Design Criteria for Sewers and Watermains

Second Edition
January 2021
Chapter 6 updated Sep 2022

TORONTO

Blank Page

This text will not print.

Design Criteria for Sewers and Watermains

TORONTO

Contact:

For questions or comments related to Design Criteria for Sewers and Watermains:

Robert Klimas
Senior Engineer – Engineering Support Tel: 416-392-8388
Email: Robert.Klimas@toronto.ca

Engineering & Construction Services
Business Improvement and Standards
5100 Yonge Street, 4th Floor
Toronto, ON M2N 5V7

City of Toronto Sewer and Watermain Design Criteria manual:

www.toronto.ca/services-payments/building-construction/infrastructure-city-construction/construction-standards-permits/standards-for-designing-and-constructing-city-infrastructure/?accordion=design-criteria-for-sewers-and-watermains

This publication is available in both print and online formats.

Second Edition – January 2021
Chapter 6 – Updated September 2022

Table of Contents

List of Tables

List of Tables

List of Tables (continued)

List of Figures

List of Figures

Introduction

We have written 'Design Criteria for Sewers and Watermains' manual for City of Toronto staff and consulting engineers. The purpose of this manual is to ensure there is consistency in our operations. Clients—that’s you—want to be instructed in the same way each time you come to us, regardless of which office you may visit. This manual will help ensure that the information provided by staff is the same in all offices.

This manual is written for City staff and consulting engineers working on capital improvement projects and for consulting engineers working for the development industry preparing engineering designs and drawings for private developments. It can also serve as a reference for third parties designing transit infrastructure, underground utilities, and any other works located within a city right-of-way, located in close proximity to City sewers and watermains.

This manual takes you step by step through all the criteria you will need in the design of a sewer or watermain and the requirements for submission. If you are going to be preparing a servicing study or designing a sewer or watermain in the city of Toronto, this manual is for you.

This manual is available in both print and online formats.

What This Manual Contains

Chapter 1 – Engineering Submissions – covers the requirements for submitting drawings for plans of subdivision or site plans, soils reports, Ministry of the Environment, Conservation and Parks, approvals and requirements of the Transfer of Review Program easement widths and as-built drawing requirements.

Chapter 2 – Sanitary Sewers – covers types of sanitary sewer systems, sewer regulations, sewer capacity assessment, level of protection, population densities, peak flow design parameters, sanitary sewer design requirements, maintenance holes, service connections, connecting to sanitary sewers, and inverted syphons.

Chapter 3 – Storm Sewers – covers choosing a hydraulic model, evaluating the receiving system capacity, levels of protection in storm and combined sewer areas, design storms, requirements for the minor and major system; sewer location, size, capacity, velocity, clearances; maintenance holes, storm sewer connections, catchbasins, outfalls, and weir structures.

Chapter 4 – Watermains – covers hydraulic modelling requirements; watermain sizing, location and depth, valve locations and direction to open valves, valve boxes and chambers, hydrant spacing, and water service connections.

Chapter 5 – Lot Grading – covers requirements for lot grading, swales, driveway slopes, grading constraints and information to show on the grading plans.

Chapter 6 – Material Specifications – covers material specifications for watermains and sewers, and their appurtenances.

Appendix A – As-built Drawings – contains requirements for consulting engineers and city staff preparing as-built drawings.

Appendix B – General Notes – contains standard general notes for consulting engineers and city staff to use as a tool to develop their own notes.

Appendix C – Maps – contains a map showing which direction to open a watermain valve based on the district you are working in and a map showing the combined sewer areas.

Appendix D – Utility Separations – contains minimum vertical and horizontal separations for various buried utilities.

Appendix E – Unit Conversion Table – contains measurement conversion factors between SI units and Imperial units.

Appendix F – Reverse Slope Driveway Guidelines – contains submission requirements for a report when a reverse slope driveway is proposed.

Appendix G –Servicing in Confined Spaces – contains submission requirement for review by the City. These types of installations are discouraged and reviewed on a case-by-case basis.

Appendix H – Hydraulic Calculations for Junction and Transition Maintenance Holes – contains example of hydraulic calculation for junction and maintenance holes.

Appendix I – Pumping Stations – contains direction and guidance on the City's minimum requirements for the design of non-gravity sewage and drainage systems.

Appendix J – Sewer Pipe Air Testing – contains letter from MECP on low air pressure testing of sewer pipes when sewer pipes do not meet minimum separation distance from watermains.

Appendix K – Bibliography – contains a listing of design criteria and guidelines published from current city of Toronto departments, former cities and boroughs of Toronto, and other neighbouring cities.

Glossary – an alphabetical list of technical terms relating to the design of sewers and watermains and their definitions.

Index – an alphabetical list of topics, keywords and synonyms used in this manual.

Chapter 1 – Engineering Submissions

The design of municipal services will be based upon the guidelines, criteria, and standards in effect at the time the engineering drawings are sealed, signed and dated. The Engineering and Construction Services division is responsible for the review and acceptance of all engineering drawings but such approval is not to be construed as verification of engineering content.

All sanitary sewers, storm sewers, watermains, their appurtenances and all roadways being constructed within the city of Toronto, will be in accordance with the latest edition of the standards and specifications which are available from the Engineering and Construction Services division.

Where there is an alleged discrepancy between which standard or specification applies due to site location, zoning, or adjacent land use, the most stringent requirement shall apply. The design criteria manual is intended to assist users in the design of servicing in the city of Toronto. It shall be used in conjunction with other applicable design criteria such as the Ministry of the Environment, Conservation and Parks (MECP) design guidelines for sewage works, MECP design guidelines for drinking water systems, Ministry of Transportation Ontario Drainage Management Manual, the Toronto and Region Conservation Authority Procedural Manual & Technical Guidelines, the Toronto and Region Conservation Authority Crossings Guideline for Valley and Stream Corridors, and the Fire Underwriters Survey. The proponent is encouraged to consult with City staff to ascertain City design requirements prior to proceeding with the design.

Development Engineering Applications

Municipal sewer and water systems shall be designed using the greatest possible demand considering the full range of potential land uses which could occur in an area. The design Engineer shall consider all active development applications and potential land uses in the area and consider the potential density to which the area could be developed to in the future. It is recommended that design assumptions be reviewed with the City before the system is designed. Long term land uses shall be considered in accordance with the City's Official Plan and approved Secondary Plans.

New development and redevelopment submissions that relate to applications submitted in accordance with the *Planning Act* should follow "*Building Toronto Together – A Development Guide*". This guide is to be used by property owners, developers, builders, and others interested in obtaining approvals from the City. It outlines the City's development review process and expected time frames for obtaining approvals from the City. The guide describes the application review process and its submission requirements for

- Community Planning Applications:
  - official plan amendment, rezoning and combined applications
  - plans of subdivisions
  - plans of condominium
  - site plan control applications
  - part lot control exemption applications
  - Terms of reference for various types of reports.

- Committee of Adjustment Applications
  - consent and minor variance applications

The latest edition of the guide can be found at website:

www.toronto.ca/city-government/planning-development/application-forms-fees/building-toronto-together-a-development-guide/ .

Third Party and Utility Review Applications

Third party and utility review applications are projects primarily within the City's right-of-way, for third party organizations such as Metrolinx, TTC, Waterfront Toronto, utility companies and so on.

Engineering Drawing Requirements

- All drawings will be neat and legible.

- All drawings will be in metric units.

- Sheet size will be 609 mm x 914 mm (24 inch x 36 inch), 609 mm x 1219 mm (24inch x 48 inch), or 609 mm x 1524 mm (24 inch x 60 inch). External sanitary and storm drainage area plans for overall catchment areas may be submitted on a larger size sheet for convenience of presentation.

- If a survey is integrated with a coordinate system

  a) The system shall be referenced to the North American Datum 1983 Canadian Spatial Reference System, NAD 83 CSRS.
  b) The coordinates shall be expressed as grid coordinates in 3 Degree Modified Transverse Mercator projection.
  c) Vertical datum will be Canadian Geodetic Vertical Datum (GVD) datum, pre 1978 readjustment.

- The lot and block numbering on all engineering drawings will be the same as shown on the plan of subdivision (66M–) plan registered in Land Titles.

- All sewer and watermain appurtenances such as maintenance holes, hydrants, valves, related design information such as pipe diameter, direction of flow, length, grade, material type, pipe class, pipe bedding, inverts and service connections, and existing basement elevations will be shown on the applicable drawings. All engineering drawings must clearly identify utilities in the line of construction, plant being removed, abandoned but not removed, existing plant that will remain, proposed plant, and future plant.

- All sanitary, storm, and combined sewer maintenance holes will be numbered. All numbers will be shown on the engineering drawings—plan and profile, general plans, and drainage plans—and the sewer design sheets.

- When streets require more than one plan, match lines will be provided with no overlapping of information. The centreline chainage of the match line will be shown in the plan and profile on the adjoining drawings.

- All engineering drawings submitted for acceptance will be sealed, signed, and dated by a professional engineer licensed to practice in the province of Ontario.

Capital Improvement Projects

All engineering drawings for capital improvement projects will be prepared in Microstation DGN format. The consulting engineer will use a title block design approved for capital improvement related projects.

For design and construction engineering capital improvement projects the Engineering & Construction Services–CADD Specification Manual will be used.

Mylars are no longer required. Drawings in PDF and CADD format are required. For more information on archiving of as-built drawing, see SOP 08a found in the Field Services Manual.

Development Engineering Projects

All engineering drawings for development engineering projects can be prepared in Microstation or AutoCAD. However, all as-built drawings must be provided in Microstation DGN format in accordance with the City's Geographic Coordinate System.

The developer’s consulting engineer will use a title block design approved for development engineering related projects. The two different title blocks in digital format for engineering drawings are available from the supervisor of design, Transportation Infrastructure section in Engineering Construction Services.

As-built PDF Requirements

- As-built drawing will show the accurate locations of construction such as storm sewers, sanitary sewers, combined sewers, watermains and other appurtenances. For more details on collecting features, see Appendix E– As-built Features Requirements in the Field Services Manual.
- Separate single page PDF file for each drawing sheet
- Each PDF should have a file name separated by underscores, not spaces, and include both the assigned drawing number and the contract number

- PDF properties populated: Title not to be confused with the file name, author, subject, and at least the City contract number as one of the keywords
- PDF format, not PDF/A or PDF/e, which are different
- Exported from CADD software, not scanned from hard copies
- Correct scale embedded in the PDF
- Unlocked, so the City can add its own drawing numbers later, if necessary.

Engineering Drawings – Utility Site Plans

The Municipal Consent Requirements (MCR) will apply to all utility site plan applications. The policies and procedures set out in the MCR document applies to all utility companies, commissions, agencies, city departments and private applications proposing to do work within the city of Toronto right-of-way. For detailed information, go to website www.toronto.ca/engineering/mcr .

This document details the construction permit application process for work requiring excavation. The requirement for a full-stream utility cut application required by the Engineering and Construction Services division is described in detail.

The requirements for full-stream application discussed in this section is not to be confused with full-stream applications as part of the STAR process from the development guide.

Drawings accompanying full stream permit applications will:

- Include a plan view plotted to a scale of 1:200 horizontal and profile view plotted to a scale of 1:100 vertical and be dimensioned in metric units.
- Include a north arrow pointing up or to the right along with a key map in the top right corner of the drawing sheet. Title block will include the name of the engineer together with the sheet title, date, and current revision status.
- Include street names and building addresses near the proposed work. If the municipal address is not available,

provide distance from the location of the work to the nearest intersection of street lines.

- Show horizontal control monuments within 5 metres of the proposed work. All elevations will relate to a geodetic datum and the benchmark will be described on all the drawings.

- All drawings will use a cadastral base completed by land surveyor licensed to practice in the province of Ontario.

- Illustrate and clearly label street lines, road pavement, sidewalks, driveways, boulevards, and curbs. Identify street furniture including vaults, transformers, pedestals, gas regulators, hydrants, valve boxes or chambers, poles, and so on and so forth. Identify structures such as areaways—structures under the sidewalk, Toronto Transit Commission (TTC) tracks and entrances, tunnels, encroachments, and so on that may impact on the work.

- Identify, either in the body of the drawing or in the legend box, the plant or service to be put into the ground. Identify plant to be abandoned.

- Where above ground plant is proposed, show all existing above ground plant within 10 metres.

- Provide the distance from the proposed work to adjacent street lines. Define start and end of construction with tie-in dimensions to the nearest intersection.

- Show proposed work with a bold line on the drawing and identify it as such in the legend.

- Show typical depth of cover. Indicate any proposed deviation in depth, approximate length and outer dimensions of plant, including duct size and configuration.

- Show existing and proposed landscaping such as trees, tree pits, and planters, including irrigation systems.

- Indicate construction method and related details for the installation of the underground plant.

- Provide cross-sections of proposed plant below grade where required for clarity.

- Illustrate existing underground services within a 2 metre zone of influence around the proposed underground plant. In lieu of a composite drawing, copies of adjacent utilities' up to date as-built drawings may be attached to the application. Include in the general conditions that the minimum clearances from other services as outlined in Appendix D, *Utility Separations* are maintained.

- All easements for city underground plant and other utilities including encroachments will be shown on the drawing including the plan number (66R-) and instrument number.

Subsurface Underground Engineering

The use of subsurface underground engineering (SUE) investigation is encouraged when there is insufficient underground information and the congestion of utilities is present.

Standard ASCE 38-02 for the collection and depiction of existing subsurface utility data shall be used to provide guidance, when City expects the various quality levels D through A. Quality levels are explained as following;

- Quality Level D – Information derived from existing records or oral recollections.

- Quality Level C – Information obtained by surveying and plotting visible above-ground utility features and by using professional judgement in correlating this information to Quality Level D.

- Quality Level B – Information obtained through the application of appropriate surface geophysical techniques to determine the existence and approximate horizontal position of subsurface utilities.

- Quality Level A – Information obtained by exposing and measuring the precise horizontal and vertical position of a utility at a specific point.

Test Pits for Locating Utilities

Test pits, where requested, will be carried out to obtain information about the location and depth of existing utilities prior to commencing construction.

Engineering Drawings – Plan of Subdivision

The detailed engineering drawings submitted by the developers engineer will consist of the following:

1 title sheet
2 general notes
3 detail sheets
4 general plan of services
5 drainage area plans
6 subdivision grading and building siting control plan
7 plan and profile drawings
8 erosion and sedimentation control plan
9 composite utilities plan
10 other drawings as required for project review

Title Sheet

A title sheet is required if there are three or more sheets included in the plan of subdivision submission—can also apply to capital improvement projects. The title sheet will contain the following:

- city logo and project number or planning application number
- key plan of site
- name of the development or developer
- name of owner, address and phone number
- name of engineering company, address, and phone number
- ECS director's name and chief engineer's name
- list of drawings

General Notes

General notes describe the standards and specifications used in the construction of the underground and above ground services. For larger subdivisions, it is preferable to have the notes on a separate page. For more information on the standard general notes to be used on all construction projects is included in Appendix B, *General Notes*. The engineer should use only the notes applicable to the project that is current at the time of design and construction. The most recent OPSD and City standards and specifications will be referenced in the notes.

The engineer is responsible to review the standard general notes and to modify the wording to suit the requirements of their design.

Typical road cross-sections will be as per Development Infrastructure Policy & Standards (DIPS) and along with the pavement design, will be shown on the plan and profile drawings.

For more information on DIPS, go to website:

www.toronto.ca/services-payments/building-construction/infrastructure-city-construction/construction-standards-permits/standards-for-designing-and-constructing-city-infrastructure/development-infrastructure-policy-standards-dips/ .

Detail Sheets

Include any standard drawings specified on the engineering drawings for reference during construction.

General Plan of Services

A general plan of services will be prepared for every engineering submission as part of a development application.

A scale of 1:500 will be used. For larger subdivisions, a scale of 1:1000 will be used or with City approval a scale deemed reasonable to ensure the limit of construction is shown from all ends.

The following information will be shown on the general plan of services:

- All road allowances, lots, and blocks along with street names in the plan of subdivision and those immediately neighbouring the subdivision.

- Proposed sanitary and storm sewers including diameter of pipe and direction of flow, maintenance holes, house and block service connections, culverts, road catchbasins and rear yard catchbasins, if applicable.

- Proposed watermains including diameter of pipe, valves, hydrants, water service connections and appurtenances.

- Proposed curbs, sidewalks, and retaining walls.

- Geodetic benchmark will also be shown and described.

- All easements for city plant and other underground utilities will be shown on the drawing.

- General plan showing drawing number and area covered by each plan and profile sheet.

- Include north arrow pointing up or to the right along with key map.

Drainage Area Plans

The drainage area plan will be drawn at the same scale as the general plan of services.

It will include the following information:

- All rights-of-way with street names, lots, blocks, easements, and other lands within the plan of subdivision or capital improvement project.

- Existing and proposed sewers, including size, length, grade, maintenance holes, maintenance hole numbers, direction of flow, and details of the receiving sewer, outlet sewer, or receiving watercourse or storm water management facility.

- Standard City sanitary and storm sewer design sheets will be used and included on the drainage area plans.

Sanitary Drainage Areas

The drainage areas within the sanitary sewer shed and the limits of any external areas, and contributing flows into the proposed system. The area contributing to each sanitary maintenance hole will be clearly outlined. The area in hectares and the population density in persons per hectare will be indicated on all drainage areas.

If the contributing area to a sanitary maintenance hole is comprised of areas with different land uses or population densities, the sub-areas showing the individual area in hectares and the population density will be clearly shown.

Storm Drainage Areas

The drainage areas within the storm sewer shed and the limits of any external areas draining into the proposed system along with areas, flows, and time of concentration. The area contributing to each storm maintenance hole will be clearly outlined. The area in hectares and the runoff coefficient will be indicated on all drainage areas.

If the contributing area to a storm maintenance hole is comprised of areas with different runoff coefficients, the sub-areas individual area in hectares along with each runoff coefficient will be clearly shown along with a composite runoff coefficient and time of concentration.

Subdivision Grading and Building Siting Control Plan

For details and additional design information, see Chapter 5, *Lot Grading*.

Plan and Profile Drawings

Plan and profile drawings are required of all streets, easements, and watercourse crossings and for all plant to be assumed by the City.

- Plan and profile drawings shall be on the same page and to a scale of 1:200 horizontal and 1:100 vertical. For less congested areas or when city base mapping is not available, or where work is on a local street, a scale of 1:500 horizontal and 1:100 vertical may be accepted by the City.

- Road stations or centreline chainage must be shown in the plan view at a maximum spacing of 25 metres.
- Show the north arrow in each plan view.
- Relate all datum to a geodetic bench mark.
- Show all existing and proposed lot numbers and blocks.
- Show all existing and proposed curbs, road allowances, and street names indicating them as such.
- Show locations of boreholes.
- Show all existing and proposed watermain sizes, valve boxes, and hydrants and other appurtenances. Water service connections to proposed lots are to be shown on all plans from street line to the existing or proposed watermain.
- Show on the profile view the pipe material, class or dimension ratio and bedding for the watermains shown along the bottom of the profile.
- Show location of cathodic protection test stations and drain cables where metallic watermain or sewer forcemain pipe is installed. Provide MTM coordinates on the drawing to assist locating in the field.
- Show all existing and proposed sewer lengths, sizes, class of pipe, grades, and maintenance holes. The slopes are to be shown to two decimal places in percent.
- On all plans and profiles, the type of bedding and class of pipe for the sewers must be shown along the bottom of the profile, as determined from the City standard drawings.
- All sewers to be terminated at the subdivision limits where outside drainage areas are to be considered in the design of same. All sewers to be designed so that they extend at least halfway across the frontage or flankage of any block or lot in the subdivision, so that the service connections can be constructed in a standard location.
- Show all existing and proposed catchbasins and indicate them as such.
- Show all house connections at street line.
- All maintenance holes must be indicated with the proper symbols and the sanitary maintenance hole numbers must be followed by the letter 'A' on both plan and profile. For more information on symbols, see the Engineering and Construction Services–*CADD Specification Manual*.
- Project the maintenance hole location perpendicular to the centre line chainage and indicate the maintenance hole at this chainage in the profile view.

- All maintenance hole benching details will be shown on the plan view and must be drawn at a minimum scale of 1:50 for larger or complicated maintenance holes only.
- All maintenance holes must refer to a City standard on the profile above the centre line of the road profile of each maintenance hole, along with the rim elevation and maintenance hole chamber diameter.
- All maintenance holes shown in the profile must indicate all existing and proposed inverts with each having reference to the compass direction such as north, south, east or west.
- Indicate on all drawings any areas of engineering fill.

Cul-de-sacs

- Temporary turning circles are required where the road is to continue in the future and designed with a combination of deeded right-of-way and easements over the lots. The street line radius will equal 15 metres. The curb radius will equal 12.5 metres. A temporary turning circle will have complete services to the future proposed street line.
- Where a road is not to be extended in the future, the radius of the street line equals 15.25 metres as shown on drawing DIPS-5. The curb radius equals 12.5 metres.
- All existing and proposed services, curbs, sidewalks, and so on, within the street line must be dimensioned.

Erosion and Sedimentation Control Plan

For details to include in an erosion and sedimentation control plan, see Appendix B, *General Notes.*

Composite Utilities Plan

Comprised of information from Toronto Public Utility Coordinating Committee (TPUCC) drawings, individual utility company drawings, and topographical surveys and by subsurface utility engineering (SUE) investigations, if required.

Sign off from all affected utility companies such as Bell Canada, Rogers Cable, Toronto Hydro, Enbridge Gas, Enwave, Canada Post, TTC and so on, as well as City Planning is required.

The Composite Utility Plan must provide the following information:

- The correct plotting is to be shown as per the draft plan.
- All utility line locations including City sanitary sewer, storm sewer, rear yard catch basins, watermain and hydrant locations are to be identified.
- All utility service drop locations are to be shown including sewer and water service laterals.
- The complete street lighting system is to be identified.
- The street furniture is to be indicated, such as pedestals, transformers.
- A note stating that all utility boxes (pedestals and transformers) are to be installed in accordance with the Municipal Consent Requirements for the installation of Plant within the City of Toronto Street; Appendix O – Vertical and Horizontal Clearance Guideline.
- Canada Post Super mailboxes are to be located.
- TTC Bus Stop locations and asphalt pads are to be located.
- Location of all proposed trees and landscaping on the subdivision road allowance are to be shown.
- All driveways are to be indicated as well as clearances from transformers, fire hydrants and streetlights.
- All sidewalks are to be located and their dimensions to be shown.
- A typical utility road cross-section is to be shown including road width, utility depths, clearances between utilities and dimensions from utility plant to curbs and lot lines.
- A typical lot servicing detail is to be shown for each type of proposed unit and the location of all utility services, driveways, transformers, pedestals, street lights, trees/landscaping shall be shown including dimensions for each from driveways and lot lines.
- Typical utility trench details are to be shown including depth, layout and identification of each utilities ducts/cables within the trench when a joint use trench is used.
- For particular minimum clearance requirements, a reference to each individual utility specifications and standards will be made.
- The Plan scale is to be 1:500 or 1:250 metric with details of particular areas of congestion as required.
- All easements must be clearly identified and registration number indicated if available.

- Symbol legend to be provided in according to City utility/road cross section standards.
- North arrow is to be shown.
- A key plan provided.

All off-site proposed utility plant and road modifications outside the Plan of Subdivision, such as on existing road allowances, do not have to be on the Composite Utility Plan and will be circulated and issued municipal consent separately according to the standard utility circulation process.

Storm and Sanitary Design Sheets

Standard City sanitary and storm sewer design sheets will be used and included on the drainage area plans. All design sheets submitted for approval will be sealed, signed, and dated by a professional engineer licensed to practice in the province of Ontario.

Geotechnical Investigation and Soils Report

This section is written for capital improvement projects. This section can also be used as a guide for development engineering projects, if desired.

For the construction of new roads or new underground utilities, a geotechnical investigation will be required. A geotechnical report would not be required for service connections or localized municipal servicing improvement.

The purpose of the investigation will be to determine the type of soil, its engineering properties, bearing capacity, soil permeability, location of groundwater, and to verify whether contamination is present. Soil investigation work is to take place after determining the proposed sewer or watermain alignment, so that the required boreholes and test pits follow the same alignment.

Soil test borings will be placed at suitable spacing to provide adequate representation of the soil conditions. Soil classification and ground water levels will not be recorded, if absent. Additional boreholes may be required to establish the water table for storm water management ponds and to design the foundations of outfall structures.

In waterfront or fill areas, piles may be required to achieve satisfactory bearing strength to support any proposed infrastructure. Bedrock profiles will be required and submitted.

The soil report will make recommendations for the design of the road base, pipe bedding, construction methods, and soil percolation rates to determine the feasibility of stormwater management infiltration works.

One paper copy of the geotechnical report will be submitted together with an electronic copy in PDF format to be catalogued and stored by the City for future reference.

Site Investigation Requirements

The following items describe the tests and investigation work which should be undertaken and provides the engineer with a summary of geotechnical requirements for a typical industrial or residential subdivision, and for any City capital improvement project. Where dewatering is planned near adjacent structures, the rate of dewatering and depth of well points will need to be considered to ensure there will be no adverse impacts to these structures.

Borehole Log Report

Keep a continuous log of materials encountered during the sinking of each borehole. All sample descriptions in the report will follow the Ontario Ministry of Transportation's soil classification system. The borehole log report, among other relevant information, will include the following:

- Project description, location, date and time of test, and drill type.
- Detailed description of the type of soil encountered, its soil classification, depth, and delineated soil stratigraphy in accordance with the Ontario Ministry of Transportation's soil classification system.
- Record the thickness of asphalt or concrete and granular road base in the borehole log report, where boreholes are located within an asphalt or concrete roadway.
- Describe colour, consistency, and moisture content of soil.
- Make specific reference to soil colour stains, odours where present, and any metal, wood, debris or organic materials

encountered. Record any observations that indicate contamination of excavated material with petroleum products, garbage or other wastes.
- Record 'N' values from any standard penetration tests and the penetration depth of a split spoon sampler.
- Record groundwater and free standing water table in the boreholes encountered during and upon completion of boring.
- Report cave-in depth, if a cave-in is found.
- Describe the degree of weathering of shale, if shale is encountered.
- Record reason if borehole cannot proceed further, for example bedrock. Record depth or elevation.

Soil Description and Classification

- Soil shall be described and classified in accordance with Ministry of Transportation of Ontario Soil Classification Chart (Appendix A).
- Give soil type, name if necessary, indicate approximate % of sand and gravel, maximum size, angularity, surface condition, and hardness of the coarse grains, degree and character of plasticity of plastic soil, local or geologic name and other pertinent descriptive information.
- Group the soil in a group symbol in parenthesis at the end of the soil descriptions based on field and or laboratory classification criteria or both as per Ministry of Transportation of Ontario Soil Classification Chart (Appendix A).
- Describe colour in wet condition, compactness in sand, consistency in silts and clays, wetness, and moisture and drainage condition.
- Describe the compactness of granular material in very loose, loose, compact, dense or very dense according to its in-situ condition.
- Describe the consistency of plastic soil in very soft, soft, firm, stiff, very stiff, hard or very hard according to its in-situ condition.
- Use the following descriptive terms to describe the amount of principle and secondary components found in soil:

Table 1: Soil description and classification

Descriptive term	Percent by mass of sample
and	40 - 60
adjective (Silty, Clayey)	30 - 40
with	20 - 30
some	10 - 20
trace	0-10

- If applicable, make specific note of soil colour stains, odours where present and any metal, wood, debris or organic materials encountered. Record any observations that indicate contamination of excavated material with petroleum products, garbage or other wastes.
- Using abbreviations to describe soils in the report are generally discouraged. Use the abbreviations as found in OPSD 100.060 for boring and test data if abbreviations are to be included in the report.

Soil description and classification reporting examples

- Sand Fill - Trace roots, trace clay, distinct organic with trace hydrocarbon odour, light brown, moist, very loose (SM)
- Clayey Silt Till - Trace sand and gravel, grey, moist, stiff (CL)
- Silty Clay Till - Trace fine sand and clay, trace shale pieces, grey, and dry, hard (ICI).

Location Identification of Boreholes

The final location of each borehole should be reported in a borehole log with reference to easily identifiable objects on the street such as house number or measurement from the centre line of the nearest intersecting road. The location of borehole should also make reference to which travelling lane of a roadway the borehole is situated if boring is carried out on a roadway.

The consultant is required to report the XY co-ordinates and the elevations of all boreholes with the help of city maps to be supplied by the City at the commencement of work. The digital city map will be equipped with spot elevations and co-ordinate grids for quick elevation and XY co-ordinate referencing. The Consultant shall submit the co-ordinates of the boreholes and their related attributes defined in an MS Excel table as part of the final report. The consultant may use the city maps to prepare borehole location key plans.

No survey is required for determining the location and elevation of boreholes.

Location Plan of Borehole

Prepare a key plan showing the positions of all bore holes with at least three location referencing field measurements and attach it to the borehole log report. For soil investigation projects carried out in a road right-of-way, one such measurement shall be made from the nearest curb, the second measurement from the centre line of the nearest intersecting street, and the third measurement from the nearest property line. The location of the property lines can be found on the city maps provided.

Submission of Final Report in Electronic Formats

In addition to submitting the required numbers of final report in hard copies, the consultant is also required to submit one copy of their final reports in an MS Word format. The borehole logs sheets, drawings, sketches, attachments, and other Non-MS Word documents of the electronic report shall be submitted in a PDF format.

Borehole Depths

Boreholes will be according to the following minimum depths

- sewer construction—6 metres deep
- watermain construction—3 metres deep
- laneway construction—4 metres deep in at least one lane area and one metre deep in remaining lanes within the same area—a lane area is one or more interconnected individual lanes
- pavement reconstruction—one metre
- sidewalk construction—one metre.

Should tunnelling or directional drilling be proposed, the borehole logs will be increased in depth, accordingly. Surface elevations at all borehole locations are to be included with the borehole logs.

Coring Samples

All coring at the same locations according to the following minimum depths: For pavement cores the depth will be half metre with 50 mm diameter cores. For streetcar track cores, the depth will be 0.7 metre with 100 mm diameter cores. Surface elevations at all coring locations are to be included with the core logs.

Standard Penetration Resistance with Codes

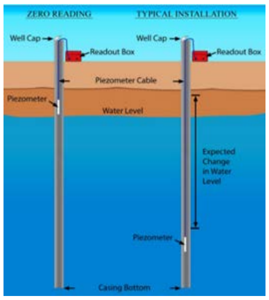
Determine and record the number of blows, of a 65 kilogram hammer, falling 760 mm, required to drive a 50 mm diameter spoon sampler 300 mm into the material. Do this for every 750 mm of depth and near the top of each layer of new material. Record the relative elevation of the above tests.

Soil Sampling

Note and log the type of soil at various levels from the geodetic datum provided by the City, to the depth of the borehole or from the road or ground surface as specified.

Take the first sample before the hole is 250 mm deep and the second sample between 250 mm and 1000 mm in depth. Thereafter, take samples with a sampling spoon of approved type, every 750 mm and at every level where there is a change in character of the soil. Immediately upon removal from the hole, samples will be tightly sealed in air tight containers, to be supplied by the engineer.

Take care to ensure all fine materials are retained and that materials are well mixed and truly representative of the soils to be encountered during construction. Assemble and label samples separately for each borehole to give a complete record of each boring, including name of project, order number, borehole number, and depth at which the sample was taken.



Installation of Piezometer

If requested, piezometers will be installed in all boreholes that are not dry upon completion of drilling. Water inside a borehole should be pumped out before a piezometer is installed prior to backfilling. Nested or clustered installations may be required to assess the hydrogeological conditions.

The geotechnical engineer should return to the site to record the free standing ground water level inside the borehole after 24 hours. Each piezometer assembly will include a proper piezometer tip, an appropriate length plastic tubing of 12.7 mm outside diameter, couplings, and protective plastic caps.

Laboratory Tests

Laboratory tests will be made on undisturbed soil samples. Only the laboratory tests which are deemed necessary by the designer will be required. The tests that may be carried out shall include the following:

- natural moisture content
- void ratio
- liquid limit
- plastic limit
- plasticity index
- unconfined compression test
- consolidation test
- soil corrosivity potential

Soil Classifications

The soils will be classified as follows:

- rock
- broken rock
- boulders
- coarse gravel
- gravel sand
- coarse sand
- fine sand
- silty sand
- silt

- clay silt
- clay
- organic silt
- peat
- rock flour
- infiltration tests

When requested, in situ infiltration tests will be performed in a separate 5 metre deep borehole by inserting a perforated casing with the bottom 3.5 metres of pipe perforated, filling the hole with water and measuring the time required for the water to infiltrate into the soil surrounding the pipe.

Estimated Permeability of Sub-Grade Materials

Pavement investigations to address the permeability of the sub-grade materials will be performed to facilitate drainage design. The permeability of the sub-grade material will be estimated by comparing the particle size distribution of the material with the established permeability correlation data. Combined sieve and hydrometer analyses will be carried out on representative samples of the subgrade material(s) to obtain the particle size distribution curves for comparison.

Soil Chemical Analysis

Major tasks will include the following:

- Consult with Ministry of Environment, Conservation and Parks (MECP) or the receiving site owners and develop a work program to analyze and classify the material, which is intended for excavation during construction. The proposed work program must be satisfactory to MECP or the receiving site owners. The work program may include only the analysis of soil samples already collected and collection and analysis of additional soil samples as considered appropriate to the site and the project at hand.

- Conduct sufficient laboratory analysis to classify soil samples for landfill disposal options in accordance with *Rules for Soil Management and Excess Soil Quality Standards*. This document is adopted by reference in O. Reg. 406/19 On-Site and Excess Soil Management made under the Environmental Protection Act, R.S.O. 1990, c. E.19 (EPA).

Other MECP Regulations, such as Reg. 347 and Reg. 153 shall be consulted as well for landfill disposal options.

The following parameters should be included in the chemical analysis for each sample tested:

- antimony
- arsenic
- barium
- beryllium
- cadmium
- chromium
- cobalt
- copper
- lead
- molybdenum
- nickel
- selenium
- silver
- zinc
- mercury
- vanadium
- electrical conductivity
- sodium absorption ratio
- pH
- petroleum hydrocarbons (F4 > C34)

Prepare a final report outlining the work program undertaken, test results, and commenting on the suitability of excavated material for on-land disposal. Where test results indicate that the material will not be suitable for on-land disposal at residential/parkland or industrial/commercial lands, include alternative landfill disposal options consistent with Ontario Regulations such as 347, 153 and MECP guidelines for disposal at a licensed landfill.

Geotechnical Investigation Report and Delivery

All findings from the geotechnical investigation, including the borehole log report, chemical analysis results, comments, and recommendations should be presented in a street by street or street grouping report format. Recommend the appropriate pavement section based on the pavement structural design matrix. Recommendations will also make reference to all relevant city standards or guidelines such as City standards and specifications, wet weather flow management guidelines, Ministry guidelines and so on. Annual average daily traffic (AADT) volumes required for the pavement design will be supplied by the City.

The geotechnical engineer will submit preliminary soil reports for each location of the investigation to the City for review and comment. The geotechnical engineer will compile the final reports according to the comments received from the City.

Location Plan

Borehole locations with three tie in measurements from permanent structures in the vicinity with offset from curb lines.

Prepare a key plan indicating the position of boreholes and attach the plan to form an integral part of the borehole log report.

Pavement Structure Design

Recommend the pavement structure design that will meet or exceed the minimum requirements specified by the Transportation Services, Planning and Capital Program, Asset Management unit.

The pavement structural design matrix can be found at: *www.toronto.ca/services-payments/building-construction/infrastructure-city-construction/construction-standards-permits/standards-for-designing-and-constructing-city-infrastructure/?accordion=road-work-standards* .

Report Delivery

The consultant will prepare and submit to the City three complete reports including borehole and test pit information. The engineering report will include a plan, general discussions, comments, and recommendations, as follows:

- field work carried out
- soil classifications

- borehole log
- pavement core details
- borehole and corehole location plan
- grain size analysis curves
- type and hardness of bedrock—if encountered
- depth of overburden
- ground water elevations
- soil proctors for overburden material
- bearing capacity of soils

Recommendations should be made for the following:

- pipe bedding—materials—requirements with respect to City's standards
- soil parameters to be used for calculation of thrust blocks and restrained joints, including coefficient of friction, shear angle, and bearing capacity
- concerns as to trench bottom uplift
- dewatering, if required, describing available methods including well points
- open trench excavation, type of shoring system, methods of tunnelling or jacking and boring
- use of native backfill, placement depth of layers and compaction specification for same
- results of infiltration testing
- findings from test pits

The geotechnical consultant will submit all reports to the City.

Piling and Shoring

Where piling and shoring is to take place, the maximum allowable vibration level requirements for construction work near bridges, trunk and local sewers, and transmission and distribution watermains, heritage or structurally sensitive buildings will be according to GN117SS. This supplementary specification should be included in the tender package. In addition, the applicant shall enter into a Tie-Back Piling and Shoring Agreement with Transportation Services division.

Crossing of Cast Iron Transmission Watermain

Where a crossing under any cast iron transmission watermain is to take place, it shall be according to supplementary specifications GN118SS. This supplementary specification should be included in the tender package.

Ministry of the Environment, Conservation and Parks Approval

The client, who is the individual or corporation requesting the approval, will submit the required Ontario Ministry of the Environment, Conservation and Parks (MECP) applications to obtain approval for sanitary sewers, storm sewers and watermains.

The City of Toronto is an agent of the ministry for processing sewage and water works applications under the *Environmental Protection Act Act* and *Safe Drinking Water Act*. The onus is on the applicant in consultation with city staff to determine if the proposed work can be reviewed under the Transfer of Review Program or if it should be submitted directly to the Ministry.

The Municipal Drinking Water Licensing and Permit Program replaced the existing approvals program for municipal drinking water systems. In February 2011 the City issued its first drinking water works permit/licence. The Transfer of Review Program no longer processes drinking water system applications. However, the same work unit at the City processes the drinking water system applications under Drinking Water Works Permit No. 010-201.

Sanitary sewage collection and stormwater management applications will continue to be processed through the existing Transfer of Review Program until such time as the City participates in the Ministry's Consolidated Linear Infrastructure Environmental Compliance Approval program. The enabling legislation for this program is Ontario Regulation 208/19: Environmental Compliance Approval in Respect of Sewage Works which came into force on July 1, 2019.

Each ECA application shall include hard copy and electronic documentation. Two sets are required, with one retained by the City and the other forwarded to the MECP. The applicant is encouraged to pre-consult with the City and the MECP to confirm which activities can be reviewed under the Transfer of Review Program and which activities must be submitted directly to the MECP. Review and administration fees specified in the MECP application for sewage works and City user fees for the review of water works are separate from the City's development review processing fees. The payment of the application fee by certified cheque or money order is to be made payable to Treasurer, City of Toronto. Electronics Funds Transfers (EFTs) are also permissible for the payment of the review fee to the city.

Direct submission applications for projects that involve municipally owned stormwater management facilities will require the ECA application forms to be submitted to the City for signature as the operating authority. The engineer's client will be responsible for any fees payable to the MECP for this review. The payment of the application fee by certified cheque or money order is to be made payable to the Minister of Finance, or credit card payment—for payments up to $10,000.

The submission requirements are noted on the MECP web site under the publication: "*Guide for Applying for Approval of Municipal and Private Water and Sewage Works*". To download a copy of the guideline and application form, go to website:

Water and Sewage Works Approvals-Sample Applications-Guides and Resources.

Each MECP submission that includes engineering drawings must be stamped by the engineer responsible for the preparation of the application and design of the municipal services for which approval is sought. The engineer's stamp must be signed and dated on all engineering drawings and any accompanying documentation.

What the City is authorized to review?

The ministry currently authorizes the City of Toronto to review the following:

Water Works

- watermains
- water booster pumping stations

Sewage Works

- storm and sanitary sewers—except for new stormwater outfalls
- sewage pumping stations and forcemains—except for those pumping directly to a sewage treatment plant
- rehabilitation of existing combined sewers—excluding outfalls
- replacement of existing combined sewers where there is no increase in combined sewer overflows
- use of roof top gardens as a stormwater management facility located on and servicing one lot or parcel of non-industrial lands that discharges into a storm sewer—that is not a combined sewer
- inlet control devices used in existing developments to control sewer surcharging and basement flooding provided that there is no increase in the stormwater collection area

What the City is not authorized to review?

The City of Toronto is not authorized to review the following:

Water Works

Water intake pipes, water supply and treatment works, high and low lift pumping stations, water storage facilities at water treatment plants and chemical feeding equipment.

Sewage Works

- sewage treatment works and outfalls
- storm water management works requiring storm water quality control other than specific installations of oil/grit interceptors/separators
- pumping stations discharging directly to sewage treatment works
- sewers with overflows, combined sewers with overflows
- combined sewers in new areas, combined sewage storage facilities
- sewer connections from land filling sites for leachate transport

Expanded Transfer of Review Program

The City of Toronto's current Transfer of Review Program is expanded to include additional types of sewers and stormwater management works for quantity control, which is specifically described under Transfer of Review Agreement No. TOR-TOR-E14-20118-28. The agreement is posted on the City of Toronto, Water intranet site:

http://insideto.toronto.ca/torontowater/policies/files/transfer-review-agreement-mecp-cot.pdf.

Facilities on Private Property

The client is requested to review Ontario Regulation 525/98 which lists approval exemptions for work under the Ontario Water Resources Act. An exemption can be applied to a proposed stormwater management facility on an individual lot or parcel of land. However, there are conditions to applying this exemption and approval shall be sought directly from the MECP whenever the conditions cannot be met.

Approval by the Toronto and Region Conservation Authority

The outfalls of replacement storm sewers located on land under the jurisdiction of the (TRCA) require a permit under Ontario Regulation 166/06 made under the Conservation Authorities Act.

Sewage Works Allowed Under the Transfer of Review Program

Works allowed to be submitted under the TOR program are described in Schedule A, Sections 1 'Standard Works Allowed' and 2 'Additional Works Allowed' below.

Applicant to request the current copy of the agreement from the case manager.

The works must also meet any requirements in the applicable section. Works that are not described in sections 1 and 2, do not meet any applicable requirements or to which Section 3 'Works Not Allowed To Be Submitted' applies under the TOR program.

Section 1 – Standard Works Allowed

Allowed Sanitary Sewage Works

Unless specified in Section 3 of Schedule A, only ECA applications for the following sanitary sewage works are allowed to be submitted by the municipality under the TOR Program:

a) 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.

b) New or modified, municipal or private sanitary sewage pumping stations that:

- are designed in accordance with the Ministry document Design Guidelines for Sewage Works, (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

Unless specified in Section 3 of Schedule A, only ECA applications for the following stormwater works are allowed to be submitted by the City under the TOR Program:

a) 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 modification 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.

b) 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 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.

Section 2 – Additional Works Allowed

The City may submit ECA applications for sanitary and/or stormwater works other than those allowed in Section 1 as described below and in accordance with any listed requirements.

The City's TOR Program is expanded to include:

a) Combined Sewers

The rehabilitation of existing combined sewers where there is no increase in combined sewage overflow.

b) Stormwater Management Facilities

- Altering, modifying, adding, optimizing or expanding the retention capacity for existing approved stormwater management facilities, including wet ponds, wetlands, dry pond, hybrid pond, stormwater outfalls, provided that:
  - o If the proposed works are required to provide quality control, the works are designed to achieve Enhanced Level water quality control and erosion protection for example 80% TSS removal and
  - o Any attenuation design requirements are satisfied;

- Stormwater pumping stations.

c) Lot Level and Conveyance Control Measures

- Altering, modifying, adding, optimizing or expanding the retention capacity for existing approved low impact development (LID) measures, including stormwater outfalls, provided that:
  - o If the proposed works are required to provide quality control, the LID measures are designed to achieve Enhanced Level of water quality control and erosion protection, for example 80% TSS removal and
  - o Any attenuation design requirements are satisfied.

- Installing new LID measures, including stormwater outfalls, provided that:
  - o if the proposed works are required to provide quality control, the LID measures are designed to achieve Enhanced Level water quality control and erosion protection, for example 80% TSS removal;
  - o any attenuation design requirements are satisfied, and

  - o the design considers corrective and remediation measures in the event of lack of performance of the LID measures;
  - o Rooftop, surface and underground storage with inlet control devices or orifices.

For Works listed in 2a through 2c the following requirements must be met:

- The Works must be designed in accordance with the Ministry documents *Design Guidelines for Sewage Works, 2008* (PIBS 6879) and *Stormwater Management Planning and Design Manual, 2003* (PIBS 4329e), as amended from time to time;
- The Works must receive drainage only from non-industrial lands, where industrial lands are defined by *Ontario Regulation 525/98*;
- Any stormwater management pond listed in 2b above shall not be used as a snowmelt facility;
- For Works that are designed to partially infiltrate or exfiltrate into the surrounding soils during high flow conditions:
  - o Based on the type of works, the vertical separation distance between the highest groundwater table (for example spring runoff) and the lowest elevation of the works shall adhere to Table 4.1 of the Ministry document *Stormwater Management Planning and Design Manual, 2003* (PIBS 4329e).
  - o Groundwater must not be utilized as a potable water resource anywhere drainage is captured by the stormwater management works;

- Infiltration or exfiltration stormwater works include:
  - o Pervious pipes and catch-basins;
  - o Filtering systems, and infiltration trenches, such as soak away pits attached to pervious catch-basins and sand filter beds;
  - o Infiltration basins;
  - o Pervious pipes and catch-basins with infiltration trench systems, rainwater and snow melt into the surrounding soils during high flow conditions; and
  - o Open channels, ditches, swale drainage systems, bio-swales, tree pits, and infiltration trenches on public roads, or right-of-way, designed to exfiltrate part or all of the

stormwater runoff from the adjacent road into the surrounding soils.

These types are to include vegetative surfaces;

- For stormwater pumping stations, high level alarm systems, appropriate response time during emergency conditions, and redundancy in pumping arrangement must be provided;
- For the rehabilitation of existing combined sewers, the Works must conform to Ministry Procedure F-5-5, Determination of Treatment Requirements for Municipal and Private Combined and Partially Separated Sewer Systems, as amended from time to time;
- 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;
- The description of the works for a new replacement outfall will identify the receiving watercourse if discharges into any provincially recognized critical receivers and/or their tributaries;
- The applicant has consulted with the local Conservation Authority and obtained necessary clearance as required, if the works discharge to a surface water body;
- As part of the Letter of Recommendation, the City has clearly identified all of the works which fall under this Section of Schedule A;
- The City has notified all applicants for works allowed in this Section that the ECA may contain conditions requiring the development of an operation and maintenance program, including a spill contingency plan for the works, the municipality shall include in their Letter of Recommendation any other conditions related to operation and maintenance of the works if applicable; and
- The City shall maintain a report with detailed records of all the stormwater management works constructed during the year.

The report and records noted above are to include, but not limited to, the approval number, date of approval, location, description of the stormwater management works, information about what, how, when, why and who operates and maintains the works.

The report must also include a summary of the operation and maintenance program activities, any trouble shooting activities, reports of any flooding conditions and/or any complaints received from the public. The report must also include a statement concerning the potential for these stormwater management systems to impact groundwater quality, which will be based upon the available evidence from inspection and maintenance activities.

The Ministry may require the submission of this report upon request. Further instructions on where and to whom the report is to be submitted will be provided by the Ministry.

In most cases, private works included in this Section will be subject to the requirements under the Environmental Bill of Rights (EBR), which includes mandatory posting of the project proposal on the Environmental Registry for a minimum of forty-five (45) days prior to the issuance of the Environmental Compliance Approval. Ontario Regulation 681/94 under the EBR sets forth the types of ECAs that are classified as Class I or II proposals which require posting on the Environmental Registry unless they relate to a discharge point which is already subject to an ECA approval and the proposed ECA would not permit an increase in the discharge of any specific contaminant from the discharge point. In addition, as per section 30 of the EBR, a proposal may be exempt from EBR requirements if the proposal has been considered in a substantially equivalent process of public participation.

Section 3 – Works Not Allowed To Be Submitted

Under no circumstances are the following applications for works identified in either section 1 or 2 to be submitted under the TOR program:

- 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 for Regional Stormwater Control Facilities or Regional Flood Control Facilities consisting of storm water management ponds that are designed to provide quality

control or contain floods greater than the 100 year flood event;
- Applications that are for airport 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.
- In addition, if the City determines that the works listed in an application have been constructed or are being constructed before an Environmental Compliance Approval has been issued, the City shall:
  - Immediately notify the local Ministry District Office; and
  - Return the application and all associated documents and fees to the applicant and instruct them that the application will not be reviewed under the TOR program and that they must submit the application directly to the Ministry for review.

Easement Requirements

Easements are required for all underground infrastructure that will be assumed by a city which is not located within a public road allowance. The easement agreement documents both the rights of the city and the rights of the property owner. The easement agreement is also registered on title of the affected property.

An easement is required to ensure that municipal services and utilities crossing the site can be properly installed and maintained by the appropriate authority. An easement provides the right to use the lands for a specific purpose which is in the public’s interest.

Types of Easements

Municipal Easements

Required for underground municipal infrastructure that crosses private property and which is owned and maintained by a city.

Utility Easements

Utility easements are required for telecommunications, hydro, gas, and cable television services. Each utility company should be consulted for their specific requirements when city infrastructure crosses a utility company's lands.

Private Easements

Private easements are required for private underground infrastructure, drainage purposes or private access roads that cross a parcel of land to service other private lands. A joint access and maintenance agreement between the interested parties will be required. It should be noted that the City has no role in private easements.

Temporary Easements and Working Easements

Temporary easementsare required during the construction of city underground infrastructure and access roads that cross a site temporarily. The services in the easement are to be maintained by the respective owner.

Minimum Easement Widths

Easement widths are determined by the depth from the centreline elevation of the road or ground to the invert of the sewer or watermain.

The City will determine the placement of the plant—on centre or offset—within the easement. Subsurface or strata easements may be specified for certain tunnelled infrastructure. The minimum easement widths required for sewer and watermain infrastructure is as follows:

Rear lot catchbasin lead crossing multiple properties will require a private easement. Private easement is not required if catchbasin lead is on the same lot.

Table 2: Easements widths

If service, size and depth is …	Then easement width shall be a minimum dimension of …
Rear lot catchbasin lead regardless of diameter and depth	3 m
Single sewer or watermain equal or less than 600 mm diameter and less than 3.7 m deep	6 m
Single sewer in excess of 3.7 m deep or single watermain equal or larger than 750 mm diameter	9 m
A combination of two mains, either sewer or water, less than 3.7 m deep	9 m
A combination of two mains, either sewer or water, in excess of 3.7 m deep and no closer than 3 m to easement limit	12 m
Major trunk sewer or transmission watermain	15m [a]
Three or more mains, no closer than 3 m to easement limits	Add 3 m for each additional sewer or watermain

[a] Sewer or watermain will be located off center in the easement for future infrastructure.

Existing easements may need to be widened based on the existing service, size and depths within the easement in accordance with the above table. In the event that the services fall into multiple categories in the table, the more stringent – wider – easement width will be required.

If the expected loading condition is not known at the time of the design, sewer pipes exceeding 900 mm in diameter within any easement, the pipe class will be increased one classification.

Zone of Influence

When a building is close to a buried pipeline, whether the building is in the easement, or close to it, the designer needs to ensure no loads are placed on the pipe. To avoid placing any load on the pipe, the base of any foundation should be below the zone of influence of the pipe. This zone of influence starts at the base of the pipe and rises at a slope of 1 in 1 to ground level.

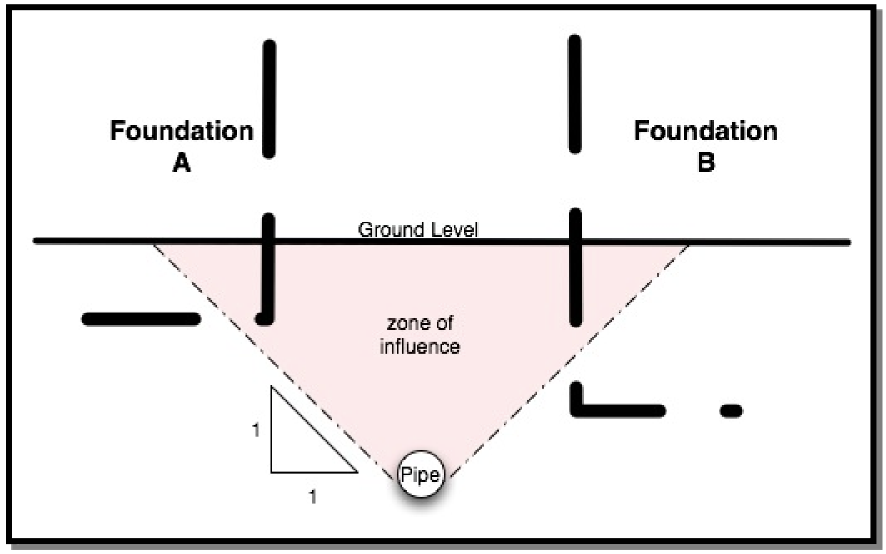


Figure 1: Zone of influence in an easement

In the diagram above

- Foundation A is unacceptable, the base is inside the zone of influence.
- Foundation B is acceptable, even though it is the same horizontal distance from the pipe as Foundation A because the base is outside the zone of influence.

The base of the foundation is the lowest point of the foundation, that is the bottom of the slab. In the case of piers, the base of the piers.

Encroachment into a Toronto Water Easement

To request an encroachment into a Toronto Water easement go to www.toronto.ca/services-payments/water-environment/water-sewer-related-permits-and-bylaws/water-related-permits/encroachment-into-a-toronto-water-easement/ .

Servicing in Confined Spaces

City Development Infrastructure Policy and Standards (DIPS) applies to residential developments. Proposed servicing in confined spaces for development that can achieve the objectives of the City of Toronto Official Plan for intensification may be considered only under exceptional circumstancances at the discretion of the City.

The applicant is advised that there is no guarantee for acceptance and that to be considered for review, additional design measures will be required to ensure that the infrastructure can be operated and maintained, while providing a level of service equivalent to infrastructure installed in a standard road cross-section. For more information on servicing in confined spaces, see Appendix G, *Servicing in Confined Spaces*.

As-built Drawing Submission Requirements

One complete hardcopy set of as-built engineering drawings along with as-built storm and sanitary sewer design sheets must be submitted and accepted by the City. The hard copy drawings must be prepared in accordance with the as-built drawing requirements detailed in Appendix A, *As-built Drawings*.

For plan of subdivision development projects, that includes the construction of new roads or mains, or both, the as-built drawings must be provided and accepted as described in the subdivision agreement.

For site plan development projects, "Site Servicing Certification" must be included as part of the "Completion Certificate" prepared by the consulting engineer and forwarded to the City or prior to condominium registration, if it is a condominium project.

For capital improvement projects, the as-built drawings must be provided no later than 60 days following substantial performance.

As-built sewer design sheets must be scanned and placed on the drainage area plan included with the as-built drawing set.

To be compliant with the City Drinking Water Works Permit, all records of alteration to the system as a result of capital improvement projects must be filed within one year of installation.

Development Engineering Projects

The developer's consulting engineer typically performs work required for completion of the as-built drawing. The developer's consulting engineer will be required to submit to the City one set of white prints redlined to clearly indicate all field changes.

The developer's consulting engineer will also incorporate all remarks provided by the City's development engineer. Two sets of prints will then be made from the revised construction or tender drawings for review.

After the development engineering section is satisfied that all remarks have been included, the City will request the drawings be submitted in a digital format acceptable to the Engineering and Construction Services division.

Each sheet will have "As-built" in the revisions box initialled by the developer's consulting engineer.

As-built drawings will use the original size of the approved drawings or will be 609 mm x 914 mm (24 inch x 36 inch) in size.

The submission to the development engineering section will include a revised electronic file in MicroStation (DGN) and PDF format on a USB. Each USB shall be labelled with the project name, company name, engineering company's name and telephone number.

Capital Improvement Projects

City personnel typically perform the work required to complete the as-built drawings. In some cases the City will instruct the design engineer, contracted by the City, to perform the work required to complete the as-built drawings.

City personnel from design and construction services section will proceed with the completion of the as-built drawings incorporating all field changes as required. If the City proceeds with having the as-built drawings completed by the design engineer, the consulting engineer carrying out the field work and inspection will supply the information required to complete the as-built drawings. One set of reproductions will be submitted showing all field changes on the final as-built drawings.

After the City contract administrator is satisfied that all remarks have been addressed and included, the City will request the hard copy of "As Built" drawing and each sheet will have "As-built" in the revision box initialled by the design engineer.

As-built drawings will use the original size of approved drawings or will be 609 mm x 914 mm (24 inch x 36 inch). Larger sheet sizes are unacceptable.

The submission to the City contact administrator will include a revised electronic file in MicroStation (.DGN) and PDF format on a USB. Each USB will be labelled with the project name, company name, design engineer's name and telephone number.

Third Party and Utility Review Projects

Third party projects such as Metrolinx, TTC, Waterfront Toronto and so on are processed by Third Party & Utility Review (TPUR).

If Toronto Water assets are involved, the proponent may have to provide hard copy and PDF format as-built drawings to Toronto Water staff as set out in the Toronto Water Wellness Report and one additional PDF copy to the TPUR unit.

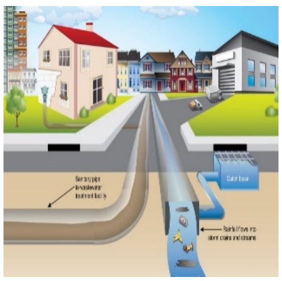
Other Drawings as Required

Shop drawings for factory manufactured infrastructure such as concrete pressure pipe, feeder mains, valve chambers or retaining walls should be included.

Chapter 2 – Sanitary Sewers

The sanitary collection system transports liquid wastes from residences, commercial buildings, institutions, industrial developments, along with ground water and stormwater that find its way into the sanitary sewer system.

The types of sewer systems are:



Separated

A separated sewer system is a system in which all municipal sewage is conveyed to sanitary sewers and all surface runoff is conveyed to storm sewers.

Partially Separated

A partially separated sewer system consists of storm sewers that conveys surface runoff, primarily from roadways, and sanitary sewers that receives municipal sewage as well as foundation drains and some driveway drains. These systems typically are found in older subdivisions prior to the introduction of fully separated systems.

Combined

A combined sewer system is a system that conveys both surface runoff and sanitary sewage. These systems are generally located in the older parts of the city.

Sewer Regulations

Sanitary Sewers

Separated sewer system is currently the standard for all new subdivisions and infill developments. Roof drains will be discharged at grade away from the low rise residential buildings. Foundation drains are not connected either to the sanitary or storm sewer systems.

The discharge of non-contact cooling water or uncontaminated water to a sanitary sewer or combined sewer from any new residential properties is prohibited as described in the Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

Combined Sewers

The construction of new combined sewers is no longer permitted other than for the replacement of existing combined sewers within the city's defined combined sewer area.

New storm drainage systems cannot be connected to existing combined sewers except as an interim measure where sewer separation is to be ultimately implemented or where circumstances allow no other alternative.

The discharge of roof drains to combined sewer area of the city will be prohibited. Exemption will be at the sole discretion of the General Manager, Toronto Water as set out in the Sewer Use Bylaw, Chapter 681 of the Municipal Code.

The discharge of groundwater inflow to combined sewer area shall be minimized. The acceptance of this flow shall be at the sole discretion of the General Manager, Toronto Water. If accepted, a sanitary discharge agreement with Toronto Water will be required.

Sanitary Trunk Sewer

Sanitary trunk sewers collect discharges from local sanitary sewers. Sanitary sewers convey sanitary sewage and some storm runoff that gain entry through infiltration or intercepted flow from combined sewers to the treatment plants.

The current inventory of sanitary trunk sewers in the city of Toronto was established under the former *The Municipality of Metropolitan Toronto Act* and are sewers that serve more than one municipality or areas in excess of 405 hectares. Contact should be made with the City for additional information prior to undertaking any design work.

Combined Trunk Sewer

Combined trunk sewers collect discharges from local combined sewers. Combined sewers carry both sanitary sewage as well as storm runoff. The combined trunk sewers were assumed by the former Metropolitan Toronto from the area municipalities in 1954. They have capacity for the peak dry weather flow plus the runoff from a 2-year storm event. This capacity is much more than the 0.26 litre/second/hectare design value for infiltration and inflow. The dry weather flows represent less than 10 percent of the sewer capacity.

In 1998, the MECP implemented procedure F-5-5, Determination of Treatment Requirements for Municipal and Private Combined and Partially Separated Sewer Systems. This procedure requires minimum Combined Sewer Overflow (CSO) controls including the capture and treatment for an average year, all dry weather flow plus 90 percent of the volume resulting from wet weather flow that is above the dry weather flow, applied above each overflow location or if it can be shown by modelling, on a system-wide basis.

The City should be contacted for additional information prior to undertaking any design work that will affect the combined trunk sewers.

Population Densities

Population Equivalents Based on Land Use

When lands are zoned for a specific use and detailed information is not available, the following population densities will apply:

Table 3: Equivalent population

If development type is …	Then equivalent population density is …
single family > 10 m frontage	50 persons/ha
single family < 10 m frontage	70 persons/ha
semi-detached	70 persons/ha
townhouse (RM1)	170 persons/ha
medium density (RM3–RM5)	270 persons/ha
apartments—if < 148 units/ha	400 persons/ha
apartments—if > 148 units/ha	2.7 persons/suite
schools, churches (R1–R4, RM2)—lot area known	86 persons/ha
schools, churches (R1–R4, RM2)—lot area unknown	GFA (m^2) x 0.0258 persons/m^2
offices	3.3 persons/100 m^2 (GFA)
commercial or retail	1.1 persons/100 m^2 (GFA)
industrial—lot area known	136 persons/ha
industrial—lot area unknown	GFA (m^2) x 0.0272 persons/m^2
institutional—nursing home, group home, hospitals, home for the aged, hostels–number of beds known	1 person/bed
institutional—nursing home, group home, hospitals, home for the aged, hostels–number of beds unknown	GFA (m^2) x 1 bed/30 m^2 x 1 person/bed
parkland	10 persons/ha

Note: R means Residential, RM means Residential Multiple, GFA means Gross Floor Area

Population Equivalents Based on Type of Housing

When the number and type of housing units within a proposed development is known, calculating the population for the proposed development will be based on the following:

Table 4: Persons per unit

If type of housing is …	Then persons per unit is …
single family dwelling	3.5
semi-detached	2.7
townhouse	2.7
duplex	2.3
triplex	3.7
apartments or condominium:	
bachelor	1.4
1 bedroom	1.4
2 bedroom	2.1
3 bedroom	3.1
4 bedroom	3.7

Cross Boundary Development

When a sewershed crosses into another municipality such as the Region of Durham, Peel or York, a cross boundary servicing agreement will be required. It is necessary to check the population per hectare equivalent or proposed flow being discharged into the City from those municipalities.

Development and Redevelopment Applications

Rezoning and Official Plan Amendment Applications

All residential, commercial, institutional, and industrial rezoning and official plan amendment applications must include a review of available downstream capacity with respect to the sanitary sewer all the way to the trunk sewer. If it is found that the public sewer system is inadequate, the developer will be responsible to fund the necessary upgrades to the system.

Site Plan Applications

All permitted as-of-right uses or intensification—that is to say complying with the current zoned designation—such as commercial, institutional, and industrial site plan applications must determine the expected sanitary flow discharge from the site.

A downstream sanitary system analysis is required if there is a change to the existing sanitary drainage pattern or groundwater discharge to the sanitary system or both.

Design Flows

The design of sanitary sewers will be based on the sewage flows from the ultimate development permitted by the zoning and expected from the tributary area. The design of sanitary sewers must account for all peak flows contributing in determining the appropriate design flow capacity for sizing the sewer pipes.

Calculation of Peak Design Flows

Sanitary sewage flows are comprised of wastewater discharges from residential, commercial, institutional, and industrial land uses, plus extraneous flow components from such sources as groundwater and surface runoff.

The peak domestic residential sewage flows are calculated from the following parameters: average daily flow per capita, contributing population, peaking factor for the domestic flows.

$Q_d = qPM / 86400$

Where,

Q_d = peak domestic sewage flow (l/s)

q = average daily flow per capita (l/cap/day)

P = population

M = peaking factor (PF in Table 5 below)

The formulae and parameters to be applied in the calculation of peak flows of different components for new or infill developments is described in the Table 5 below.

Design flow Q for sanitary sewers will be the sum of all peak flows;

Domestic/residential Q_d, institutional Q_{ins}, commercial Q_{com}, and industrial Q_{ind} plus inflow/infiltration allowance IA.

$Q = Q_d + Q_{ins} + Q_{com} + Q_{ind} + IA$

Table 5: Peak flow design parameters

Average wastewater flows for new local sewers	
average wastewater flow	450 litres/capita/day
commercial average peak flow	180,000 litres/floor ha/day [a,b]
industrial average peak flow	180,000 litres/floor ha/day [a,b]
institutional average peak flow	180,000 litres/floor ha/day [c]
Peaking factors	
residential peak factor	Harmon equation: $PF=1 + (14/(4+(P/1000)^{½}))$ Where P=population PF=ratio of peak flow to average flow
commercial peak factor	included in average peak flow
institutional peak factor	included in average peak flow
industrial peak factor	included in average peak flow
Extraneous flows	
infiltration allowance	0.26 litre/second/ha (all areas)
Foundation drain allowance	
<10 ha	5 l/s/ha (if necessary for existing partially separated and combined areas only)
>10 ha and ≤ 100 ha	3 l/s/ha for additional area above 10 ha (if necessary for existing partially separated and combined areas only)
>100 ha	2 l/s/ha for additional area above 100 ha (if necessary for existing partially separated and combined areas only)
Groundwater discharges	
groundwater inflow allowance	Included in sanitary discharge agreement

[a] Floor space index is one half of the gross land area, unless designated otherwise in the secondary plan.

[b] The area is calculated using the number of gross hectares of the site or lot. The flow criteria will apply unless evidence shows there will be additional flow volume.

[c] Where the total floor area does not exceed the size of the lot, the area is calculated using the number of gross hectares included in the institutional site.

Residential Developments

Where new sewers are planned or when a Greenfield development is proposed, all local sanitary sewers will be designed using 450 litres/person/day. The Harmon equation will be used for the peaking factor.

Commercial and Institutional Flows

The sewage flows from commercial and institutional businesses vary greatly with the type of water-using facilities present in the development, the population using the facility, the extent of extraneous flows entering the sewers and so on. If approved actual flow records are not available, a unit rate value of 180,000 litres/floor area in hectares/day should be used which includes any extraneous flows. This value can be used at the functional design level, for example as in a servicing study.

The peaking factors applicable for sewage flows from commercial and institutional businesses already have a built in peaking factor and applied to the average dry weather flow calculations.

Industrial Flows

Peak sewage flow rates from industrial areas vary greatly with the extent of the area, the types of industry present, and the provisions on in-plant treatment or regulation of flows, the presence of cooling waters in the discharge and so on.

If the water usage of the proposed industry is known, the data should be used in the design of the system at the site plan application stage. If water usage for the proposed industry is not known, a unit rate value of 180,000 litres/floor area in hectares/day should be used which includes any extraneous flows and peaking factor. This value can be used at the functional design stage, for example as in a servicing study.

Extraneous Flows – New Areas

In computing the total peak flow rates for the design of new sanitary sewers, an allowance of 0.26 litre/second/gross hectare will be applied, irrespective of land use classification to account for ground water infiltration and wet weather inflow into the pipes and maintenance holes. Assume no roof drains or foundation drains are connected directly or indirectly to the sanitary sewer.

In case there exist groundwater discharges permitted under the future Sanitary Discharge Agreements, these groundwater inflows must be accounted as another element of extraneous flows in addition to the allowance of 0.26 l/s/ha when computing design flow.

Extraneous Flows – Existing Areas

The connection of foundation drains to the sanitary sewer system is not permitted for new developments, unless authorized through a Sanitary Discharge Agreement when the effluent quality does not meet the Toronto Municipal Code, Chapter 681, Sewers Table 1 for sanitary and combined sewers and Table 2 for storm sewers. Typically a specific allowance for foundation drain flow to sanitary sewers is not required, however, the base amount permitted under the Sanitary Discharge Agreement should be included in the design flow.

When groundwater flows are quantified on a sanitary sewer design sheet, the capacity of the existing sewers must be checked to confirm that they have capacity to receive these flows. In absence of specific monitored data, the figures in Table 5: *Peak flow design parameters* should be used in calculating the design flows.

For new developments where the hydrogeological investigation indicates that groundwater or the effluent quality does not meet the Toronto Municipal Code, Chapter 681, Sewers requirements for discharge to storm sewers, the capacity of the existing sanitary sewers receiving these groundwater inflows must be checked to confirm that they have capacity to receive these flows.

Sewer Capacity Assessment

The assessment of existing sanitary and combined sewer systems shall be conducted in accordance with the guiding principles, capacity criteria and assessment procedures set out in the *Sewer Capacity Assessment Guideline*. The design of new sewer improvements or upgrades may be identified and proposed where the existing sewer system does not meet established sewer capacity criteria.

In computing design flows to size the new sewers, Table 5, *Peak flow design parameters* is required to use. In this table, the average wastewater flow of 450 litre/capita/day is applied for the residential population. The City recognizes that this rate for the design of a proposed sewer is

1 More conservative than the rates to be used for the analysis of an existing sewer system, and

2 The proposed sewer will ultimately be part of the existing sewer system.

Therefore, when an application is made for Ministry of the Environment Conservation and Parks (MECP), Environmental Compliance Approval (ECA) for proposed sanitary sewers, the consultant is to perform calculations for both 450 litre/capita/day and 240 litre/capita/day for residential population, or 250 litre/capita/day for ICI equivalent population for the proposed sewer, when analysing the impact on the hydraulic grade line of the existing downstream sewer system, prior to connecting to the trunk sewer system.

The analysis of the 450 litre/capita/day rate shall be supported by a design brief which

1) Interprets the results of the analysis, and
2) Compares the results to the 240 litre/capita/day for residential or 250 litre/capita/day for ICI equivalent population.

The design brief shall provide conclusions and recommendations on the ability of the existing sewer system to accommodate the proposed sanitary sewer flows.

Monitored Flows

Where the need for estimating infiltration and inflow rates using flow monitoring is identified for sewer capacity assessment, flow monitoring and infiltration and inflow estimation will be conducted according to Appendix B, *Flow Monitoring and I&I Estimation Protocol* from the *Sewer Capacity Assessment Guideline*.

Wet Weather Flow

Stormwater runoff is generated by rainfall and snowmelt. A secondary source of infiltration and inflow is from foundation drains or other drains from rainfall or snow melt that can discharge to either

- a sanitary sewer
- a combined sewer, or a
- a storm sewer that can discharge to either
  - a sanitary sewer,
  - a combined sewer, or
  - a storm sewer.

Groundwater

The discharge of private water, including groundwater to the City's sewage works is prohibited under Toronto Municipal Code Chapter 681, Sewers unless an exemption against these provisions and a connection to City's sewage works is authorized by the General Manager of Toronto Water.

Before considering a request for an exemption pursuant to the Toronto Municipal Code Chapter 681, the applicant shall be required to submit for approval of a servicing report justifying that there is no practical alternate means of drainage available and identifying the groundwater quantity and quality control measures being proposed for the site.

The issuance of a private water discharge approval shall come in the form of a permit or agreement which is issued through the

Private Water Discharge Approval Application process administered by the Environmental Monitoring and Protection unit of the Toronto Water Division. Detailed procedures relating to the exemption application for discharging private water into the City’s sewage works can be found at www.toronto.ca/services-payments/water-environment/water-sewer-related-permits-and-bylaws/water-related-permits/discharge-permits-agreements-for-private-water/ .

Groundwater which is classified under private water shall be subject to the compliance with the above noted requirements or examined for eligibility of an exemption application as outlined in the Toronto Municipal Code Chapter 681, Sewers. The quality of discharged private water, including groundwater, into the City's sewers system shall comply with Toronto Municipal Code Chapter 681, Table 1 for sanitary and combined sewers, and Table 2 for storm sewers.

The City is in the process of developing a Foundation Drainage Policy for development applications submitted under the *Planning Act.* With the implementation of the policy, the criteria stipulated in the policy shall prevail should any conflicts is found between the above requirements and the criteria of the policy.

Furthermore, discharge of groundwater into the City's sewage works must be factored into the municipal sewer capacity analysis and stormwater management design, as applicable.

Level of Protection

Hydraulic Grade Line Requirements

Sanitary sewers will be designed to operate under free flow conditions during dry weather unless the receiving sewer is experiencing surcharge due to outlet conditions. The impact of downstream surcharge on the new system must be addressed when connecting to an existing system. To prevent basement flooding due to surcharging of the new system from the existing downstream system at connection point, the maximum hydraulic grade line must be greater than 1.8 m below the crown of the road. When assessing individual basements, a free board of one metre between the new basement floor elevation and hydraulic grade line is desirable with an absolute minimum of one half-metre.

Basement Flooding Protection Requirements

To help mitigate the impacts of basement flooding, City Council has adopted a level of protection representing the May 12, 2000 storm for the sanitary sewer system. When designing sanitary sewers discharging to or located in a basement flooding protection area, the affected sanitary systems must be assessed under this storm event. In this assessment, the domestic or residential flow component is computed by using the most recent population data available and applying the rate of 240 litres/capita/day.

The ICI components are computed based on the most recent land uses and water consumption data. In case water consumption data are not available, the peak flow design parameters for ICI can be used, see Table 5: *Peak flow design parameters*.

The inflow/infiltration (I/I) component is the I/I generated from May 12, 2000 storm event as gauged at City's Oriole Yard location. In addition, if there exist permitted groundwater inflows, these inflows to the assessed sewer systems are also taken into account. The flow in sanitary sewers is the total of these flow components.

Using this flow, it must be demonstrated that each leg of the assessed sanitary sewer in the study area meets the corresponding criteria, according to Table 6:

Table 6: Capacity criteria for sanitary and combined sewers

Criteria	**Discharge to sewer system**	
	Sanitary sewer	**Combined sewer**
Criterion 1 "*Design Function"*	Under proposed design flow conditions, there will be no surcharge[1] in the sewer system.	Under proposed design flow conditions, plus contributing peak stormwater flows under the 2-yr design storm event, there shall be no surcharge in the sewer systems.
Criterion 2 *"Basement Flooding Protection"*	Under proposed extreme WWF conditions, which includes I&I generated under the May 12, 2000 storm event[2], the HGL in the sewer will be at least 1.8 m below grade.	*[Not applicable if Criterion 3 is met]* Under proposed extreme WWF conditions, which includes I&I generated under the 100-yr design storm event, the HGL in the sewer will be at least 1.8 m below grade.
Criterion 3 *"WWF Mitigation"*	*[Not applicable if Criterion 2 is met]* Under proposed extreme WWF conditions, WWF mitigation measures will ensure that the proposed HGL will be no higher than the existing HGL. The proposed peak flow rate will be no greater than existing peak flow rate at the connection to the trunk sewer or pumping station.	Under the 2-yr design storm event, off-site WWF and I&I mitigation measures will offset two times the proposed increase from on-site discharges to the system. For systems containing CSO points for CSO control, ensure there will be no increase in peak overflow rate at the CSO point.

[1] No surcharge deemed when HGL is under pipe obvert.

[2] Estimate equivalent 25-yr design storm, where no WWF I&I for May 12, 2000 storm event is available from BFPP studies.

For more details on sanitary and combined sewer assessments, see the *Sewer Capacity Assessment Guideline*.

Sanitary Sewer Design

Pipe Capacities

Sewer capacities will be computed by using the Manning formula. Generally, sanitary sewers will be designed to flow at a maximum of 80 percent full flow design capacity of the pipe size. The sewer will be designed for sub-critical flows.

Roughness Coefficients

In a new sewer design, the value of 'n' using Manning formula will be:

Table 7: Manning 'n' value

If pipe material is …	Then value of 'n' is …
concrete (CONC)	0.013
polyvinyl chloride (PVC)	0.013
high density polyethylene (HDPE)	0.013

Pipe Size

The minimum allowable size for a sanitary sewer will be 250 mm diameter.

Minimum Velocity

All sewers should be designed with such slopes that they will have a minimum sewage flow velocity, when flowing full, of at least 0.6 m/s. In cases where the flow depth in the sewer, under peak flow, will not be 0.3 of the pipe diameter or greater, the actual flow velocity at the peak flow should be calculated using a hydraulic elements chart. If this velocity is less than 0.6 m/s and the pipe size is the minimum allowable one–250 mm–, the pipe slope should be increased to achieve adequate flushing velocity.

For replacement sewers where there is an alignment change and fixed inverts at two ends, the minimum velocity requirements will be reviewed at the discretion of the City on a case-by-case basis.

To determine sewage velocities based on actual flow, refer to the Figure: *Hydraulic Elements Graph for Circular Pipe.*

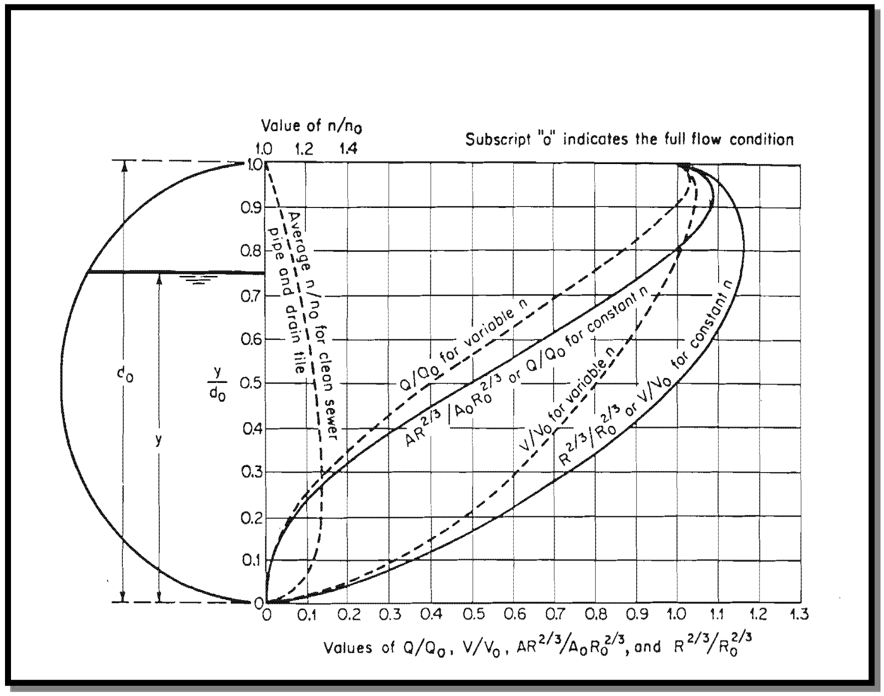


Figure 2: Hydraulic elements graph for circular pipe

Maximum Velocity

The maximum velocity permitted in sanitary sewers is 3 metres/second. Where steeper grades are unavoidable, additional design factors will be taken to protect against pipe displacement and erosion.

Minimum Grades

The minimum grades for sanitary sewers shall be according to the following table.

Table 8: Minimum grades for sanitary sewers

If diameter or condition is …	Then minimum slope is …
first leg—mh to mh	1 %
250 mm	0.5 %
300 mm and larger	MECP guidelines

The minimum grade on all sewer sizes will be established by determining the minimum grade necessary to achieve an actual velocity of at least 0.6 metre/second.

Flow from Less Than 10 Single Family Dwellings

Flows in upper reaches of sewer systems are often insufficient to reach flushing velocity, resulting in deposition of solids. It is recommended that upstream legs in a sewer system be installed with a one percent slope, until 10 single family units are connected, or at whatever slope can achieve the recommended 0.6 m/s flushing velocity.

The designer is expected to maximize the actual cleansing velocity by adjusting the slope to ensure

1) the service connections can be connected to the pipe and
2) that the full bore velocity of 3 m/s scouring velocity will not be exceeded, which is approximately 5 percent for a 250 mm pipe.

Bedding Requirements—Flat Sewers

In cases—usually existing small diameter sewers— where sewers have flat slopes, the replacement sewer pipe will be concrete and concrete encased so it can hold its grade. For details and additional design information, see City standard T-802.032-1, Bedding Type S2.

Reinforced concrete pipe is only available for diameters 300 mm and larger. Non-reinforced sewer pipe 250 mm and smaller is not acceptable for use.

For flat grade PVC sewers, it is preferred to use granular bedding compacted to 100% Standard Proctor Density. Should concrete bedding be used for PVC sewers, the pipe must be encased in concrete all the way around the pipe, with the encasement terminating at a pipe joint to provide flexibility in case of differential settlement.

Cradling the pipe in concrete bedding up to the spring line will not be permitted. This is due to the possibility of expansion/contraction of the PVC pipe relative to the concrete bedding or due to differential settlement, which may result in the pipe popping out of its cradle.

The section of pipe between the last pipe joint and maintenance hole wall shall be placed in compacted granular bedding with a rubber boot connector at the maintenance hole. For details, see City standard T-708.020.

Shallow Sewers

Shallow sewers will be insulated according to OPSD 1109.030.

Pipe Material

Both rigid and flexible pipe are permitted in the construction of sanitary sewer systems including municipal service connections. These materials include reinforced concrete, PVC, and vitrified clay. The bedding design, however, must be compatible with the type of pipe material used.

Rigid pipe is recommended in areas of high utility congestion, where bedding may be undermined in the future.

In non-industrial areas, the pipe material of the sanitary sewer depends on the diameter.

Table 9: Sanitary sewer preferred material

If diameter is …	Then pipe material to use is …
less than or equal to 375 mm	PVC
equal to 450 mm	PVC or CONC
greater than 450 mm	CONC

For flat grade installations, additional review may be required by the City. PVC pipe is not permitted to be connected to a trunk sewer according to City standard T-1006.01-1.

Only PVC and vitrified clay pipe material will be allowed for industrial areas.

Ultra-rib pipe is not approved for use as a sanitary sewer.

For more information regarding acceptable pipe materials, reference should be made to Chapter 6, *Material Specifications*.

Bedding Requirements

The class of pipe and the type of bedding will be selected to suit loading and proposed construction conditions.

Rigid pipe bedding will be as per OPSD 802.030, 802.031, 802.032 802.033 and 802.034. Flexible pipe bedding will be as per OPSD 802.010, 802.013 and 802.014.

Granular A Native or Granular A RCM shall be according to TS 1010 and TS 401. Granular A RAP is not allowed.

If there is a high ground water table, the designer shall perform calculations to quantify the amount of seepage along the pipe. Clay seals can be used to according to OPSD 1205. Alternatively, filter diaphragms and subdrains may be considered depending on the embankment conditions.

The pipe material, class, and type of bedding will be shown on the profile drawing for each section of sanitary sewer.

Specialty designs that require custom bedding to compensate for poor soil conditions, are subject to additional review and approval by the City. These situations may include areas of flat slope, steep slope, fill areas, and areas of high groundwater.

Geoweb Geocell

Geoweb geocell is permitted by the City to compensate for poor soil conditions and to provide a stable, uniform trench base and bedding condition. The Geoweb serves as a compaction aid on the subgrade allowing for proper compaction of the base granular.

Geosynthetic reinforced bedding is permitted by the City to promote embankment and trench stability. The geosynthetic can be used for land formation created by lakefill, which can consist of non-homogenous waste materials that are prone to decomposition and settling.

Pipe Class

Pipe class will be selected to suit the bedding class, final buried depth and surface loading.

Mainline PVC sewer pipes will have a minimum dimension ratio (DR) of 35 and be green in colour.

Mainline reinforced concrete sewer pipes will be a minimum class of 65-D.

Minimum Depth of Cover

The minimum depth of a sanitary sewer will be 2.75 metres measured from the centre line elevation of the road to obvert of the sewer.

If the standard depth for a residential sanitary sewer is not possible the sewer inverts must be at least 0.9 metre to 1.5 metres below the basement floor levels.

When the standard depth is not possible, all basement slab elevations of a depth up to 900 mm above the above the sanitary pipe invert will be shown on the profile drawing and the lot grading plans.

In new commercial areas, sewer depths should be a minimum of 3.5 metres below the centre line of road, where possible.

Where existing sewers are present, for proposed buildings with basements substantially below street level, the installation of ejector pumps from the building into the sewer are acceptable.

Table 10: Sanitary sewer minimum depths

If land use …	Then minimum depth is …
residential	2.75 m
industrial	2.75 m
commercial	3.50 m

Maximum Depth of Cover

Maximum depth of cover for concrete pipe will be in accordance with OPSD 807 010 for confined trench or OPSD 807 030 for embankment. For PVC gravity sewer pipe, the maximum cover will be in accordance with OPSD 806.040 for trench or embankment.

Location and Alignment

Sanitary sewers will be located 1.5 metres—as measured from the centre line of pipe—on either the south side or the west side of the road centre line unless a conflict with other utilities requires a revised location. Exceptions will occur on curved streets. In order to avoid excess surface water entering sanitary sewer maintenance holes, they should be located at least 1.5 metres from the curb line and away from low points. Sanitary maintenance holes must be located in the asphalt area of the road, for maintenance purposes.

Pipe Crossing Clearances

The minimum clearances required when sanitary sewers cross other services will be measured from outside wall to outside wall of pipe. Clearances with respect to watermains will be as per MECP procedure F-6-1.

Table 11: Pipe clearances

If crossing is …	Then minimum clearance is …
Over or under a storm sewer	300 mm
Under a watermain 450 mm diameter or less	300 mm
Over a watermain 450 mm diameter or less	500 mm
Over or under a watermain greater than 450 mm diameter	500 mm

Low pressure air testing of the sanitary sewer is noted. However, the air testing is done as a substitute to hydrostatic testing, which should be the first method considered. Hydrostatic testing is currently noted in MECP F-6-1, while air testing is not. Air testing was permitted as per a separate communication by the MECP with IPEX.

The minimum horizontal separation between a sewer and watermain is 2.5 metres. In cases where it is not practical to maintain separate trenches or the recommended horizontal separation cannot be achieved a deviation may be allowed.
If a new sanitary sewer DR35 cannot meet the 2.5 m horizontal or 0.5 m vertical clearance, low pressure air testing of the sanitary sewer according to TS 410.07.16.04.03 shall be performed and indicated on the General Notes.

For more information on MECP's letter on sewer pipe air testing, see Appendix J, *Sewer Pipe Air Testing.*

For more information go to Chapter 4, Watermains, section Crossings and Parallel Trench Installations.

Minimum Distance between Sewers

The minimum distance between new parallel sewers in a separate trench will be 3 metres, as measured from centre line of pipe to centre line of pipe. Exceptions can be made for site specific design constraints and depths such as dual maintenance hole installations.

It is preferred that a one metre minimum separation from outside wall to outside wall will be provided to permit installation of service connections and the future maintenance of the underground servicing.

When sanitary and storm sewers are constructed in a common trench, the storm sewer will be constructed parallel to the sanitary sewer with 600 mm minimum separation between the outside wall of the two pipes.

Clay Seals, Filter Diaphragms and Subdrains

When there exists a possibility that groundwater may be diverted and follow the path of the new sewer, the seepage patterns must be analysed. Groundwater barriers can be considered and designed in adequate numbers to prevent groundwater migration down sewer trenches for smaller embankments. Specific attention is required at crossings with other utilities and plant which rely on the stability of the existing sewer. For larger embankments filter diaphragms and subdrains should be considered depending on groundwater conditions and seepage patterns.

The following conditions are to be considered as sufficient reasons for discussing the need for additional seepage controls along the pipe alignment with the engineer on a specific pipe location basis

- the natural sub-base and culvert foundation materials are of a granular nature
- the embankment material is of a non-cohesive nature
- significant hydraulic head between ends of the culvert.

Clay seals shall be installed at 50 m intervals. Clay seals to extend the full trench width and from bottom of trench excavation to underside of road structure with a minimum thickness of one metre along pipe.

For details and additional design information, see OPSD 802.095 and OPSS.MUNI 1205.

Gaskets in Contaminated Soil Conditions

Prior to specifying the pipe material, the soils should be assessed for contamination. Should the assessment reveal that there is contamination—even in trace amounts—the longevity of ordinary rubber gaskets becomes a concern. Therefore, when locating sewer pipes in areas of soils contaminated with hydrocarbons, nitrile gaskets will be specified for the installation.

There are other types of contaminated soil such as soil high in chlorinates—there are various types, volatile organic compounds. The other types of contaminated soil should be mentioned. The appropriate gasket type should be indicated for each type of contaminated soil. Gasket types include plain rubber, EPDM, neoprene, Nitrile, Fluorel Viton.

Drawings must show locations of all nitrile gaskets.

Deflection Testing

Plastic sewer pipes will be tested for deflection according to TS 410. Ring deflection testing will be performed on all sewer pipes constructed using plastic pipe.

Pipes in sizes 250 mm to 450 mm in diameter will have an allowable deflection of 7.5 percent of the base inside diameter of the pipe.

The test will be carried out a minimum of 30 days after the sewer trench has been backfilled and installation of service connections or prior to paving the roadways.

Abandoned Pipes

Abandoned pipes shall be left in place according to TS 510 and the pipe shall be capped on both ends. Removal of abandoned pipe will be on case-by-case basis.

Maintenance Holes

Spacing of Maintenance Holes

Maintenance holes will be located at each change in alignment, pipe size, grade or pipe material, and at all junctions with lateral sewers.

Generally, the maximum allowable horizontal spacing between maintenance holes is as follows:

Table 12: Sanitary maintenance hole spacing

If diameter of sewer is …	Then maintenance hole spacing is up to …
250 mm–450 mm	120 m
525 mm–750 mm	150 m

Larger diameter sewers—larger than 750 mm— may use a greater maintenance hole spacing. The design will be made in consultation with the City.

Maintenance Hole Sizing

All sizing of sanitary precast maintenance holes are based on incoming and outgoing pipe sizes and will be sized as per City standard T-701.021. The minimum diameter for maintenance holes is 1200 mm.

The construction of maintenance holes will be in accordance to City standards T-701.010, T-701.011, T-701.012-1, T-701.013 and the pre-cast manufacturer specifications.

The type and size of the maintenance hole will be specified on the profile drawing.

When any dimension of a maintenance hole differs from the standard, the maintenance hole will be individually designed and detailed.

Maintenance Hole Frame and Covers

Maintenance hole frame and covers are required for all maintenance holes and will be in accordance with OPSD 401.010 type 'A' closed.

Where there is an existing type 'B' open maintenance hole cover, adequate ventilation of the combined sewer may be necessary. In this case, replace with OPSD 401.010 type 'B' open.

Maintenance hole frame and cover will be clear of curb and gutters and clear of bends in the road for new construction.

All maintenance hole chamber openings will be located on the upstream side of the maintenance hole.

Watertight Maintenance Hole Lids/Covers

Watertight bolt down covers are required when sanitary maintenance holes are located within sag points, ponding areas and overland flow routes. Overland routes can include flood plain areas, walkways within an easement, open space areas, gutter locations or any other location where overland flow is directly over and adjacent to the maintenance hole lids. Watertight maintenance hole lids will also be required to be installed at locations where it is necessary to guard against sanitary surcharge conditions.

Where significant sections of sanitary sewers are provided with watertight covers, extended vents will be required at every third maintenance hole to prevent excessive sulphide generation. The elevation of the vents will be above the regional flood elevation as determined by the Toronto and Region Conservation Authority (TRCA). When possible, maintenance holes will be positioned in a suitable location to allow venting.

For details and additional design information, see OPSD 401.030.

Lockable Maintenance Hole Covers

Lockable maintenance hole covers are required to control access and to protect the public. It is recommended that they be located through park blocks, open space blocks, pumping stations or water pollution control plants.

Maintenance holes located within easements in parks, open space or other locations as deemed necessary will be equipped with lockable watertight maintenance covers.

For details and additional design information, see OPSD 401.060.

Maintenance Hole Steps

For pre-fabricated maintenance holes, steps will be solid circular steps as per OPSD 405.020.

For cast-in-place maintenance holes, steps will be solid rectangular steps as per OPSD 405.020.

Drop Structure

A drop pipe should be provided for a sewer entering a maintenance hole at an elevation of 610 mm or more above the invert. Where the difference in elevation between the incoming sewer and the maintenance hole invert is less than 610 mm, the invert should be benched to prevent solids deposition.

The external drop pipe will be one size smaller than the sewer line—minimum 200 mm diameter. The alternative of providing a deeper sanitary sewer instead of a drop maintenance hole may be considered at the City's discretion. The preferred drop structure is Type 'C' in accordance with the City Standard T-1003.01.

Internal drop pipes—if considered—requires the maintenance hole diameter to be increased by one size, unless it is shown that access and maintenance is not compromised. Internal drop pipes must be secured to the interior wall of the maintenance hole. They will only be used if the use of an external drop pipe is not possible. For details and additional design information, see City standard T-1003.01-2.

Maintenance Hole Safety Landings

When the depth from invert to top of maintenance hole exceeds 4.5 metres, a safety platform will be provided. Safety grates will not be more than 4.5 metres apart. The platform will be located 2 metres below the maintenance hole cover and 2.8 metres above the maintenance hole invert. Incoming pipes are to be below landings, where possible. Access hatches in safety gratings are to line up to allow proper use of fall arrest equipment.

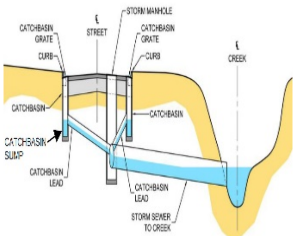
Benching

Benching of maintenance holes will conform to City standard T-701.021. Benching height will extend from the pipe obvert to improve hydraulic performance.

A benching detail is to be shown on the plan portion of the engineering drawing when the proposed benching differs from the City standard.

Steps in Benching

Steps in maintenance hole benching will be required when the pipe diameter is greater than 450 mm. The last step will be 300 mm above benching or 600 mm above the invert, if no benching.



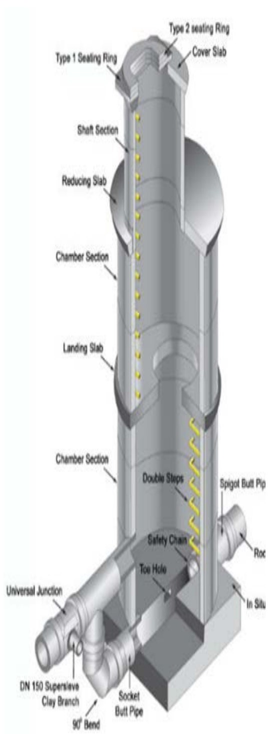
Hydraulic Losses at Maintenance Holes

Suitable drops will be provided across maintenance holes to compensate for the energy losses due to the change in flow velocity and to accommodate the difference in depth of flow in the upstream and downstream sewers. When the pipe size does not change through a maintenance hole and the upstream flow velocity does not exceed 1.5 metres/second, the following allowances will be made to compensate for hydraulic losses.

Table 13: Allowance for hydraulic losses (sanitary sewers)

If alignment change is …	Then drop required is …
straight run	grade of sewer or 0.03 m
15°–45°	0.030 m – MECP minimum 0.075 m – preferred
45°–90°	0.06 m – MECP minimum 0.15 m – preferred
junctions and transitions [a]	MECP calculations

[a] For all junctions and transition maintenance holes and when the upstream flow velocity exceeds 1.5 meter/second, the drop required will need to be calculated using the Appendix H, *Hydraulic Calculations for Junction and Transition Maintenance Holes*. Calculations for hydraulic losses will be included in the design submission.



The engineer will adhere to the following guidelines:

- Endeavour to keep entrance and exit velocities equal in order to reduce the amount of drop required, the engineer will try to restrict the change in velocity. Velocity change from one pipe to another in a maintenance hole will not exceed 0.6 metre/second.

- No acute interior angles will be allowed.

- No decrease in pipe diameter from a larger size upstream to a smaller size downstream will be allowed regardless of an increase in grade.

- Where an increase in pipe size occurs at the downstream side of the sanitary maintenance hole, maintain obvert elevations of the incoming and outgoing pipes or have incoming pipe obverts higher than outgoing pipe obverts.

Alignment of Pipe in Maintenance Holes

When two lateral sewers connect at a maintenance hole and are aligned opposite to one another such that the flows impinge on one another, the losses are extremely high. The flow is restricted causing back-ups. Therefore, aligning 600 mm and larger lateral sewers opposite one another in a maintenance hole is to be avoided. In order to reduce the losses, the installation of an upstream maintenance hole to turn the flow 45 degrees prior to intersecting the mainline sewer is preferred.

Pipe Connections to Maintenance Holes

Sewer connections at maintenance holes will be obvert to obvert. If this is not possible, the downstream pipe obvert will be lower than the upstream pipe obvert. Invert to invert connections will not be allowed.

The connection of the sewer pipe at the maintenance hole will utilize a flexible joint for either rigid or flexible pipe. Pipe connection to a maintenance hole using rigid pipe shall use concrete cradle. For details and additional design information, see City standard T-708.020.

Flexible Rubber Connectors

Flexible rubber connectors can also be used for connecting pipe to maintenance holes. Rubber connectors are either cast-in-place during manufacture of the pre-cast product or installed into a cored or preformed hole in the finished maintenance hole. For product information, go to Chapter 6, Material Specifications.

Pipe Connections to Existing Sanitary Sewer

For connecting sewers greater than 375 mm in diameter, a new maintenance hole is required over the collector sewer provided the collector sewer is no larger than 1050 mm in diameter. In such cases, place the off-line maintenance hole outside of the main traffic corridor in the street being serviced by the local sewer.

The exception is works constructed in accordance with City standard T-1006.01-1 for connections to the City's trunk sewer system which can be applied to rigid pipe connections.

New plastic pipe such as PVC or HDPE connections to trunk sewers including the maintenance holes are not allowed due to not being able to achieve a chemical or mechanical bond, the potential for differential settlement, the criticality of the infrastructure, and the need to ensure a watertight connection during the lifespan of the asset.

There may be situations where a maintenance hole cannot be constructed at an intersection. For these projects City standard T-1006.01-1 can be applied. T-1006.01-1 was developed from a standard specifically designed for trunk sewer connections at a time when the pipe was designed to be half full.

The preferred pipe-to-pipe connection location is 2 metres downstream of the nearest maintenance hole so the maintenance hole can be used for both inspection and installing flow monitoring equipment. The standard can also be applied to pipe-to-maintenance hole connections, which method is preferred when a pipe-to-pipe connection is too risky due to high sewage flows or poor ground conditions.

The 8 m dimension from the main line sewer to the connection maintenance hole was determined by the standard easement width of 50 feet (15.24 metres); half of which is approximately 8 metres. For proposed projects this dimension can be adjusted, however, to obtain the requirement of having the invert of the connection maintenance hole above obvert of the downstream trunk sewer, while having a maximum slope to control the flow, the spacing may have to be increased. Therefore, it may not always be possible to meet this requirement. The maximum slope should be used to govern the design.

Concrete pipe must be used to achieve a mechanical bond with the concrete pipe or maintenance hole. Plastic pipe cannot be used. The concrete encasement needs to extend to the flexible joint on the connecting sewer to ensure that if there is a leak, it will be a safe distance away from the trunk sewer. Reinforced concrete pipe must be used which is only available in 300 mm diameter and larger. The maximum grade for a 300 mm pipe is 1.10 percent.

Stacked Maintenance Hole

Where congestion of utilities precludes the preferred horizontal pipe connection to be made, and it is difficult to install a standard type of maintenance hole or catchbasin, a stacked maintenance hole or catchbasin can be used.

A maintenance hole over a stack is allowed in certain conditions, but there are limitations when connecting to brick sewers because the material is fragile, brittle, and can break. Therefore, an overstack installation is not recommended.

A structural analysis of the maintenance hole over the stack should address the following:

- Failure or deflection strain of the pipe from dead and live load bearing directly on the pipe crown which has been compromised by the penetration needed for the new connection pipe.
- Consideration of fatigue failure from repetitive traffic loadings.
- Long term differential settlement on the pipe section from the dead and live load bearing on the pipe section and the associated strain(s) on the pipe section connections with the adjoining pipe sections.

For details, see City standard T-701.015-1, T-701.015-2 and T-708.01-1.

Municipal Sanitary Service Connections

Sanitary service connections to single family and semi-detached dwellings will be individual service connections. No dual connections are permitted.

No new connections for foundation drains, weeping tile drainage, or roof drains are permitted to connect to the sanitary sewer in accordance with Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

Location

Sanitary service connections will be installed at the mid-point of the frontage of a single family lot, whereas water connection will be on the right of the sanitary service connection—when facing the lot—and ending inside the property line on private property. Cleanouts will be installed at the street line.

The location of the sanitary sewer service connections for semi-detached lots will suit the house style.

Minimum Size and Grades

Table 14: Service connection minimum size and slope

For example, if development is …	Diameter of sanitary /combined sewer is …	Then diameter and slope of the service connection is …	Preferred method of connection
residential, single family and semi-detached	250 mm	100 mm or 150 mm @ 2 % (recommended)	100 mm pipe – service saddle, 150 mm pipe – prefabricated "T" for new pipe
		100 mm or 150 mm @ 1 % (minimum)	
high rise residential condominium	300 mm	150 mm or 200 mm @ 2% (recommended)	150 mm pipe – service saddle, 200 mm pipe – prefabricated "T" for new pipe
		150 mm or 200 mm @ 1% (recommended)	

Service connections for multi residential, commercial, industrial, and institutional buildings will be individually sized according to the intended use and the requirements of the Ontario Building Code—Section 8.2.1.1 to 8.2.2.4., *Design Standards*. New minimum size sewers and service connections shall be PVC. Service connections to existing sanitary sewers other than PVC pipe, such as concrete, asbestos cement, clay, and brick may require the connection to be made to the existing stub connection with the approved flexible connector and reviewed on a case-by-case basis.

Pipe Class and Embedment for Laterals

PVC service laterals 100 mm to 150 mm in diameter will be class SDR 28 and green in colour. The embedment material will be Granular A Native or Granular A RCM according to TS 1010. Compaction will be 95% dry density.

Depth of Cover

The minimum cover at street line will be 2.3 metres below the finished centre line road elevation. However in situations where achieving 2.3 metres at street line is not possible, 1.82 metres cover will be acceptable.

The maximum cover at street line will be 2.75 metres below the finished centre line road elevation.

Sanitary Service Connections to Sewers

New Residential Service Connections

Sanitary service connections to the newly installed mainline sewer will be made with a manufactured tee for sewers size up to 375 mm, while saddles and Inserta–Tees or EZ–Tee are preferred for larger sizes and for tie–ins to existing sewer mainlines of all diameters. Inserta–Tees and EZ–Tee can be installed on mainlines up to 1050 mm and 1500 mm, respectively, with outlet sizes ranging from 100 mm to 300 mm. Strap–On Gasket PVC saddles can be made to pipe as large as 1050 mm with outlet sizes up to 150 mm.

All service connections to the mainline sewer will be made above spring line on the main pipe.

No gravity drain sanitary service connections 150 mm and smaller will be constructed into any existing sanitary maintenance hole.

For additional design information, see City Standard T-708.01 for rigid sewer service connections and T-1006.010 for flexible sewer service connection.

Connections to Existing Mainline Sewer

For retrofit installations, when the service has a size greater than half the diameter of the mainline sewer for example 250 mm service into 400 mm sewer, a maintenance hole, must be installed at the intersection of the service connection and sewer on the mainline sewer.

Using this rule of thumb will reduce the number of maintenance holes in the roadway.

Rule of thumb
If the service connection diameter is less than or equal to half the diameter of the mainline sanitary sewer, then no maintenance hole is required.

Service Connections will be connected at 90 degrees to the main. For additional design information, see City Standard T-708.01 for rigid sewer service connections and T-1006.010 for flexible sewer service connection.

Exceptions

In the case of a 150 mm service connection to a 250 mm mainline sewer, if a manufactured tee is installed and the invert of the service connection is above the spring line of the main sewer, a maintenance hole is not required.

In neighbourhoods where there are existing 200 mm diameter mainline sewers, a 100 mm diameter service connection will be permitted to connect to the mainline sewer with a strap and saddle.

Where it is not feasible to connect the service connection to the mainline sewer, it is permissible to connect to the upstream maintenance hole in cul-de-sacs. An effort shall be made to connect as many service connections to the mainline sewer as possible.

Residential Service Connections in Cul-de-sacs

A maximum of three connections will be permitted into the upstream maintenance hole in cul-de-sacs. The connection should be aligned within 15 degrees of the main sewer. Lateral service connections must be benched as per City standard T-701.021. Lateral service connections and downstream mainline sewer obverts are to be equal. The City will not accept drop structures for the sanitary service connections into the maintenance holes.

Connections to Existing Sewers for Lot Infill Situations

When connecting a sanitary service connection to an existing sewer in an infill situation, the connection must be sized appropriately and made utilizing a saddle or manufactured tee. To determine if the area you are working in is a combined sewer area, see Appendix C, *Maps*.

Multi-family, Commercial, Institutional and Industrial

Sanitary service connections 250 mm in diameter and larger will be connected to the mainline sewer with maintenance holes for new sewer construction, if the service connection is greater than half the pipe diameter. Where the sanitary sewer is existing, a tee will be installed on the mainline sewer and a maintenance hole will be placed on private property as close to the property line as possible.

Control Maintenance Hole

The City requires a control maintenance hole located on the property of the owner, as close to the property line as possible as per Section 681-10-A. (1) of the Toronto Municipal Code. This requirement will apply to multi-family, commercial, industrial and institutional developments.

Sampling Access Point

When groundwater is discharged to the municipal sewer system, the City requires a private water sampling access point located on the property of the owner to monitor the quality and quantity of private water discharged to the City's sewage works in accordance with Chapter 681, Sewers, Section 681-10-A of the Toronto Municipal Code. The City requires a 24 hours a day 7 days a week accessible location, upstream of the control maintenance access hole. This requirement will apply to all multi-family, commercial, industrial, and institutional blocks. The private water sampling access point must have the required overhead clearance—depth of sampling access point plus 2 metres—to allow the sampling access point to be installed at the proposed location. For additional design information, see City Standards T-709.010, T-709.020, T-709.030, and T-709.040.

Sanitary Service Connection Risers

In the case of deep sewers, vertical service risers from the main sewer at depths exceeding 4 metres should be installed at an angle not less than 45 degrees from the vertical. When the sanitary service connection is installed between 45 degrees and 67.5 degrees, an approved controlled settlement joint is required at the tee. The riser will not exceed 3 metres in height without approval from the City. The riser will be installed so that the elevation is 2.75 metres below the centre line road elevation. For details and additional design information, see City standard T-708.01 or T-1006.010.

Residential Sanitary Service Connection Cleanouts

All residential sanitary laterals are required to have cleanouts within the right-of-way and will be according to City standard T-708.01-5 Sanitary Sewer Cleanout Option "A" or T-708.01-6 Sanitary Sewer Cleanout Option "B". The vertical cleanout pipe will be 100 mm in diameter and capped with a cast iron cover in heavy traffic areas such as driveways. Plastic cleanout caps are suitable for sodded areas.

Service Connections in Easements

Sanitary sewer service connections in an easement will only be allowed subject to the satisfaction of the General Manager, Toronto Water as per Section 681-11-B of the Toronto Municipal Code. Water and Sewer Service Installation Agreement stipulating the conditions of the encroachment will be required for all sanitary sewer service connections.

A service connection to a trunk sanitary sewer is not allowed. Any application for an exemption must be approved by the General Manager, Toronto Water.

Slope Anchors

Sewers at a 20 percent grade, or greater, should be anchored securely with concrete blocks or equivalent, spaced as follows:

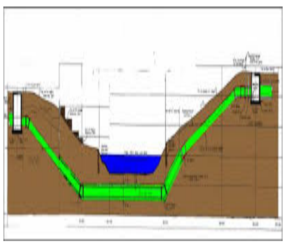
- grades 20 to 35 percent – not over 11 metres centre to centre

- grades 36 to 50 percent – not over 7 metres centre to centre
- grades over 50 percent – not over 5 metres centre to centre

At steep grades, air jumpers may be required to ensure hydraulic performance.

Flexible pipe such as PVC is not permitted to have rigid concrete anchor blocks as it creates a shear point.

Inverted Syphons



Inverted syphons should be avoided and only be used when crossing an obstacle such as a river or pedestrian tunnel, and when lowering the downstream system is impractical. Due to the additional maintenance costs associated with this type of system, a cost effectiveness analysis is to be prepared by the engineer. The use of this pipe system will be reviewed on a case-by-case basis and require approval by the General Manager, Toronto Water.

Number of barrels – minimum of two barrels to convey various flow conditions. One barrel is to be designed to be used for low to average flows and the additional pipes added for higher flow conditions. Syphon barrels will be installed in a casing using low strength grout.

Minimum pipe size and pipe strength – the minimum barrel diameter will be 150 mm. Pressure pipe will be specified at the required pipe strength for the anticipated internal pressures resulting from excessive surcharging.

Velocity at design – for each barrel should have a minimum velocity of one metre/second.

Uplift protection – syphon pipes and chambers, when subject to hydrostatic uplift forces, must have sufficient weight or anchorage to prevent their flotation when empty.

Chamber design – special attention should be taken for the design of the inlet and outlet chambers on any syphon installation. For details respecting the design of inlet and outlet chambers reference should be made to "*Wastewater Engineering: Collection, Treatment, Disposal*" by Metcalf and

Eddy, Inc. and "*WPCF Manual of Practice No. 9 – Design and Construction of Sanitary and Storm Sewers*".

Maintenance provisions – provisions will be made at all syphon installations for routine maintenance or flushing of the barrels. These flushing facilities are to be located at the inlet end of the syphon.

To avoid the accumulation of odorous, hazardous and corrosive gases such as hydrogen sulphide in the syphon, the designer should consider the need for an air jumper pipe.

Sanitary Pumping Stations and Forcemains

Sanitary pumping stations and forcemains shall be minimized. Where required, they shall be designed in accordance with MECP Design Guidelines for Sewage Works and City specifications which include but are not limited to Toronto Water; Instrumentation Specification Standards Division 13000, Electrical Specification Standards Division 16000, and Process Control System (PCS) requirements for the electronic tag management system.

For more information on pumping station requirements, see Appendix I, Pumping Stations.

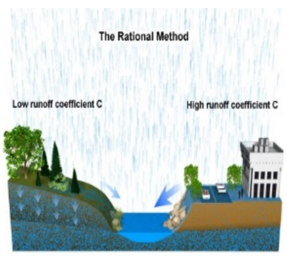
Chapter 3 –Storm Sewers

The storm drainage system is designed to limit flooding and minimize hazardous conditions under major storm events. The storm drainage system shall provide a reasonable level of convenience and safety for pedestrians, cyclists and motorists by removing lot and street surface runoff under the minor storm event.

Calculation Methods

There are numerous planning and design tools available to perform hydrologic and hydraulic analyses on a sewer system. The tools range from steady state manual calculations with spreadsheet type models to more complex fully dynamic sewer network models that are more representative of actual conditions.

Rational Method



Historically when designing a storm sewer system under steady state and free flow conditions, most designers use a model based on the Rational Method and Manning's formula to determine peak flows and pipe capacity, respectively. Under certain circumstances, these types of models are acceptable provided that the drainage area is less than 40 hectares and the outlet isn't submerged. The Rational Method cannot be used for dual drainage analyses. For larger areas such as collector sewers, a complete hydrologic and hydraulic computer model analysis must be undertaken.

Dynamic Sewer Computer Models

When stormwater management is included in designing a storm sewer system, a dynamic computer model that simulates inflow hydrographs and the effect of storage attenuation should be used. A dynamic model will help ensure that a 2-year level of protection with no storage is provided for the 2-year storm and will also ensure that the sewer system is protected against critical surcharging during the 100-year storm event. Also when a system is at risk of experiencing surcharge, the use of a dynamic hydraulic model is preferred. The 6-hour Chicago storm distribution with 10 minute time steps and a ratio to peak r=0.38 should be used for modelling. Currently, the City uses InfoWorks to create dynamic sewer network models.

When analyzing the capacity of an existing system, a dynamic computer model will provide more realistic results since it can account for effects of limited catchbasin capture, depression storage, times of concentrations, diurnal flow patterns and so on.

When designing large collector storm sewer systems with drainage areas greater than 40 hectares, computer models or similar hydrograph based simulation methods must be used unless the engineer can provide adequate justification as to why an alternative method should be used. For smaller developments—less than 15 hectares—simplified methods based on the results of detailed modeling is acceptable.

In choosing a computer model, it is important that the engineer consider the data and model limitations.

Similar to sanitary sewers, the use of more complex models is recommended for the analysis and retrofit of existing combined sewer systems.

Calibration of Models

If a hydrologic or hydraulic model is being used to determine the capacity of an existing system, it is recommended that the model be calibrated using actual flow data.

Existing Models

Many storm and sanitary sewer sheds throughout the city have previously been modeled. The City may already have calibrated dynamic or static models for these sewer sheds. The consulting engineer for the developer should contact the development engineering section prior to undertaking any work to confirm whether existing models or existing data sets are available for the study area.

Receiving System Capacity

When determining the capacity of an existing storm sewer system or combined sewer system, flow monitoring information may be used to calibrate a hydrologic or hydraulic model.

Infill Development

Refer to the Wet Weather Flow Management Guidelines for water balance targets and recommended stormwater management strategies.

All infill development or re-development such as developments within an existing built-up subdivision must adhere to the drainage requirements of the Wet Weather Flow Management (WWFM) guidelines. If the existing subdivision is partially separated, that is the foundation drains are connected to the sanitary sewer system, any new development must drain its foundation drain to the surface via sump pump.

Where an exemption has been granted by the General Manager, Toronto Water, and any new foundation drain connections to a storm sewer must have a backwater prevention valve.

The valve will be installed in an accessible location and maintained by the property owner.

Rezoning Applications

All residential, commercial, institutional, and industrial rezoning applications must manage storm wet weather flow at the source according to the WWFM guidelines. If it is found that the public sewer system is inadequate, the developer will be responsible to provide the necessary upgrades to the system.

Site Plan Applications

All commercial, institutional and industrial site plan applications must include on-site stormwater management measures to minimize the impact on the downstream storm system. For more information, see the WWFM guidelines.

Connecting to Existing Combined Sewer System

New development within the city's combined sewer area must incorporate measures to reduce the volume of runoff to the combined sewer system.

An analysis of the downstream sewer system will be required to ensure that there will be no increase in combined sewer overflow compared to the existing condition.

Supporting information to show compliance with MECP Procedure F-5-5 is required.

Residential Areas

For low rise residential buildings, direct roof drain connections to the combined sewer system are not permitted. Rather, the roof drain will discharge to the surface as far away as is practical from the foundation wall to help minimize seepage into the foundation drains.

Commercial and Industrial Areas

Commercial and industrial areas will use on-site detention techniques to limit the runoff from the subject site. The flow for post-development is for 100-years, while 2-year for pre-development; the runoff coefficient is 0.50 or the existing runoff coefficient, whichever is less.

New storm drainage systems from infill developments will not be permitted to connect to existing combined sewers except as an interim measure, where sewer separation is to be ultimately implemented, or where circumstances allow no other alternative. An application is to be made to the General Manager, Toronto Water for review and approval.

Greenfield Development

All greenfield developments draining to an existing outlet must ensure that the downstream system has adequate capacity for the additional volumes.

Storm and Combined Sewer Design

The total design flow for a combined sewer will include the total domestic flow, including extraneous flow plus the storm flow for the required design period.

Dual Drainage Considerations

The accepted best practice for the collection of urban storm drainage systems consist of two distinct systems—the minor system and the major system. This two system approach is called a "dual drainage system". The minor system consists of ditches and underground storm sewer system which provides the first response level of protection by conveying flows from the more frequent, lower intensity rainstorms, with minimal overland flow for traffic convenience. The major system, which consists of specially engineered overland flow routes along the street network, swales, high capacity water courses and so on, is designed to convey runoff from the less frequent high intensity storm events that are in excess of the minor system design capacity to an engineered receiving point.

Flow to the minor system is restricted to the capacity of the pipes, which is typically the runoff from a storm event with a 2-year return period. During the greater than 2-year up to the 100-year events, which exceed the capacity of the minor system, inlet control devices limit the flow into the pipes causing excess flow to stay at the surface where it is controlled and conveyed overland.

If there are no outlets available for the major system, flow storage areas may be created to detain water and allow it to flow through the minor system once the storm subsides, thus reducing the risk of surface flooding. These flow storage areas can be street low points, park storage—subject to approval from parks department—or stormwater management ponds or underground tanks. When designing a dual drainage system the designer must consider that the streets will act as open channels during severe events and that they must be designed accordingly.

Hydraulic Grade Line Calculations

For minor flow, storm sewers must be designed to convey design flows when flowing full with the hydraulic grade line (HGL) at or below the crown of the pipe. In some cases, the HGL may be elevated due to boundary conditions.

Storm sewers must be designed to account for hydraulic losses due to bends, junctions, and pipe transitions.

HGL calculations are required where surcharge conditions may occur due to backwater from stormwater ponds, outlets, downstream systems or as required by the City.

Levels of Protection

This section outlines levels of protection required for stormwater systems in existing separated sewer areas, new greenfield developments and combined sewer areas. City Council adopted requirements for level of protection against basement flooding are outlined.

Minor System in Existing Separated Sewer System Areas

Existing separated areas are defined as all currently developed areas other than combined sewer areas that have been designed and constructed with minor drainage systems only. When designing a storm sewer system in existing separated areas, the following should be considered:

- In existing separated areas, the minor system within local and collector roads shall be designed to accommodate the runoff from a storm with a return period of 2-years, under free flow conditions. The flow must be controlled to meet the existing level of protection of the existing system if it is less than 2-years.

- Within urban arterial roads the minor system shall be designed for a 10-year return period under free flow conditions.

- Within road underpasses, the minor system shall be designed for a 10-year return to 25-year return period under free flow conditions. Due to the low elevation, overland flow away from the depressed areas will not normally be possible.

- If the new pipe or an upgraded pipe is to be designed with a return period greater than that used for both a proposed upstream pipe and an existing downstream pipe, such as within an urban arterial road located downstream of a new development; the engineer must analysis the system to a downstream free outlet for the lesser storm event up to the greater storm event, show the pipe design can accommodate the greater storm event, and summarize the results in a design brief.

- If a new pipe or an upgraded pipe receives flow from areas where the existing storm system is designed with a return period greater than 5-years such as arterials, road underpasses, and so on, the engineer must accommodate the increase in the flow contributions from these areas in the new design, and summarize the results in a design brief.

- Connecting new storm drainage systems and associated flows to existing combined sewers will not be permitted except as an interim measure where sewer separation will ultimately be implemented or where circumstances allow no alternative. In all cases, an analysis of the downstream sewer system will be required to ensure that there will be no increase in combined sewer overflow compared to the existing condition. Detention storage and flow rate attenuation may be required.

Typical return period for type of road is as follows:

Table 15: Minor system return period in existing separated sewer system areas

Type of road	Minor storm
local	2 year
collector	2 year
arterial	10 year
highway	10 year
road underpass [1, 2]	10–25 year

[1] For road underpasses of importance and or on a case-by-case basis alternate means such as pumping may be considered to increase the storm level of protection beyond the minor system capacity.

[2] For road underpasses that include pedestrian walkways, the appropriate stormwater management measures shall be incorporated in the design to ensure pedestrian safety at all times. Should ponding depths in excess of 300 mm be encountered as shown by hydraulic modelling for any design storm event and/or pumping station outage, the facility shall be designed to minimize the depth of ponding and equipped with appropriate signage notifying users that walkway section of the underpass is closed during severe storm events.

Major System in Existing Separated Sewer System Areas

In older neighbourhoods of the City, most storm sewers have been designed with a minor system only. These storm sewer systems do not have inlet control devices or watertight maintenance hole covers to control inflow and prevent sewer surcharge. These systems also do not have engineered overland flow routes or defined outlets to control surface water depths. During a storm event in excess of the minor system capacity, depending on the intensity and duration of the storm, the minor system can be expected to surcharge.

When considering rehabilitating or upgrading an existing storm sewer system, consideration must be also given to upgrading the major system drainage, if possible. The engineer should contact Toronto Water –Water Infrastructure Management to find out if overland flow routes are being planned for the design area. Otherwise, without the availability of an outlet, favourable topography, and level controls; setting maximum depths for flow control during events in excess of the minor system capacity may not be practical or affordable.

The major system will be reviewed to ensure that any new development will not have a negative impact on an existing major system.

- If site major system peak flow rates and runoff volumes don't increase, then the development can proceed without municipal infrastructure upgrades.

- If site major system peak flow rates or runoff volumes increase, and the downstream system can convey a 100 year storm event, then the development can proceed without downstream major system upgrades.

- If site major system peak flow rates or runoff volumes increase, and the downstream system cannot convey a 100 year storm event, then the development cannot proceed until the capacity deficiencies are resolved.

Minor System in Greenfield Development

All new storm sewers in greenfield developments will be designed based on the principles of dual drainage. The following shall be considered when designing a storm sewer system in a greenfield development.

- Storm sewers must be designed to convey design flows when flowing full with the hydraulic grade line at or below the crown of the pipe. The only exception to this rule is for shallow cover sewers which do not have any properties directly fronting the sewer pipe, and receive flow from an upstream drainage area.

- New sewers must incorporate inlet control measures to prevent surcharge and thereby prevent basement flooding for events up to a 100-year return frequency. This is to provide for the possibility that a service connection will be connected to the storm sewer. If installed, a backwater prevention valve will required to provide additional basement protection for storm sewer backups during these rare events.

- The minor system for local and collector roads will be designed to accommodate a 2-year and 5-year return period under free flow conditions, respectively.

- Collector sewers will be designed to accommodate the flow they receive under free flow conditions. If a new pipe receives flow from areas where the existing storm system is designed with a return period greater than 2-years, the engineer must accommodate the increased flow contribution from these areas in the new design under free flow conditions.

- If the downstream receiving system has capacity restrictions, the new system must be controlled to the available capacity and in a manner that will not cause adverse impacts downstream.

Typical return period for different types of road is as follows:

Table 16: Minor system return period in greenfield developments

Type of road	Minor storm
local	2 year
collector	5 year
arterial	10 year
highway	10 year
road underpass [1, 2]	10–25 year

[1] For road underpasses with high traffic volumes and or on a case-by-case basis alternate means such as pumping may be considered to increase the storm level of protection beyond the minor system capacity.

[2] For road underpasses that include pedestrian walkways, the appropriate stormwater management measures shall be incorporated in the design to ensure pedestrian safety at all times. Should ponding depths in excess of 300 mm be encountered as shown by hydraulic modelling for any design storm event and/or pumping station outage, the facility shall be designed to minimize the depth of ponding and equipped with appropriate signage notifying users that walkway section of the underpass is closed during severe storm events.

Major System in Greenfield Development

The major system must be able to convey the flow resulting from a 100-year event without causing damage to private property and with minimum inconvenience to the public. The maximum permissible overland flow depth for each type of road is listed below.

Table 17: Major system flow spread in greenfield developments

Type of road	Major storm	Assessment criteria for overland flow depth
open spaces	greater than 2 up to 100 year	As required for overland flow outlets.
local	greater than 2 up to 100 year	Maximum depth of flow shall be the lesser of 0 cm above the crown of the road or the water level up to the right-of-way.
collector	greater than 2 up to 100 year	Maximum depth of flow shall be the lesser of 0 cm above the crown of the road or the water level up to the right-of-way.
arterial	greater than 10 up to 100 year	No barrier curb overtopping.[1] Flow spread must leave at least one lane free of water in each direction.
road underpass	greater than 10 or 25 up to 100 year	Since there is no overland flow route possible, water can be expected to accumulate for the event.[2,3]

[1] When no barrier curb exists, encroachment onto adjacent property is not to occur.

[2] For road underpasses with high traffic volumes and or on a case-by-case basis alternate means such as pumping may be considered to increase the storm level of protection beyond the minor system capacity.

[3] For road underpasses that include pedestrian walkways, the appropriate stormwater management measures shall be incorporated in the design to ensure pedestrian safety at all times. Should ponding depths in excess of 300 mm be encountered as shown by hydraulic modelling for any design storm event and/or pumping station outage, the facility shall be designed to minimize the depth of ponding and equipped with appropriate signage notifying users that walkway section of the underpass is closed during severe storm events.

Major System Flow Routes in Greenfield Development

Major system flow routes must be unobstructed with continuous slopes such as no sags or low points, exceeding their permissible depth, leading to a stormwater management facility, outlet structure or receiving watercourse.

Flow routes for the major system consist of roadways, open channels, roadside ditches, rear yards or swales in easement on private property. They do not include multi-use pathways for which the primary design use is for pedestrians and cyclists. No part of the major system flow should be allowed on private property or close to the finished floor elevation of a building.

Velocities in overland flow channels should be minimized as the force of moving water on objects in its path increases with the square of velocity. If the public has access to the flow routes, the velocities and depths of flow for the major overland flow system should not exceed the values indicated in the following table. The table lists the flow depths that a child weighing 20 kilograms would be able to withstand in a concrete lined channel at the selected velocities. Values outside of these limits must be approved by the General Manager, Toronto Water.

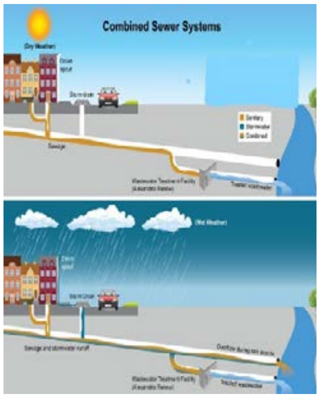
Table 18: Permissible depths for submerged objects

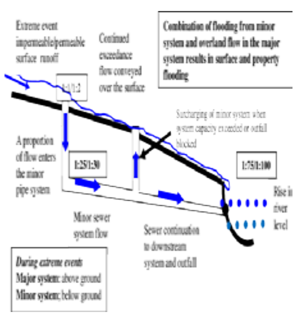
Water velocity (m/s)	Permissible depth (m)
0.5	0.80
1.0	0.32
2.0	0.21
3.0	0.09

If a pathway between houses is used as a major system flow route, the pathway must be designed according to the principles of open channel flow. Basement windows will not be permitted on the side of the dwelling abutting the overland flow route.

In order to prevent water from accumulating at or near buildings and not adversely affecting adjacent properties, an overflow must be provided from all sags or depressions. This overflow must control the maximum water elevation to a vertical separation—freeboard—of 0.15 metre below the finished floor elevation of the building or below the top of foundation for homes.

Combined Sewer System Areas





The level of protection within a combined sewer system area is similar to those identified for existing storm and sanitary sewer systems. The combined sewer system is subject to a higher risk of property damage compared to separated and partially separated sewer systems due to the direct capture of storm flows and the presence of direct private property connections to the minor system.

Combined sewer system renewal or upgrade projects shall be designed to improve the level of protection in that area, to the greatest extent possible. Contact Toronto Water –Water Infrastructure Management to find out if overland flow routes are being planned for the design area. If cost effective, provide a dual drainage system as outlined above. Otherwise the level of protection targets in combined sewer areas are the following:

A minor combined system must be designed to convey at least a 2-year storm event without surface ponding or basement flooding for the replacement or rehabilitation of existing sewers and a minimum of a 2-year return period for any new extension of a sewer. Sewers designed to a 2-year level of protection may still require flow restrictions to a 2-year level such as catchbasin Inlet Control Devices (ICDs) if downstream capacity restrictions exist.

The ultimate level of protection provided should minimize the risk of basement flooding and maintain acceptable levels of convenience related to the use of roadways as well as public open spaces, that is to say surface flow storage or conveyance.

Surcharge of a combined sewer system is not permitted as the impacts are not predictable without detailed hydraulic modeling of the system in question and all upstream areas. The total accumulated capture rates should be no greater than the free flow capacity of the pipe.

Surcharge of the combined sewer may be allowed in situations where the vertical distance between the sewer and basement floors is greater than normal, at the discretion of the General Manager, Toronto Water. These situations may include where the sewer is constructed in a tunnel, is rated for pressurized flow, where the length of surcharge is limited to a localized area, and where there are no service connections.

Without the availability of an engineered major system—that is favourable topography, a suitable outlet, and level controls—setting maximum depths for flow control during events in excess of the minor system capacity will not be practical or affordable.

The use and operation of combined sewer systems is permitted within the designated combined sewer area. The City can confirm as to whether a proposed sewer renewal or upgrade falls within the boundaries of the designated combined sewer area, and will review these proposals on a case-by-case basis.'

Currently the Ontario Ministry of the Environment, Conservation and Parks (MECP) sewer design guidelines do not permit the design of combined sewers for new construction, however the MECP states that existing combined sewers may undergo rehabilitation or be replaced by new combined sewers provided that the municipality has met the requirements set out in MECP procedure F-5-5.

Service connections to combined sewers will comply with Chapter 681 Sewer Usebylaw of the Toronto Municipal Code.

Basement Flooding Protection Program

The Basement Flooding Protection Program (BFPP) is a program that was created by City Council in 2006 to reduce the risk of pluvial flooding by increasing the level of protection offered by municipal drainage systems. This program, in accordance with City Council direction, pursues municipal drainage system upgrades and targets a 100 year storm event level of protection for storm and combined sewer drainage systems—collectively including the minor and major drainage systems. The criteria identified in this section are in addition to the criteria already identified earlier within this manual. Outlined below are criteria that are too be met during a 100 year storm, whenever municipal drainage system, that is to say storm and/or combined sewer changes are required.

Specific to development applications, where new municipal minor system infrastructure – for example storm sewers – is proposed, the basement flooding performance service levels as listed in Table 19 will apply for the storm drainage system. If contributing drainage catchments from a new development has demonstrated to discharge peak flows in accordance with the WWFMG and less than pre-development conditions to the storm drainage system, the BFPP criteria is not applicable.

Where a dynamic dual-drainage computer model is required to design hydraulically/hydrologically connected major and minor systems, the relevant systems must be assessed by applying the flow during this event:

Flow = 100-yr Wet Weather Flow (WWF100-yr)

Where:

WWF100-yr = runoff from 100-year event

Using this flow, the model must demonstrate that all storm and combined systems meet the performance service levels as listed in Table 19. The proposed systems in a dual drainage model shall consider both the existing minor and major system to which they will be connected.

Table 19: Basement flooding performance service levels

<table>
<tr><th>System type</th><th colspan="2">Service level to follow</th></tr>
<tr><td>Local storm sewer (minor)</td><td colspan="2">HGL must be ≥ 1.8 m below the crown of the road</td></tr>
<tr><td>Shallow storm or combined sewers (where obvert < 1.8m below crown of the road elevation)</td><td colspan="2">No surcharge permitted; and
Proposed HGL must be lower than, or equal in elevation to existing HGL</td></tr>
<tr><td>Local combined sewer</td><td colspan="2">HGL must be ≥ 1.8 m below the crown of the road</td></tr>
<tr><td rowspan="5">Storm overland (major) system</td><td>Local and collector roads</td><td>Maximum depth of flow shall be the lesser of 0 cm above the crown of the road or the water level up to the edge of the right-of-way.</td></tr>
<tr><td colspan="2">Permissible depths for submerged objects:</td></tr>
<tr><td>Water velocity (m/s)</td><td>Permissible depth (m)</td></tr>
<tr><td>2.0</td><td>0.21</td></tr>
<tr><td>3.0</td><td>0.09</td></tr>
</table>

For example, a dual drainage model with major and minor storm systems is run with the $WWF_{100\text{-}yr}$ event. It shows that the minor system condition is not met because the HGL in some storm sewers is < 1.8 m below ground surface. Therefore, a redesign is required. The redesign may include changes to the major or minor system or both.

Design Flow and Hydrology

All design flows for storm and combined sewer systems will meet the level of protection return period requirements outlined in this chapter.

Run-off Calculation

Rational Method

The Rational Method is a runoff estimation method based on relating the peak flow to the discharge area, rainfall intensity, and a runoff coefficient.

The Rational Method is expressed as:

$$Q = 2.78\ C\ I\ A$$

Where:

- Q = flow in litres per second
- A = drainage area in hectares
- C = run-off coefficient, dimensionless
- I = intensity of rainfall in mm/hr

Storm sewers shall be designed to drain all lands for individual catchment areas based on the Rational Method. For drainage areas greater than 40 hectares, the Rational Method will not be accepted where storage, flooding, storm water quality and design of watercourses is involved. In those cases, only computer modeling methods will be acceptable.

Modified Rational Method

The modified Rational Method can also be used to obtain design flows.

Combined Sewer Design Flow

The sanitary flow for a combined sewer will include the total domestic flow—including extraneous flow—plus the storm flow for a required design period. It may also include groundwater flow, if permitted by the City, up to a maximum discharge rate.

All new sewers draining to a combined sewer system or the rehabilitation of existing combined sewers must follow the principles of dual drainage, if an adequate major system is available.

An analysis of the downstream sewer system will be required to ensure that there will be no increase in combined sewer overflow compared to the existing condition. Supporting information to show compliance with MECP Procedure F-5-5 is required.

Storm Design Requirements

IDF Curves and Equations

The following intensity duration frequency (IDF) curves will be applied to all districts across the City.

The equation of IDF curves is expressed as:

$$I = A\, T^{C}$$

Where:

I = intensity of rainfall in mm/hour

T = time of concentration in hours

(use 10 minutes inlet time or initial time of concentration)

Parameters of A and C are as follows:

Table 20: Parameters of A and C

Return period (year)	A	C
2	21.8	-0.78
5	32.0	-0.79
10	38.7	-0.80
25	45.2	-0.80
50	53.5	-0.80
100	59.7	-0.80

Note: The parameter C is a negative value because the equation is written in a "multiplication" instead of "reciprocal" format. It can also be written in the familiar format as $i = a/(t + b)^C$, where for a 2-year storm, a = 21.8, b=0 and c=0.78.

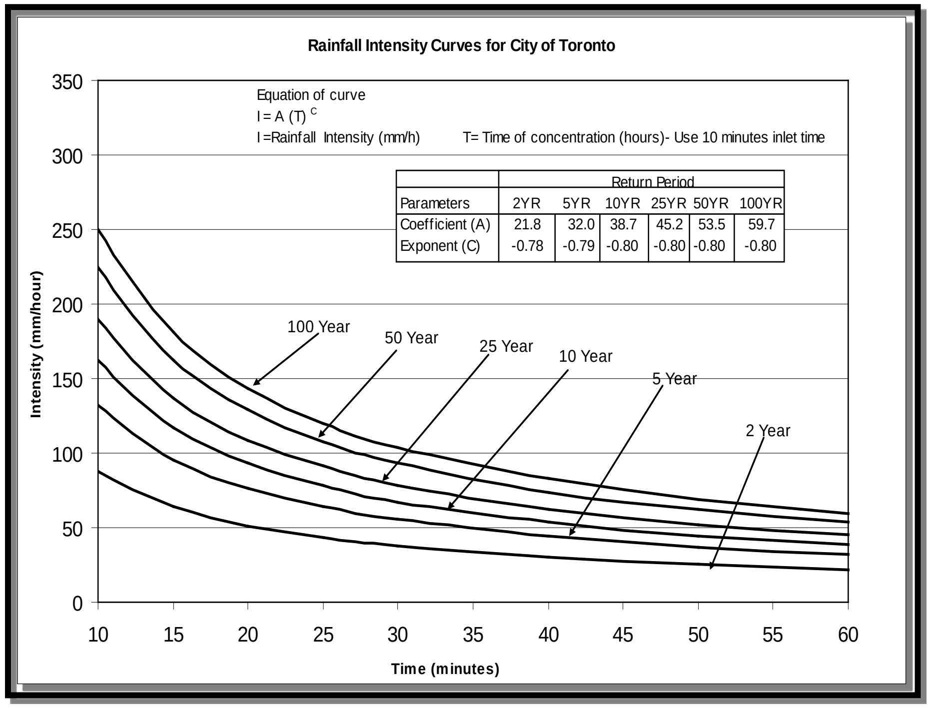


Figure 3: Rainfall intensity curves for City of Toronto

Storm (Minor System)

Storm sewers shall be designed, to convey a storm event of return period based on the road type and shall be designed to not surcharge during this storm event.

Storm (Major System)

Runoff flows in excess of the design capacity of the minor system will be conveyed via streets, open channels, and pathways to a public outlet. The overland flow system will be designed for a 100-year return period storm, to prevent flooding of private property.

Road grading must direct flows from the right-of-way to a safe outlet at specified low points. Outlets can be walkways or open sections of roads leading to open spaces or river valleys. Roads may be used for major system overland flow conveyance during the 100-year storm.

Runoff Coefficients

Runoff coefficients are based on the amount of impervious area for a particular land use:

Table 21: Runoff coefficients

Land use	Runoff coefficient
forest and dense wooded areas	0.10–0.25
parks, open space and playgrounds	0.25
single family residential	0.65
semi-detached residential	0.70
townhouse or rowhouse	0.75
apartments or hi-rise residential	0.75–0.85
industrial	0.85
commercial	0.90
institutional	0.75
densely built, paved	0.90
asphalt, concrete, roof areas—without green roofs	0.90
green roofs – when 10 year storm is used	0.25 (non-saturated) and 0.85 (saturated)

The above runoff coefficients are provided in absence of actual runoff coefficients. When the development consists of a mix of land uses, a weighted average value of the runoff coefficient should be calculated with its respective area percentages.

Pre-development Runoff

The allowable release rate from the site during a 100-year post development storm shall not exceed the 2-year pre-development condition or the existing capacity of the receiving storm sewer, whichever is less.

Should the controlled rate of flow be limited by the existing capacity of the storm sewer, the existing capacity shall be considered to be the minimum manning flowrate with no surcharge of the existing storm sewer located immediately downstream of the development extending to the first junction maintenance hole.

When the percent imperviousness of a development site under pre-development conditions is higher than 50 percent, regardless of what the post-development condition is, the runoff coefficient 'C' to use in calculating the pre-development peak runoff rate is limited to a maximum value of 0.5.

Controlling Runoff from Developments

Runoff rates resulting from new development must be controlled as required by the City and according to the WWFM guidelines before being discharged to an approved outlet. A stormwater management report must be prepared in support of development applications. This report must demonstrate how the development meets the requirements for stormwater quantity control, quality control, and water balance as specified in the WWFM guidelines. The use of non-structural measures to control runoff such as rear lot swales, grass filter strips, and the preservation of existing trees are encouraged.

Storm Trunk Sewers

Storm trunk sewers convey storm runoff. They provide an outlet for local storm sewers which crossed a former area municipality boundary to an outlet at a watercourse. Storm trunk sewers also provide drainage for former Metropolitan Toronto owned roads such as the W.R. Allen Expressway. These major drainage systems can include sections of open channel. New connections to a trunk sewers will only be allowed when there is no other alternative. The engineer should contact the Toronto Water, Water Infrastructure Management unit for additional information prior to undertaking any design work.

Storm Sewer Design

Storm sewer systems in the city will be designed in accordance with the City's WWFM guidelines and this criteria manual.

Pipe Capacities

Sewer capacities shall be computed by using the Manning formula. Generally, storm sewers shall be designed to flow at the full design capacity of the pipe. The sewer shall be designed for sub-critical flow.

Roughness Coefficient

For a new storm sewer design, the value of 'n' using the Manning formula will be:

Table 22: Manning 'n' value

If pipe material is …	Then value of 'n' is …
concrete (CONC)	0.013
polyvinyl chloride (PVC)	0.013
high density polyethylene (HDPE)	0.013
corrugated steel pipe (CSP)	0.024

Pipe Size

The minimum allowable size for a storm sewer will be 300 mm diameter.

Minimum Velocity

The minimum full bore velocity permitted in storm sewers will be 0.8 metre/second.

Maximum Velocity

The maximum full bore velocity permitted in storm sewers will be 6 metres/second.

Where velocities in excess of 3 metres/second are proposed, additional design factors shall be taken to protect against pipe displacement, scouring, erosion, and hydraulic jumps.

Supercritical flow should not occur.

Minimum Grades

The minimum grade on a 300 mm diameter storm sewer will be half percent.

For replacement of pipe sections of existing storm sewer systems, a minimum flow velocity of 0.8 metre/second shall be achieved.

Pipe Material

Both rigid and flexible pipe are permitted in the construction of storm sewer systems including municipal service connections and catchbasin leads. These materials include reinforced concrete and polyvinyl chloride. However, the bedding design must be compatible with the type of pipe material used.

Table 23: Storm sewer material

If diameter is …	Then pipe material to use is …
less than or equal to 375 mm	PVC
equal or greater than 450 mm	CONC

Rigid pipe is recommended in areas of high utility congestion, when bedding may be undermined in the future.

Ultra-rib pipe is not approved for use as a storm sewer.

For more information regarding acceptable materials, see Chapter 6, *Material Specifications*.

Bedding Requirements

The class of pipe and the type of bedding will be selected to suit loading and proposed construction conditions.

Rigid pipe bedding will be as per OPSD 802.030, 802.031, 802.032 802.033 and 802.034. Flexible pipe bedding will be as per OPSD 802.010, 802.013 and 802.014.

Granular A Native or Granular A RCM according to TS 1010 and TS 401 shall be used.

If there is a high ground water table, the designer shall perform calculations to quantify the amount of seepage along the pipe. Clay seals can be used to according to OPSD 1205. Alternatively, filter diaphragms and subdrains may be considered depending on the embankment conditions.

The pipe material, class, and type of bedding will be shown on the profile drawing for each section of storm sewer.

Specialty designs that require custom bedding to compensate for poor soil conditions, are subject to additional review and approval by the City. These situations may include areas of flat slope, steep slope, fill areas, areas of high groundwater, and outfall pipes which bedding requires clay seals or filter diaphragms and subdrains near the watercourse.

Geoweb Geocell

Geoweb geocell is permitted by the City to compensate for poor soil conditions and to provide a stable, uniform trench base and bedding condition. The Geoweb serves as a compaction aid on the subgrade allowing for proper compaction of the base granular.

Geosynthetic reinforced bedding is permitted by the City to promote embankment and trench stability. The geosynthetic can be used for land formation created by lakefill, which can consist of non-homogenous waste materials that are prone to decomposition and settling.

Pipe Class

Pipe class will be selected to suit the bedding class and height of fill. The minimum pipe class for reinforced concrete storm sewer will be 65-D. Minimum Depth of Cover

The minimum depth of a storm sewer on roadways will be 1.7 metres measured from the centre line road elevation to obvert of the pipe. For storm sewers located in open space such as parks, the minimum depth of cover will be 1.2 metres from finished ground elevation to obvert of the pipe.

Maximum Depth of Cover

Maximum depth of cover for concrete pipe will be in accordance with OPSD 807.010 and 807.030. For PVC gravity sewer pipe, the maximum cover will be in accordance with OPSD 806.040.

Location and Alignment

Storm sewers will be located 1.5 metres—as measured from the centre line of pipe—on either the north side or the east side of the road centre line in a separate trench unless a conflict with other utilities requires a revised location. Exceptions will occur on curved streets. Storm maintenance holes must be located within the asphalt area of the road for maintenance purposes.

Pipe Crossing Clearances

The minimum clearances required when storm sewers cross other services will be measured from outside wall to outside wall of pipe. Clearances with respect to watermains according to MECP procedure F-6-1 are as follows:

Table 24: Pipe clearances

If crossing is …	Then minimum clearance is …
Over or under a sanitary sewer	300 mm
Under a watermain 450 mm diameter or less	300 mm
Over a watermain 450 mm diameter or less	500 mm
Over or under a watermain greater than 450 mm diameter	500 mm

The minimum horizontal separation between a sewer and watermain is 2.5 metres. In cases where it is not practical to maintain separate trenches or the recommended horizontal separation cannot be achieved, a deviation may be allowed, when the pipe material is upgraded to provide an equivalent factor of safety. A DR35 gravity rated pipe can be upgraded to DR26 pressure rated pipe, which can withstand a higher joint pressure—1100 Kpa versus 345 Kpa—and minimize the risk of cross contamination.

The designer is advised that DR35 gravity pipe cannot be connected to DR28 sewer service connections as DR28 sewer pressure pipe has Iron Pipe Size Outside Dimension (IPSOD). In cases where different pipes are connected, the connection would have to be done with custom fabricated transition fittings.

For more information go to Chapter 4, Watermains, section Crossings and Parallel Trench Installations.

A minimum clearance of 0.6 metre between the obvert of the sanitary sewer and the invert of the storm sewer must be provided if any sanitary service connections are required to go under the storm sewer.

Minimum Distance between Sewers

The minimum distance between new parallel sewers in separate trenches will be 3 metres as measured from centre line of pipe to centre line of pipe. Exceptions can be made for site specific design constraints and depths as in the case of dual maintenance holes installations.

It is preferred that a one metre minimum separation from outside wall to outside wall will be provided to permit installation of service connections and the future maintenance of the underground servicing.

When sanitary and storm sewers are constructed in a common trench, the storm sewer shall be constructed parallel to the sanitary sewer with 600 mm minimum separation between the outside wall of the two pipes.

Clay, Seals Filter Diaphragms and Subdrains

When there exists a possibility that groundwater may be diverted and follow the path of the new sewer, the seepage patterns must be analysed. Groundwater barriers can be considered and designed in adequate numbers to prevent groundwater migration down sewer trenches for smaller embankments. Specific attention is required at crossings with other utilities and plant which rely on the stability of the existing sewer. For larger embankments filter diaphragms and subdrains should be considered depending on groundwater conditions and seepage patterns.

The following conditions are to be considered as sufficient reasons for discussing the need for additional seepage controls along the pipe alignment with the engineer on a specific pipe location basis

- the natural sub-base and culvert foundation materials are of a granular nature
- the embankment material is of a non-cohesive nature
- significant hydraulic head between ends of the culvert.

For details and additional design information, see OPSD 802.095 and OPSS.MUNI 1205.

Abandoned Pipes

Abandoned pipes shall be left in place according to TS 510 and the pipe shall be capped on both ends. Removal of abandoned pipe will be on case-by-case basis.

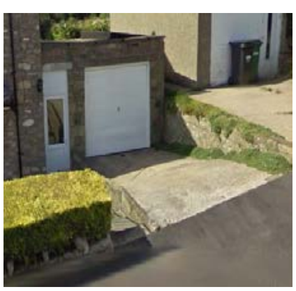
Radius Pipe

Prefabricated concrete pipe bends will be allowed for storm sewers 1050 mm in diameter and larger provided that a maintenance hole is located at the end of curve, that is to say upstream end of the sewer line. The minimum centre line radius allowable will be in accordance with the minimum radii table as provided by the pipe manufacturer.

Roof Drains

For low rise residential buildings roof drains will be discharged to the ground surface onto splash pads with flows directed away from the building onto grass filter strips, where possible and towards the road. Any above ground discharge will be contained on the property in a manner that is not likely to cause damage to any adjoining property or create a hazardous condition on any stairway, walkway, street or boulevard.

Lot grading will be finished to prevent ponding. The slope of the grading should be away from the building.



Reverse Driveway Drainage

Zoning By-law 569-2013 prohibits the construction of below-grade garages for residential buildings anywhere in the city.

An application for exemption can be applied for through a Minor Variance Application or a Re-zoning application. This process will require a Toronto Water technical review if any of the following applies:

- The Committee of Adjustment's Notice of Decision or an Ontario Municipal Board decision requires a technical review and approval by Toronto Water.
- A request is made through a re-zoning application process.
- The application proposes a storm connection to the City's sewer system to discharge water from the reverse slope driveway's trench drain. Drainage shall comply with Sewer Use Bylaw, Section 681-11-O of the Toronto Municipal Code.

Where a catchbasin is installed on private property to drain storm water from a driveway that slopes towards any structure located on the property, the catchbasin will be connected to the city storm sewer where such is available and the installation will include:

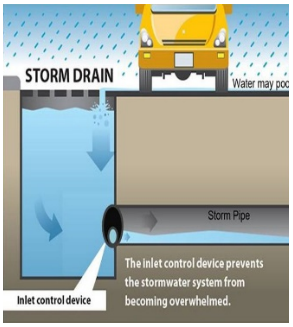
- A flap gate backwater valve installed at 2% slope directly downstream of the private catchbasin, so that no storm water may back up from the city storm sewer into the private catchbasin; and
- A sump pump, located in the overflow sump, to discharge any storm water which has collected in the catch basin while the above noted flap gate backwater valve has closed to prevent a backup of storm water.

Reverse slope and below grade driveways are susceptible to surface flooding in low lying areas and should be discouraged.

For report submission guidelines for reverse slope driveways, see Appendix F, *Reverse Slope Driveway Guidelines*, which is applicable for residential, industrial, commercial, or institutional type developments.

Storm Backwater Prevention Valves

Storm backwater prevention valves are required on all foundation drain systems connecting to storm or combined sewer systems to minimize backup of stormwater, where an exemption has been made by the City to allow foundation drain connections. Backwater prevention valves will be located inside the building, if there is a sump pump or outside the building with a riser to allow ease of access and maintenance—if a sump pump is not part of the system.

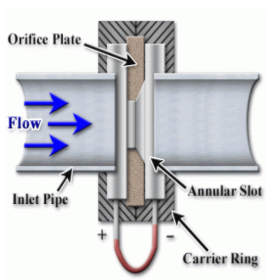


Sewer Inlet Controls

To reduce surcharging of the storm sewer, if required, storm sewer inlet controls such as flow controls installed in roadside catchbasins, restricting the stormwater runoff entering the sewer system to the system design capacity, be installed in cases where the overland flow can be routed away from low lying areas or where stormwater detention facilities are proposed.

Orifice Controls

For development applications, the City prefers the use of orifice tubes to restrict storm flows on private property to the allowable release rate in accordance with the Wet Weather Flow Management Guidelines. The maximum length of an orifice tube should be limited to one metre. For capital works projects and other proposed works within the right-of-way, the City prefers the use of orifice plates to restrict storm flows.



For development applications, orifice controls must be located entirely within private property and should be located as close as possible to the property line at street line for ease of access, maintenance and monitoring. Orifice controls are not permitted to be installed on the downstream side of the control maintenance hole as this hinders the ability of City staff to access, sample and monitor stormwater.

An orifice plate is a thin plate with a hole in it, which is usually placed in a pipe. When water passes through the orifice, its pressure builds up slightly upstream of the orifice but as the water is forced to converge to pass through the hole, the velocity increases and the fluid pressure decreases. A little downstream of the orifice, the flow reaches its point of maximum convergence, where the velocity reaches its maximum and the pressure reaches its minimum—vena contracta. Beyond vena contracta diameter point, the flow expands, the velocity falls and the pressure increases. By measuring the difference in water pressure across tappings upstream and downstream of the plate, the flow rate can be obtained from Bernoulli's equation.

When calculating the peak flow from an orifice plate using the orifice equation derived from Bernoulli's equation, the typical discharge coefficient (cd) value used is 0.63 while the typical discharge coefficient for an orifice tube is 0.82. The use of other values may be permitted if technical supporting documentation is included, subject to review of the case manager in Development Engineering.

Orifice plate openings shall not be smaller than 75 mm. The type of orifice device permitted and minimum size of the orifice opening is given as follows:

- The orifice can control the rate of sites storm run-off so that the development complies with the City's Wet Weather Flow Management Guidelines.
- Based on the site requirements, the following can be used
  - tube > 100 mm
  - plate 100 – 75 mm
  - vortex < 75 mm
- The plate cannot be removed easily by the property owner.
- The diameter of the opening does not result in blockage due to debris of the system on the private side.
- For orifice openings 100mm in diameter and smaller, the designer shall consider the use of a trash screen protection device to help prevent blockage due to debris buildup and additional maintenance requirements as indicated in a maintenance manual.

Vortex valve flow control systems such as Hydro-brake® systems may be permitted in lieu of orifice plates, in the right-of-way subject to Development Engineering case manager's approval.

Duckbill shaped elastomer check valves are not approved for general use but can be reviewed for project specific applications upon request.

Gaskets in Contaminated Soil Conditions

Prior to specifying the pipe material, the soils should be assessed for contamination. Upon determination that there is contamination, even in trace amounts, the longevity of ordinary gaskets becomes a concern. When locating sewer pipes, rubber gasket inserts, and service lines in areas of soils contaminated with hydrocarbons, nitrile gaskets will be specified in the area of contamination.

There are other types of contaminated soil such as soil high in chlorinates—there are various types, volatile organic compounds. The other types of contaminated soil should be mentioned. The appropriate gasket type should be indicated for each type of contaminated soil. Gasket types include plain rubber, EPDM, neoprene, Nitrile, Fluorel Viton.

Drawings must show locations of all nitrile gaskets.

Maintenance Holes

Maintenance holes will be located at each change in alignment, pipe size, grade, material and at all pipe junctions, and at intervals along the pipe to permit entry for maintenance to the sewer. Maintenance holes on a radius pipe will be placed at the end of curve, that is to say upstream end of the sewer line.

Spacing of Maintenance Holes

Generally, the maximum allowable horizontal spacing between maintenance holes shall be as follows:

Table 25: Storm maintenance hole spacing

If diameter of sewer is …	Then maintenance hole spacing is upto …
300 mm–975 mm	110 m
1050 mm–1350 mm	130 m
1500 mm–1650 mm	160 m
1800 mm and larger	305 m

Larger diameter sewers—larger than 1800 mm—may use a greater maintenance hole spacing. The design will be made in consultation with the City.

Maintenance Hole Sizing

All sizing of storm precast maintenance holes are based on incoming and outgoing pipe sizes and will be sized as per City standard T-701.021. The minimum diameter for a maintenance hole is 1200 mm.

The construction of maintenance holes shall conform to current City standards T-701.010, T-701.011, T-701.012-1, T-701.013 and the pre-cast manufacturer’s specifications.

The type and size of the maintenance hole will be specified on the profile drawing.

When any dimension of a maintenance hole differs from the current standard, the maintenance hole will be individually designed and detailed by the design engineer.

Where a street configuration and congestion with other utilities required a sewer pipe to turn at an angle greater that 45 degrees, upsizing a maintenance hole to provide a longer radius bend inside the maintenance hole may be permissible, subject to approval by the City. These installations will be reviewed on a case-by-case basis.

Manufactured Maintenance Hole Tees

On straight through installations only, precast manufactured maintenance hole tees can be installed instead of a regular maintenance hole on 1200 mm diameter or greater trunk sewer. No deflections or lateral connections will be constructed within the proposed maintenance hole tee. Tees are to be located upstream of a change in alignment or change in pipe size.

For details and additional design information, see OPSD 707.010.

Maintenance Hole Frame and Covers

Maintenance hole frame and covers are required for all maintenance holes and shall conform with OPSD 401.010, Type 'A' closed.

When adequate ventilation may be necessary for sub-surface storage systems, for example tanks, chambers and so on, ensure the hydraulic functions under the storm event to prevent air entrapment issues. In this case, replace with OPSD 401.010 Type 'B' open.

Maintenance hole chamber openings must be located on the upstream side of the maintenance hole.

Lockable Maintenance Hole Covers

Lockable maintenance hole covers are required to control access and to protect the public. It is recommended to be located in park blocks and open space blocks. For details and additional design information, see OPSD 401.060.

Maintenance Hole Steps

For pre-fabricated maintenance holes, steps will be solid circular steps as per OPSD 405.020.

For cast-in-place maintenance holes, steps will be solid rectangular steps as per OPSD 405.020.

Drop Structures

A drop pipe should be provided for a sewer entering a maintenance hole at an elevation of 610 mm or more above the invert. Where the difference in elevation between the incoming sewer and the maintenance hole invert is less than 610 mm, the invert should be benched to prevent solids deposition.

The external drop pipe will be one size smaller than the sewer line—minimum 200 mm diameter. The alternative of providing a deeper storm sewer instead of a drop maintenance hole may be considered at the City's discretion. The preferred drop structure is Type 'C' accordance with the City Standard T-1003.01.

The entire outside drop connection should be encased in concrete due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the maintenance hole.

Drop maintenance hole should be constructed with an outside drop connection. Inside drop connections when necessary should be secured to the interior wall of the maintenance hole and provide access for cleaning.

Maintenance Hole Safety Landings

When the depth from invert to top of the maintenance hole exceeds 4.5 metres, a safety platform will be provided. Safety grates will not be more than 4.5 metres apart. The platform will be located 2 metres below the maintenance hole cover and 2.8 metres above the maintenance hole invert. For details and additional design information, see OPSD 404.020.

Benching

All benching of maintenance holes will conform to City standard T-701.021. Benching height will extend from the pipe obvert to improve hydraulic performance. Catchbasin maintenance holes will not be benched so that a 0.3 metre sump remains.

A benching detail will be shown on the plan portion of the engineering drawing when the proposed benching differs from the City standard.

Steps in Benching

Steps in maintenance hole benching will be required when the pipe diameter is greater than 450 mm. The last step will be 300 mm above the benching or 600 mm above the invert, if no benching.

Stacked Maintenance Hole

Where congestion of utilities precludes the preferred horizontal pipe connection to be made, and it is difficult to install a standard type of maintenance hole or catchbasin, a stacked maintenance hole or catchbasin can be used.

A maintenance hole over a stack is allowed in certain conditions, but there are limitations when connecting to brick sewers because the material is fragile, brittle, and can break. Therefore, an overstack installation is not recommended.

A structural analysis of the maintenance hole over the stack should address the following:

- Failure or deflection strain of the pipe from dead and live load bearing directly on the pipe crown which has been compromised by the penetration needed for the new connection pipe.
- Consideration of fatigue failure from repetitive traffic loadings.
- Long term differential settlement on the pipe section from the dead and live load bearing on the pipe section and the associated strain(s) on the pipe section connections with the adjoining pipe sections.

For details, see City standard T-701.015-1, T-701.015-2 and T-708.01-1.

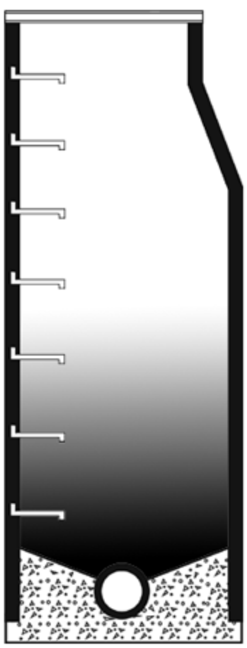
Hydraulic Losses at Maintenance Holes

Suitable drops will be provided across maintenance holes to compensate for the energy losses due to the change in flow velocity and to accommodate the difference in depth of flow in the upstream and downstream sewers. When the pipe size does not change through a maintenance hole and the upstream flow velocity does not exceed 1.5 metres/second, the following allowances will be made to compensate for hydraulic losses.

Table 26: Allowance for hydraulic losses (storm sewers)

If alignment change is …	Then drop required is …
straight run	grade of sewer or 0.03 m
15°–45°	0.030 m – MOE minimum 0.075 m – preferred
45°–90°	0.06 m – MOE minimum 0.15 m – preferred
junctions and transitions [a]	MOE calculations

[a] For all junctions and transition maintenance holes and when the upstream flow velocity exceeds 1.5 metres/second, the drop required will need to be calculated using the Appendix H, *Hydraulic Calculations for Junction and Transition Maintenance Holes*. Calculations for hydraulic losses will be included in the design submission.



The engineer shall adhere to the following guidelines:

- Endeavour to keep entrance and exit velocities equal. In order to reduce the amount of drop required, the engineer will try to restrict the change in velocity from one pipe to another in a maintenance hole to less than 0.6 metre/second.
- No acute interior angles will be allowed.
- No decrease in pipe diameter from a larger size upstream to a smaller size downstream will be allowed regardless of an increase in grade.
- When an increase in pipe size occurs at the downstream side of the storm maintenance hole, match obvert elevations of the incoming and outgoing pipes or have incoming pipe obverts higher than outgoing pipe obverts.

Changes in Pipe Alignment

The maximum change in direction for pipe sizes 675 mm and larger is 45 degrees. For 675 mm and larger diameter pipes where the change in direction is greater than 45 degrees, additional maintenance holes 1200 mm in diameter will be required to reduce the angle.

Where a street configuration and congestion with other utilities required a sewer pipe to turn at an angle greater that 45 degrees, upsizing a maintenance hole to provide a longer radius bend inside the maintenance hole may be permissible, subject to approval by the City. These installations will be reviewed on a case-by-case basis.

Municipal Storm Service Connections

New Private Sewer Connections

The direct connection of any new private storm sewer to a municipal storm sewer system is prohibited for any new or re-constructed residential, industrial, commercial, or institutional buildings. Application for an exemption must be supported by a stormwater management report identifying the storm water quantity and quality control measures being proposed for the site. A proposed connection may be approved for a connection to the municipal storm sewer system, where the report successfully demonstrates that there is no practical alternative means of drainage available on the site and the proposed method is satisfactory to the General Manager, Toronto Water.

Roof Water Drains or Downspouts

No new connections to a sanitary, combined, or storm sewer will be permitted for roof water drains or downspouts for low rise residential buildings.

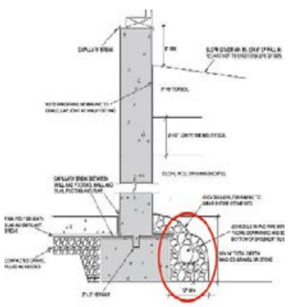
Storm water collected from roof water drains or downspouts will be directed to pervious areas for infiltration or other areas for reuse on site. Storm water collected by a down pipe from an eavestrough will be discharged at grade with provisions to prevent soil erosion and will be conveyed away from the building in such a manner that the storm water will not accumulate at or near the building and will not adversely affect adjacent properties.

The discharge of roof drains to a combined sewer or storm sewers in the combined sewer area of the city is prohibited. Exemptions will be at the sole discretion of the general manager as set out in the Sewer Use Bylaw, Chapter 681 of the Toronto Municipal Code.

Existing Roof Drain Connections

Existing roof drain or downspouts connections to the combined sewer system will be eliminated except under exceptional circumstances. Exceptional circumstances may be when it is not practical or affordable or when it is a capital sewer replacement project and the contractor will have to work on private property. If necessary due to site constraints, existing roof or drainage connections to the combined sewer system may be permitted to reconnect to the storm sewer system, where road sewer separation from the combined sewer system has been implemented. Any application for an exemption will be at the sole discretion of the General Manager, Toronto Water.

Foundation Drains



All new foundation drains or weeping tiles will be pumped to grade, subject to soil conditions with respect to environmental impacts and soil permeability. The foundation drains will not be connected to any municipal sewer. If necessary due to site constraints, foundation drains may be permitted to reconnect to the storm sewer systems, where road storm sewer separation from the combined sewer system has been implemented.

When foundation drains are directly connected to the storm sewer system, the elevation of the basement floor will be at least one metre above the elevation of the storm sewer obvert at that point and preferably 150 mm above the hydraulic grade line generated by the 100-year storm. For building connections located close to the point where the storm sewer discharges into the major system, the basement floor elevation must be above the 100-year flood elevation at this same point.

Any application for an exemption must be approved by the General Manager, Toronto Water.

Minimum Size and Grades

The minimum diameter and grade of a municipal storm service connection is 150 mm diameter at 2 percent slope. The actual size of the storm service connection required for non-residential, commercial, institutional, and high rise condominiums is determined by the maximum flow permitted from the development.

For non-residential sites, commercial, institutional and high rise condominiums, the service connection can not act as the orifice control for the site.

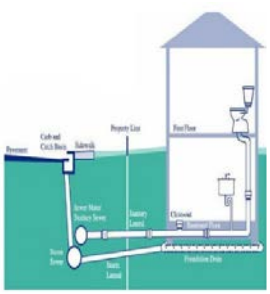
Pipe Class and Embedment for Laterals

PVC service laterals 150 mm in diameter will be class SDR 28 and white in color. The embedment material will be Granular A Native or Granular A RCM according to TS 1010. Compaction will be 95% dry density.

Depth of Cover

The minimum cover at street line will be 1.5 metres as measured from the finished road elevation to obvert of the storm service connection.

The maximum cover at street line will be 2.4 metres from the finished centre line road elevation to obvert of the storm service connection.



Storm Service Connections to Sewers

For multi-family, commercial, institutional and industrial land use, a maintenance hole will be required when the service connection is of a size greater than half the diameter of the main storm sewer—except in cases where the main sewer is 900 mm in diameter or larger, in which case the storm service connection may be directly connected into the sewer.

Using this rule of thumb will reduce the number of maintenance holes in the roadway.

Rule of thumb

If the service connection diameter is less than or equal to half the diameter of the main storm sewer, then no maintenance hole is required.

Service connections will be connected at 90 degrees to the main. For additional design information, see City Standard T-708.01 for rigid sewer service connections and T-1006.010 for flexible sewer service connection.

Pipe Connections to Maintenance Holes

Match obvert elevations of the incoming and outgoing pipes or have incoming pipe obvert higher than outgoing pipe obverts. Invert to invert connections will not be allowed.

The connection of the sewer pipe at the maintenance hole will utilize a flexible joint for either rigid or flexible pipe. A concrete cradle may be used for rigid pipe. For details and additional design information, see City standard T-708.020.

Flexible Rubber Connectors

Flexible rubber connectors can also be used for connecting pipe to maintenance holes. Rubber connectors are either cast-in-place during manufacture of the precast product or installed into a cored or preformed hole in the finished maintenance hole. For product information, go to Chapter 6, Material Specifications.

Control Maintenance Hole

The City requires a control maintenance hole located on the property of the owner, as close to the property line as much as possible as per Section 681-10-A. (1) of the Toronto Municipal Code. This requirement will apply to all multi-family, commercial, industrial, and institutional blocks.

Sampling Access Point

When groundwater is discharged to the municipal sewer system, the City requires a private water sampling access point located on the property of the owner to monitor the quality and quantity of private water discharged to the City's sewage works in accordance with Chapter 681, Sewers, Section 681-10-A of the Toronto Municipal Code. The City requires a 24 hours a day 7 days a week accessible location, upstream of the control maintenance access hole. This requirement will apply to all multi-family, commercial, industrial, and institutional blocks. The private water sampling access point must have the required overhead clearance—depth of sampling access point plus 2 metres—to allow the sampling access point to be installed at the proposed location. For additional design information, see City Standards T-709.010, T-709.020, T-709.030, and T-709.040.

Service Connections in Easements

Storm sewer service connections in easements will only be allowed subject to the satisfaction of the General Manager, Toronto Water as per Section 681-11-B of the Toronto Municipal Code. An easement encroachment agreement stipulating the conditions of the encroachment will be required for any storm service connection.

In addition, the property owner will be required to enter in a Water and Sewer Installation Agreement with the City if the sewer main is not located within the City right-of-way.

Hydro Vault Drain Connection

Hydro vault drain connection exemption process applies to all hydro equipment on development sites, right-of-way and private property where encroachment agreements are in place. All such approved exemptions for connections to City storm, sanitary or combined sewers shall be delineated in writing, in the form of a Sanitary Discharge Agreement (SDA) or Storm Sewer Discharge Agreement (SSDA).

Toronto Hydro shall conduct a site specific borehole investigation for each proposed cable chambers, switching vault, transformer vault, pad mounted equipment and customer owned substations installation.

Furthermore, Toronto Hydro shall take all reasonable measures to control the quality and quantity of private water entering the city sewer system.

For more details, refer to the Hydro Vault Drain Connection Exemption Approval Process document by contacting Toronto Water, Water Infrastructure Management unit.

Catchbasins

Catchbasins will be provided to collect drainage from both pervious and impervious areas. The engineer will limit the number of catchbasins connected to each section of sewer so that the minor system is not overloaded.

Location

Street

At street intersections, catchbasins will be located immediately upstream of sidewalk or pedestrian crosswalks when the road grade falls towards the intersection.

Catchbasins will not be located within one metre of a driveway or walkway curb depression.

Catchbasins and its lead connections will be designed to capture the expected maximum flow.

Double catchbasins will be required when drainage is received from more than one direction or the catchment area is greater than 200 square metres.

Rear Lot/Yard

The catchbasin and lead will be offset from the property line, entirely on one lot or block. Pipe will be concrete encased to avoid possible penetration from fence posts. The lead will not be the responsibility of the City, and therefore no easement is required. A cleanout at street line is not required by the City, but could be installed at the request and cost of the owner.

When a catchbasin lead passes through two or more adjoining lots, a 3 metre wide private easement is required. The owner of the pipe shall confirm the drainage area for this pipe and determine whether there are any additional approval requirements prior to construction.

Parks/Landscaped Areas

Catchbasins will be located adjacent to walkways or bike paths to minimize flow and to provide positive drainage from park facilities and to minimize impacts on surrounding playfields. The location of catchbasins shall be subject to the approval of the parks, forestry and recreation division.

Minimum Lead Diameter and Grade

Street

For a single catchbasin, the minimum lead connection diameter will be 250 mm and the minimum grade will be 1.0 percent.

For double catchbasins, the minimum lead connection diameter will be 300 mm and the minimum grade will be 0.7 percent.

Rear Lot/Yard

The minimum diameter of a catchbasin lead in a rear yard will be 250 mm and the minimum grade will be half percent. All rear lot catchbasin leads will be concrete encased.

Parks/Landscape Areas

The minimum diameter of a catchbasin lead in a park or landscape area will be 250 mm and the minimum grade will be 0.7 percent.

Catchbasin Lead Length

The maximum length of the catchbasin lead is 30 metres.

Spacing

Catchbasins should be provided at adequate intervals to ensure that the road drainage is able to be intercepted up to the capacity of the storm sewer which will be the basis to determine the type, location, and spacing of the catchbasins. The spacing will vary with the road width, grade, and cross fall and with the design storm frequency. The spacing will also be affected by the location of pedestrian crossing points, intersections, major depression points, driveway depressions, and so on. The recommended maximum spacing is as follows:

Table 27: Catchbasin spacing

Pavement width	Grade < 4 % grade	Grade > 4 % grade
7.3 m–8.5 m	90 m	60 m
8.5 m–9.8 m	82 m	55 m
9.8 m–12.2 m	73 m	50 m
12.2 m–14.0 m	60 m	40 m

The spacing of catch basins may be altered for grades greater than 4 percent, by using side inlet catchbasin.

The desired maximum distance from a crest in a road to a catchbasin is 90 metres, measured along the curb line for each side of the road.

The maximum area to be serviced by any catchbasin shall be 0.2 hectare of paved area or half hectare of sodded area.

Types of Catchbasins

Single Catchbasin

Single catchbasins will be constructed on all streets. For details and additional design information, see City standard T-705.010.

Double Catchbasin

Double catchbasins will be constructed at sag points when the catchment area is greater than 200 square metres and received from more than one direction in the road way or in cul-de-sacs. For details and additional design information, see City standard T-705.020.

Catchbasin Maintenance Hole

No combination of a maintenance hole and catchbasin will be installed on private property as per Section 681-10-D. (3) of the Toronto Municipal Code. The use of catchbasin maintenance holes in the right-of-way is not permitted. The use of catchbasin maintenance holes in public laneways is permitted.

Single Catchbasin without Sump

Single catchbasins without a sump will be constructed in all rear lots and yards. For details and additional design information, see City standard T-705.010-1.

Ditch Inlet Maintenance Holes/Catchbasins

Ditch inlet maintenance holes/catchbasin will be constructed along arterial roads which have ditch drainage. They can also be constructed for temporary block drainage in a new subdivision and for outlets or inlets within a stormwater management pond. The grate blockage should not exceed 50 percent of the total grate area. For details and additional design information, see OPSD 702.040 Type 'A', and OPSD 702.050 Type 'B' or OPSD 705.030 and OPSD 705.040.

Infiltration Trench with Catchbasin

Infiltration catchbasins can be constructed in laneways where no storm sewer is nearby. This installation is considered to be stormwater management works and requires approval of the MECP. For details and additional design information, see City standard T-705.010-5.

Use of French Drains for Underpasses

French drains can be considered for underpasses where low groundwater conditions exist. However, the pavement design and boulevard design may require additional approval by Transportation Services and there must be a secondary method to provide drainage. The project area should be graded such that water that originates outside of the depressed areas should not be allowed to enter the depressed areas to minimize the need for pumping. The preferred method of rainwater storage is either to enlarge the collection system or to construct an underground storage facility. The preferred location for the underground storage facility is under the existing roadway or in the median. Additional right-of-way should not be required. The pump station can remove stored water by either a dry well or a wet well depending on the site conditions.

The recommended design storm for depressed areas and underpasses, where ponded water can be removed only through a storm drainage system is a 50-year event. The use of a more severe event, such as a 100-year storm can be used as a check storm event to assess hazards at critical locations where water ponds to depths over 300mm.

Depth of Cover

The minimum depth of cover over a catchbasin lead is 1.5 metres within the traveled portion of the road and 1.2 metres within the boulevard.

Allowable Ponding

No surface ponding is allowed to accumulate for a 2-year design storm event within the public road allowance.

Maximum water depth allowed on major overland flow routes is up to 0.3 metre over street catchbasins and 0.3 metre over rear yard catchbasins.

Catchbasin Frame and Grates

Cast Iron Square Frame with Square Flat Grate

To be used on catchbasin maintenance holes in laneways and single and double catchbasins on private property. For details and additional design information, see OPSD 400.020.

Cast Iron Raised Square Frame with Circular Flat Grate

To be used on local, collector and arterial roads with single and double catchbasins. For details and additional design information, see OPSD 400.070.

Galvanized Steel, Honey Comb Grate

To be used with a ditch inlet catchbasin. For details and additional design information, see OPSD 403.010.

Cast Iron, Square Frame with Square Overflow Type Flat Grate

To be used on rear lot/yards and in parks with single catchbasins. For details and additional design information, see OPSD 400.110.

Cast Iron, Square Frame with Square Flat Grate

To be used on arterial and collector roads where additional residential catchbasin draining capacity is required. For details and additional design information see OPSD 400.100 or OPSD 400.110.

Cast Iron, Curb Inlet Frame with Two-Piece Raised Cover

Side inlet catchbasin can be used on arterial and collector roads. They are also acceptable for use on local roads where snow is not plowed to the curb.

On local roads there is a potential for blocked inlets and ponding of water, designer should review if acceptable. Where there are reduced lane widths, side inlet catchbasins are an option when surface inlet catchbasin in the road would have buses travelling over them. Safe where you have bike lanes.

If street slopes greater than 1.5 percent, the capture efficiency diminishes and surface inlet becomes preferable due to their capture efficiency. For details and additional design information, see OPSD 400.081 or OPSD 400.082.

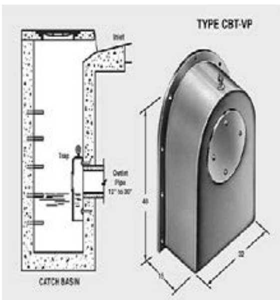
Catchbasin Lead Connections

Rigid Catchbasin Leads

Rigid catchbasin lead connections to rigid sewers shall be constructed according to City standard T-708.01

Flexible Catchbasin Leads

Flexible catchbasin lead connection to flexible or rigid sewer main shall be constructed according to the City standard T-1006.010.



Goss Trap

Goss traps are required on all new single or double catchbasins on local, collector and arterial roads. Rear lot catchbasins do not require a goss trap.

Inlet control devices are not to be included in a catchbasin unless specified by the engineer. The designer should be aware that some manufacturers produce goss traps that have a built in inlet control device that could render a storm system design less effective or even ineffective in controlling large storm events if used without being specified.

Inlet Control Devices

Catchbasin inlet control devices to restrict flow into the sewer system can be used. Designer to calculate maximum flow to determine radius of orifice. For details and additional design information, see City standard T-706.010.

Culverts

Driveway culverts will be designed to accommodate the minor flow unless otherwise indicated. The minimum culvert diameter will be 300 mm for driveways and 600 mm for roadway crossings. The owner of the pipe shall confirm the drainage area for this pipe and any associated ditch drainage, swale, or storm sewer system and determine whether there are any additional approval requirements prior to construction.

Stormwater Pumping Stations and Forcemains

Stormwater pumping stations and forcemains shall be minimized. Where required, they shall be designed in accordance with MECP Design Guidelines for Sewage Works and City specifications which include but are not limited to Toronto Water; Instrumentation Specification Standards Division 13000, Electrical Specification Standards Division 16000, and Process Control System (PCS) requirements for the electronic tag management system.

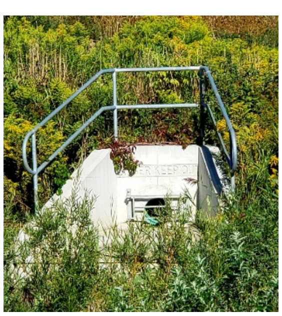
Stormwater pumping stations are typically required in locations where there is no overland flow route, which means additional underground storage will need to be incorporated in their design. The MECP Design Guidelines do not specifically address stormwater pumping stations. They will need to be designed on a case-by-case basis for the 100-year design storm event unless advised otherwise by the City.

For more information on pumping station requirements, see Appendix I, *Pumping Stations*.

Outlet Structures

Provincial approval and permits are required for all outfalls discharging into a watercourse. In order to minimize erosion, outfalls will extend to the bottom of drainage courses or to the edge of streams. Discharging onto steep slopes will not be accepted.

Hydraulic Requirements



Exit velocities must be designed to minimize potential erosion or damage in the vicinity of the outfall from maximum design flows.

In an instance where the discharge velocity is high or supercritical, prevention of erosion of the natural channel bed or banks in the vicinity of the outlet requires an energy dissipating structure, such as rip rap, concrete slab, gabions, or headwalls and wing wall with stilling basins.

In an instance where there is an existing utility crossing of the natural channel bed downstream of the outfall structure, an armour stone mat may be required to be constructed on the natural channel bed at an appropriate location to guard against erosion near the existing utility crossing.

Outfalls to natural watercourses should discharge at or above the average water elevation of the watercourse. If high water levels cause the submergence of the outlet, the impact of the submergence on the sewer system must be assessed.

The outlet obvert must be above the 25-year flood elevation of the receiving channel.

Outfalls Grates

Outfalls debris/safety grates shall consist of horizontally placed bars with a maximum clear space of 150 mm between bars according to OPSD 804.050. Provisions must be made for opening or removing the grate for cleaning purposes. The use of cage type racks is discouraged due to their poor debris handling characteristics. Where vertical reinforcement is required based on structural considerations it shall be kept to a minimum.

Outfall grating for up to 1800 mm diameter shall be designed such that the full diameter of the outfall pipe can be accessed for periodic maintenance. Gratings shall be secured with “tamper-proof” bolts, or a locking device. Outfall gratings for outfalls greater than 1800 mm shall require site specific designs addressing the general design concepts presented herein.

Debris grating must have sufficient clear space to minimize the impact of clogging on hydraulic capacity and the horizontal bars shall be designed to minimize the occurrence of clogging. For non-symmetrical bars, the thinnest portion of the bar, shall be pointed at the direction of flow.

Debris grating shall be structurally designed with a break away feature such that the grating will break open under the design condition of a 40 percent reduction in cross sectional area and the anticipated velocities from a 10-year synthetic storm event. The outfall grating shall be designed such that the grating is not lost when the break-away feature is utilized. This may be accomplished by the use of hinges with one break-away side, a chain, or by other suitable means as may be determined by the designer.

Outfalls should be made as safe as possible by utilizing fencing along the headwalls and wingwalls to prevent accidental falls. Submerged outfalls need to be specifically designed to withstand freeze-thaw cycles and ice dams.

Sewer Discharging to Culverts

Storm sewers should not discharge into culverts, for example bridge culvert for roads. Each storm sewer should have their own structure to the water course. For any future outfalls and culverts being constructed, upgraded or replaced should be separated with the outfalls on the downstream side of the culvert. For any proposed realignment of storm sewers within a roadway that connect to a culvert, the proposed reconnection to the culvert will be reviewed on a case-by-case basis.

Chapter 4 – Watermains

The water distribution system must be designed to deliver potable water without appreciable degradation of quality for domestic consumption while having sufficient capacity at all times to deliver adequate quantities of water at adequate pressure for firefighting purposes.

Water Demand

The water demand used for watermain size selection should be sufficient to satisfy maximum day demand plus fire flow or the peak hour demand, whichever is greater.

The common demand factors used in defining water supply requirements are as follows:

Average day – is the total amount of water demand within a certain time period, usually one year, divided by the number of days within that time period.

Maximum day – is the average water demand over the day—midnight to midnight—of highest water demand day within any one year.

Minimum hour – is the smallest short term—1 hour—demand in one day.

Peak hour – is the highest short term—1 hour—demand within a system not including fire flow in one day.

Domestic – is any residential or industrial non-fire water use.

Per Capita Demand

The residential demand can be divided into single family residential per capita demand and multi-unit residential per capita demand.

Table 28: Residential per capita demand

Sector	Per capita demand
single family: single-detached, semi-detached, row housing (3–6 units), plexes (2–6 units)	310 litres/capita/day
multi-unit: high-rise or low-rise apartment buildings, condominiums, co-operatives, each with greater than six units	190 litres/capita/day

Commercial and Institutional Water Demand

Commercial and institutional flows should be determined by using historical records, where available. Where no records are available, the values in the following table should be used. For other commercial and tourist-commercial areas, an allowance of 28 m^3/ha/day average flow should be used in the absence of reliable flow data.

When using the above unit demands, maximum day and peak rate factors should be developed. For establishments in operation for only a portion of the day such as schools and shopping plazas, the water usage should also be factored accordingly.

For example, with schools operating for 8 hours per day, the water use rate would be at an average rate of 70 litres/student/day x 24/8 or 210 litres/student over 8 periods of operation. The water use will drop to a residual amount during the remainder of the day. Schools generally do not exhibit large maximum day to average day ratios and a factor of 1.5 will generally cover this variation.

For estimation of peak hour demand rates, an assessment of the water-using fixtures is generally necessary and a fixture-unit approach using the Ontario Building Code should be used.

Table 29: Typical water demands for selected commercial and institutional users

Commercial and institutional use	Water use daily average
shopping centres−based on total floor area	2500–5000 litres/m²/day
hospitals	900–1800 litres/bed/day
schools	70–140 litres/student/day
motels	150–200 litres/bed-space/day
hotels	225 litres/bed-space/day
commercial space retail	site specific
office space	site specific
institutional space	site specific

Hydraulic Modelling

A hydraulic network model simulation should be carried out as required to determine if the demand flow exceeds the capacity of the supply and to demonstrate that the studied system will not adversely affect the surrounding system in terms of pressure and supply.

Peaking Factors

The peaking factors used to calculate minimum hour, peak hour and maximum day are based on City water consumption records.

Table 30: Peaking factors

Land use	Minimum hour	Peak hour	Maximum day
residential >150,000 population range	0.80	2.25	1.50
commercial	0.84	1.20	1.10
industrial	0.84	1.90	1.10
institutional	0.84	1.90	1.10
apartments	0.84	2.50	1.30

Whenever possible, peaking factors based on usage records for the water supply system should be used. The developer's consulting engineer should contact the Development Engineering unit of Engineering and Construction Services division to obtain the current GIS data to build a calibrated hydraulic model.

A request to Toronto Water, through the Development Engineering unit will advise if the development site is in an area experiencing problematic static and residual pressures along with any deficiencies in meeting fire flow requirements.

Friction Factors

Hazen Williams 'C' values to be used for the design of new water distribution systems, regardless of pipe material, will be:

Table 31: C factors

Diameter of main	**'C' factor**
150 mm	100
200 mm or 250 mm	110
300 mm to 600 mm	120
larger than 600 mm	130

When evaluating existing systems, the 'C' factor should be determined by actual field tests, whenever possible.

Duration and Number of Hydrants when Modelling

For modelling pressure zones, simulating high fire flows, the duration and number of hydrants needs to be considered to access the hydraulic capacity of the water distribution system. The following table shall be used for water distribution hydraulic modelling when placing fire flow at node points in the model.

Estimated fire flow requirements compiled from the Insurance Services Office (ISO) is shown in the table below:

Table 32: Duration and number of hydrants for fire flows when conducting hydraulic modeling

Use categories	Fire flow (litres/minute)	Duration (hour)	Number of hydrants
single family and two family dwellings	3,800	2	1
community facilities	5,680	2	1
multi-family—one and two stories—and closely built residential	7,570	2	2
multi-family—three stories or more—and closely built residential	9,460	3	2
multi-family attached residential	11,360	3	2
commercial—up to two stories	11,360	3	3
commercial—over two stories	19,000	5	4
high-rise residential	19,000	5	4
industrial park	19,000	6	4
shopping centre	22,700	6	4

Fire Protection

Fire Demand Calculation Method

When calculating the fire flow requirements and affected pipe sizing, designers shall use the method developed by the Fire Underwriters Survey (FUS).

The requirements for levels of fire protection on private property are covered in Section 7.2.11 of the Ontario Building Code.

In accordance with (FUS), fire flows for residential areas will not be less than 4,800 litres/minute for a 2 hour duration in addition to maximum daily domestic demand, delivered with a residual pressure of not less than 140 kilopascals.

For commercial, institutional and industrial areas, the minimum fire flow available will not be less than 5,000 litres/minute for 4 hours, delivered with a residual pressure of not less than 140 kilopascals. These are considered minimum requirements.

Rule of Thumb

The number of hydrants required from a fire protection perspective for a building or complex of buildings is based on the formula: required fire flow = [number of private hydrants] x [5,690 litres/minute].

Fractions greater than or equal to one-half are rounded to the next higher whole number, while fractions less than one-half are dropped.

Hydrant Spacing

Hydrant spacing after calculating the fire flow requirements using the (FUS) method, confirms whether the average spacing between hydrants in the right-of-way and minimum number of hydrants is met for your development site.

It is recommended that carrying capacity along adjacent streets be assessed when determining the impact of fire flow requirement in pipe sizing.

In keeping with the International Fire Code (IFC), fire hydrants should be spaced and numbered as shown below in Table 33:

Table 33: Fire hydrant spacing and location

Fire flow Requirements (l/min)	Minimum number of hydrants	Average spacing between hydrants [a,b,c] (m)	Maximum distance from access point of a building or lot to a hydrant [d] (m)
6650 or less	1	150	75
7600–8550	2	135	70
9500	3	135	70
11,400	3	120	70
13,300–15,200	4	110	65
17,100–19,000	5	90	55
20,900	6	90	55
22,800	6	75	45
24,700–26,500	7	75	45
28,500 or more	8 or more [e]	60	40

[a] Reduce by 30 metres for dead-end roads or streets.

[b] Where streets are provided with median dividers that cannot be crossed by firefighters pulling hose lines or arterial roads with four or more traffic lanes having a traffic count of more than 30,000 vehicles per day, hydrant spacing should average 150 metres on each side of the street.

[c] Where new watermains are extended along streets where hydrants are not needed for the fire protection of structures or vegetation, fire hydrants should be spaced at intervals not exceeding 300 metres to provide for protection from transportation hazards.

[d] Reduce by 15 metres for dead-end roads or streets.

[e] One hydrant for each 3,800 litres/minute or fraction thereof.

Where a hydrant serves a building(s) that is provided with a siamese connection, the hydrant will be located not more than 45 metres unobstructed from the siamese connection(s). Where the building(s) is not provided with a siamese connection, according to OBC 3.2.5.7, hydrants shall be located within 90 metres horizontally of any portion of a building that is required to face a street.

The door to the furthest dwelling unit in a residential structure such as single family dwellings, apartments, condominiums, hotels, motels and so on must be no more than 90 metres from a fire hydrant.

The required fire flow is the amount and rate application required to confine and control the fires possible in a building or group of buildings which essentially the same fire area by virtue of immediate exposure. This may include as much as a city block.

Fire Flow Demands for a Development Proposal

For estimating fire flow demands for a development proposal, the FUS document *Water Supply for Public Fire Protection 1999* by Fire Underwriters Survey will be used.

The City expects that most developments do not fall within the non-combustible classification, which allows for a reduction of 25 percent of water demand. Should the design engineer choose this lesser value, additional support is required in the form of detailed water demand calculations and fire content loading calculations to show when a classification of non-combustible can be supported.

The capacity for a single hydrant is a maximum of 5,690 litres/minute. There should be a sufficient number of municipal hydrants on watermains capable of supplying the fire flow volumes needed, that are within the maximum distance to the lot lines. For example, if a lot is 100 metres wide, with a fire flow of 11,000 litres/minute, a minimum of two fire hydrants connected to the watermain intended to support the fire demand, are within the maximum permissible distances to the property's lot line.

When designing a watermain for a new subdivision, fire hydrant spacing should start by placing fire hydrants as close as possible to a tee or cross in the water system, on the largest pipe that is connected to that tee or cross. This will provide the fire department with a hydrant with much more volume available for firefighting than those spaced midway along the watermain or at the end of the watermain.

The FUS document was written in 1999, when home furnishings had less or limited amounts of synthetic materials versus what are present today. The difference between the material content of traditional furniture vs new furniture containing synthetic materials is that when a synthetic material burns, it results in a much faster and hotter burning fire, which releases more heat in a shorter period of time, allowing the fire to spread much faster in today's homes than years ago when fewer of these materials were present.

Private hydrants intended to substitute new municipal hydrants shall be designed by the design engineer to provide either the FUS fire flow requirement or 5,690 litres/minute, whichever is smaller and supported by a letter from the design engineer. Private hydrants will only be considered when the required spacing of municipally owned hydrants has been met along the right-of-way.

Fire Flow Testing

The City of Toronto carries out fire flow tests on its water distribution system only for its own design and maintenance purposes. The results of such testing can be made available to anyone for the purpose of designing or checking the adequacy of their private fire protection system, but users may not reference the City information in their design or proposal.

Any person requesting a fire hydrant flow test shall pay in advance of the test the amount specified in Toronto Municipal Code, Chapter 441, Fees and Charges, Appendix D - Schedule 2, Water Services.

The person or their representative requesting the test will provide all gauges and test equipment necessary to carry out the test and shall make all necessary calculations.

Every fire flow test result received by Engineering Review will be shared with the Analytics Services unit of Toronto Water. Results of previous fire flow tests carried out by others will be made available to any interested party—upon written request—on the understanding that the results are not warranted by the City and are not to be construed as a definitive statement of actual conditions.

Users of such data must be aware that the conditions in a water distribution system vary continuously, depending on the demand on the system, as well as with the age and condition of the various system components and any maintenance or rehabilitation work occurring at the time.

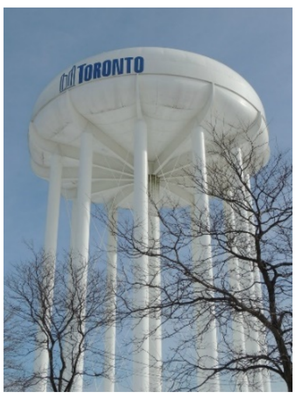
Fire flow testing is required for all re-zoning, official plan amendment and draft plan of subdivision to confirm static and residual pressures and flows. Fire flow testing may be required for site plan control, plan of condominium and committee of adjustment applications which will be determined on a case-by-case basis. Testing must conform to NFPA 291 and the date of the test must not exceed two years from the time of the application. Results from older tests may be considered at the discretion of the case manager in Development Engineering. If any operational problems are discovered during the fire flow testing, it should be brought to the attention of the City.

Maximum Velocity

All distribution watermains must be able to supply the greater of maximum day plus fire flow or peak hour.

The maximum velocity; under normal operating conditions will not exceed 2 metres/second, while during fire flow conditions, the maximum velocity will not exceed 3 metres/second.

The maximum head loss allowed in the distribution system under peak hour operating conditions—excluding fire flow situations—is 2 to 5 metres/1000 metres.



Pressure Range

The preferred design pressure ranges for:

- average day and maximum day is—350 kilopascals to 550 kilopascals
- minimum hour and peak hour is—275 kilopascals to 700 kilopascals

Pressures outside of these ranges are acceptable to the limits outlined below but are not desirable.

Minimum Pressure

Non-Fire Scenarios

The minimum pressure under any non-fire demand scenario will not be less than 275 kilopascals.

Fire Scenarios

The minimum residual pressure during maximum day plus fire scenarios will not be less than 140 kilopascals at any location in the water distribution system.

Maximum Pressure

The maximum static pressure in the watermain system should not exceed 690 kilopascals.

In cases where all services are protected by an individual pressure reducing device, the maximum pressure in the watermain system will not exceed 825 kilopascals.

Unless otherwise required, all watermains will be designed for 1000 kilopascals test pressure.

Watermain Design

Both metallic and plastic pipe are permitted in the construction of distribution watermains. These materials include ductile iron (DI), polyvinyl chloride (PVC), molecularly orientated polyvinyl chloride (PVCO), high density polyethylene (HDPE) and type 'K' soft copper tubing. In general, all distribution watermains up to and including 300 mm diameter will be PVC or PVCO with copper tracer wire and ductile iron fittings.

New municipal watermain systems should be fed from existing municipal watermain systems of equivalent or greater capacity.

Sizing

The minimum diameter for single family residential subdivisions will be 150 mm.

The minimum diameter on a new street for high density residential, industrial, and commercial developments will be 300 mm.

The standard diameters for distribution watermains are 150 mm, 200 mm, 300 mm, and 400 mm. Watermains, fittings, appurtenances, and connections will be as indicated in Chapter 6, *Material Specifications*.

Watermains Ending in Cul-de-sacs or Dead Ends

Watermains in cul-de-sacs will dead end with a fire hydrant. No water services will be connected after the fire hydrant. Each property will be serviced with a separate water service. For more information, see City standard T-1107.05.

If a 19 mm water service is to be replaced and the distance is greater than 20 metres to the existing building face within a cul-de-sac or dead end, the service shall be replaced with a 25 mm diameter copper service. Outside of cul-de-sacs and dead ends, if the distance is greater than 30 metres to the existing building face, the water service shall be replaced with a 25 mm diameter copper service.

In case there is a requirement for a hydrant lead greater than 50 metres in length, an automatic hydrant flushing device will be installed, draining to a storm sewer.

To reduce the frequency that Toronto Water, Distribution and Collection (Central Services) have to flush dead-end water systems, the designer of a new development shall minimize the frequency of flushing needed on a dead-end water system by locating a water service within three metres of a flushing hydrant. This will minimize the buildup of stagnant water that is inherently present in dead-end watermains, through the normal usage of water at the water service.

Location

The location of the watermain in a new road allowance will be on the north or east side of the street. Watermains will be offset from street line as indicated in the City's typical standard road cross-section from DIPS.

Table 34: Watermain offset from street line

Street type	Right-of-way width	Distance from north or east street line
major local street – option a	20.0 m	5.0 m
major local street – option b	20.0 m	5.0 m
intermediate local street – option a	18.5 m	4.3 m
intermediate local street – option b	18.5 m	4.3 m
minor local street – option a	16.5 m	4.7 m
minor local street – option b	16.5 m	4.7 m

When the location for a new watermain is being chosen on an existing street, it may be necessary to adjust the standard offset location having regard for existing services and utilities, traffic management during construction, and future construction within the road allowance.

For more information on DIPS, go to website: *www.toronto.ca/services-payments/building-construction/infrastructure-city-construction/construction-standards-permits/standards-for-designing-and-constructing-city-infrastructure/development-infrastructure-policy-standards-dips/ .*

Crossings and Parallel Trench Installations

Sewers and watermains located parallel to each other will be constructed in separate trenches maintaining a minimum clear horizontal separation distance of 2.5 metres from closest pipe edge to closet pipe edge.

Parallel Installations

Under unusual conditions where congestion with other utilities will prevent a clear horizontal separation of 2.5 m, a watermain may be laid closer to a sewer, provided that the elevation of the crown of the sewer is at least half metre below the invert of the watermain. Such separation will be of in-situ material or engineered fill.

Crossings

Under normal conditions, watermains will cross above sewers with sufficient vertical separation to allow for proper bedding and structural support of the watermain and sewer main. Where it is not possible for the watermain to cross above the sewer, the watermain passing under a sewer will be protected by providing:

- A vertical separation of at least half metre between the invert of the sewer and crown of the watermain.
- Adequate structural support for the sewers to prevent excessive deflection of joints and settling.
- That the length of water pipe be centred at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.

If a new watermain DR18 pipe cannot meet the 2.5 metres horizontal or 0.5 metres vertical clearance, upgrade to pressure class 305 psi DR 14 pipe.

Refer to MECP procedure F-6-1 “Procedures to Govern the Separation of Sewers and Watermains.”

Shallow Cover Crossing Sewers and Utilities

Watermains which cannot be constructed with the specified minimum cover will be insulated. For below grade insulation, rigid foam slab insulation placed above the watermain can be used. The insulation material will be polystyrene foam HI 60 or Plastispan 60. In general, the thickness of the insulation should be 25 mm for every 300 mm reduction in the depth of cover. A maximum reduction of 0.6 metre in depth will be permitted before other alternatives must be considered.

For insulation details for watermains and service connections adjacent to ventilated underground structures or where there is insufficient ground cover, see City standard T-708.01-4.

Embedment or Bedding Requirements

The class, material type, embedment or bedding and backfill will be indicated on the profile for each section of the watermain pipe. The engineer must ensure that the class or pressure rating of the pipe is not exceeded given the expected dead and live loadings and anticipated maximum water pressures.

The class of pipe and the type of embedment or bedding will be selected to suit loading, pipe material and trench soil type for example Type 1, 2, 3 or 4. Class of pipe will be according to OPSD 806.060 and flexible pipe embedment or bedding according to OPSD 802.010 and TS 401. Granular A Native or Granular A RCM according to TS1010 can be used. Granular A RAP is not allowed for embedment or bedding for watermains.

In cases where existing embedment contains reclaimed asphalt pavement (RAP), the plastic pipe shall be fitted with hydrocarbon resistant nitrile gaskets or equivalent. The installation of a carrier pipe for the plastic watermain is permitted as a method to protect the plastic pipe from the RAP embedment material.

Geoweb Geocell

Geoweb geocell is permitted by the City to compensate for poor soil conditions and to provide a stable, uniform trench base and bedding condition. The Geoweb serves as a compaction aid on the subgrade allowing for proper compaction of the base granular.

Geosynthetic reinforced bedding is permitted by the City to promote embankment and trench stability. The geosynthetic can be used for land formation created by lakefill, which can consist of non-homogenous waste materials that are prone to decomposition and settling.

Minimum Slopes

There are no minimum slope requirements for distribution watermains. However, the minimum slope for a transmission watermain installation is half percent. This is to prevent the accumulation of trapped air and to avoid localized high points

Thrust Blocks and Mechanical Restraints

Adequate restraint must be provided to the water distribution systems to prevent pipe movement and subsequent joint failure. In the case of bell and spigot or push-on joint, this restraint should be provided by an adequately sized concrete thrust block or mechanical thrust restraint positioned at all fittings, bends, tees, valves, hydrants, crosses, reducers and plugged or capped dead ends, horizontal or vertical bends deflecting 11¼ degrees or more, and connections ranging in size from 100 mm to 300 mm in diameter. For details and additional design information, see City standard T-1103.01, T-1103.020 and T-1103.020-2.

Where thrust blocks cannot be laid on undisturbed ground due to excessive excavation or fill conditions, mechanical thrust restraints will be used.

In areas of engineered fill such as reconstruction projects or when congested works are exposed, mechanical thrust restraints will be installed and shown on the drawings. The joints will terminate at least one pipe length into undisturbed ground.

In areas subject to possible future settlement, the bedding design must be such that it will minimize pipe movement. Mechanical thrust restraints must be installed throughout the limits of the possible settlement area. The minimum number of restraints required after a fitting on a watermain pipe 300 mm in diameter and smaller will be:

Table 35: Mechanical thrust restraint required (dia ≤ 300 mm)

If watermain pipe …	Then restraint is required at…
has a tee or cross	fitting [1]
has 45 degree bend	fitting [1]
has 90 degree bend	fitting and next pipe joint [1]
is placed on engineered fill	fitting and all pipe joints
is 300 mm in diameter	fitting and next pipe joint [1]

[1] If pipe length less than 6.1 metres, then any joint within 6.1 metres of a fitting will be restrained.

All valves on 300 mm diameter and greater PVC watermains will be restrained. Use the approved restraining devices as indicated in Chapter 6, Material Specifications.

All valves installed in chambers will be tied down as per City standard T-1100.010-2 and T-1100.010-3.

Pipes greater than 300 mm in diameter

For plastic watermain pipes 350–600 mm in diameter, mechanical thrust restraints on all fittings and valves will be shown on the shop drawings as recommended by the pipe manufacturer.

Depth of Cover

Curb and Gutter Roads

The minimum depth of cover will be 1.8 metres measured from the top of watermain to the centre line of road to minimize the risk of frost damage to the watermain and services.

The maximum depth of cover allowed on a watermain pipe, unless it occurs at the crossing of a watercourse or a structure, is 2.1 metres.

Open Ditch and Unimproved Roads

The minimum depth of cover over top of a watermain will be 2.1 metres below the existing centre line of the road, or 1.4 metres below the bottom of the ditch, or 1.8 metres below grade. If there is no ditch, use the greater depth of cover.

Watercourse

Where a watermain crosses under a creek, the minimum cover over the watermain below the creek bottom will be 2 metres. The ductile watermain will be concrete encased and the concrete encasement is to extend to the points where the pipe is beyond the high water level—100-year storm. Stabilization of the creek bottom may be required to ensure this amount of cover is maintained. For approved material products for horizontal directional drilling, see Chapter 6, *Material Specifications*.

Where a watermain is proposed to be suspended over a watercourse, the designer should first verify that the associated crossing structure spans the 100-year erosion limit of the watercourse prior to considering this design. To view the *TRCA Crossing Guideline for Valley and Stream Corridors, September 2015,* go to www.trca.on.ca/dotAsset/214493.pdf .

Shallow Watermains

Designer to calculate the required insulation for shallow pipe installations and increase the thickness of the insulation accordingly. Shallow bury installation shall not be less than 0.8 m in depth.

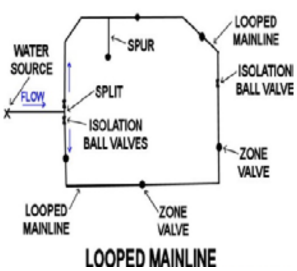
Ductile iron pipe is recommended in lieu of PVC or PVCO pipes where depth is less than one metre. PVC or PVCO pipes should be upgraded from DR18 to DR14 where depth is from 1.0 m to 1.3 m. When ductile iron is used over a short length, an additional sacrificial anode will be installed along with a test station.

When a proposed watermain is being looped over a proposed pedestrian tunnel as an example, the additional mechanical protection provided by ductile iron over PVC is recommended.

Steam Pipes near Watermains

Plastic watermains that run parallel or cross steam pipes, should be encased in a metallic sleeve. For plastic watermains that cross steam mains, the pipe segment that crosses the steam main should have a metallic sleeve upto one metre beyond the outside wall of the steam main.

Looping



Distribution mains shall be looped whenever possible to provide redundant supply and improved circulation and water quality. Staging of watermain construction in new subdivisions shall be designed in a manner that provides looping to ensure adequate circulation and fire flows during all stages of construction.

Dead ends should be avoided as much as possible by looping of mains whenever practical. Where dead-end mains cannot be avoided, they shall be a maximum 150 mm diameter, unless a larger size is needed for supply reasons, or the watermain is planned to be extended during the next phase of the development.

Taking Watermain Out-of-Service

Existing Watermain

Plug ends of all abandoned metallic mains with concrete. Plug all tees and crosses where the abandoned main connects to a main remaining in service. Remove mechanical joint valves in chambers and salvage. Abandon and bury lead joint type valves. Remove hydrants for disposal or salvage for reuse—if model complies with current standard. Remove top one metre of chamber, salvage frame and cover for future reuse. If remaining chamber is in the roadway, backfill with unshrinkable fill according to TS 13.10 or if in the boulevard area, backfill with suitable native material or Granular B Type II, according to TS 4.60.

Existing Water Service

Water services which are being abandoned should be detached at the main. In case of a driven nipple, it should be plugged or a sleeve repair used around the main to cover the nipple's hole. If it is a tee, it is to be removed and a filler piece installed. If it is a tapping valve and valve is in good condition, the valve can be shut off and the main capped.

If service connection to main is in the roadway, backfill with unshrinkable fill according to TS 13.10 or if in the boulevard area, backfill with suitable native material or Granular B Type II, according to TS 4.60.

Transmission Watermain Material Type

When selecting material types for large diameter trunk watermains, see TS 7.80 for pipe material suitability in high, medium and low risk areas.

Watermain under Railway Crossing

For railway crossings and tunnel liners see standard drawings Tunnel Liner Detail Pre-stressed Concrete Cylinder Pipe, Tunnel Liner Detail HDPE Pipe and Tunnel Liner Detail Steel or Stainless Steel Pipe, T-1110.02-1, T-1110.02-2 and T-1110.02-3, respectively.

Electrical Continuity

Install bonding cables, if the metallic watermain is cut and a new tee is installed to maintain electrical continuity. See City standard T-1106.03-2.

Line Valves

Sizing of Valves

Distribution mainline valves will be the same size as the watermain. For transmission mainline valves on 750 mm diameter mains and larger, the valve size will either be the same size or one size smaller than the main.

Number of Valves

At "tee" intersections, three valves are required and at "cross" intersections, four valves are required for new subdivisions. Similarly on arterial and collector roads three to four valves are required, while on local roads two to three valves are recommended. The location of valves should be optimized to achieve the best performance, that is to say the minimum number of valves that will be required to be shut– off for the maintenance of any given watermain.

Location of Valves

The valves will generally be located at the point where the projection of the street line intersects the watermain. However, care should be taken to ensure that the valve does not conflict with the curb and gutter. Valves should also not be located in the travelled portion of the road, if possible.

Burying Valves

When burying existing valves in the open position without a box, it is necessary to protect such valves from corrosion by using corrosion protection anodes or Denso tape wrap.

Spacing of Valves

The maximum spacing of mainline valves will be based on the diameter of the watermain.

Table 36: Spacing of valves

If diameter of watermain is …	Then maximum valve spacing is …
150 mm to 300 mm	200 m
400 mm	300 m
600 mm to 900 mm	600 m
Over 900 mm	600 mm or higher dependant on number of connections

Gate versus Butterfly Valve

Gate valves will be used on watermains 100 to 400 mm in diameter and butterfly valves may be used for watermains greater than 400 mm diameter. A butterfly valve can be used instead of a gate valve where there is a space constraint.

Direction to Open Valves

To determine the direction to open the valve in your district when you order the valve, see Appendix C, Maps.

Open Clockwise

In districts Etobicoke/York (former city of York, east of the Humber River), North York, Toronto/East York all valves supplied to these areas of the city will open by operating in a clockwise direction and the operating nut supplied will be painted in red.

Open Counter Clockwise

In districts Etobicoke/York (former city of Etobicoke, west of the Humber River) and Scarborough all valves supplied to these areas of the city will open by operating in a counter clockwise direction and the operating nut supplied will be painted in black.

Valve Box and Chambers

Valve Box for Gate Valves

All valves on watermains smaller than 400 mm in diameter will be installed with valve boxes as per City standard T-1101.02-2. The valve box will be shown on the plan and profile drawing.

Valve boxes shall be used on all water services unless they are located in a ditch or inaccessible area. In this case the valve is buried and a second valve is installed at the property line with the valve box on it.

Valve Chamber

All valves on watermains equal to or greater than 400 mm in diameter will be set in precast waterproof concrete valve chambers, according to City standard T-1101.010. Chamber size will be shown on both the plan and profile drawings.

Valve chambers will contain a sump and be drained by a 150 mm diameter drain to a storm sewer, where possible. An approved backwater valve will be installed on the storm drain. If there is no storm sewer or the storm sewer is not deep enough to drain the valve chamber, a 600 mm diameter sump will be installed in the bottom of the valve chamber to allow water to infiltrate into the surrounding soils—assuming there is no high water table.

The depth of cover at valves will be reviewed on an individual basis to ensure the operation of the valves is not compromised by excessive depth.

Chamber Space Constraints

Where there is a space constraint a butterfly valve can be used instead of a gate valve. These valves can be used on watermains between 300 to 400 mm in diameter according to City standard T-1101.030-1.

Air Valves and Drain Valves

For watermains 400 mm and larger, provisions for air release and drainage is required at the high and low points, respectively. This may be incorporated within the mainline valve chamber or in separate chamber, respectively.

Significant amounts of air can accumulate at localized high points, long stretches of flat or gently sloping watermains or at changes in grade. In these instances, an automatic air release valve will be installed inside a chamber.

For large diameter mains, drain valves positioned at low points may be required to permit main repairs. Consideration should be given to locating low points adjacent to suitable discharge locations such as near catchbasins. Drain valves at watercourse crossings will not be required. Small diameter watermains can generally be drained through hydrants using compressed air or pumping.

Zone Boundary Valves

Valves which are installed to separate pressure districts should not be opened under any circumstances due to the potential damage this may cause to properties in the low pressure district. Consequently the operating nut on zone boundary valves should be tagged and locked to prevent accidental opening. All boundary valves will be in valve chambers.

Any changes to the pressure district boundary must be approved by the General Manager, Toronto Water.

Insertion Valves

Insertion valves should only be used in isolated cases where dewatering the watermain is not feasible or advisable and must be pre-approved by Toronto Water, Distribution and Collection (Central Services) at the 60% design stage.

Any new valves to be installed at project limits or required for constructability should be cut-in valves and not insertion valve.

Valves to be installed at project limits should be referred to the corresponding construction yard for the opportunity to install them "in-house" in advance of project commencement.

The use of a tapping sleeve and valve should be encouraged in lieu of insertion valves, if possible. Lastly, the insertion valves should not be used for structurally lined watermains. Insertion valves should not be left in place and treated as a permanent valve.

Anchor Tee and Valve

The following is on the use of anchor tees for new watermain construction project.

Fire Hydrants – Short Side of Street

Install anchor tee and attach hydrant isolation valve with a 105 mm valve box to anchor tee. Fire hydrant lead will be pressure tested and chlorinated only. Not considered a branch connection, therefore no blow-off required for sampling.

Fire Hydrants – Long Side of Street

Install anchor tee and attach hydrant isolation valve with a 105 mm valve box to anchor tee. Fire hydrant lead will be pressure tested and chlorinated only. Not considered a branch connection, therefore no blow-off required for sampling.

Long side fire hydrant leads should only be used in situations where no other options prevail. An additional hydrant lead secondary valve is not required, regardless of lead length. Long side fire hydrant lead to be used in situations where no other options prevail.

Large Diameter Water Services – Short Side of Street

Install anchor tee and valve at watermain and install secondary valve at street line. Do not bury open valve at anchor tee. Install 105 mm valve box at anchor tee and 105 mm valve box at street line.

If length of services is less than 3.5 m then attach isolation valve to anchor tee at watermain. For example, in the former city of Toronto, where faces of buildings are at street line with little or no set back, it may not be possible to install street line valves, therefore anchor tee and valve would be a better option.

The rational for this rule is to be consistent with Note 1 on drawing T-1105.02-1 and T-1105.02-2. Note 1 reads as follows: "For service connections 100 mm diameter or larger, the service line valve may be located at the watermain location on the street if the length of the service connection is less than 3.5 m."

- Large diameter water services are larger than 50 mm in diameter.
- The short side water service is considered a branch connection and is part of the public watermain system to street line. The short side water service line is pressure tested and chlorinated at the same time as the main line. A blow-off will be installed and serve as a sampling point requiring two consecutive passing samples.
- Regardless of the installed location of the secondary valve, the water service shall be connected at street line to the private side water service with an approved coupling. Connection to the private water system will be completed after the public system successfully passes the disinfection test.
- At locations where there are physical obstacles at street line, the secondary valve shall have sufficient above ground clearances to allow valve operation. A one-half metre valve turning radius should be adhered to, to allow the opening and closing of the valve.

Large Diameter Water Services – Long Side of Street

Install anchor tee and isolation valve at watermain, install secondary valve at street line. Valve at street line restrained two pipe lengths only. Do not bury open valve at anchor tee. Install 105 mm valve box at anchor tee and 105 mm valve box at street line.

- Large diameter water services are larger than 50 mm in diameter.
- The long side water service is considered a branch connection and is part of the public watermain system to street line. The water service line is pressure tested and chlorinated at the same time as the mainline. A blow-off will be installed and serve as a sampling point requiring two consecutive passing samples.
- It may not be possible to install a valve at street line and then make a connection to an existing service due to a requirement for bends, couplings and filler pieces. It may be possible for new water service installations. Connection to the private water system will be completed after the public system successfully passes the disinfection test.
- At locations where there are physical obstacles at street line, the secondary valve shall have sufficient above ground clearances to allow valve operation. A one-half metre valve turning radius should be adhered to, to allow the opening and closing of the valve.

Side Street Connections – Short Side of Street

Install anchor tee and valve at watermain with a 130 mm valve box. Do not bury open valve at anchor tee. Install valve with a 130 mm valve box at a location before the existing street line valve or at street line.

In areas with heavily congested utilities, designer to provide valid reasons to Toronto Water, Distribution and Collection (Central Services) why both valves cannot be installed. Designer to confirm that the overall length of pipe is less than 6.1 m if street line valve is omitted.

Side Street Connections – Long Side of Street

Install anchor tee and valve at watermain with a 130 mm valve box. Do not bury open valve at anchor tee. Install valve with a 130 mm valve box at a location before the existing street line valve or at street line.

Isolation Valve Cover Size

Isolation valves attached to anchor tees on fire hydrants and secondary valves for large diameter water services will use a 105 mm diameter valve box with 149 mm diameter cover as opposed to line valve boxes which are 130 mm in diameter with a 184 mm diameter cover.

Fire Hydrants

Hydrant Spacing in Right-of-Way

Hydrants will be installed on 150 mm diameter and larger watermains with the following being the maximum spacing measured along the right of way.

The hydrant spacing information shown in this table can be used as a guideline for watermain replacement projects where fire flow requirements are not known. The designer shall check the related City zoning prior to proceeding with the design. At zoning boundaries the most stringent requirement shall apply. A FUS fire flow calculation shall be completed.

Table 37: Hydrant spacing in right-of-way

If use is …	Then maximum spacing is …
Low density residential use and local streets	115 m–120 m
collector streets, high density residential, commercial, industrial, mercantile, educational and institutional	90 m or 45 metres to any opening in a building
cul-de-sacs, townhouses	75 m
arterial roads	150 m

Location of Hydrant from Streetline

The location of the hydrant in relation to the street line will be in accordance with the City's typical standard road cross-section from DIPS.

Drawings DIPS-1B and DIPS-2B offset distance from hydrant to watermain will be updated in future to reflect constructability.

Table 38: Hydrant distance from street line

Street type	Right-of-way width	Distance from street line
major local street – option a	20.0 m	2.7 m
major local street – option b	20.0 m	4.5 - 0.58 = 3.92 m
intermediate local street – option a	18.5 m	2.4 m
intermediate local street – option b	18.5 m	3.8 – 0.58 = 3.22 m
minor local street – option a	16.5 m	2.0 m
minor local street – option b	16.5 m	2.0 m

In addition, use the following criteria where applicable:

- On the same side of the road as the watermain.
- Within the City's road allowance at the extension of the lot line between two lots to avoid conflicts with driveways.
- If near a driveway, hydrant will be located a minimum of 1.2 metres clear from the driveway edge —projected garage wall—in residential applications.
- Not located between the intersection "tee" or "cross" and the mainline valve.
- 5 metres away from street intersection valves on the largest pipe to provide hydrant with more volume available for firefighting.
- For watermains up to and including 300 mm diameter, hydrants will be located at high and low points to function as manual air release and drain points.
- Within 60 metres of a cul-de-sac, if one not installed.
- One metre away from an underground utility or open ditch.
- In urban areas with sidewalks extending from the curb to building face, hydrants shall be set back a minimum of 0.6 meters from the face of the curb.

The reason for placing the hydrant close to the cross or tee and on the largest pipe, is to provide hydrant with more volume of water for firefighting. In this case water flows from 3 or 4 directions to support that open hydrant flowing versus only 2 or 1 direction for hydrant spaced midway along the watermain or at a dead-end.

- In areas, typically residential, with curbside sidewalks in the range of 1.5–1.8 metres in width, hydrants should be installed behind the sidewalks and no more than 2.1 metres from the face of the curb.
- In other areas with no sidewalk adjacent to the curb, hydrants should ideally be located in the boulevard, with an ideal setback of 1.2 metres. Hydrants shall not be closer than 0.6 metres or further than 2.1 metres from face of the curb or roadway shoulder.

The above points notwithstanding, designers shall ensure that hydrants maintain minimum pedestrian clearway widths according to City standard T-310.010-10.

Any non-standard location will require individual approval and circulation of the drawings to Toronto Fire for their consent.

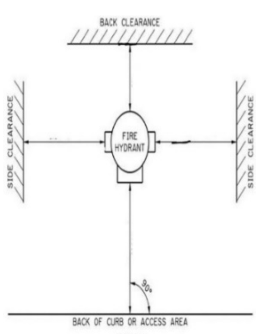
When replacing existing hydrants use the same location, if possible. If a hydrant is to be located to a new location, notify the affected homeowners prior to installation.

Isolation Valve and Box

All fire hydrants will have a 150 mm diameter lead and isolation control valve and box attached to an anchor tee. Hydrant control valves will open in the same direction as the mainline watermain valve and be a minimum of one metre away from the fire hydrant. If the isolation valve is positioned next to the watermain, attach it to the anchor tee.

If the isolation valve is separated from the watermain, restrain the valve, hydrant and all joints in between. For details and additional design information, see City standard T-1105.01. Hydrants will not be placed on watermains greater than 400 mm in diameter.

Above Ground Clearances



The minimum clearance from above ground obstructions to a fire hydrant will be as follows:

- behind—1.2 metres
- each side—1.2 metres
- front—clear to the curb line

Protection from Damage

Hydrants located adjacent to parking areas, vehicle traffic areas or in areas without curbing will be protected by bollards or guard posts. The bollards must be located so they are not directly in front of a nozzle cap.

The posts should be of 150 mm diameter steel pipe positioned at least 1.2 metres from the hydrant, cemented in the ground vertically, buried at least 0.6 metre below grade and exposed by at least 0.9 metre above ground. The post will be filled with soil or concrete and capped with concrete. Upon cement curing, the posts will be painted with reflective safety yellow enamel for ease of visibility.

Markings

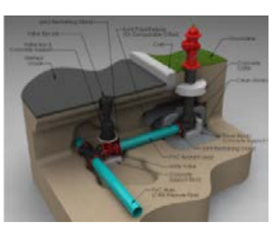
Hydrants will be colour coded in accordance with NFPA 291 "*Fire Flow Testing and Marking of Fire Hydrants*." Accordingly, barrels are to be chrome yellow. Coloured hydrant flow identification disks shall be installed by Toronto Water staff on each side nozzle of the hydrant to visually identify the rated flow capacity of the hydrant.

- AA—rated capacity of 5680 litres/minute or greater—blue
- Class A—rated capacity of 3785–5675 litres/minute—green
- Class B—rated capacity of 1900–3780 litres/minute—orange
- Class C—rated capacity of less than 1900 litres/minute—red

Rated capacity is measured at 140 kilopascals residual pressure.

Dead-Ended Watermains

Where the road is not designed to be extended in the future, all dead-ended 150 mm diameter and larger watermains will not use a blow-off but have a hydrant installed at the end for bleeding, charging, and flushing of the watermain.



Fire Hydrant Leads

Hydrant leads will be PVC regardless if the new watermain is PVC or ductile iron, except in the following cases:

- Ductile iron leads will be used under TTC subway or railway tracks to overcome stray current.
- In situations where there is low cover such as pedestrian tunnels where the watermain is shallow, it is recommended to use ductile iron or metallic pipe.

Municipal Water Service Connections

Water service connections will be sized based on:

- peak water consumption of the building serviced
- length of service to reach the building
- available pressure in the watermain and the relative elevation of the building being served

The size of a water service will be a minimum of 19 mm diameter for single residential connections. If the distance is greater than 30 metres to the existing building face, the water service shall be replaced with a 25 mm diameter copper service.

All water service installations will comply with the City's fee schedule for the service diameter installed. Commercial, industrial, and institutional water service connections will be sized according to the intended use. All service connections will be constructed in accordance to City standard T-1104.01, T-1104.02-1, T-1105.02-1 and T-1105.02-2.

Water services 100 mm in diameter and larger should be installed at the same time as the main line with a new valve at street line. This will allow the service to be pressure tested and disinfected at the same time as the main line watermain.

When the watermain is ductile iron, the service connections will be metallic—that is copper or ductile iron.

All water services must be installed with a minimum of 1.8 metres of cover or no more than 2 metres of cover from the final surface grade.

Building Higher Than 84 Metres

In accordance with Ontario Building Code, Section 3.2.9.7, if the building(s) is 84 m or more high, measured between grade and the ceiling level of the top storey, the building(s) shall be served by not less than two sources of water supply from a public water system. The City requires that if two separate watermains are available to service the development, then the applicant must connect to each watermain. Where there is only one watermain available to service the development, the applicant can connect two service connections to the same watermain however an isolation valve is required to be installed between on the watermain between the two connections.

If a building 84 m or more in height is proposed on a street with a dead end watermain, the applicant shall install a second watermain so there is a second source of water to supply the building.

Sizing Water Service Line

For sizing large diameter water services, see AWWA Manual M22 Sizing Water Service Lines and Meters.

Coupling on Water Services

As a rule of thumb, allow for one coupling to facilitate cut and reconnects and cut and extensions. In the event there are more than two couplings, the recommended practice is to replace the entire water service.

Electrical Ground

When the watermain is PVC, the service connection—25 millimetres and less—will be plastic or copper. If the water service is plastic, a grounding electrode must be installed as per the Ontario Electrical Safety Code.

The use of water services as an electrical ground will comply with the Ontario Electrical Safety Code.

Fire Line and Domestic Service Connections

Domestic connections off a fire line can be made. The size of a domestic service is to be one size or smaller than the fire service line.

Table 39: Fire line and domestic service connection sizes

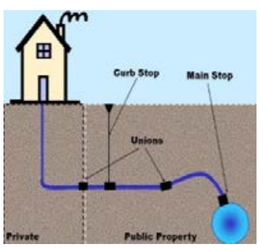
Fire service size (mm)	Maximum domestic size (mm)
300	250
250	200
200	150
150	100
100	50

For details and additional information, see City standard T-1104.02-3.

Restraints

All 100 mm diameter and larger water service connections, including the valves, bends and fittings will be fully restrained from the watermain pipe to the property line. If there are more than two consecutive pipe joints, the necessity of installing restraints will be reviewed on an individual case-by-case basis.

Water Service Valving



For services 50 mm and smaller, all services will have main stop adjacent to the watermain buried, and a valve installed at the property line, complete with curb stop and a service box provided to finished grade. For details and additional design information see City standard T-1104.01 and T-1104.02-1.

For services larger than 50 mm, go to the Anchor Tee and Valve section.

Service Connections to Transmission Mains

No service connections will be allowed to connect to a transmission watermain under the jurisdiction of the water supply unit. Generally transmission watermains are 600 mm in diameter and larger.

Service Connections inside Easements

Water service connections to distribution watermains within easements will not be allowed unless an exemption is provided by the General Manager, Toronto Water. A Water and Sewer Services Installation Agreement stipulating the conditions of the encroachment will be required for all water service connections.

Backflow Prevention

Where there is a risk of contamination at a property, such as non-potable water, wastewater, or any other liquid, chemical or substance entering the waterworks that may affect the quality of the water supply, the owner of the property will install a backflow prevention device.

Backflow prevention devices will be selected, supplied, installed and tested at the owner’s expense in accordance with Water Supply Bylaw, Chapter 851 of the Toronto Municipal Code, Ontario Building Code, CSA B64 and NFPA 13/14 standards and specifications.

For more information related to back flow prevention devices for private water services, go to the Water Servicing and Metering Manual.

Fire Service Main

Fire service mains must be metered to detect underground leakage or help locate illegal taps in accordance with the water supply bylaw. A CSA approved detector assembly should be installed in accordance with CSA B64.10 series standard. The device must have the ability to accept a positive-displacement type meter.

Typically, the assembly comes pre-installed with a water meter. If the meter is not an approved water meter, Toronto Water will supply its own meter which the owner will install on the detector assembly's bypass.

The required detector assembly on the fire service is determined based on the fire sprinkler or standpipe classification as found in Section 7.6.2.4, Backflow from Fire Protection Systems, of the 2012 Ontario Building Code and Section 5.5 of the CSA B64.10 series standard.

If the building code and CSA B64.10 series standard requires a double check valve assembly for the fire service then the bylaw requires it to be a double check detector assembly.

Alternatively, if a reduced pressure principal assembly is required by the building code or CSA B64.10 series standard, then it should be a reduced pressure detector assembly.

It should be noted that a reduced pressure detector assembly cannot be installed below grade in a vault or chamber.

Corrosion Protection

All metallic components of the water distribution system will be protected from corrosion directly, by using approved protective coatings or indirectly, by means of sacrificial anodes or distributed impressed current systems. Microcrystalline wax and petrolatum tape coating system shall be according to OPSS.MUNI 442.

The pipe-to-soil potential should be less than -850 millivolts for the pipe to be adequately protected.

Cathodic Protection of Plastic Mains

All plastic mains with directly buried metallic fittings including bends, tees, crosses, valves, and hydrants and each copper service pipe will be cathodically protected by the installation of a sacrificial anode of the specified size and type. For details and additional design information see City standard T-1106.04 and TS 7.22.

Electrical Continuity

Ductile iron watermains will be connected with copper bond cables at each joint to ensure continuous electrical continuity throughout the watermain system.

If an existing metallic watermain is cut and a filler piece is replaced with PVC, electrical bonding of the existing metallic watermain on either side of the PVC filler piece will be electrically bonded according to City standard T-1106.03-2.

Soil Resistivity and Corrosiveness

As part of the geotechnical report, the resistivity and corrosiveness of the soil must be determined. Where metallic watermains are to be installed, an appraisal must be done to determine if corrosion protection is required. This appraisal will be performed using a 10–point soil evaluation procedure as described in AWWA C105. If the appraisal establishes a need for corrosion protection, the anode spacing will be clearly shown on the construction drawings.

Tracer Wires

Tracer wires will be installed on all non-metallic watermains along the full length of the pipe to provide a means of locating the main. For details and additional design information, see City standard TS 7.40.

Electrical Grounding

On reconstruction projects or local improvement projects where existing structures will be serviced by a replacement or new water distribution system, the engineer will determine if the electrical grounding systems are connected to the water service. If so, appropriate measures must be taken to ensure that electrical grounding systems are not compromised. Possible solutions include using copper services or installing new grounding rods or plates.

Watermains and water services will not be used as an electrical ground in new buildings without verifying the electrical continuity.

PVC Pipe in Contaminated Soil

When choosing a watermain material for installation in contaminated soils containing volatile organic compounds (VOC), the following should be considered.

Subject to proper identification of contaminants and in consultation with the pipe manufacturer as per AWWA and CSA

B137, thermoplastic pipes with nitrile gaskets will be used if the volatile organic compound—organic solvents and petroleum products—is low in concentration and if, based on proposed land use, no further contamination is likely to occur in the subject area.

Thermoplastic pipe shall not be used in soil with high volatile organic contamination—organic solvents and petroleum products—or in areas with a high risk of contamination such as near buried petroleum fuel tanks, gas stations and petro storage areas. As an alternative, metal pipes with nitrile gaskets will be used.

Toronto Transit Commission

PVC and Ductile Iron Pipe near TTC Street Car Tracks

New or replacement watermains which are parallel and within the same road allowance as Toronto Transit Commission (TTC) street car tracks can be PVC, PVCO and ductile iron pipe including service pipes. Ductile iron pipes will be adequately cathodically protected. In case of using PVC pipes near TTC tracks it is recommended to upgrade pipe dimension ratio or pipe wall thickness from DR18 to DR14.

Stray Current Prevention

The primary source of stray current is the TTC electrified rail system. Drainage bonds and blocking diodes are used to provide a unidirectional return path for any stray direct current (DC) picked up by a watermain by connecting the watermain to the negative pole of the DC source. This metallic connection will have a lower resistance than the alternative earth return path. This method of "drainage" is one of the techniques used in stray current corrosion protection.

When working near one of the 55 TTC substations make sure the drainage cable is not accidentally disconnected.

Suspended Watermains

Suspended watermains will require approval from the owner of the superstructure. For additional information on the limitations for their use, refer to section *Depth of Cover, Watercourses* in this chapter.

Suspended watermains from bridges will be properly insulated. The thickness of the insulation will be a minimum of 50 mm or as approved by the consulting engineer. Pre-insulated high density polyethylene pipe (HDPE) may be used for external bridge crossings.

Water Meters

The terms and conditions under which water meters will be installed are set out in the City's Water Supply Bylaw, Chapter 851 of the Toronto Municipal Code. The City is responsible for installing a water meter on all new or replacement residential water services unless other arrangements with the builder have been agreed to by Toronto Water.

Generally, residential water meters will be sized one size smaller than the diameter of the service pipe installed, unless supported by calculations.

- 38 mm service receives a 25 mm x 38 mm water meter
- 25 mm service receives a 19 mm x 25 mm water meter
- 19 mm service receives a 16 mm x 19 mm water meter

For 50 mm and larger water services, provisions should be made in the piping system for the installation of a water meter of the same diameter as the private system. The sizing of the water meter will be such that the accuracy of the low flow measurement is optimized while ensuring that the rated supply to the property is not adversely affected.

Watermain Replacement

There are two basic approaches that can be taken when replacing watermains.

Design Approach One

Install a new watermain system in a parallel location. The new system also includes the installation of new fire hydrants, valve boxes or chambers, valves, and water services. This method allows the existing system to remain in service until the new watermain is disinfected and the new services are transferred to the appropriate homes or businesses.

The old system is taken out of service and decommissioned by capping the ends, removing the valves; breaking down the valve chambers approximately one metre below grade and filling the remaining valve chamber with unshrinkable fill. If the new system is to be installed in the boulevard and mature trees are in the direct path of the proposed watermain, the watermain should be installed by a trenchless method to minimize the impact on the trees.

Design Approach Two

Remove the existing watermain and replace it with a new system in the same location. The new system also includes the installation of new fire hydrants, valves and water services. Valve chambers must be inspected to determine their condition and if found to be satisfactory, may remain in place.

This method requires the installation and disinfection of a temporary by-pass watermain and temporary services. The new system is disinfected and new water services are connected to the appropriate homes or businesses.

The approach in order of preference from most desirable to least desirable is as follows:

1. New watermain system in a parallel location. Location of the new watermain is in the boulevard area on the same side as the existing fire hydrants.

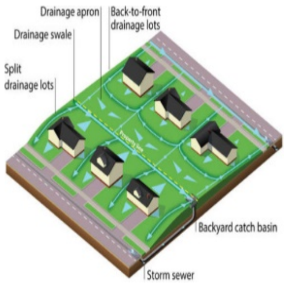
2. New watermain system in a parallel location. Location of the new watermain is in the pavement area on the side closest to the existing fire hydrants.

3 New watermain system in parallel location. Location of the new watermain is in the boulevard area on the opposite side of the existing fire hydrants.

4 New watermain system in parallel location. Location of the new watermain is in the pavement area on the side farthest from the existing fire hydrants.

5 Remove the existing watermain and replace it with a new system using a temporary by-pass system. The new system is installed in the same location as the old system.

Chapter 5 – Lot Grading



When a lot grading plan is required as part of a plan of subdivision, the drawing will be titled "*Subdivision Grading and Building Siting Control Plan*" as per Section 12 of the subdivision agreement at the time of the engineering drawing submission. The plan will indicate the lot grading information based on the lot grading criteria and it will indicate the siting of the proposed houses and the driveway locations. The driveways should be located to meet the objectives of the residential vehicle parking bylaw, have adequate clearance from utilities and existing trees, and permit safe vehicular access.

The lot grading criteria outlined in this chapter also applies to site plan applications.

The grading plan will be reviewed by the development engineering section of Engineering and Construction Services to verify that it agrees with the engineering plan submissions and appropriate specifications. This plan must be reviewed and accepted at the same time as the other engineering drawings.

Information to Show

The following information will be shown on the lot drainage and house siting control plan:

Location Information

- Indicate the north arrow on the plan.
- Key plan showing the site or proposed development. For larger subdivisions, show the location of the lots on the street in relation to the overall development.
- Description of the nearest geodetic bench mark and site bench marks. Refer all elevations to a geodetic city benchmark.
- Show all existing and proposed lot numbers and blocks.
- All existing and proposed easements within the site plan or subdivision.

- Indicate type of lot drainage on the plan. For example:
- FS – front split
- F – front drainage
- BS – back split drainage or WO – walkout
- R – rear
- Indicate finished floor elevations for each dwelling on site development plans.
- Plans should be on a standard metric A 1 sheet (594 mm x 841 mm) with a scale of 1:250.
- Show a table for a list of revisions above the title block.

Existing Information

- Existing ground contours at half metre intervals over the entire subdivision and sufficient area of adjacent lands to establish the overall drainage pattern.
- Show direction of existing flow outside boundary perimeter.
- Along the perimeter of the development lands, existing ground elevations obtained by an actual field survey, will be shown at the lot corners of all existing abutting properties and along two additional lines parallel to the subdivision perimeter lot line—at approximately 3 metres and 6 metres from the perimeter lot line—into the adjoining property.
- If the adjoining property is large, then existing ground elevations along the common property line and along three parallel lines—distant 5 metres, 10 metres, and 15 metres from the common property line—within the adjoining property, taken at a minimum spacing of 15 metres will be shown, as well as at all locations where the ground topography changes abruptly.
- Show location of all road catchbasins, maintenance holes, hydrants, street lights and hydro vaults, utility poles, telephone boxes and cable boxes.

- Show all sidewalks and curbs.

- Show existing trees to be preserved and above ground utility structures and other structures as necessary.

Proposed Information

- Show proposed ground elevations at all lot corners and at intermediate points for change in grade. On large blocks, proposed ground elevations at 15 metres spacing along the frontage of the block and at reasonable spacing along the sides and rear of the block will be shown.

- Show proposed ground elevations at the front of all dwellings on the proposed lots. For split type drainage patterns where the elevation at the rear or side of dwelling will vary by more than 0.4 metre from the elevation at the front of the dwelling, the proposed ground elevation at the rear or side of the dwelling will also be specified.

- Show minimum basement floor elevations of the proposed dwellings. Minimum basement floor elevations will be calculated based on the elevation of the sanitary or the storm connections. For all practical purposes such as when the hydraulic grade line is not known and unless the design of the services indicates special consideration for the service connections, the generally accepted practice is that the minimum basement floor elevation is 1.7 metres lower than the centerline of the road at the location of the service connection.

- Proposed road centre line elevations at all changes in grade, at all intersections, and opposite each proposed lot and block corner. If the frontage of the blocks is greater than 45 metres, proposed centerline road elevations at 15 metres spacing will be provided.

- Show proposed road grades, lengths, and elevations on all streets with symbols at grade changes, indicating direction of slope.

- Show a driveway envelope from the street line to the proposed curbs or edge of the traveled surface of the road.

- Location of any proposed private rear yard catchbasins, leads and the top of grate elevations and inverts.

- Typical sections for all proposed drainage courses and swales.

- Typical details of proposed drainage types of the lots.

Spot Elevations

Proposed spot elevations will be shown at the following locations on the development site plan:

- the four corners of each row of parking spaces
- change in pavement materials
- change in slopes
- centre of driveways
- top of catchbasins and maintenance holes
- building entrances
- top and bottom of curb in front of a building entrance
- beginning and ending of any radius, crest or drainage divides
- a minimum of three spot elevations along each property line or lot line greater than 10 metres in length.

Driveways

For residential site plans where a driveway is reconstructed, expanded, or proposed, spot elevations must be shown along both sides of the driveway, at the centre of the driveway three metres from the property line, at the property line, at the sidewalk closest to the road and at the existing gutter of the curb.

Reverse Grade Driveways

The City prohibits the construction of reverse driveways. For existing reverse driveways, their drainage will comply with the Sewer Bylaw, Section 681-11-O of the Toronto Municipal Code.

For report submission guidelines for reverse slope driveways, see Appendix F, *Reverse Slope Driveway Guidelines.*

Landscape Features

- show limits of landscape features
- top and bottom of slopes
- minimum of four spot elevations around base of a landscape feature, such as a berm
- beginning and ending of a ridge or depression of a feature and any intermediate points
- show grading contours

Other Information

- The consulting engineer will determine if there is an approved development application on adjacent vacant lands and shall co-ordinate the grading with the consulting engineer of the adjacent development, so as to match proposed and existing grades.

- Show any additional plans, sections and details for drainage courses and erosion protection, steep topography, screening, and noise abatement features as may be required.

- All existing and proposed slopes and embankments showing top and bottom of the slope or embankment elevations and degree of slope, for example 3:1.

- Drainage arrows showing the direction of surface drainage on all lots and blocks.

- Drainage arrows indicating the route of the major storm overflow.

- Location, details and x-sections of any retaining walls.

- Percent grades shown to one decimal place.

Lot Grading Requirements

Grading plan will show the existing and proposed grading of lands within the plan of subdivision or site plan to ensure that proper drainage within both the lands being developed and adjacent lands, are not adversely affected.

All areas shall be graded in such a way as to provide proper drainage and maximum use of land. Drainage flows shall be directed away from houses.

Storm drainage is to be self-contained within the subdivision or development site limits. There may be pre-existing conditions where drainage may need to be accepted from surrounding lots.

Rear Yard Slope

The average slope of rear yard surfaces will not exceed 10 percent and will be measured by dividing the elevation difference by the measured distance using one of the following three methods:

1. From the rear of the house to the rear lot line, or

2. From the rear of the house to the lowest invert elevation of the rear swale, and

3. From side lot line to side lot line over the full width of the lot.

Should the average slope exceed 10 percent, the City will require construction of a retaining wall to reduce the average gradient to an acceptable amount.

No alterations to existing boundary elevations or adjacent lands will be undertaken unless a written agreement with the adjacent property owner is obtained and submitted in a format acceptable to the City.

In most cases, each lot will be designed to drain independently. Drainage to a nearby street through the rear of an adjacent lot is not permitted, unless the adjacent lot is part of the same development. However, for lots where “zero lot line” zoning is permitted, drainage to a nearby street through the rear of an adjacent lot is not permitted.

Rear Yard Drainage

Through draining lots will only be considered where lots backing onto each other have common rear lot corners and there is no change in direction of the matching side lot lines. The drainage rights should be registered on title for any affected properties.

Swales

Swales will have a

- minimum slope of 2 percent
- maximum slope of 5 percent
- minimum depth of 150 mm
- maximum side yard depth of 300 mm
- maximum rear yard depth of 400 mm
- maximum side slope is 3:1
- side slopes greater than 5 percent or 2:1 side slopes should not be used in order to maximize the usable areas in the backyard.

Sod cannot be maintained on side slopes greater than 3:1, therefore side slopes steeper than 3:1 will not be permitted.

The maximum side slope between houses in any direction will be 3:1. If these objectives cannot be met, steps or retaining walls will be required.

All swales having a velocity in excess of 1.5 metres/second will be designed to incorporate erosion protection.

Drainage flows which are carried around houses are to be confined in defined swales located as far from the house as possible. The depth of these swales should be held as close to the minimum of 150 mm.

The alignment of swales will not change more than 45 degrees. If this occurs, additional catch basins may need to be installed.

For lots less than 15 metres in width, rear yard swales will not exceed 50 metres in length.

Maximum Swale Flows

The maximum flow allowable in a side yard swale will be that volume contributing from a drainage area of half hectare or three backyards—where lot widths are 15 metres or greater, whichever is less.

The maximum flow allowable in a rear yard swale will be that volume contributing from a drainage area of half hectare.

The maximum flow in any swale, which may discharge directly onto any road allowance, will be that from a maximum area of half hectare of contributory area. Areas in excess of half hectare necessitate installation of an inlet structure to intercept run-off prior to its entering the road allowance.

For infill developments where lot widths are small, no rear yard swale will exceed 50 metres in length.

The maximum distance from any rear lot line to the centre of any rear lot swale will be one metre.

Residential Driveways

The minimum slope on any driveway will be 2 percent. The recommended maximum slope on any driveway will be 4 percent.

Proposed driveway slope in excess of 4 percent will only be considered upon the receipt of written justification for the owner’s consulting engineer. The maximum slope on any driveway will be 8 percent.

Driveway slopes will be calculated based upon the back edge of a sidewalk constructed at the City’s standard location and elevation, regardless of whether or not the sidewalk actually exists. For up grade slopes, see OPSD 351.010.

Boulevard Areas

The boulevard area will have a 2 to 4 percent slope within the right-of-way.

Transition Slopes

Transition slopes located adjacent to property lines will be constructed such that the top of slope is adjacent to the property line.

Transition slopes between 5 percent and 33 percent or 3:1 will not be used to maximize usable land.

Transition slopes will not be located within the side yard area between dwellings, except for walkouts. Within the rear yard area, transition slopes will be offset 0.6 metre from the property line to maintain common side yard or rear yard swales.

The maximum vertical grade transition across a front or rear yard will be 1.2 metres. For walkout lots, the maximum vertical grade transition within the side yard between dwellings will be 2.5 metres.

Three to one slopes will not exceed a maximum height of 0.6 metre within the rear yard area. Two transition slopes may be used, one offset from each property line to accommodate grade transitions exceeding 0.6 metre within the rear yard area.

Retaining Walls

Retaining walls will be constructed entirely on the upper property so that tie backs, if required, do not encroach onto adjacent properties.

If a retaining wall is required, a detailed drawing showing location and cross section of the design will be submitted for approval. If the retaining wall exceeds one metre in exposed height and is adjacent to space used by the public, adjacent to access points to a building or private property to which the public is admitted, a building permit will be required. You will have to contact Toronto Building to determine the review, certification, permit issuance and inspection process. Retaining walls greater than 1000 mm in height will require guards according to OBC 4.4.3.1. Retaining walls greater than 1000 mm in height as designated by OBC 1.3.1.1 (1) a) will require a structural design sealed, signed and dated by a professional engineer licensed to practice in the province of Ontario. The proposed retaining wall detail will show off-sets to lot lines, length, height, sufficient top of wall and footing elevations, wall material type, drainage ports, bedding and backfilling requirements

Retaining Walls in the Road Allowance

No retaining walls are allowed in the road allowance. If an encroachment is granted, the City does not accept wood retaining walls.

Catchbasins

Front yard catchbasins are not permitted and will not be specified. Catchbasins in reverse driveways are acceptable. However, reverse slope and below grade driveways are susceptible to surface flooding in low lying areas and should be discouraged. For report submission guidelines for reverse slope driveways, see Appendix F, *Reverse Slope Driveway Guidelines.*

All rear lot catchbasin leads will be concrete encased. A cleanout at street line is not required by the City, but could be installed at the request and cost of the owner.

For a single property that drains to the front road allowance, the rear lot catchbasin and lead will be constructed entirely within the property.

The maximum offset from the centre line of any catchbasin to any rear lot line will be 1.5 metres. The minimum offset will be 0.9 metre.

The offset from the centre line of any catchbasin lead to any side lot line will be 0.60 metre.

Catchbasin leads crossing multiple properties should be discouraged during the review phase. Use only if no alternative is available.

The catchbasin frame will be set at the elevation of the invert of the lowest swale.

In cases where a catchbasin is constructed on one property and its lead is constructed passing through another or other properties, a 3 metres wide maintenance access easement from the municipal road allowance to the catchbasin is required over the properties. This easement will be a private easement and not a municipal easement.

Catchbasins in Parking Lots

Catchbasins in parking lots will not be located within parking spaces but within the drive lanes. Consideration should be given to increasing the inlet capacity for low points where there is an increased possibility of debris accumulating.

The maximum water ponding depth in parking lots will be 0.3 metre.

Fencing

Any house or lot fronting or abutting on any street may make an application for a permit to construct and maintain in any portion of the boulevard abutting a house or lot, a fence which complies with the following criteria:

A fence is to be no more than 1.9 metres in height where it is not located beyond the front wall of a building and one metre in height in front of a building and does not present a hazard to the public or interfere with any public utility use or proposed use.

The fence will be set back a minimum of 0.46 metre from the rear edge of the sidewalk or a minimum of 2.1 metres from the curb where no sidewalk is present. The footings for the fence which are located within the street allowance will not exceed a depth of 0.61 metre.

For more information on fences and retaining walls, see Toronto Municipal Code, Chapter 629, Property Standards.

Fencing on Private Property

For more information on fences on private property, see Chapter 447, Fences of the Toronto Municipal Code and any conditions set out in Section 21–Fencing and Barriers in the subdivision agreement.

Grading Constraints

Provide a 0.6 metre wide flat access strip at a 2 percent slope along at least one side of the building where side yard setbacks permit—usually along the garage side or side door entrance. This stipulation is in addition to the 150 mm apron required around buildings and is needed to permit the construction of a walkway to the rear of the house.

An undisturbed flat area having a width of half metre will be provided at the boundary limits adjacent to other properties in order that the existing boundary elevation will be maintained. No filling or regrading on adjacent lands will be permitted unless written permission is obtained from the affected owner.

Clear stone rather than topsoil and sod is required for combined side yards between two buildings which are less than 1.2 metres apart. For side yards greater than 1.2 metres, clear stone may be required at the discretion of the City.

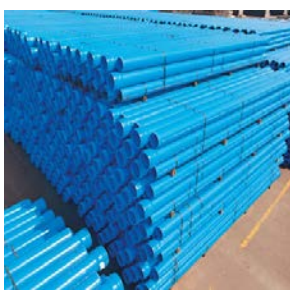
Chapter 6 – Material Specification

Materials incorporated in the finished work and used during construction shall be according to the standards and specifications specified in this chapter. Alternate materials will not be permitted without written consent of the General Manager, Toronto Water.

Watermain Pipe

Ductile Iron

Ductile iron (DI) pipe shall be manufactured according to AWWA/ANSI standard C151/A21.51, Pressure Class 350 in sizes 150 mm up to and including 600 mm diameter, with standard cement lining thickness according to AWWA/ANSI C104/A21.4. Ductile iron pipe shall be installed with polyethylene encasement according to AWWA/ANSI C105/A21.5.



Polyvinyl Chloride

All polyvinyl chloride (PVC) pipes ranging in size from 100 mm through 600 mm in diameter, will be Pressure Class 235, DR 18 and manufactured according to AWWA C900, certified to CSA B137.3 and have the same outside diameter dimensions as cast iron.

Molecularly Oriented Polyvinyl Chloride

Molecularly oriented polyvinyl chloride (PVCO) pipes, ranging in size from 100 mm through 450 mm in diameter and manufactured according to AWWA C909, certified to CSA B137.3.1 and certified as compliant with NSF/ANSI standard 61. Piping shall be pressure class 235, have cast iron outside dimensions, colour coded blue and be biaxially oriented, that is to say molecular orientation in two directions.

High Density Polyethylene

Where high density polyethylene (HDPE) pressure pipe is specified and approved by the engineer for situations of specialized installations, it will have ductile iron or gray pipe outside diameter, co-extruded blue or blue stripe in colour and meet the requirements of OPSS.MUNI 1842.

Concrete Pressure Pipe

Prestressed concrete pressure pipe, steel cylinder type shall be manufactured according to AWWA C301 for pipe diameters 600 mm and larger. Concrete pressure pipe, bar-wrapped, steel cylinder type shall be manufactured according to AWWA C303 for pipe diameters 400 and 500 mm.

Fittings shall be manufactured according to AWWA C301 and AWWA C303. Concrete pressure pipe and fittings will be joined using rubber gaskets and approved joints as outlined in the manufacturer's installation guide and AWWA C301 and AWWA C303. All joints shall be protected on the exterior using diapers and grout.

Thrust restraint will be provided through the use of restraining joints approved and supplied by the manufacturer.

Reinforced concrete bedding may be required for large diameter pipes which have welded joints.

Horizontal Directional Drilling

TerraBrute and Cobra Lock for PVC pipes and HDPE are approved for use on horizontal directional drilling.

Appurtenances

Special Fittings

Metallic

Ductile iron compact fittings shall be according to AWWA/ANSI C153/A21.53. Rubber gasket joints, fittings will be supplied with mechanical joint or push-on joint type ends according to

AWWA/ANSI C111/A21.11. All special fittings will be cement lined according to AWWA/ANSI C104/A21.4.

Non-Metallic

PVC fittings shall be according to AWWA C907. PVC fittings shall be used with PVC pipe only, having cast iron outside diameter dimensions, DR 18, Pressure Class 235, certified to CSA B137.2. PVC fittings will be supplied with push-on rubber gasketed joints in nominal sizes 100 mm through 300 mm.

Transition Couplings

Transition couplings—100 mm and over—shall be according to AWWA C219.

All couplings must be coated with fusion bonded epoxy according to AWWA C213 and supplied with stainless steel nuts, bolts, and non-corrosive washers. Transition couplings will be supplied with rubber gaskets shall be according to AWWA/ANSI C111/A21.11.

Flanged Transition Coupling Adapters

Flanged transition—100 mm and over—coupling adapters shall be according to AWWA C219.

All flanged coupling adapters must be coated with fusion bonded epoxy in accordance with AWWA C213 and supplied with stainless steel nuts, bolts, and non-corrosive washers. Flanged coupling adapters will be supplied with rubber gaskets manufactured according to AWWA/ANSI C111/A21.11.

Joint Restraint Devices

Joint restraints used on PVC pressure pipe, shall be according to AWWA C900 and must adhere to ASTM F1674 and ULC standard testing procedures. Approved manufacturers are:

- Uni-Flange Series 1300–C, 1350–C, 1390–C
- Ebba Iron Series 1600, 2000PV, 2500
- Romac Grip Ring
- Clow Tyler Union PVC TUFGrip

- Star PVC StarGrip 4000P, 4100P, Series 1000CP, 1100C, 1200C
- Sigma One-LOK Series SLCEP, PV-LOK Series PWP, PVPF, PWPF
- SIP Industries EZGrip Series Models EZPVC and EZPVCU

Joint restraints used on ductile iron Class 52 pressure pipe, shall be according to AWWA/ANSI C151/A21.51 and must adhere to ULC standard testing procedures. Approved manufacturers are:

- Uni-Flange Series 1300, 1390, 1400
- Ebba Iron MegaLug Series 1100, 1700
- Romac Grip Ring
- Clow Tyler Union Ductile TUFGrip
- Star StarGrip Series 3000P, 3100P, 3100S
- Sigma One-LOK Series SLDEH, SSLDP
- SIP Industries EZGrip Series Model EZD

Joint restraints used on PVCO pressure pipe, shall be compatible with both C900 and Bionax. Recommended products are:

PVCO Pipe to PVC Fitting 100 mm to 300 mm

- Clow 360c
- Ebba Iron Series 2600
- Sigma PV-Lok PWPF
- Star PVC 3500PF with 1200 Series
- Uni-Flange Series UFR 1369
- SIP Industries EZGrip Series Model PTPFC

PVCO Pipe Standard Bell and Spigot Push-On Joints 100 mm to 300 mm

- Clow 390c
- Ebba Iron Series 1900
- Sigma PV-Lok PWP
- Star PVC 3500C Series
- Uni-Flange Series UFR 1399
- SIP Industries EZGrip Series Model PTPPVC

PVCO Pipe to Mechanical Joint Fitting 100 mm to 300 mm

- Clow 300c
- Clow TUFGrip
- Ebba Iron 19MJ00
- Sigma PWM
- Sigma One-Lok SLC
- Star PVC 3500 Series
- Star PVC 4000 Series
- Uni-Flange 1500
- SIP Industries EZGrip Series Models PTPDF, EZPVC and EZPVCU

Adapter flanges used on PVC pressure pipe, shall be according to AWWA C900 and must adhere to ASTM F1674 and ULC standard testing procedures. Approved manufacturers are:

- Uni-flange Series 900–C
- Ebba Iron Series 2100
- SIP Industries EZGrip Series Model FAPVC

Adapter flanges used on ductile iron Class 52 pressure pipe, shall be according to AWWA/ANSI C151/A21.51 and must adhere to ULC standard testing procedures. Approved manufacturers are:

- Uni-Flange Series 800, 1400
- Ebba Iron Series 1000, 2100
- Robar 7404/7506
- Romac FCA 501
- Smith Blair 912
- SIP Industries EZGrip Series Model FADP

Gate Valves – 100 mm to 400 mm

All valves shall be according to AWWA C509 or C515. Approved manufacturers for valves in sizes 100 mm to 400 mm inclusive, shall be:

- Mueller resilient seat gate valve A2361
- Clow resilient seat gate valve F-6100
- AVK resilient seat gate valve Series 65 – upto 300 mm
- AVK resilient seat gate valve Series 45 – upto 400 mm

- Clow McAvity II–figure 20075

All valves will have inside screw non-rising spindle, complete with mechanical joint ends. Valves specified to open right must be supplied with 'Toronto Operating Nut' and valves specified to open left must be supplied with 50 mm square operating nut. To determine the direction to open the valve in your district, see Appendix C, Maps.

All valves must be coated with fusion bonded epoxy in according to AWWA C550. All unprotected nuts and bolts used in the bonnet and valve stem assembly will be made of stainless steel. All 100 mm diameter valves must be supplied with a stainless steel stem.

Valve tie downs to be pre-fabricated as manufactured to City specifications, as approved by the engineer.

Valve tie downs to be galvanized and supplied with stainless steel nuts and bolts.

Tapping Sleeves and Valves

All valves will be manufactured according to AWWA C509 or C515. All valves are to have inside screw non-rising spindle, 50 mm square operating nut, complete with a flanged end with a male spigot and a mechanical joint at the other end. Direction to open valve clockwise or counter clockwise is district specific. To determine your requirements, see Appendix C, Maps. All valves must be interior coated with fusion bonded epoxy according to AWWA C550. All unprotected nuts and bolts, used in the bonnet and valve stem assembly will be made of stainless steel. All 100 mm diameter valves must be supplied with stainless steel stem.

Approved manufacturers for tapping valves will be:

- Mueller resilient seat gate valve T-2360
- Clow resilient seat gate valve F-6114
- AVK resilient seat gate valve Series 45
- Clow McAvity II–20695

Tapping sleeves for ductile iron, cast iron, polyvinyl chloride, and asbestos cement pipe will be:

• Robar	6606
• Ford	all stainless steel (FAST)
• Romac	SST 304
• Mueller	H615 s/b H-304

All tapping sleeves will be stainless steel and supplied with stainless steel nuts and bolts and non corrosive washers. Size of tapping sleeves must provide a full seal around the outside circumference of the pipe. Size of tapping sleeves must have a longer body as specified by the engineer.

Air Valves

Air valves are to be 25 mm, 50 mm, and 100 mm and shall be:
Valmatic 15 A.3
Golden Anderson
Empire

Note: Mueller A206 main stop must be used

All air valves must be coated with fusion bonded epoxy according to AWWA C550 on both interior and exterior surfaces and supplied with a ring check valve T480Y–13 mm pressure tested to 1725 kilopascals.

Valve Boxes

Valve box on watermains less than 400 mm in diameter will be 130 mm, regular style, slide type with guide plate and with 184 mm diameter cover. Approved manufacturers are:

• Bibby-Ste-Croix	VB2200
• Mueller Canada	MVB—bottom section only

Valve box for service valves on watermains smaller or equal to 300 mm diameter shall be 105 mm, regular style, and slide type with guide plate and with 149 mm diameter cover. Approved manufacturers are:

• Bibby-Ste-Croix	VB1200
• Mueller Canada	MVB—bottom section only

Repair Clamps

Repair clamps will be:

- Cambridge Brass — Series 425
- Clow Concord — D–76R all stainless
- Mueller — full seal series 520
- Smith Blair — 261/256 full circle
- Robar — style 5636–style 1
- Romac — SS1
- Ford — FS1 style
- EZ–Max — 4000

All repair clamps to be all stainless steel and be supplied with stainless steel nuts with passified bolts. Body length to suit repair as per manufacturer's installation instructions.

All repair clamps will provide a full rubber seal around entire outside diameter of the pipe to be repaired.

Service Saddles

All service saddles shall be made of a stainless steel band fastened with a minimum double bolt mechanism, tapered rubber gaskets and supplied with stainless steel nuts, bolts, and non-corrosive washers.

For existing cast iron, ductile iron, and asbestos cement pipe, service saddles are required for 19 mm, 25 mm, 32 mm, 38 mm, and 50 mm diameter main stops —all AWWA tapered threads.

On PVC pipe, service saddles must be used for 19 mm, 25 mm, 32 mm, 38 mm, and 50 mm diameter main stops —all AWWA tapered threads.

For new ductile iron only, small water services greater than 25 mm in diameter require saddles.

Approved manufacturers are:

- Romac — 306
- Smith Blair — 372
- Mueller — Servi–Seal 521 to 529 series
- Ford — FS 303
- Cambridge Brass — Teck series 403

- Robar 2616DB
- Robar 2706

Water Services

The standard water service diameters are 19 mm, 25 mm, 32 mm, 38 mm, and 50 mm. Copper pipe will be ASTM B88-03 (ASTM B88M-05 for metric sizes) type 'K' soft copper.

All main stops will have a compression joint and approved manufacturers are:

- Cambridge Brass Series 301NL
- A.Y. McDonald 4701T
- Ford F–1000
- Mueller H15008N

All curb stop will have a compression joint. Approved manufacturers are:

- Cambridge Brass century ball valve
- Ford ball valve B–44 series
- Mueller H15209N
- A. Y. McDonald 6100 T ball valve

All couplings shall have a compression joint. Approved manufacturers are:

- Cambridge Brass Series 118
- Ford C–44
- Mueller H15403
- A.Y. McDonald 4758T

Service boxes will be made of cast iron and will suit the respective curb stop. The boxes will be adjustable from 1800 mm to 2100 mm bury.

The rods will be 1125 mm long, made of passivated #304 stainless steel with M5 x 70 mm brass cotter pins.

The plug must be brass and screw type.

Where further extension is required for the box because of extra depth, the extension and the coupling must be of threaded type.

If the final grade is more than 1000 mm above the top of the rod, then the rod must be replaced with one which is made of continuous passivated #304 stainless steel.

Box top to be stamped "water".

Self-draining stop and drain. Approved manufacturers are:

- Emco Series–15790
- Mueller H15219

Hydrants

Hydrants shall be:

- AVK Model 2780
- Canada Valve Century
- Clow–McAvity Brigadier M67
- Mueller Modern Centurion

All hydrants shall be according to AWWA C502 and NSF/ANSI 61 for dry barrel hydrants and open counter clockwise. Hydrants will have tapped drain ports, 150 mm mechanical joint inlet with brass to brass fittings on the main valve seat, two 63.5 mm hose nozzles spread 180 degrees apart and a 114.3 mm pumper nozzle with a 100 mm ULC S543 approved Storz connection. Hydrants will be connected to the watermain using a 150 mm lead, 150 mm gate valve and anchor tee. Hydrants will be supplied for a minimum bury depth of 1.8 metres.

Hydrant extensions required to adjust the length of the hydrant barrel are to be obtained from the hydrant manufacturer or approved supplier.

Hydrant anti-tamper devices shall be manufactured according to City specifications, as approved by the engineer.

Hydrant paint will be high gloss exterior chrome yellow and shall be applied over a quality dry red oxide primer. Storz nozzles shall be painted black.

Petrolatum Tape Systems

Anti-corrosion wrap shall be as supplied by Denso North America Inc. or Trenton Tape. Only material from one supplier exclusively shall be used on an installation. At no time will materials from either system be utilized with the other.

Microcrystalline wax and petrolatum tape coating system components shall meet the material and testing requirements of AWWA C217.

Denso coatings material will consist of Denso paste or Denso priming solution for cold temperature application, Denso profiling mastic or Denso Mastic Blanket and Denso LT Tape.

Trenton Tape coating material will consist of TecTape Primer, Fill Putty, and TecTape petrolatum tape.

Insulation Type

Any non-buried watermain will be insulated with polyisocyanurate foam or polyurethane foam and wrapped in an aluminium jacket. The thickness of the insulation will be determined by the engineer. In most cases the thickness will be 50 mm.

Sewer Pipe

Both rigid and flexible pipe are permitted in the construction of sanitary and storm sewer systems including service connections. These materials include concrete and polyvinyl chloride. However, the bedding design must be compatible with the type of pipe material used. To determine the preferred pipe material based on the diameter of the pipe, go to Chapter 2, *Sanitary Sewer*, Table: *Sanitary sewer preferred materials* or Chapter 3, *Storm Sewers*, Table: *Storm sewer preferred material.*

Pipe materials for storm and sanitary sewer mainline, fittings, and service laterals will be CSA certified and according to the following:

Concrete Sewer Pipe and Fittings

Circular concrete pipe and fittings will conform to OPSS.MUNI 1820 and will be manufactured at a plant certified under the Ontario concrete plant prequalification program. Non reinforced concrete pipe will be according to CSA A257.1. Reinforced concrete pipe will be according to CSA A257.2. Joints and gaskets will be according to CSA A257.3.

PVC Sewer Pipe and Fittings

Circular PVC pipe and fittings complete with bell and spigot joints, rubber gasket, lubricant and all other necessary appurtenances will be manufactured according to OPSS.MUNI 1841 and certified to CSA B182.2 for PVC sewer pipe and fittings. PVC pipe will have a minimum pipe stiffness of 320 kilopascals.

s

HDPE Sewer Pipe and Fittings

Circular PE pipe and fittings complete with bell and spigot joints, rubber gasket, lubricant and all other necessary appurtenances will be manufactured according to OPSS.MUNI 1840 using virgin resin and will be certified to CSA B182.6 for polyethylene sewer pipe and fittings for non-pressure applications. Circular PE pipe and fittings will have a minimum pipe stiffness of 320 kilopascals and 100 kilopascals gasketed joints.

Hybrid Pipe Systems

The City will review and consider the use of specialized pipe designed to minimize inflow and infiltration in areas of high groundwater. These pipe products combined both concrete and plastic materials into one pipe system. The acceptance of these pipe systems for use will be considered on a case-by-case basis.

Table 40: Sanitary sewer pipe materials

Type of pipe	Specification	Diameter	Approved use
non-reinforced concrete	CSA A257.1 extra strength	200 mm to 250 mm	service laterals
reinforced concrete	CSA A257.2	300 mm and larger	mainline
DR 35 PVC	CSA B182.2 320 kPa stiffness	200 mm and larger	mainline
DR 28 PVC	CSA B182.2 625 kPa stiffness	100 mm and 150 mm	service laterals
vitrified clay	CSA A60.1 and CSA A60.3	200 mm and larger	mainline and laterals

Sanitary public and private side laterals sewers will be SDR28 and green in color.

Sanitary Forcemain Material

Sanitary forcemain material will be selected to suit the installation and system requirements and be pre-approved by the City. Under no circumstances will the material selected for the forcemain be colour coded blue.

Table 41: Storm sewer pipe materials

Type of pipe	Specification	Diameter	Approved use
non-reinforced concrete	CSA A257.1 extra strength	200 mm to 250 mm	service laterals
reinforced concrete	CSA A257.2	300 mm and larger	mainline
DR 35 PVC	CSA B182.2 320kPa stiffness	200 mm and larger	mainline
DR 28 PVC	CSA B182.2 625kPa stiffness	150 mm	service laterals

Storm public and private side laterals sewers will be SDR28 and white in color.

Sewer Related Appurtenances

Maintenance Hole and Catchbasin Adjustment Units

Concrete adjustment units shall be manufactured according to material specification OPSS.MUNI 1351. Precast adjustment units will be laid in a full bed of mortar with successive units being joined using sealant as recommended by the manufacturer. A minimum of one adjustment unit will be installed with a minimum height of 75 mm. A maximum of four adjustment units be installed to a height not in excess of 0.3 metre.

Rubber adjustment units shall be manufactured according to material specification OPSS.MUNI 1853 and installed according to City standard T-704.010-1.

Integrated Frame and Cover (IFC-25) Maintenance Hole System

A single precast adjustment unit sizes vary from 100mm-550mm eliminating the use of multiple precast adjustment units and mortared joints. Reduces inflow and infiltration and frequency of sunken maintenance holes and surrounding road deterioration. Applications include new infrastructure as well as rehabilitation of existing precast maintenance holes such as tapered tops, chambers and flat caps.

Precast Maintenance Holes and Catchbasins

Precast maintenance holes and catchbasin shall be as manufactured in according to material specification OPSS.MUNI 1351.

Maintenance Holes, Catchbasins Frame and Covers

Maintenance holes and catchbasin frame and covers will be manufactured in accordance with material specification OPSS.MUNI 1850.

Optimized Maintenance Hole Assembly

Optimized castings provide superior performance with reduced weight, saving energy and raw materials. These castings exceed the current OPSS 1850 load requirement and adhere to AASHTO M306 specifications that improve material quality and loading requirements.

Optimized maintenance frame and cover assembly

- East Jordan MC401010406

Optimized frame for catchbasin

- East Jordan MC401040105

Standard OPSD 400.070 Herring Bone catchbasin grate

- East Jordan MC400070302

Flexible Rubber Connectors

Flexible rubber connectors for connecting pipe to maintenance holes can be either cast-in during the manufacture of the precast product, or installed into a cored or preformed hole in the finished maintenance hole. Both types shall be according to CSA A.257.3 and ASTM C923M.

EZ–TEE is manufactured by Galaxy Plastics Ltd and Inserta Tee manufactured by Advanced Drainage System Inc. (ADS) can be used to connect laterals to both existing and new pipes.

Flexible rubber connectors for connecting pipe of dissimilar material or pipe sizes on mainline sewers will not be approved.

Concrete Pipe Gaskets

The standard gaskets supplied with any concrete product are generally formulated for maximum sealing performance in a standard sewer installation carrying storm water or sanitary sewage. Other types of gaskets would be required where resistance against hydrocarbons, acids, ultraviolet rays, ozone, and extreme heat is needed. Nitrile gaskets should be specified where hydrocarbon oil and petroleum resistance is required.

Approved Manufacturers' Product List

If the City receives product approval requests from suppliers interested in having the products evaluated for purchase by the City, the supplier should contact The Road Authority.

The City supports the efforts of the Ontario Good Roads Association (OGRA) and the Ontario Provincial Standards (OPS) organization. As part of these relationships, the City is considering to use The Road Authority (TRA) to post its approved manufacturer's product list for watermain and sewer related products on the Internet. The Road Authority is a service provided by the OGRA and is "an Internet-based information resource that provides a mechanism for infrastructure owners, consultants, contractors and product suppliers to collaborate and share information. TRA provides users with information on products, services and technical solutions available for use in the public works sector."

If a product is listed on the TRA approved supplier list, it means the product is approved for its intended use, however, it is at the City's discretion whether to use the product.

For more information on The Road Authority, go to web site: www.roadauthority.com .

Appendix A – As-built Drawings

As-built Drawing Requirements

This section describes the minimum format and content requirements for the production of construction as-built drawings. These requirements apply to capital improvement, developer, and third party and utility review projects.

General Requirements

- Use the approved CADD plans as the base for the as-built drawing—do not redraw the plans.
- Each sheet is to be labelled as “As-built Drawing”.
- Indicate in the revision box, the year the underground infrastructure was constructed, not the year the as-built plan was prepared.
- Place “As-built” with date when as-built submitted in revision box.
- As-built drawings completed by the City must be initialled by a City designated person.
- As-built drawings completed by a consulting engineer must be initialled by the consulting engineer.
- All changes will be made in a manner that is clear, legible, and neat.
- The as-built drawing will identify all existing or abandoned utilities that were constructed or exposed during construction which was not shown on the approved construction drawing. If a utility line was moved, show the new location on the drawing.
- If the word “Proposed” is shown, then remove text or drawing information to indicate changes.
- Electronic versions of the as-built drawings will be provided in Microstation (.DGN) format and colour (PDF).

- All elevations will be referenced to the same datum as the original design plans.

Water Distribution Systems

- Show any changes to the watermain diameter, material type, and class of pipe, depth, and bedding type.
- When there is a change in alignment of the proposed watermain, location of valves, tees and so on, the as-built drawing must reflect this change accurately.
- Show offset distance of watermain as originally indicated on the plan, only if the source as-built data is not from an electronically co-ordinated file.
- Indicate cut and plug locations.
- Indicate any abandonment of valve chambers and so on.
- Cover provided over piping is to be noted at intervals along the main, especially in areas of minimum cover or where cover is less than the City standard of 1.8 metres. Show locations where insulation is used.
- Fire hydrants and water valves will be labelled and shown.
- Vertical and horizontal bends will be indicated in plan view and labelled by type, station, and bend direction in profile view.

Example: 22.5 degree horizontal bend, Sta.1+78.4

- Indicate locations of all newly replaced water services and water curb stops—as per plan chainage.
- Show location of cathodic protection test stations. Provide as-built MTM coordinates on the drawing.
- Show location of any drain cables connected to the Toronto Transit Commission (TTC) electrified rail system.

- Label bores and tunnels to show steel casings or tunnel liner type, size, length, and thickness. Show stations at end points.
- Show type of shoring used if it was left in place. Also indicate type and quantity of grout used.
- Pertinent easement information including width of easement, instrument number, reference plan number, and distance from watermain centreline to sides of easement.
- The watermain should be redrawn in plan view if the horizontal alignment has changed.
- The watermain should be redrawn in profile view if the vertical elevation has changed.
- Do not strike through text or drawing information to indicate changes. Remove and replace information on drawing with as-built information.

Sewage and Storm Collection Systems

- Show any changes to sewer lengths, size, slopes, depth, class of pipe, and bedding type.
- When there is a change in alignment of the proposed sewer pipe or location of manholes, the as-built drawing must reflect this change accurately.
- Recalculate pipe slopes on invert-to-invert elevations along the linear distance between maintenance holes.
- Sewer pipe slopes are to be labelled in percents to the nearest hundredths.
- Replace proposed maintenance hole rim elevation and inverts and write in the as-built elevations.
- Maintenance holes are to be designated by stationing from a known and easily located starting point or their coordinates shown in a table on the drawing.

- Show horizontal and vertical location of lift stations/wet wells with inverts of all connections, piping, and pump descriptions indicating size and type of pumps.
- Provide summary of type of lift station, depth, and size of pumps.
- Show location of force mains and gravity mains from property lines as originally indicated on the plan only if source as-built data is not an electronically co-ordinated file.
- Pertinent easement information including width of easement, instrument number, reference plan number, and distance from sewer centreline to sides of easements.
- Indicate locations of all newly replaced sewer services and sewer clean outs—as per plan chainage.
- For sewer laterals, indicate stationing of wyes from maintenance hole, if lateral is not perpendicular to the sewer main.
- Label bores and tunnels to show steel casings or tunnel liner type, size, and thickness. Show stations at end points.
- Show type of shoring used and indicate whether or not if it was left in place. Also indicate type and quantity of grout used.
- The sewer should be redrawn in plan view if the horizontal alignment has changed.
- The sewer should be redrawn in profile view if the vertical elevation has changed.
- When there is a change in the proposed slope of the sewer pipe, the profile view must reflect this change accurately: That is to say, the invert elevation, stations, slope percent, and pipe lengths should be revised as needed.
- Increase the text size of invert elevations to show as-built elevations.
- Do not strike through text or drawing information to indicated changes. Remove and replace information with as-built information.

Stormwater Management Facilities

- A topographical survey of the storm water management facility will be prepared. The plans will contain sufficient spot elevations and grading contour lines to show whether the storm water management facility has been constructed in compliance with the approved design plans.
- Submit certified calculations of the as-built pond volume and verify that it equals or exceeds the required volume. Show stage / storage table showing the volume of the pond on the plan.
- The as-constructed average and peak release rates as compared with the design release rates must be provided in tabular form when major deviations from the approved design have occurred.
- Verify high water elevation, overflow constrictor, and normal water levels.
- Certify installation and size of flow restrictors or outlet system.
- Verify amount of free board around pond.

Grading

- Verify overland flow route.
- Show as-built grading of all outlets, parks, stormwater management facilities, and major drainage ways.
- If a subdivision, grading for individual lots will be submitted when built on.
- If a commercial, industrial or non-residential site, show as-built grading of site.

Revision Notes

Revision notes will include a disclaimer depending on the source of the data provided in producing the as-built drawing.

Data Provided by the City

Projects for which the City provided all supporting data will have the following note.

Example: Note when City provides the information

3	Oct/2020	As-built drawing prepared by [name of	RK	
		engineering company] using data provided		
		by the City. Watermain constructed in		
		2019.		
No.	Date	Revisions	Initial	Signed

Data Not Provided by the City

Projects for which there was no supporting data available from the City and where the consulting engineer undertook field locates and surveying.

Example: Note when field survey for completion of as-built.

3	May/2020	As-built drawing prepared by [name of	RK	
		engineering company] with no data		
		provided by the City. Watermain,		
		chambers and storm and sanitary		
		manholes were field located by [name of		
		engineering company].Watermain, storm		
		and sanitary sewer constructed in 2019		
No.	Date	Revisions	Initial	Signed

Year of Construction in Revisions Box

Indicate the year of construction of the watermain, storm or sanitary sewer in the revisions box as this will differ from the date the as-built drawing was completed.

Indicate on drawing or drawing set title page, any related Ministry or City sewer and watermain approval or acceptance numbers with issue date.

Seal

References to the original sealed drawings should be made on the as-built drawing. In lieu of a seal, the following note will be added on the as-built drawing.

Note:
Original sealed by……..
Dated ……….

The above note will be applicable only when the original sealed construction drawing is available.

Appendix B – General Notes

General Notes Usage

Development Engineering Projects

Coordinate with your case manager for the latest version of the General Notes. In addition, if the consultant engineer deems to add additional notes, include them in a separate section on the "General Notes Drawing" as an "additional notes" section.

Capital Improvement Projects

Coordinate with your project engineer, project manager or program manager for the latest version of the General Notes. In addition, if the consultant engineer deems to add additional notes, include them at the end of each section of the "General Notes Drawing".

Third Party & Utility Review Projects

Coordinate with your case manager for the latest version of the General Notes. In addition, if the consultant engineer deems to add additional notes, include them in a separate section on the "General Notes Drawing" as an "additional notes" section.

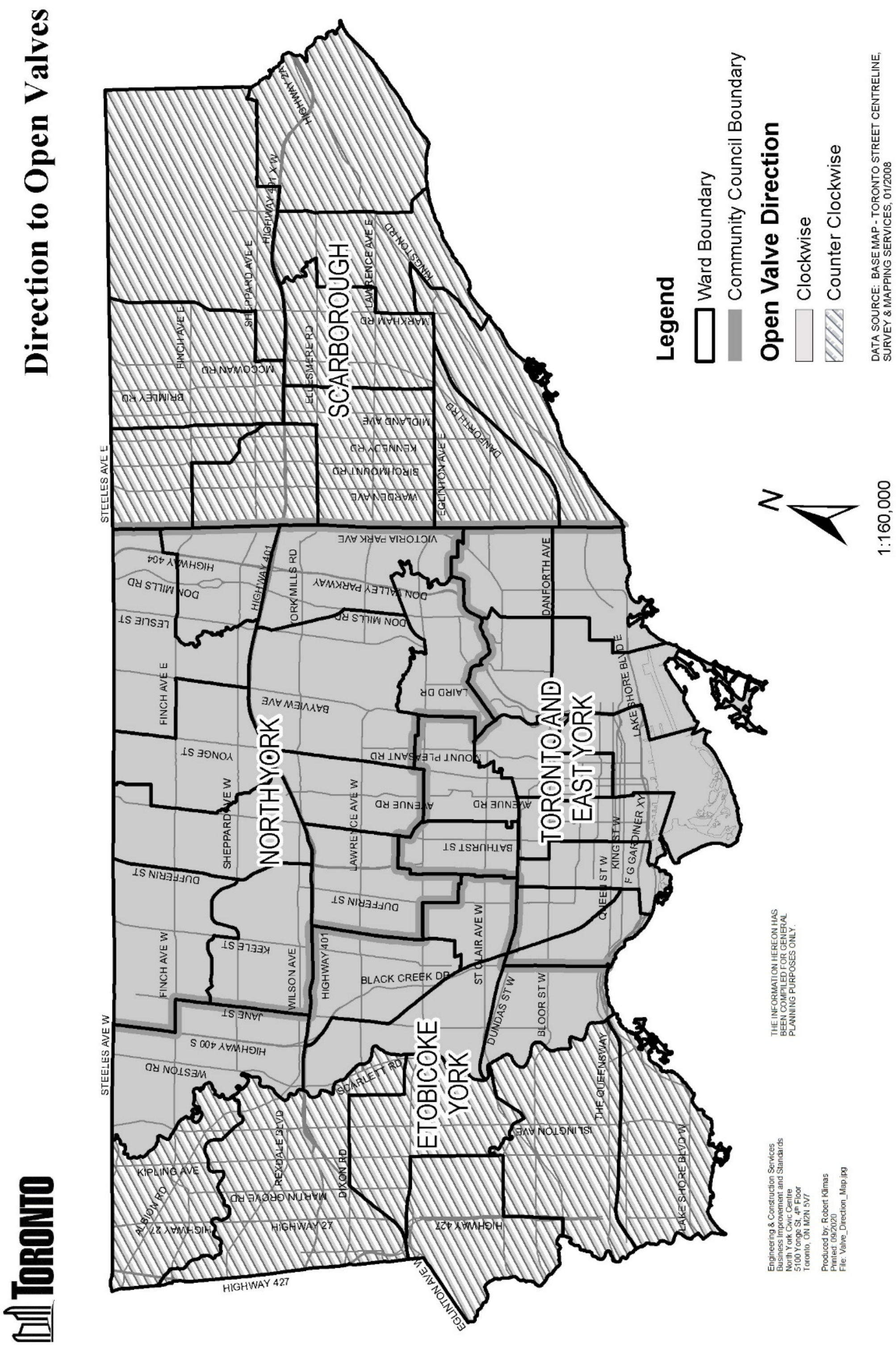
PDF version and Microstation version of General Notes can be found on ECS's web page Design Criteria for Sewers and Watermains – General Notes.

Other Notes

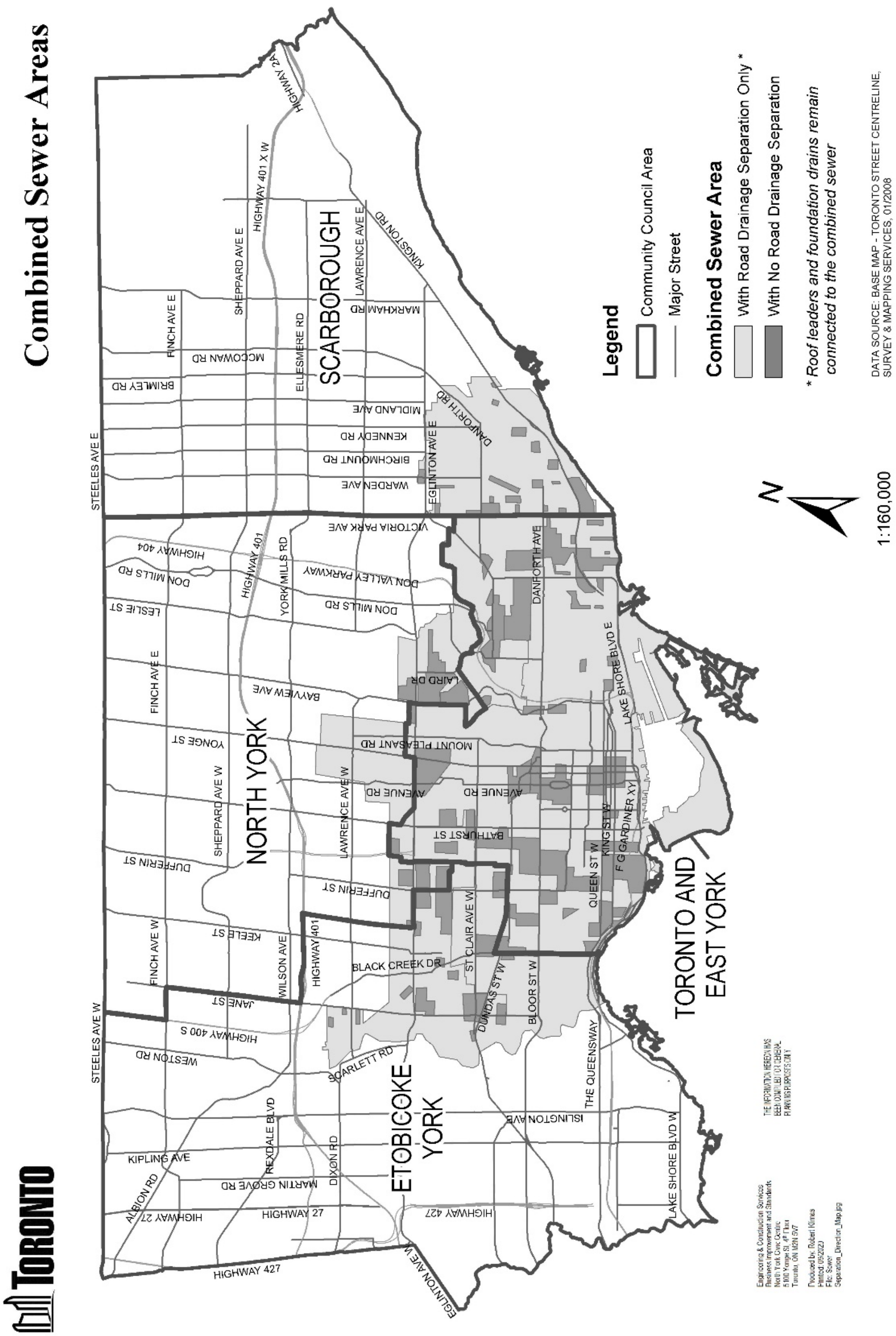
This note is to appear on the grading and servicing plan within a box, as shown.

> Prior to commencing any work within the municipal right-of-way the contractor, developer or consultant will obtain all necessary road occupancy permits from Transportation Services, Permits and Enforcement, Construction Activity unit, contact 416-xxx-xxxx. [1]
>
> [1] Contact should reflect district where application is made.

Appendix C – Direction to Open Valves



Appendix C – Combined Sewer Areas



Appendix D – Utility Separations

Table: Utility Separations for buried plant

Utility	**Minimum vertical separation (mm)**	**Minimum horizontal separation (mm)**
MTS Allstream Inc. (formerly MetroNet, UniTel, AT&T, CNCP)	300	600
Videotron Telecom (formerly Stream Networks Inc.)	300	600
Telus Communications Inc.	300	600
Rogers Cable Communications Inc.	300	600
Toronto Hydro Telecom Inc.	300	600
Bell Canada		
• maintenance holes	1000 from floor of maintenance hole	1000 from outside edge of walls
• conduit	600 from bottom edge of conduit – concrete encased	600 from outside edge of conduit
• direct buried or non-concrete encased conduit	300	600
• above ground infrastructure	[a]	600
Group Telecom (formerly 360 Networks)	300	600
Enbridge Gas Distribution Inc. (formerly Consumers Gas)		
• gas main < 300 mm diameter – open trench method	300	600

Table: Utility Separations for buried plant (continued)

Utility	**Minimum vertical separation (mm)**	**Minimum horizontal separation (mm)**
• gas main ≥ 300 mm diameter – open trench method	600	600
• NEB regulated pipelines and vital mains – open trench method	600	1000
• all pipelines – directional drilling/boring machine	1000	1000
• regulator stations	[a]	1000
Enwave Energy Corporation (formerly Toronto District Heating Corporation)		
• chilled water pipes	300	300
• steam lines	600	600
Toronto Water		
• inside diameter < 100 mm	150	600
• 100 mm ≤ inside diameter < 400 mm	300	750
• inside diameter ≥ 400 mm	500	900
• valve chamber	[a]	600
Toronto Water – fire hydrants		
• above-ground plant clearance from fire hydrant		1200
• buried plant clearance from fire hydrant including lead and valve	400	1500
Toronto Water – storm sewers including catchbasins and sub-drains		
• inside diameter < 150 mm	150	600
• inside diameter ≥ 750 mm	500	900

Table: Utility Separations for buried plant (continued)

Utility	**Minimum vertical separation (mm)**	**Minimum horizontal separation (mm)**
• 150 mm ≤ inside diameter < 750 mm	300	750
• maintenance hole	[a]	600
Toronto Water – sanitary / combined sewers		
• inside diameter < 100 mm	150	600
• 100 mm ≤ inside diameter < 375 mm	300	750
• inside diameter ≥ 375 mm	500	900
• maintenance hole	[a]	600
Transportation Services – general		
• clearance from road, curb and sidewalks		500
• clearance from catch basins	[a]	500
Transportation Services – traffic signals		
• traffic signal duct	300	600
• above-ground plant clearance from controller boxes	[a]	front 1500 side/back 500
• above-ground plant clearance from traffic signal poles	see MCR	500
Road Emergency Service Communications Unit (RESCU)		
• all infrastructure	300	600
• RESCU CCTV cameras	1000	2000

Table: Utility Separations for buried plant (continued)

Utility	Minimum vertical separation (mm)	Minimum horizontal separation (mm)
Hydro One Networks Inc. (formerly Ontario Hydro)	1000	1000
Toronto Hydro Electric System Limited		
• roof of hydro chambers	600	600
• poles	[a]	1000
Toronto Hydro Street Lighting Inc.		
• street lighting duct	300	600
Toronto Transit Commission		
• streetcar track allowance	600	500

[a] Clearance above and below to be determined on a case-by-case basis.

The table above includes minimum separation distances required by both the City and Utility companies. The purpose of the listed minimum clearances is to provide a factor of safety for the proposed and existing plant during both construction and the service life of the asset. The City recognizes that Intensification can place constraints on available clearances between utilities within the road allowance, and will consider alternative proposals from an applicant affecting City of Toronto plant on a case-by-case basis. However, the proposed solution must include additional design factors to compensate for a reduction in separation, such that the intended factor of safety being provided by the minimum separations described in the table will continue to be achieved.'

Source: This table is taken from Municipal, Consent Requirements, Appendix O – Vertical and Horizontal Clearance Guideline which can be found at *www.toronto.ca/services-payments/building-construction/infrastructure-city-construction/construction-standards-permits/standards-for-designing-and-constructing-city-infrastructure/?accordion=utility-cut-permit-applications-and-municipal-consent-requirements-mcr*

Appendix E – Unit Conversion Table

Table: Unit conversions

Measure	Unit x	Conversion factor	Unit
volume	litre	0.2642	gallon (US)
	gallon (US)	3.785	litre
	gallon (IMP)	4.546	litre
	gallon (US)	0.8327	gallon (IMP)
	gallon (IMP)	1.201	gallon (US)
length	inch	25.4	millimetre
	inch	2.54	centimetre
	foot	304.80	millimetre
	foot	30.480	centimetre
	foot	0.3048	metre
	centimetre	0.39370	inch
	centimetre	0.03281	foot
	metre	3.28084	foot

Table: Unit conversions (continued)

Measure	Unit x	Conversion factor	Unit
area	$metre^2$	10.76391	$foot^2$
	$foot^2$	0.09290	$metre^2$
	hectare	10,000	$metre^2$
	hectare	2.47105	acre
	acre	0.40469	hectare
	acre	4,047	$metre^2$
pressure	pascal	1	$newton/metre^2$
	kilopascal	1,000	pascal
	kilopascal	0.14504	$pound/inch^2$
	$pound/inch^2$	6.89476	kilopascal
mass	kilogram	2.205	pounds
	pound	0.4536	kilogram
	metric tonne	1000	kilograms
	metric tonne	2205	pounds
	metric tonne	1.1023	short ton
	short ton	2000	pounds
	short ton	907.2	kilograms
	short ton	0.9072	metric tonne

Appendix F – Reverse Slope Driveway Guidelines

Reverse slope driveways cannot be drained naturally since they create a low lying area that water cannot outlet from but only accumulate in. If the mechanical drainage appurtenances such as catch basins, sumps or sump pumps fail or are overwhelmed by a large storm, then storm water can enter the home resulting in expensive flood damage for the property owner. In addition, it can surcharge the local sanitary sewer system by way of the homeowners’ floor drain which could cause sewer backups of neighbouring properties.

Submission Guidelines for Reverse Slope Driveways

Zoning By-law 569-2013 prohibits the construction of below-grade garages for residential buildings anywhere in the city. Should an application for exemption be applied through a Minor Variance Application or a re-zoning application, the following is provided for information.

Toronto Water division requires that a report be prepared by a licensed professional engineer and be submitted for approval prior to the construction of a reverse slope driveway.

Applicants are asked to demonstrate in the report that the drainage from the area will not lead to flooding of the reverse slope driveway. The minimum submission requirements that applicants should use when preparing this report are listed below.

Report Submission Requirements

1 Provide design calculations demonstrating that a reverse driveway, where allowed, will not adversely be affected by any storm events up to and including the 100-year storm event. The high water level of adjacent overland flow routes shall be 100 millimetres below the high point of the driveway entrance.

2 No reverse slope driveway will be constructed adjacent to the low point on a street subject to ponding or accumulation of storm water under any storm event.

3 No reverse slope driveway will be constructed if the low point is below the local water table.

4 No reverse slope driveway will be constructed if the low point is below the local water table. Within the street allowance, provide a positive 2 to 4 percent slope from the property line, down to the top of curb, or 150 millimetres above the gutter, whichever is higher. If there is no curb, then to the edge of pavement. For down grade slopes, see OPSD 351.010.

5 A review and analysis of the overland storm run-off adjacent to the reverse driveway or ramp must be conducted by the applicant's engineer. No surface drainage from the site will be allowed to discharge onto the driveway. The property should be graded to prevent recurrent ponding. In addition, the overland storm runoff should be diverted away from the driveway and restricted from entering onto the driveway or ramp so as to eliminate flood damage to the site or adjacent property.

6 No direct or indirect connection of storm area drain to the sanitary sewer system is allowed—no exceptions.

7 The area drain inlet, piping, sump, and sump pump will be sized to accommodate flow from a 100-year storm without storm water entering into the building. Discharge from a sump must be pumped to either one of the following on the property:

- ground surface
- dry well
- storm water storage facility for future use

Storm water from the sump must not cause ponding, erosion or runoff onto neighbouring properties.

8 If a sump pump is used it shall be equipped with a self-resetting thermal overload protection switch. The pump should be rated to run for a continuous amount of time to pump all water from the sump pit. It is recommended that a

secondary pump be installed and that both primary and secondary pumps be supplied with backup electrical power to provide up to six hours of continuous pumpage in the event of a temporary electrical failure or black out.

9 Provide a 1:100 scale base plan showing the property lines, ground floor plan, and adjacent roads, sidewalks, retaining walls, and neighbouring buildings.

10 Provide a plan and profile of the reverse driveway, driveway grading plans, storm grading plans, spot elevations on the driveway and adjacent land and supporting calculations. Show pre-development and post-development drainage areas when a change in the drainage area has been made.

11 Applicants are asked to include spot elevations on the plan and profile drawing. The drawings shall follow the Engineering and Construction Services *CADD Specification Manual* drafting standards. Vertical elevations and horizontal coordinates shall be referenced to the City geodetic benchmarks. A total of nine spot elevations must be included between the street curb and the top of the driveway adjacent to the front of the house. If there is a sidewalk, a total of 27 spot elevations will be shown on the upper and lower driveway and sidewalk, as shown in the figure below.

12 Show on the drawing the applicable storm and surface water drainage directions for both the major and minor systems.

13 Use appropriate runoff coefficient and additional hydrologic parameters when performing calculations.

14 The report should include the following information:

- key map showing location of the subject property
- property address
- present owner contact
- an external drainage plan showing flood and fill lines along schematic layout of existing and proposed sanitary and storm sewer system around the perimeter of the site, including sewer lateral connections to the subject property

- schematic layout of the sub watershed, if any of the existing flow is within 100 metres of the site, for example, a watercourse or trunk sewers
- any supporting calculations, reports, and drawings, such as calculation of surface run-off, ponding elevations, elevations corresponding to the required level of controls and text indicating embankments and retaining walls, calculations of existing run-off coefficient, if different and release rates.
- Applicant is required to obtain all necessary permits from Toronto Building related to retaining wall construction, which status shall be indicated in the report.

The report must be prepared, by a professional engineer, licensed to practice in the province of Ontario, with experience in storm drainage analysis and design.

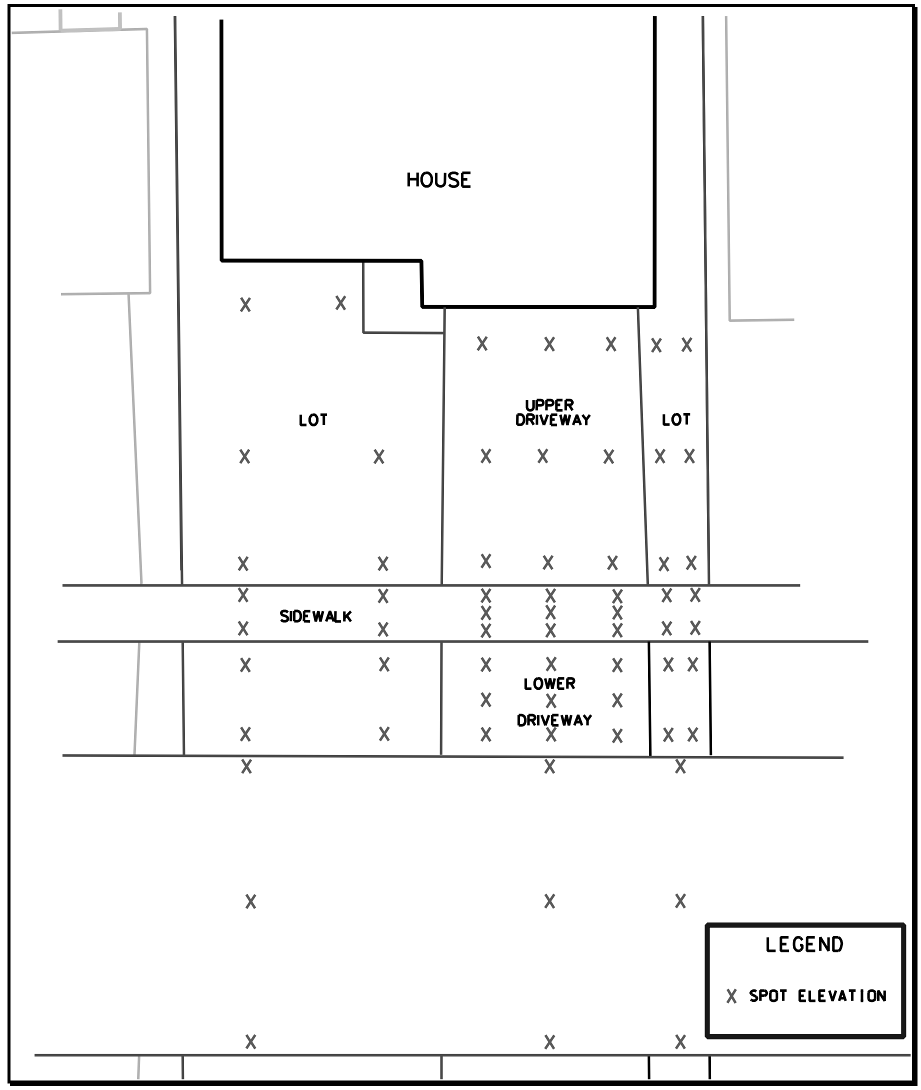


Figure: Spot elevation locations

Appendix G – Servicing in Confined Spaces

The City of Toronto does not have standards for servicing within a confined space corridor. These types of installations are discouraged and reviewed on a case-by-case basis.

The land to be used for the proposed servicing of the watermain, storm sewer and sanitary sewer must account for the room needed to accommodate access and future work. This applies to both easements and laneways.

A proponent, at its discretion can prepare a detailed submission for review by the City. The submission should address yet not be limited to the following concerns;

1) future site and adjacent land conditions,

2) the access road,

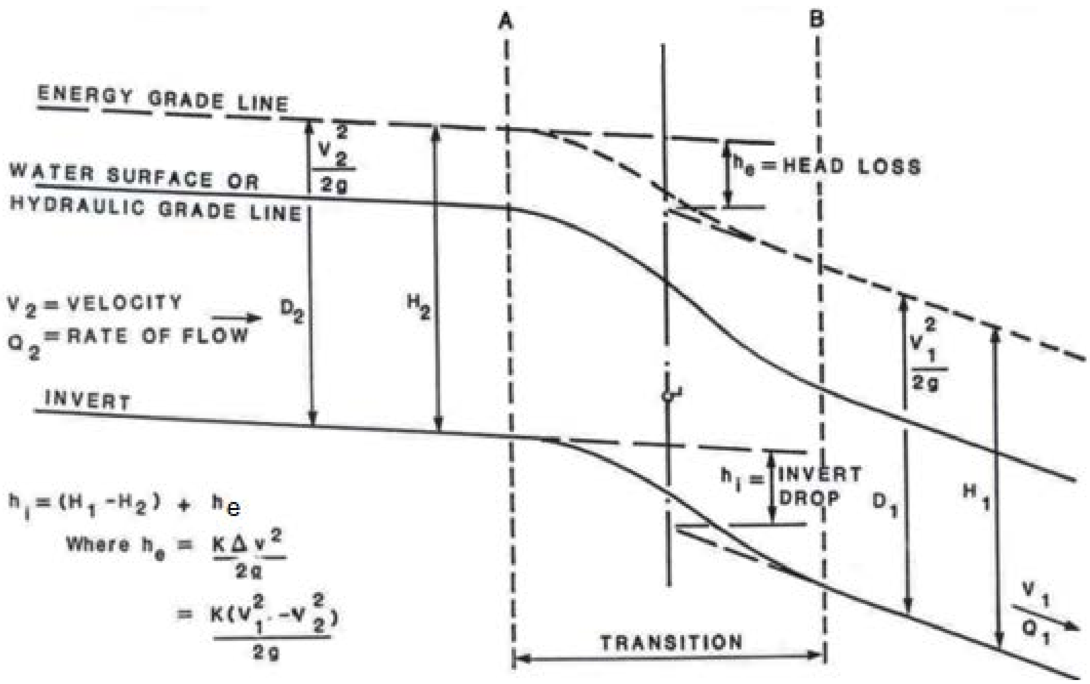
3) swing space for equipment and transport of material to the excavation, and

4) additional design factors to be implemented to compensate for the risk involved in installing infrastructure in a confined space.

The City of Toronto may also consider the sale of public laneways should the proposal be in line with City development objectives.

Appendix H – Hydraulic Calculations for Junction and Transition Maintenance Holes

Criteria and Basis of Design



K= 0.1 FOR INCREASING VELOCITY CHANGE

K= 0.2 FOR DECREASING VELOCITY CHANGE

Assumption

Maintenance hole length is relatively short so that it can effectively be taken to be the actual drop in inverts at the extremes of the maintenance hole.

Method

1. Each incoming pipe must be analyzed separately together with the outgoing pipe.

2. Employ Hydraulic Elements Chart (Figure 1) for % depth of flow and % velocity.

3. The designer should, wherever possible, restrict the change in velocity to not more than 0.6 m/s in special cases, consideration should be given to bellmouth entrances.

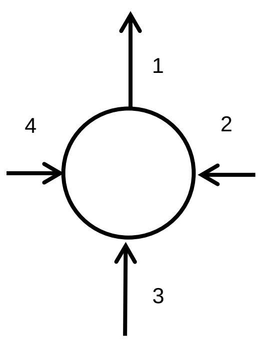
4. Complete the hydraulic calculations outlined in the following.

Location Maintenance Hole No ....

Designed By .... At ....

Checked By ....

Date ....



PIPE NO.	DIAM.	GRADE (%)	CAPACITY (Qcap)	ACTUAL FLOW (Qact)
1				
2				
3				
4				

Pipe No. 1

Q_1 cap = __________ Q_1 act = __________ $\frac{Q_1 \text{ act}}{Q_1 \text{ cap}}$ = __________

From Fig. 1 read Depth of Flow = _____ %

V_1 cap = _______ from above depth of flow and

Fig. 1 read ratio of $\frac{V_1 \text{ act}}{V_1 \text{ cap}}$ = ____________

□ V_1 act = V_1 cap x $\frac{\_\_\_\_\_ \%}{100}$ = _____ x $\frac{\_\_\_\_\_}{100}$ = _____

H_1 = pipe diameter x % depth = $\frac{(V_1 \text{ act})^2}{2g}$ =

______ + x ______ + ______ = ______

Pipe No. 2

Q_2 cap = __________ Q_2 act = __________ $\frac{Q_2 \text{ act}}{Q_2 \text{ cap}}$ = __________

From Fig. 1 read Depth of Flow = __________ %

V_2 cap = _____ from above depth of flow and

Fig. 1 read ratio of $\frac{V_2 \text{ act}}{V_2 \text{ cap}}$ = ________

□ V_2 act = V_2 cap x $\frac{\_\_\_\_\_ \%}{100}$ = _____ x $\frac{\_\_\_\_\_\_}{100}$ = _____

H_2 = pipe diameter x % depth + $\frac{(V_2 \text{ act})^2}{2g}$ =

______ + x _____ + _____ = ______

Pipe No. 3

Q_3 cap = __________ Q_3 act = __________ $\frac{Q_3 \text{ act}}{Q_3 \text{ cap}}$ = __________

From Fig. 1 read Depth of Flow = __________ %

V_3 cap = _____ from above depth of flow and

Fig. 1 read ratio of $\frac{V_3 \text{ act}}{V_3 \text{ cap}}$ = ________

□ V_3 act = V_3 cap x $\frac{\_\_\_\_\_}{100}$ % = _____ x $\frac{\_\_\_\_\_\_}{100}$ = _____

H_3 = pipe diameter x % depth + $\frac{(V_3 \text{ act})^2}{2g}$ =

______+ x _____ + _____ = ______

Pipe No. 4

Q_4 cap = ___________ Q_4 act = ___________ $\frac{Q_4 \text{ act}}{Q_4 \text{ cap}}$ = ___________

From Fig. 1 read Depth of Flow = ____________ %

V_4 cap = _____ from above depth of flow and

Fig. 1 read ratio of $\frac{V_4 \text{ act}}{V_4 \text{ cap}}$ = ________

□ V_4 act = V_4 cap x $\frac{\_\_\_\_\_}{100}$ % = _____ x $\frac{\_\_\_\_\_\_}{100}$ = _____

H_4 = pipe diameter x % depth + $\frac{(V_4 \text{ act})^2}{2g}$ =

______+ x _____ + _____ = ______

Head Loss

$h_e = \frac{K (V_2^2 - V_1^2)}{2g}$ for pipes 1 and 2

Select K = 0.1 or 0.2 as above

For pipes 1 and 2 h_e = _____ (_____ - _____)

= _____

For pipes 1 and 3 h_e = ______ (______ - ______)

= _____

For pipes 1 and 4 h_e = ______ (______- _____)

= ______

For pipes 1 and 2 $h_i = (H_1 - H_2) + h_e$

h_i = ______ - ______ + ______

= ______ drop

For pipes 1 and 3 h_i = ______ - ______+_____

= ______

For pipes 1 and 4 h_i = ______ - ______+_____

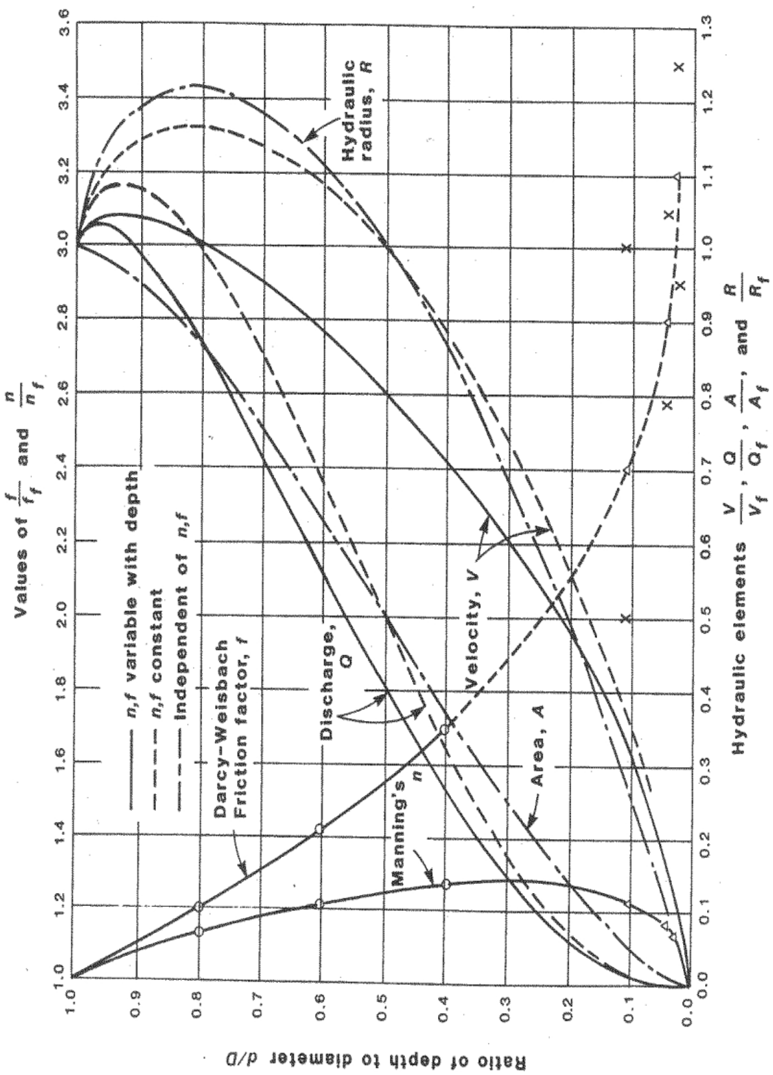
= ______

Summary

Take a maximum condition of the above three cases as the governing factor which sets the required maximum drop through the maintenance hole.

FIGURE 1

HYDRAULIC - ELEMENTS GRAPH FOR CIRCULAR SEWERS



Appendix I – Pumping Stations

The city of Toronto topography is conducive to gravity drainage systems. However, the City does have sewage pumping stations and stormwater pumping stations. This appendix is intended to provide direction and guidance on the City's minimum requirements for the design of these non-gravity sewage and drainage systems.

Drainage Systems – Order of Preference

Following is the order of preference when selecting a drainage system.

Gravity System
Inverted Siphon
Pumping Station

Should the best practical alternative for solving a drainage deficiency, be the installation of a stormwater pumping station, the design shall proceed with the objective of minimizing life-cycle costs for operation and maintenance. Traffic safety and guarding against flooding hazards on the roadway is paramount. Every attempt should be made to minimize the drainage area tributary to the station serving a roadway. Sites abutting the roadway are required to follow the principles of the Wet Weather Flow Management (WWFM) guidelines.

Sewage Pumping Stations and Sewage Forcemains

The requirements indicated in the MECP *Design Guidelines for Sewage Works 2008* shall be followed.

Combined Sewage Pumping Stations and Sewage Forcemains

These facilities must comply with the requirements of MECP *Procedure F-5-5 Determination of treatment requirements for municipal and private combined and partially separated sewer systems*, and must be designed on a case-by-case basis.

Stormwater Pumping Stations, Forcemains, and Storage/ Detention Tanks

The requirements indicated in the MECP *Stormwater Management Practices Planning and Design Manual* and the WWFM guidelines shall be checked to ensure the facility design is

a) in compliance with these storm water management practices and
b) integrated with the overall stormwater management plan for the drainage area.

Application

Stormwater pumping stations maybe required for grade separations, multi-use pathways, the maintenance of inverted siphons, and re-circulation of stormwater in a dunker facility, or dewatering of a basement flooding prevention facility for which no gravity drainage outlet can be provided.

Commonality

The design of stormwater pumping stations with respect to performance curves of pumps, hydraulic losses in pipes, fittings and appurtenances, pump characteristics of minimizing cavitation and vortexing are covered by requirements in the MECP *Design Guidelines for Sewage Works*. As such, these items are not discussed as being part of City design criteria for stormwater pumping stations.

Multi-use Pathways

For designs servicing pedestrian use only areas, acceptable ponding depths need to be identified, when all pumps are inoperable—worst case scenario.

Design Criteria when Stormwater Pumping Station Inoperable	
Storm Event	**Depth of Ponding**
10-year	No ponding permitted
25-year	0.15m
50-year	0.30m
100-year	See note
Note: A public notification or closure system or both is required for the pathway to alert pedestrians that the tunnel is closed during 50-year or higher storm events. The 100-year storm event shall be analysed to quantify the depth of ponding with results incorporated in the design requirements of the closure system.	
These requirements apply to pumping stations that require an ECA under the Environmental Protection Act. They do not apply to underground pedestrian tunnels reviewed under the Ontario Building Code.	

Station Capacity

The designer shall determine the station capacity by optimizing the number and capacity of the duty pumps with the storage volume. The capacity of the downstream storm sewer will need to be verified. The City preference is to use a dry well/ wet well configuration.

Design Storm Event

A 100-year design storm event shall be used for all roadways such as cross-boundary, arterial, collector, and local. The City preference is for the input hydrograph to be generated as part of an InfoWorks model.

The hydrologic design shall include drainage area boundaries and area, appropriate runoff coefficients, a City accepted design runoff hydrograph 6-hour Chicago storm distribution with 10 minute time steps and a ratio to peak r=0.38 and all cumulative inflow.

Storage/Detention Tank

The storage/detention tank should be designed to store the volume of the 100-year design storm rainfall generated by the inflow hydrograph. Provide adequate venting for sub-surface detention systems, for example tanks and chambers to ensure hydraulic functioning under 100-yr design storm and prevent air entrapment issues.

A grinder is the preferred option to reduce the particle size prior to pumping. An influent screen equipped with a grit chamber is required if there is no grinder. Depending on the estimated inflow, and the proximity of upstream manufactured treatment units, a grit chamber suitable for the collection of debris and sediments may be incorporated in the design.

The tank must include a flushing system to remove accumulated sediments on the floor of the tank after a tank dewatering event. A tipping bucket assembly which utilizes recycled stormwater is preferred. Other flushing system options, including those which require a potable water supply line to fill the tipping buckets, complete with remote control, can also be considered and require City approval.

Odour control, ventilation and gas detection monitoring system must be included in design. Passive ventilation systems are preferred over active ventilation systems.

The minimum outlet pipe diameter, connecting the storage/detention tank to the wet well, shall comply with the City's minimum standard for the design of a storm sewer, which is 300mm. If a further reduction is required to control flow, an orifice plate shall be used with a minimum diameter of 75 mm. The plate shall be designed such that it can be removed to facilitate maintenance.

Flooding

The extent of potential flooding should be analyzed for both the existing condition and the proposed condition. Ponding diagrams should be prepared to show the depth and area for the full range of storm events (2, 5, 10, 25, 50 and 100 year). This is required to establish and quantify the adverse impacts when the pumping station is inoperative, which may occur during a power outage or mechanical failure. Private property should not be flooded. A suitable factor of safety should be built into the design of the stormwater pumping station and the associated storage facility, depending on the risk and the criticality of the surrounding infrastructure and services, for example, hospitals, fire stations, schools and so on.

The analysis for the 100 year event should include the following criteria:

- No barrier curb overtopping with the flow spread leaving at least one lane open in each direction to vehicle traffic
- Inlets at the sag designed assuming the capacity has been reduced by 50 per cent as a result of blockage associated with debris; Reference–MTO SD-7 Depressed Roadways and Underpasses, *https://collections.ola.org/mon/20000/279197.pdf* .
- Allowable high water elevation in the pumping station shall have at least 0.3m of freeboard below the lowest roadway inlet; Reference -MTO SD-7 Depressed Roads and Underpasses, *https://collections.ola.org/mon/20000/279197.pdf* .

The siting of the stormwater pumping station should ensure the structure and equipment is protected from damage caused by the 100-year flood event, with the station remaining fully operational and accessible during the 100-year storm event.

Electromechanical equipment and associated instrumentation shall be housed above the 100-year event rainfall elevation.

Location, Siting, Accessibility and Security

The location of the station should consider future maintenance. Access hatches should be large enough to permit equipment entry and located away from any overpass structure. Preferably, the station itself should not be located on the travelled portion of the municipal right-of-way.

The station shall be accessible to City vehicles that may need to be parked next to the chambers and provide enough room for setting up a mechanical hoist. The access should be located near the area of the pump intakes to facilitate cleaning and maintenance.

Provisions are also required to secure against unauthorized entry. This includes proper lighting, fencing, locking systems including lockable maintenance hole covers, and providing an unauthorized entry alarm incorporated into the SCADA system.

Provisions for safe access and operation include, guard rails, ladders, stairwells, slip-free surface treatments, ventilation, heating, dehumidification, and posting of a laminated operations schematic diagram showing the station piping, valves, and by-pass connection points.

Stormwater Quality

The design shall consider operational problems that could result from grit and suspended solids when it reaches the wet well. The pump impeller/ propeller shall be designed to convey a minimum solid size of 75 mm. The WWFM guidelines with respect to water quality control targets may apply.

Fire Safety

The designer shall conduct a review to establish the classification of the facility as per the National Fire Protection Association (NFPA) requirements (NFPA 820 (2016)) and the Ontario Electrical Safety Code OESC. All electrical equipment shall be designed for the area of classification, with an objective of installing the equipment in an unclassified area where possible. Refer to the Electrical/ Mechanical Systems, SCADA and Process Control System section of this appendix for more details.

Design

The site constraints will control and determine the design. It is possible that a stormwater pumping station can either:

a) serve a small drainage area and require a large pump or,
b) serve a large drainage area and require a small pump, depending on the size of the storm detention tank that can be positioned at the site.

The upstream collection and detention system should be designed to minimize the depth of the station. The allowable high water level in the wet well will govern the depth of the uppermost inlet to the pumping station.

Design considerations may include, but not limited to:

- determine existing drainage area,
- survey site for existing sewers, watermains, power and telephone line sources, vehicle and pedestrian areas, site access, and available area for the pumping station installation,
- locate low point and minimize the drainage area to the pumping station,
- geotechnical investigation,
- hydrogeological investigation,
- evaluate receiving sewer capacity and any basement flooding concerns,
- develop inflow hydrograph,
- develop mass curve from inflow hydrograph,
- establish storage unit size together with utilizing the existing collection system to achieve target outflow rate to pumping station,
- storage tank empty duration
- systematic analysis including minimum and maximum downstream and upstream water level considerations
- select initial wet well dimensions,
- develop stage versus storage relationship,
- establish usable storage,
- identify need for check valves and/or flap gate control
- establish pump switching/sequencing (cut-on, cut-off elevations),
- mass curve routing,
- routing sufficiency checks,
- determine Total Dynamic Head,
- development of system head curves,
- develop process control narratives,
- establish an operation range,
- establish power requirements,
- select pumps and piping from manufacturers' performance curves and catalogue data,
- perform cycle time checks,
- design optimization (balancing storage with pump type and size) that will minimize the total life-cycle cost,

- analysis ponding areas and depths in the event of a power outage and develop provisions to minimize impacts,
- determine back-up power requirements and site unit location,
- backup/standby power system,
- perform a hydraulic/ transient analysis of the forcemain(s), and
- failure prevent contingency plan.

Provisions should be made for potential station expansion to accommodate any future road widening. If there is a significant modification to the roadway, the pumping station may have to accommodate a higher flow or a higher volume or both. It is preferred that the station is designed such that it can be expanded to accommodate an additional pump and/or larger pumps as opposed to extensive structural changes to storage structures.

A cost benefit analysis should be conducted to account for this possibility.

The pumping station shall be designed to provide adequate clearance between the pipes, appurtenances, and structures to permit on-going operation and maintenance.

Structures

The City prefers pre-cast concrete circular units as opposed to cast-in-place units. Watertight gaskets are to be used for precast sections.

The City will accept pre-packaged pumping stations constructed of reinforced fiberglass plastic which are designed to minimize infiltration and inflow from groundwater, subject to the review of the support documentation.

All structures should be designed and constructed to minimize infiltration and inflow, and resist hydrostatic uplift pressures with an appropriate safety factor. New proposed products shall follow the process indicated in *Chapter 6, Material Specifications* of the manual prior to being accepted for use by the City.

Pumps

Pumps operating with variable frequency drive (VFD) are required. As a minimum, there is to be one pump operating (duty pump) and one pump standby.

In most cases, it is preferred all the pumps are of equal capacity to give more flexibility for operation. Please note that VFD pumps can be set to operate as fixed rate pumps when operating at the maximum frequency.

The specific type of pump chosen is dependent on the application, the amount of head (static lift (SL) and total dynamic head (TDH)), the rate of inflow (Qin), the volume of flow, and electromechanical requirements. For most applications the City preference is to use non-clog centrifugal pumps, single-stage, mixed flow type pumps.

Submersible pumps shall be self-priming and mounted such they can be easily lifted and removed from the wet well for maintenance and replacement. The station design shall built-in redundancy to a) allow for the possibility of pump failure and b) a reduction in performance due to the usage of the equipment, throughout the life span of the asset.

The City may require oversizing the pumps (duty and standby) beyond the minimum operating requirements to handle the peak flows; depending on the criticality of the infrastructure located within the drainage area. Pump protection sensors must include vibration sensors, temperature sensors and leak sensors as well as upper and lower bearing temperature sensors.

Electrical/ Mechanical Systems, SCADA and Process Control System

The design requirements are similar to sewage pumping stations. The applicable reference documents in the City specifications include:

- Toronto Water Process Equipment Standards Division 11000
- Toronto Water Instrumentation Design Standards Division13000

- Toronto Water Mechanical Requirements Standard Division 15000
- Toronto Water Electrical Specification Standards Division 16000
- City of Toronto's PCS Implementation Standards.

The division documents are provided with requests for proposals and tenders through the Purchasing and Materials Management Division.

The pumping station Motor Control Center (MCC) / control panel / electrical kiosk shall be installed in a location above the 100-year return period water elevation.

All electrical equipment required for the pumping station shall be designed for the area of classification, with an objective of installing the equipment in an unclassified area where possible. The designer shall consider the possibility of the presence of flammable gases and floating flammable liquids, along with the possibility of a buildup of vapors from flammable or combustible liquids. It is possible that these hazardous substances could emanate to a storm sewer as a result of a motor vehicle accident. As noted under the Fire Safety section, all equipment and materials installed at the pumping station shall be in accordance with the National Fire Protection Association (NFPA) requirements (NFPA 820 (2016)) and the Ontario Electrical Safety Code (OESC).

The designer shall then determine the classification of the facility, by assessing the probability of an explosive gas atmosphere, and its associated frequency of occurrence and duration, along with the design of the ventilation system.

SCADA is required for operation and monitoring station equipment/instrumentation performance and alarms, including

a) sensing power loss,

b) Automatic Transfer Switch (ATS) activation,

c) alarms to indicate unauthorized entry, power failure, and high water levels, and

d) when the pumping station is off line. Hard wiring is preferred over a wireless system. The City remote locations are currently located at two Toronto Water facility yards.

Pump sequencing will be designed on a case-by-case basis to ensure the minimum cycling time complies with that specified by the manufacturer for a pump type and size.

Wet Wells

The wet well volume should be sized for the ultimate capacity of the station, including any potential future expansion resulting from a road widening. The wet well should, however, not be designed for storage as this justification for enlargement will encourage sedimentation around the pumps.

The wet well size is based on the cycle time of the pump as per the manufacturer's recommendation and industry standard.

After a pump ON/OFF cycle the minimum time for a pump to be called again into operation will be 10 minutes based on the wet well design.

The clearance between the pump and sump floor should be based on the manufacturer's recommendation together with a hydraulic study of the wet well, a computational fluid dynamic (CFD) modeling to assess optimal hydraulic efficiency in the well for the pumps efficient operation.

Trash screens or racks may be provided at the wet well entrance to prevent large debris from interfering with the pump propellers/ impellers.

The wet well for a dry-pit station should be designed to ensure even distribution of flow to all pump inlets.

Baffles may be required to ensure uniform flow distribution is achieved to all duty pumps, while trapping silt before entering the wet well pump chamber.

Detention Tank Located Upstream of Wet Well

Concrete is the preferred material for an in roadway installation. Other materials can be reviewed for acceptance on a case-by-case basis. New proposed products shall follow the process indicated in *Chapter 6, Material Specifications* of the manual prior to being accepted for use by the City.

The detention tank shall be sized to store the volume under the inflow hydrograph for the 100-year storm event. The detention time shall:

a) optimize settling,

b) minimize odours,

c) control the discharge to the pumping station wet well and receiving sewer, and

d) meet requirements for emptying the tank prior to the next storm event.

The detention tank shall be designed to facilitate maintenance. A facility also designed to promote infiltration will only be considered if there is a low groundwater table with favourable soil conditions, and located off of the roadway.

For pumping stations in the public right-of-way, a pre-treatment Manufactured Treatment Device (MTD) (e.g., oil grit separator or filter device) unit may be installed for the removal of TSS from stormwater runoff upstream of the facility. Refer to City's most up-to-date policy and guidelines on MTDs.

Valves, Appurtenances, Suction and Discharge Piping

The discharge pipe from the pumping station shall be designed to be as simple as possible. For a lift station, the discharge piping shall be horizontal where it exits the station and use gravity discharge to a downstream sewer. When a forcemain is required, its length shall be minimized, and installed on a uniform grade.

A discharge pipe in a pumping station may consist of check valves, plug valves, air release valves, gate valves, and reducers, along with a discharge manifold, elbows and bends. The design should ensure these appurtenances can be kept free from sedimentation and silt build-up. This can be achieved by the downstream forcemain being designed to carrying the sediments in suspension to the discharge point with a minimum velocity of 0.8 m/s and a maximum velocity of 3 m/s.

The piping shall be installed below frost depth. Insulation will be required for any piping with less than 1.65 m cover. Check valves should be located on horizontal lines rather than vertical lines to prevent sedimentation on the downstream side after the valve closing.

Gate valves shall be provided on each pump discharge line to facilitate operation and maintenance. However, the number of valves should be minimized to reduce head loss.

The results and recommendations from a hydraulic/transient analysis shall determine the need for, type and size of air release valve on the discharge line. The size of these valves is dependent on the pump capacity and the volume of air to be released, which should be determined through a hydraulic/ transient study recommendation. All outlet pipes are to be above the flood level of the outfall, however, if this is not achievable then a flap gate is to be installed at the end of the pipe to prevent the re-entry of water after pumping. Adequate access shall be provided for all forcemain controls that are exterior to the station.

Flow Measurement, Sampling and Monitoring

Sampling ports may be required when determined by the City. Typically, no sampling is required for a stormwater only system, however, is required when combined sewer overflow is present. It may also be required if the station is located near a decommissioned landfill site for which a leachate containment system is present.

Monitoring shall include but not limited to; the level indicating transmitter (LIT), flow indicating transmitter (FIT), pressure indicating transmitter (PIT), high water in the wet well, the number of starts for each motor, cumulative operation time of each pump, leakage in dry well (for dry-pit stations), debris levels/amounts, motor/ engine failure, ambient temperature, temperature of bearings and motor wiring, gases, and unauthorized entry in accordance with Toronto Water Instrumentation design standards and Toronto Water process equipment standards.

Flushing Systems and Water Supply

The City's preference is for an automatic flushing system. Tipping buckets which use stormwater are preferred to systems that use potable water. Any system using potable water must have backflow preventer in accordance with CSA B64.1 to avoid back siphonage to the City's water supply system.

There should be no physical connection between any potable water supply and a sewage pumping station which under any condition might cause contamination of the potable water supply. The same principle applies to a stormwater pumping stations, which by definition under the Ontario Water Resources Act is considered to be 'sewage'.

The incoming water supply line to the station should be a minimum of 50 mm diameter and be equipped with a reduced pressure principle backflow preventer. Where a potable water supply is to be used for human purposes, that is to say washrooms, sinks, showers, drinking fountains, eye wash stations and safety showers, a break tank, pressure pump and pressure tank needs to be provided. Water needs to be discharged to the tank through an air gap at least 150 mm above the maximum flood line or the spill line of the tank, whichever is higher.

The location and sizing of the access points shall consider the need for manual flushing in the event that the automatic system is inoperative.

Special Considerations

A manifold at a pumping station must be sized to ensure there is no adverse reduction in hydraulic efficiency when there is more than one pump in operation.

Stormwater pumping stations designed to operate on an infrequent basis will require regular inspection and performance verification. This includes the inspection of level sensors used to activate the pumping station. Options include floats, probes, pressure transducers, ultrasonic transducers, bubblers and radar. The device chosen shall be mounted correctly and some redundancy shall be provided in the design. Other concerns include corrosion resistance of metallic material and seal deterioration which can lead to seizing of the pumps.

The pump station building shall include remote monitoring and controls for temperature, humidity and ventilation.

Standby Power and Emergency Operations

Standby power is required for all stormwater pumping stations designed to convey stormwater. This may be achieved by using hydro service from two independent power grids, a natural gas generator, or a diesel generator. Battery power for backup is not acceptable. An Automatic Transfer Switch (ATS) is required to change to the standby power source in the event of a power failure at the station. This is a requirement of the Site Acceptance Test (SAT) for the station.

Pumping stations specifically designed for the maintenance of inverted siphons, recirculation of stormwater in a dunker facility, or for dewatering; such as for a basement flooding prevention facility without a gravity outlet, must be designed to accommodate a plug-in generator as a minimum.

In all cases, the City shall be consulted during the design stage about the standby power requirements.

Operation and Maintenance

An operation and maintenance manual is to be provided to recommend the frequency of inspection, monitoring, and maintenance, as well as a contingency plan in the event of abnormal conditions. An electronic logbook is required for record keeping, including quantifying the amount of silt removed. A Work Management System (WMS) standard shall be included in the design and contract (provision) for maintenance programming /scheduling of equipment and associated appurtenances.

Forcemains

A twin forcemain – one standby – is required to permit maintenance and emergency works. Should it be proposed to eliminate a standby forcemain from the design, it would need approval of the City. Typically this would only be acceptable when the discharge pipe from the pump station is very short and the pump station itself is designed specifically to permit maintenance of individual barrels on an inverted siphon, recirculation of stormwater, or for dewatering.

Each forcemain shall be designed to convey the design capacity of the pumping station to the discharge maintenance hole. The pumping of the discharged flow through the alternate forcemain is preferred to be controlled by valves operation via SCADA. The forcemains shall be installed on a uniform slope to avoid the need for high points. The outlets of the forcemains shall be to the same maintenance hole at an elevation which provides an air gap. A hydraulic/transient analysis is required for the forcemain design. A Computational Fluid Dynamic (CFD) analysis is required for large wet wells and storage shafts/ tanks.

Installations close to Lake Ontario should provide for the possibility of a high groundwater/lake water level, with fluctuating elevations on a seasonal and yearly basis. This will require the installation of a flap gate/ valve at the end of the forcemain to prevent the re-entry of water into a submerged forcemain outlet.

For installations where the pump discharge rate requires restriction to the receiving sewer due to insufficient sewer capacity, a water level monitoring sensor must be installed in the receiving maintenance hole connected to the receiving sewer. A signal can then be transmitted back to the pump control system, instructing the pumps to reduce its discharge rate to avoid pumping above the permissible allowable discharge rate to the sewer.

The preferred minimum forcemain diameter is 100 mm. However, 75 mm forcemains will be considered on a case-by-case basis depending on the pipe length, hydraulic computations and firm capacity of the station.

The preferred pipe material is PVC. Other pipe material may be used based on the designer’s assessment and dependent on the existing soil and site conditions along the proposed forcemain route.

A hydrogeological assessment of the soil conditions may be necessary to determine the bearing capacity and groundwater level to determine the bedding and pipe material to be used.

Appendix J – Sewer Pipe Air Testing

Ministry of the Environment and Climate Change

Environmental Approvals Access and Service Integration Branch

135 St. Clair Avenue West
Toronto ON M4V 1L5
Tel.: 416 314-8001
Fax: 416 314-8452

Ministère de l'Environnement et de l'Action en matière de changement climatique

Direction de l'accès aux autorisations environnementales et de l'intégration des services

135, avenue St. Clair Ouest
Toronto ON M4V 1L5
Tél : 416 314-8001
Téléc. : 416 314-8452

May 20, 2015

Alex Sandovski, P.Eng., MBA
IPEX Inc.
6810 Invader Crescent
Mississauga, ON LST 2B6

Dear Mr. Sandovski:

This is a follow up to our recent meetings where we discussed the field testing requirements for sewer pipes and the implementation of Source Water Protection (SWP) policies.

As you are aware, current MOE standards under Procedure F-6-1, section 4.0 require sewer pipes that do not meet the minimum separation distance from watermains, to have the sewer pipes constructed of materials and with joints that are equivalent to watermain standards and shall be pressure tested in accordance with Division 401 of the Ontario Provincial Standards Specification (OPSS) published by the Ontario Ministry of Transportation, at a pressure of 350 kPa (50 psi), with no leakage. In addition to this, the ministry is in the process of implementing a SWP policy that would make this similar requirement for new sanitary pipes that fall under a designated significant drinking water threats. I understand from your presentation that this stipulation is causing hardship in the industry as pressure fittings and mechanical restraints are not available in sewer pipe sizes.

After careful review of this issue please note that an alternate approach that is considered acceptable to the ministry is to construct the sanitary sewers with materials and with joints that are equivalent to watermain standards of construction and are to be pressure tested with a low air pressure test of 5 psi as per OPSS 410 performed in situ during construction. For the low air pressure test, and to satisfy ministry requirements, you must ensure that:

(1) The sanitary sewer pipe joints are certified to 50 psi hydrostatic pressure (on lab, manufacturing facility or in situ) by a third party accredited by the Standards Council of Canada; and
(2) The sanitary sewer pipes are mandrel tested or tested by laser profile with satisfactory results.

2069 (2011/10)

- 2 -

Please note that this is an interim decision and will no longer apply should the Ministry revise Procedure F-6-1 with respect to its in-site pressure testing requirements for sewers installed without the required minimum separation from watermains.

Again, thank you for bringing your concerns to my attention, and please accept my best wishes.

Yours sincerely,

Edgar Tovilla, P.Eng.
Director, Part II.2 of the EPA

2069 (2011/10)

Appendix K – Bibliography

Design Criteria (Former Municipalities in Toronto)

City of Etobicoke – Guide for Consulting Engineers for the Development of Land in the City of Etobicoke
By City of Etobicoke Works Department. Published by City of Etobicoke, 1991.

City of North York – Public Works Engineering Design and Development Guidelines
By North York Works Department. Published by City of North York Works Department, 1994.

Borough of Scarborough – Design Manual
First Edition, by Borough of Scarborough. Published by Borough of Scarborough, 1971.

City of Toronto – Guidelines for the Design of Local Water Distribution and Sewer Systems
By Tim Dennis. Published by City of Toronto, 1999.

Design Criteria (Provincial)

Ministry of the Environment – Design Guidelines for Drinking–Water System
By Ministry of the Environment. Published by Province of Ontario, 2008.

Ministry of the Environment – Design Guidelines for Sewage Works
By Ministry of the Environment. Published by Province of Ontario, 2008.

Ministry of the Environment – Stormwater Management Planning and Design Manual
By Ministry of the Environment. Published by Province of Ontario, 2003.

Design Guidelines (Current City Departments)

Building Toronto Together – A Development Guide
By Toronto Building. Published by City of Toronto, 55 John Street, Toronto, Ontario, M5V 3C6, 2006.

Wet Weather Flow Management Guidelines
By Toronto Water. Published by City of Toronto, 55 John Street, Toronto, Ontario, M5V 3C6, 2006.

Reports

Metropolitan Toronto – Metropolitan Toronto Wastewater System
By Metro Works. Published by The Municipality of Metropolitan Toronto, 55 John Street, Toronto, Ontario, M5V 3C6, 1993.

Design Criteria (Other Cities)

City of London – Design Specifications and Requirements Manual
By Environmental and Engineering Services Department. Published by City of London, 2019.

City of Ottawa – Ottawa Design Guidelines
By City of Ottawa Infrastructure Services Department. Published by City of Ottawa, 2010.

Region of Peel – Sanitary Sewer Design Criteria
By Region of Peel Public Works Department. Published by Region of Peel, Modified March 2017.

The Regional Municipality of Durham – Design Specifications
By Works Department. Published by the Regional Municipality of Durham, 605 Rossland Road East, Whitby, Ontario, L1N 6A3, 2019.

Style Guides

Writing Clearly – A Writing and Style Guide for the Toronto Public Service
By Strategic Communications, City Manager's Office. Published by City of Toronto, 55 John Street, Toronto, Ontario, M5V 3C6, 2016.

Writing Revisable Manuals – Print and Online
By Duncan A. Kent. Published by Carswell Thomson Professional Publishing, One Corporate Plaza, 2075 Kennedy Road, Scarborough, Ontario, M1T 3V4. ISBN 0-459-56346-7.

Glossary

AADT – Annual average daily traffic is a calculated annual estimate of the average number of vehicles travelling through a traffic monitoring site during a midnight to midnight period on any day of the year.

ASTM – American Society for Testing Materials

AWG – American Wire Gauge

AWWA – American Water Works Association

Catchbasin – Box like underground concrete structure with openings in the curb and gutter designed to collect runoff from the streets and the pavement.

City – The City of Toronto—the corporation—and will be referred to as the City for the purposes of this document.

Combined Sewer – A sewer that is designed to function simultaneously as a storm sewer and a sanitary sewer.

Combined Sewer Systems – A network of pipes that includes combined sewers and includes overflows to the natural environment prior to connecting to a wastewater treatment plant. These types of systems are generally located in older parts of the City, specifically the downtown core. The construction of new combined sewers are no longer permitted other than for the replacement of existing combined sewer pipes to keep the sewage system in a state of good repair.

Consulting Engineer – A professional engineer or firm of engineers retained by the City or a developer and skilled and experienced in municipal work and land development projects and registered with the Professional Engineers of Ontario.

Contract Administrator – The individual or firm responsible for overseeing the construction and administration of the works and representing the City's interest.

Canadian Standards Association (CSA) – is a non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems and personnel in Canada.

Developer – The owner of land upon which municipal services will be located and ultimately owned by the City.

DIPS – Development Infrastructure Policy and Standards apply to public local streets and private streets or mews that are created to serve grade related residential developments.

Drinking Water Works Permit – Refers to Drinking Water Works Permit No. 010-201 between the City of Toronto and the Ministry of the Environment, Conservation and Parks. It also refers to the program for the review of drinking water works under Form 1 - Record of Watermains Authorized as a Future Alteration for watermains up to 1500 mm. Whereas above 1500 mm it is a Schedule C application submitted directly to the MECP as its review is not covered under Drinking Water Works Permit No. 010-201. Form 2 - Record of Minor Modification or Replacement to the Drinking Water System, and Form 3 - Record of Addition, Modification or Replacement of Equipment Discharging a Contaminant of Concern to the Atmosphere.

The Drinking Water Works Permit is an agreement between the City of Toronto and the Ministry of the Environment, Conservation and Parks (Permit No. 010-201) for which the City is granted the authority as owner of the drinking water system, to permit alterations to the drinking water system, subject to the conditions particularly described in the permit.

Dry Weather Flow – Sewage from wastewater flows such as the combined input of industrial, domestic and commercial flows, and infiltration and inflows from foundation drains or other drains during periods when rainfall or snowmelt is not occurring.

Dual Drainage – The accepted best practice for the collection of urban storm drainage systems consist of two separate and distinct systems—the minor system and major system.

Engineer – The licensed individual or firm responsible for the design of the works or their designate and registered with the Professional Engineers of Ontario. May also be referred to as the design engineer.

Chief Engineer and Executive Director – The person appointed by the City from time to time as the Chief Engineer and Executive Director of Engineering and Construction Services and his or her successors or his or her duly authorized representative.

Fillets – A curve that is a fillet is a smooth blending arc between two curves.

General Manager – The person appointed by the City from time to time as the General Manager of Toronto Water and his or her successors or his or her duly authorized representative.

GFA – Gross Floor Area

Groundwater – Groundwater is defined as water below the surface of the ground that occupies a zone of the earth's mantle that is saturated with water.

Greenfield Development – Development of land where there has been no previous development.

GSC – Geodetic Survey of Canada

IDF – An intensity duration frequency curve is a statistical description of the expected rainfall intensity for a given duration and storm frequency.

Imperial – British system units

Major Drainage System – That storm drainage system which carries the total runoff of the drainage system less the runoff carried by the minor system—storm sewer. The major system will function whether or not it has been planned and designed and whether or not developments are situated wisely with regard to it. The major drainage system usually includes many features such as streets, gullies and major drainage channels.

Minor Drainage System – That storm drainage system which is frequently used for collecting, transporting and disposing of snowmelt, miscellaneous minor flows and storm runoff up to the capacity of the system. The capacity should be equal to the maximum rate of runoff to be expected from the minor design storm which may have a frequency of occurrence of one in 2 years. The minor system may include many features ranging from curbs and gutters to storm sewer pipes and open drainage ways.

MCR – Municipal Consent Requirements—referred to as “Requirements for the installation of services within the city of Toronto streets”.

MECP – Ministry of the Environment**,** Conservation and Parks

MTM – Modified Transverse Mercator projection

NAD – North American Datum

NFPA – National Fire Protection Association

Non-Industrial Land – Is any land that is not defined as industrial land. Industrial land is defined by Ontario Regulation 525/98 under Section 53 of the Ontario Water Resources Act and includes, for example, gas stations, auto repair shops, warehouses for storage of goods or materials, sites were any waste storage or waste management activities occur.

NSF – National Sanitation Foundation

OCPA – Ontario Concrete Pipe Association

OPSD – Ontario Provincial Standard Drawing

OPSS – Ontario Provincial Standard Specification

Overland Flow Path – Open space floodway channels, road reserves, pavement expanses and other flow paths that convey flows typically in excess of the capacity of the minor drainage system.

Partially Separated Sanitary Sewer – A partially separated sewer system consists of storm sewers that convey surface runoff, primarily from roadways, and sanitary sewers that receiving sanitary sewage as well as foundation drains and some driveway drains. These types of systems are typically found in older subdivisions prior to the introduction of fully separated systems.

RAP – Reclaimed Asphalt Pavement

RCM – Reclaimed Concrete Material

R.R.O. – Revised Regulation Ontario

Runoff – That portion of the water precipitated onto a catchment area, which flows as surface discharge from the catchment area past a specified point.

SI – System International units

DR – Dimension ratio describes the correlation between the pipe outside diameter and the thickness of the pipe wall. The lower the DR number, the thicker the pipe wall and therefore stronger.

Section 681 – Sewer Use Bylaw

Section 851 – Water Supply Bylaw

Separated Sanitary Sewer – A separated sewer system is a system in which all municipal sewage is conveyed to sanitary sewers and all surface runoff is conveyed to storm sewers. Foundation drains are not connected to either the sanitary or storm sewer systems. This type of system is currently the standard for all new subdivisions.

Sewershed – The drainage area of one or more contributing sewer areas to a sewer system.

STAR process – Streamlining The Application Review. This process establishes criteria for the streaming of most planning applications and sets target timelines for their resolution. The STAR process establishes clear service level expectations, a co-ordinated approach to reviewing applications and clearly defined roles and lines of communication for City staff. The goal of STAR is to provide a faster, more efficient review of applications.

Transfer of Review – The Transfer of Review Program is a program where a designated municipal authority reviews the application and supporting documentation on behalf of the Ontario Ministry of the Environment, Conservation, and Parks. The municipal authority then submits the application to the ministry together with their recommendations for approval or comments explaining why an application is not recommended for approval.

Toronto Municipal Code – A municipal code adopted by Toronto city council under Section 248 of the Municipal Act, 2001 or a predecessor of that section, or deemed to be a bylaw adopted by council under the City of Toronto Act, 1997.

The Toronto Municipal Code is updated four times per year. The city of Toronto web site can be checked for “recent amendments” or changes to specific code chapters since the last code update. These bylaws must be consulted along with the code chapters.

TRA – The Road Authority is a service provided by the Ontario Good Roads Association and is an internet based information resource to promote the sharing of information.

TRCA – Toronto Region Conservation Authority

ULC – Underwriters Laboratories of Canada

UNI-B – Uni-Bell PVC Pipe Association

Wet Weather Flow – Flow resulting during periods when rainfall or snowmelt is occurring.

WWFM Guidelines – Wet weather flow management guidelines prepared to support the wet weather flow management master plan. These guidelines provide the technical and quantitative tools needed to support the WWFM policy and the wet weather flow management master plan and are based on recent performance monitoring data and synthesis and provincial and international wet weather flow technical guidelines, standards and manuals of practice.

Index

City of Toronto

Engineering and Construction Services – Business Improvement and Standards
North York Civic Centre
5100 Yonge St. 4th Floor
Toronto, Ontario
M2N 5V7

toronto.ca/ecs-standards