4.0 STORM DRAINAGE SYSTEM

4.1 General

Urban development alters the hydrology of the land surface, affecting the quality and quantity of surface runoff. The storm drainage system is to be designed to carry surface runoff from residential, commercial, industrial and roadway areas. In some instances, foundation drainage from residential dwellings may also be routed to the storm drainage system. Surface runoff is to be conveyed by a dual drainage system (minor/major) comprised of an underground storm sewer and a continuous, overland flow route on a roadway surface or open channel. Ultimately, surface runoff is to be conveyed to natural receiving waters, often following treatment and control in a stormwater management facility (refer to Section 5.0) to prevent the impairment of water quality and degradation of natural streams, rivers and their ecosystems. The overall purpose of a storm drainage system is to provide an affordable, functional and continuous system to protect property, assets and the environment.

The minor storm drainage system is typically comprised of an underground network of pipes and structures. The minor system is designed to provide a reasonable level of conveyance and safety for pedestrian and traffic use through removal of lot and street surface runoff from relatively minor (more frequent, less intense) rainfall events.

The major storm drainage system is typically comprised of a surface network of roadways and/or overland flow channels designed to convey stormwater runoff from extreme (less frequent, more intense) rainfall events. The major system is designed to function when the minor system capacity is exceeded or a component of the minor system fails. A major system exists, whether it is designed or not. Failure to properly design the major system may result in unnecessary flooding and property damage.

Where development proposals include any sort of alterations to a municipal drain, the laws, regulations and specifications of the Ontario Municipal Drainage Act shall be strictly adhered to and the design specified by the Consulting Engineer for the Municipal Drain shall be met.

A majority of the Town of New Tecumseth is within the jurisdiction of the Nottawasaga Valley Conservation Authority (NVCA), while a smaller area in the southeast corner of the Town of New Tecumseth is within the jurisdiction of the Lake Simcoe Region Conservation Authority (LSRCA). The Consulting Engineer responsible for the design of storm drainage systems shall consult both the Town and the Conservation Authority to confirm/clarify issues, policies and design requirements. Many of the standards included herein refer to design parameters and criteria set by NVCA. The Consulting Engineer is responsible for ensuring these design parameters and criteria are appropriate when working within the jurisdiction of LSRCA.

4.2 Service Area

Systems shall be designed to service all areas within the subdivision to their maximum future development in accordance with the Official Plan. Development applications must take into consideration surface runoff on a subwatershed basis. Consideration shall be given to the effect of upstream future development on the storm drainage system design. Connections to existing sewers shall be approved by the Town of New Tecumseth. Discharge of the storm drainage system to a natural receiving system must be approved by the Town of New Tecumseth and the Conservation Authority. In some circumstances, the Town of New Tecumseth may request that existing receiving storm drainage systems be upgraded to meet current standards or improve functionality and safety.

4.3 Design Standards

4.3.1 Minor System

The purpose of the minor system is to quickly and efficiently remove stormwater runoff from the surface and transport runoff to a safe outlet, such as a stormwater management facility or natural watercourse. Downspouts are not to be connected to the storm sewers. Stormwater pumping or siphons are not acceptable; storm systems must drain by gravity. In the event that Minimum Standard No. 1 can be achieved, then Minimum Standard Nos. 2 and 3 will not be permitted.

Minimum Standard No. 1

A 1:5 year return period storm design, plus adequate provision for continuous overland drainage of roads. Dwelling units shall be fitted with sump pumps to collect foundation drainage, which shall be pumped over the foundation wall and directed to the storm sewer system. Town of New Tecumseth Standard Drawing TNT.SD 406 shall be referenced for the sump connection to the storm sewer.

The Consulting Engineer shall demonstrate, through the use of a dual drainage and hydraulic grade line analysis as outlined in Sections 4.5.10 and 4.5.11, that the hydraulic grade line in the storm sewer will not cause unreasonable operating conditions during 1:100 year storm conditions (e.g ., uplift of maintenance hole lids, extended flooding of road base via subdrains, etc.)

Minimum Standard No. 2

A 1:5 year return period storm design with gravity foundation drain connections to the dwelling units, plus adequate provision for continuous overland drainage of roads. The Consulting Engineer shall demonstrate, through the use of a dual drainage and hydraulic grade line analysis as outlined in Sections 4.5.10 and 4.5.11, that the hydraulic grade line in the storm sewer is a minimum of 0.3 m below the underside of footing elevation of the dwelling units during 1:100 year storm conditions.

Minimum Standard No. 3

A 1:2 year return period storm design (1:5 year storm for arterial roads) with a separate collection sewer for foundation drainage, plus adequate provision for continuous overland drainage of roads.

The Consulting Engineer shall demonstrate, through the use of a dual drainage and hydraulic grade line analysis as outlined in Sections 4.5.10 and 4.5.11, that the hydraulic grade line in the storm sewer will not cause unreasonable operating conditions during 1:100 year storm conditions (e.g ., uplift of maintenance hole lids, extended flooding of road base via subdrains, etc.)

4.3.2 Major System

The major drainage system conveys surface runoff from the extreme rainfall events that exceed the capacity of the minor system. In the Town of New Tecumseth, the major system must be designed for the 1:100 year return period storm. The major system shall facilitate the safe conveyance of these overland flows within the roadway or overland flow channel to a stormwater management facility or natural stream corridor. A preferential route for overland flow generated by an event greater than the 1:100 year return period storm shall be provided to a receiving system.

4.4 Design Methodology

4.4.1 Meteorology

The intensity-duration-frequency (IDF) curve information in accordance with Design Chart 1.01(e): District IDF Curves, District 5 - Owen Sound: for Basins East of Collingwood; Ontario Ministry of Transportation, "MTO Drainage Management Manual 1997 and shall be used for calculating intensity values for input to the Rational Method.

Confirm IDF Chart constants?

Return Period	IDF Equation Constants		
	A	B	C
2-yr	771.981	7.180	0.819
5-yr	1105.505	8.570	0.829
10-yr	1372.607	9.291	0.836
25-yr	1648.685	10.000	0.838
50-yr	1872.495	10.099	0.842
100-yr	2022.828	10.034	0.837

The average rainfall intensity shall be calculated using the following equation:

$$I = \frac{A}{(T_c + B)^C}$$

where I is average rainfall intensity (mm/hr)
A,B,C are the IDF equation coefficients (dimensionless)
T_c is the time of concentration (min)

4.4.2 Rational Method

Minor storm sewer systems with tributary areas less than 50 hectares shall be designed according to the Rational Method formula:

$$Q = 2.778 \cdot C \cdot I \cdot A$$

where Q is the peak flow (L/s)
C is the runoff coefficient (dimensionless)
I is the average rainfall intensity (refer to Section 4.4.1, mm/hr)
A is the tributary area (ha)
2.778 is the unit correction coefficient

When using the Rational Method to determine peak flow rates up to the 1:10 year design storm, the following values of C should be used. An average weighted runoff coefficient shall be calculated for drainage areas comprising a combination of land uses.

Chart from the MTO SWD manual?

Land Use	Runoff Coefficient, C
Parks, Cemeteries or Open Space (> 4 hectares)	0.20
Parks, Cemeteries or Open Space (< 4 hectares)	0.25
Single Family Residential (< 10 m frontage)	0.xx
Single Family Residential (> 18 m frontage)	0.40
Single Family Residential (< 18 m frontage)	0.45
Semi-Detached Residential	0.55
Townhouses, Mainsonettes, Row Houses	0.65
Arterial Roadways	0.65
Apartments and Condominiums	0.75
Schools and Churches	0.75
Industrial	0.75
Commercial	0.90

Gravel and Paved Areas	0.95

Note: If a parking lot is required within the park, a composite C value shall be developed assuming a C value of 0.95 for the parking lot.

For estimating peak flows for events larger than the 1:10 year design storm, the runoff coefficient shall be adjusted based on the following expressions[1], up to a maximum of 0.95:

$$C_{25} = 1.10 \cdot C_{avg}$$
$$C_{50} = 1.20 \cdot C_{avg}$$
$$C_{100} = 1.25 \cdot C_{avg}$$

where: C_{25}, C_{50}, C_{100} is the adjusted runoff coefficient for higher return period storm (dimensionless)
C_{avg} is the average weighted runoff coefficient (dimensionless)

4.5 Storm Sewer Design

4.5.1 Design Flow

The minor system design flow is to be determined according to the level of service as discussed in Section 4.3.1, based on the IDF parameters presented in Section 4.4.1. The first leg of a storm sewer system shall be designed using an initial time or concentration or inlet time of 10 minutes. If an external drainage area exists, the Consulting Engineer will be responsible for determining an appropriate inlet entry time using the Airport Formula and providing supporting calculations.

$$T_c = \frac{0.057 \cdot L}{S_w^{\ 0.2} \cdot A^{0.1}}$$

where T_c is the time of concentration (min)
L is the watershed length (m)
S_w is the watershed slope (%)
A is the watershed area, (ha)

4.5.2 Capacity and Size

The hydraulic capacity of sewers shall be based on Manning's formula (for pipes flowing full):

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

where Q is the capacity of the pipe (m^3/s)
n is the Manning's roughness coefficient (dimensionless)
A is the cross-sectional area of the conduit (for pipes flowing full; m^2)
D is the nominal diameter of the pipe (m)
R is the hydraulic radius of the conduit (for pipes flowing full; R = D/4; m)
S is the slope of the pipe (for pipes flowing full; m/m)

For circular pipes flowing full, Manning's formula can be expressed as follows:

$$Q = \frac{\pi}{n} \cdot \frac{D^{\frac{8}{3}}}{4^{\frac{5}{3}}} \cdot S^{\frac{1}{2}}$$

where D is the nominal diameter of the pipe (m)

Appropriate values of Mannings n are:

- Concrete, PVC and Profile Rib Pipe n = 0.013
- HDPE Pipe n = 0.021
- Corrugated Steel Pipe (CSP): n = 0.024 (for culvert use only)

[1] "MTO Drainage Management Manual", Drainage and Hydrology Section, Ontario Ministry of Transportation, 1997, Ch. 8, p. 19.

Minimum storm sewer diameters are as follows:

- Residential areas: 300 mm
- Industrial and Commercial areas: 375 mm

4.5.3 Flow Velocities and Minimum Slope

Regardless of flow velocities obtained, the minimum design grades for storm sewers for all materials shall be as follows:

Storm Sewer Size	Minimum Slope
Up to 375 mm	0.40%
450 mm to 525 mm	0.30%
600 mm to 1200 mm	0.20%
1350 mm and greater	0.15%

The maximum design flow velocity is 4.5 m/s. In special circumstances, flow velocities exceeding 4.5 m/s may be considered, for example a storm sewer down a valley slope, but provisions shall be made to protect against displacement of the storm sewer by sudden jarring or movement. Anchor collars may be required on pipes subjected to high flow velocities or as required by the Town of New Tecumseth.

4.5.4 Cover

The minimum depth of cover for frost protection shall be 1.5m to the crown of the pipe.

The depth of the storm sewer shall be sufficient to provide gravity connections for the building foundation drains, where applicable. Storm sewers can be set at shallower depths provided that they are insulated in accordance with the Ontario Building Code (OBC A-7.3.5.4.) or any other applicable standard and that the sewer material satisfies structural strength requirements.

4.5.5 Sewer Alignment

All storm sewers shall be located as shown on the standard Town of New Tecumseth road cross section drawings. Storm sewers less than 600 mm in diameter shall be laid in a straight line between maintenance holes. Curvilinear storm sewers are permitted for pipe 600 mm and greater in diameter and shall be designed in accordance with radii tables as provided by the manufacturers. Radius pipe is acceptable for storm sewers 1050 mm and greater in diameter. Curve data must be shown on the drawings.

4.5.6 External Drainage

Any storm sewer system or part of a system shall be designed to serve the area within the development boundary, plus any external area tributary to the system. The external area may be determined by referencing the appropriate Subwatershed Study or Master Drainage Plan for the area, where applicable. In the absence of such reports, the Consulting Engineer shall delineate the pre-development contributing area using appropriate topographic references.

4.5.7 Limits

All storm sewers shall be terminated at the subdivision limits with a maintenance hole when external drainage areas are considered. Provision in the design (depth, alignment and slope) shall be made to allow for the future extension of the sewer.

In other cases, the sewer shall extend at least half way across the frontage and/or flankage of any lot or block within the development, where storm or foundation drain service connections may be required. Otherwise, the sewer shall terminate at the location of the most upstream catchbasin.

4.5.8 Pipe Crossings and Clearances

Minimum clearances to watermains shall be in accordance with MOE guidelines[2].

4.5.9 Changes in Pipe Sizes

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

4.5.10 Dual Drainage Analysis

The dual drainage analysis shall include:

- A spreadsheet or computer model, such as OTTSWMM or DDSWMM, that is capable of determining the minor and major peak flows during the 1:100 year storm event.
- Use of the 1:100 year storm IDF criteria outlined in Section 4.4.1. For computer models, a 4-hour Chicago distribution storm shall be simulated.
- Catchment data shall be based on the storm drainage plan.
- Catchbasin capture will depend on the type of catchbasin: flow-through or sag. The rating curves shall be based on the data provided in Section 4.7.4. If reduced catchbasin leads are used, the capture rates shall be based on Town of New Tecumseth Standard Drawing TNT.SD 201.
- Input parameters for computer models shall be based on the NVCA Hydrology Standards and Standard Hydrologic Parameters, or determined as necessary.

A table shall be provided in the Stormwater Management Report that outlines locations within the development where overland flow depths at the gutter exceed 0.10 m under 1:100 year storm conditions. The table shall include the location, major system peak flow, flow depth at the gutter and roadway centerline, flow velocity and the available freeboard to the property line. Flooding of private property and flow depths greater than 0.30 m at the gutter will not be permitted under any circumstances during the 1:100 year storm.

4.5.11 Hydraulic Grade Line Analysis

A hydraulic grade line (HGL) analysis of the storm sewer system under 1:100 year storm conditions is required for all minor storm drainage systems for all instances.
The following demonstrations are only required under Minimum Standard No.2 where there are gravity foundation drains: The HGL analysis shall demonstrate that the underside of footing for all buildings is located a

[2] MOE Guideline F-6, "Sewer and Watermain Installation: Separation Distance Requirements", and MOE Procedure F-6-1, "Procedures to Govern Separation of Sewers and Watermains", April 1994.

minimum of 0.30 m above the estimated 1:100 year storm HGL elevation in the receiving storm sewer. Minimum underside of footing elevations shall be determined and placed on the grading plans for all lots or blocks where the 1:100 year storm HGL is located less than 2.50 m below the centerline of the roadway and to be shown on all applicable profiles.

The HGL analysis shall include:

- A spreadsheet (or equivalent method) that uses design information, including storm sewer sizes, lengths and inverts, tailwater elevations, flow and velocities to determine the losses that will occur through the storm sewer system.
- The 1:100 year storm sewer peak flows shall be derived from the dual drainage analysis results.
- The 1:100 year storm elevation in the receiving natural stream corridor or stormwater management facility shall be used as the starting tailwater elevation for the analysis.
- The HGL in the storm sewer system shall consider head losses in the pipes and the maintenance holes.
- The pipe obvert shall be used as the minimum HGL elevation in all sewers.

Head losses through the storm sewer system shall be calculated using Bernoulli's equation of head loss in the form of:

$$h = \frac{kV^2}{2g}$$

where
h head loss (m)
k loss coefficient (dimensionless)
V actual pipe flow velocity (m/s)
g gravitational constant, (9.81 m/s^2)

For the frictional component of the losses through the pipe, the k coefficient becomes:

$$k = \frac{fL}{D}$$

where
k loss coefficient (dimensionless)
f friction factor (dimensionless)
L length of storm sewer (m)
D actual diameter of the pipe (m)

The friction factor is defined by:

$$f = 124\frac{n^2}{d^{1/3}}$$

where
f friction factor (dimensionless)
n Mannings n (dimensionless)
d actual diameter of the pipe (m)

Head losses through maintenance holes shall be calculated using Bernoulli's equation of head loss, as outlined above, with an appropriate value of k consistent with the type of junction[3].

For a straight through maintenance hole, with one incoming and one outgoing pipe, the loss shall be calculated as follows:

$$h_{MH} = 0.05\frac{{V_d}^2}{2g}$$

where
h_{MH} head loss through the maintenance hole (m)
0.05 loss coefficient, k (dimensionless)
V_d actual pipe flow velocity in the downstream sewer (m/s)
g gravitational constant, (9.81 m/s^2)

[3] "Design and Construction of Urban Stormwater Management Systems", ASCE, 1992, p.146 – 159.

For a junction maintenance hole, with an incoming pipe, outgoing pipe and one or more laterals, the loss shall be calculated based on the velocities in the main branch sewers and the angle of the lateral sewer to the main branch as follows:

45° lateral: $$h_{MH} = \frac{V_d^2}{2g} - 0.45\frac{V_u^2}{2g}$$

60° lateral: $$h_{MH} = \frac{V_d^2}{2g} - 0.35\frac{V_u^2}{2g}$$

90° lateral: $$h_{MH} = \frac{V_d^2}{2g} - 0.25\frac{V_u^2}{2g}$$

where
h_{MH} head loss through the maintenance hole (m)
V_d actual pipe flow velocity in the downstream main branch sewer (m/s)
V_u actual pipe flow velocity in the upstream main branch sewer (m/s)
g gravitational constant, (9.81 m/s^2)

For a maintenance hole, with an incoming and outgoing pipe benched through 90°, the loss shall be calculated based on the radius of curvature of the benching as follows:

Radius = the diameter of the pipe: $$h_{MH} = 0.50\frac{V_d^2}{2g}$$

Radius = 2 to 8 times the diameter of the pipe: $$h_{MH} = 0.25\frac{V_d^2}{2g}$$

Radius = 8 to 20 times the diameter of the pipe: $$h_{MH} = 0.40\frac{V_d^2}{2g}$$

where
h_{MH} head loss through the maintenance hole (m)
V_d actual pipe flow velocity in the downstream sewer (m/s)
g gravitational constant, (9.81 m/s^2)

4.6 Maintenance Holes

4.6.1 Location

Maintenance holes shall be located at each change in alignment, slope or pipe material, at all pipe junctions and at intervals along the pipe to permit entry for maintenance. Radius pipe sections shall be designed with a maintenance hole at the beginning and end of the curvilinear section.

4.6.2 Spacing

The maximum spacing between maintenance holes shall be as follows:

Storm Sewer Size	Maximum Maintenance Hole Spacing
300 mm to 750 mm	110 m
825 mm to 1050 mm	125 m
1200 mm and greater	150 m

4.6.3 Types

The type, size and depth of all maintenance holes shall be indicated on the plan & profile engineering drawings. The minimum sized maintenance hole is to be 1200 mm in diameter. All standard specified maintenance holes, up to 3600 mm in diameter, to be pre-cast as per latest OPSD 701.010 to 701.015 and OPSD 701.030 to 701.080. Maintenance hole sizing based on pipe opening and benching shall be determined in correspondence with the latest OPSD 701.021. Frost straps are to be provided between the upper section through to the base of the maintenance hole section, as per OPSD 701.100.

Although the standard OPSD drawings provide details for maintenance holes up to certain maximum depths, the Consulting Engineer shall analyze individually each application of the standards related to soil conditions, loading and other pertinent factors to determine structural stability. In all cases where the standards are not applicable, or where unique custom maintenance holes are required, the maintenance holes shall be individually designed and detailed. Shop drawings shall be stamped by a structural engineer and submitted to the Town of New Tecumseth for review and approval.

4.6.4 Design

To ensure proper operation of, and safe access to, maintenance holes, the following criteria shall be applied:

- The obvert(s) on the upstream side shall not be lower than the obvert of the outlet pipe.
- The direction of flow in any maintenance hole shall not be permitted at acute interior angles.
- The maximum change in direction of flow in maintenance holes is 90° for sewers 900 mm and smaller and 45° for pipes over 900 mm.
- Where the difference in elevation between the obvert of the inlet and outlet pipes exceed 1.0 m, an external drop structure shall be placed on the inlet pipe.
- All maintenance hole covers shall be located on the side of the maintenance hole parallel to the flow for straight runs, or on the upstream side of the maintenance hole at all junctions.
- Safety gratings shall be provided when the maintenance hole depth exceeds 5.0 m. The maximum spacing between safety gratings shall not exceed 4.5 m.
- Detailed base designs shall be provided when the maintenance hole depth exceeds 9.0 m.
- Maintenance holes shall be located a minimum of 1.5 m from the face of curb or other utilities.

4.6.5 Head Losses

The minimum drop across a maintenance hole is as follows:

Alignment	Minimum Drop
Straight Run	30 mm
Up to 45° Deflection	50 mm
45° to 90° Deflection	75 mm

Confirm w/ RV & DL moduloc max. 450mm?

Hydraulic calculations shall be submitted for all junction and transition maintenance holes on sewers where the outlet pipe is 1050 mm or greater to ensure that sufficient invert drop is provided.

4.6.6 Grades for Maintenance Hole Frames and Covers

All maintenance holes located within the traveled portion of the roadway shall have the rim elevation set flush with the surface of the base course asphalt. The concreting and setting of the frame and cover shall be completed in accordance with OPSS and OPSD details. A A maximum of 450 mm of modular rings shall be permitted. No concrete shall extend over the edge of the maintenance hole.

Prior to placement of the final lift of asphalt, maintenance hole frames shall be reset to final grade.

4.7 Roadway Catchbasins

4.7.1 Location and Spacing

Catchbasins shall be selected, located and spaced in accordance with the conditions of the design. The design of the catchbasin location and type shall take into consideration the lot areas, the lot grades, pavement widths, road grades and intersection locations. The maximum ponding depth at a catchbasin in sag shall not exceed 0.20m or impact private property under any circumstances.

Catchbasins shall be generally located upstream of sidewalk crossings at intersections and upstream of all pedestrian crossings. Catchbasins shall not be located in driveway or sidewalk curb depressions. Additional catchbasins may be required at road intersections, curves and cul-de-sacs to facilitate satisfactory drainage.

Double catchbasins shall be located at sag points, where the catchbasin intercepts flow from more than one direction.The recommend maximum spacing is as follows:

Pavement Width	Maximum Spacing		
	0. 5% to 2% grade	2 to 4% grade	greater than 4% grade
≤ 10 m	60m	90 m	75 m
> 10 m	60m	75 m	60 m

4.7.2 Types

Single catchbasins shall be 600 mm x 600 mm pre-cast concrete in accordance with OPSD 705.010 complete with cast iron frame and grate. Double catchbasins shall be 600 mm x 1450 mm pre-cast concrete in accordance with OPSD 705.020 complete with cast iron frame and grate.

The preferred choice for catch basin grates shall be the fish style grates manufactured by Bibby-Ste-Croix or an approved equal. Single catch basin grate to be as per the Bibby-Ste-Croix detail JW107AF and double catch basin grates as per JW100AF. Alternatively, standard single catch basin grate as per OPSD 400.010 and double catch basin grate as per OPSD 400.020 will be considered as a secondary choices at the discretion of the Town, in situations where the specific design characteristics are required or when the supply or cost competitiveness for the fish style grates is in question.

Catchbasin connections to the curb sub-drain system to be in accordance with OPSD 216.021.

If special catchbasins and inlet structures are required for certain circumstances, then they shall be individually designed and fully detailed. Shop drawings shall be stamped by a structural engineer and submitted to the Town of New Tecumseth for review and approval.

4.7.3 Catchbasin Leads

Catchbasins located in close proximity of a maintenance hole shall have their leads connected to the maintenance hole. Long catchbasin leads, in excess of 20 m, shall be connected to a maintenance hole. The maximum length of a catchbasin lead is 30 m.

Lead sizes and minimum slopes are as follows:

- Single catchbasins: 250 mm @ 1.0%
- Double catchbasins: 300 mm @ 1.0%

4.7.4 Capacity

Two flow conditions occur at catchbasins: flow along a continuous grade or flow in sag. Catchbasins on a continuous grade, or flow-through conditions, will capture only a portion of the flow. The balance of the flow will bypass the catchbasin and continue downstream. For catchbasins in sag, the flow will be completely captured by the catchbasin, until the maximum overtopping depth is reached and flow continues downstream. The Consulting Engineer shall use the following tables to properly represent the hydraulic capacity of the catchbasins in the dual drainage analysis.

Single Catchbasin on Grade[4]			
Approach Flow (L/s)	Capture (L/s)	Approach Flow (L/s)	Capture (L/s)
0	0	60	35
8	6	90	46
15	8	110	50
19	12	140	55
24	14	600	70
40	23	3300	85

[4] Design Chart 4.04 and 4.14, “MTO Drainage Management Manual”, Drainage and Hydrology Section, Ontario Ministry of Transportation, 1997

Ponding Depth (m)	Single Catchbasin in Sag	Double Catchbasin in Sag
	Max. Capture (L/s)	Max. Capture (L/s)
0.05	11	16
0.10	60	88
0.15	120	167
0.20	155	242
0.25	177	253
0.30	180	257

Note: Values are computed as the minimum of the lead capacity and the grate capacity (Design Chart 4.19, MTO Drainage Management Manual)

4.7.5 Inlet Control Devices and Reduced Catchbasin Leads

Inlet control devices (ICDs) are not permitted for use in new subdivisions in the Town of New Tecumseth.

The widespread use of reduced catchbasins leads is discouraged in the Town of New Tecumseth. In the event that hydraulic grade line constraints require the extensive use of reduced leads, the Consulting Engineer shall consult with the Town of New Tecumseth regarding the use of Minimum Standard Nos. 2 or 3 (Section 4.3.1).

In some locations, reduced catchbasin leads may be required to prevent excessive flow into the storm sewer system during the 1:100 year design storm event. Reduced catchbasin leads shall be no less than 100 mm in diameter. Town of New Tecumseth Standard Drawing TNT.SD 201 shall be referenced for reduced catchbasin lead configuration and capacities.

The dual drainage analysis should be customized to include reduced catchbasin leads, where necessary.

4.7.6 Grades for Catchbasin Frames and Grates

All catchbasins located within the traveled portion of the roadway shall have the frame elevation set flush with the surface of the base course asphalt. The adjusting and setting of the frames and grates shall be completed in accordance with OPSS and OPSD.

Temporary asphalt curbing shall be placed behind all catchbasins within the traveled portion of the roadway at the stage of base course asphalt. Asphalt curbing shall be placed in accordance with OPSD 601.01, between the two adjacent expansion joints.

Prior to placement of the final lift of asphalt, temporary asphalt curbs shall be removed and replaced by concrete curb and the catchbasin frames shall be reset to final grade.

4.8 Rear Lot Catchbasins

Rear lot catchbasins (RLCBs) are often required for split draining lots to capture and convey rear lot drainage. Drainage areas to each RLCB shall be delineated on the storm drainage plan and included in the storm sewer design sheet.

It is noted that RLCBs and their leads are located on private property with easements in favour of the Town, and shall not be assumed by the Town as a municipal service. They are to be maintained by the respective property owner.

Rear lot catchbasins and leads should be designed according to the following criteria:

No "beehive type" ? confirm w/ RV

- RLCBs are to be in accordance with Section 4.7.2 and shall be sumpless.
-
- The minimum lead size is 250 mm diameter with a minimum slope of 0.5%.
- It is preferable to connect catchbasin leads to a maintenance hole, catchbasin or catchbasin maintenance hole on the adjacent street. In cases where this is not possible, direct connections to the storm sewer may be permitted.
- Reduced catchbasin leads are not permitted in any RLCB or street catchbasin connected to a RLCB.
- Leads are to be concrete encased for the full length of the lot and to the back of the street curb.
- The RLCB and lead shall be located on the same lot.

- Refer to Section 8.3.1.2 for information relating to the maximum permissible drainage areas tributary to swales and rear-lot catchbasins.

4.9 Service Connections

4.9.1 Residential

All storm service connections shall generally be located in accordance with the Town of New Tecumseth Standard Drawings TNT.SD 401, TNT.SD 402, TNT.SD 403, and installed in accordance with OPSD 1006.010 & 1006.020. Non-standard locations are subject to the Town's approval and must be detailed on the plan and profile and utility coordination plans. The connection to the main sewer shall be made with an approved manufactured tee or approved saddle.

Storm service connection sizes and minimum slopes to the property line are as follows:

- Single storm service connections: 125 mm @ 2.0%
- Double "Y" storm service connections: 150mm @ 2.0%

Generally the cover at the street line shall be 2.3 m, since it is preferable for the dwellings to be fully serviced by gravity. If this is not possible, a minimum cover of 1.5 m, or as required for frost protection, may be used and sump pumps shall be installed to pump foundation drainage over the foundation wall and direct flow to the storm sewer system or dwellings shall be connected to a separate foundation drainage collection system. Risers shall be used when the obvert depth of the storm sewer main exceeds 4.0 m. Service connections should cross under any watermains, wherever possible.

All residential storm service connections shall have a test fitting, clearly marked "STM", inspection plate and plug installed at the street line.

The location of the end of a new service lateral connection at the street line shall be marked by a 50 mm x 100 mm wooden stake, projecting 1.0 m above the ground, with the top 300 mm painted. orange

4.9.2 Industrial / Commercial / Institutional (ICI)

Storm service connections for industrial, commercial or institutional will be considered on an individual basis if similar locations as per Section 4.9.1 cannot be used. Non-standard locations are subject to the Town's approval and must be detailed on the plan and profile and utility coordination plans.

The service connections for industrial, commercial or institutional areas shall be sized individually according to the intended use. The minimum size of service pipe shall be 200 mm in diameter. The preferable minimum grade is 2%, and the absolute minimum grade is 1%. The minimum cover at the street line shall be of sufficient depth to permit servicing of buildings by gravity, wherever possible.

Storm service connections to industrial, commercial or institutional blocks shall require the installation of an inspection maintenance hole (minimum 1500 mm diameter) located on private property immediately adjacent to the property line.

4.10 Foundation Drainage Collection System Design

Weeping tile, or a foundation drain, is typically provided to drain groundwater away from the foundation of a building. Three approaches are commonly used to deal with foundation drainage:

- A sump pump with a connection to the storm sewer may be used in situations where a gravity connection is not possible or recommended (Minimum Standard No. 1, Section 4.3.1).
- A gravity connection to the storm sewer (Minimum Standard No. 2, Section 4.3.1). Connection to the sanitary sewer is not permitted.
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- In some situations, it may be appropriate to install a separate foundation drainage collection (FDC) sewer (Minimum Standard No. 3, Section 4.3.1).

Foundation drainage collection sewer sizes and minimum slopes are as follows:

- Single FDC service connections: 125 mm @ 2.0%
- Double FDC service connections: 150 mm @ 2.0%
- FDC sewer: 250 mm @ 0.5% (first leg of FDC shall be 1.0%)

In the event that an FDC sewer is required, an FDC design sheet shall be prepared in similar to the sanitary sewer design sheet. The design flow rate per unit is assumed to be 0.075 L/s/unit. In addition, an infiltration allowance shall be applied according to Section 6.3.4 of the Sanitary Drainage System. In general, the FDC sewer shall be designed using the criteria (maintenance hole spacing, drops, etc.) for a sanitary sewer system (Section 6, Sanitary Drainage System).

All FDC sewers shall be located as shown on the standard Town of New Tecumseth road cross section drawings. The FDC sewer shall be offset 1.0 m from the sanitary sewer towards the curb, except at manholes where additional separation may be required. The FDC sewer shall be directed to the nearest location where a gravity outlet to a natural watercourse is available. The Consulting Engineer is responsible to ensure that the 1:100 year storm flood level in the receiving watercourse will not result in upstream basement flooding.

4.11 Material Specifications

All Canadian Standards Association (CAN/CSA) specifications, American Society for Testing and Materials (ASTM) specifications and Ontario Provincial Standard Specifications (OPSS) referenced hereto are to be the latest revision.

4.11.1 Main-Line Sewer and Catchbasin Lead Pipe Material

The type and classification of storm sewer pipe shall be clearly indicated on all plan & profile engineering drawings for each sewer length.

4.11.1.1 Polyvinyl Chloride (PVC) Pipe

- PVC pipe is acceptable for use in all areas (residential, industrial, commercial, and institutional).
- All catchbasin leads to be PVC, unless site-specific circumstances dictate otherwise, then concrete pipe to be used.
- For 250 mm to 375 mm (inclusive), pipe to be manufactured to the latest edition of CSA Standard B-182.2 (ASTM Specification D 3034) with rubber gasketed bell and spigot joints. Pipe and fittings shall have a maximum Standard Dimension Ratio of 35 (SDR-35) and a minimum pipe stiffness of 320 kPa, or higher strength as may be required by the design.
- For 450 mm up to a maximum of 600 mm, pipe to be manufactured to the latest edition of CSA Standard B-182.2 (ASTM Specification F 679 (T-1)) or CSA Standard B-182.4 (ASTM Specification F 794) with rubber gasketed bell and spigot joints. Pipe and fittings shall have a maximum Standard Dimension Ratio of 35 (SDR-35) and a minimum pipe stiffness of 320 kPa, or higher strength as may be required by the design.
- All PVC pipes and rubber gasketed joints shall conform to the requirements of OPSS 1841 and OPSD 806.040 & 806.060 (with regard to maximum fill / cover).
- The allowable maximum joint deflection and minimum curve radius recommended by the manufacturer shall not be exceeded. Tangent length of service Tee connections must be taken into consideration when calculating the minimum radius that can be achieved.

4.11.1.2

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4.11.1.3 Concrete Pipe

- Concrete pipe is acceptable for use in all areas (residential, industrial, commercial, and institutional) provided the pipe size is equal to or greater than 300 mm.
- For up to 900 mm (inclusive), pipe to be manufactured to the latest editions of CSA Standards A-257.1 or A-257.2 (whichever applies) and A-257.3, including corresponding appendices.
- For greater than 900 mm, pipe to be manufactured to the latest edition of CSA Standard A-257.2. Joints shall conform to the latest edition of CSA Standard A-257.3.
- All standard strength and extra strength non-reinforced concrete pipes shall conform to CSA A-257 Series and ASTM C-14, C-76, and C655.
- All pipe fittings and joints shall conform to the requirements of CSA A-257 Series and OPSS 1820.
- Class of pipe to be used shall be in accordance with the design requirements.
- In special instances, the Town of New Tecumseth may specify Sulphide Resistant concrete where a severe corrosive environment may be anticipated.
- All concrete pipes shall be supplied from a pre-qualified plant registered with the Ontario Concrete Pipe Association (OCPA).

4.11.1.4 High Density Polyethylene (HDPE) Pipe

Valdor HDPE usage for storm pipe?

- High Density Polyethylene pipe is acceptable for use in all areas (residential, industrial, commercial, and institutional) only upon the Town's approval.
- For 250 mm and larger, pipe to be manufactured to the latest edition of CSA Standard B-182.6 with rubber gasketed bell and spigot joints, OPSS 1840 and OPSD 806.020. Pipe and fittings shall have a minimum pipe stiffness of 320 kPa, or higher strength as may be required by the design.
- Fittings are to be moulded PVC manufactured to the latest edition of CSA Standard B-182.1, B-182.2 or B-182.4.

4.11.2 Roadway and Driveway Culverts

4.11.2.1 Corrugated Steel Pipe (CSP)

- All CSP to be galvanized pipe in accordance with OPSS 1801 and CSA Standard G.401
- For 150 mm to 600 mm (inclusive), pipe to manufactured with the profile dimensions being 68 mm x 13 mm with a minimum wall thickness of 1.6 mm.
- For 700 mm to 1000 mm (inclusive), pipe to manufactured with the profile dimensions being 68 mm x 13 mm with a minimum wall thickness of 2.0 mm.
- For 1200 mm to 2400 mm (inclusive), pipe to manufactured with the profile dimensions being 125 mm x 26 mm with a minimum wall thickness of 2.0 mm.
- For 2700 mm to 3000 mm (inclusive), pipe to manufactured with the profile dimensions being 125 mm x 26 mm with a minimum wall thickness of 2.8 mm.
- For 3300 mm and larger, pipe to manufactured with the profile dimensions being 125 mm x 26 mm with a minimum wall thickness of 3.5 mm.
- All CSP to be manufactured with Annular Corrugated ends to allow for a variety of joints to be utilized for standard pipes and pipe-arches. Three recommended and approved types of coupler are the Hugger band, the Annular corrugated standard bolt and angle coupler, and the Dimpled coupling band.

4.11.3 Service Connection Material

Storm service connection pipes are to be only white in colour. Any other coloured pipe is reserved for sanitary service connections.

4.11.3.1 Polyvinyl Chloride (PVC) Pipe

- Pipe and fittings shall be manufactured to the latest edition of CSA Standard B-182.1 (ASTM Specification D 3034) with rubber gasketed bell and spigot joints. Pipe and fittings shall have a Standard Dimension Ratio of 28 (SDR-28) and a minimum pipe stiffness of 630 kPa.

4.11.4 Service Saddles and Tees

4.11.4.1 Concrete Pipes

- For services up to 375 mm (inclusive):
  - Factory-made and approved Tees; or
  - Kor-N-Tee (300 mm and larger); or
  - Romac 202S.

- For services larger than 375 mm
  - Factory-made and approved Tees; or
  - Crowle saddles; or
  - Kor-N-Tee; or
  - Romac 202S.

4.11.4.2 Polyvinyl Chloride (PVC) Pipes

- For services up to 375 mm (inclusive):
  For New Construction,
  - Factory-made and approved Tees are to be used.

  For Existing Installations,
  - Kor-N-Tee (300mm and larger); or
  - Romac 202S; or
  - IPEX moulded saddles.

- For services larger than 375 mm:
  - Factory-made and approved Tees; or
  - Crowle saddles for pipe manufactured in accordance with CSA Standard B-192.2 (ASTM Specification D 3034); or
  - Romac 202S; or
  - IPEX moulded saddles; or
  - Le-Ron Plastics “Epoxy-On” saddle for pipe manufactured in accordance with CSA Standard B-182.4 (ASTM Specification D 3034); or
  - Kor-N-Tee.

4.11.5 Service Test Fittings and Plugs

4.11.5.1 Test Fittings

- Crowle – Cast Iron; or
- IPEX PVC: 125 x 125, or 125 x 125 x 150 wye.

Note: Fittings must be marked “STM” in accordance with Town’s Service Connection Design Criteria (Section 4.9).

4.11.5.2 Plugs

- Epoxy coated end plug as manufactured by Crowle Fittings; or
- Zinc plated; or
- Plastic (PVC).

4.11.6 Bedding and Backfill

- Bedding materials shall be in accordance with OPSD 802.010 with Granular ‘A’ bedding and OPSD 802.030 Class ‘B’ with Granular ‘A’ bedding for concrete pipes unless otherwise recommended by a qualified geotechnical engineer.
- The sewer bedding type shall be clearly indicated on all plan & profile engineering drawings for each sewer length.
- Pipe strength design calculations shall accompany the design submission.
- For corrugated steel pipe culverts, bedding and backfill to be in accordance with OPSD 802.010 to 802.014. Arch culvert bedding and backfill to be in accordance with OPSD 802.020 to 802.024. All culverts to satisfy frost protection in accordance with OPSD 803.030 & 803.031.

4.12 Testing and Inspection

Upon completion of the storm sewer system including maintenance holes, roadway catchbasins, rear lot catchbasins complete with leads, and service connections to the property line, but prior to the placement of concrete curb and gutter and base course asphalt, a leakage test (either infiltration or exfiltration test) in accordance with OPSS Sections 410.07.15.02, 410.07.15.03, and 410.07.15.04 shall be conducted.

The deflection test and visual inspection by the Town shall not be conducted until the system has been thoroughly flushed and cleaned, and a minimum of 30 days following backfill of pipe as per OPSS 410.07.15.05. Any deficiencies must be rectified prior to the commencement of the maintenance period.

Prior to the issuance of the Certificate of Substantial Completion (underground services) and prior to expiration of the maintenance period, the system shall undergo a Closed Circuit Television (CCTV) inspection in accordance with OPSS 409 and the Town shall be provided with a copy of the appropriate data in electronic and paper format prior to final approval. Any components of the system which are determined by the Town to be unacceptable shall be repaired or replaced to the satisfaction of the Town. Additional CCTV inspection of the system maybe required prior to assumption, at the discretion of the Town.

4.13 Overland Flow

4.13.1 Roads

The roadway network shall be designed to convey overland flow under extreme storm event conditions to stormwater management facilities or natural stream corridors. The following criteria shall be followed:

- The overland flow generated by a 1:100 year return period storm shall be conveyed within the public road allowance with a maximum flow depth of 0.30 m measured at the gutter.
- A dual drainage analysis shall be undertaken to determine the overland flow that would be experienced on the roads during a 1:100 year return period storm (Section 4.5.10).
- Overland flow routes shall be continuous between adjacent developments that are tributary to the same stormwater management facility or natural stream corridor.
- Sag points are permitted within the overland flow route, but the maximum ponding depth at the gutter shall be limited to 0.30 m. Appropriate catchbasin capture rates (Section 4.7.4) or ICDs shall be used in the dual drainage analysis.
- The roadway overland flow capacity downstream of sag points shall be calculated by applying the broad-crested weir equation at the high point downstream of the sag and shall be checked against the expected overland flow.

4.13.2 Channels

Overland flow channels shall be designed to convey the 1:100 year storm peak flow without flooding adjacent private properties. The channel cross-section and gradient shall be selected to produce subcritical flow. In the event that supercritical flow conditions cannot be avoided, the Consulting Engineer shall provide sufficient calculations to the Town of New Tecumseth to demonstrate that the channel design is appropriate.

Appropriate stabilization shall be provided to protect against velocity conditions experienced during the 1:100 year storm and calculations shall be provided to the Town of New Tecumseth for review and approval. The maximum velocities during the 1:5 and 1:100 year storms shall be 1.5 m/s and 2.5 m/s, respectively for sod lined channels. Channels expected to experience higher flow velocities shall be stabilized using other measures approved by the Town of New Tecumseth, such as soil reinforcement or stone lining. Calculations, using the Maximum Permissible Tractive Force method[5], shall be provided to the Town of New Tecumseth and Conservation Authority for review

4.13.3 Conveyance from Street to SWM Facility or Channel

The Consulting Engineer must demonstrate that overland flows during the 1:100 year storm can be safely conveyed from the road allowance to a SWM facility or open channel without flooding adjacent private properties. Overland flows may be routed as follows:

- Overland flow may be routed over the curb and boulevard. The Consulting Engineer must demonstrate that sufficient hydraulic capacity exists using the broad-crested weir equation. The flow route from the boulevard into the SWM facility or open channel must be stabilized to prevent slope erosion.
- Overland flow must be contained within publicly owned lands.
- Overland flow must be captured and piped at the major system low point(s) on the roadway unless the engineer can demonstrate that the flow can be conveyed by other means to the satisfaction of the Town. For instance, where major system flows from a roadway into a SWM facility, the 100-year ponding level in the roadway should be shaded on the grading plan at an elevation corresponding to the headwater required to convey said flow using the broad crested weir equation.
- The Consulting Engineer must demonstrate that the inlet grates required to capture the major system flow have sufficient hydraulic capacity using the orifice or sharp-crested weir equation (whichever governs), assuming 50% bar area and blockage.

4.14 Outfall Channels

4.14.1 General

The following general principles are to be applied when designing storm sewer or FDC outfalls to a natural watercourse:

- Headwall designs shall conform to OPSD 804.03 for pipes less than 900 mm in diameter. OPSD 804.02 shall be applied for pipes 900 mm in diameter or greater and shall be complemented by armourstone wing walls. Headwall grates, as per OPSD 804.05, shall be specified for all headwalls.
- Outfall inverts are to be located at or above the 1:2 year storm flood level in the receiving watercourse.

[5] Chapter 5, Pages 112 – 115, "MTO Drainage Management Manual", Drainage and Hydrology Section, Ontario Ministry of Transportation, 1997

- Headwalls shall be protected by a 1200 mm height black vinyl chainlink fence and the posts shall be cored into the concrete headwall and/or armourstone wing walls.
- All exposed concrete faces shall be treated with natural Wiarton stone cladding and copping stone or must be treated with a commercially available form liner in a mason stone cut relief (Dayton Superior Pattern #1506SYM or #1502ES Cut Block Ashlar Stone or approved equivalent).
- Outfall channels to a natural watercourse shall be constructed of riverstone or other natural stone. Rip-rap is not permitted.
- An access roadway shall be provided to all outfall headwalls.
- All outfalls require a permit from the Conservation Authority.

4.14.2 Hydraulics

The following hydraulic considerations are to be incorporated to all outfall channel designs:

- To minimize erosion, outfall channels shall be extended from the headwall to the natural watercourse. The outfall channel shall be designed, where possible, such that flow in the outlet channel is tangential to the flow in the natural watercourse at the confluence. The outfall channel shall tie into the natural watercourse at or above the natural water level in the watercourse.
- Discharge onto steep slopes shall not be permitted.
- Outfall channels shall be designed to withstand the erosive forces experienced under the design storm event. Calculations, using the Maximum Permissible Tractive Force method[6], shall be provided to the Town of New Tecumseth and Conservation Authority for review.
- Tailwater impacts of the natural watercourse shall be accounted for in the design of the outfall channel, control structures and upstream storm sewer/FDC systems.

4.15 Roadside Ditches and Culverts

Rural roadways, including roadside ditches and culverts, shall only be constructed in areas approved by the Town of New Tecumseth. Submission of hydraulic design calculations to identify design flow conditions and inlet and outlet head conditions are required. Energy dissipation, erosion control measures and cutoff walls shall be considered in the design.

The design of roadside ditches shall consider the following:

- Ditch inverts shall be located a minimum of 0.15 m and a maximum of 0.50 m below the roadway subgrade elevation. Where the minimum of 0.15 m cannot be met, a ditch subdrain will be required and shall outlet to the ditch once the minimum depth criterion is met.
- The minimum and maximum ditch gradients shall be 1.0% (wherever possible) and 6.0%, respectively.
- Ditch protection shall consist of 100 mm topsoil and staked nursery sod on the side slopes and bottom of the ditch. In the event that the 1:5 year storm velocity in the ditch exceeds 1.5 m/s, or the 1:100 year storm velocity exceeds 2.5 m/s, the ditches shall be stabilized using other measures approved by the Town of New Tecumseth such as soil reinforcement or stone lining.
- All roadside ditches shall transport runoff to a safe outlet, such as a stormwater management facility or natural watercourse, approved by the Town of New Tecumseth.

The design of culverts shall consider the following:

- The minimum culvert diameter for driveway shall be 400mm. The minimum culvert diameter for road crossing culverts shall be 600 mm
- A minimum of 300 mm cover shall be provided at the edge of the shoulders.
- End protection shall be provided on all road crossing and driveway culverts, including metal aprons, concrete, , concrete headwalls or precast stones.
- Driveways that provide access to private dwellings shall be flooded to a maximum depth of 0.30 m during the 1:100 year storm.
- All road crossing and driveway culverts shall be designed to convey the peak flow generated by a 1:25 year storm using the Rational Method (Section 4.4).

[6] Chapter 5, Pages 112 – 115, "MTO Drainage Management Manual", Drainage and Hydrology Section, Ontario Ministry of Transportation, 1997