City of Hamilton

Sewer Design Criteria

2024

Public Works – Engineering Services

Technical Working Committee

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Preface

This manual was compiled to serve as a valuable resource for City of Hamilton Staff, consultant firms, and contractors who are involved in design, maintenance, and construction of City of Hamilton infrastructure projects. The manual provides information and guidance on forcemain, storm sewer, and sanitary sewer design intended to address site-specific performance, serviceability, and safety requirements while satisfying project requirements. The information contained and methodologies presented are specific to the City of Hamilton and should not be used for other purposes.

This document is to be used in conjunction with other design guideline documents prepared by COH and other regulatory authorities including, but not limited to:

- *Watermain Design Criteria* (COH, 2024);

This document provides requirements for the design of watermains, valve chambers, and appurtenances in support of COH Capital and Maintenance works, infrastructure for which COH will assume Ownership upon completion, and works completed under a COH Permit and/or Approval.

- *Stormwater Management Design Criteria* (COH, in development);

This document is currently under development. It will supersede sections in the Comprehensive Development Guidelines and Financial Policies Manual relating to stormwater management once it has been released.

- *LRT Wastewater Analysis in Support of MECP ECA* (COH, 2023);

This document is specific to High Level Transit Guideway applications.

- *Comprehensive Development Guidelines and Financial Policies Manual* (COH, 2019);

This document was prepared for developers, landowners, municipal engineers, planners, and architects to detail development engineering requirements related to subdivision and site plan approvals. It is in the process of being replaced by a series of Design Criteria but will be applicable until the new documents are available. The Comprehensive Development Guidelines and Financial Policies Manual will be superseded by this Sewer Design Criteria unless otherwise stated.

- *Construction and Materials Specifications Manual* (COH, 2022);

This includes construction specifications, the *Approved Products List*, and standard drawings.

- *Wastewater Outstation Design Manual* (COH, in development);

This document provides engineering requirements related to the design of wastewater pumping stations and combined sewer overflow tanks.

- *Water and Wastewater Master Plan* (COH, 2006);

The Master Plan provides the City with a water and wastewater servicing strategy in support of the Growth Related Integrated Development Strategy.

- *Right-of-Way Utility Installation and Permit Manual* (COH, 2022);

The Manual provides standards and processes for the design and installation of utilities within the municipal right-of-way to ensure that required safety criteria and procedures are being followed and adhered to, clearances and separations are maintained, and that physical space is optimally utilized.

- *Stormwater Management Planning and Design Manual* (MECP, 2003);
- *Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under an Environmental Compliance Approval* (MECP, 2023); and
- *Design Guidelines for Drinking-Water Systems* (MECP, 2023).

Although this document is intended to support the design of drinking water systems, it should be used to obtain peaking factors for residential land uses where the population is less than 1000 (see *SEW 6.3 Sanitary Peak Factor*).

Revision History

Issue date	Rev	Complete Manual released for use
January 3, 2023	1	First Draft
July 7, 2023	2	Version 1
May 24, 2024	3	Version 2
November 214, 2024	4	Version 3
December 2, 2024	*5*	*Final Version*

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List of Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CCTV	Closed Circuit Television
CLI ECA	Consolidated Linear Infrastructure Environmental Compliance Approval
COH	City of Hamilton
CPP	Concrete Pressure Pipe
CSA	Canadian Standards Association
CSO	Combined Sewer Overflow
DI	Ductile Iron
DWF	Dry Weather Flow
EPDM	Ethylene Propylene Diene Monomer
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
ID	Inner Diameter
LID	Low Impact Development
LRT	Light Rail Transit
MECP	Ministry of the Environment, Conservation and Parks
MTD	Manufactured Treatment Device
MTO	Ontario Ministry of Transportation
NACE	National Association of Corrosion Experts
NBR	Nitrile Butadiene Rubber
OD	Outer Diameter
OPSD	Ontario Provincial Standard Drawing
OPSS	Ontario Provincial Standard Specification
O. Reg.	Ontario Regulation
PVC	Polyvinyl Chloride
PVCO	Molecularly Oriented Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
QP	Qualified Person
ROW	Right-of-Way
RTC	Real Time Control
SDR	Standard Dimension Ratio
SLR	Surface Loading Rate
TBM	Tunnel Boring Machine
WWTP	Woodward Wastewater Treatment Plant
WWF	Wet Weather Flow

Definitions

Combined Sewer: Pipes that collect and transport both sanitary sewage and other sewage from residential, commercial, institutional, and industrial buildings and facilities and stormwater runoff through a single pipe system but does not include nominally separate sewers.

Combined Sewer Overflow: Discharge to the environment at designated location(s) from a combined sewer or partially separated sewer that usually occurs as a result of precipitation when the capacity of the sewer is exceeded. An intervening time of twelve hours or greater separating a combined sewer overflow from the last prior overflow at the same location is considered to separate one overflow event from another.

Effective Treatment Area: The area within an Oil-Grit Separator where sedimentation occurs.

High Order Transit Guideway: A physical or designated route that supports and guides trains or individual vehicles (for example, bus rapid transit or light rail transit).

Lay-By: a designated paved area beside a road where cars can stop temporarily.

Low Impact Development: A stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution by managing runoff as close to its source as possible. Low impact development comprises a set of site design strategies that minimize runoff and distributed, small-scale structural practices that mimic natural or predevelopment hydrology through the processes of infiltration, evapotranspiration, harvesting, filtration, and detention of stormwater.

Manufactured Treatment Device: Devices that may be used in stormwater management plans to target the treatment and removal of pollutants from stormwater runoff to achieve regulatory water quality objectives.

Nominally Separate Sewer: Separate sewers that also have connections from roof leaders and foundation drains and are not considered to be combined sewers.

Oil-Grit Separator: A structure consisting of one or more chambers that remove sediment, screen debris, and separate oil from stormwater.

Partially Separated Sewer: Combined sewers that have been retrofitted to transport sanitary sewage but in which roof leaders or foundation drains still contribute stormwater inflow to the partially separated sewer. Also referred to as storm relief sewers.

Right-of-Way: A dedicated strip of land intended for the accommodation of public roads/guideways, utilities, drainage, and other similar public uses. The Right-of-Way extends from property line to property line on either side of a public road.

Sanitary Sewer: Pipes that collect and transport sanitary sewage and other sewage from residential, commercial, institutional, and industrial buildings.

Separate Sewer: Pipes that collect and transport sanitary sewage or stormwater from residential, commercial, institutional, and industrial buildings.

Storm Relief Sewer: Sewers that collect and transport overflow from an adjacent combined sewer to a CSO tank or outfall in the event of a large rainfall.

Storm Sewer: Sewers that collect and transport, but not exfiltrate or lose by design, stormwater resulting from precipitation and snowmelt.

Stormwater: Rainwater runoff, water runoff from roofs, snowmelt, and surface runoff.

Stormwater Management Facility: A Facility for the treatment, retention, infiltration, or control of stormwater.

Surface Loading Rate: A hydraulic loading factor expressed in terms of flow per surface area.

Third Party Utility: Utilities not owned or operated by City of Hamilton

Treatment-Train: A series of stormwater management facilities designed to meet stormwater management objectives for a given area, and can consist of manufactured treatment devices, low impact development, and end-of-pipe controls.

List of Units and Measurements

°C	celsius
GHz	gigahertz
ha	hectare
hr	hour
J	joule
kg	kilogram
kJ	kilojoule
km	kilometre
kN	kilonewton
kPa	kilopascal
kPa/mm	kilopascal per millimetre
L	litre
L/ca/d	litre per capita per day
L/s	litre per second
L/s/ha	litre per second per hectare
MHz	megahertz
MPa	megapascal
m	metre
m/s	metre per second
m^3/s	cubic metre per second
µm	micrometres
mm	millimetre
mm/hr	millimetre per hour
min	minute
W	watt

SEW 1 REGULATORY FRAMEWORK

The Designer shall ensure Federal and Provincial requirements are satisfied in the design and construction of storm sewers, sanitary sewers, and forcemains. These requirements include, but are not limited to, the provisions of the Ontario Water Resources Act and the Environmental Protection Act, R.S.O. 1990. The Designer shall also ensure that the design follows the requirements of all applicable municipal by-laws, including but not limited to 06-026 Sewer and Drain By-law, 14-090 Sewer Use By-law, and 17-068 To Amend By-law No. 11-285, a By-law to Control Noise.

Consolidated Linear Infrastructure Environmental Compliance Approvals (CLI ECAs) for the Municipal Sewage Collection System (Sanitary sewers and Forcemains) and for Stormwater were submitted by the City of Hamilton (COH) to the Ministry of the Environment, Conservation and Parks (MECP) in 2022 for acceptance. The Designer shall make all efforts to ensure that the proposed design (new construction or proposed alterations to existing infrastructure) follows the CLI ECA conditions.

Alterations to sewer systems inclusive of adding, modifying, replacing or extending sanitary sewers, forcemains or storm sewers that are not compliant with CLI ECA conditions provided by the approving MECP Director, current *Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under Environmental Compliance Approval* (MECP, 2023) or the *Stormwater Management Planning and Design Manual* (MECP, 2003) require the COH to apply for an CLI ECA amendment from the approving MECP Director. This assessment shall consider all downstream pipes, including (but not limited to) partially separated and combined sewers where any increase in flow may result in surcharging (and thus non-compliance). Refer to *Appendix SEW1: MECP Permit Application Process*.

The Designer shall inform the COH as soon as possible if they believe an amendment is required (i.e., they are unable to comply with the existing CLI ECA). If a CLI ECA-compliant solution cannot be found and the COH agrees that an amendment is needed, the Designer shall also prepare the application to amend the existing CLI ECA and provide supporting technical documentation in support of its submission. Alterations must be satisfactory to COH staff and shall meet the requirements of the Environmental Compliance Approval application, namely:

- be prepared by a Professional Engineer licensed in the province of Ontario;
- require identification and mitigation of Infiltration and Inflow contributions per COH direction;
- not be designed to treat wastewater;
- not result in flows which exceed uncommitted downstream hydraulic capacity of sewer infrastructure inclusive of the stormwater conveyance system, sewage pumping stations, or receiving sewage treatment or stormwater management and treatment facilities;
- not be permitted in the absence of a COH Plan and process to forecast and track uncommitted downstream hydraulic capacity and verify alterations can be accommodated;
- not adversely impact or cause an adverse discharge to the natural environment;

- not adversely impact approved effluent quality of sewage treatment facilities or stormwater works;
- be inclusive of the submission of the requisite COH and MECP documentation; and
- minimize stormwater management flows and reliance on end of pipe controls using an integrated stormwater treatment-train approach inclusive of source control, lot level control and conveyance techniques designed to address:
  - Soil characteristics and the management of excavated materials;
  - Hydrogeological conditions inclusive of regular and seasonal groundwater elevations and associated flotation and intrusion potential;
  - Inspection, operation, and maintenance requirements; and
  - Heave due to frost action.

An assessment of the proposed works shall also be completed to determine if the works pose a significant drinking water threat. If so, the design shall incorporate features that mitigate the threat to sources of drinking water, such as those included in the Ministry’s Standard Operating Policy for Sewage Works as amended, and Source Protection Plan policies pertaining to the works.

SEW 2 TYPES OF SEWER SYSTEMS

The City of Hamilton storm and sanitary sewer network includes fully separated, partially separated, combined sewers and forcemains.

Pipes that collect and transport sanitary sewage and other sewage from residential, commercial, institutional, and industrial buildings are referred to as separate sewers. A fully separated sewer system is a dual pipe and dual lateral system comprised of storm and sanitary sewers. Surface flows associated with the roadway are collected and conveyed by storm sewers and sewage is collected and conveyed by sanitary sewers. Roof drains for single-detached and semi-detached residential properties discharge at grade via splash pads and foundation drains should not be connected to sanitary sewers. Fully separated systems are required for growth projects.

A nominally separated sewer is also a dual pipe and dual lateral system comprised of storm and sanitary sewers. but, unlike fully separated systems, subsurface flows associated with foundation drains are collected and conveyed by sanitary sewers. A partially separated sewer is also a dual pipe and dual lateral system comprised of combined sewers that have been retrofitted to transport sanitary sewage but in which roof leaders or foundation drains still contribute stormwater inflow. In the City of Hamilton, partially separated sewers are also referred to as storm relief sewers. The storm sewers convey surface flows associated with the roadway and roof drains. New nominally separated or partially separated systems are not permitted; however, they comprise part of the COH's existing infrastructure. As such, nominally separated and partially separated sewers may need to be upgraded when deficient capacity exists and/or they require maintenance. The designer must consult with COH staff prior to consideration of any proposed connections or upgrades to nominally separated or partially separated sewers.

A combined sewer system is a single pipe and single lateral system with associated trunk sewers. Sewage and surface flows associated with the roadway, roof drains and foundation drains from adjacent lands are collected and conveyed by a common pipe. During dry weather and minor rain events, flows are conveyed to the Woodward Wastewater Treatment Plant (WWTP) and ultimately released to Hamilton Harbour via Red Hill Creek. During more significant rain events, the City's Real Time Control (RTC) system manages wet weather flows within the City's collection and treatment systems and untreated wastewater is stored in a network of Combined Sewer Overflow (CSO) tanks until such time that the WWTP has capacity which may be multiple days in duration. In addition to providing temporary storage, the CSO tanks protect the treatment plant against hydraulic overloading that could upset sewage treatment processes. Where volumes exceed capacity, untreated wastewater may overflow into the natural environment. Although they comprise a significant part of the COH's existing infrastructure, new, addition to, or extension of existing combined sewers are not permitted. Storm sewer connections to a combined sewer are not permitted unless the municipality plans a temporary storm connection to a combined system during a combined sewer separation project. Pre-consultation with Hamilton Development Services and Hamilton Water is required for sewer and sewer laterals connecting to the combined sewer system for the identification of discharge constraints and approval in principle.

Forcemains are single pipe systems, without laterals, which convey sanitary or storm flows under pressure. They are used in the absence of gravity piping solutions as permanent infrastructure and are therefore inclusive of pumping stations. Forcemains connect to the existing sewer system at a maintenance hole. They may convey storm flows or sanitary flows from a lower upstream gravity system to higher downstream gravity system. Forcemains may also be used in construction as temporary bypass system for interrupted gravity flows utilizing portable pumps.

The use of forcemains shall be minimized and consideration of their installation by COH will be restricted to circumstances where a gravity sewer solution is not deemed to be achievable. It shall be incumbent on the Designer to consult with COH where the need for a forcemain has been identified to facilitate an approval in principle and so the requisite design, operation and maintenance standards can be provided at the onset of the project. Municipal pumping stations are Schedule B projects and will therefore require completion of a Municipal Class Environmental Assessment.

Design requirements for pumping stations and CSO tanks may be found in the Wastewater Outstation Design Manual.

SEW 3 GENERAL REQUIREMENTS FOR SEWER AND FORCEMAIN SYSTEMS

Except where approved by COH, sewers shall not outlet to smaller downstream pipes regardless of increases in grade, velocity and capacity. Capacity shall not decrease from an upstream pipe to a downstream pipe regardless of energy dissipation upstream. Elliptical pipes will be considered by COH on a project-by-project basis where round pipes are not feasible.

SEW 3.1. Location

Sewers shall be located within the COH Right-of-Way (ROW). Exceptions to this shall require pre-consultation with COH to facilitate an Approval in Principle and will be at the sole discretion of the COH.

New sanitary sewers should generally be constructed on the centreline of the ROW, parallel to and in a common trench with storm sewers (see *Standard Road Drawings* RD-113.01 through RD-113). Where possible, storm sewers should be located north and west of sanitary sewers. There must be a minimum 450mm horizontal separation between the outer diameters of sewers installed in a common trench, step trench, or adjacent to an existing sewer. Where a sewer passes a maintenance hole, the separation between the outer diameter of the sewer and the outer diameter of the maintenance hole must be a minimum of 300mm.

Placement of proposed structures, forcemains, and storm/sanitary services shall provide a separation greater than 1.2m between the outer diameter (OD) of watermains/water services and the exterior wall of the structure. Where portions of the exterior walls or floor (new structure installations) of maintenance holes, catch basins, and valve chambers do not meet the separation requirement, insulation shall be provided on the structures (see *SEW 3.6 Insulation*).

For mainline sewers connections at a maintenance hole, the downstream obvert shall not be higher than the upstream obvert. Exceptions to this requirement shall be at the sole discretion of COH and consideration for such is predicated upon 80% of the downstream pipe’s internal height being below the upstream obvert.

SEW 3.1.1. Clearance and Separation between Sewers/Forcemains and Watermains

Watermain, water services, and appurtenances shall be constructed in separate trenches from forcemains, sewers, sewer laterals and catch basin leads. The joints of the two pipes shall be offset as per *MECP – F-6-1 Procedures to Govern Separation of Sewers and Watermains*.

Parallel installations of forcemains, sewers and sewer laterals that are adjacent to watermains or water services shall be addressed per the following order of precedence and inclusive of the requirements and restrictions of *SEW 3.5 Depth of Cover*:

- Minimum clear horizontal separation of 2.5m.

- If the horizontal separation does not meet 2.5m, spacing should be maximized and the sewer shall be installed below the watermain with 0.5m minimum vertical separation.
- If the horizontal separation does not meet 2.5m, it should be maximized and the sewer is installed below the watermain with a vertical separation of less than 0.5m, or the watermain is installed below the sewer with a vertical separation of 0.5m, then:
    - the sewer shall be constructed of watermain quality pipe and fittings and pipe joints shall be certified and tested to 350kPa hydrostatic pressure; and
    - the sewer shall meet the requirements of *OPSS.MUNI 410* for Laser Profile or Mandrel Deflection Testing of Pipe Sewers[1].
- the sewer shall meet the requirements of *OPSS.MUNI 410* for Low Pressure Air Testing (35kPa).

Where watermains or water services cross sewer pipes (i.e., mainline piping, sewer laterals and catch basin leads), the following shall be addressed to the satisfaction of COH:

- In general, all watermains shall cross over sewers;
- where watermains cross over sewer pipes:
    - 0.5m desirable and 0.25m minimum vertical separation and meets MECP requirement for adequate structural support; and
    - midpoint of full length watermain and sewer pipes shall be centred at points of crossing;
- where watermains cross under sewer pipes:
    - 0.5m minimum vertical clearance;
    - the sewer shall be constructed of watermain quality pipe and fittings and pipe joints shall be certified and tested to 350kPa hydrostatic pressure;
    - the sewer shall meet the requirements of *OPSS.MUNI 410* for Laser Profile or Mandrel Deflection Testing of Pipe Sewers[2]; and
    - The sewer shall meet the requirements of *OPSS.MUNI 410* for Low Pressure Air Testing (35kPa).
- midpoint of water services (50mm and greater) shall be centred at points of crossing; and
- crossings shall be perpendicular.

Minimum vertical separation from other sewer infrastructure and third-party utilities at points of crossing shall be 0.5m desirable and 0.3m minimum.

If sewers, maintenance holes, etc. are constructed in a way that could result in water services freezing, then watermains and water services shall be insulated. See *SEW 3.6 Insulation*.

[1] Mandrel Testing Equipment shall be designed for the tested Pipe Material
[2] Mandrel Testing Equipment shall be designed for the tested Pipe Material

SEW 3.2. Easements

A Minimum easement width of 4.5m shall be provided for swales, as identified by COH.

Easements shall be exclusive to COH[3].

Easements shall be unencumbered and of a width such that the extension of a 1:1 slope from the deepest point of an existing or proposed adjacent structure passes beneath the forcemain and/or sewer trench. Exceptions to this requirement shall be at the sole discretion of COH.

Easements shall be (as a minimum):

- 6m (sewer-centred) for single sewer or forcemain installations (400mm diameter and smaller);
- 10m for single watermain (400mm and smaller) and single sewer installation, 3m offset to watermain and 2.5m separation from sewer;
- 12m for dual sewer installation; or
- 12m for single watermain and dual sewer installation.

For sewers and forcemains larger than 400mm diameter and deeper than 3.7m:

- 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. In general, for each meter of depth below 3.7m the easement width should increase by 3m; and
- the Designer shall confirm the required width of easement with COH prior to confirmation of the sewer design.

Widths of easements shall satisfy the COH's operational, maintenance and reconstruction need in all cases. Minimum easements widths listed above shall be verified with COH as meeting these primary needs on a case-by-case basis at the sole discretion of COH staff.

SEW 3.3. B-Line High Order Transit Projects

A High Order transit guideway is a physical or designated route that supports and guides trains or individual vehicles (for example, bus rapid transit or light rail transit). Sewer infrastructure related to the collection of storm flows within a High Order transit guideway shall be located under the guideway and shall remain the responsibility of the Owner for both the purposes of locates, replacement and maintenance except as otherwise defined in writing by COH.

The location and number of connections to municipal sewer infrastructure shall be per COH direction.

[3] COH reserves the right to require additional width where adjacent structures, installation depths, topography, operational needs, and/or pipe sizes warrant.

Water quality mitigation shall be provided within the guideway limits and prior to connection to municipal sewer infrastructure.

Construction, Consolidation and/or Merging of Sewers and Servicing of Adjacent Lands in the B-Line High Order Transit Project Corridor shall be per the more stringent provisions of this document and the successor documents for the *LRT Wastewater Analysis in support of MECP Application* (December 13, 2019) report and appendices being developed in support of storm separation in the corridor.

At a minimum, the Designer shall confirm:

- The system hydraulic grade line (HGL) under proposed conditions is less than or equal to the HGL under existing conditions based on modelled Dry Weather Flow (see *SEW 6.2 Average Dry Weather Flow*) and design storm simulations;
- There is no increased risk of combined sewer overflows (CSOs), surface flooding, and/or basement flooding by providing modelling results which demonstrate that the HGL under proposed conditions is not higher than under existing conditions; and
- Dry and Wet Weather Flow paths have been maintained in the proposed model.

Except as otherwise directed by COH, the Designer shall ensure:

- the frequency of CSO events, volumes released during such events, and risk of surface flooding, or basement flooding are not increased;
- Dry and Wet Weather Flow paths and volumes at downstream or intermediate connections to the existing system are maintained;
- there is low flow channelization within maintenance holes;
- Dry Weather Flows are not diverted from outletting at the Woodward Avenue Wastewater Treatment Plant;
- there are individual connection points for contributing sewers;
- sewers and flows that pass through a corridor are intercepted; and
- use of common high point maintenance holes.

Redundant and/or abandoned maintenance holes shall be removed to their full depth. Abandoned sewers shall be pressure-filled with concrete end capping.

Connection of catch basin leads, sewer laterals, and chamber drains shall be as identified by COH.

SEW 3.4. Infiltration and Inflow

Infiltration is groundwater that enters sewers and maintenance holes through breaks, joint failures, connection failures, and holes. Inflow is surface water that enters the sewer system from roof drains, footings, cross-connections, maintenance covers, downspouts, and is the result of storm events.

Infiltration and inflow create challenges because they:

- increase the risk of flows overwhelming the Woodward Avenue Wastewater Treatment Plant and CSO Tanks, leading to sewer discharges to watercourses;
- increase the risk of basement sewer backups;
- reduce sewer capacity available for future growth;
- decrease sewer treatment efficiency;
- increase operational costs due to dilution;
- reduce the lifespan of sewer infrastructure;
- weaken road subgrades leading to premature failure; and
- can trigger costly expansions to sewer and/or sewage treatment facilities.

Design, construction, rehabilitation, and maintenance techniques should prioritize prevention of infiltration and the control of inflows without negatively impacting the built environment or use of the natural environment.

SEW 3.4.1. Sewer Design Requirements to Address Inflow and Infiltration

Groundwater table elevation information can be obtained through existing hydrogeological and geotechnical investigation reports, soil investigations, and borehole logs. If existing information is insufficient to identify the groundwater table elevations within the Project Area, then this information should be obtained through a hydrogeological or geotechnical investigation during design.

For areas where weeping tiles are designed to be drained by gravity or where a separate foundation drain collector sewer is proposed, the minimum inflow and infiltration rate used in sewer sizing shall be 0.4 litres per second per hectare (L/s/ha). For areas where there are no storm sewers, or where shallow storm sewers require weeping tiles to be drained by sump pump, the infiltration rate used in sewer sizing shall be 0.6 L/s/ha.

Groundwater table elevations typically fluctuate throughout the year with seasonal highs (typically in spring) and lows (typically in winter). Where the seasonally high groundwater table is 0.6m or more above the top of the sanitary sewer pipe (or as directed by COH), the sewer shall minimize inflow and infiltration inclusive of the following measures:

- sewers to be constructed of watermain quality pipe and fittings as directed by COH;
- pipe joints certified to 350kPa hydrostatic pressure;

- precast joints in maintenance holes below the frame and cover shall be externally wrapped with a minimum 300mm wide strip of waterproofing per the *Approved Products List;*
- sewers shall meet the requirements of *OPSS.MUNI 410* for Laser Profile or Mandrel Deflection Testing of Pipe Sewers (Mandrel testing equipment shall be designed for the tested pipe material); and
- sewers shall meet the requirements of *OPSS.MUNI 410* for Low Pressure Air Testing (35kPa)

The design shall also include strategies to mitigate pipe buoyancy and floatation.

Except where data is submitted that clearly demonstrates that the seasonally high groundwater table is not located 0.6m or more above the sanitary sewer obvert, sanitary sewers shall, by default, be per these requirements.

SEW 3.5. Depth of Cover

Depth of cover shall be measured vertically from the crown of pipe to the lower of:

- final road and/or ground elevation in the Project or
- ultimate road and/or ground elevation4 identified in documents inclusive of a preliminary design, environmental assessment, and/or masterplan.

Minimum depth of cover on sewers shall be 2.75m. Exceptions to this requirement shall be considered on a case-by-case basis and only upon submission of a Functional Servicing Report (FSR) which clearly identifies that the depth of cover on the sewer has been maximized and that alternate outlets would not allow for the provision of greater depths of cover.

SEW 3.6. Insulation

Insulation of forcemains, sewers, sewer laterals, and catch basins (where required) shall be provided in accordance with *OPSD 1109.030* as amended by COH (see the *Approved Products List*).

To mitigate trench loads due to frost penetration, heaving and to prevent storm and sanitary services from freezing, insulation will be required where the provisions of *SEW 3.5 Depth of Cover* are not met. Insulation shall be reflective of *OPSD 3090.101 - Frost Penetration Depths for Southern Ontario*.

Insulation shall be minimum 50mm thick polyurethane foam insulation to match or exceed the thermal and engineering characteristics of the Urecon U.I.P.® system of pre-insulated pipes (*https://www.urecon.com/applications/municipal_freeze.html*) or as designated by COH. The designer shall

[4] Use of the elevations shall be at the direction of COH and independent of whether the documents are completed or in progress.

provide temperature loss calculations to COH in support of the proposed insulation method. The equation for time to freeze is as follows:

$$t = AR_T C \ln\left(\frac{t_i - t_a}{t_f - t_a}\right)$$

$$R_T = \ln\left(\frac{D_2 \div D_1}{2\pi k}\right)$$

Where
- t = time for water to freeze (hours)
- A = area of the pipe (m^2)
- R_T = combined thermal resistance of pipe wall and insulation (m°C/W)
- C = specific heat capacity of water (4190 J/kg°C for water at 0°C)
- t_a = ambient air temperature (°C)
- t_i = initial water temperature (°C)
- t_f = freezing temperature of water (°C)
- k = thermal conductivity of insulation (0.036 W/m°C for polystyrene foam)
- D_1 = external diameter of pipe (m)
- D_2 = external diameter of insulation (m)

A separation greater than 1.2m shall be provided between the outer diameter of sewers, sewer laterals, and catch basin leads and the exterior wall of structures. Where portions of the exterior walls or floors (new structure installations) of maintenance holes, catch basins, catch basin pups, and chambers do not meet these requirements, insulation shall be provided on the structures as follows:

- 50mm of high-density Styrofoam (H100) insulation where the offset is 0.9m to 1.2m
- 100mm of high-density Styrofoam (H100) insulation where the offset is 0.6m to 0.9m

High density styrofoam widths of 100mm shall be achieved by placing two 50mm pieces with 300mm of overlap at edges.

Insulation shall be provided from the pipe invert to the top of the exterior wall and fastened with 50mm galvanized washers and 6mm diameter Tapcon concrete anchors at 450mm centres.

Where a pipe crosses a culvert with a clearance of 1.2m or less, 100mm of high-density Styrofoam (H100) insulation shall be provided for the width of the trench beneath the pipe bedding.

Those portions of the exterior walls of third-party utility vaults/chambers placed within 0.9m of the outside diameter of a watermain or water service shall be insulated. Insulation shall be per the *Right-of-Way Utility Installation and Permit Manual*.

SEW 3.7. Sewers Suspended on Structures

Where the grades and elevations of a sewer require it, or where the construction requirements and long-term maintenance impacts related to lowering a sewer under a watercourse, railway, or roadway adjacent to a bridge or large culvert are deemed unacceptable by COH, storm and/or sanitary sewers shall be suspended from the structure subject to approval from the owner of the structure.

The Designer must demonstrate that the existing structure can support the load of the pipe and flows. Any modifications to the structure will require the prior approval of the owner.

Connection of the sewer to the structure will need to consider expansion of the pipe material, expansion of the bridge structure, and incorporation of flex couplings and/or expansion joints to accommodate this movement.

Suspended sewers shall be insulated per *SEW 3.6 Depth of Cover*

Refer to *SEW 9.1.1 Forcemains Suspended on Structures* for forcemain-related applications.

SEW 3.8. Corrosion Control

The Designer shall provide protective interior and exterior coatings and/or line maintenance holes, chambers and pipes to mitigate chemical attack from hydrogen sulfide and other corrosive chemicals to the satisfaction of COH.

The risk of hydrogen sulfate attack on downstream pipes shall be evaluated and the Designer shall provide recommendations for mitigation and address as directed by COH.

For forcemains, refer to *SEW 9.7 Corrosion Control for Forcemains.*

SEW 3.9. Trenchless Construction

The use of trenchless construction methods to construct sewers, forcemains, and watermains has become increasingly common where conventional open cut construction methods are not feasible (for example, crossing a watercourse, constructing large, deep trunk sewers, or crossing a rail/freeway corridor). Current trenchless technologies include but are not limited to horizontal directional drilling, tunnel boring machine, microtunneling, or jack-and-bore. If a project requires (due to a third-party owner's requirements) or would benefit COH by using a trenchless construction method, the Designer shall work closely with the COH and the third-party owner (if applicable) to ensure that the most appropriate method is selected.

In addition to the general requirements for sanitary or storm sewer construction (see SEW 6 *SANITARY SEWER DESIGN and SEW7 STORM SEWER DESIGN*), sewers constructed by trenchless methods require additional considerations during the design phase.

At a minimum, the Designer shall consider the following additional parameters when designing a sewer to be constructed using trenchless construction methods:

- System capacity inclusive of future growth
- Regional and international availability of tunnelling equipment (if applicable)
- Space constraints and whether system elevation will limit future expansion options
- Access shaft and maintenance hole spacing and locations
- Construction compound space requirements
- In-service dates and construction durations
- Traffic disruption from shaft area road closures (if applicable)
- Property acquisition (if applicable)
- Third-party infrastructure crossings (if applicable)
- Third-party utility relocations
- Pipeline, railway, highway, and/or waterbody crossings (if applicable)
- Environmental Assessment requirements
- Potential environmental impacts
- Geological conditions, including but not limited to rock/soil type, moisture content, the presence of transition zones, pH, rockline, groundwater table elevations, perched aquifers, and potential contaminants
- Management of excess soil/excavated materials including hauling and disposal
- Well locations
- Construction sequencing and excavation staging
- Construction methodology
- Structural capacity
- Flow bypassing
- Connections to existing and proposed infrastructure
- Head loss and internal pressures
- Construction loads and permanent loads
- Pipe materials suitable to methodology with appropriate corrosion characteristics
- Mitigation of hydrogen sulfide and odour control
- Segmental lining design

- Groundwater controls at shaft locations and watertightness for maintenance holes
- Ring design, including watertightness
- Joint design, including watertightness
- Gasket design, including material (tensile strength, hardness, relaxation, etc.), groove geometry, and watertightness
- Grouting
- Lining and annular space requirements
- Pressure testing requirements and methodology
- Opportunities to minimize maintenance beyond visual inspection
- Technological innovations that may improve construction and/or tunnel performance
- Operations and maintenance requirements
- Any additional considerations identified by COH in the contract documents

Pipeline installation by tunneling shall be in accordance with *OPSS.MUNI 415*.

Due to the complexity of these projects, the Designer must work closely with COH to ensure that project objectives can be achieved and contractual timelines can be met.

SEW 3.10. Existing Sewer Modifications

Where the project involves shifting the alignment of an existing sewer within the corridor, impacts to the clock position of the sewer lateral connection to the sewer and the grade of the sewer laterals shall be mitigated to meet the requirements of *SEW 3.14 Sewer Laterals*.

The obvert of upsized sewers shall be maintained except where it can be demonstrated that 2% grade cannot be achieved. Elevation of the downstream pipe obvert must be equal to or lower than the obvert of the upstream pipe obvert.

The Designer must show that the system hydraulic grade line (HGL) under proposed conditions is less than or equal to the HGL under existing conditions based on modelled DWF and design storm simulations. Model results showing that the HGL under proposed conditions will be no higher than under existing conditions will be the accepted measure that there is no increased risk of CSO, surface flooding and/or basement flooding. The updated wastewater model must also clearly show that dry and wet weather flow paths have been maintained under the proposed design. Sewer works shall maintain:

- low flow channelization within maintenance hole;

- flow diversions, splits, and/or channelization that directs flows to existing CSO tanks and/or Woodward Wastewater Treatment Plant;
- individual connection points of contributing sewers;
- intercepting sewers and flows that pass through a corridor; and
- shall include removal of redundant and abandoned maintenance holes full depth, pressure filling and concrete end capping of abandoned sewers, and the connection of catch basin leads, storm sewer laterals and chamber storm drains to the storm sewer on the corridor or side street identified by COH.

SEW 3.11. Pipe Materials

Acceptable sewer pipe materials shall be per *Form 500.04 Approved Sewer Pipe Materials* and COH direction. Where there is a discrepancy between *Form 500* and this document, *Form 500* shall take precedence.

Acceptable forcemain pipe materials shall be per *Form 1100.04 Approved Forcemain Pipe Materials* and COH direction. Where there is a discrepancy between *Form 1100* and this document, *Form 1100* shall take precedence.

Product and material selection shall be inclusive of a review of static and dynamic loadings, pressure ratings and pipe strength. The Factor of Design Safety for sewers shall be 2 for relevant AWWA calculations.

Re-use of sewer and forcemain infrastructure, inclusive of valving and chamber appurtenances, is not permitted.

Radial and elliptical pipes shall only be used where approved by COH (i.e., where alternatives are not feasible). Maintenance hole requirements related to an alignment change shall not be decreased by the provision of radial pipe.

SEW 3.12. Pipe Restraints

Maintenance holes shall be provided in number such that steep pipe slopes (>20%) are eliminated. Receiving sewers shall be designed for protection against maximum scouring velocity and erosion control measures shall be taken where velocity in the sanitary sewers approaches or exceeds 3m/s due to steep grades and where providing a drop maintenance hole is not possible. Where it can be demonstrated that site conditions preclude mitigation of these slopes, the following shall apply:

- Anchors and anchorage spacing shall be designed by a Licensed Engineering Practitioner based on Sewer material, anchor type and site conditions.
- Sewers with slopes of 20% and greater shall be restrained with concrete anchor blocks. The Designer shall address the following in their design:
  - Sewer Material
  - Site Conditions, inclusive of Soil Characteristics

  - Erosion Control
  - Exceeding Maximum Scouring Velocity
  - Constructability
- Spacing of concrete anchors shall not exceed the following spacing requirements:
  - 11m for grades between 20% and 35%
  - 7.3m for grades between 35% and 50%
  - 4.9m for grades exceeding 50%

Provisions for joint restraints (i.e., anchor blocks, thrust blocks, and mechanical restraints) are provided in *SEW 9.13 Pipe and Fitting Restraints*.

SEW 3.13. Pipe Deflections at Maintenance Holes

Sewer grade may be maintained across maintenance holes so long as the minimum required flow velocity is maintained. Otherwise, the minimum drop across maintenance holes shall be as follows:

- 25mm for straight runs (0° deflection),
- 50mm for 90° deflection (exclusive of sewers 675mm and greater)

Where the upstream or downstream pipes are 675mm or greater, the maximum allowable deflection in pipe alignment is 45°. Additional maintenance holes may be added to meet this requirement (see *SEW 4.7 Dog-Leg Maintenance Holes*).

Drop pipes shall be provided for changes in elevation 0.6m and greater (see *SEW 4.4 Drop Structures*).

Consideration shall be given for the elimination of additional maintenance holes and/or the minimum drop requirements where it can be demonstrated to COH that constraints exist that preclude the provision of such.

SEW 3.14. Sewer Laterals

Sewer laterals are generally considered to be public property within the ROW and private property beyond the property line. Sewer (re)construction shall be inclusive of full-length sewer lateral replacement within the ROW. In addition, sewer laterals shall be replaced full length where they cross high order transit guideways. Exceptions to these criteria shall be at the sole discretion of the COH.

Sewer laterals shall be watertight individual services. Some streets have multiple sewers, and some properties sit at intersections where different sewers along the different roads convey flow to different catchment areas. Where this is the case, laterals shall be connected to the sewer identified by COH.

Laterals shall be provided with a riser to a depth of 2.75m with depth of cover on the sewer greater than 3.7m. The first 1m of each riser shall be encased in concrete. The top of the sanitary lateral at the street line shall be a minimum 2.2m below the elevation of the controlling road centerline elevation. Laterals shall also be provided with the minimum desirable 2.0% crossfall. Reductions to the minimum crossfall of 1.0% in retrofit installations may be approved by COH on a location-by-location basis (see *SEW 3.10 Existing Sewer Modifications*).

Sewer laterals to be installed per the following *Standard Sewer Drawings*:

- SEW-300 – Sewer Bedding and Riser Details
- SEW 302 – Bedding Details for Private Drains
- SEW 303 – Dual Private Drain Connection to a Combined Sewer

and constructed to the limits of the ROW (for existing servicing or retrofit applications) or to 1.0m beyond the ROW and marked with a stake extending 1.0m above grade (for new/greenfield developments). Stakes indicating the location of the lateral shall be painted to match the pipe colour (i.e., white for storm, green for sanitary).

SEW 3.14.1. Lateral Connections, Sizing, and Location

For new installations, connections shall be via a prefabricated wye per the *Approved Products List*. For retrofit installations, connections shall be via a saddle per the *Approved Products List* (sewer shall be cored). All connections to be made at the 10 and 2 o'clock positions on the sewer. Pre-consultation with COH is required for any proposed connections to combined sewers to identify any discharge constraints.

Sewer laterals shall be minimum 150mm in diameter. Sanitary sewer laterals for multi-residential, commercial, industrial, and institutional blocks shall be sized individually by the Designer.

Where possible, sanitary sewer laterals shall be located 1.5m to the right of the lot centre for single detached residential lots.

The Designer shall determine the location of sanitary sewer laterals for semi-detached, street townhouse and maisonette units for approval by COH. Storm service connections for blocks within a Plan of Subdivision (for commercial, institutional, industrial, or multi-family block townhouses) shall be designed based on the specific Land Use of the block.

SEW 3.15. Bedding and Backfill

Bedding and cover material for sewers and forcemains shall be Granular "A". Granular "A" material shall also be used as bedding and cover for sewer laterals. Backfill of sewers and sewer laterals shall be select approved excavated native materials, Granular "A" or Granular "B" Type II. All granular materials shall be in accordance with the *Construction and Material Specifications Manual*.

Re-use of select approved excavated native materials shall be prioritized as trench backfill. Ashes, cinders, refuse, or organic material found at the bottom of the trench at the required pipe grade shall be excavated and replaced with Granular “A”.

Unshrinkable fill per *OPSS.MUNI 1359* shall be used where designated by COH and where normal procedures cannot produce the required degree of compaction of materials.

Non-traceable, 150mm-wide “Caution Sewer Line” warning tape shall be provided 0.6m above of sewer pipe for the full length of the installation and affixed to the pipe sufficiently to prevent backfilling operations from dislodging it. The warning tape shall be green with black text (see *Approved Products List*).

SEW 3.16. Perforated Polyethylene Drainpipe (Sub-Drains)

Perforated polyethylene drainpipe (sub-drains) shall be provided under each curb on arterial and collector roads, in new subdivisions, in urbanization and streetscaping projects, and in High Order Transit Corridors. Sub-drains shall be minimum 100mm pipe with filter sock and stone encasement and meet the requirements of *Standard Road Drawing* RD-101 and *OPSS.MUNI 405*. Upsizing to a 150mm pipe shall be reviewed where the width of the multi-modal surface features collected by the perforated polyethylene drainpipe is greater than 25m. Sub-drains shall connect to catch basins as directed by COH.

Placement of sub-drainpipe shall be considered adjacent to parks and significant green areas draining to the road, adjacent to stormwater management facilities, and in areas with a high groundwater table and/or frequent surface flooding.

SEW 3.17. Catchments

Sewers shall be designed in both plan and profile to service the lands within the Project or Plan of Subdivision, to the upper reaches of each external drainage area and shall:

- provide the minimum depth of cover per *SEW 3.5 Depth of Cover*
- permit existing and future sewer lateral placements per *SEW 3.14.1 Lateral Connections, Sizing, and Location.*
- confirm the absence of vertical conflicts with existing or proposed sewers, forcemains and/or watermains
- confirm depths of cover and clearances satisfy the requirements of the approving authorities at crossings of watercourses, third party utility pipelines, railways, and/or highways.

SEW 3.17.1. Drainage Area Plans

Contributing areas to maintenance holes shall be subdivided and labelled as sub-areas where land use or population densities vary (sanitary sewers) or where runoff coefficients vary (storm sewers). Where composite areas comprised of sub-areas are used, both shall be indicated and labelled.

Drainage area plans shall be to the same scale as the General Plan of Services, 1:500 preferred, annotated, inclusive of Phased Implementation and the following:

- ROWs, planned street patterns, lots, blocks, easements and other lands within the Plan of Subdivision, capital project and contributing areas
- existing and proposed sewer sizes, lengths, grades, maintenance holes, maintenance hole numbers, direction of flow, and major overland flow routes
- limits, flows, and times of concentration for storm sewers for the internal and external drainage areas within the sewershed
- details of the internal and external contributing drainage areas, receiving or outlet sewers, watercourses and stormwater management facilities
- Where deemed impractical by COH, large external drainage areas may be detailed at a smaller scale than the General Plan of Services but shall as a minimum provide existing ground contours at 1m intervals or as otherwise directed.

See *SEW 6.2 Average Dry Weather Flow* for minimum sanitary densities.

See *SEW 7.2.3 Runoff Coefficients*.

SEW 3.18. Sewer Design Sheets

Sewer design sheets shall be prepared in accordance with the example provided in *Appendix SEW2: Sewer Design Sheets* and submitted in PDF and excel formats. The design sheets shall be inclusive of the Consultant stamp, seal, signature, license number and date.

SEW 4 MAINTENANCE HOLES

As per *Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under an Environmental Compliance Approval* (MECP, 2023), protective coatings or corrosion-resistant material shall be used in maintenance holes to prevent deterioration due to the presence of hydrogen sulfide or other corrosive chemicals.

Maintenance holes with non-standard dimensions shall be fully designed and detailed in the drawing set. Best practices encourage the use of separate maintenance holes and catch basins; however, catch basin maintenance holes may be required at the COH's discretion in some circumstances (ex. where a rear lot catch basin leads to a road catch basin). Use of offset maintenance holes shall be at the sole discretion of COH.

Except where directed by COH, common high point maintenance holes which are not associated with the splitting of upstream flows shall be replaced as individual maintenance holes.

Historically, some shared maintenance holes were installed on some portions of the combined sewer network. Although the common point of connection provides an alternate path for flows during surcharging, it can result in negative downstream impacts in the secondary pipe. The Designer shall consult with COH to determine whether a secondary pipe should be disconnected from the shared connection point and provided with a separate maintenance hole.

Collector maintenance holes (also called total capture maintenance holes) are structures where multiple inlet pipes are combined to one outlet pipe (see *Figure 2. Minimum Maintenance Hole Sizes and Benching Details*).

Design requirements for flow splitting maintenance holes are discussed in *SEW 8.1 Flow Splitting Maintenance Holes*.

SEW 4.1. Maintenance Hole Construction

Except where otherwise approved by COH, maintenance holes shall be constructed of precast units and inclusive of factory installed benching and openings/bulkheads for pipe connections. Cast-in-place structures will be considered by COH on a project-by-project basis. Benching shall be carried to the springline of the outlet pipe. Non-standard benching configurations that are not conducive to factory installation shall be detailed in the drawing set.

SEW 4.1.1. Maintenance Hole Safety Platforms, Frames and Covers

Safety platforms shall be provided where the depth measured from top of cover to the lowest outlet pipe invert is 5.0m or greater. In circular maintenance holes, safety platforms shall conform to *OPSD 404.020*. Non-circular safety platforms. In rectangular maintenance holes and deep valve chambers, safety platforms shall conform to *OPSD 404.010.*

Incoming pipes shall be below the elevation of the lowest safety platform or provided with a drop pipe. Alternate configurations shall be subject to the approval of COH.

Sanitary frames and covers shall be *OPSD 401.010 Type A (Closed)* except where COH direction or conditions requires a watertight installation per *OPSD 401.030.* Storm frames and covers shall be *OPSD 401.010 Type B (Open).*

SEW 4.1.2. Maintenance Hole Waterproofing

Sanitary maintenance holes subject to submergence by overland flows shall be made watertight and provided with watertight covers per *OPSD 701.010*.

SEW 4.1.3. Frost Straps

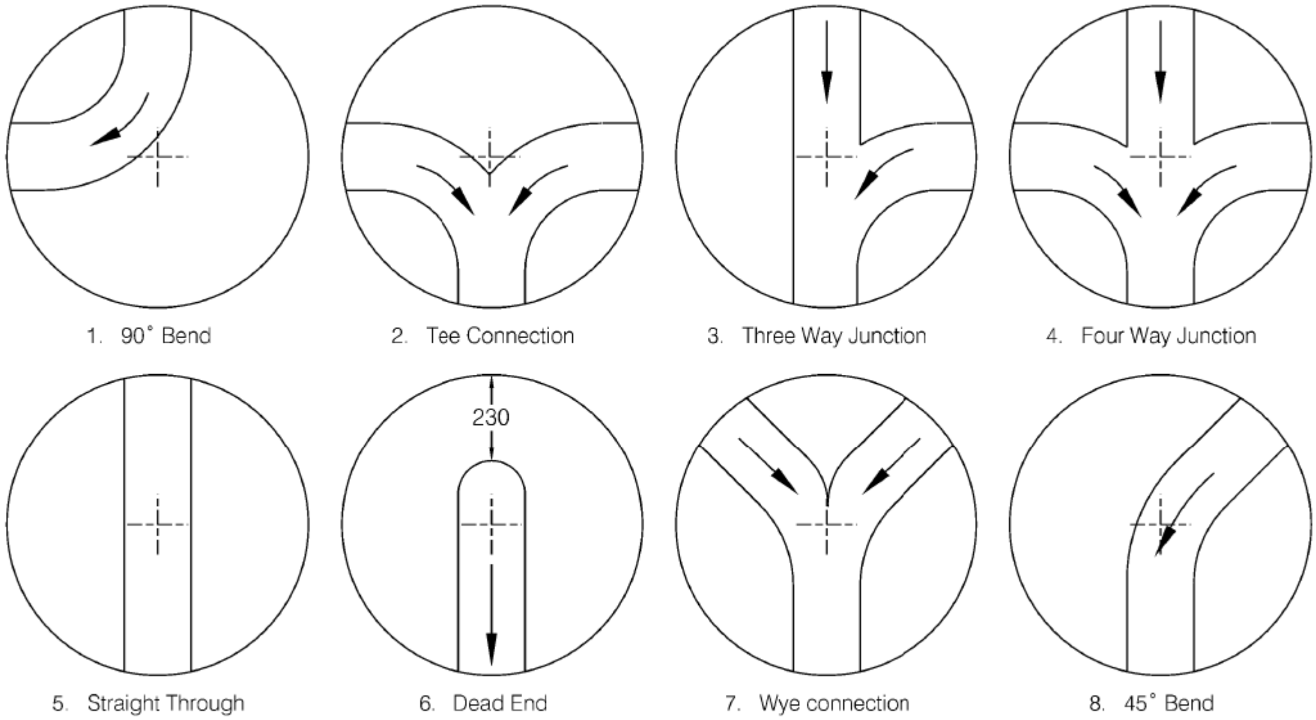
Frost straps shall be provided per *OPSD 701.100* and a minimum of 3 shall be provided between sections.

External straps shall be provided vertically from top to bottom or to a minimum 1m below frost depth as directed by COH.

SEW 4.2. Maintenance Hole Sizing

Requisite minimum maintenance hole sizes are provided in Figure 1 and shall be reflective of the number of pipes, pipe sizes, and deflection angle. Maintenance Hole sizes shall be increased where either the horizontal or vertical separation between pipe openings compromises the structure's strength. Tee maintenance holes are permitted for sewers 1200mm diameter and larger.

Figure 2. Minimum Maintenance Hole Sizes and Benching Details



MAXIMUM SIZE CIRCULAR PIPE IN THE WALL OF PRECAST RISER SECTIONS					
Maintenance Hole Diameter (mm)	No. 1-4 (mm)	No. 5 & 6 (mm)	No. 8 (mm)	No.7	
				Inlet Hole (mm)	Outlet Hole (mm)
OPSD 701.010 (1200mm)	450	600	525	450	600
OPSD 701.011 (1500mm)	600	900	675	600	900
OPSD 701.012 (1800mm)	900	1050	900	900	1050
OPSD 701.013 (2400mm)	1050	1500	1350	1050	1500
OPSD 701.014 (3000mm)	1500	1800	1650	1500	1800
OPSD 701.015 (3600mm)	1650	2400	2100	1650	2400

SEW 4.3. Spacing and Provision

Maintenance holes shall be provided at the end of each sewer line, at changes in horizontal alignment, pipe grade, elevation, and/or material, at pipe intersections, or at the following maximum spacing:

- 120m for sewers from 200mm up to 1050mm diameter
- 150m for sewers 1200mm and larger diameter.

Maintenance holes shall also be provided for inspection and sampling opportunities on industrial sewer laterals and on commercial and institutional sewer laterals where discharges exceed or can be reasonably expected to exceed the treatable parameters identified in *By-Law No.14-090 - Sewer Use.*

Where site conditions preclude placement of a requisite maintenance hole at specific location, a request to relocate the maintenance hole will be approved by COH on a case-by-case basis. Relocation of the maintenance hole shall adhere to spacing requirements and maintain the number of maintenance holes provided. The relocated maintenance hole shall be upstream of the required location by a distance not to exceed 10m for a maintenance hole required at the connection point of sewers or 30m for a maintenance hole required for changes in horizontal alignment, pipe grade and pipe material. Maintenance holes provided at a drop in pipe elevation, change in pipe material, the connection point of sewer laterals or for inspection and sampling opportunities are not candidates for relocation. Flow monitoring equipment shall be installed per COH direction.

SEW 4.4. Drop Structures

Drops across maintenance holes are provided to compensate for the energy dissipation associated with changes in flow velocities, depths of flows in the pipes, and pipe alignment. Changes to the flow velocity in inlet and outlet pipes in a maintenance hole shall not exceed 0.6 m/s.

Depth of drop shall be measured as the difference between the inverts of the inlet and outlet pipes for mainline sewers or as the difference between the invert of these sewers and the top of the benching provided within the maintenance hole for intersecting sewers. The minimum drop across maintenance holes shall be 25mm for straight runs and 50mm for bends up to and including 90 degrees. Alternatively, sewer grade may be maintained across maintenance holes provided minimum required flow velocity is maintained.

Drops greater than 0.6m shall require the placement of an external drop structures sized and constructed in accordance with *OPSD 1003.010*, which restricts drop pipe sizes to between 200mm and 300mm for sanitary sewers and between 200mm and 600mm for storm and combined sewers. The drop pipe shall be one size smaller than the inlet pipe for pipes 675mm and smaller (600mm is the maximum drop pipe size). Where possible, the depth of drop shall be greater than the drop pipe diameter.

The Designer shall make all efforts to eliminate the need for a drop structure by changing the sewer gradient while respecting COH’s maximum velocity criteria and keeping velocities consistent (see *SEW 6.4.3 Sanitary Sewer Design Velocity* and *SEW 7.2.5 Storm Sewer Design Velocity*). The Designer shall also ensure there is sufficient space adjacent to the maintenance hole for the drop structure and its construction. Internal drop structures are not permitted in maintenance holes except at the discretion of COH.

External drop structures shall be designed per *Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized Under an Environmental Compliance Approval* (MECP, 2023). The concrete foundation of the adjacent maintenance hole shall be extended beneath the external drop structure.

For sanitary sewers, the entire drop structure maintenance hole shall be lined to fully encapsulate the drop connection and all hardware used for mounting it. The lining should be uniform and applied seamlessly to prevent corrosion.

SEW 4.4.1. Structures for Drops Greater than 5m

Vortex or baffle drop structures may be used to dissipate energy, increase aeration, and minimize turbulence and odour production for drops greater than 5m, at the discretion of COH.

The following should be considered before including a vortex drop structure in the design:

- Depth of drop should be between 5m and 30m
- Whether there is sufficient space adjacent to the maintenance hole for the structure and corresponding construction at the proposed depth of drop
- Number of inlet pipes. A vortex structure only allows for one inlet unless additional inlet pipes can be combined into a single inlet pipe at one elevation at an upstream combination maintenance hole prior to entry.
- Size of inlet pipe is greater than 200mm diameter. 200mm diameter pipe may be used if flow depth is 50mm or greater.
- Flow capacity should be less than 5,000L/s
- Whether the vortex drop structure can be combined with an external plunge drop where the plunge drop can be used only when vortex is out of service for maintenance.

The Designer shall evaluate proposed drop structures for the effects of air eduction and pressurization of the receiving sewer. Adjustments in the drop shaft design may be required to minimize corrosive conditions and odour release effects, such as oversizing the structure or providing air return piping. The intention is to avoid hydraulic instability that could result in surge events and possible ‘blow-outs’.

The Designer shall also provide a cleanout near the inlet of the vortex drop structure for maintenance access.

Baffle drop structures may be considered where design flows exceed 5,000L/s, depth of drop exceeds 30m, sufficient space exists adjacent to the connecting maintenance hole, there are multiple inlet pipes inclusive of those at different elevations, and/or at the direction of COH.

SEW 4.5. Provisions for Future Extensions

Maintenance holes constructed at the top end of sewer that have been identified for future extension shall be inclusive of the ultimate benching and temporary bulkheads that are labelled on Engineering Drawings in Plan and Profile, sized for the connection of future sewer(s), and placed at the required elevation for the connection of future sewer(s). Where COH deems it would become redundant in terms of spacing upon the extension of the sewer, a maintenance hole shall be labelled for future removal and the provision of a temporary bulkhead is not required as directed by COH.

SEW 4.6. Odour Control

Odours resulting from sewer gases and the creation of hydrogen sulfide (H_2S) are generally attributable to overstrength discharges, flow turbulence associated with improper benching, hydraulic jumps due to higher pipe slopes or vertical drops and forcemain/gravity sewer connections to gravity sewers, or low initial flows in phased constructions of forcemains and gravity sewers resulting in longer residence times in pipes. Possible mitigative measures are inclusive of corrosion resistant pipes or liners, typically PVC or dosing with oxidizing agents.

Odour control shall be provided where more than one consecutive maintenance hole is sealed to mitigate submergence.

SEW 4.6.1. Ventilation Pipes

Ventilation pipes shall be provided at every third maintenance hole where long sections of sanitary sewer are provided with watertight covers. Where possible, the ventilation pipes should be installed within the Right-of-Way at least 1 metre from the sidewalk/back of curb and/or 3 metres from the property line.

Ventilation pipes shall be made of 304 stainless steel and fitted with a mesh screen at the return bend outlet to prevent birds and other animals from nesting within the pipe. The elevation of the outlet shall be above the Regional floodplain elevation.

Supplemental odour control may be required in locations that are adjacent to sensitive receptors as directed by COH.

SEW 4.7. Dog-Leg Maintenance Holes

Dog-leg maintenance holes are used to allow for direction changes in larger sewers. They feature bends of up to 45 degrees on the inlet and outlet pipes. Dog-leg maintenance hole configurations shall be used for sewers with a nominal diameter 675mm and greater on storm, combined, consolidated, and merged sewers.

SEW 5 CATCH BASINS

This section outlines requirements for the design of new catch basins. Retrofitting and/or rehabilitation of existing catch basins shall meet these requirements unless the Designer is otherwise directed by COH.

For the purposes of this document the term double catch basin shall be interchangeable with the term twin inlet catch basin.

Single catch basins shall be per *OPSD 705.010* and double catch basins shall be per *OPSD 705.020*.

SEW 5.1. Catch Basin Spacing

Catch basin spacing shall be determined as described in Table 1. Maximum Length of Contributing Road Surface for Single and Double Catch Basins, unless prescribed otherwise by a detailed Stormwater Management design.

Table 1. Maximum Length of Contributing Road Surface for Single and Double Catch Basins

Road Width (Face of Curb to Face of Curb)	Road Grade 2.9% or less	Road Grade 3.0% to 4.9%	Road Grade 5.0% or greater
9.9m or less	90m	75m	65m
10.0m to 12.9m	75m	65m	55m
13.0m to 15.9m	60m	50m	40m
16.0m and greater	50m	45m	45m

The minimum diameter of the catch basin lead is 100 mm and the minimum of 1% slope shall be provided for a catch basin lead. The maximum length of contributing road surface drained by a double catch basin shall be set to the values provided for a Road Grade 2.9% or less.

Those portions of High Order Transit guideway and/or lanes without a separate storm collection system shall be considered part of the road for the purposes of catch basin spacing.

SEW 5.2. Catch Basin Placement

Catch basins shall be placed upstream of crosswalks and crossrides to minimize surface flows across them and to mitigate potential icing of the road surface. They shall also be placed to minimize surface flows from one road onto an intersecting road, into multi-use and/or cycling facilities constructed at road level, at points where surface flows are interrupted (inclusive of bump-outs and elevated crossings/intersections), and where the creation of low points in topography would result in significant ponding. Catch basins shall be placed minimum 1m away from the edge of a driveway, walkway or approach.

Where the crossfall of a High Order road creates a low point on an intersecting minor road, catch basins shall be provided at the low point and the intersection shall be graded so that flows are directed towards the minor road to the end of the curb return radii to facilitate proper drainage of the intersection.

Double catch basins shall be considered for greater volumes of surface flows (i.e., at low points along a road alignment) and where impacts to use by more sensitive users may result. Incorporation of Low Impact Development (LID) measures may be evaluated for inclusion (see *Comprehensive Development Guidelines and Financial Policies Manual*).

Double catch basins shall be considered for road grades 3.0% and greater where herringbone openings are utilized, where leaf fall from significant adjacent tree canopy may impede capture of surface flows, and where drainage is directed to the end of a cul-de-sac. To mitigate blockages associated with debris and leaf fall at double catch basins, the structure shall be oriented such that the cell with the lead is placed furthermost downstream position.

Catch basin placement shall consider the impact to surface flows resultant from road superelevation.

Catch basin pups shall be used where alternate locations are not viable, to mitigate conflicts between the structure or lead with COH or third-party utility infrastructure. The transfer of vehicle loads to such COH or third-party utility infrastructure should be evaluated.

SEW 5.3. Frame and Covers

Where a utility-free boulevard is available adjacent to the road, preference shall be given to offset curb placement to remove the frame and cover from the wheel path of road users. Where the boulevard is concrete, delineation from the adjacent concrete sidewalk shall be provided to direct pedestrians from this hazard. Offset curb placement shall be per *Standard Road Drawings* RD-110.01 and RD-110.02 with frame and cover per *OPSD 400.100 (Flat Grate with Square Openings)*.

Where a utility-free sidewalk is available adjacent to the road, preference shall be given to side inlet placement to remove the frame and cover from the wheel path of road users. Potential placement of a watermain or third-party utilities within the sidewalk should be evaluated as part of the placement of side inlet structures. Side inlet frame and cover shall be per *OPSD 400.082 (Raised Curb Inlet)* with inlet bars per the *Approved Products List*.

Where single and double catch basins are placed at locations where surface flows are trapped (inclusive of low points and locations adjacent to bumpouts and elevated walkways/intersections), frames and covers shall be per *OPSD 400.020 (Flat Grate with Square Openings).*

Where double catch basins are provided at low points, preference shall be given to frames and covers per *OPSD 400.100 (Flat Grate with Square openings)*.

Where single and double catch basins are placed in an at-grade multi-use or cycling facility at a grade of 2.9% grade or less, preference shall be given to frames and covers with herringbone openings.

Where single or double catch basins are placed within the travel path of a bike lane/multi-use path that is not adjacent to a curb, then the square frame and circular cover with herringbone openings should be used (no hinges) per *OPSD 400.070*.

Where road drainage is problematic, consideration shall be given to the placement of frames and covers per *OPSD 400.020 (Flat Grate with Square Openings)*.

For placement in swales and adjacent low areas within the ROW, there are two options for frame and covers:

- Option 1: per *OPSD 400.100 (Flat Grate with Square Openings)*
- Option 2: per *OPSD 400.120 (Birdcage Grate)*

SEW 5.4. Rear Lot Catch Basins

Rear lot catch basins shall be fully located within a single lot inclusive of the lead. They shall be per *OPSD 705.010* and provided with a frame and cover per *OPSD 400.120*. Rear lot catch basins shall not be provided with a sump or goss trap.

Rear lot catch basins that are provided for the collection of surface flows from rear lot swales, inclusive of that portion of the lead outside of the ROW, are deemed private. Therefore, maintenance is the responsibility of the Property Owner.

SEW 5.5. Leads and Goss Traps

Single and double catch basin leads shall be 250mm in diameter and provided with goss trap per *Standard Sewer Drawing* SEW-304. Ditch inlets connected to storm sewers by a 250mm outlet pipe also require a goss trap. Catch basin and double catch basin leads shall have a minimum grade of 1%, however this may be reduced to 0.7% in a park or landscape application where dictated by site conditions and with the approval of COH.

SEW 5.6. Lay-by Drainage

Where possible, the road and lay-by shall share a common crossfall and surface flows are directed to the back curb of the layby installation. Where local constraints dictate it is permissible to direct surface flows from the layby to the continuous curbing separating them from the road. Where flows are directed to the continuous curbing, *OPSD 600.030 (Mountable - 800mm in width)* shall be used.

SEW 6 SANITARY SEWER DESIGN

Sanitary Sewers shall, by default, be designed per the provisions of *SEW 3.4.1 Sewer Design Requirements to Address Inflow and Infiltration* except where data is submitted that clearly demonstrates that the seasonally high groundwater table is not located 0.6m or more above the sanitary sewer obvert.

This section outlines requirements for the design of new sanitary sewers. Retrofitting projects may require more stringent design criteria based on available downstream capacity, limited space for construction, the presence of combined sewers, and/or allowances for future intensification. Design criteria for retrofit sewers shall be per COH direction and in accordance with population density information from the *Water, Wastewater and Stormwater Master Plan.*

For sewer rehabilitation projects, the Designer shall demonstrate that the proposed method of rehabilitation will meet the capacity and velocity requirements outlined in *SEW 6.4 Sanitary Sewer Sizing, Capacity and Velocity* unless otherwise directed by COH.

Designs for new, retrofitted, and rehabilitated sanitary sewers may require an application to amend the COH's existing CLI ECA if they do not comply with the *Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under Environmental Compliance Approval* (see *SEW 1 REGULATORY FRAMEWORK*).

SEW 6.1. Sanitary Design Flows

Sanitary flows are inclusive of wastewater discharges from Residential/Commercial/Institutional/Industrial lands and the infiltration associated with surface runoff and groundwater flows.

Sanitary trunks convey these flows and that portion of combined sewer flows that are intercepted at common locations along the system.

Sanitary Design Flow = Average Dry Weather Flow x Sanitary Peak Factor (M) + Infiltration Allowance

See *SEW 3.17.1 Drainage Area Plans*.

SEW 6.2. Average Dry Weather Flow

In accordance with the *Water and Wastewater Master Plan* (COH, 2006), sanitary sewers shall be designed for 300 litres per capita per day (L/ca/d) for residential land use and 260 litres per employee per day for employment lands (including industrial, commercial, and institutional land uses).

Minimum Inflow and Infiltration rate used in sanitary sewer sizing shall be per *SEW 3.4.1 Sewer Design Requirements to Address Inflow and Infiltration*.

Average Dry Weather Flow for sanitary sewers shall be based on the population densities identified in the *Water, Wastewater and Stormwater Master Plan* or as directed by COH. For external areas not currently identified shall be assigned values that are reflective of anticipated development patterns to the satisfaction of COH.

Requests for exception to these criteria shall be reviewed by COH on a project-by-project basis. Requests shall be based on actual sanitary flow monitoring data (commercial and industrial) or historical water use data (institutional) of a minimum 2-year duration.

SEW 6.3. Sanitary Peak Factor

Sanitary Peak Factor (M) shall be determined by the Babbit equation:

$$M = \frac{5}{P^{0.2}}$$

Where P = persons (in thousands) contributing to the sewer.

For residential flows, the peaking factor should range from 2 to 5. Where the population is smaller than 1000, the Designer shall use the peaking factors defined in the *MECP Design Guidelines for Drinking Water Systems*.

For sewage flows from individual commercial or institutional properties, the peaking factor can be determined using peak water usage rates for these facilities. At minimum, a peaking factor of 1.5 shall be used in the design.

SEW 6.4. Sanitary Sewer Sizing, Capacity and Velocity

SEW 6.4.1. Sanitary Sewer Sizing

Permissible sanitary sewer sizes range from 250mm to 600mm diameter for residential developments. Smaller (i.e., 200mm diameter) sewers may be permitted on a project-by-project basis, subject to COH approval, and shall be restricted specifically to the last run of a sanitary system at full buildout (i.e., the upstream-most segment where there is not anticipated further upstream contribution). Industrial and commercial applications require a minimum sanitary sewer size of 375 mm diameter. Sewers larger than 750 mm diameter will be considered by COH on a project-by-project basis.

SEW 6.4.2. Sanitary Capacity

Sanitary sewers shall be designed to flow at 75% full design capacity for sewers up to and including 450mm diameter and 60% full design capacity for sewers 525mm diameter and larger.

Capacity shall be determined using the Manning Equation:

$Q = AV$ $V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$ $R = \frac{A}{P}$

Where Q = capacity of the pipe flowing full (m^3/s)
V = velocity (m/s)
R = hydraulic radius (m)
A = cross-sectional area of pipe (m^2)
P = wetted perimeter (m)
S = gradient of pipe (m/m)
n = Manning's factor (0.015 for sewers up to 525mm diameter, 0.013 for sewers 600mm diameter and larger)

SEW 6.4.3. Sanitary Sewer Design Velocity

Sanitary design velocities (flowing full) shall range from 0.75m/s to 2.75 m/s to prevent deposition of solids, impair sulfide formation, and minimize erosion. Self-flushing velocities in sewers with lower pipe flows, such as those located on a cul-de-sac, shall be mitigated to the satisfaction of COH.

Where existing conditions preclude compliance in retrofit installations and at the sole discretion of the COH, measures inclusive of increased flushing operations shall be performed to mitigate sewer performance and maintenance operations.

SEW 7 STORM SEWER DESIGN

This document provides storm sewer design criteria related to conveyance to facilitate works within a municipal ROW, such as guideways, road widening, or municipal sewer system upgrades. Refer to the *Stormwater Management Design Criteria* for guidance relating to the design of stormwater management facilities, linear storage, Low Impact Development, and other stormwater management features.

Storm sewers shall be designed so that maximum depths of flows at the surface and the maximum HGLs in the sewer shall remain below the depth of footings for basements for up to the 100-year design storm.

Downspouts shall not be connected to storm sewers.

In retrofit situations, surface flows to the storm sewer or ditch from abutting lands shall continue to be collected by the constructed storm sewer or ditches. The Designer shall make reasonable efforts to capture flows from the ROW to abutting properties.

SEW 7.1. Storm Design Flows

Storm sewers shall be designed to the 5-year storm event at 85% pipe capacity (non-surcharged). The Designer shall also provide a capacity analysis of the major (overland) and minor (sewer) systems under no inlet capacity restriction and under 50% inlet capacity restriction.

Drainage areas shall be established in consideration of the following, to the satisfaction of COH:

- largest scale contour maps available for the area
- overall storm drainage area maps for the storm trunk sewers
- revisions to the development patterns or boundary conditions anticipated in the trunk sewer design
- concurrent Growth Project submissions
- current construction

See *SEW 3.17.1 Drainage Area Plans*.

SEW 7.2. Storm Sewer Sizing, Capacity and Velocity

SEW 7.2.1. Storm Sewer Sizing

Permissible storm sewer sizes range from 300mm to 2400mm diameter. Larger sizes will be considered by COH on a project-by-project basis.

SEW 7.2.2. Storm Sewer Capacity

Storm sewer capacity shall be determined using the Rational Equation:

$$Q = \frac{CiA}{360}$$

Where Q = Peak rate of runoff (m^3/s)

C = Runoff Coefficient (see *SEW 7.2.3 Runoff Coefficients*)

I = Rainfall intensity (mm/hr – see *SEW 7.2.4 Rainfall Intensity*)

A = Drainage area (ha)

The Designer shall determine storm sewer capacity using the Manning equation (see *SEW 6.4.1 Sanitary Sewer Capacity*) and a Manning's factor (n) of 0.013.

SEW 7.2.3. Runoff Coefficients

Runoff coefficients are summarized in *Table 2. Runoff Coefficients*. Conservative assumptions for land use and the runoff coefficient shall be used for blocks of land within a Plan of Subdivision without a proposed Site Plan. For external areas, coefficients shall be chosen to reflect the current neighbourhood Secondary Plan. In the absence of such, assigned values shall be reflective of expected development patterns as directed by COH.

Table 2. Runoff Coefficients

Land Use	Coefficient
Parks	0.25
Single Detached Residential	0.5 to 0.65
Semi-Detached Residential	0.65
Townhouses, Maisonettes, Row Houses, Apartments etc.	0.75
Institutional	0.75
Industrial and Central Business Districts	0.80
Commercial	0.90
Paved Areas	0.90 to 1.0

SEW 7.2.4. Rainfall Intensity

Rainfall Intensity (i) shall be determined using the Mount Hope IDF curves (refer to *Appendix SEW3: IDF Curves for Mount Hope*) and the following equation:

$$i = \frac{A}{(t_d + B)^C}$$

Where i = rainfall intensity (mm/hr)

t_d = time of duration (min)

A = refer to *Appendix SEW3: IDF Curves for Mount Hope*

B = refer to *Appendix SEW3: IDF Curves for Mount Hope*

C = refer to *Appendix SEW3: IDF Curves for Mount Hope*

The top end of the storm sewer system shall be assigned an initial time of duration (t_d) of 10 minutes. Time for conveyance for storm flows shall be based on full pipe flow velocities. Initial time of duration for external lands scheduled for future development shall be based on the most probable street pattern and storm sewer routing, in consideration of current neighbourhood Secondary Plans for the catchment area.

An IDF study was completed in 2022 to assess appropriateness of COH's current IDF curve with respect to climate projections. It was determined that, at this time, the IDF curve and its application would remain as-is but should be re-evaluated approximately every 5 years.

SEW 7.2.5. Storm Sewer Design Velocity

Storm design velocities (flowing full) shall range from 0.80m/s to 3.65 m/s.

SEW 7.3. Guideway Storm Collection

Sewer infrastructure related to the collection of storm flows within a transit guideway shall be located under the guideway and shall remain the responsibility of the Owner for the purposes of locates, replacement, and maintenance except as otherwise defined in writing by COH.

Location and number of connections to municipal sewer infrastructure shall be per the direction of COH.

Water quality mitigation shall be provided within the guideway limits and prior to connection to municipal sewer infrastructure.

SEW 7.4. Ditches and Swales

A swale is a shallow vegetated, u-shaped trench positioned at a low point in a landscape to detain, infiltrate, and/or evaporate water. In contrast, a ditch is typically a deeper, narrower trench that is intended to capture and convey flows to a downstream outlet like a storm sewer. Although they can be vegetated, ditches are more likely to be lined with concrete or rip-rap to mitigate erosion. Swales are more commonly applied in rear yards and parks, while ditches are more commonly applied at roadsides. Both ditches and swales require regular maintenance; for swales, this can entail mowing of vegetation while for ditches, this can involve clearing debris from the inlet to a downstream outlet.

Design criteria for swales is currently provided in the *Comprehensive Development Guidelines and Financial Policies Manual*; however, it will be superseded by the *Stormwater Management Design Criteria* once that document is released.

Roadside ditches shall have a maximum side slope of 2:1 and a minimum longitudinal slope of 2%. Where possible, the ditch shall have a minimum bottom width of 1m to allow for maintenance; however, v-shaped ditches are permitted if they are concrete- or rock-lined. The maximum depth shall be 1m and the freeboard under minor-system design flows shall be 0.3m below the top of the road subgrade.

SEW 7.5. Manufactured Treatment Devices

Manufactured Treatment Devices (MTDs) are devices such as oil-grit separators (OGSs) and filter devices that may be used in stormwater management plans to target the treatment and removal of pollutants from stormwater runoff to achieve regulatory water quality objectives. This section only discusses the use of MTDs in ROW installations. Refer to the *Stormwater Management Design Criteria* for MTD applications related to development and stormwater management facilities.

Oil-grit separators are structures consisting of one or more chambers that remove sediment, screen debris, and separate oil from stormwater. These devices typically use gravity separation to target coarse-particle suspended solids removal and phase separation to facilitate oil and grease removal.

Filter devices, such as Jellyfish filters, typically use filtration cartridges, filter media, or bio-filtration to target coarse- and fine-particle suspended solids removal. Depending on their design, these devices may also target other pollutants for removal such as nutrients or metals.

MTDs will be considered by the City of Hamilton on a project-by-project basis.

The Designer shall size MTDs to treat design flows from a minimum capture of 90 % average annual rainfall volume from its contributing drainage area(s), assuming no upstream flow attenuation. MTD performance shall demonstrate overall site-wide compliance with applicable suspended solids removal targets (to be confirmed with COH during design) as a standalone treatment device or as part of a larger stormwater management plan (refer to *Comprehensive Development Guidelines and Financial Policies Manual* or *Stormwater Management Design Criteria* – see Preface for order of precedence).

In addition, MTD units shall be sized to target a maintenance cleanout frequency of no more than once per year based on the accumulated annual sediment loading (average event mean concentration of 200 mg/L; sediment wet density of 1230 g/m^3) generated from the average annual precipitation volume (840 mm).

Where two or more MTDs are proposed to be installed in series, the combined removal efficiency of the MTDs will be assumed to equal the highest removal efficiency of any of the MTD units within the series.

SEW 7.5.1. Oil-Grit Separators

To determine the annual suspended solids removal performance for the OGS, the Designer shall:

- Calculate removal efficiencies for all design surface loading rates (SLRs) using the following formula:

$$SLR = \frac{Q}{A_T}$$

where:
SLR = surface loading rate
Q = flow (L/minute)
A_T = effective treatment area of the device (m^2)

- Interpolate the verified removal efficiency for each design SLR. The Design SLRs should fall between tested SLRs for the proposed OGS device.
  - If a design SLR is lower than the lowest tested SLR, then the Designer shall assume that the removal efficiency for that design SL's removal efficiency is equal to the verified removal efficiency for the lowest tested SLR.
  - If a design SLR is higher than the highest tested SLR, then the Designer shall assume that the design SL's removal is equal to the verified removal efficiency at the highest tested SLR.

In accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators* (Canadian Environmental Technology Verification Program, 2014), the sediment removal rate at the specified SLR determined for a tested full-scale OGS may be applied to similar OGSs of smaller or larger size by scaling. Scaling the performance results of a tested OGS to other model sizes without completing additional testing is acceptable provided that:

- sediment removal efficiencies for similar OGSs are the same or lower than the tested OGS at identical SLRs; and
- the similar OGS is scaled geometrically proportional to the tested unit in all inside dimensions of length and width and a minimum of 85% proportional in depth.
- An OGS may be installed in-line when:

- the hydraulic bypass capacity of the internal bypass structure is greater than the full pipe capacity of the inlet sewer, minus the design treatment flow required for 90 % average annual rainfall volume capture; or
- the hydraulic bypass capacity of the internal bypass structure is greater than the full pipe capacity of the inlet sewer, minus the maximum tested scour flow rate, and the TSS effluent concentration for the maximum tested scour flow rate does not exceed 25 mg/L (Canadian Environmental Quality Guidelines for High Flow) above the tested background influent concentration level.

An OGS may be installed off-line when the hydraulic bypass capacity of an upstream flow-diversion structure is greater than the full pipe capacity of the incoming sewer, minus the design treatment flow required for 90 % average annual rainfall volume capture.

SEW 7.5.2. Filter Devices

The filter device must have at least one of the following certifications:

- Washington State Technology Assessment Protocol – Ecology (TAPE) certification with General Use Level Designation (GULD) and be field tested per the TAPE Protocol (i.e., three rainfall events are captured that exceed the design rainfall intensity and depth corresponding to 90% of the average annual rainfall volume); or
- Field-tested per the TAPE Protocol and have valid ISO 14034: ETV verification.

The Designer shall use the Rational Method to estimate the design treatment flow to the filter device using the design rainfall intensity required for 90 % average annual rainfall volume capture. The filter device shall be sized to treat the design treatment flow to demonstrate compliance with site-wide water quality control targets, assuming no upstream attenuation.

The suspended solids removal claimed from the filter device will be based on the tested average removal efficiency of suspended solids up to a 95% confidence interval for the design treatment flow. The suspended solids removal rate determined for the filter device may be applied to other model sizes of that filter device, provided that:

- depth, composition, and gradation of media are scaled to provide the same efficiency of suspended solids removal;
- the ratio of the design treatment flow rate to effective filtration treatment area is the same or less than the tested filter device;
- the ratio of effective sedimentation treatment area to effective filtration treatment area is the same or greater than the tested filter device; and
- the ratio of wet volume to effective filtration treatment area is the same or greater than the tested filter device.

A filter device may be installed in-line when the hydraulic capacity of the internal bypass structure is greater than the full pipe capacity of the inlet sewer, minus the design treatment flow required for 90% average annual rainfall volume capture.

A filter device may be installed off-line when the hydraulic bypass capacity of an upstream flow-diversion structure is greater than the full pipe capacity of the incoming sewer, minus the design treatment flow required for 90% average annual rainfall volume capture.

SEW 8 COMBINED SEWER DESIGN

As discussed in *SEW 2 TYPES OF SEWER SYSTEMS*, new combined sewers are not permitted. As such, this section is intended to provide design criteria related to sewer separation projects or rehabilitation of existing combined sewers where separation of the system into storm and sanitary sewers is not feasible. Pre-consultation will be required with COH staff regarding the connection of sewer laterals and/or inclusion of flow splitting maintenance holes (this also requires pre-consultation with MECP). Combined sewer-related design must also conform to the requirements outlined in *Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under an Environmental Compliance Approval* (MECP, 2023).

Rehabilitation of existing CSO tanks shall only be permitted if the proposed modifications are intended to reduce the volume, frequency, or duration of a CSO discharge and/or to improve the quality of combined CSO discharges. New CSO tanks are not permitted. *F-5-5 Determination of Treatment Requirements for Municipal and Private Combined and Partially Separated Sewer Systems* requires minimum CSO controls including the capture and treatment for an average year, all DWF plus 90 % of the volume resulting from WWF that is above the DWF, applied above each overflow location or if it can be shown by modelling, on a system-wide basis.

Sewer construction or the introduction of a sewer lateral shall not increase the risk of CSO, surface flooding, or basement flooding.

Construction, consolidation and/or merging of sewers in High Order Transit Projects shall be per the provisions of this document and the *LRT Wastewater Analysis in Support of MECP ECA* (See *SEW 3.3 B-Line High Order Transit Projects*).

SEW 8.1. Flow Splitting Maintenance Holes

Flow splitting maintenance holes can be used to route flows up to a target flow rate to a target facility (i.e.: to WWTP), while bypassing flows that exceed the target flow rate to a CSO tank. They typically include concrete baffles, passive weirs, or a half tee section with a solid top and an orifice in the bottom of the tee section to split the flows. The Designer must consult with COH staff prior to incorporating a flow splitting maintenance hole in their design.

In addition to the requirements identified in *SEW 4 MAINTENANCE HOLES*, the following criteria shall be applied to the design of flow splitting maintenance holes:

- top of the baffle wall shall be located at the water surface for the design flow rate (i.e.: maximum flow rate to be directed towards WWTP).
- remaining flows shall enter the bypass line.
- Continuous simulation flow models shall use a 10-minute time step.
- maximum head shall be minimized for flows exceeding the design flow rate (i.e., flows to WWTP at the 100-year water surface shall not exceed the design flow rate by more than 10%)

- as an alternative to using a half tee section, a full tee section may be used with the top of the tee at the 100-year water surface elevation. This alternative would route emergency overflows (if the overflow pipe were plugged) through the target facility rather than back up from the maintenance hole.
- special applications, such as roads, may require the use of a modified flow splitter. The baffle wall may be fitted with a notch and adjustable weir plate to proportion runoff volumes other than high flows.

SEW 9 FORCEMAIN DESIGN

Forcemains are single pipe systems, without sewer laterals, which convey sanitary or storm flows which are used in the absence of gravity piping solutions as permanent infrastructure. As such, forcemain design must be inclusive of pumping stations (refer to the *Wastewater Outstation Design Manual*).

Forcemains may be used in several applications including:

- construction as a bypass system for interrupted gravity flows using portable pumps
- conveying storm flows without an overland flow route
- conveying sanitary flows from a lower upstream gravity system to a higher downstream gravity system.

If a project necessitates the design of a forcemain, the Designer shall consult with COH to facilitate approval in principle so that the requisite design, operation, and maintenance standards can be provided at the onset of the project. Forcemains and pumping stations shall be designed together to optimize lifecycle costs with operations and maintenance activities.

The Designer shall approach forcemains holistically, considering interactions between the pumping station and the forcemain with respect to maintenance.

Forcemains systems provided for the purpose of site servicing shall be inclusive of transition maintenance holes located outside of the ROW and shall remain the responsibility of the Owner. COH ownership shall be restricted to the maintenance hole at the connection point with the existing sewer system.

Negative internal or positive external pressure conditions in the system create a potential for contaminated groundwater or surface water entering forcemain systems at leaks or breaks in piping, air release and vacuum relief valves and blow-offs or sewer systems at joints breaks in piping.

To avoid misidentification as water infrastructure, forcemains shall be constructed of green or white piping per the direction of COH. Tape marked “Sanitary” shall be provided full length above the pipe.

Stainless Steel piping shall be provided in chambers and transitioning of pipe materials shall be restricted to outside the chambers. See *SEW 9.12.3 Chamber Piping and Fittings*.

Protective interior coatings and/or materials shall be applied within transition maintenance holes to address deterioration related to the presence of hydrogen sulfide and other corrosive chemicals.

Provision of maintenance holes shall be inclusive of the requirements of forcemain connections.

Forcemains of lengths 150m and greater shall be inclusive of swab launching chambers per the provisions of *SEW 9.12.11 Inspection, Swab Launching, and Retrieval Ports*.

Flushing ports, swab catching ports and isolation valves shall be provided on forcemains to facilitate maintenance operations as identified by COH.

Cleanouts/drain chambers are to be provided at the low points of a forcemain to facilitate maintenance. Chambers must contain drain valves with flanged connections. Where possible, valve chambers shall be drained to nearest gravity sanitary sewer/MH or drained back into the wet well.

For projects involving road widening, the Designer shall place valves outside of the widening area where possible to minimize the need for vent relocations in the future.

To facilitate maintenance and emergency works, forcemains crossings of watercourses, railways and highways shall be twinned to achieve redundancy inclusive of dual casings and requisite valving. Additional pipe twinning measures shall be provided at the direction of COH.

Casings at crossings of third-party utility infrastructure (MTO, rail, gas main corridors) shall follow the requirements of the third-party. Casings shall also be provided at river/creek/culvert crossings, major trunk/watermain crossings, or when suspended on bridge.

For forcemains, the casing diameter shall be at least 400mm larger than the diameter of the carrier pipe. Annular space shall be grouted with cementitious grout or as per third-party requirements. The casing material shall be per the *Approved Products List* or third-party requirements.

Forcemain infrastructure and appurtenances shall be placed below the HGL associated with lower pumping rates to minimize use of air release and vacuum relief valves.

A cleanout or blow-off valve shall be included in forcemain chambers. A Cam-Lock connection may be provided in chambers for pumping to a truck where bypassing to a nearby gravity sewer is not feasible. The Designer shall also consider inclusion of a swab catch in forcemain chambers to aid future maintenance.

Non-return (check) valves shall be provided where forcemains are connecting into a common forcemain. They shall be sized based on the smaller forcemain.

SEW 9.1. Forcemain Sizing and Velocity

Permissible forcemain sizes shall be restricted to 100mm to 350 mm diameter. Smaller (i.e., 75mm) or larger sizes (i.e., greater than 350mm diameter) will be considered by COH on a project-by-project basis.

Velocity of flows through forcemains shall be calculated using the Hazen-Williams formula:

$$V = kCR^{0.63}S^{0.54}$$

Where V = velocity (m/second)
k = conversion factor (for Metric system value = 0.849)
C = roughness coefficient
R = hydraulic radius (m)

S = Slope of the energy line (head loss per length of pipe or hf/L)

Where data is unavailable, forcemains shall be designed using representative roughness coefficients presented in MECP Design Criteria, namely 100 for unlined steel pipe or concrete pipe and 120 for PVC, HDPE, or lined ductile iron. Forcemains may have significantly higher initial "C" factors.

Full-flowing forcemain design velocities shall range from 0.6m/s to 2.5m/s, however the desirable minimum velocity is 1.0m/s.

Forcemains shall maintain a uniform grade to the satisfaction of COH.

Forcemain connections, size and profiles shall be chosen to minimize excessive negative head to the system and minimize the duration where the pipe is not flowing full.

SEW 9.1.1. Forcemains Suspended on Structures

Where the grades and elevations of a forcemain require it, or where the construction requirements and long-term maintenance impacts related to lowering a forcemain under a Watercourse, Railway or roadway adjacent to a bridge or large culvert are deemed unacceptable by COH, the forcemain shall be suspended from the structure subject to approval from the owner of the structure.

The Designer must demonstrate that the existing structure can support the load of the forcemain running full and impacts from surge pressures during operation. Any modifications to the structure will require the prior approval of the owner.

The pressure class of the suspended forcemain shall be based on hydraulic analysis using the COH model.

Permitted forcemain materials:

- Butt-fused HDPE pipe to match or exceed the thermal and engineering characteristics of the Urecon U.I.P.® system of pre-insulated pipes complete with aluminum spiral-wound wrap designated by COH. Maximum size permitted is 600mm diameter.
- Restrained joints not permitted for suspended forcemains.

Butt-fused joint tolerance shall not be off the OD by more than 5% of wall thickness.

Connection of the forcemain to the structure will need to consider expansion of the pipe material, expansion of the bridge structure, and incorporation of flex couplings and/or expansion joints to accommodate this movement.

Suspended forcemains shall be insulated per *SEW 3.6 Insulation.*

SEW 9.2. Forcemain Connections

Forcemains shall discharge to maintenance holes and be sized per *SEW 6.4.1 Sanitary Sewer Sizing* or *SEW 7.2 Storm Sewer Sizing*.

Transition maintenance holes shall be provided at forcemain discharge points for flows greater than 30 L/s to provide smooth flow transition into the receiving gravity sewers. An additional upstream transition maintenance hole shall be provided such that flows are laminar when they reach the downstream maintenance hole being provided at the point of connection to the existing gravity system.

Transition maintenance holes shall have no gravity sewer connections except for the downstream pipe. These maintenance holes shall be a minimum size of 1200mm per *OPSD 701.010* with a minimum access diameter of 610mm. The upstream forcemain invert at a transition maintenance hole shall not be more than 300mm above the flow line, at an elevation below historical and anticipated surcharging, or at an elevation above groundwater levels. Gravity sewer leaving the transition maintenance hole shall be:

- sized to flow at half depth;
- at least one size larger than the forcemain;
- 300mm or larger;
- provided with protective interior coating of corrosion resistant material in transition maintenance holes and the next downstream maintenance hole to prevent deterioration due to presence of hydrogen sulfide or other corrosive chemicals, it is further required that provision of protection on piping 30m upstream of transition maintenance holes and to the second maintenance hole beyond transition maintenance holes be reviewed. Where such piping is PVC or lined, this requirement is waived. Piping between the maintenance holes and the downstream maintenance hole shall be restricted to PVC;
- provided with backflow prevention; and
- where the available, downstream sewer capacity requires restrictions of pump discharge rates, a water level monitoring sensor shall be installed to transport a signal back to the pump control system.

SEW 9.3. Odour Control for Forcemains

The Designer shall provide engineering calculations of potential for H_2S generation in the forcemain and provide measures to prevent odour generation.

Passive odour control modules shall be installed in:

- Transition maintenance holes
- chambers with air release and vacuum relief valves
- downstream maintenance holes identified by COH

The modules must be constructed with non-corrosive materials and hold at least 20 pounds (9 kilograms) of catalytic granular activated carbon (see *Approved Products List*).

SEW 9.4. Transient Pressures

The Designer shall include transient analysis for all proposed forcemains. The transient analysis shall:

- address the worst-case failure scenario (most critical pump and forcemain-in-service combination) to the satisfaction of COH;
- be based on hydraulic modeling which reflects the finalized size and layout of pumps, pipe profile and the location of sewage air/vacuum release valves;
- identify the requirement for devices which protect forcemain infrastructure and address impacts from water hammer and cyclical reversals of stresses, inclusive of air release and vacuum relief valves5, surge valves, surge tanks and slow closing check valves;
- determine HGLs for minimum, average and maximum anticipated pumping rates; and
- identify requisite increases to pipe strength over the minimum standards provided.

Forcemains pipes, joints, fittings and valves shall be designed to withstand the maximum operating pressure plus the surge pressure created by stopping a water column moving at the greater of:

- 0.6 m/s, or
- the theoretical velocity in the forcemain.

SEW 9.5. Abandonment of Forcemain Infrastructure

Prior to removing or abandoning a Forcemain, piping shall be cleaned, flushed and the debris removed using a Hydrovac vehicle. Operation shall be inclusive of COH permits, water costs and disposed costs at a MECP-licensed landfill.

Where the length of the forcemain exceeds 150m, swabbing shall be used in lieu of flushing. The Designer shall incorporate access for swab launching/catching in chambers for long forcemains.

Abandoned forcemains shall be grouted if under critical infrastructure such as roads or railways, if the pipe diameter is 525mm or larger, or at the direction of COH (to be assessed on a project-by-project basis).

[5] Design shall assume air release and vacuum relief valves are in a non-functional state.

SEW 9.6. Temporary Bypass of Sewer Flows

Although full design of temporary bypass is typically provided by the Contractor during construction (see *Construction and Material Specifications*), the Designer shall consider the constructability and components of the by-pass and consult with COH during the design phase. This is inclusive of:

- size of bypass piping
- proposed flow rates
- duration of each phase of the work
- delineated staging areas for pumps
- location of maintenance or access points for suction and discharging piping
- size, material, and location of suction and discharge piping
- standby power generator size and location
- requirements monitoring equipment
- characteristics of standby pump(s) such as size, capacity, and power requirements
- standby power generator refueling requirements and restrictions
- method of noise control for each pump and generator
- details of bypass pipe crossings, for example, driveways and sidewalks
- strategies to mitigate issues related to night work and spills (light, noise, odour, and protection of environmental features)

Where pumps are required to provide a temporary path around construction operations, the system shall be sized to convey the capacity of the upstream pipe flowing full.

The duration of the by-pass system shall be minimized to the satisfaction of COH.

SEW 9.7. Corrosion Control for Forcemains

All metallic components in forcemain systems shall be protected from corrosion.

Where ductile iron, steel or concrete forcemain pipe are to be used, resistivity and corrosiveness of the soil must be completed by geotechnical investigation for the purposes of designing corrosion protection systems for these pipe materials. The corrosion protection systems for the forcemain shall be designed by an engineer who is National Association of Corrosion Experts (NACE) Certified.

Consideration should be given to protection against galvanic corrosion when appurtenances and metal pipe of differing materials are connected. Flanged connections with dissimilar metals shall have full isolation gaskets to prevent corrosion.

Dielectric insulation shall be installed at the points of connection to the existing system to isolate the works within an electrified corridor and 3m from both limits of an overhead hydro corridor. The Contractor shall not compromise existing electrical grounding system connected to a metallic water service.

In electrified High Order Transit corridors, subsurface metallic forcemain infrastructure that is removed from service shall be excavated and disposed of in its entirety.

Zinc anode caps shall be provided on all valves located within chambers.

Concrete forcemains shall be made of sulfate-resistant concrete (type 50) and shall also meet all corrosion-proof recommendations as indicated by the geotechnical findings.

Wet wells, transition maintenance holes, and gravity sewers that directly receive flows from forcemains shall be lined or made of sulphate-resistant materials (type 50) to minimize corrosion. The Designer shall also consider whether hydrogen sulphide gas could affect the downstream maintenance hole and provide a requirement for sulphate-resistant lining if needed.

Where metal fittings are used on PVC mains, an approved corrosion protection tape system (primer, mastic and tape) and cathodic protection shall be installed on the fittings. The corrosion protection tape system shall cover the entire fitting, including restraints and bolts.

Protective coating systems for metal fittings and piping shall be considered additional to the corrosion control system. Petrolatum coatings meeting AWWA C217 are the preferred method of corrosion protection of metallic appurtenances both inside and outside of chambers.

Metallic fittings, valves and joint restraints shall be wrapped end to end with an approved corrosion protection system inclusive of petrolatum prime, petrolatum moulding mastic, and low temperature petrolatum tape. Materials from a single manufacturer shall be used exclusively throughout a project.

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.

Anodes shall be used to cathodically protect ductile iron forcemains. All sacrificial anodes shall consist of a packaged magnesium casting with a minimum weight of 14.5 kg and a length of approximately 560 mm. Anodes shall be installed along the entire length of ductile iron forcemain following the spacing requirements as per *OPSS.MUNI. 442 Table 4*.

SEW 9.8. Third-Party Utility Infrastructure

As part of a Municipal Consent Application, pre-consultation with COH is required for third-party utility installations that cross forcemains, do not meet minimum offset requirements to COH subsurface infrastructure, or are part of a coordinated third-party utility relocation in a corridor.

Where directed, third party utilities shall field verify (by hydro-excavation) the location(coordinates), depth to top of pipe, and obvert elevation of the forcemain at the point of crossing during the design stage of the project. COH will review and identify whether the installation may pass under or over the forcemain. COH will also identify if hydro-excavation shall be required during construction.

Where forcemain operations are adjusted to facilitate construction, the third-party utility shall provide COH with a Purchase Order to facilitate invoicing the costs to the Owner associated with:

- operation of valves;
- draining, dechlorinating and discharging;
- monitoring of discharges;
- temporary trucking; and
- the provisions of COH *By-Law No.14-090 - Sewer Use.*

Duration shall be minimized to the satisfaction of COH and in accordance with the current Municipal Access Agreement.

Where forcemain is to be taken out of operation to facilitate construction of a third-party utility, the Designer shall obtain consent from COH for the crossing and the duration of shutdown.

Clearance requirements for the construction of third-party utility infrastructure in relation to sewer infrastructure are provided in the *Right-of-Way Utility Installation and Permit Manual*. Exceptions to these requirements shall be at the sole discretion of COH.

SEW 9.9. Support of Forcemains during Construction

All existing forcemains shall be temporarily supported when sewers, watermains, forcemains or third-party utilities are installed under them. The temporary support shall be designed by a licensed professional engineer practicing in the Province of Ontario and submitted as a shop drawing by the Contractor in accordance with *Form 500* for review by COH. The temporary support system shall be designed to achieve zero or no deflection to the existing forcemain.

The existing forcemain must be permanently supported using unshrinkable fill before the temporary support is removed.

SEW 9.10. Forcemain Alignment, Vertical and Horizontal Deflections

Deflections in forcemain alignments (i.e., longitudinal and vertical bends) shall be placed per the following order of precedence: 11.25°, 22.5°, 45°. The use of 90° longitudinal or vertical bends for forcemains should be avoided.

The midpoint of forcemains shall be centered at crossing points of COH and third-party utilities.

Forcemains and retaining walls shall not be constructed such that a forcemain is behind the wall.

Forcemains and associated valve chambers shall be placed such that maintenance and future replacement activities, using standard construction equipment and trench boxes can be fully achieved by excavation in either the road or the sidewalk/boulevard or without impacting multiple surface features and treatments inclusive of curbs.

Shifts in longitudinal alignments shall be minimized to the satisfaction of COH.

Placement of forcemain infrastructure shall mitigate impacts to the use of vehicular lanes during maintenance activities.

Forcemain installations shall be provided with 2.5m separation from High Order Transit guideway and/or lanes where placed parallel to them.

Deflections in forcemain alignments and the use of horizontal bends shall be minimized to the satisfaction of COH.

Axial (Barrel) deflection of PVC and PVCO piping is not permitted.

Deflection per pipe and number of pipes being deflected shall be annotated on Engineering Plans.

Permissible pipe deflections shall be restricted to 50% of the manufacturer’s recommendations.

Restrained PVC pipes shall not be deflected.

Deflection of the pipe barrel for changes in line or grade are not permitted.

Provision and location of bends and associated anchor blocks on forcemains shall be minimized and to the satisfaction of COH.

SEW 9.11. Forcemain Depth and Vertical Clearances

The minimum depth of cover for forcemains shall be 1.6m. Depth of cover shall be measured from the crown of pipe, to the lower of the following:

- final road and/or ground elevation in the Project; and

- ultimate road and/or ground elevation[6] identified in documents inclusive of:
  - a preliminary design;
  - an Environmental Assessment; and
  - a Master Plan.

Minimum 2.0m cover shall be provided from the exposed slopes of ditches and/or roadside grading. Perpendicular crossings of ditches and roadside culverts shall be per the following:

- 1.8m cover under roadside culverts 600mm and less; or
- 2.0m cover under ditches.

Staging shall be such that:

- a permanent reduction in depth of cover does not results from a temporary constraint; or
- forcemain depths remain constant and vertical conflicts between new and existing forcemains are addressed to the satisfaction of COH.

Depth of cover may be incrementally increased to a maximum of 3.0m when the following are addressed to the satisfaction of COH:

- operability of associated chamber appurtenances;
- chamber dewatering;
- instances of low and/or high points in the forcemain profile, number of chambers and costs are minimized; and
- provisions of *SEW 3.1.1 Clearance and Separation between Sewers/Forcemains and Watermains* and/or *SEW 9.8 Third-Party Utility Infrastructure* are met.

Depths of cover on forcemains and chamber piping greater than 3.0m shall be at the sole discretion of COH upon review of alternate profiles and confirmation that depth does not compromise the operability of valves from outside the chamber.

SEW 9.12. Valves and Chambers

To minimize the provision of chambers and simplify maintenance operations, the Designer shall look for opportunities to locate line valve chambers at high and low points in the forcemain profile and near a suitable discharge location (see *SEW 11 REFERENCES*).

[6] Use of the elevations shall be at the direction of COH and independent of whether the documents are completed or in progress. Where the future profile of a rural road (collector or arterial) is undetermined the Watermain shall be provided with a minimum 2.0m depth of cover.

The supply of pre-cast chambers shall be limited to plants identified Plant Prequalification Program by the Canadian Concrete Pipe and Precast Association.

Chambers, inclusive of service valves and access points, shall be located to promote safe operation and mitigate traffic impacts associated with future maintenance. Placement shall prioritize minimizing impacts to the main road or as identified by COH. Valve and person access covers shall not be located in the wheel path of vehicles.

Frost heaving of chambers shall be mitigated with the installation of frost strapping (per *OPSD 701.100*) or an alternate methodology to the satisfaction of COH.

Additionally, the following shall apply:

- chamber removals shall be full depth;
- minimum 1.8m clear height within chambers;
- maximum 500mm chimney height (finished ground to underside of chamber ceiling);
- thrust walls are required on both sides of chambers and shall be capable of withstanding the requisite thrust forces;
- removable chamber roof slabs are to be located above valves as directed by COH;
- chamber access hatches shall be lockable, where identified by COH;
- pipe material transitions shall be:
  - outside the valve chamber;
  - placed at standard depths where the point of connection and replacement valving is at the deeper depth of cover. The transition to the shallower depth can then be achieved by close-coupling two vertical bends in the other legs; and
  - achieved by connecting the deeper forcemain by close-coupling two vertical bends to the existing cross or tee after the placement of valving on the deeper forcemain.

The Contractor shall taper the bottom of earth trench with Granular “A” for 2m where it transitions to the bottom of a rock trench to mitigate differential settlement between the two bedding conditions.

- a full pipe length outside of chambers shall be installed at a grade of 0%.
- valving is not permitted in, or adjacent to the vehicular lane of a roundabout or traffic circle. COH approval is required for the placement of valving in the truck apron where such is provided.

The Contractor shall be responsible for the repair of valving on forcemains that impact a shutdown per the direction and under the supervision of COH three (3) days in advance of the shutdown operation.

Where a COH standard is not available for a requisite valve chamber, the design shall be inclusive of the following components of standard chamber installation:

- backflow preventers, couplings, curb stops, pitometers, fittings, flanges, valves, insulation, joint restraints, reducers, stainless steel flange bolts, main stops, corporation stop, service boxes, tracer wire, adaptors, line valve, check valves, blow-off valve, air release and vacuum relief valves, main stops, valve supports, service saddles, waterproofing, piping, ladder rungs, safety grating, lifting hooks, valve stem extensions, grouting, concrete, frames and covers
- vertical and horizontal separations, clearances and offsets
- frames and covers at the point of person entry shall be 750mm diameter per *OPSS 1850.*
- openings in the roof slab shall be manufactured or cored
- concrete adjustments shall be inclusive of bond breaker
- thrust walls inclusive of dimensions, concrete, dowelling and reinforcing steel.

COH and third-party utility maintenance holes, chambers and vaults shall be removed full depth. Where the associated piping and ducts are not removed by construction operations, the ends of piping and ducts shall be capped with concrete and backfilled with Granular “A”.

Valve chamber orientation shall be mirrored on the pipe axis and perpendicular to it to best suit surface and subsurface constraints.

At air release valve chambers, the Designer shall incorporate swab ports for pigging and CCTV access where possible.

SEW 9.12.1. Forcemain Standards

Forcemain line valves shall be bi-directional, resilient seat, stainless steel knife gate valves and be provided on the pump side of lowerings, in swab launching chambers, and as directed by COH.

Concrete valve chambers shall be provided for all forcemain valves (direct bury is not permitted).

Valve chamber covers shall be set flush with the finished grade. Where chambers are located in the shoulder of the road, the shoulder shall be paved and constructed per *Standard Road Drawing RD-111.*

Impacts of future COH maintenance operations to the use of sidewalks, cycling facilities and vehicular lanes shall be addressed to the satisfaction of COH. The placement of valve and person access covers shall be prioritized on minor roads. Where possible, placement of valve and person access covers shall be eliminated in:

- crosswalks, urban Braille clearways/shorelines and sidewalks adjacent to High Order Transit guideways/routes/stops or corridors with higher pedestrian volumes;
- cycling facilities that are bounded by the roadway curbing and continuous concrete curbing or barrier; and/or
- adjacent to single lanes bounded by roadway curbing and a central median or guideway or station stops

The placement of valve and person access covers shall also be minimized:

- in and within 30m of signalized intersections;
- in sidewalks, multi-use trails and cycling paths;
- within 3m of overhead utility wires;
- where impacts would extend to multiple lanes on the street and/or side street;
- in unsignalized intersections (inclusive of maintaining turning movements);
- at transit stops and in parking spots;
- in the wheel path of vehicles; and/or
- minimized in unsignalized intersections (inclusive of maintaining turning movements).

SEW 9.12.2. Valve Chamber Placement

Valve chambers shall be placed to facilitate safe chamber access for workers/crew/maintenance vehicles considering traffic flow and movements in the surrounding area.

Designers shall follow valve manufacturer’s recommendation for valve tie downs.

SEW 9.12.3. Chamber Piping and Fittings

Forcemain chamber piping shall be restricted to stainless steel, minimum Schedule 40, Grade 304L or 316L. Installation shall be inclusive of stainless-steel piping for air release and vacuum relief valves and pitometers. Consideration of stainless-steel chamber piping shall be predicated on COH review and acceptance of detailed piping layout drawings provided prior to shop drawing submission. Fittings shall be stainless-steel.

The use of ductile iron, minimum pipe Class 54 and per AWWA C151 and C104 within a swab launching chamber will be approved by COH on a project-by-project basis.

SEW 9.12.4. Chamber Drainage

Chambers and related automatic air and vacuum release valves shall not be located:

- at low points in the topography;
- in areas subject to surface flooding; or
- in areas where the water table is higher than the chamber floor.

Where placement per above the above restrictions can’t be achieved, buoyancy and the infiltration of ground and/or surface water shall be mitigated to the satisfaction of COH.

All chambers shall be inclusive of a sump and the provision of a backflow preventer.

Intermediate connections of forcemain chambers to existing sewers or maintenance holes will be considered by COH on a project-by-project basis. As a minimum, forcemains shall not be connected to a sewer or maintenance hole where the sewer's hydraulic grade line is above the chamber floor or to a storm sewer where the sewer outlets to a watercourse.

Chambers or pits shall drain to the ground surface, to sub-surface absorption pits, or to a sump within the chamber where the groundwater level is above the chamber floor.

Contractor shall be responsible for emptying chambers that are fully or partially submerged to facilitate COH operation of the valves related to the construction activities.

SEW 9.12.5. Limits of Work

Valving on side streets and at the project limits shall be cut-in at the beginning of construction operations to provide reliable control and mitigate unscheduled impacts to users outside of the project. Exception to these criteria shall be at the discretion of COH.

Construction of side street forcemains from a corridor (inclusive of valving and removals) shall as a minimum, extend to the greater of the following:

- 10m beyond the applicable back of walk in the corridor under construction;
- beyond the side street catch basins; or
- beyond the curb return.

SEW 9.12.6. Supplemental Valving - Crossings and Lowerings

Chambered line valves for forcemains are required on the upstream side of the crossing for watercourses, railway corridors, provincial highways, High Order Transit corridors, and roads. They are also required adjacent to watercourses, railway corridors, or provincial highways. To facilitate leak detection, a pitometer shall be located on both sides of the line valves.

Valving shall be located a minimum of one pipe length from:

- the terminus of the casing pipe;
- the extension of a railway corridor; or
- a lowering.

SEW 9.12.7. Air Release and Vacuum Relief Valves

Air release and vacuum relief valves shall be provided at all high points in the forcemain profile (including local high points) or spaced along significant lengths of pipe to mitigate the accumulation of air during their operation. They open against internal pressure because the internal lever mechanism multiplies the float force to be more than the internal pressure.

Air and vacuum release valves shall be chambered and provided on the downstream side of chambered line valves or as directed by COH. Chambers containing air and vacuum release valves shall not be located in areas where submergence by surface waters could occur or connected to a sewer except where identified by COH.

Air release and vacuum relief valves shall conform to AWWA standard C512-15 Air Release, Air/Vacuum and Combination Air Valves for Water and Wastewater Service and this document.

Sizing and location(s) of air release and vacuum relief valves on forcemains shall be determined by transient analysis per *SEW 9.4 Transient Pressures*.

Air release and vacuum relief valve piping shall be provided with a screened, downward-facing elbow to prevent blockages and the ingress of water per *Standard Water Drawing WM-201.04*.

SEW 9.12.8. Automatic vs Manual Operation

Where the need for an automatic valve is not clear, manually operated valves shall be used initially. COH will monitor air accumulations and substitute an automatic valve as required.

Where drainage is provided for a manually operated valve, air release and vacuum relief piping shall be extended to the top of the chamber. For automatic valves, air release and vacuum relief piping shall be extended to a minimum 300mm above grade.

Discharge piping from air and vacuum release valves shall not connect directly to sewers or drainpipes.

SEW 9.12.9. Blow-Offs (Drain Valves)

Blow-offs are provided at low points in the forcemain profile to facilitate draining in maintenance, inspection and construction operations and shall be located near suitable discharge locations per the provisions of *SEW 9.12.4 Chamber Drainage*.

Blow-offs chambers shall be provided on forcemains inclusive of a flanged connection and as directed by COH. They shall not be located near watercourses or connected to a sewer except where identified by COH.

Blow-offs valves shall also be chambered and provided on the upstream side of chambered line valves or as directed by COH.

Every design effort should be made to drain all chambers that house a blow off to an accessible storm sewer.

SEW 9.12.10. Pumping Stations

It shall be incumbent on the Designer to inform COH as soon as possible where the need for a pumping station has been determined so requisite design, operation and maintenance standards can be provided at the onset of the project.

Pumping stations shall be designed and constructed as long-term facilities independent of their expected duration of use.

Relaxation of criteria for short-term facilities will at no time be given consideration.

SEW 9.12.11. Inspection, Swab Launching, and Retrieval Ports

Forcemain installations 150m and longer shall be inclusive of the placement of a swab launching chamber adjacent to the pump station.

SEW 9.13. Pipe and Fitting Restraints

SEW 9.13.1. Anchor and Thrust Blocks

Provision of anchor and thrust blocks is applicable to rock installations and in soils with a bearing capacity of 2000 to 4000psf (15 to 30 blows/300mm penetration). Otherwise, piping shall be inclusive of full mechanical restraint at fittings and pipe joints.

Except where precluded above, anchor and thrust blocks shall be mandatory in forcemain construction in addition to, and shall not reduce the requirements for, mechanical joint restraint, chamber restraint and/or thrust walls. Anchor and thrust blocks shall be:

- located outside of areas which have been disturbed by the construction of sub-surface installations in the 5-year term preceding the project;
- located outside of areas which could be disturbed by the maintenance or construction of other COH and third-party utility sub-surface infrastructure; or
- placed against undisturbed soil. Where thrust blocks cannot be placed against undisturbed soil due to excessive excavation or fill conditions, mechanical joint restrainers may be used in conjunction with concrete thrust blocks.

Anchor and thrust blocks shall be composed of 30MPa concrete and shall be provided at horizontal and vertical bends, tees and plugs per the following *Standard Watermain Drawings*:

- *WM-204.01 - Concrete Anchor Blocks - 300mm and smaller*

- *WM-204.02 - 11.25°, 22.5° Anchor Block - 400 to 900mm D.I. Watermain*
- *WM-204.03 - 45° Anchor Block - 400 to 900mm D.I. Watermain*
- *WM-204.04 - 45° Anchor Block with Leg - 400 to 900mm D.I. Watermain*
- *WM-204.05 - 90° Anchor Block - 400 to 900mm D.I. Watermain*
- *WM-204.06 - 90° Angle Anchor Block with Leg - 400 to 900mm D.I. Watermain*
- *WM-204.07 - Tee Anchor Block - 400 to 900mm D.I. Branch Watermain*
- *WM-204.08 - Tee Anchor Block with Leg - 400 to 900mm D.I. Branch Watermain*
- *WM-204.09 - Thrust Block - 400 to 900mm Dia. D.I. Watermains*
- *WM-204.10 - Anchor Block - 100 to 300mm D.I. Watermains - 11.25°, 22,5° Vertical Bend*
- *WM-204.11 - Anchor Block - 100 to 300mm D.I. Watermains - 45° Vertical Bend*
- *WM-204.12 - Vertical Bend Anchor Block - 7.25° to 22.5° - 400mm D.I. Watermain*
- *WM-204.13 - Anchor Block - 100 to 300mm Watermain Lowering*
- *WM-204.14 - Vertical Bend Anchor Block 45° - 400mm D.I. Watermain*

Thrust blocks shall be located such that thrust forces are not directly applied to adjacent buildings and/or COH and third-party utility surface and subsurface infrastructure inclusive of servicing.

SEW 9.13.2. Mechanical Joint Restraints

Forcemains shall be fully restrained under heavy rail and High Order Transit guideways/routes/stops to the satisfaction of COH.

Forcemains laid through fill materials shall be provided with full length pipe and joint restraint.

Restraints shall be addressed per the provisions of *SEW 9.7 Corrosion Control for Forcemains.*

SEW 9.14. Commissioning, Acceptance and Assumption

SEW 9.14.1. Commissioning

Commissioning of forcemains is defined as when the forcemain is installed and the following are conducted in accordance with the COH *Construction and Material Specifications Manual*:

- Pressure leakage testing;
- Cleaning and flushing; and

- Acceptance and Assumption of the forcemain.

SEW 9.14.2. Pressure and Leakage Testing

Hydrostatic testing of the forcemain shall be conducted in accordance with *OPSS.MUNI 412*. The minimum test pressure shall be 1035 KPa for ductile iron and PVC forcemains.

Leakage testing shall have a minimum 2-hour duration. The maximum leakage allowed shall be 0.128 L/mm of pipe diameter/km of pipe over the 2-hour period.

The Contractor may elect to swab the forcemain to assist in the removal of air pockets prior to testing.

SEW 9.14.3. Cleaning and Flushing

All forcemains shall be cleaned and flushed. Discharging to the surface shall minimize the potential for icing of surfaces used for active transportation and vehicles.

SEW 9.14.4. Acceptance Requirements

Refer to the COH *Construction and Material Specifications Manual.*

SEW 9.14.5. Assumption Requirements

Prior to the assumption of the constructed forcemain infrastructure, the following are required:

- requirements for the acceptance of forcemain infrastructure have been satisfied;
- the Designer certifies that subsequent inspection confirms that the:
    - identified deficiencies have been addressed in the prescribed manner;
    - chambers are free of standing water;
    - anti-tampering devices have been removed; and
    - testing confirms the tracer wire system on PVC forcemain remains in good working order;
- COH final inspection confirms deficiencies have been remedied and operability of the forcemain infrastructure is satisfactory; and
- COH is in receipt of the approved as-constructed drawing set in PDF and archive quality mylar formats.

SEW 10 INVERTED SIPHON DESIGN

COH may consider the use of an inverted siphon in lieu of a forcemain on a project-by-project basis where practicable. Due to additional maintenance costs, any proposals to use siphons must include a hydraulic analysis with plan and profile drawings for alternatives with and without the siphon as well as a full cycle cost benefit analysis inclusive of increased maintenance costs.

Siphon design shall be per *Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under an Environmental Compliance Approval* (MECP, 2023), inclusive of (but not limited to) the following:

- Minimum pipe size of 200mm diameter
- Achieves self-cleansing velocity (1.1m/s to 1.3m/s) at least once per day or incorporates flushing
- Incorporates adequately-sized inlet and outlet chambers with gravity drains and ventilation to facilitate operation, maintenance and inspection
- Includes odour control and ventilation system with adequately-sized air jumpers and maintenance measures incorporated as required
- Slope for upward vertical leg shall be 2:1 (H:V) at minimum
- Draining and dewatering activities
- Ability to isolate and divert flows

When subject to hydrostatic uplift forces, siphon pipes and chambers shall be designed to have sufficient weight or anchorage to prevent their flotation when empty.

SEW 11 REFERENCES

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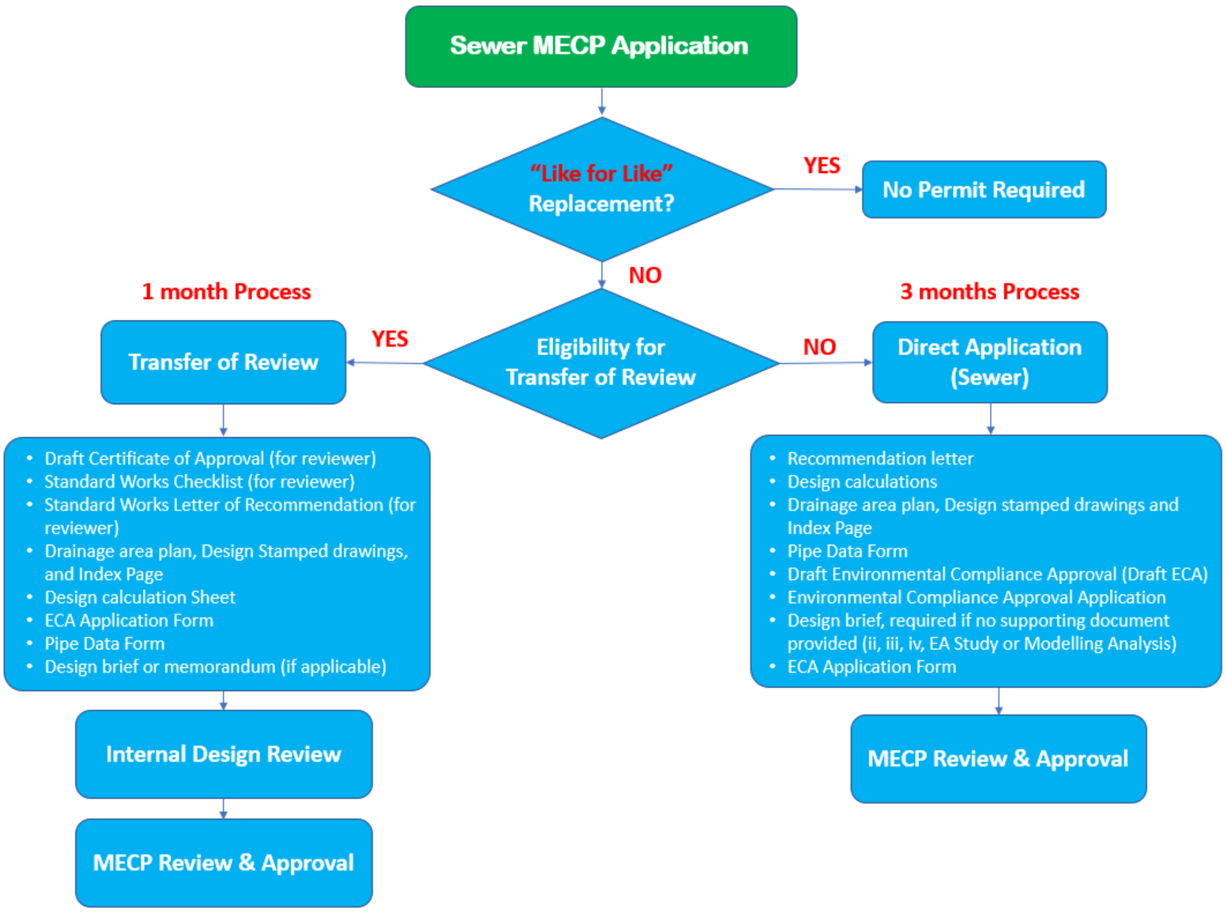
Appendix SEW1:
MECP Permit Application Process - Sewer

APPENDIX SEW1: MECP PERMIT APPLICATION PROCESS - SEWER



Transfer of Review (TOR):

1. Eligibility Criteria:
   - Allowed Sanitary Sewage Works
     - New or modified, municipal or private sanitary sewers, forcemains or siphons that:
       - are designed in accordance with the Ministry document Design Guidelines for Sewage Works, 2008 (PIBS 6879) as amended from time to time;
       - are not combined sewers; and
       - do not discharge directly to a sewage treatment plant.
     - New or modified, municipal or private sanitary sewage pumping stations that:
       - are designed in accordance with the Ministry document Design Guidelines for Sewage Works, 2008 (PIBS 6879) as amended from time to time; and
       - do not discharge directly to a sewage treatment plant.
       - For greater clarity, any sanitary sewage works that provide any treatment of sanitary sewage are not allowed to be submitted under the TOR program.

- Allowed Stormwater Works
  - New or modified municipal or private storm sewers, ditches, culverts and grassed swales that:
    - Are designed in accordance with the Ministry document Stormwater Management Planning and Design Manual, 2003 (PIBS 4329e) as amended from time to time;
    - Are designed primarily for the collection and transmission of stormwater;
    - Discharge to existing storm sewers, other existing stormwater conveyance works, an approved stormwater management facility, or a Municipal Drain;
    - For drainage works under the Drainage Act, approval of a petition for the modifications must be obtained under the Drainage Act prior to submitting an application for an ECA;
    - Are not combined sewers or superpipes and does not connect to a combined sewer;
    - Are not located on industrial land or designed to service industrial land;
    - Do not propose to collect, store or discharge stormwater containing substances or pollutants (other than Total Suspended Solids, or oil and grease) detrimental to the environment or human health; and
    - Do not require the establishment and monitoring of effluent quality criteria.

  - New or modified, municipal or private oil/grit separators that:
    - Are designed in accordance with the Ministry document Stormwater Management Planning and Design Manual, 2003 (PIBS 4329e) as amended from time to time;
    - Discharge to existing storm sewers, other existing stormwater conveyance, an approved stormwater management facility, or a Municipal Drain;
    - For drainage works under the Drainage Act, approval of a petition for the modifications must be obtained under the Drainage Act prior to submitting an application for an ECA;
    - Are not located on industrial land or designed to service industrial land;
    - Do not propose to collect, store or discharge stormwater containing substances or pollutants (other than Total Suspended Solids, or oil and grease) detrimental to the environment or human health; and
    - Do not require the establishment and monitoring of effluent quality criteria.

2. Send to: Internal Review (Approved MECP reviewers only) → Send only the to "Draft Certificate of Approval" to MECP Hamilton Office at Shelley.Yeudall@ontario.ca → Send all documents to enviropermissions@ontario.ca

3. Documents to Include:
   - Draft Certificate of Approval (for reviewer)
   - Standard Works Checklist (for reviewer)
   - Standard Works Letter of Recommendation (for reviewer)
   - Drainage area plan, Design Stamped drawings, and Index Page
   - Design calculation Sheet
   - ECA Application Form
   - Pipe Data Form
   - Design brief or memorandum (if applicable)
   - Fill the cost part in the ECA form BUT don't pay

4. Timing Required: 1-month process

CLI ECA – To Replace TOR #1 for Sewer

See 2022-Apr-22 Design Criteria Final from MECP for Qualification.

Direct Application (Sewer):

1. Eligibility Criteria:
   - Applications that are identified by the local Ministry District Office as being proposed within the zone of influence of a landfill area;
   - Applications for sanitary sewage works that provide any treatment of sanitary sewage;
   - Applications that are for airports or airparks;
   - Applications that are for pumping stations that service combined sewer systems;
   - Applications for projects that have received a Part II Order request, until the request has been decided;
   - Applications for projects that have undertaken an individual Environmental Assessment; and
   - Applications that are likely to trigger the Duty to Consult.
   - Swales, Ditches, and Culverts (Changes of Flow patterns in industrial area)

2. Send to: MECP Directly (Confirm Locations, Direct Water MECP has different location)

3. Documents to Includes:
   - Letter of Recommendation
   - Drainage area plan, Design stamped drawings and Index Page
   - Design calculation sheet
   - ECA Application Form
   - Pipe Data Form
   - Draft Environmental Compliance Approval (Draft ECA)
   - Environmental Compliance Approval Application
   - Design brief, required if no supporting document provided (b, c, d, EA Study or Modelling Analysis)

4. Timing Required: 3-month Process

NOTE: MECP TRACKING FORM is designated to track the MECP application progress

Appendix SEW2:
Sewer Design Sheets

Site Plan ____________
Consultant ____________
Drainage Area Plan No. ____________

CITY OF HAMILTON
Storm Sewer Design Sheet
5-year Storm

Sheet ______ of ______
Designed by: ____________

Catchment Area ID	Street Name	From MH	To MH	Area A (ha)	Runoff Coefficient C	Incremental AxC	Accumulated Area A_C	Accumulated AxC	Time of Concentration Total (min)	Time of Concentration Flow Time (min)	Intensity (mm/hr)	Total Q (m^3/s)	Diameter (mm)	Mannings n	Length (m)	Slope (%)	Q_{pipe} (m^3/s)	Velocity (m/s)	Capacity Check Q/Q_{pipe} %
									10.00										

Site Plan ____________________
Consultant ____________________
Drainage Area Plan No. ____________________

CITY OF HAMILTON
Sanitary Sewer Design Sheet

Sheet ________ of ________
Designed by: ____________________

Street Name	From		To		Area				Residential Population	Industrial		Commercial	Cumulative Institutional	Residential			Peak Flow (Q)					Total Design (m^3/s)	Diameter (mm)	Material	Mannings n	Length (m)	Slope (%)	Capacity (m^3/s)	Velocity (m/s)	Velocity at Design Flow (m/s)	Drop in lower MH (m)
	MH	Inv (m)	MH	Inv (m)	Industrial (ha)	Commercial (ha)	Residential (ha)	Units		Peaking Factor	Area (ha)	Area (ha)	Area (ha)	Peaking Factor	Area (ha)	Population	Industrial (m^3/s)	Commercial (m^3/s)	Institutional (m^3/s)	Residential (m^3/s)	Infiltration (m^3/s)										

Appendix SEW3:
IDF Curves for Mount Hope Rainfall Gauge

Appendix B. IDF Curves for Mount Hope

Table B1. Intensity-Duration-Frequency Values, Mount Hope Rainfall Gauge

Duration (min)	Rainfall Intensity (mm/hr)					
	2-year	5-year	10-year	25-year	50-year	100-year
5	102.7	140.1	165.0	196.3	219.6	242.4
10	72.1	100.4	119.1	142.8	160.4	177.8
15	58.4	81.2	96.3	115.4	129.5	143.6
30	39.6	55.2	65.6	78.6	88.3	97.9
60	24.7	36.2	43.8	53.4	60.6	67.7
120	15.0	22.2	25.9	33.0	37.4	41.9
360	6.6	9.4	11.3	13.6	15.3	17.0
720	3.7	5.2	6.2	7.5	8.4	9.3
1440	2.2	3.0	3.5	4.2	4.6	5.1

Table B2. IDF Parameters, Mount Hope

Parameter	2-year	5-year	10-year	25-year	50-year	100-year
A	646.0	1049.5	1343.7	1719.5	1954.8	2317.4
B	6.0	8.0	9.0	10.0	10.0	11.0
C	0.781	0.803	0.814	0.823	0.826	0.836