Regional Municipality of Halton

Water & Wastewater Linear Design Manual

Version 7

December 2025

Public Works
Development Services
1151 Bronte Road
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December 2025

ABOUT THIS MANUAL

The Water & Wastewater Linear Design Manual, version 7 is intended to be used as a guide towards ensuring consistency in meeting the Regional Municipality of Halton's (Region, Halton) quality expectations in the implementation of water and wastewater linear infrastructure.

The manual outlines the standards that are to be adhered to in designing the Region's water and wastewater linear infrastructure. The use of this design manual does not absolve the Design Engineers from their professional obligations in delivering a safe and functional design that meets the needs of the Region as well as requirements of all applicable standards and guidelines. It is the Design Engineer's obligation to ensure they are using the most recent version of this manual.

Any inquires related to this manual shall be directed to: developmentengineering@halton.ca

Lee Anne Jones
Commissioner of Public Works

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SECTION 1 SUBMISSION OVERVIEW

1.1. General Requirements

1.1.1. Halton Region's Water & Wastewater Linear Design Manual has been developed for use by Consulting Engineers and Regional staff. The manual outlines the minimum requirements for the design of water distribution and wastewater collection linear systems. The sound engineering and judgment of the Design Engineer undertaking the design shall always prevail. All designs shall be subject to the final approval of Halton Region, following all applicable standards and guidelines. All designs shall be based on the latest LDM manual at the time of approval (or as directed by Halton Region or as specified in the project RFP).

1.1.2. In the case of new subdivisions, the Owner or Design Engineer acting on behalf of the Owner is required to establish the geodetic invert elevations and ties of all water service connections and wastewater lateral connections at the street line. All this information is to be incorporated on the "As Constructed" plans.

1.1.3. All Design, Issued for Tender, Issued for Construction, and As Constructed" drawings are to be submitted to Halton Region in the form of paper (if requested), PDF and AutoCAD Civil 3D (current Regional version) drawings.

1.2. Other Halton Reference Manuals

1.2.1. This document, Water & Wastewater Linear Design Manual, is one within a series of Halton Region Design Standards and Guidelines. In the event of any conflicts, MECP and other local guidelines will take precedence. The manual herein is complemented by the most recent versions of the following documents:

- Wastewater By-law (2-03), as amended
- Wastewater Systems By-law (184-95), as amended
- Drinking Water System By-law (71-19), as amended
- Approved Manufacturers Products List for Water Systems
- Approved Manufacturers Products List for Wastewater Systems
- Consultants Procedures Linear Manual
- SCADA Standards Manual
- Water & Wastewater Facility Design Manual
- Uniform Traffic Signal Specifications for Operating Authorities
- Inspection Services Manual (Water, Wastewater and Transportation Assets)
- CADD Standards for Linear Design Drawings
- Water & Wastewater Master Plan / Infrastructure Master Plan, as amended
- Development Charges Background Study, as amended
- Development Charges Update Water/Wastewater Technical Report, as amended
- Development Engineering Review Manual

- Urban Services Guidelines
- Halton Water & Wastewater Hydraulic Models
- Survey Practices and Standards
- Regional Road Landscaping Guidelines and Specifications

1.3. Other Applicable Acts, Legislations, Design Guidelines

1.3.1 This manual and its standards do not supersede, nor replace any legislation governing the design of such water and wastewater linear systems. The Design Engineer must be fully familiar with legislation such as the Ontario Water Resources Act, Safe Water Drinking Act, Environmental Assessment Act and Environmental Protection Act when carrying out the design of linear systems.

1.4. Dispensation

1.4.1 The requirements in this manual must be complied with and may only be changed with the written approval of the Commissioner of Public Works or his/her/their designate. When approved in writing, the Design Engineer may deviate from the standard and only for the specific project where dispensation has been granted to that project. The proponent must fill in the Deviation Memo (Appendix 1) and submit it to the Halton Region Project Manager for circulation and approval.

If you require clarification or would like to suggest a change or comment to the manual, please contact the Region by email at developmentengineering@halton.ca. In the subject line of the email state the section and page number corresponding to the clarification and or comment in the body of your email.

SECTION 2 WATERMAIN DESIGN

2.1. General

2.1.1. All watermains and appurtenances shall be designed and constructed in accordance with the following:

a) MECP Watermain Design Criteria for Future Alterations Authorized Under a Drinking Water Works Permit
b) Current Ontario Provincial Standard Specification (OPSS) and Ontario Provincial Standard Drawing (OPSD) as amended by Halton Region
c) Current Ontario Ministry of the Environment, Conservation and Parks Design Guidelines for Drinking-Water Systems
d) Halton Region (RH) Standard Drawings and Specifications
e) Region of Halton Drinking Water System By-law (71-19)
f) Region of Halton CADD Standards for Linear Design Drawings
g) Applicable standards and guidelines from regulatory authorities.

2.1.2. All watermains, appurtenances, materials and components shall comply with all current applicable industry standards and specifications for quality management and quality control, such as:

a) The Canadian Standards Association (CSA)
b) American Water Works Association (AWWA)
c) American Standard and Testing Materials (ASTM)
d) Underwriters Laboratory (UL)
e) Factory Mutual (FM)
f) Approved Manufacturers Products List for Water Systems
g) NSF International (NSF)
h) CGI Risk Management Services (formerly the Insurers' Advisory Organization Inc.)

2.2. Design Water Demand

2.2.1. The system shall be designed to meet the greater of either of the following demands:

a) Maximum Daily Demand Plus Fire Flow
b) Maximum Hourly Demand

2.2.2. Halton Region's latest water hydraulic model must be used to ensure conditions in are met.

2.2.3. Due to gradual rise in elevation northerly from Lake Ontario to Halton Hills, Halton Region is serviced by separate water pressure zones, each spanning an elevation of approximately 26 to 30 m. The design of water distribution systems within Halton Region must consider the location of the project site in context of the water pressure zones and proximity to outlying booster stations.

2.2.4. The water distribution system has been modeled using Halton Region's all-pipe water hydraulic model and the Design Engineer may be required to access this model to set conditions enabling the design of the site-specific water system. The design may require:

a) Setting of boundary conditions to enable the modeling of the site
b) Checking the proposed system for water flows and pressures under average day, maximum day and peak hour conditions
c) Checking the available fire flows under the maximum day condition
d) Proposing system pressure reducing valves to ensure operating pressures are maintained within standard operating limits

2.2.5. When proposing zone boundaries adjustment to ensure pressures are within standard operating limits, required fire flow shall be calculated in accordance with the Fire Underwriters Survey (FUS)
a) Water Supply for Public Fire Protection 1999 (FUS) published by CGI Risk Management Services (formerly the Insurers' Advisory Organization Inc) shall be used in calculating fire flows.
b) Halton may consider the published FUS 2020 version if detailed building information is available.

2.2.6. Individual hydraulic and capacity studies may be required for development areas.

2.3. Equivalent Population

2.3.1. Liters Per Capita Per Day
a) Residential – 230 L/cap/day
b) ICI – 190 L/emp/day

2.3.2. In designing watermains greater than 300 mm dia., populations are to be derived from the latest version of the Joint Best Planning Estimates.

2.3.3. In designing watermains 300 mm dia. and less, populations are to be derived from either of the following sources, based on the most accurate and appropriate information available:
a) Unit count and Persons per Unit (Table 2-1) for residential; building floor area and m2 per Employee (Table 2-2) for non-residential.
b) Equivalent population densities listed in Table 2-3 and 2-4.

2.3.4. Individual studies shall be made on a case-by-case basis for special commercial establishments, major commercial areas, special industrial areas, and major industrial areas (e.g. venues with large populations such as stadiums, theatres, etc.).

Table 2-1 PERSONS PER UNIT

Residential Category[1]	Persons per Unit
Singles & Semi Detached	3.8
Multiples except apartments	2.9
Apartments	1.7
Special Care or Special Need	1.1

Table 2-2 m2 per Employee

Employment Category[2]	m^2 per Employee
Commercial	37.4
Industrial	129.0
Institutional	68.7

Table 2-3 EQUIVALENT POPULATION DENSITIES – RESIDENTIAL

Type of Development	Equivalent Population Density (Persons/Hectare)
Single Family	95
Semi-detached duplex and 4-plex	165
Street Townhouse, Townhouses within Intensification Areas, or Back-to-Back	260
Stacked Townhouses Low/Mid-Rise Apartments outside Strategic Growth Areas	420
Apartments – Intensification Areas	600
Apartments within MTSA or Urban Growth Areas	2000

Table 2-4 EQUIVALENT POPULATION DENSITIES – ICI

EQUIVALENT POPULATION DENSITIES	Equivalent Population Density (Employees/Hectare)
Light Commercial Areas	105
Community Services / Institutional	50
Light Industrial Areas	145
Hospitals / Long Term Care Facilities	5 employees per bed

2.4. Design Factors

2.4.1. In designing watermains, design factors are to be as per the Design Criteria established by the Halton Region Water & Wastewater Master Plan or Development Charges Update Water/Wastewater Technical Report, whichever is most current.

Table 2-5 MAX DAY AND PEAK HOUR DEMAND PEAKING FACTORS

Parameter	Peaking Factor
Max Day Lake-based Supply	1.9
Max Day Well-based Supply	1.6
Peak Hour	3.0

2.5. Hydraulic Design

2.5.1. Pipe Design Flow

a) Hazen Williams equation may be used as follows:

$$Q = 0.84918 * C * A * R^{0.63} * S^{0.54}$$

Q	=	design flow (m^3/sec)
C	=	coefficient of roughness
R	=	hydraulic radius (m)
S	=	slope of energy grade line (m/m)
A	=	sectional area of flow (m^2)
1 m^3	=	1,000 litres

Table 2-6 Coefficients of Roughness

"C-Factors" as recommended by the MECP (*Watermain Design Criteria for Future Alterations Authorized Under a Drinking Water Works Permit)*, based on nominal diameter of the pipe, made of traditional material.

Nominal Diameter (mm)	C-Factor
150	100
200 to 250	110
300 to 600	120
>600	130

Notes:

1) In evaluating existing systems, the C-Factor shall be as per the latest version of the water hydraulic model.
2) In calculating the maximum velocity for transient pressure, use a C-Factor of 140 for new pipe conditions.
3) C-Factors in Table 2-3 include minor losses and shall be used for new systems.

2.5.2. Standard Pipe Sizes

a) 50, 100, 150, 200, 300, 400, 500, 600, 750, 900, 1050, 1200 mm dia. and larger, as required.
b) Any watermains up to 400 mm dia. are considered small diameter watermains. Any watermains 400 mm dia. or greater are considered large diameter watermains.

2.5.3. Pipe Networking

a) Local distribution mains are defined by pipes of less than 400 mm dia. with service connections permitted.
b) Feeder mains are defined by pipes of 400 mm dia. or greater with service connections permitted.
c) Transmission mains are defined by pipes of 400 mm dia. or greater with no service connections permitted.

2.5.4. Minimum Pipe Sizes

a) For institutional, commercial, and industrial areas, pipes shall be a minimum of 200 mm dia. or sized in accordance with design flows, whichever is greater.
b) For residential areas, the minimum pipe size shall be 150 mm dia.
c) As an alternative to a dead end, in the case of a court, a minimum 50 mm dia. watermain may be used to maintain water quality, refer to Halton Region Standard Drawing RH 411.010 & RH 411.020. The watermain sizing for the looping shall be confirmed by the Design Engineer.
d) For dead end mains and mains exceeding minimum size, proper analysis shall be carried out to ensure that the size of pipe proposed is adequate to deliver the required domestic demands and fire flows.

2.5.5. Pressure

a) The system should be designed to maintain a minimum pressure of 140 kPa (20 psi) at ground level at all points in the distribution system under maximum day demands plus fire flow conditions.
b) The normal operating pressure in the distribution system should be approximately 350 kPa to 550 kPa (50 to 80 psi) and not less than 275 kPa (40 psi).
c) The maximum pressures in the distribution system should not exceed 700 kPa (100 psi).

2.6. System Layout

2.6.1. Design Considerations

a) Engineering drawings submissions shall include:
   i) 60m Plan and Profile detail for all roadway infrastructure constructed within or in conjunction with an adjoining existing street or easement.
   ii) 120 m Plan and Profile detail for all roadway infrastructure constructed within or in conjunction with an adjoining future street or easement.

2.6.2. Watermain Location

a) The watermain shall be located in accordance with the Local Area Municipality's Standard Drawings. Where this location cannot be provided, a non-standard location would be approved by Halton Region in consultation with the Local Municipalities and utilities.
b) The submission of proposed locations and alignments are to be based on an accurate topographical survey incorporating utility and other existing infrastructure locates. Utilities are to be exposed to verify location within 1.0 m of the proposed pipeline and associated structures.
c) Watermains shall be located 4.5 m off the street line, however, location within the road allowance is to be considered on a case by case basis, depending on: whether there are existing mains within the proposed corridor or Right Of Way (ROW), the size of the main, pressure rating and service type, relative location of other utilities, potential traffic management problems during construction, and any future or simultaneous construction within the road allowance including road widening by the Ministry of Transportation Ontario (MTO).

2.6.3. Grid Design

a) Dead ends are discouraged, but if they are incorporated into the design, the pipe must be sized to meet maximum day plus fire flow demands and there must be a hydrant and/or a 50 mm dia. watermain will be installed to manage the water quality, refer to Halton Region Standard Drawing RH 411.010 & RH 411.020.
b) The use of easements to loop watermains is discouraged.
c) No service connections will be allowed off a main on an easement.
d) Pipe barrel bending/deflection shall not be allowed unless the watermain is installed using fusible horizontal direction drilling methodology.
e) Pipe joint deflections are discouraged, however if absolutely necessary, the maximum allowable pipe joint deflection shall be 50% of the manufacturer's specifications.
f) Grid Design shall, for mains 400 mm dia. or larger, take into consideration the location of watermain cleaning apparatus (e.g. hydrants, swab/access ports etc.), local drainage areas and regulated areas to facilitate the cleaning of watermains.
g) No flushing device shall be directly connected to any stormwater or wastewater main unless approval from the operating authority is obtained.
h) The use of 90-degree bends is not permitted in Halton Region.

2.6.4. Permanent Easements

a) Permanent easements should be avoided.
b) Easements to be at minimum 8 m wide for standard depth of bury between 1.7 m to 3.7 m for watermains of less than 600 mm dia.
c) Easements to be at minimum 9 m wide for single watermains with a standard depth of bury between 1.7 m to 3.7 m and 600 mm dia. or greater.
d) For pipe bury greater than 3.7 m depth the width of easement shall be such that it permits installation to be made by conventional excavation methods and that the operation be totally contained within the easement.
e) In general, for each meter of depth below 3.7 m the easement width should be increased by 3 m. All infrastructure within easements shall be placed within casings.
f) The minimum clearance from the outside edge of the pipe to easement limit is 3m.
g) When watermains or related infrastructure are installed within an easement adjacent to an existing or future structure, the following requirements shall apply:
    i) A projected slope of 1:1 shall be considered, projected from the deepest point of the structure’s foundation. No portion of the watermain or associated appurtenances shall be located within this zone.
    ii) For trench design and excavation planning, the 1:1 slope shall also be projected from the bottom edge of the proposed excavation toward the deepest point of the adjacent foundation. This ensures that excavation activities do not compromise the structural integrity of the building.
h) Pipe Encasement (i.e. tunneling methods) is not an acceptable substitute where the above minimum easement width requirements or projected 1:1 slope requirement cannot be satisfied.
i) Where an easement has multiple uses for Regional and/or third-party utilities, the minimum horizontal separation between dry utilities and the watermain shall be 1.2 m. Between watermains and storm or wastewater mains the minimum horizontal separation shall be 2.5 m, and the minimum 3.0 m offset from the limits of the easement shall be maintained in all cases.
j) Easements shall be accessible via municipal roadways and shall be designed to allow construction equipment to maintain the infrastructure within the easements.

2.6.5. Casings and Encasements

a) Steel casing and/or tunneling casing are required for river/creek crossings, railway crossings, large storm culvert crossings, and for other structural integrity requirements.
b) Only approved spacers are to be used, and runners must be of ultra-high molecular weight polymer or equivalent. Wood blocking is NOT an approved or equivalent product. Refer to Halton Region Standard Drawing RH 412.010.
c) Watermain pipes to be centered in the casing with a minimum 200 mm clearance all the way around at the largest outside pipe bell or harness joint.
d) The watermain must be installed as per the specifications of the manufacturer and shall be restrained along the entire length of the casing.
e) Grouting shall be a 3 to 1 (3:1) sand to cement mix ratio unless otherwise stated in the approved Utility Crossing Agreement.
f) Steel casing and/or tunneling casing ends shall be sealed wrapped with high quality rubber (or equivalent) around both the casing ends and the pipe and secured with Type 316 stainless steel bands to prevent entry of water or excess moisture. Concrete pipe with a continuous steel liner is also acceptable.
g) Concrete encasements of PVC watermains are not permitted. Encasement of other pipe materials will be evaluated and approved by Halton Region on a case-by-case basis.
h) A water valve and box or a valve in chamber is required at each end of the crossing and shall be placed before the first service connection. The depth of the valves should be at standard depth not at the depth of the casing, refer to Halton Region Standard Drawing RH 412.010.

2.6.6. Separation from “Sewers” (Stormwater Sewers and Wastewater Mains)

a) Parallel Installations
   i) Under normal conditions, watermains shall be laid with at least 2.5 m horizontal separation from any sewers or sewer maintenance holes. The distance shall be measured from the nearest edges or outside surfaces.
   ii) Under unusual conditions, where congestion with other utilities will prevent a clear horizontal separation of 2.5 m, a watermain may be laid closer to a sewer, provided that the vertical separation of the sewer is at least 0.5 m below the watermain (The distance shall be measured from the nearest edges or outside surfaces).
   iii) When this vertical separation cannot be obtained, where applicable, the sewer main shall be constructed with joints that are equivalent to watermain standards (MECP F-6-1 Procedures to Govern Separation of Sewers and Watermains).
b) Watermain and Sewer Crossings
   i) Under normal conditions, watermains shall cross above the sewer with sufficient vertical separation to allow for proper bedding and structural support of the watermain and sewer.
   ii) Minimum separation/clearance shall be 150 mm where watermains cross above mainline sewers and laterals and 500 mm where the watermain crosses under a mainline sewer and laterals (The distance shall be measured from the nearest edges or outside surfaces).
   iii) If the minimum cover of the watermain or water service cannot be obtained due to the watermain or water service crossing above the sewer, the watermain or water service shall be constructed under the sewer or insulated for its entire length using pre-insulated pipe until the minimum depth (1.7m) is obtained. When crossing over a stormwater sewer, the stormwater sewer must also be insulated with minimum 100 mm extruded foam (HI 100) insulation, refer to Halton Region Standard Drawing RH 408.020 & 408.030.
   iv) In conditions where a watermain crosses over a sewer and standard cover cannot be maintained, insulation is required in accordance with Halton Region Standard Drawing RH 408.020. The minimum allowable cover in such cases is 1.2m. Under these circumstances approval from Halton Region must be obtained.
   v) A watermain passing under a sewer shall be protected by providing adequate structural

support for the sewer to prevent excessive deflection of joints and settling.

vi) Where a watermain crosses under a creek or an open bottom culvert, the minimum cover over the watermain casing below the creek bottom shall be 3.0 m or as required by the appropriate Conservation Authority and geotechnical report recommendations.

vii) Where a watermain crosses under a closed bottom culvert, the minimum cover over the watermain casing below the culvert bottom shall be 1.7 m or as required by the appropriate Conservation Authority and geotechnical report recommendations.

2.6.7. Pipe Depth

a) The top of the watermain shall have a minimum of 1.7 m cover, measured from the top of the pipe to the finished grade.

b) On open ditch or unimproved roads, an increased cover of minimum 2.3 m shall be provided to allow for future road improvements or lowering of the road profile when urbanization occurs.

c) In areas where the pipe cover is less than 1.7m but more than 1.2m (per Std. Dwg 408.020), or when freezing of pipe may be anticipated (e.g. culverts or large diameter stormwater mains), special provision shall be considered to protect pipes and services from live loading and freezing. Under these circumstances approval from Halton Region must be obtained via Design Deviation memo.

d) Where the pipe depth is greater than 3.0 m a chamber must be used. Direct bury of valves at this depth or greater is not permitted, refer to 2.6.9.i and Halton Region Standard Drawing RH 405.020.

2.6.8. Valves

a) Mainline Valves

i) All valves on watermains 400 mm dia. and larger are to be installed in chambers. Single valves on watermains less than 400 mm dia. and not at junctions can be direct buried, refer to Halton Region Standard Drawing RH

ii) 413.010. In certain circumstances, like high traffic areas, Halton Region will require that valves smaller than 400 mm dia. be installed in a chamber, refer to Halton Region Standard Drawing RH 402.060.

iii) Resilient seat gate valves conforming to AWWA C509 or C515 (latest revision) may be used for watermains 400 mm dia. and smaller. Resilient seat gate valves conforming to AWWA C515 (latest revision) shall be used for watermains larger than 400 mm dia. and include a by-pass valve installation.

iv) Butterfly valves conforming to AWWA C504 (latest revision) and Halton Region Specifications may be used on watermains greater than 400 mm dia., depending on the swab/access port and inspection requirements and with approval from Halton Region.

v) All valves shall be of the approved type with non-rising stem and shall have a 50 mm square standard AWWA operating nut.

vi) All valves are to open left (counterclockwise).

vii) All valves and flexible joints shall be restrained. Refer to Halton Region standard drawings.

b) Valve Sizes

i) The size of the valve shall be the same size as the watermain up to and including 600 mm dia. Valves on 750 mm dia. and larger watermains may be one size smaller than the watermain size.

c) Number, Location and Spacing

i) Three valves are required at a tee intersections and four valves are required at a cross intersection. All clustered valves shall be placed in valve chambers on flanged fittings. Refer to Halton Region Standard Drawings (RH 410 series).

ii) Line valve spacing shall conform to the following:

iii) Watermains 150 to 400 mm dia. – maximum valve spacing 300 m.

iv) Watermains 500 to 750 mm dia. – maximum valve spacing 1000 m.

v) Watermains 900 mm dia. and larger – maximum valve spacing to be determined by discussions between the Design Engineer and Halton Region.
vi) Multi-unit commercial, employment/residential, institutional shall require three valves in a chamber; refer to Halton Region Standard Drawing RH 402.080, unless isolation of the watermain can be achieved within the existing system while keeping the service feed operational.

d) Air Release Valves
   i) Air release valves shall be provided in a chamber on 400 mm dia. watermains and larger. Chambers are to be a minimum of 1200 mm dia., refer to Halton Region Standard Drawings RH 404 Series.
   ii) Sizing, type, and location of combination air release valves must be confirmed and validated by the Design Engineer based on the hydraulic requirements of the system determined by the Design Engineer.
   iii) Air release valves are to be installed directly onto the watermain without offsets and to be vented to the atmosphere, refer to Halton Region Standard Drawings RH 404 Series.
   iv) Air vent pipes are to be located at a minimum of 2.0 m behind the curb and 1.5 m above final grade, refer to Halton Region Standard Drawing RH 404.012.
   v) Watermains that are smaller than 400 mm dia. shall incorporate hydrants at high points to facilitate air management. Hydrants located at these high points should be equipped with appropriate valving to allow them to function as air inlets during draining and to enable manual air discharge (e.g., on small mains crossing railways, creeks, or other similar constraints).
e) Drain Valves
   i) Drain valves shall be provided at all significant low points on 300 mm dia. watermains and larger in a separate chamber. Chambers are to be a minimum of 1200 mm dia., refer to Halton Region Standard Drawing RH 403.010.
f) Pressure Reducing Valves
   i) Pressure reducing or pressure sustaining valves are permitted in special circumstances and upon consultation and approval by Halton Region, where pressures within the system exceed 690 kPa (100 psi) and impacts to the rest of the water system are considered.
   ii) Where a Pressure Reducing Valve (PRV) is being used to feed a small system or sub-zone, consideration shall be given to times of low flow as well as times of higher flows for fire protection. In most cases there should be 2 PRVs, a smaller one to handle the low flows and a larger one for fire protection.
   iii) The design shall always allow for redundancy so that maintenance can be performed on the PRV without affecting service to customers. All PRVs require isolation valves upstream and downstream from the PRV. On a sub-zone that is being fed by more than one feed, consideration of which PRV will be the lead PRV and which one will be the lag should be done during the design.
   iv) For water quality and maintenance purposes, a hydrant is required downstream from the PRV with an isolation valve further downstream to allow the PRV and hydrant to be isolated from the rest of the system. Where PRVs are being installed as a back-up and don’t have water flowing through them on a regular basis, anti-stagnation devices must be considered to keep water fresh. Also, the ability to monitor water quality must be provided through sampling ports or hydrants.
   v) For Halton Region’s approved PRV chambers and setup, refer to Halton Region Standard Drawings RH 410 series.
g) Valve Boxes
   i) All valves require valve boxes. In a chamber the roof slab shall be cored to allow the valve box installation.
   ii) The tops of valve boxes and valve chamber access hole covers shall be set flush with

finished grade.

iii) A 1.0 m minimum dia. and 50 mm thick circular asphalt collar shall be installed around a valve box located in a gravel shoulder.

iv) No valve box extensions will be permitted for direct buried valves less than 2.3 m deep.

h) Bypass

i) For gate valves larger than 400mm dia., a permanent bypass line must be provided within the chamber around each valve to equalize pressure and facilitate valve opening. The bypass size and location shall comply with AWWA C500 (latest version).

i) Zone Valves

i) Regional staff will advise where zone valves are required and if required, refer to Halton Region Standard Drawing RH 402.070.

2.6.9. Water Valve Chamber

a) For all watermains, the chamber size shall be designed adequately to accommodate all the following:

i) Chamber access and worker height should be a minimum 1.7 m from floor to ceiling of chamber

ii) Working distance around outside surface of flanges to the inside wall shall be a minimum 500 mm

iii) Working distance from the floor to the bottom of the valve / flanges shall be equal to the pipe diameter with a minimum 300 mm and maximum 1 m

iv) All valves (refer to Section 2.6.8), including future replacements (refer to Halton Region standard drawings RH Series 400)

v) All connections to tees and crosses within chambers must be fully restrained

vi) Swab/Access ports (refer to Section 2.6.11) and launch connections

b) Other ancillary equipment Standard 2400 mm x 2400 mm Square Valve Chamber shall be used in all other combinations of valves up to 300 mm dia. in size, refer to Halton Region Standard Drawing RH 402.020.

c) Standard 1800 mm x 2400 mm Rectangular Valve Chamber shall only be used when there are up to three valve combinations for main sizes 150 mm to 300 mm dia. (refer to Halton Region Standard Drawing RH 402.080) or if the chamber design is for zone isolating valves 150mm dia. and larger (RH 402.070).

d) The top of the roof slab of valve chambers shall be at least 600 mm below the profile of the finished pavement. An engineered collar may be required to make up for elevation differences.

e) Chamber joints shall have a continuous rubber gasket adhered to the concrete as supplied by the manufacturer.

f) Chambers shall be watertight. Waterproofing shall be installed around all exterior section joints, and the waterproof membrane shall extend completely around all joints with a minimum 300 mm wide strip centered on the joint.

g) If reducers are required, they should be placed outside the chamber walls.

h) Drainpipe connections from valve chambers are not permitted.

i) Valve extension stems are required when the distance between the top of the operating nut and finished grade is greater than 3 m. The *valve extension stems shall be designed to withstand twisting or be*nding and include all necessary supports and shall be 1.3 m below final grade. Refer to Halton Region Standard RH 405.020. All chambers shall be designed to ensure that all valves can be operated from above.

j) For valve chambers located inside the travelled portion of the road, chambers shall be designed with buried removable concrete access slabs to allow for valve removal and installation. For chamber access standard frame and cover shall be used.

2.6.10. Hydrants

a) Hydrants shall be installed on all distribution watermains with the following maximum linear allowable spacing along the watermain:

TABLE 2-7 MAXIMUM ALLOWABLE HYDRANT SPACING

Development Area	Maximum Spacing
Residential (Single Family)	150 m
Commercial, Industrial, Institutional, High Density Residential and Mixed Use	90 m

b) All hydrant connections to the main line require an anchor tee with a 150 mm mechanical joint secondary gate valve (direct buried) bolted to the anchor tee.
c) All joints on the hydrant lateral are required to be restrained.
d) Where a dead end watermain occurs, it shall be provided with a fire hydrant at the termination of the watermain.
e) In new residential areas, hydrant offset locations shall conform to the requirements of the Local Area Municipality.
f) Hydrants shall be located outside of ditch line.
g) Minimum cover over hydrant lateral shall be 1.7m. If a hydrant main valve seat exceeds 1.7m, a suitable hydrant bottom extension must be used and placed between boot and hydrant barrel, refer to Halton Region Standard Drawing RH 407.010.
h) At least one hydrant shall be installed between valves.
i) When replacing existing hydrants:
    i) Locate the hydrants a maximum of 45 m away from any building with a Siamese connection.
    ii) Replacement hydrants shall be placed in the same place as the previously approved location.
    iii) Across undeveloped land, river valleys and non-buildable lands, install one hydrant between valves to facilitate testing and flushing, preferably at a high point.
j) A 10-gauge TWU stranded copper, light coloured plastic coated tracer wire must be installed and brought to the surface at each hydrant. Tracer wire shall be attached to the pipe by means of tape and looped around the base of the hydrant.

2.6.11. Swab/Access Ports

a) Swabbing of distribution mains from 150 mm to 300 mm dia. shall be completed through the 150 mm dia. hydrant barrel.
b) For watermains 400 mm dia. and larger, an access arrangement for swabbing shall be provided and incorporated into the design of valve chambers and approved by Halton Region. Refer to Section 2.6.9 for valve chamber requirements.
c) The minimum size of the access port shall be half the diameter of the watermain pipe to be swabbed, rounded up to the nearest standard pipe size. Refer to Section
d) 2.5.2 for the standard pipe size. Table 2-8 outlines the minimum design provision for the access ports.
e) The maximum distance between swab/access ports shall be 1 km, unless approved by Halton Region.

TABLE 2-8 SWAB/ACCESS PORT SIZES

Watermain Size (mm dia.)	Swab/Access Port Size
150 – 300	hydrant barrel
400 – 600	300 mm dia. pipe flange
750	400 mm dia. pipe flange
900 – 1200	600 mm dia. pipe flange
> 1500	n/a

2.7. Pipe Requirements

2.7.1. Pipe Materials and Fittings

a) The pipe design pressure rating shall be a minimum of 1034 kPa (150 psi), in locations where the system is designed to operate within regular pressure ratings outlined in section 2.5.5.
b) Current AWWA procedures shall be adopted for the computation of strength and thickness of the pipe.
c) See Table 2-6 for the preferred watermain design range, joint type, service connections, and specifications.

TABLE 2-9 PREFERRED DESIGN RANGE, PIPE MATERIALS AND FITTING TYPES

Material	Watermain Size (mm dia.)	Joint Type	Standard	General Comments
Polyvinyl Chloride Pipe (PVC)	≤ 300	Thickened Bell & Spigot, Butt-fused	AWWA M23, AWWA C900 & C907 CSA B 137.3	Pressure Class 235 (1620 kPa) DR 18 only. Use of PVC for distribution mains only. Service saddles shall be used when tapping services to PVC mains.
Molecularly Oriented Polyvinyl Chloride Pipe (PVCO)	≤ 300	Gasketed Bell & Spigot	AWWA C909	Pressure Class 200 (1380 kPa); Use of PVCO for distribution mains only. Service saddles shall be used when tapping services to PVCO mains.

Concrete Pressure Pipe (CPP)	400 - 500	Gasketed Bell & Spigot	C303	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
	400 - 1500		C301(L) & C304	Pre-stressed Concrete Lined Cylinder Pipe
	1050 - 3600		C301(E) & C304	Pre-stressed Concrete Embedded Cylinder Pipe
Ductile Iron	≤ 400	Mechanical, Flanged or Tyton	AWWA C104, C105, C110, C111, C115, C150, C151, C153	Pressure Class 350 (2410 kPa) for up to 300mm dia., and Class 250 (1725 kPa) for 350 mm to 400 mm dia. only. Project specific basis as accepted by Halton Region and determined by design review process. Cathodic Protection is required as per latest OPS requirements.
High Density Polyethylene (HDPE)	≤ 400	Butt-fused	AWWA C906	Project specific basis as accepted by Halton Region and determined by design review process. Not to be used as distribution main where services are required. Requires a Design Deviation Memo approved by the Commissioner of Public Works.
Steel Pipe	≥ 600	Gasketed Bell & Spigot, Field Welded Joints	AWWA C200, C205, C209, C214	Internal lining & external coating must be approved by Halton Region. External coating to meet geotechnical recommendation.
Fiberglass Pressure Pipe (FPP)	≥ 600	Gasketed Bell & Spigot, Mechanical or Flanged	AWWA 950, AWWA M45	Pressure Class to be determined by Hydraulic analysis.
Copper	50	Coupling	AWWA C800, ASTM B88	

Notes: The function of the watermain (distribution or transmission) shall be determined by Halton Region as outlined in Section 2.5.3.

2.7.2. Structural Requirements

a) Thrust
   i) All watermains and thrust restraints shall be designed to withstand the maximum operating pressure plus the transient pressure to which it will be subjected. The value of the transient pressure will not be less than the pressure surge that would be created by immediate stoppage of a water column moving at 0.6 m/s. The design pressure shall not be less than 1034 kPa (150 psi). The actual value of maximum transient pressure must be obtained.
   ii) All plugs, caps, tees, and bends must have approved mechanical thrust restraints, refer to design requirements.
   iii) Mechanical thrust restraint devices to be used shall be on Halton's Approved Manufacturers Products List for Water Systems.

b) Bedding, Cover and Backfill
   i) Pipe bedding, cover and trench backfill shall be determined based on type of pipe (rigid or flexible), installation depth and soil conditions.
   ii) Bedding requirements shall be determined by the depth of bury of the pipe, soil type and trench conditions. As a minimum requirement, watermain shall be laid on 150 mm of Granular 'A' bedding and shall conform to OPSS MUNI. 401.
   iii) Backfill shall be 100% SPMDD beneath roads, sidewalks, curbs and 95% SPMDD elsewhere and conform to OPSS MUNI. 401 Granular 'B' Type I or II or approved select native as recommended by the geotechnical report and monitored during construction. Loose material shall be compacted to 95% SPMDD before subsequent layer are placed.
   iv) In replacement conditions on local area roads, the requirements of the Local Area Municipal Consent shall be satisfied on backfill material and compaction density.
   v) Use of 'High Performance' bedding, cover or backfill is not permitted.

c) Trench Plugs
   i) Trench plugs are required when the watermain is determined to be located below the water table.
   ii) Trench plug design and construction shall be undertaken as directed by a geotechnical report.

d) Rock Squeeze
   i) Rock squeeze mitigation recommendations shall conform to a geotechnical report.

2.7.3. Tracer Wire

a) Tracer wire shall be installed on all new installations of watermain pipe and services greater than 50 mm dia. for locating purposes. A solid 10-gauge TWU copper wire shall be installed along the top of the pipe, strapped to the pipe at 6 m intervals.
b) The tracer wire shall be installed between each valve and/or the end of the new watermain to ensure a continuous signal for locating the main. Joints in the tracer wire between valves are discouraged, but when necessary, splicing must be waterproofed (refer to OPSD 1109.025) or use outdoor waterproof electrical connectors and done in such a way to ensure electrical conductivity. At each valve, a loop of wire is to be brought up outside the valve box to the top of the box, refer to Halton Region Standard Drawing RH 406.010.
c) Tracer wire for horizontal directional drilling and pipe bursting installation shall be in accordance with Halton Region's Amendments to OPSS.

2.8. Removal and Abandoning

2.8.1. Abandoned pipes shall be completely removed. If watermains are to be abandoned in place, refer to OPSS MUNI. 510, including grouting.

2.8.2. Remove valves in chambers and salvage where applicable.

2.8.3. When abandoning a water service connection or watermain connected to a live main, the contractor shall remove the valve and tee and insert a sleeve on the watermain. Where a sleeve is not practical, approval from Halton Region for an alternate method is required.

2.8.4. Remove hydrants for disposal or salvage at the direction of the Region.

2.8.5. Water valve chambers to be abandoned shall be broken down 1.0 m below final grade and backfilled with unshrinkable backfill.

2.8.6. All ends of the abandoned watermain are to be capped and restrained by mechanical means. Concrete plugging is not acceptable.

2.9. Service Connections

2.9.1. Water Service connections to a transmission main are not permitted

a) Transmission Mains
   i) No connections permitted with feedermains or watermains
   ii) No service connections allowed
b) Major Distribution Feedermains greater than 600mm
   i) Connections with other feedermains and local watermains permitted
   ii) No service connections allowed
c) Major Distribution Feedermains 600mm or less
   i) Connections with other feedermains and local watermains permitted
   ii) Industrial connections may be considered under special circumstances when no other options are present
   iii) No residential connections permitted
d) Local Distribution Feedermains 400mm – 500mm
   i) Connections with other feedermains and local watermains permitted
   ii) Industrial, Commercial and Institutional connections permitted
   iii) Residential connections may be considered under special circumstances

2.9.2. Each property shall have an individual service to the property line.

2.9.3. Water service connections shall be sized based on:

a) Peak water consumption requirements of the service

b) Available pressure in the watermain and the relative elevation of the area/building being served.

c) The minimum diameter of new water service connections shall be 25mm.

2.9.4. All water service connections shall be installed perpendicular to the watermain.

2.9.5. No water service is allowed to be tapped off the fire hydrant lateral.

2.9.6. Pipe for water service connections including 25, 38 & 50mm shall be type ‘K’ soft copper tubing meeting AWWA C800 (latest version).

2.9.7. PVC pipes are required for water service connections 100 mm dia. and larger meeting AWWA C900 (latest version).

2.9.8. Ductile iron cement lined pipe may be used for water service connections 100 mm

dia. and larger upon approval of Region of Halton meeting AWWA C104 (latest version)

2.9.9. Single water service connections to private property servicing more than one building shall conform to the latest version of the Drinking Water System By-law.

2.9.10. All water service connections shall be provided with a main stop and a curb stop with service box at the property line. Service box stem extension rods are to be used on water services of 25 mm dia. The top of stem rods shall be minimum of 0.5m and maximum of

2.9.11. 1.0 m from finished ground elevation.

2.9.12. An oversized service box shall be used on 38mm dia. and 50mm dia. water service connections with no stem extension rods.

2.9.13. For all new water services, copper is required to be installed at a minimum of 1.0 m beyond the curb stop on private property.

2.9.14. Major water service connections 100mm dia. and larger shall have valves at the main and at the property line.

2.9.15. Standard fire service connection and domestic water service connection installations refer to Halton Region Standard Drawing RH 409.010. For fire service connections, the minimum pipe size shall be 200 mm dia. The fire service connection may be reduced to 150 mm dia. on private property in compliance with NFPA 24: Standard for the Installation of Private Fire Service Mains and their Appurtenances.

2.9.16. When tapping services to mains, service saddles must be used. Pipe and saddle manufacturer's recommendations shall be followed on the use and installation.

2.9.17. The depth of water service connections at property line shall be a minimum of 1.7 m and a maximum of 2.0 m from finished ground elevation.

2.9.18. Where the minimum of 1.7 m cover cannot be achieved the water service shall be pre-insulated, refer to Halton Region Standard Drawing RH 408.020 & 408.030 and as per Halton Region's latest Approved Manufactures Products List for Water Systems.

2.10. Corrosion Prevention

2.10.1. All metallic components in the water distribution system shall be protected from corrosion.

2.10.2. Petrolatum Coatings meeting AWWA C217 are the required method of corrosion protection of metallic appurtenances both inside and outside of chambers.

2.10.3. Corrosion-resistant, fluoropolymer coated high-strength low-alloy steel (as per ANSI/ AWWA C111/ A21.11) restraining rods and T-head bolt with nut shall be used inside chambers.

2.10.4. Accepted methods of installation for Cathodic Protection using sacrificial anodes, instead of the required method of petrolatum coatings, are as follows:

a) Existing Cast or Ductile Iron Watermains
   i) Anodes shall be used to cathodically protect existing cast iron or ductile iron watermains.
   ii) All sacrificial anodes shall consist of a packaged magnesium casting. Anodes for metallic watermain pipes shall have a minimum weight of 14.5 kg and length of 500mm. Fittings and appurtenances shall have a minimum anode weight of 11 kg as per the

Region's OPSS Amendment 442.07.04.

iii) Anodes shall be installed along the entire length of existing watermain following the spacing requirements as per OPSS MUNI. 442 Table 4.

b) Water Service Connections:
   i) Each copper water service connections shall be protected with a minimum weight of 10.8 kg Zinc anode and installed in accordance with OPSS 442.07.04, OPSD 1109.010 & 1109.011, and Halton Region's Amendments to OPSS & OPSD. Services larger than 50 mm dia. are to be treated like any metallic watermain.
   ii) All sacrificial anodes shall conform to ASTM B-418 Type II and shall be made of high-grade electrolytic zinc 99.99% pure.

2.10.5. Polyethylene Encasement is not permitted for corrosion protection of metallic watermain and appurtenances.

SECTION 3 WASTEWATER MAIN DESIGN

3.1. General

3.1.1. Halton Region's latest wastewater hydraulic model must be used for the design of wastewater systems in cases where the drainage area includes existing developed areas.

3.1.2. For drainage areas that do not include existing developed areas, design computations for wastewater systems must be completed on the Halton Region Standard Calculation Sheet RH 2001.010, unless the design sheet provided by the Design Engineer includes all design computation requirements of Sheet RH 2001.010.

3.1.3. All wastewater mains and appurtenances shall be designed and constructed in accordance with the following:

a) MECP Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under an Environmental Compliance Approval
b) Ontario Provincial Standard Specification (OPSS) and Ontario Provincial Standard Drawing (OPSD), as amended by Halton Region
c) Canadian Standards Association (CSA)
d) American Standard and Testing Materials (ASTM)
e) Halton Region (RH) Standard Drawings and Specifications
f) Wastewater Systems By-law (184-95) and Sewer Use By-law (2- 03)
g) Region of Halton's CADD Standards for Linear Design Drawings
h) Approved Manufacturers Products List for Wastewater Systems
i) Applicable standards and guidelines from regulatory authorities.

3.2. Design Wastewater Flow

3.2.1. Average Dry Weather Flow

a) Liters Per Capita Per Day
   i) Residential – 215 L/cap/day
   ii) ICI – 185L/emp/day
b) In designing wastewater mains greater than 450mm dia., populations are to be derived from the latest version of the Joint Best Planning Estimates.

c) In designing wastewater mains 450 mm dia. and less, populations are to be derived from

either of the following sources, based on the most accurate and appropriate information available:

i) Unit count and Persons per Unit (Table 3-1) for residential; building floor area and m2 per Employee (Table 3-2) for non-residential.
ii) Equivalent population densities listed in Table 3-3 and 3-4.

d) Individual studies shall be made on a case-by-case basis for special commercial establishments, major commercial areas, special industrial areas, and major industrial areas (e.g. hospitals, etc.).

TABLE 3-1 Persons per Unit

Residential Category[1]	**Persons per Unit**
Singles & Semi Detached	3.8
Multiples except apartments	2.9
Apartments	1.7
Special Care or Special Need	1.1

TABLE 3-2 m2 per Employee

Employment Category	**m^2 per Employee**
Commercial	37.4
Industrial	129.0
Institutional	68.7

TABLE 3-3 EQUIVALENT POPULATION DENSITIES

Type of Development	**Equivalent Population Density (Persons/Hectare)**
Single Family	95
Semi-detached duplex and 4-plex	165
Street Townhouse, Intensification Area Townhouse, or Back-to-back	260
Stacked Townhouses Low/Mid-Rise Apartments outside Strategic Growth Areas	420
Apartments – Intensification Areas	600
Apartments within MTSA, Urban Growth Areas	2000

TABLE 3-4 COMMERCIAL, INDUSTRIAL, AND INSTUTIONAL EQUIVALENT POPULATION DENSITY

Type of Development	Equivalent Population Density (Employees/Hectare)
Light Commercial Areas	105
Community Services / Institutional	50
Light Industrial Areas	145
Hospitals / Long Term Care Facilities	5 employees per bed

e) Equivalent population shall be used to calculate the Average Dry Weather Flow for each wastewater main, determined by multiplying the total tributary equivalent population by Liters per Capita per Day as shown below:

Average Dry Weather Flow = Liters per Capita per Day x Equivalent Population

3.2.2. Peak Wet Weather Flow

3.2.3. The wastewater main shall be designed to accommodate peak wet weather flow (as Design Flow specified below) unless directed otherwise by Halton Region.

$$\text{Design Flow} = \text{Average Dry Weather Flow} \times \text{Average Peak Wastewater Flow Factor} + \text{Inflow/Infiltration Allowance}$$

a) For drainage areas that do not include existing developed areas, design wastewater flow may be calculated according to the Halton Standard Sewer Design sheet (reference?) unless a more rigorous analysis is carried out and approved by Halton Region:
b) Design wastewater flow for drainage areas that include existing developed areas shall be calculated using the latest version of Halton Region's wastewater hydraulic model according to the Levels of Service in the Halton Water and Wastewater Master Plan.
c) No surcharge (d/D<1))
   i) Under 5-year design storm
   ii) No basement flooding risk (freeboard over 1.8m below ground) under 10-year design storm

3.2.4. Peak Wastewater Flow Factor

d) For all tributary area land use mixes, the peaking factor shall be calculated using the modified Harmon Formula as follows:

$$M = 1 + \frac{14}{4 + \sqrt{P_e}}$$

M = ratio of peak flow to average flow*
P_e = equivalent tributary population in thousands
* The minimum permissible peaking factor M is 2.0

Land use determinations should be based on approved or planned land use designations (Official Plans) and zoning (By-laws). Tributary populations should be calculated as described in Section 3.2.1. Average Dry Weather Flow.

3.2.5. Inflow/Infiltration Allowance

e) For drainage areas that do not include existing developed areas, the inflow/infiltration allowance shall be 0.28 x 10-3 m3/ha/s for all land use types.

3.3. Pipe Size

3.3.1. To determine the pipe size and its capacity, the Halton Region Standard Design Tables RH 2000 series or Manning's Formula shall be used. Manning's Formula is expressed as:

$$Q = \frac{1}{n} \times R^{2/3} \times S^{1/2} \times A$$

Q = design flow (m³/sec)
n = coefficient of roughness (n=0.013 for all pipe material)
R = hydraulic radius (m)
S = slope (m/m)
A = section area of flow (m^2)

3.3.2. Pipe sizing shall be in accordance with flow requirements, but the minimum pipe size shall be 200 mm diameter for residential developments and 250 mm diameter for ICI areas.

3.3.3. Standard Pipe Sizes

a) 200, 250, 300, 375, 450, 525, 600, 675, 750, 825, 900, 975, 1050, 1200 mm dia. and larger, as required.
b) Any wastewater main up to and including 375 mm dia. are considered small diameter wastewater mains. Any wastewater mains 450 mm dia. or greater are considered large diameter wastewater mains.

3.4. Flow Velocities

3.4.1. The flow velocity shall be determined from the Halton Region Standard Design Tables RH 2000 series or from the following:

$$V = \frac{Q}{A}$$

V = flow velocity (m/sec)
Q = design flow (m^3/sec)
A = cross section area of flow based on the actual depth of flow (m^2)

3.4.2. The minimum velocity in a pipe shall be 0.6 m/sec based on Design Peak Wastewater Flow (as defined in Section 3.3.1) not flowing full based on actual depth of flow to ensure adequate flushing velocities.

3.4.3. The maximum velocity shall not be greater than 3.0 m/sec.

3.4.4. When pipe is not flowing full, design velocity shall be calculated using formula in Section 3.3.1 Dry Weather Flow.

3.4.5. When sizing wastewater mains in existing areas, Halton Region reserves the right to have existing flows validated using the latest wastewater hydraulic model to confirm the wastewater main sizes. When sizing wastewater mains in greenfield areas using Halton Region RH 2000 Series Standard Design Tables, the flow ratio of design flow/full flow (Q/Qf) in Table 3-3 shall be used for sizing.

TABLE 3-5 FLOW RATIO Q/Qf STANDARDS

Diameter	Flow Ratio (Q/Qf)
525mm or greater	<=**80%**
450mm or smaller	<=**70%**

3.5. Minimum Slopes

3.5.1. All wastewater mains shall be designed with a minimum (0.2%) slope. If minimum slopes cannot be achieved, approval must be received from the Commissioner of Public Works for the deviation.

Notwithstanding the above, the first leg of a gravity wastewater system, which is the first section of wastewater main from the most upstream maintenance hole to the next, shall have a minimum slope of one (1%) percent. All following pipe sections shall be designed to achieve a minimum design velocity of 0.6 m/s.

3.6. System Layout

3.6.1. Wastewater Main Location

a) All new wastewater mains shall be located in accordance with the Local Municipality's Standard Drawings. Where this location cannot be provided, a non-standard location must be approved by the Commissioner of Public Works.
b) Location of replacement wastewater mains shall be determined specifically based on the location of existing utilities and other site conditions.
c) All wastewater mains in new developments that are connected to the existing system shall be plugged at the connection point to the active system until written approval from Halton Region has been received to accept flows.
d) For separation from watermains, refer to Section 2.6.6 of the Design Criteria for Water System.
e) All new pipes for new developments shall be designed, to reduce the occurrence of basement flooding, a vertical clearance of at least 0.9 m between the lowest basement floor elevation (basement slab elevation) and the obvert elevation of the wastewater main at the center line of the road shall be achieved. Refer to Figure RH 304.020. Deviations should consider private side solutions acceptable to the Region.

3.6.2. Grid Design

a) Wastewater mains changing in alignment shall have maintenance holes at the point of the alignment change. Pipe deflection is not allowed.
b) The maximum change in alignment for wastewater mains equal to or greater than 450 mm dia. shall be 45°, and 90° for smaller diameter mains.

3.6.3. Permanent Easements

a) Permanent easement should be avoided.
b) Lateral connections to the mainline within easements are not allowed.
c) Easements are to be a minimum of 8 m wide for standard depth of bury (1.7m to 3.7m) for wastewater mains of less than 600 mm dia.
d) Easements are to be a minimum of 9 m wide for single wastewater mains with a standard depth of bury (1.7 m to 3.7 m) and a diameter of 600 mm or greater.
e) For pipe bury greater than 3.7 m depth the width of easement shall be such that it permits installation to be made by conventional excavation methods and that the operation be totally contained within the easement.
f) For each meter of depth below 3.7 m, the easement width should be increased by 3 m or as determined by Halton Region.
g) All wastewater mains shall be 3 m from the easement limits.
h) Where the easement is adjacent to an existing or future structure, a projected slope of 1:1 must be considered calculated from the deepest depth of the foundation of the structure. The pipe shall not be placed within the zone encumbered by the 1:1 slope.
i) Pipe encasement (i.e. tunneling methods) is not an acceptable substitute where the above minimum easement width requirements or projected 1:1 slope requirement cannot be satisfied.
j) Third-party utilities will not be allowed within Regional easements.
k) The minimum horizontal separation between wastewater mains and watermains shall be 2.5m from the most outer edges of the pipe.
l) Where an easement has multiple uses all mains shall be 3.0 m offset from the easement limits.

3.6.4. Casing

m) Steel casing and/or tunneling casing are required for river/creek crossings, rail crossings, large storm culvert crossings and for other structural integrity requirements. Refer to Halton Region Standard Drawing RH 412.010. This is required to ensure that failure of the wastewater main is contained within the casing and does not affect other infrastructure or watercourse crossings.
n) Only approved spacers are to be used and runners of ultra-high molecular weight polymer or equivalent. Wood blocking is NOT an approved or equivalent product.
o) Wastewater main pipes to be centered in the casing with a minimum 200 mm clearance all the way around at the largest outside pipe bell or harness joint.
p) The wastewater main must be installed as per the specifications of the manufacturer and shall be restrained along the entire length of the casing.
q) Grouting shall be a 3 to 1 (3:1) sand to cement mix ratio unless otherwise stated in the approved Utility Crossing Agreement.
r) Steel casing and/or tunneling casing ends shall be sealed wrapped with high quality rubber (or equivalent) around both the casing ends and the pipe and secured with Type 316 stainless steel bands to prevent entry of water or excess moisture.
s) Concrete encasements of PVC wastewater mains are not permitted. Encasement of other pipe materials will be evaluated and approved by Halton Region on a case-by-case basis.

3.6.5. Pipe Depth

t) The minimum cover shall be 2.75 m below the centre line of the road allowance and not less than 1.4 m from ground surface to any other location. In open ditch or unimproved roads an increased cover (3.35 m minimum) shall be provided to allow for future road improvements or lowering of the road profile when urbanization occurs. In areas where minimum cover can't be achieved, special provisions shall be considered to protect the pipe from live loading and freezing.

3.6.6. Maintenance Holes

a) All maintenance holes shall be designed from the following criteria:
   i) The maximum spacing shall be 150 m between maintenance holes for all wastewater mains up to and including 750 mm dia. Wastewater mains greater than 750 mm dia. may use a greater spacing as approved in writing by the Commissioner of Public Works.
   ii) The minimum drop across maintenance holes shall be 25 mm for straight runs and 50 mm for any bends up to 90-degree. Alternately, wastewater main slope may be maintained across maintenance holes provided minimum required flow velocity is maintained.

b) At maintenance holes where pipe sizes change, the requirements of clause (i) and (ii) shall be applied as follows:
   i) Downstream Pipe Larger: Match the obvert elevations.
   ii) Downstream Pipe Smaller: Not allowed.

c) Safety grates are not allowed in Halton Region. In accordance with the Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under an Environmental Compliance Approval (Ministry of Environment, Conservation and Parks) as amended, acceptable alternate safety measures for deep maintenance holes (greater than 5 m in depth) shall be determined on a case-by-case basis.

d) An external drop structure shall be provided for wastewater mains entering a maintenance hole at an elevation of 610 mm or more above the maintenance hole outlet pipe invert. The drop pipe shall be one size smaller than the wastewater main. The economic feasibility of providing deeper wastewater mains to avoid excessive invert drops, drop maintenance holes, or excessively steep benching shall be explored.

e) Prefabricated drops internal to the maintenance hole are only allowed on maintenance holes 1500 mm dia. or greater, as per Halton Region Standard Drawing RH 303.01 with approval from the Commissioner of Public Works or designate

f) All maintenance holes shall conform to the OPSS and OPSD, as amended by Halton Region, and CAN/CSA A-257.

g) Watertight and locking covers shall be provided on maintenance holes located on all easements and in areas where maintenance holes are susceptible to flooding.

h) Maintenance holes shall be located away from any overland flow route or ponding area. If any maintenance hole structures that are located within the 25-year overland flow route, these structures are to be watertight and shall be vented. Refer to the MECP design criteria for further information on this requirement.

i) Where significant sections of wastewater mains are provided with watertight covers, extended vents may be required.

j) A minimum 1500 mm dia. maintenance hole shall be used for pipes larger than 450 mm dia.

k) Tee maintenance holes may be used for wastewater mains 1200 mm dia. or larger.

l) Wastewater lateral connections into maintenance holes are permitted and must come in above the spring line.

m) Benching to obvert is required to provide a smooth transition through the maintenance hole and parging is required around the inlet and outlet pipes.

n) All maintenance holes are to be watertight. Waterproofing shall be installed around all exterior section joints, and the waterproof membrane shall extend completely around all joints with a minimum 300 mm wide strip centered on the joint.

3.6.7. Trench Plugs

a) Trench plugs are required when the wastewater main is determined to be located below the water table.
b) Trench plug design and construction shall be undertaken as directed by the geotechnical report.

3.6.8. Bedding, Cover and Backfill

c) Unless otherwise indicated by the geotechnical report and local municipal consent conditions, Granular 'A' crusher run limestone (CRL) is to be used for pipe bedding and cover and Granular 'B' Type I is to be used for trench backfilling.
d) In addition to the above, the wastewater main bedding, cover and trench backfill shall also conform to OPSD 802.030, 802.031 and 802.033 and Halton's Amendments to the above OPSDs.
e) The use of 'High Performance' (1 mm to 8 mm crushed and washed aggregate) bedding, cover or backfill is not permitted.

3.6.9. Rock Squeeze

a) Rock squeeze mitigation recommendations shall conform to the geotechnical report.

3.7. Pipe Requirements

3.7.1. Pipe Materials

a) All Canadian Standards Association (CAN/CSA) and American Society for Testing and Materials (ASTM) specifications referenced are to be the current revision.
b) Polyvinyl Chloride (PVC) Pipe
   i) Halton Region will accept PVC pipe sizes to a maximum of 675 mm dia.
   ii) PVC pipe shall be green in colour.
   iii) Radius pipe is not permitted in Halton Region.
   iv) PVC pipes and gaskets shall conform to the requirements of CSA B182.2, OPSS 1841, OPSD 806.040 and OPSD 806.060.
   v) Only manufactured tees shall be used.
c) Concrete Pipe
   i) Concrete pipes may be used for pipe sizes greater than or equal to 300 mm dia.
   ii) All pipe fittings and joints shall conform in all respects to the requirements of the CAN/CSA A-257 Series, OPSS 1820, OPSD 807 and be registered with the Ontario Concrete Pipe Association (OCPA).
   iii) Standard strength and extra strength non-reinforced concrete pipes shall conform to CSA A-257 and ASTM C-14.
   iv) Reinforced concrete radius pipe (also referred to as beveled or mitred pipe) is not recommended. It can only be used for short radius bends upon the approval of the Commissioner of Public Works. Radius pipe shall be supplied with tracer wire as per the requirements of Section 2.7.3. The tracer wire shall be continuous from maintenance hole to maintenance hole. The pipe shall meet the requirements of CSA A-257 for reinforced concrete radius pipe for sizes 675 mm to 3050 mm dia.
   v) AWWA C301 pipe and joints shall be used when wastewater main installation is deeper than 4 m from the top of pipe to the finished grade.
   vi) In areas of high-water table, joints must be diapered and grouted.
d) High Density Polyethylene (HDPE) Pipe
   i) High density polyethylene profile pipe sizes shall be a maximum of 600 mm dia. and shall conform to CSA B182.6, OPSS 1840 (OPSS 1842 for forcemain use) and OPSD 806.020 and 806.021.
   ii) Joints shall be butt-fused for forcemains and bell and spigot pipe for gravity mains.
   iii) Only manufactured tees shall be used.
e) Glass Reinforced Polymer (GRP) Pipe

i) GRP pipe may be used for pipe size equal or greater than 500 mm dia. and shall conform to ASTM D3262.
ii) All pipe joints shall conform in all respects to the performance requirements of the ASTM D4161.
iii) All fittings shall be fabricated from pipe material meeting the requirements of ASTM D3262 and ASTM D4161.
iv) Minimum pipe stiffness provided by pipe diameter shall be determined by the Design Engineer. Stiffness shall be tested in accordance with the test method of ASTM D2412.
v) For chemical resistance, GRP pipe shall meet or exceed the requirements of ASTM D3262 Table 4 when tested in accordance with ASTM D3681.
vi) Only manufactured GRP tees shall be used.

3.7.2. Manufacturer of Pipe and Fittings

TABLE 3-6 PREFERRED DESIGN RANGE AND PIPE MATERIALS FOR WASTEWATER MAINS

Material	Main Size Dia.	Joint Type	Services	Standards
Concrete	**≥300 mm**	**Gasketed Bell & Spigot**	**NA**	**CAN/CSA A-257**
Polyvinyl Chloride (PVC)	**150 mm to 675 mm**	**Gasketed Bell & Spigot**	**≥125 mm**	**CSA B182.2**
High Density Polyethylene (HDPE)	**150 mm to 600 mm**	**Gasketed Bell & Spigot**	**NA**	**CSA B182.6**
Glass Reinforced Polymer (GRP)	**≥500 mm**	**Gasketed Bell & Spigot**	**NA**	**ASTM D3262 ASTM D4161 ASTM D2412 ASTM D3681**

3.7.3. Structural Requirements

a) In determining the suitable pipe class to be used, live load, dead load, soil type and trench conditions shall be considered in the calculation. The pipe manufacturer's recommendations shall be incorporated into the design.
b) For concrete pipe, the specified minimum class of pipe shall conform to OPSD 807 series and wide trench condition shall be used for concrete pipe.
c) For flexible pipe, Granular 'A' bedding material shall be used and conform to OPSD 802.010 to 802.014 with 98% Standard Proctor Density.
d) A minimum DR 35 shall be used for mainline wastewater mains and DR 28 shall be used for service connections. A K value of 0.110 and an E value of 1.38 x 106 shall be used in the design calculation.
e) Pipe joints shall be watertight.

3.8. Service Laterals

3.8.1. Wastewater service laterals to single family, semi-detached and rowed townhouse dwellings will be individual service laterals. Shared service laterals are not permitted.

3.8.2. Service laterals shall be sized in accordance with requirements of the Local Municipality and the Ontario Building Code provided they meet the minimum size requirements of this manual for municipal right-of- ways.

3.8.3. Single family, semi-detached dwellings and rowed townhouses in residential areas shall have a minimum 125 mm dia. lateral to the property line.

3.8.4. Commercial, industrial, and institutional laterals shall be a minimum of 150 mm dia.

3.8.5. Horizontal bends are not allowed on wastewater laterals from the wastewater main to the property line. For lateral service connections with diameters greater than or equal to 200 mm, a maintenance hole connection is required at the wastewater main.

3.8.6. Lateral connections from the property line to the main line shall be gravity fed. For new developments, a 2% minimum slope for lateral connections shall be maintained.

3.8.7. The minimum and maximum cover at property line for all service connections shall be 2.15m and 3.15m respectively.

3.8.8. Sanitary laterals in areas where the depth of the sewer main obvert exceeds 4.5m from the road centerline elevation refer to RH 304.030

3.8.9. In multiple family blocks in residential areas, the lateral connections shall meet the requirement in Tables 3-7:

TABLE 3-7 MAXIMUM DWELLING UNIT DENSITIES

Type of Development	Maximum Densities (units/hectare)
Semi-detached duplex and 4-plex	**165**
Street Townhouse, Intensification Area Townhouse, or Back-to-Back	**260**
Stacked Townhouses Low/Mid-Rise Apartments outside Strategic Growth Areas	**420**
Apartments – Intensification Areas	**600**
Apartments within MTSA, Urban Growth Areas	**2000**

Notes:

1) Loading shall be calculated using 20 fixtures per unit/dwelling.
2) To use the tables:
   i) Determine dwelling density and total area of block.
   ii) Calculate the total number of fixtures from:
      • Area of Block × Dwelling Units/Hectare × 20
   iii) Select connection size and slope. The minimum requirement shall be 125 mm dia. at 2% slope.

3.8.10. PVC pipe shall be used for residential lateral connections. PVC pipes shall be green in colour and DR 28 shall be used.

3.8.11. Lateral connections shall be installed perpendicular to the wastewater main. Refer to Figure RH 304.010.

3.8.12. The lateral profile shall be connected to the receiving wastewater main and/or maintenance hole above its spring line at a maximum of 45° from the horizontal as per Halton Region Standard Drawing RH 302.010 and RH 302.020

3.8.13. Joints and bedding shall be equivalent to the joints and bedding specified for the main line wastewater pipe.

3.8.14. Two separate lateral connections in a common trench are acceptable in residential areas where the difference in basement elevation between the residences does not exceed 0.60 m and must have a min. 1.0m horizontal separation between connection tees at the wastewater main Refer to Figure RH 304.010

3.8.15. Service laterals are not permitted to connect into wastewater mains sized 450 mm dia. or larger, including associated maintenance hole structures.

3.8.16. For multi-unit residential, commercial, industrial, and institutional establishments, an inspection maintenance hole must be placed 1.0 m behind the property line to service the lateral connection. In the case of multi-unit residential units, where space does not permit a property line maintenance hole, a maintenance hole on the wastewater main shall be installed.

3.9. Forcemain

3.9.1. System Design

a) The primary consideration in the hydraulic design of forcemain(s) is to select a pipe size which will provide the required velocities, between 0.8 and 2.5 m/s, without creating excessive energy losses due to pipe friction. Pump-forcemain performance curves must be used to compare the operating characteristics of a set of pumps along with the associated forcemain(s) configurations.
b) Provide a design criteria report, which discusses the range of design flow for the planning period, the proposed design of the pumping station and the forcemain(s) as a unified system. Pump-forcemain performance curves must be used to compare the operating characteristics of the set of pumps along with the associated forcemain(s) configurations, and must be evaluated at the initial design period, 10-year design period, 20-year design period, and final design point.
c) Provide engineering calculations of the potential for hydrogen sulphide generation in the forcemain and provide measures to prevent generation of odorants.
d) Multiple barrel forcemains should be evaluated in consideration of the life-cycle costs, to satisfy conditions for initial period, 10-year period, 20-year period, and final design point, to optimize Total Dynamic Head, and for crossings which may hinder access or repair.
e) Where multiple barrel forcemains are used, flow velocities must be maintained between 0.8 and 2.5 m/s during normal operation and with one forcemain out-of- service the velocity shall not exceed 3.5 m/s.
f) A hydraulic transient analysis shall be undertaken as part of the design process considering the worst-case failure scenario involving the most critical pump and forcemain-in-service combination. The analysis will be completed using hydraulic models based on the final sizes and layout of pumps and forcemains including locations of air/vacuum release valves. Based on the hydraulic transient analysis, provide devices, if necessary, to protect the forcemain such as, but not limited to, air/vacuum breaker, surge valves, surge tanks, etc. Hydraulic transient analysis shall be redone for any change in the forcemain material, class, alignment, or profile.
g) Forcemains must be designed with adequate strength to withstand an internal operating

pressure equal to the pump discharge head plus an allowance for transient pressures caused by water hammer.

h) Forcemains shall be designed with suitable swab/access ports. Forcemain accessories and hydraulic structures associated with the forcemains shall not constrain the accomplishment of these tasks. To allow for temporary pumping all forcemains shall be equipped with suitable access/swab ports to permit connection of discharge piping from a portable pump.
i) Drain valves on the forcemain are to be flanged installed in valve chambers. Where possible given location the valve chamber may be drained to the closest gravity wastewater main or maintenance hole or drained back into the wet well.
j) All line valves shall be full port opening type and be located on the pump station property, immediately outside the pump station wall.
k) Bedding requirements for forcemains will be based upon the type and class of pipe used. As a minimum requirement, forcemains shall be laid on 150 mm of Granular 'A' bedding material. The type of backfill material will be determined by the location of the forcemain within the right-of-way (ROW). Under pavement, an approved granular backfill shall be used.
l) Forcemain profile shall avoid abrupt vertical bends that will promote the settlement and accumulation of solids and become a trap that decreases forcemain capacity. Grade changes shall be gradual.
m) For multiple forcemains, a maintenance hole shall be installed on each pipe prior to discharging into one common maintenance hole, so that isolation from each forcemain will be possible. No permanent valves are required.

3.9.2. Pipe Size

a) Forcemains shall be sized to have a flow velocity in the range of 0.8 to 2.5 m/s, with the lower limit being required for the initial phase. The minimum flow velocity shall also be considered when only one pump is operating.
b) The minimum pipe size shall be 100 mm dia.

3.9.3. Pipe Depth

a) The top of the forcemain shall have a minimum of 1.7 m cover, measured from the top of the pipe to the finished grade.
b) On open ditch or unimproved roads, an increased cover of minimum 2.3 m shall be provided to allow for future road improvements or lowering of the road profile when urbanization occurs.
c) In areas where minimum cover cannot be achieved or when freezing of pipe is anticipated (e.g. culverts or large diameter stormwater sewers), special provisions shall be considered to protect pipe from live loading and freezing. Approval from the Commissioner of Public Works shall be obtained.

3.9.4. Tracer Wire

a) Tracer wire shall be installed on all new installations of forcemain pipe for locating purposes as per Section 2.7.3.
b) Joints in the wire are not permitted.
c) For traceability of the forcemain and accessibility of the tracer wire, handwells complete with lids labeled "Forcemain" are to be used along the forcemain and shall be installed at 150 m intervals along the forcemain or at each horizontal and vertical bend in the forcemain, refer to Halton Region Standard Drawing RH 406.030.
d) Where the installation of handwells is not suitable, cast iron (screw type) valve boxes may be installed. At each valve box, a loop of tracer wire shall be brought up the inside to the top, refer to Halton Region Standard Drawing RH 406.030.

3.9.5. Pipe Requirements for Forcemains

a) Ductile Iron (DI) Cement Lined Pipe
    i) Ductile iron cement lined pipe with tyton joints or equivalent may be used. The current requirement of the AWWA C104 shall apply to all classes of DI pipe. DI pipe shall have

corrosion protection as detailed in Section 2.10 Corrosion Prevention of Water Systems.
ii) Ductile Iron forcemains shall be marked “Forcemain”.

b) Polyvinyl Chloride (PVC) Pipe
   i) A maximum size of 300 mm dia. PVC pipe with gasketed or butt-fusion joints shall be used. The current requirements of CSA B137.3 and AWWA C900 shall apply to all classes of PVC pipe.
   ii) PVC forcemains shall be marked as “Forcemain” and must have a green identification strip on each side of the pipe as to identify them as forcemains.
c) High Density Polyethylene (HDPE) Pipe
   i) HDPE pipe conforming to CSA B182.6 and AWWA C906 with butt-fusion joints shall be used. The polyethylene resin compound used in the pipe shall conform to Type 3 Category 5 Class C Grade P34 in accordance with ASTM D-1248 and ASTM D-3350 minimum cell class to be PE 345434C for PE3408 material.
   ii) HDPE forcemains shall be marked as “Forcemain” and shall have a green identification strip on each side of the pipe as to identify them as forcemains.
d) Reinforced Concrete Pipe
   i) For sizes 400 mm dia. and larger, reinforced concrete pipe with gasketed and diapered joints shall be used as indicated below:
      • Concrete pressure pipe, bar wrapped steel cylinder pipe conforming to AWWA C303
      • Pre-stressed concrete pressure pipe, steel-cylinder type conforming to AWWA C301
   ii) Concrete forcemains shall be marked as “Forcemain” and shall have a green identification strip to each side of the pipe as to identify them as forcemains.
   iii) The concrete forcemains shall be made of sulfate resistant concrete (type 50) and shall also meet all corrosion proof recommendations as indicated by geotechnical findings.
e) Fittings
   i) Ductile Iron Fittings shall be cement lined to conforming AWWA C104 and shall have Petrolatum Coating protection as detailed in Section 2.10 Corrosion Prevention for Water Systems.
   ii) PVC fittings shall conform to AWWA C900 and C905 and CSA B-137.3.
   iii) Polyethylene pipe fittings shall conform to AWWA C906 and be thermally fused.
   iv) Reinforced concrete fittings shall conform to AWWA C303, C301 and C304.
f) Thrust Restraints
   i) Concrete thrust blocks shall not be used.
   ii) All fittings and bends shall have mechanical thrust restraint.
   iii) Mechanical thrust restraints shall be designed to withstand the maximum operating pressure plus the number and timing of the pump cycles to which they will be subjected.

3.9.6. Forcemains shall only discharge into transition maintenance holes or wet wells.

a) Forcemain discharge points to provide smooth flow transition into the receiving gravity Sewers.
b) The transition maintenance hole shall be designed based on the pipe size, alignment, inspection, and maintenance needs. The minimum diameter of maintenance holes shall be 1200 mm (48 in). A minimum access diameter of 610 mm (24 in) shall be provided
c) The forcemains shall enter the transition maintenance hole at a point not more than 0.3 m above the flow line. No other gravity Sewers shall enter the transition maintenance hole.

3.9.7. Air Release/Vacuum Chamber and Valve Unit

a) Air release chambers shall be precast, conforming to ASTM C-478, latest revision.
b) Air release and cleanout chambers shall be sized to accommodate the piping and valves inside them and to allow maintenance personnel sufficient ingress, egress, and working room.

c) A drainpipe with p-trap shall be connected from the chamber to the nearest wastewater main.
d) The sewage air release/vacuum chamber must be designed for sewage.

e) The inlet of the valve shall be sized, and the discharge orifice shall be designed to provide a venting capacity of 1.4 CMAM with forcemain pressures of 345 to 1034 kPa (50 to 150 Psi) minimum design standard.

3.9.8. Removal and Abandoning

a) Where possible and/or as directed by Halton Region completely remove abandoned pipes. If wastewater mains are to be abandoned in place, refer to OPSS MUNI. 510, including grouting.
b) Remove maintenance holes where applicable.
c) When abandoning a wastewater connection connected to a live sewer, the contractor shall cut and cap at the riser as close to the sewer as possible without interfering with the sewer.

SECTION 4 LIST OF APPENDICES

Appendix No.	Name
1	Deviation Memo
2	OPSD Amendments
3	OPSS Amendments
4	Halton Region Standard Drawings (200, 300 & 400 Series)
5	Water Meter Standard Drawings (500 Series)
6	Backflow Prevention Assembly Standard Drawings (600 Series)