it falls to the Building Code. Engineering involved with environmental impact. Parking garages to be “water tight” rather than allowing permanent dewatering. • T of WB – spoke to volumes of water and MECP regulations/requirements. If over 50,000 L/day but less that 400,000 L/day, an EASR is required (online registration). Over 400,000 L/day, a full PTTW is required from MECP. In terms of drinking water quantity related concerns, applications are reviewed by RMO with regard to impact on drinking water source. • York Region – approvals from MECP; Hydro-G reviewed by RMO; where does water get pumped to? Only dewater into regional storm sewers, can’t exceed storm sewer capacity during regional storm. • Whitby – do not allow permanent dewatering? Enforced at pre-consultation and design review. City of Toronto has a good document - discussion on impact and cost of permanent dewatering. Believes the City requires a private agreement for de-watering/discharge? • T of WB – garages constructed partially underground/above groundwater table in the Town (therefore no permanent dewatering). • Vaughan – control flows – environmental department. • Bradford West Gwillimbury – by-law sets water quality parameters, no discharge to sanitary sewer; discharge to storm sewer must control flows, submit a dewatering plan, identify where they propose to discharge to; quality is to be monitored.	Chris Lato City of Oshawa

	• See Toronto document here: http://wx.toronto.ca/inter/clerks/fit.nsf/0/9aec51f24e82ebc48525807a005638e3/$File/Private%2BWater%2BApplication%2Bv1.6.pdf • Another Toronto link here: https://www.toronto.ca/services-payments/water-environment/water-sewer-related-permits-and-bylaws/sewers-by-law/managing-foundation-drainage/	
5	Automated Speed Enforcement (ASE) • Mandate that Developers be required to install ASE on behalf of the municipality? (within the subdivision development to control speeding) • ASE are typically funded through tax base. • T of WB – investigated, based on cost, no local process for issuing the tickets (has to be outsourced for processing). Found to be too costly. Only to be installed in Community Safety Zones (CSZs) • Whitby – Council requested to implement traffic control within new developments. Primarily utilizing speed bumps. • Discussion with regard to lowering speed limit throughout municipalities – 40 km/hr. However, it is deemed in most cases that it is only perceived speeding. General consensus is not to lower posted speed limits.	Andrea Dale Town of Whitby
6	Cranes carrying of loads over the right-of-way (and other conditions, requirements / agreement…?) • Licensing Agreement in Whitby. • Richmond Hill – refer to tower guidelines. Do not permit live loads to swing over live lanes in roadways. **Dev. Eng. refers to York Region's High Rise Construction Guidelines and are also developing Richmond Hill construction and traffic management guidelines. Crane location, type, and crane swing are required to be shown on the CMP. Live loads not permitted to swing over City's lands. Crane safety and operations per https://www.labour.gov.on.ca/english/hs/sawo/pubs/fs_mobilecranes.php)** • York Region – required to submit a swing plan, identifying location of crane, length of boom, etc. cannot swing over lanes. An Encroachment Permit/Agreement is entered into. • T of WB – does Region allow for a road closure for temporary swing over lanes? • York Region – lane closures are allowed to “pick” loads from truck to crane – Road Occupancy Permit (ROP) required (with traffic control plan). Curb lane closure 2-3 hours – off hours. • Richmond Hill – ~~**case by case. Allowed developer to install fencing at back of curb – more space for storage in Municipal Boulevard – clause in Agreement with regard to this boulevard use and reinstatement.**~~ **allowed developer to partially encroach in the boulevard (no sidewalk here) to provide more room for hoisting materials (only on a case-by-case basis when other options not available). We allowed the temp. hoarding to be installed 0.6m from the back of curb for Operations' winter maintenance. Developer responsible for conveying the road widening and ensuring a Ph1 ESA is completed to ensure lands can be returned to City in compliance.**	Brandon Ewart Town of Whitby

	Collingwood – planning application – encroachment agreement. No live loads to be carried over live lanes.	
7	CLI ECA transition – no more ECA applications; design guidelines to adhere - Consolidated Linear Infrastructure: Consolidating all previous ECA's - Similar to Water License / Approvals process - Municipalities will now become the approval Authority - Ajax – MECP seem to not be too concerned with "completeness" of the application; they will be sending "bare minimum" data (GIS mapping, listing of ECA #'s, etc.) - T of WB – "gaps" in data exist. Municipality has a heightened level for review of submissions and responsibility with this new process. - Design guidelines – discussion with regard to guidelines that may not be in current municipal standards. How will these criteria be met? - Collingwood – most infrastructure is mapped, need time to prepare maps. Share concerns with draft development design guidelines. However, it is noted that MECP have received numerous comments from municipalities (over 200) regarding the guidelines, and revisions are expected. - London – working towards January deadline. Have not gone through design guidelines in detail yet. - T of WB – GIS compiling maps; Project Coordinator compiling data for the two applications; PW admin compiling ECA's; aiming to meet the January deadline.	Mike Pincivero Town of Wasaga Beach
8	When / will municipalities adjust design parameters for sanitary sewers to recognize low flow design households? - Operations Manager raised this question with regard to bearing on (the lack of) self flushing of systems. - No other municipalities commented on this subject. **<u>POST MEETING NOTE</u>: MP received comment from Region of Waterloo (who were not able to attend the meeting) regarding this subject: "the Region of Waterloo conducted a review of the design rates as part of our last Wastewater Treatment Master Plan. The attached document (now attached to these Minutes for reference) may be helpful in the discussion. The summary is that through this review they recommended a reduction of the design flow rates in our Design Guidelines. However, it also recommended an increase to the extraneous flows allowance, so the net impact was not as substantial as it could have been."**	Mike Pincivero Town of Wasaga Beach
9	Round Table / Open Mic - Town of Grimsby - how municipalities are dealing with too much flow in sanitary sewers – excess flow in sanitary system (opposite of #8 above). Flow monitors – where to be placed? This item to be placed on Agenda for discussion at next meeting. - Vaughan – SWM ponds/Parks – underground storage tanks in parks and/or ROW to avoid loss of developable land. Replacement cost for future maintenance of underground tanks? **SWM tanks in lieu of traditional SWM ponds, being placed underground in the parkland contribution.** - T of WB – allow underground tanks with park on top, but all private developments / ownership. - Richmond Hill – walkway connection/park, "Strata Sale / Agreement" (i.e. different owners of different layers of space: municipality owns the park / above ground area, condo owns underground infrastructure) Alternative arrangements – will provide	All attendees

	documentation to Grimsby. **Will request R.Hill's Manager Engineering Subdivisions and Infrastructure Planning to connect with City of Vaughan.** • Grimsby – concerned with maintenance of underground tanks long term. Monetary concerns long term – future maintenance, different costs from Ponds. Looking into difference of long-term maintenance cost for a SWM ponds vs underground storage tanks – developer should give capital contribution for the difference. MP requested that this item to be discussed further at next meeting (presented by Marvin – Grimsby). • Please email comments/questions to Mike P. for topics to be added to next meeting. • Happy Holidays!	
13	Next Meeting – March 2022 (TBD) • Aim for quarterly meetings again next year.	

Attendees:

Mike Pincivero,	Town of Wasaga Beach
Patti Kennedy,	Town of Wasaga Beach
Jason Peters,	Town of Wasaga Beach
Matt Davenport,	City of London
Nasir M,	York Region
Frank Lombardi,	York Region
Julie Tot,	Brant County
Alick Wong,	City of Toronto
Stuart West,	Town of Collingwood
Marvin Ingebrgtsen,	Town of Grimsby
Cynthia Tam,	York Region
Chris Lato,	Oshawa
Ivan Gonzalez,	York Region
John Kisneris,	Halton Region
Neil Miles,	Brant County
Mary Angelo,	City of Guelph
Peyman Samimian,	Bradford West Gwillimbury
Arif Khan,	Region of York
Alex Donn,	Brant County
Calvin Mollett,	York Region
Mirella Bertini,	York Region
Trevor Catherwood,	York Region
Lori Fox,	Township of Woolwich
Anwer Mumtaz,	York Region
Saad Yousaf,	Vaughan
Mirella Betini,	York Region
John Lau,	York region
Carl Smith,	York Region
Rollie Orial,	Whitby
Andrea Dale,	Whitby
Annie Kwok,	Richmond Hill
Amin Mneina,	MEA
Stephen Ruddy,	Ajax
Brandon Ewart,	Whitby
Matthew D’Hondt,	Brant County

(appologies if anyone is missed)

4.1.5 The AHJ shall use recognized fire protection measures to meet local conditions because this standard does not set forth general fire protection features or procedures addressed in other codes or standards.

4.1.6 Where a provision of any other standard, code, law, or regulation recognized by the AHJ is in conflict with this standard, the more restrictive provision shall apply.

4.1.7* Prior to occupancy of any portion of the development, supporting infrastructure shall be installed, operational, and approved by the AHJ.

4.2* Plans.

As a minimum, the AHJ shall require preliminary, working, and as-built plans to be submitted in a timely manner.

4.2.1 Plans shall be limited to the provisions of this standard.

4.2.2* Preliminary Plans.

4.2.2.1 All preliminary plans, when submitted, shall contain, as a minimum, a site plan showing proposed water supply, roadway access, fire department access, conceptual future development, and other items pertinent to the specific project.

4.2.2.2 The AHJ shall be permitted to make recommendations to the submitter, based on the preliminary plans, to assist the developer in developing the working plans.

4.2.3 Working Plans.

4.2.3.1 Previously engineered working plans and any modifications to them shall be drawn to scale and signed by a licensed architect or engineer and shall illustrate the final design of items required by this standard.

4.2.3.2 The AHJ shall approve the plans when the requirements of this standard have been reflected in the plans.

4.2.4 As-Built Plans. As-built drawings showing items listed in 4.2.2.1 shall be submitted to the fire department upon completion of the project.

4.3 Wildland Areas.

In addition to other requirements in this standard, land use changes in wildland areas shall be subject to the requirements in NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*.

4.3.1 All new construction in wildland/urban interface areas shall be designed, located, and constructed to comply with NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*.

Chapter 5 Means of Access

5.1 General.

5.1.1 This section shall apply to all means of access, publicly or privately owned, whether or not they are designated as public thoroughfares.

5.1.2 Means of access shall consist of roads, roadways, bridges, fire lanes, parking lots, or a combination thereof, and shall be provided to all buildings more than 400 ft^2 (37 m^2) in ground floor area and to public occupancies with structural components.

5.1.3* The length of any cul-de-sac shall not exceed the fire-fighting capability of the fire department.

5.1.4* A cul-de-sac exceeding 1200 ft (366 m) in length shall be provided with approved intermediate turnarounds at a maximum of 1200 ft (366 m) intervals.

5.1.5 Number of Means of Access.

5.1.5.1* A land development shall have one or more means of access in accordance with Table 5.1.5.1(a), Table 5.1.5.1(b), or 5.1.5.2, whichever produces the greater number.

Table 5.1.5.1(a) Required Number of Access Routes for Residential Areas

Number of Households	Number of Access Routes
0–100	1
101–600	2
>600	3

Table 5.1.5.1(b) Required Number of Access Routes for Nonresidential Areas

Number of Parking Spaces	Number of Access Routes
0–1250	1
1251–3000	2
>3000	3

5.1.5.2 Where residential areas are mixed with nonresidential areas, the minimum number of access routes shall be determined by calculating five parking spaces for each dwelling unit, adding that number to the parking spaces count for the nonresidential area, and using Table 5.1.5.1(b).

5.1.5.3 Where multiple means of access are required, one of the means of access shall be permitted to be restricted for emergency use only, when approved by the AHJ.

5.1.5.4 Where multiple means of access are required, they shall be located as remote from each other as practical and acceptable to the AHJ.

5.2 Roadways.

Roadways shall be constructed and maintained in accordance with this section.

5.2.1* The legal right-of-way for a roadway shall accommodate the width necessary for the construction, drainage, erosion control, and maintenance of the roadway, and provisions for utilities and sidewalks.

5.2.2 Roadways shall be constructed of a hard, all-weather surface designed to support all legal loads of the jurisdiction.

5.2.3 Roadways shall have a minimum clear width of 12 ft (3.7 m) for each lane of travel, excluding shoulders and parking.

5.2.3.1 Curves shall not reduce the width of the roadway.

5.2.3.2 Provisions shall be made for drainage, snowbanks, parking, utilities, and the like such that they do not impinge on the minimum clear width.

Private Roadway Design

PURPOSE

To provide direction to follow when involved in the review and approval of private roadways for residential or commercial developments provided with a single access point that fall outside the prescriptive requirements of the Ontario Building Code as amended.

SCOPE

This procedure applies to all personnel in Fire Prevention.

POLICY

All lengths of roadway are to be measured along the centerline of the roadway.

The roadway shall be constructed such that it will be a minimum 6m wide, with a minimum 12m centerline-turning radius and be at least 3m from any portion of a building.

Maximum 90m long access street or “throat” entering into the property from a municipal road (this measurement shall be taken from the centerline of the municipal roadway lane closest to the subject property and measured to the curb at which an intersection is created).

The maximum distance from centerline of municipal road to the furthest point of private roadway shall not exceed 250m. This dimension shall be measured to the centerline of the most remote point in the roadway.

The minimum distance from building to building across private roadway shall not be less than 12m.

The cumulative length of all private roadways within the subject development area shall not exceed 750m.

If the private roadway is connected to a municipal road that also has a single access point of access (ie cul-de-sac), all measurements shall be calculated from the single access point of the municipal road. Therefore, the distance from the single point of access for the private roadway to single point of access for the municipal road, shall be added to all private roadway lengths.

Each development shall be reviewed on a case-by-case basis. Any deviations from the above requirements shall be submitted in a proposal outlining compensating measures. These measures shall include a rationale prepared by a Professional Engineer or Architect. The compensating measures shall be approved by the Fire Chief and/or Deputy Fire Chief in consultation with the Chief Fire Prevention Officer.

RESPONSIBILITY

It is the responsibility of all Fire Prevention Staff to follow these guidelines.

It is the responsibility of the Chief Fire Prevention Officer or his/her designate to ensure that these guidelines are adhered to.

REFERENCE

Excerpt from City of Oshawa Engineering requirements

3.16 Secondary or Emergency Access

The City of Oshawa does not support permanent Emergency Access locations and the need for such should be eliminated through road network design techniques.

A maximum street length of 250 metres, from any single access point will be permitted before a secondary street access is required. This distance shall be measured along the centre line of the road.

Temporary emergency access locations are discouraged. However, they will be permitted to accommodate the phasing of Plans of Subdivision when all other alternatives have been exhausted.

The emergency access shall be a minimum of 6.00 metres in width and constructed to a minimum depth of 300mm granular A and 50mm HL 8 asphalt. The access shall be constructed as per City of Oshawa Design Standard OS-315. P-Gates or Swing Gates are required at both limits of any secondary or emergency access constructed.

The Subdivider is responsible for the removal of the emergency access when it is no longer required (ie road network complete for subsequent phase) and must ensure that all municipal services (ie curb and boulevard) are restored.

The Subdivider shall ensure that the access is clear of material at all times. The City will assume winter control of the access at the same time it assumes snow clearing responsibilities for other streets in the plan.

subgrade drainage.

- Desirable minimum longitudinal ditch grade shall be 1.0% with absolute minimum being 0.3%.
- Ditch grades greater than 3.0% shall have staked sod protection; and;
- Ditches greater than 5.0% shall have hand laid rip rap protection.

C3.07 Subdivision Emergency Access

1. The following criteria shall be used for the approval of urban subdivision developments:

   (a) Cul-de-sacs shall not exceed 230 metres in length;

   (b) The entrance portion to P-Loops and B-Loops shall not exceed 90 metres;

   (c) Where the circumference of a P-Loop (or one half of a B-Loop) exceeds 490 metres, the entrance portion shall have a minimum road width of 12 metres, exclusive of any median required or incorporated;

   (d) The maximum circumference of a P-Loop (or one half of a B-Loop), or any combination of street pattern, shall not exceed 700 metres; and,

   (e) For the purpose of the Subdivision Emergency Access policy it is assumed that in the case of items (c), (d) and (e) that any P-Loop or B- Loop shall include a service lane adjacent to a collector or arterial road. Where a service lane is not included in the design of a P-Loop or B-Loop, a permanent walkway providing emergency access shall be required where a P-Loop or B-Loop exceeds 430 metres, subject to the minimum design standards.

2. Where the limits of the items in C3.07, Item 1 are exceeded, a second means of access shall be provided.

3. Where an emergency access or a temporary access is to be installed then the following design criteria shall be used:

   - Minimum width of 4.0 metres;
   - Maximum slope of 8.0%;
   - 12.0 metres minimum centerline turning radius;
   - 5.0 metre minimum overhead clearance from grade;
   - Asphalt or other permanent surface;
   - Barrier consisting of bollards and chain or other acceptable measures; and,
   - Adherence to the Ontario Building Code.

4. Prior to the issuance of a building permit the emergency access will be required to be fully constructed and operational.

NOTE:

1. Circumference is measured at centre line of road.
2. Road width – face of curb to face of curb.

C4.00 Boulevards, Sidewalks and Walkways

C4.01 Sidewalks

Sidewalks are generally required on both sides of collector and arterial roadways. On local roads, sidewalks are required on at least one side and on both sides if significant pedestrian volumes are anticipated or located near schools, parks, churches, hospitals, etc. Cul-de-sac may not require sidewalks, if less than 150 metres in length.

All sidewalks are to be designed in accordance with the Town of Whitby Standard Drawing No. 208 and shall be installed at locations shown on the typical road cross-sections.

At all driveway locations the sidewalk thickness shall be increased to 175mm for both residential and commercial driveways. On commercial driveways, a 150mm x 150mm wire mesh shall also be placed in accordance with Town of Whitby Standard Drawing No. 208.

A curb keyway shall be incorporated into the curb where sidewalks are constructed adjacent to curbs as detailed on Town of Whitby Standard Drawing No. 206 and OPSD 600.404.

Requirements for temporary asphalt sidewalks are shown in the Town of Whitby Standard Drawing No. 210.

C4.02 Boulevards

Boulevards are to be graded according to the Town of Whitby Standard Drawing No. 208. On new construction the grade of the boulevard shall be constant from the back of the curb to the street limit or sidewalk.

Where required, Coloured Impressed Concrete is to be installed as per Town of Whitby Standard Drawing No. 211.

C4.03 Walkways

Walkways shall be constructed in accordance with Town of Whitby Standard Drawing No. 209 to promote proper circulation of pedestrian traffic and also to provide an overland flow route for storm flows.

C4.04 Multi-use Pathways

Multi-use Asphalt Pathways shall be constructed in accordance with Town of Whitby Standard Drawing No. 214.

Regional Municipality of Waterloo

REVIEW OF WATERLOO DESIGN GUIDELINES WASTEWATER PER CAPITA FLOWS

Partners in excellence
5935 Airport Road, Suite 500
Mississauga, Ontario
L4V 1W5
Canada
Phone: (905) 695-1005
Fax: (905) 695-0525
www.cima.ca

January 2017

T000737A

Preparation and Review Log

Version	Date	Prepared by (Deliverable Lead)	QC Reviewer	Project Manager Sign-off
Draft v1.0	January 3, 2017	Stacey Romas, EIT Shujun Dong, P.Eng.	Erin Longworth, P.Eng. Troy Briggs, P.Eng.	Erin Longworth, P.Eng.
Final	January 16, 2017	Shujun Dong, P.Eng.	Erin Longworth, P.Eng. Troy Briggs, P.Eng.	Erin Longworth, P.Eng.

Table of Contents

List of Tables

List of Figures

1. Introduction

The Regional Municipality of Waterloo (the Region) is an upper tier municipal government, providing municipal services to seven lower-tier municipalities with a total residential population of approximately 550,000 people. The Region owns a total of thirteen (13) wastewater treatment plants treating an average of 66 million cubic meters annually of wastewater.

The Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services (DGSSMS), January 2016 (revised February 2016) stipulate sanitary design flows for residential, industrial, commercial and schools, as well as infiltration allowances for the purposes of sanitary pipe design. Based on decreasing trends in water demand and usage, the Region wishes to review the sanitary criteria used in the DGSSMS.

This memorandum has been prepared to review the Region's design criteria used for estimating sanitary wastewater flow, and to make recommendations on any adjustments that may be justified based on analysis of historical flow data and trends. The purpose is to ensure that the projected wastewater flows are accurate and reflect recent trends to support decision making for the sizing and timing of future infrastructure including pipes and facilities. Included in this memorandum is the comparison of the current wastewater design criteria with several Ontario municipalities, analysis of historical wastewater flow data and analysis of current and projected water demand data as it relates to wastewater flow generation.

The memorandum is organized into the following sections:

1. Design Criteria Comparison
2. Review of Historical WWTP Data
3. Review of Water Demand Data
4. Review of Infiltration Rates
5. Other Issues and Considerations
6. Recommendations

2. Design Criteria Comparison

A review of the design criteria for many locations across Southern Ontario and the Greater Toronto Area (GTA) was conducted to enable a comparison of design criteria and further understanding of how these criteria relate to the guidelines within the Region of Waterloo. The municipalities assessed include:

- Region of Halton
- Region of Peel
- Region of York
- Region of Durham
- City of Toronto
- City of Hamilton

- City of London
- Town of Brantford
- County of Brant
- City of Barrie

It is important to note that some of these systems have combined sewer components, however most of these systems would be considered separate wastewater systems for new growth. Each system is subjected to varying levels of wet weather influence.

In order to project and plan wastewater flows, a common approach amongst the majority of municipalities is to establish total peak flow as a combination of peak dry weather flow plus extraneous flows. The base dry weather flow is established as a per capita flow rate. It is also most common to use the Harmon formula to calculate a dry weather peaking factor to account for daily fluctuations in flow, with the following formula:

$$M = 1 + \frac{14}{4+\sqrt{P}} \quad 2 \leq M \leq 5$$

P = Population in Thousands

Another potential method of calculating a dry weather peaking factor is the Babbitt formula, which is less common amongst the municipalities reviewed. The Babbitt formula is as follows:

$$M = 1 + \frac{5}{P\text{^}0.2} \quad 2 \leq M \leq 5$$

P = Population in Thousands

The extraneous flow typically represents the level of inflow and/or infiltration that can enter the sewer system. The peak wet weather flow is typically in L/s and is calculated using the following formula:

$$\begin{aligned} &Peak\ Wet\ Weather\ Flow \\ &\qquad = (Avg\ Day\ Dry\ Weather\ Flow\ x\ Peaking\ Factor) + Peak\ Extraneous\ Flow \end{aligned}$$

Table 1 provides a comparison of the key criteria from other municipalities that were reviewed against the Regional Municipality of Waterloo's design criteria. It can be seen that the different municipalities provide a range of residential and employment per capita design criteria for use in calculating the average dry weather wastewater flow, and an extraneous flow allowance for calculating peak wet weather flow.

Table 1 Summary of Wastewater Flow Rate Criteria Review

Municipality	Average Dry Weather Flow Criteria				Peaking Factor Methodology	Extraneous Flow (L/s/ha)	Source
	Residential (L/cap/s)	Industrial (L/ha/s)	Commercial (L/ha/s)	Institutional (L/ha/s)			
Waterloo	0.0041 (350 L/cap/d)	0.50	Core: 1.16 Shopping Mall: 0.30 General: 0.60	MOECC	Harmon Formula	Infiltration: 0.15	2016 DGSSMS
Halton	0.0032 (275 L/cap/d)	0.40	Light Commercial: 0.29	Hospitals: 0.013 L/bed/s Community services: 0.13	Harmon Formula	Infiltration and Inflow: 0.286	2015 Water and Wastewater Linear Design Manual
Peel	0.0035 (302.8 L/cap/d)	Light Industrial: 0.25	0.18	Junior School: 2.10 L/s Senior School: 3.15 L/s Secondary School: 5.26 L/s Hospitals: 0.011 L/bed/s	Harmon Formula	Infiltration: 0.20 (1)	2013 Water and Wastewater Master Plan, and 2009 Sanitary Sewer Design Criteria
York	0.0031 (265 L/cap/d)	0.17 – 0.23 (2)	0.17 – 0.23 (2)	0.17 – 0.23 (2)	Harmon Formula	Infiltration and Inflow: 0.26	2016 Water and Wastewater Master Plan
Durham	0.0042 (364 L/cap/d)	Local sewers: 2.08 (peak) Truck Sewers: 1.04 (peak)	2.08 (peak)	1.30 (Peak)	Harmon Formula	Infiltration: 0.26 - 0.52 (3)	2016 Design and Construction specifications
City of Toronto (separated system)	0.0028 (240 L/cap/d)	0.39	Commercial/Retail: 0.32 Office Building: 0.95	Institutional (nursing home/hospital): 0.003 L/bed/s School/Church: 0.25	Harmon Formula	Infiltration and Inflow: 0.26	2009 Design Criteria for Sewers and Watermain
Hamilton	0.0042 (360 L/cap/d)	0.52 – 3.13	0.52 – 3.13	0.31 – 0.52	Babbitt Formula	Infiltration: 0.40 - 0.60 (4)	2012 Engineering Guidelines for Serving Land under Development Applications
London (5)	0.0027 (230 L/cap/d)	0.23 – 0.29	0.27	Institutional: 0.27 Elementary School: 1.60 L/s Secondary School: 4.0 L/s Church: 0.27	Harmon Formula	Infiltration: 0.10	2015 Design Specifications & Requirements Manual
Brantford	0 0031 (270 L/cap/d)	300 L/cap/d (6)	300 L/cap/d (6)	300 L/cap/d (6)	Harmon Formula	Infiltration and Inflow: 0.20	2014 Master Servicing Plan.
Brant	0.0041 (350 L/cap/d)	0.52	Light Commercial: 0.47	Institutional (Schools): 0.14 Hospitals: 0.021 L/bed/d Community services: 0.21	Harmon Formula	Infiltration: 0.23	2014 Development and Engineering Standards
Barrie	0.0026 (225 L/cap/d)	General Industrial: 0.41 Heavy Industrial: 0.64 General & Heavy Ind: 0.58	0.32	0.32	Harmon Formula	Infiltration and Inflow: 0.10	2012 Sanitary Sewage Collection System Policies and Design Guidelines:

Municipality	Average Dry Weather Flow Criteria: Residential (L/cap/s)	Industrial (L/ha/s)	Commercial (L/ha/s)	Institutional (L/ha/s)	Peaking Factor Methodology	Extraneous Flow (L/s/ha)	Source
MOECC	0.0026-0.0052 (225 - 450 L/cap/d)	Varies	Shopping Center: 0.30 – 0.60	School: 0.0008 – 0.0016 L/student/s Hospital: 0.010 – 0.021 L/bed/s Hotel: 0.003 L/bed/s Motel: 0.0017 – 0.0023 L/bed/s	Harmon or Babbit Formula	No value	MOECC Design Guidelines for Sewage Works
Average/Range	0.0033 (290 L/cap/d)	0.38 (Range: 0.17 – 3.13)	0.31 Range (0.17 – 3.13)	0.26 Range (0.13 – 0.52) Hospital: 0.003 – 0.021 L/bed/s	Harmon or Babbit Formula	0.25	

Notes :

(1) When designing sewers that accept flow from areas developed more thatn 25 years ago, an additinoal allowance should be made for foundation drains equals to 0.08 L/s/foundation drain. Additional allowance for maintaince hole inflow : 0.28 L/sec/mh or equivalent of 0.028 L/s/drain (Region of Peel Design Criteria, 2009).

(2) The value varies between 0.17 – 0.23 L/s/ha depending on area densities developed within Master Plan.

(3) 0.26 L/s/ha when foundation drains are not connected to the sanitary sewers; 0.52 L/s/ha when foundation drains are connected to the sanitary sewers

(4) 0.40 L/s/ha for areas with deep storm sewers, i.e. storm sewers is below weeping tiles of the dwellings or where separate foundation drain collector sewer is proposed.
0.60 L/s/ha for areas where there are no storm sewers or have shallow storm sewers, i.e. where the weeping tiles of the dwellings are drained by sump pumps.

(5) Uncertain development factor of 1.1 applied to tributary areas <200 ha for average day dry weather flow for resiedential and ICI.

(6) No specific population densities provided by the City.

Average Residential Dry Weather Flow

Residential average day dry weather flow design criteria for the various municipalities is generally between 0.0026 and 0.0052 L/cap/s with an average of 0.0033 L/cap/s, which is within the MOECC Guidelines. In general, the Region of Waterloo falls within the range of the other municipalities and the MOECC Guidelines, but at the relatively upper end of this range for the residential wastewater generation rate, as shown in Figure 1.

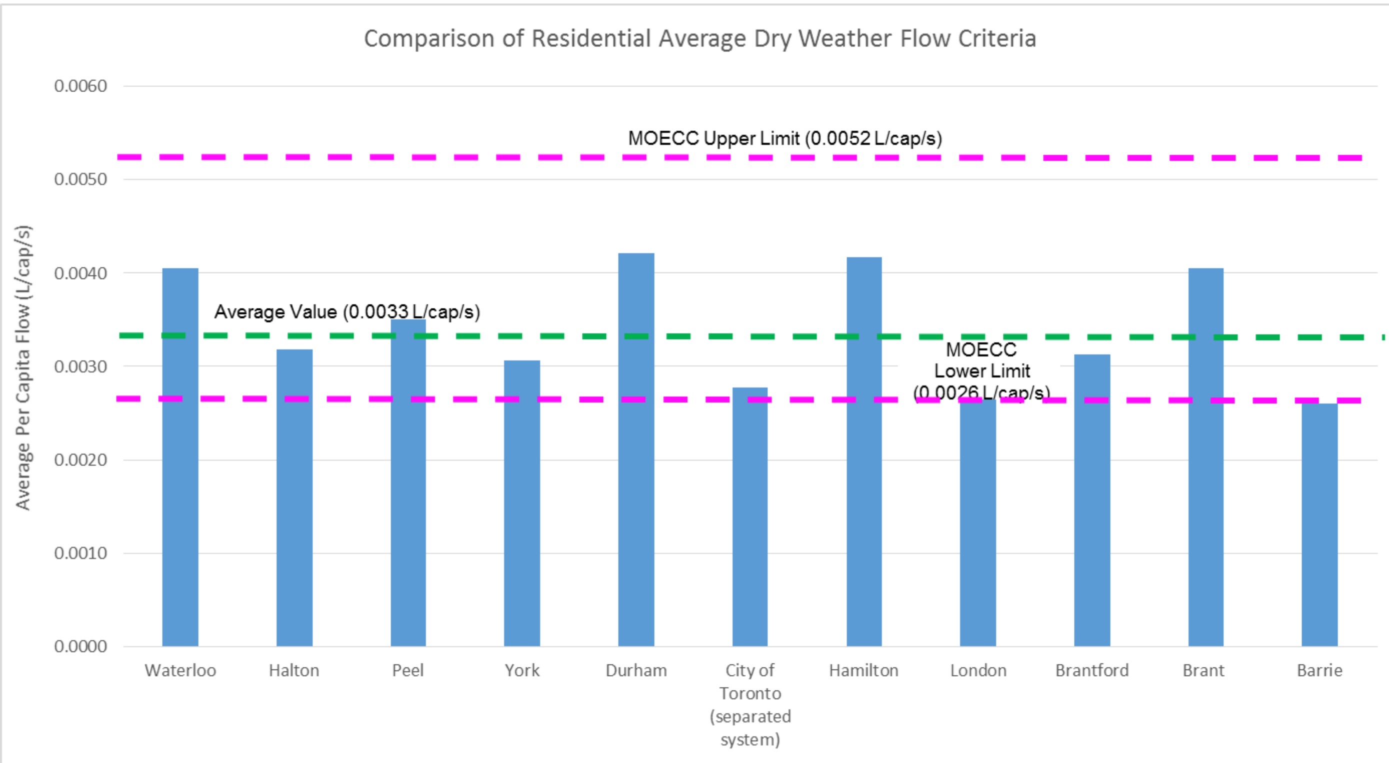

Figure 1 Comparison of Residential Dry Weather Flow Criteria among Municipalities

Industrial, Commercial and Institutional (ICI)

There is a larger variance with the employment criteria, mainly due to the method in which the criteria is listed. Some municipalities provide a design criteria based on area (hectares) while others give a per capita (employee) based criteria and densities of persons per hectare to be assumed when developing the flow projections. Figure 2, Figure 3 and Figure 4 show the comparison of average dry weather flow criteria among the municipalities reviewed for industrial, commercial and institutional, respectively.

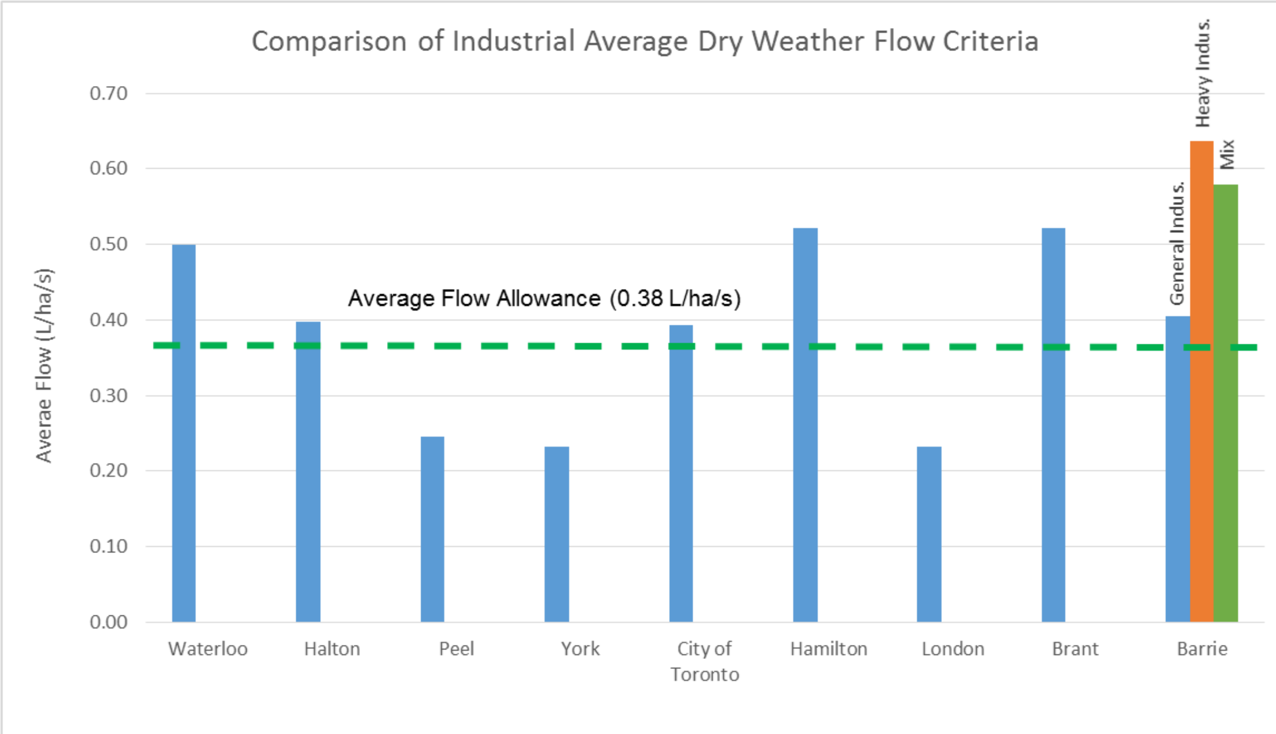

Figure 2 Comparison of Industrial Average Dry Weather Flow Criteria among Municipalities

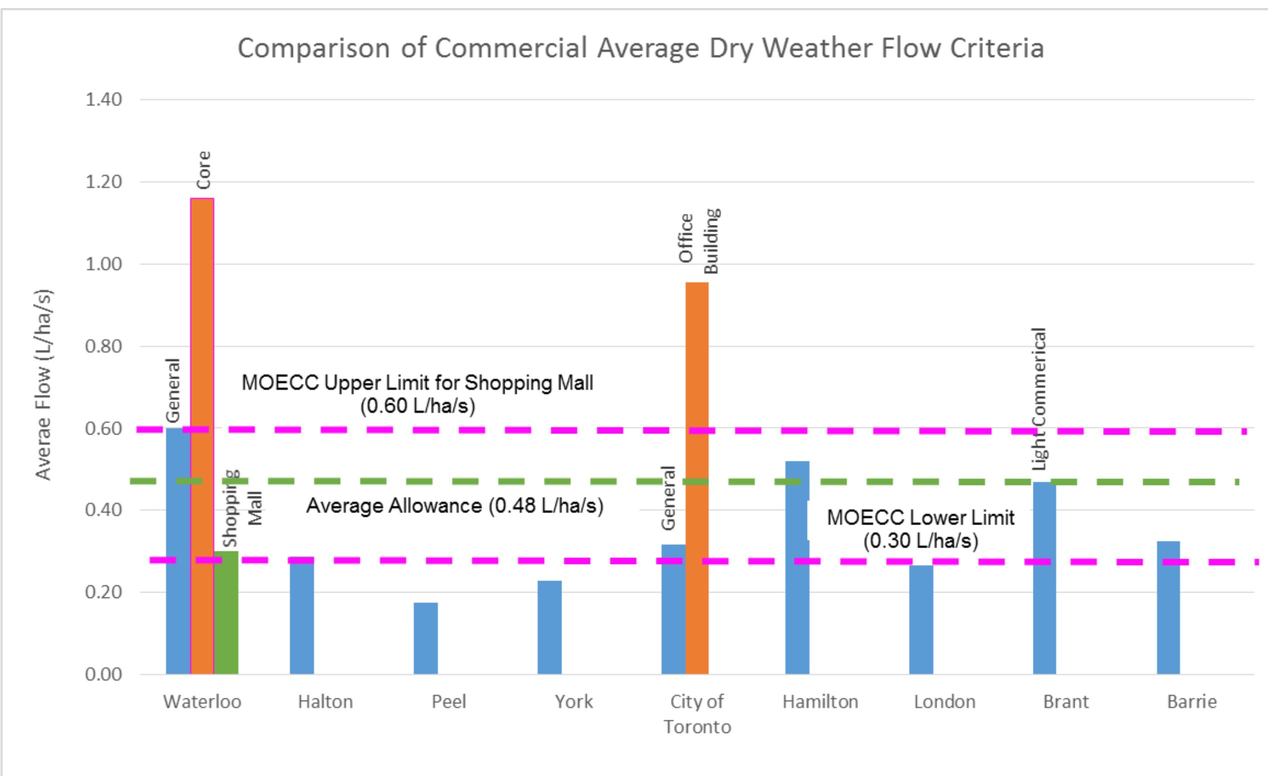

Figure 3 Comparison of Commercial Average Dry Weather Flow Criteria

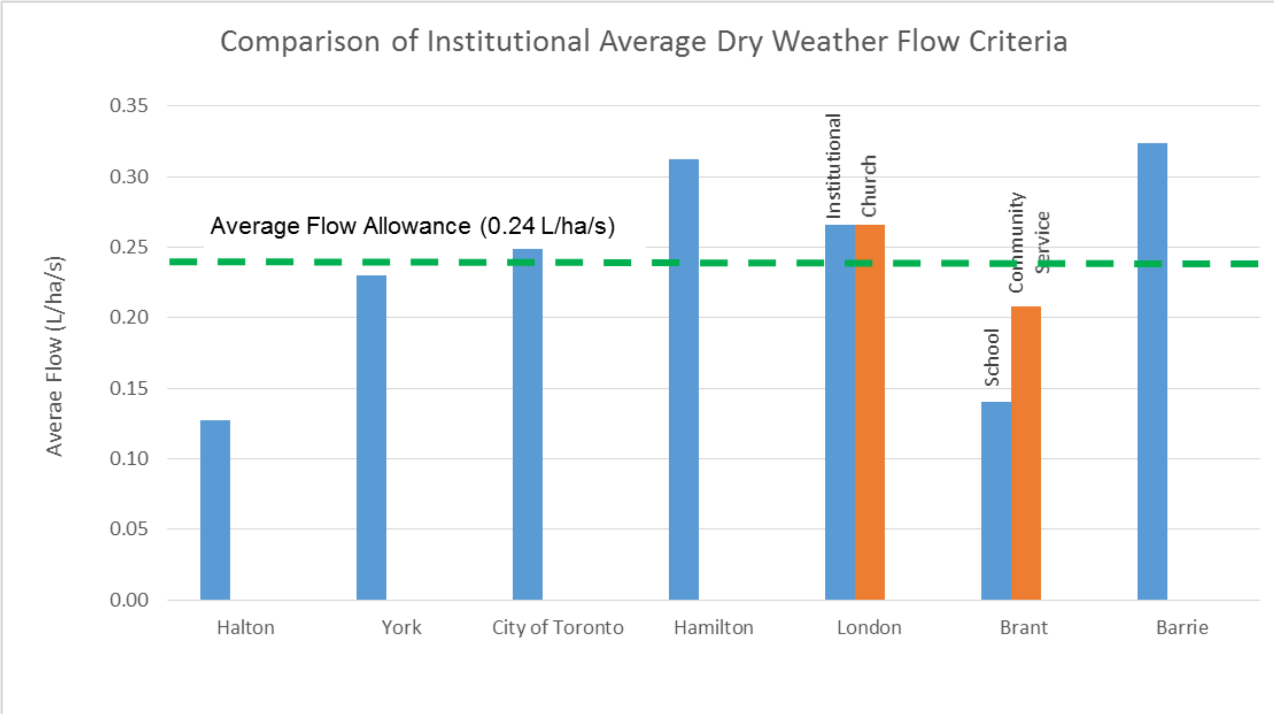

Figure 4 Comparison of Institutional Average Dry Weather Flor Criteria

The following points summarize the ICI review results:

- Industrial average day dry weather flow: ranged from 0.23 L/s/ha to 0.52 L/s/ha, with an average of 0.38 L/s/ha. The Region's design criteria of 0.50 L/s/ha is at the higher end of the municipalities reviewed.
- Commercial average day dry weather flow: ranged from 0.18 L/s/ha to 1.16 L/s/ha, with an average of 0.48 L/s/ha. The Region's design criteria of 1.16 L/s/ha for core commercial is the highest the municipalities reviewed.
- Institutional average day dry weather flow: ranged from 0.13 L/s/ha to 0.32 L/s/ha, with an average of 0.24 L/s/ha. The Region of Waterloo DGSSMS value for institutional is not specified and refers to the MOECC Design Guidelines.

Since the criteria for hospitals is common amongst other municipalities and differs greatly from other institutional criteria, a comparison of hospital average dry weather flow criteria was also conducted and is presented in Figure 5. The values range from 0.003 L/s/bed to 0.021 L/s/, with an average value of 0.012 L/s/bed, which is within the MOECC design guideline range of 0.010 to 0.021 L/s/bed.

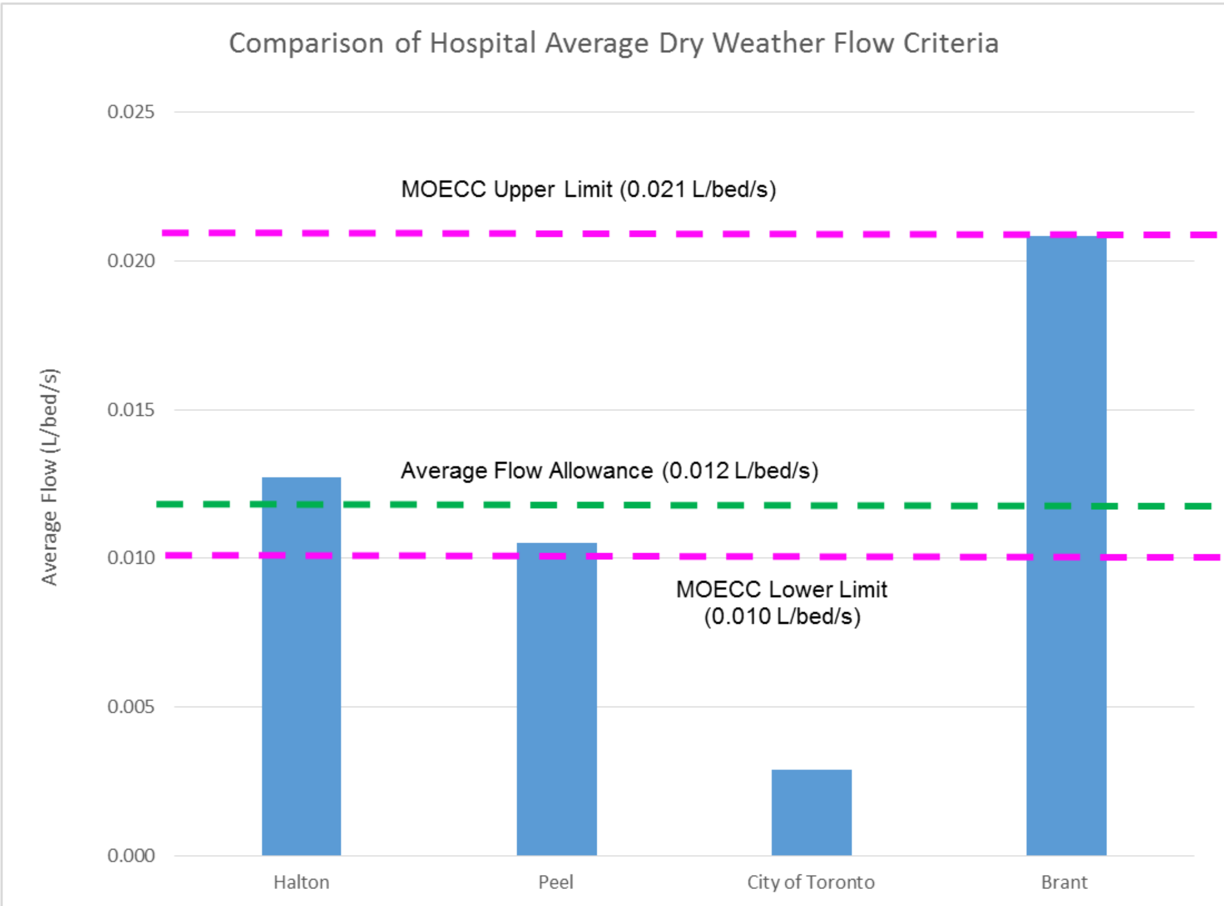

Figure 5 Comparison of Hospital Average Dry Weather Flow Criteria

<u>Extraneous Flow Allowance</u>

Due to variation in each municipality's wastewater system and response to wet weather events, there is a wide range of extraneous flow values reviewed, with an average of 0.24 L/s/ha. The DGSSMS value of 0.15 L/s/ha is on the lower end of the infiltration and inflow range of those municipalities reviewed, as shown in Figure 6.

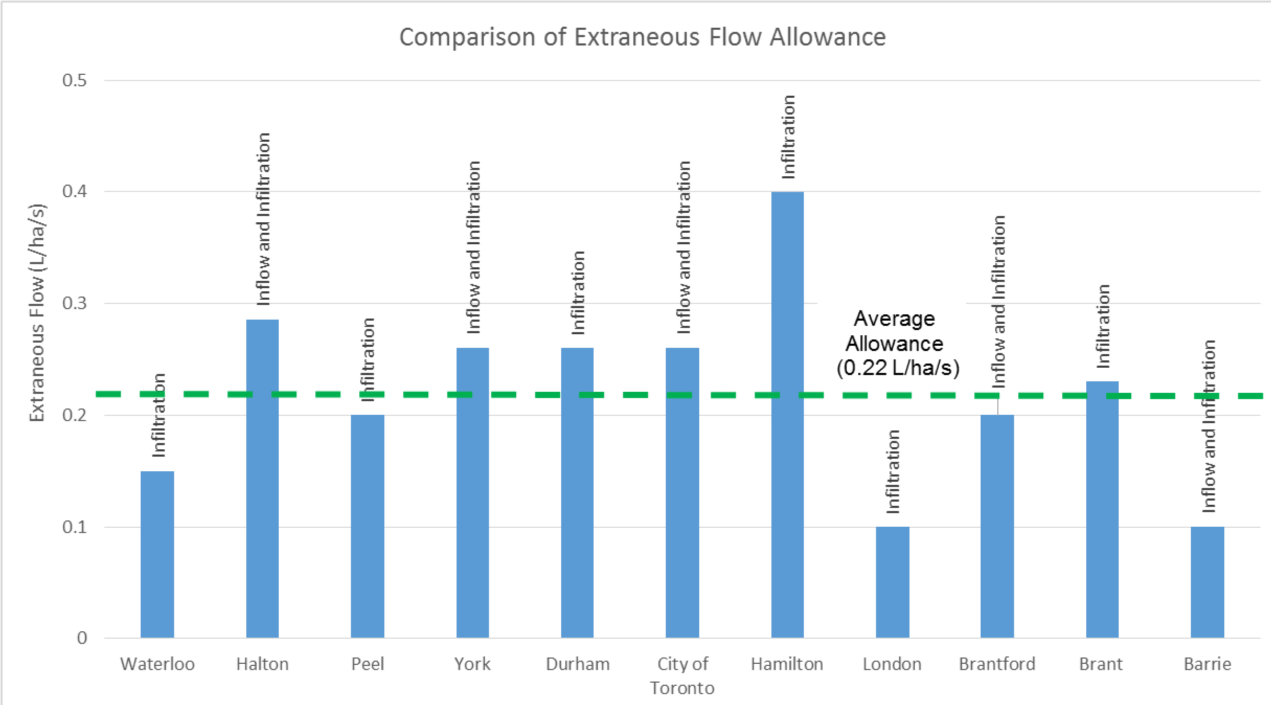

Figure 6 Comparison of Extraneous Flow Allowance Criteria among Municipalities

3. Review of Historical WWTP Data

In addition to the comparison of the Region of Waterloo Design Criteria with that of other municipalities, an analysis has been performed on the historical wastewater treatment plant flow records for the Region, and the results were compared to the existing design criteria.

The average daily wastewater flow is measured at each of the Region's ten major wastewater treatment plants and is documented in annual Water and Wastewater Monitoring Reports (WWWMR). The information provided in Table 2 is taken from the Region of Waterloo's 2016 WWWMR.

The WWWMR also summarizes the average flow per capita per day to each wastewater treatment plant by dividing the measured flow by the residential service population for that treatment plant. This value ranges from 231 L/cap/d in 2013 at the Wellesley WWTP to 687 L/cap/d in 2005 at the St. Jacobs WWTP, with an average of approximately 390 L/cap/d. This data is compiled in Table 2 and is graphically illustrated in Figure 7. While each sewershed has its own characteristics (such as level of residential versus employment, age of infrastructure, etc.), this graph shows a steady decline in the amount of per capita flow to each of the plants over the last ten year period and illustrates the steady decrease in flows being generated and treated at the wastewater treatment plants.

Table 2 Historical Average Flow Per Capita to Region WWTPs

Year	Kitchener WWTP	Waterloo WWTP	Galt WWTP	Preston WWTP	Hespeler WWTP	Elmira WWTP	New Hamburg WWTP	Ayr WWTP	St. Jacobs WWTP	Wellesley WWTP
2005	339	385	421	572	360	537	378	362	687	304
2006	341	383	409	581	361	526	370	346	673	301
2007	338	371	410	577	355	490	353	328	632	286
2008	337	376	418	586	357	471	352	311	637	284
2009	336	373	427	587	353	440	348	316	607	273
2010	327	365	433	553	341	431	337	314	577	256
2011	318	359	439	522	330	434	329	311	564	243
2012	310	354	429	499	318	438	321	304	545	236
2013	304	348	419	464	302	450	308	295	519	231
2014	299	345	410	438	287	448	298	283	514	234
2015	296	334	405	433	275	427	293	274	497	233

Note: The data in this table shows 5-year rolling average per capita flows derived from the Region's 2016 Water and Wastewater Monitoring Report.

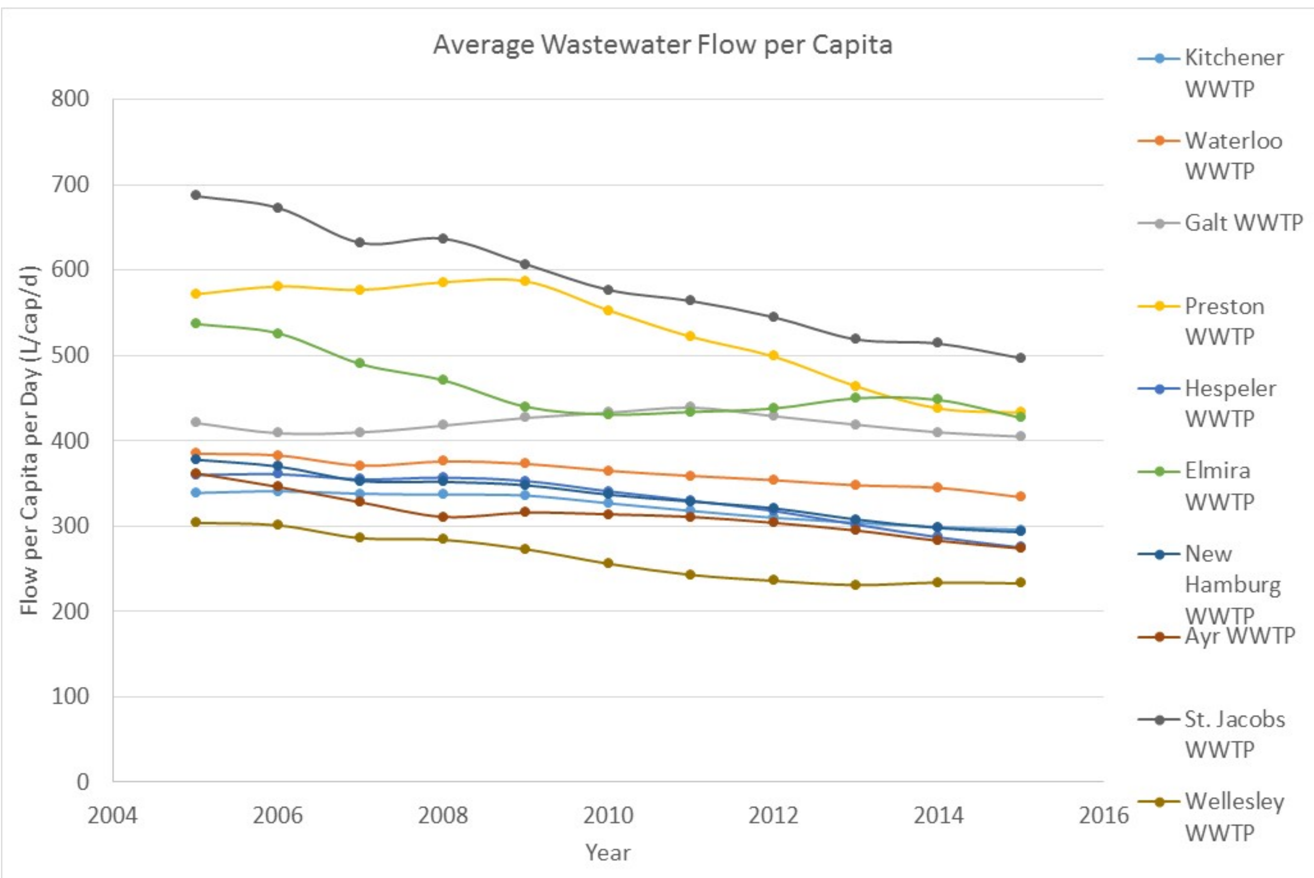

Figure 7 Average Wastewater Flow Per Capita, By Treatment Plant

Two items to note regarding the per capita flows in the WWWMRs:

- The flow values documented are total flows to the treatment plant, which include the ICI flow and the base level of inflow and infiltration (I/I), in addition to the residential flow
- Populations used to calculate per capita rates presented in the WWWMR are based on only residential populations, and therefore do not account for employment population

Both of these items noted suggest that the residential per capita values in the WWWMR are overestimates and therefore the per capita flows are likely much less than the 2016 DGSSMS design criteria value of 350 L/cap/d.

In order to attempt to estimate the per capita flows to the treatment plant, accounting for both residential and employment populations, the total Region-wide average daily flow was divided by the total residential population plus employment, based on an estimate of employment populations within the service areas.

To obtain the information in this table, actual annual flow measured at each treatment plant was converted into a daily flow and the total residential populations were taken from the 2016 Region Water/Wastewater monitoring report. In the absence of detailed data, in order to estimate the employment population, a rule of thumb of 50% of the residential population was applied, based on similar estimates made in the Region's 2007 Wastewater Treatment Master Plan (Earthtech, 2007) and 2011 Water Supply Master Plan Update (Stantec, 2015).

The average daily flow for each year was then divided by the equivalent population (residential and employment) to develop an average flow per capita for 2005 to 2015. Table 3 summarizes this calculation and also provides a five year rolling average to show the trend of per capita consumption. The five-year rolling average between 2009 and 2015 ranges from 246 to 219 L/cap/d. This range, even including I/I components, is still considerably lower (approximately 30%-35%) than the design criteria of 350 L/cap/d currently used by the Region. This may indicate that the Region should reduce their design criteria from 350 L/cap/d, especially if flows continue to decrease over time.

Table 3 also shows that although population continues to increase in the Region, the average daily flows and flow per capita have been decreasing, beginning in 2012.

The historic measured WWTP flow data gives a good indication of the average daily flow per person (residents and employees) under normal conditions with an average level of inflow/infiltration on a Region-wide basis. While this gives a good indication of the overall Regional per capita flow, further analysis is needed to separate the average daily dry weather flow from I/I component. In addition, it is important to note that while the employment figure of 50% of the residential population was found to be a reasonable estimation on a Region-wide basis, there may be considerable differences between the ratio of residential to employee populations within the various treatment plant service areas, so a level of conservatism should be used in applying this wastewater per capita generation data across all treatment plant service areas.

Table 3 Region-Wide Total Per Capita Flows

Year	Total Flow[1] (m^3/d)	Total Residential Population[1]	Total Employees	Equivalent Population	Average Flow (L/cap/d)	5 Year Rolling Average (L/cap/d)
2005	169,258	469,069	234,535	703,604	241	
2006	177,680	479,809	239,905	719,714	247	
2007	169,786	488,071	244,036	732,107	232	
2008	193,680	495,000	247,500	742,500	261	
2009	188,101	501,491	250,746	752,237	250	246
2010	166,346	508,850	254,425	763,275	218	242
2011	179,242	513,744	256,872	770,616	233	239
2012	164,923	524,959	262,480	787,439	209	234
2013	184,256	528,223	264,112	792,335	233	229
2014	181,106	534,816	267,408	802,224	226	224
2015	159,825	540,510	270,255	810,765	197	219

1. Taken from 2016 Regional Water and Wastewater Monitoring Report

4. Review of Water Demand Data

In order to reflect actual water consumption and to take into account the Region's water efficiency and conservation advancements, the current wastewater generation rates may need to be modified based on water consumption rates. The approach to forecasting wastewater generation data using water demand data is desirable since it recognizes the link between water usage and wastewater generation.

In this section, the Region's water demand data and water consumption rates were reviewed against the design criteria of the wastewater generation rates, based on the Water Supply Master Plans and annual actual water demand data provided by the Region. The Region has recently completed two Master Plans related to water supply, including the Water Supply and Distribution Operations Master Plan (WSDOMP), and the Water Supply Master Plan Update (WSMP). A summary of the water demand and forecasting findings of these studies are discussed in the following sections.

Water Supply and Distribution Operations Master Plan

The Water Supply and Distribution Operations Master Plan (WSDOMP) has recently been completed for the Region to develop strategies to optimize the operating efficiency of the distribution system (Stantec, 2015). As part of this Master Plan, water demand forecasting for the Region's Integrated Urban System (IUS), including cities of Cambridge, Kitchener, Waterloo, Towns of St. Jacobs and

Elmira, and portions of Woolwich, Wilmot and North Dumfries Townships, was completed up to 2031 to quantify the future water storage, supply and source requirements for the Region (Stantec, 2011).

An important consideration for demand forecasting was to reflect the observed declining trend in water demand experienced in the Region despite the increasing population. Since the completion of the previous update of the WSMP (2007 Strategy), it became evident that there was a new declining water demand trend. The decline is attributed to a number of factors including water conservation and water efficiency efforts, intensification, and economic factors. Environment Canada has indicated that this decreasing trend is also evident in other Municipalities across Canada (Environment Canada, 2011).

Based on these conditions, system demands were estimated for the Region based on forecasts for residential demand and ICI demand. Multiple scenarios were evaluated to develop a range in probable future demands for average and maximum day demands. The forecasted 2031 average day demand is 158 MLD for the IUS for the preferred scenario, which is comparable to the 2005 demand of 160 MLD. The forecasted 2031 maximum day demand is 208 MLD, which is comparable to the 2007 demand of 212 MLD (Stantec, 2014).

The forecasted per capita water consumption rates for the overall IUS for the planning period (2011-2031) are summarized in Table 4. Per capita water consumption rates show overall declining trends for residential, ICI and total demands over the planning period. The estimated residential water consumption rates between 2011 and 2031 are expected to decrease from 186 to 155 L/cap/d, which are significantly lower than the Region’s current design criteria for residential wastewater generation rate of 350 L/cap/d.

Table 4 IUS Projected Per Capita Water Consumption Rates [1]

Year	Per Capita Water Consumption Rate (L/Capita/d)	
	Residential	ICI
2011	186	153
2016	167	141
2021	158	136
2026	156	133
2031	155	131

1. Based on the Region of Waterloo Water Supply and Distribution Operations Master Plan: Water Demand Forecasting Tech Memo (Stantec, 2011).

<u>Water Supply Master Plan Update</u>

The Water Supply Master Plan Update (WSMP Update) has recently been completed for the Region to guide medium to long-term (10-40 years) water supply planning for the Region’s IUS to ensure the availability of a sustainable water supply (Stantec, 2015). The drivers for this update were declining water demands on both a per capita basis and general usage by ICI experienced in the Region despite the population growth and new regulations that impact groundwater well supplies.

As part of the WSMP Update, water demand forecasting was updated, which was adapted up to 2031 (refer to WSDOMP) and developed from 2031 to 2051. Water demands were estimated based on population forecasts and per capita water use trends anticipated to represent probable future demands. The result was a revised projection for the average and maximum day demands forecasted for the Region up to 2051. The forecasted 2051 average and maximum day demand is 197 MLD and 258 MLD for the IUS, respectively (Stantec, 2015).

The forecasted average per capita water consumption rates are presented in Table 5 and depicted in Figure 8. Per capita water consumption rates show an overall constant or declining trend for residential and ICI demands over the planning period. The estimated residential water consumption rates between 2036 and 2051 are expected to remain fairly constant at 158 to 159 L/cap/d.

Table 5 IUS Projected Per Capita Water Consumption Rates [1]

Year	Per Capita Water Consumption Rate (L/Capita/d)	
	Residential	ICI
2036	159	131
2041	159	131
2046	158	131
2051	158	131

1. Based on Region of Waterloo Water Supply Master Plan Update: Tech Memo 1: Verify and Update Demand Forecasting: (Stantec, 2014).

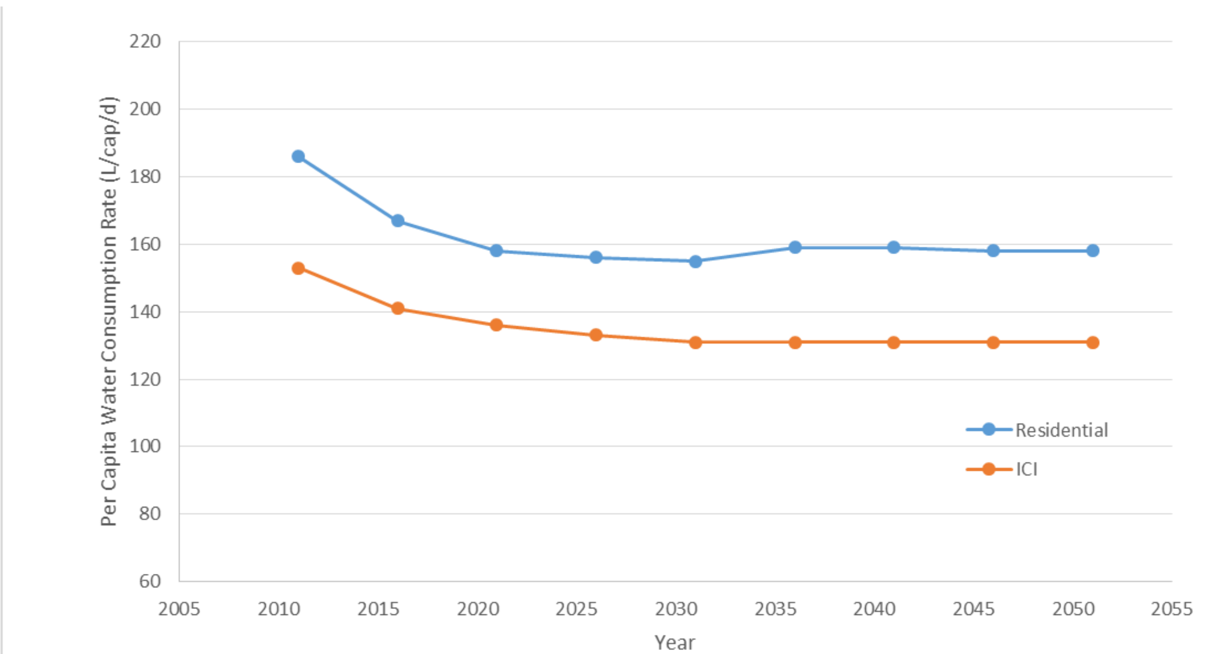

Figure 8 Summary of IUS Projected Per Capita Water Consumption Rates

(Source: WSDOMP (Stantec, 2015) and WSMP Update (Stantec, 2015))

Comparison with Historic Water Consumption Rates

The design criteria of residential wastewater generation rate of 350 L/cap/d was compared to the historic water consumption rates as it relates to wastewater flow generation. The wastewater flow per capita is commonly considered as a fraction of the water consumption per capita (Metcalf & Eddy, 2003). Derivation of wastewater generation rates from water consumption rates generally accounts for water loss due to leakage and outdoor use, and water entering the system from infiltration and inflow.

The Region provided CIMA with historical annual actual water consumption data (1999-2015) that was summarized and converted to a per day flow. The data was compared to the 1999 – 2015 wastewater flow data collected from the Region's WWTPs in Table 3. It was found that there is a correlation between annual water consumption and the wastewater generated.

The historic water consumption data has been summarized in Figure 9. As can be seen, there has been a steady decline in water consumption in the Region since 2001 until 2011 where it began to stabilize until 2015. If the water consumption continues to decrease significantly, it will affect the wastewater flow generation rates as well.

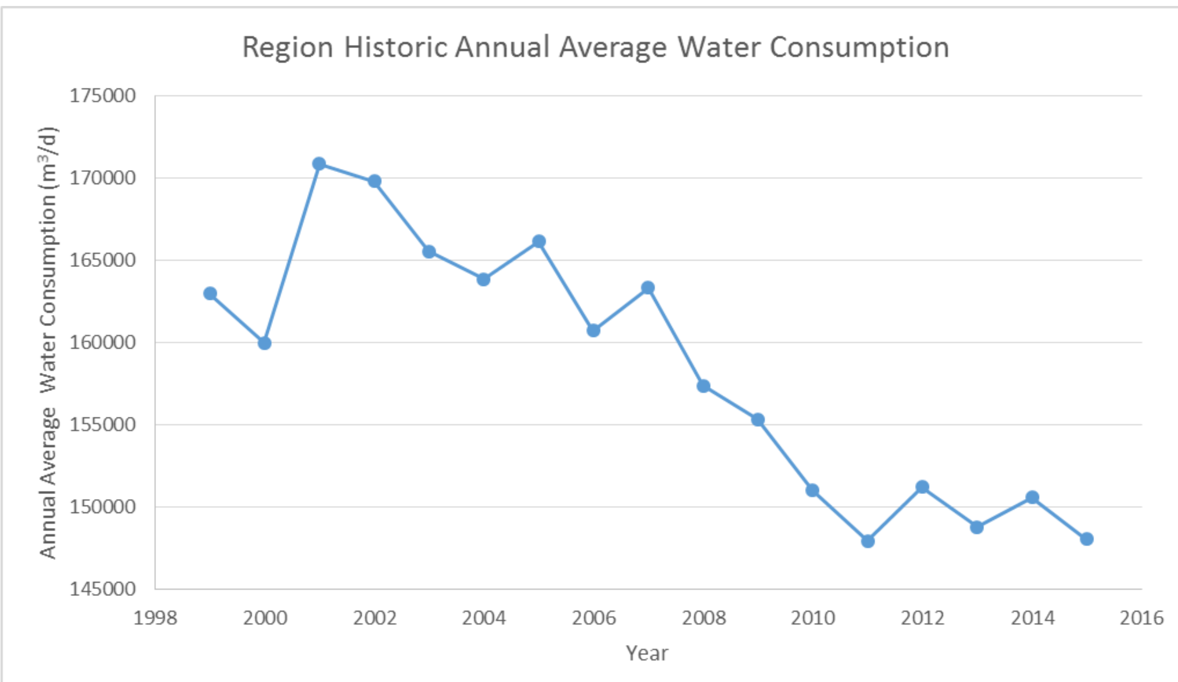

Figure 9 Region Historic Annual Average Water Consumption

The average per capita water consumption rate was calculated by dividing the overall actual water consumption by the equivalent population (residential plus employment) of the Region. Table 6 summarizes this calculation and also provides a five-year rolling average to show the trend of water consumption rates. The five-year rolling average between 2009 and 2015 generally decreases with a range from 220 to 188 L/cap/d.

This range of between 188 to 220 L/cap/d is considerably lower (35% - 45%) than the recommended dry weather flow criteria of 350 L/cap/d in the current DGSSMS. This data suggest that the Region should consider reducing their design criteria from 350 L/cap/d to a lower value, especially if the water demands continue to decrease over time.

Table 6 Water Consumption Rates

Year	Total Consumption[1] (m^3/d)	Total Population[1]	Total Employees	Equivalent Population	Average Consumption Per Capita (L/Capita/d)	5 Year Rolling Average (L/cap/d)
2005	166,161	469,069	234,535	703,604	236	
2006	160,742	479,809	239,905	719,714	223	
2007	163,353	488,071	244,036	732,107	223	
2008	157,391	495,000	247,500	742,500	212	
2009	155,369	501,491	250,746	752,237	207	220
2010	151,045	508,850	254,425	763,275	198	213
2011	147,967	513,744	256,872	770,616	192	206
2012	151,255	524,959	262,480	787,439	192	200
2013	148,801	528,223	264,112	792,335	188	195
2014	150,596	534,816	267,408	802,224	188	192
2015	148,079	540,510	270,255	810,765	183	188

1. Taken from 2016 Region Water and Wastewater Monitoring Report.

The recommended dry weather wastewater generation rate can be estimated from the highest reviewed historic 5-year rolling average water consumption rate of 0.0026 L/cap/s (220 L/cap/d), with an assumption that 100% of the average water demand would be utilized to represent the average wastewater generation rate. The recommended dry weather wastewater generation rate is 0.0032 L/cap/s (275 L/cap/d), based on applying a safety factor of 25% to the 0.0026 L/cap/s (220 L/cap/d) water consumption value. While this may still be somewhat conservative relative to the observed decreasing trends in both water consumption and wastewater generation, this represents a significant reduction from the existing design criteria value and is on the lower end of the MOECC guideline range and design criteria range of other municipalities. It is slightly greater than the historic wastewater flow range of 0.0025 to 0.0029 L/cap/s (219 to 246 L/cap/d) observed from 2005-2015, therefore it provides a reasonably conservative estimate for the average dry weather flow, considering the variability in per capita flows observed amongst the area municipalities.

5. ICI Design Criteria

A high-level review of ICI generation rates was conducted based on available data and background sources. The WSMP Update noted that a review of historical ICI per capita rates indicated large variations based on both year and location, resulting in a low level of confidence for these rates. As a result, the WSMP Update projected ICI demands based on overall ICI demands rather than forecasted per capita rates. These forecasted ICI demands were previously presented in Table 4 and Table 5, with projections provided from 2011 to 2031 and 2031 to 2051, respectively. It can be seen from these projections that there is a decreasing trend in ICI water demands from 153 L/cap/d in 2011 to 131 L/cap/d in 2051. Although the trend is similar between the ICI water demands and the residential water demands, the same assumptions between the ratio of water use to wastewater generation cannot be made for ICI flows as can be made for residential flows.

In addition, there is a wide variance with the ICI employment criteria observed amongst the surrounding municipalities. Some municipalities provide a design criteria based on area (hectares) while others give a per capita (employee) based criteria. For comparison purposes, these per capita criteria were converted to area based criteria based on stipulated planning land use densities, however there is still significant variation amongst the criteria between municipalities. In general, the DGSSMS value of 0.50 L/s/ha for industrial and 1.16 L/s for commercial (core area) are on the higher end of the ICI range of those municipalities reviewed (refer to Section 2).

Based on the declining trend of the projected ICI demands and the comparison with the other surrounding municipalities, the following recommendations are made for ICI for the Region of Waterloo:

- Industrial: reduce the current design criteria from 0.50 L/s/ha to 0.40 L/s/ha, which was determined based on the average value of the surrounding municipalities.
- Commercial:
  - Core: reduce the current design criteria of 1.16 L/s/ha for core to 0.95 L/s/ha.
  - General: reduce the current design criteria of 0.60 L/s/ha to 0.50 L/s/ha, which was determined based on the average value of the surrounding municipalities.
  - Shopping Mall: maintain the current design criteria of 0.30 L/s/ha unchanged, which is the lower limit value of the MOECC guidelines for shopping mall.
- Institutional: It is recommended that the Region use a value 0.25 L/s/ha, which was determined based on the average value of surrounding municipalities. For the hospitals, it is recommended that the Region use a value of 0.015 L/s/bed, which was determined based on the MOECC design guideline values.

6. Review of Inflow and Infiltration Rates

The inflow and infiltration rates were reviewed for the larger area municipalities including the City of Cambridge, City of Waterloo and City of Kitchener, based on previous sanitary Master Plans completed for these Cities.

<u>City of Cambridge</u>

A City-wide Sanitary Servicing Master Plan was completed for the City of Cambridge in 2013 (AECOM, 2013). As part of this Master Plan, a review of the City's design criteria used for estimating residential and employment wastewater flow was undertaken. A hydraulic modelling component was included with a calibration of the existing modeling network for each of the three Cambridge WWTP drainage areas. The calibration exercise used required analysis of the WWTP SCADA flow data as it relates to the rainfall data that was collected. This analysis led to quantifying the minimum night flows (base infiltration) and development of both the average and peak dry weather flow and extraneous flows observed in the system.

This review of the inflow and infiltration modeling results are shown in Table 7. The peak extraneous flows for the three Cambridge WWTPs (Preston, Galt and Hespeler) ranged from 0.111 L/s/ha to 0.447 L/s/ha, with an overall average of 0.274 L/s/ha.

Table 7 Summary of Inflow and Infiltration, City of Cambridge [1]

Sewershed Area	Total Peak Inflow and Infiltration Rate (L/s/ha)			
	Preston WWTP	Galt WWTP	Hespeler WWTP	Overall City
Modeled 1 in 25 year Storm	0.362	0.370	0.277	0.336
Modeled 1 in 10 year Storm	0.324	0.370	0.277	0.324
Modeled 1 in 5 year Storm	0.298	0.275	0.215	0.263
1 in 2 year Storm	0.256	0.206	0.199	0.220
2012 Flow Monitoring Date	0.447	0.121	0.111	0.226
Average	0.337	0.268	0.216	0.274
Range	0.256 – 0.447	0.121 – 0.370	0.111 – 0.277	0.111-0.447

Note:
1. Based on City of Cambridge Sanitary Servicing Master Plan: Design Criteria Memo, Volume III Appendix 1 (AECOM, 2013).

<u>City of Waterloo</u>

A City-wide Sanitary Servicing Master Plan Update project was conducted for the City of Waterloo in 2015 (Stantec, August 2015). A critical piece of work completed as part of this Master Plan was the review of the flow monitoring programs that have been undertaken in the past to assess the performance of the existing sanitary collection system. The purpose of the review is to generalize the dry weather infiltration (baseflow) and wet weather inflow and infiltration (I/I) results for the sewersheds across the City of Waterloo. Several areas within the City were identified as having the highest reported I/I rates, including the University Trunk, Cedar Trunk, William Trunk, Clair Trunk, and Beachwood/Erbsville Trunk. The observed infiltration rates are provided in Table 8, and are summarized as follows:

- Average dry weather infiltration rates ranged from 0.050 L/s/ha in the Clair sewershed to 0.137 L/s/ha in William trunk, with an average of 0.093 L/s/ha, which are all less than the Region's design value of 0.15 L/s/ha.
- Average wet weather I/I rates: ranged from 0.013 L/s/ha in Beechwwod/Erbsville area to 0.70 L/s/ha in the Clair sewershed, with an average of 0.278 L/s/ha.

Table 8 Summary of Inflow and Infiltration, City of Waterloo

Sewershed Area	Dry Weather Infiltration Rate (L/s/ha)		Wet Weather I/I (L/s/ha)	
	Average	Peak	Average	Peak
University Trunk (2)	0.089	0.208	0.150-0.225	0.313
Cedar Trunk (2)	0.109	0.324	0.246	0.423
William Trunk (2)	0.137	0.197	0.208	0.491
Clair Sewershed (3)	0.050	0.185	0.70	1.60
Beechwood/Erbsville Area (4)	0.081	0.205	0.001-0.013	0.149
Average	0.093	0.224	0.278	0.595
Overall Range	0.050 – 0.137	0.197 – 0.324	0.013 – 0.70	0.313 – 1.60

Note:
(1) Based on City of Waterloo City-wide Sanitary Servicing Master Plan Update (Stantec, August 2015).
(2) Based on Sanitary Sewer Flow Monitoring Program (Gore & Storrie, 1994).
(3) Based on Clair Sewershed I/I Pilot Project (Stantec, 2012).
(4) Sanitary Sewer Flow Monitoring Program - 1998, Eastbridge on the Grand and Upper Beechwood Subdivisions (CRA, 1999).

It should also be noted that the City of Waterloo's Sanitary Master Plan specifically refers to the 0.15 L/s/ha as dry weather base infiltration. It states that the allowable infiltration in DGSSMS is defined by the dry weather base infiltration rate of 0.15 L/s/ha, and there is no wet weather I/I guideline within the DGSSMS.

City of Kitchener

A City-wide Sanitary Sewer System Capacity Study was conducted for the City of Kitchener in 2011 (AECOM, February 2011). As part of this study, an extensive flow monitoring program was completed. The flow monitoring component of the program involved the collection and analysis of flow and rainfall data from 17 sites across the system and the analysis of SCADA data from the city's 22 sewage pumping stations. The flow monitoring was conducted for a total period of three months and comprised of two monitoring periods of November 2009, and March through April 2010. This data was utilized to assess the performance of the existing sanitary collection system.

Based on the flow analysis completed for all 17 in-sewer flow monitoring locations, the observed infiltration rates are provided in Table 9, and summarized as follows (AECOM, 2011):

- Dry weather infiltration rates: ranged from 0.003 to 0.060 L/s/ha, with an average of 0.023 L/s/ha, which is all within the Region's design criteria of 0.15 L/s/ha
- Peak wet weather I/I rate: ranged from 0.061 to 0.563 L/s/ha, with an average of 0.218 L/s/ha

Table 9 Summary of Inflow and Infiltration for Flow Monitoring Stations, City of Kitchener [1]

Sewershed Area	Average Dry Weather Infiltration Rate (L/s/ha)	Average Peak Wet Weather I/I Rate (L/s/ha)
Site 1	0.04	0.412
Site 2	0.04	0.167
Site 3	0.05	0.284
Site 4	0.004	0.139
Site 5	0.03	0.563
Site 6	0.006	0.221
Site 7	0.02	0.165
Site 8	0.02	0.128
Site 9	0.003	0.276
Site 10	0.01	0.271
Site 11	0.004	0.321
Site 12	0.03	0.204
Site 13	0.02	0.139
Site 14	0.009	0.137
Site 15	0.01	0.088
Site 16	0.04	0.061
Site 17	0.06	0.128
Average	0.023	0.218
Range	0.003 – 0.060	0.061 – 0.563

Note:
(1) City of Kitchener City-wide Sanitary Sewer System Capacity Study (AECOM, February 2011).

Meanwhile, the SCADA monitoring data collected during the same period as the flow monitoring program was analyzed for the dry and wet weather flows for the 22 sewage pumping stations in the City of Kitchener. The measured infiltration rates at each pumping station monitoring location in Table 10, and are summarized as follows:

- Dry weather infiltration rates: ranged from zero to 0.05 L/s/ha, with an average of 0.012 L/s/ha, which is all within the Region's design criteria of 0.15 L/s/ha
- Peak wet weather I/I rate: ranged from 0.009 to 0.804 L/s/ha, with an average of 0.20 L/s/ha.

Table 10 Summary of Inflow and Infiltration for Pumping Stations, City of Kitchener [1]

Site Location	Average Dry Weather Infiltration Rate (L/s/ha)	Average Peak Wet Weather I/I Rate (L/s/ha)
Bleams	No Inflow Data	No Inflow Data
Carson	0.02	0.132
Chandos	0.001	0.187
Donald Milne	0.005	0.072
Falconbridge	No Inflow Data	No Inflow Data
Forwell	No Inflow Data	No Inflow Data
Freeport	No Inflow Data	No Inflow Data
Homer Watson	0.04	0.105
Manchester	0.005	0.055
Moore	0.02	0.203
Mew Dundee	0.002	0.804
Old Mill	0.01	0.074
Oxford	0	0.009
Patricia	0	0.216
Pioneer Tower	0	0.049
River Birch	No Inflow Data	No Inflow Data
Springmount	0.05	0.324
Spring Valley		No Inflow Data
Stoke	0.001	0.382
Veronica	0	0.213
Victoria	No Inflow Data	No Inflow Data
Zeller	No Inflow Data	No Inflow Data
Average	0.012	0.20
Range	0 – 0.05	0.009 – 0.804

Note:
(1) City of Kitchener City-wide Sanitary Sewer System Capacity Study (AECOM, February 2011).

Impact of Inflow and Infiltration on Wastewater Flows

In order to determine how inflow and infiltration from precipitation affects the wastewater flows to the WWTPs, the annual average flows from the area municipalities were plotted against annual precipitation from 2010 to 2015, presented in Figure 10.

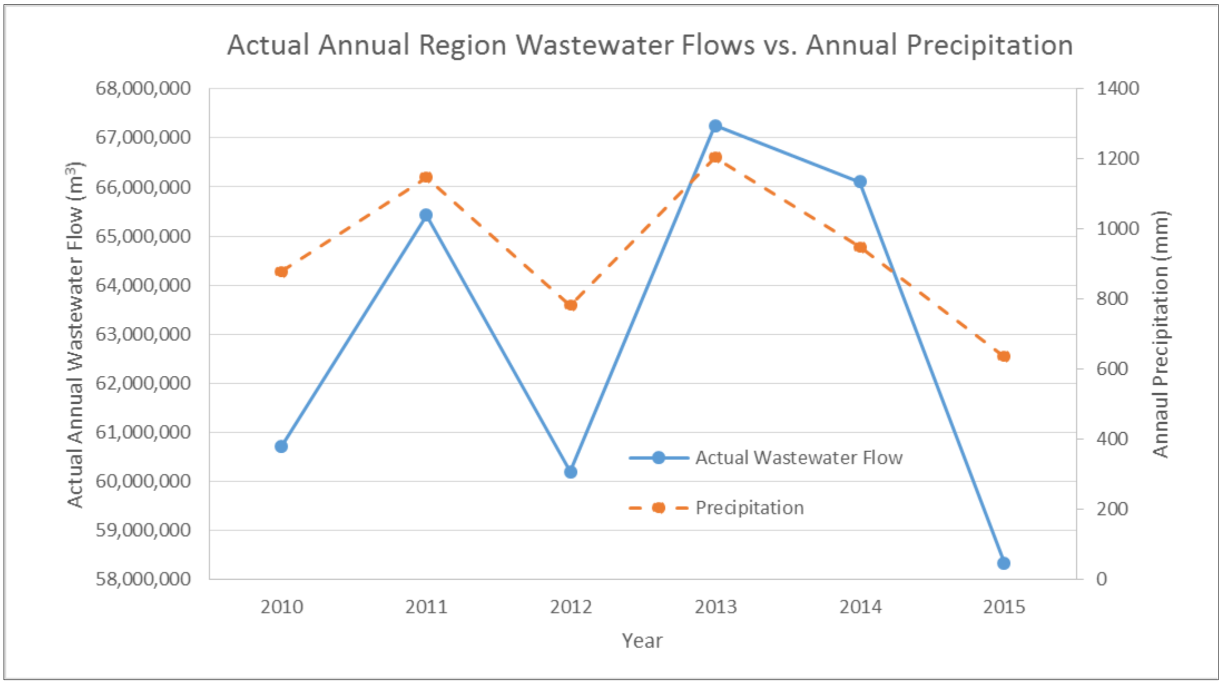

Figure 10 Actual Annual Region Wastewater Flows versus Annual Precipitation

There is a clear correlation between precipitation and wastewater flow from the area municipalities. This indicates that the wastewater flows to the WWTPs are being influenced by inflow and infiltration during wet weather events.

Summary

The observed average dry weather infiltration rate (base flow) for the Cities of Waterloo and Kitchener are 0.093 L/s/ha and 0.023 L/s/ha, respectively, with an average of 0.058 L/s/ha. These values are all well below the base infiltration allowance of 0.15 L/s/ha in the Region's DGSSMS Design Guidelines.

The observed average peak wet weather I/I rate for the Cities of Cambridge, Waterloo and Kitchener are 0.274 L/s/ha, 0.278 L/s/ha and 0.218 L/s/ha respectively, with an average of 0.26 L/s/ha, which is slightly higher than the average extraneous flow of 0.22 L/s/ha of the other municipalities reviewed.

As indicated previously in Section 2, the DGSSMS "Infiltration Allowance" value of 0.15 L/s/ha is on the lower end of the infiltration and inflow range of those municipalities reviewed. This value is defined as the base infiltration rate and does not include wet weather inflow to the sanitary sewer system (Stantec, 2015). The following recommendations are made for the Region of Waterloo:

- Revise the term "Infiltration Allowance" in Section B.3.1.2.6 in the current DGSSMS to "Extraneous Flows". The term "extraneous flow" is to be used to account for both ground water infiltration and wet weather inflow into the pipes and maintenance holes.

- Increase the DGSSMS extraneous flow value from 0.15 L/s/ha to 0.25 L/s/ha, which was determined based on the average peak wet weather I/I value of the tri-cities and other surrounding municipalities.

7. Other Issues and Considerations

As the costs of water and energy have increased and the importance of reducing domestic water and energy demands have gained significance in recent years, households have begun using energy saving methods to reduce water usage and subsequently wastewater flows. More efficient water fixtures may be the reason for the observed decrease in wastewater flows and water demand in the Region. As energy efficiency continues to be a trend, the Region may experience further decreased water and wastewater demands moving forward and therefore, may need to further adjust their per capita design criteria. It is recommended that this criteria be reviewed on a five-year basis to ensure that the design criteria are accurately reflecting the observed trends.

There is also a rise in inflow and infiltration reduction programs reducing the volume of extraneous flows making their way into the wastewater collection systems. Initiatives include downspout disconnections, foundation drain disconnections and removal of combined sewage systems. As long as per capita water use trends continue to decline and I/I control programs continue to grow, then it should be expected that wastewater flows in the system would decrease over time. The following additional observations and considerations are noted:

1. While the current design criteria for average day flow of 0.0040 L/cap/s, as recommended by the 2016 DGSSMS, is within the typical range of other municipalities, as the water demands and wastewater generation continue to decrease, it will be necessary for the Region to review and adjust this number on an on-going basis.
2. The extraneous flow allowance of 0.15 L/s/ha that is recommended in the DGSSMS is within the range of other municipalities, however it is at the low end of the range.
3. Use of the Harmon peaking factor is common among other municipalities as well as the Region of Waterloo.
4. Calculation of the peak wet weather flow using an overly high design criteria may result in overestimation of flows throughout the system. This may incorrectly identify issues in the sewer system and recommend infrastructure upgrades that may not be necessary.

8. Recommendations

Based on the criteria review undertaken and analysis of the water and wastewater flow data, some recommendations are being made to the existing criteria for calculating the peak design flow for wastewater sewer pipe sizing purposes. It is recommended that design criteria in DGSSMS be modified as follows:

- Section B.3.1.2.1: The current design criteria for residential flow should be reduced from 0.004 L/cap/s to 0.0032 L/cap/s in, which was determined from the historic water consumption rates during 2005 to 2015, as well as trends in wastewater generation within the Region. This value is within the MOECC guidelines, and within the design criteria range of other municipalities. It also provides a slightly conservative estimate for the average dry weather flow.

- Section B.3.1.2.2: Industrial: reduce the current design criteria from 0.50 L/s/ha to 0.40 L/s/ha, which was determined based on the average value of the surrounding municipalities.
- Section B.3.1.2.3: Commercial:
  - Core: reduce the current design criteria of 1.16 L/s/ha for core to 0.95 L/s/ha.
  - General: reduce the current design criteria of 0.60 L/s/ha to 0.50 L/s/ha, which was determined based on the average value of the surrounding municipalities.
  - Shopping Mall: maintain the current design criteria of 0.30 L/s/ha unchanged, which is the lower limit value of the MOECC guidelines for shopping mall.
- Section B.3.1.2.4: Institutional: the current design criteria follow MOECC Design Guidelines. It is recommended that the Region use a value 0.25 L/s/ha, which was determined based on the average value of surrounding municipalities. For the hospitals, it is recommended that the Region use a value of 0.015 L/s/bed, which was determined based on the MOECC design guideline values.
- B.3.1.2.6: It is recommended that the Region revise the title of "Infiltration" to "Extraneous Flows", to account for both ground water infiltration and wet weather inflow into the sanitary sewer systems. The current infiltration allowance of 0.15 L/s/ha is at the lower end of the infiltration and inflow range of those municipalities, and analysis of the recorded flow and rain data for the Cities of Kitchener, Waterloo and Cambridge suggest that this value is lower than the observed extraneous flows. It is recommended to revise the value from 0.15 L/s/ha to 0.25 L/s/ha.

The final recommended design criteria are summarized in Table 11.

Table 11 Recommended Design Criteria

Parameter	DGSSMS Section [1]	DGSSMS Value[1]	Suggested Revised Value	Basis
Residential	B3.1.2.1	0.0040 L/s/cap (0.35 m^3/cap/d)	0.0032 L/s/cap (0.27 m^3/cap/d)	Water consumption and wastewater generation data
Industrial	B3.1.2.2	0.50 L/s/ha	0.40 L/s/ha	Water consumption data
Commercial	B3.1.2.3	Core =1.16 L/s/ha; Shopping Mall = 0.3 L/s/ha; General = 0.6 L/s/ha	Core =0.95 L/s/ha; Shopping Mall = 0.3 L/s/ha; General = 0.5 L/s/ha	Surrounding municipalities and MOECC Design Guidelines
Institutional	B3.1.2.4	MOECC Design Guidelines	0.25 L/s/ha Hospital: 0.015 L/s/bed	MOECC Design Guidelines
Infiltration	B3.1.2.6	0.15 L/s/ha	0.25 L/s/ha	I/I data of the Tri-cities

Notes:
1. Region of Waterloo and Area Municipalities Guidelines and Supplemental Specifications for Municipal Services (DGSSMS) (ROW, 2016).

The final recommended design flow formula is as follows:

$$Q = (a \times M) + b$$

Where:

- Q is the peak wet weather design flow
- a x M is the peak dry weather flow
- a is the average dry weather flow of 0.0032 L/cap/s (275 L/cap/d) for residential development
- M is the peaking factor as derived from the Harmon Formula, the minimum permissible being 2.0 with P in equivalent persons in ‘000s
- $M = 1 + \frac{14}{4+P^{0.5}}$
- b is the peak extraneous flow allowance of 0.25 L/s/ha

9. References

1. AECOM (2013). City of Cambridge Sanitary Servicing Master Plan: Design Criteria Memo Volume III Appendix 1.
2. AECOM (2011). Halton Region Sustainable Halton Water and Wastewater Master Plan.
3. AECOM (2011). City of Kitchener City-wide Sanitary Sewer System Capacity Study.
4. Blue Plan and AECOM (2014). Region of Peel 2013 Water and Wastewater Master Plan for Lake Based System.
5. Blue Plan (2014). City of Brantford 2014 Master Servicing Plan (MSP) for Water, Sanitary and Stormwater Services: Wastewater Master Plan.
6. City of Barrie (2012). Sanitary Sewage Collection System Policies and Design Guidelines
7. City of Toronto (2009). Design Criteria for Sewers and Watermains.
8. City of London (2015). Design Specifications & Requirements Manual.
9. County of Brant (2014). Development and Engineering Standards.
10. City of Hamilton (2012). Engineering Guidelines for Servicing Land under Development Applications.
11. Earth Tech (2007). Region of Waterloo Wastewater Treatment Master Plan.
12. Environmental Canada (2011). 2011 Municipal Water Use Report - Municipal Water Use 2009 Statistics.
13. Metcalf & Eddy (2003). Wastewater Engineering: Treatment and Reuse.
14. Ontario Ministry of the Environment and Climate Changes (MOECC) (2008). Design Guidelines for Sewage Works.
15. Region of Peel (2009). Sanitary Design Criteria.
16. Region of Waterloo (2016). Region of Waterloo and Area Municipalities Guidelines and Supplemental Specifications for Municipal Services (DGSSMS).
17. Region of Waterloo (2016). Water and Wastewater Monitoring Report.
18. Stantec (2015). Region of Waterloo Water Supply and Distribution Operations Master Plan Final Report.
19. Stantec (2011). Region of Waterloo Water Supply and Distribution Operations Master Plan Water Demand Forecasting Memo.
20. Stantec (2014). Region of Waterloo Water Supply Master Plan (2011) Update – Tech Memo 1: Verify and Update Water Demand Forecasting.
21. Stantec (2015). Region of Waterloo Water Supply Master Plan Update Final Report.
22. Stantec (2015). Waterloo Sanitary Master Plan.
23. The Regional Municipality of Durham (2016). Design and Construction Specifications for Regional Services.
24. The Regional Municipality of York (2016). Water and Wastewater Master Plan.