CLEARVIEW
TOWNSHIP

Section C – Stormwater Management and Drainage Systems

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C1.00 Stormwater Policies

The Township has prepared a detailed set of design criteria and applicable parameters for the design of minor and major storm drainage facilities. These policies are to be adhered to in the production of all stormwater control facilities.

C1.01 Design Criteria

The Township operates under a CLI-ECA for the approval of qualifying SWM projects and is thus the approval authority. For all projects that do not fall under the CLI-ECA, the MECP continues to be the approval authority. The Developer shall design stormwater infrastructure in accordance with the most current version of the Township's CLI-ECA and associated design requirements. If the design does not fulfill these requirements, an application to the MECP for a Schedule C amendment to the CLI-ECA will be required.

The Developer is responsible for obtaining and reviewing the CLI-ECA documents and design requirements from the Township to ensure adherence.

The most current version of the following MECP, NVCA guidelines, policies, and standards apply to the design of storm drainage facilities in the Township.

- Ministry of the Environment, Conservation and Parks (i.e., Stormwater Management Planning and Design Manual, March 2003).
- Design Criteria for Sanitary Sewers, Storm Sewer, and Forcemains for Alterations Authorized under Environmental Compliance Approval.
- NVCA Natural Hazards Technical Guide (December 2013), NVCA.
- NVCA Stormwater Technical Guide (December 2013), NVCA.
- **Or the most up-to-date version of the above, or any new documents issued by these agencies.**

Development proponents are also required to confirm design criteria and obtain approvals from any other relevant ministries or agencies (i.e., MTO, MNRF, DFO, etc.). The most current version of OPSD shall also apply to design and construction of storm drainage facilities as determined by the Township.

The consulting engineer responsible for the design of SWMFs shall consult with the Township and the NVCA early in the process to confirm / clarify issues, policies and design requirements, and shall focus on minimizing the number of pond facilities. Master Servicing Plans (where available) for the various Community Planning Areas layout the general location of all planned SWMFs.

Water quality and quantity control in new development areas are to be provided in Township-owned Township blocks.

LID techniques in lieu of and / or in combination with end-of-pipe designs where reasonable / feasible will be considered by the Township in consultation with the NVCA on a case by case basis. In the case of infilling proposals, on-site SWM concepts may be considered by the Township in conjunction with any potential off-site storm drainage improvements.

Redundancy to protect for blockage or plugging of LIDs and sequential runoff events is to be provided.

The design of each SWMF shall also focus on opportunities to integrate the SWMF with the surrounding topography and land uses. SWMFs are to be created as public amenity features and are to be, when possible, visible to the general public. Opportunities for linkages through the use of trails to larger open space, parkland areas, or other SWMFs are to be maximized.

The design of SWM works is to have full regard for riparian rights of both upstream and downstream landowners. Any change in flow rates, or water levels, that would occur as a result of the development, SWM drainage areas, and / or in-stream works to neighboring private properties must be adequately addressed. Written permission from affected landowners must be sought prior to final design submissions, in cases where acknowledged impacts are proposed, and any governing legislation, in this regard, must be adhered to.

C1.02 Water Balance Report

See Section A of these standards for submission requirements.

C1.03 Significant Drinking Water Threat Report

See Section A of these standards for submission requirements.

C1.04 Low Impact Development Design

LID measures may be required based on the results of the accepted Water Balance Report. The planning and preliminary design of LID measures is to be documented in the Preliminary FSR and accepted by the Township and the NVCA prior to approval of the Draft Plan. The final design and details of the LID system is to be documented in the SWM and LID Design Reports.

The Township may limit LID measures on private residential lots in urban areas due to conditions which may exist, the increasing density and coverage on residential lots and the expected use and enjoyment by homeowners of private residential lots.

The Developer's engineers may consider the use of LID measures in lieu of, and / or in combination with, end of pipe designs where reasonable / feasible and supported through geotechnical review. LID measures will be considered by the Township in consultation with the NVCA on a case by case basis, particularly with regard to the downstream receiving Township-owned property's capacity to convey stormwater flows in the event of LID measures failing. In the case of a residential development with multiple LID structures proposed, the design engineer shall be required to demonstrate conveyance to and the impact on the downstream receiver, should 50% of the LID structures fail, to the satisfaction of the Township, before being accepted by the Township.

LID measures to be considered shall include but not be limited to underground pipe storage, infiltration galleries, low gradient grassed infiltration swales, bio-retention swales, rain gardens, permeable pavers / surfaces, and / or other industry standard / acceptable means of lot level control for stormwater quantity and quality. The designer should review the Toronto and Region Conservation Authority (TRCA) and Credit Valley Conservation Authority (CVCA) LID SWM Planning and Design Guide, along with the NVCA's Stormwater Technical Guide for LID design considerations.

Non-residential developments are to investigate the suitability of private LID measures within each development block, subject to discussions with the Township and the NVCA at the time of the pre-consultation meeting and submission of supporting documentation.

C1.05 Levels of Service

The level of service to be provided by the storm drainage infrastructure is listed in the following table, unless stipulated otherwise. The planning of access routes for emergency services (i.e., police, fire, and ambulance) may result in higher levels of service as determined by the Township.

Table 1: Levels of Service for Major and Minor Systems

Item	Level of Service	Comments
Storm Sewers	1:5 Year Storm	Use CB inlet controls (as required), to meet hydraulic grade line (HGL) elevation criteria. Storm sewers shall be required in all new developments.
Hydraulic Grade Line (HGL)	1:100 Year Storm	Subject to pre-design confirmation with Township staff, HGL analysis is required (for both 5-year and 100-year storms). Confirm there is no surcharging under the 5-year storm event.
Major System	1:100 Year Storm	Overland flow cannot exceed width or flow capacity of ROW or 0.3 m depth.
Major System	Regional Storm Level of Control	Safe conveyance of the Regional Storm through to the SWMF, or a positive outlet via overland flow routes including drainage blocks and / or municipal ROWs, unless otherwise directed by the NVCA or Township Public Works department.
Culverts	Per Highway Drainage Design Standards (March, 2024)	Refer to current MTO standards.
Bridges	Per Highway Drainage Design Standards (March, 2024)	Refer to current MTO standards

C2.00 Stormwater Management

C2.01 General

Urban development alters the hydrology of the land surface, altering the quality and quantity of surface runoff. The storm drainage system is to be designed to convey surface runoff from residential, commercial, industrial, and roadway areas to an adequate outlet.

Surface runoff is to be conveyed by a dual drainage system (minor / major) comprised typically of an underground storm sewer and a continuous, overland flow route within a ROW, drainage block, or open channel.

Ultimately, surface runoff is to be conveyed to natural receiving waters, following treatment, and control to prevent the impairment of water quality and degradation of natural streams, rivers, and ecosystems. The overall purpose of SWM is to provide a feasible and continuous system to protect property, assets, and the environment.

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 for the municipal drain shall be met.

The purpose of this section is to outline the minimum design requirements for the construction of municipal and private services related to stormwater drainage systems and SWMFs in the Township. These requirements are general in nature and do not relieve the Developer of the responsibility to submit a completed product demonstrating competent engineering design in full compliance with all applicable legislation. Any deviation from the minimum Township standards shall be identified by the Developers and / or their consultant, submitted to the Manager of Engineering for review and approval, prior to the first engineering submission.

Stormwater ponds / facilities are required to meet provincial SWM prerequisites as set out by the MNR, MECP, and the NVCA. SWM pond / facilities locations, functions, and design criteria shall be confirmed through consultation with the NVCA and the Township. Where Stormwater Master Plans have been completed, the design criteria shall follow the approved Master Plan.

In general, an SWM report will be required for all development applications. The SWM report shall consider all relevant environmental and flood protection guidelines including water quantity control, erosion control, flood susceptibility, and water quality control requirements.

End-of-pipe facilities are acceptable to the Township when the designs meet the Preferred Criteria as set by the MECP, are maintainable, integrated with the surrounding landscape, and aesthetically pleasing. All SWM ponds / facilities

shall meet the most current version of the Preferred Criteria – SWM Planning and Design Manual.

The Township requires the overall design requirements to the most recent provincial direction, as is acceptable to the NVCA. Exceptions to this are in circumstances that involve:

- Matters of public safety and aesthetics.
- Maintenance requirements.
- Protecting the riparian rights of private landowners.
- Protection of municipal infrastructure and maintaining an acceptable level of protection to residents whose homes drain into a municipal drainage system.
- Conflicts with land use.

In these cases, the Township may invoke additional release rate stipulations and design requirements over and above those required by other agencies.

The Township requires integration of SWM pond / facility grading design with the surrounding landscape. The design is to consist of varied contour grading, provide improved aesthetics, support a variety of plantings and vegetation and provide passive recreational activities (i.e., walking trails, bike paths, vistas, etc.). This includes identifying the use of gentle slopes in areas where passive recreation takes place, an increasing density of appropriate plantings and vegetation on steeper slopes, handrails / guardrails at headwalls and placing signs which inform of the function and potential hazards of SWM ponds / facilities.

C2.02 Service Area

Storm drainage systems and the SWM Plan shall be designed to service all upstream drainage areas within the development boundary, as well as any external areas tributary to the system. The external area may be determined by referencing the appropriate sub-watershed 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 topographical data.

Storm drainage systems and the SWM Plan shall be designed considering interim and ultimate conditions in accordance with the Official Plan. Development applications must take into account surface runoff on a

sub-watershed basis. Consideration shall be given to the effect of upstream future development on the storm drainage system design.

Connections to existing storm sewers shall be approved by the Township. Discharge of the storm drainage system to a natural receiving system must be approved by the Township and the NVCA, as applicable. In some instances, the Township may request that existing receiving storm drainage systems be upgraded to meet current standards or improve functionality.

C2.03 Minor Storm System

The minor system is typically comprised of underground pipes and structures to quickly and efficiently convey stormwater from the surface to an outlet such as a SWMF or natural watercourse, from relatively minor (more frequent, less intense) rainfall events. Storm sewers are to be designed to convey a 5-year return frequency storm without surcharge where adequate overland drainage capacity exists to satisfy the major system requirements.

Storm sewers shall be of adequate size and depth to provide service for the development of lands within the upstream watershed and / or for the drainage of any areas designated by the Township. Stormwater pumping or siphons are not acceptable; storm sewers must drain by gravity.

C2.04 Major Storm System

The major storm drainage system is typically comprised of a surface network of roadways and / or overland drainage 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.

The major system must be designed for the 100-year return frequency storm and shall convey these overland flows within the roadway or overland drainage channel to an outlet considered adequate in the opinion of the Township and the NVCA, such as a SWMF or natural watercourse corridor.

A preferred route for overland flow generated by an event greater than the 100-year design storm shall be identified to a receiving system (i.e., SWMF or natural watercourse).

C2.05 Hydrology and Hydrologic Modeling

Pre-development peak flows shall be computed by a method such as the Rational Method or by an approved computer model. Watershed definition and pre-development flows must be reviewed and accepted by the Township Public Works Department.

Preliminary estimates of post-development flow rates may be computed using a method such as the Rational Method.

For all systems and for the design of surcharged sewers and detention facilities, the latest version of the computer model OTTHYMO or PCSWMM is recommended. Other hydrograph methods may be considered if it is demonstrated that the results are comparable to those from OTTHYMO. Post-development design flows may be determined using the Rational Method only where the design area is less than 40 ha and SWMFs are not considered.

Rainfall intensity-duration-frequency (IDF) equations or their curves and design storm hydrographs must be approved by the Township Public Works Department. The Township requires use of the online MTO IDF Curve lookup tool. Based on a review of literature regarding projected climate change scenarios, the IDF intensity values from the MTO IDF Curve lookup tool are to be increased by 15% to account for future climate change impacts.

Where the first leg of a residential storm sewer system is sized using the Rational Method, the initial inlet time shall be 15 minutes for the 5-year storm. This shall apply where the upstream drainage area does not include large open space areas. Where peak flows from external areas enter a subdivision sewer system, the more critical case based on either the time of concentration including the external area or the time of concentration excluding the external area shall be used. Actual velocities of computed peak flows shall be used to estimate time of concentration.

A design evaluation of inlet times shall be submitted to justify inlet times different from those specified above, especially in the cases where the sewer is designed for certain surcharge levels for larger storms and where the sizing is optimized for both situations. Such an evaluation shall be approved by the Township Public Works Department prior to submission of design drawings.

Please refer to the NVCA Design Criteria and CLI-ECA Design Criteria for runoff coefficients. Provide justification for the selection of the runoff coefficients.

Runoff coefficients for higher return period storms shall be modified by the Antecedent Precipitation Factor "Ca" to account for saturated ground conditions, reduced depression Storage and infiltration capacity during these events. The following factors shall be applied to the extent that the product of C x Ca does not exceed 1.00.

Table 2: Runoff Coefficient Modification Factors

Design Storm Return Period	Runoff Coefficient Modification Factor (Ca)
5-year	1.00
25-year	1.10
50-year	1.20
100-year	1.25

Manning's Formulae shall be used to determine the capacity of the sewers. The following roughness coefficients shall be used. Polyvinyl chloride (PVC) pipe and Concrete pipe: 0.013. Corrugated pipe: 0.024.

In general, a storm sewer system shall be designed to convey not less than the 5-year return frequency storm without surcharge. Surcharged design may be considered for higher design levels where suitable methods are used, subject to the approval of the Township Public Works Department.

The Township or NVCA may request other design storm lengths and distributions for evaluation during the pre-consultation process.

C2.06 Stormwater Management Facility Design Requirements

Where deemed necessary by the Township to reduce runoff increases and to meet identified downstream flow constraints, detention and / or retention facilities shall be provided for both the major and minor systems.

Land area set aside expressly for SWMFs where it is not part of a privately-owned facility (i.e., roof top storage or otherwise incorporated into industrial / commercial lands) shall be designated as a "stormwater detention / retention site" and dedicated by the Developer to the Township. It shall not be considered as part of the park system.

All SWMFs shall be provided with an outlet (overflow spillway) designed to accommodate the regional storm flow without failure. Freeboard shall be 0.3 m from high water level (HWL) to the top of the outlet berm. Suitable erosion

protection shall be provided downstream of the outlet for all flow conditions. Operation during spring snow melt or freezing conditions shall be investigated, and any required changes shall be incorporated.

SWMFs to be assumed by the Township must include aesthetic considerations to achieve a visually pleasing final constructed form. Undulations to be incorporated into pond perimeter grading to achieve an "organic" pond shape; no box-shaped ponds. Pond landscaping should be visually pleasing and long-term, low maintenance. Pond layout and design shall be approved by the Public Works Department.

If an SWMF contains a permanent pool, a minimum 1.5 m high chain link fence shall be required for the "block" that the facility is located within, where the block is adjacent to residential property lines, or as directed by the Township.

Grading to provide gentle slopes to the permanent pool shall follow the most current MECP preferred criteria SWM guidelines. Planting techniques should also follow the current MECP SWM guidelines.

Table 3: Wet Pond Design Criteria Permanent Pool

Slope / Depth	Measurement
Maximum Slopes	7:1 near normal water level (NWL) plus use of 0.3 m steps
Maximum Slopes	4:1 elsewhere
Average Depth	1.0 to 2.0 m
Maximum Depth	2.5 m

Extended Detention

Slope / Depth	Measurement
Maximum Slopes	7:1 near NWL plus use of 0.3 m steps
Maximum Slopes	4:1 to top of extended detention
Maximum Depth	1.0 m

Flood Storage

Slope / Depth	Measurement
Maximum Slopes	4:1 above the maximum extended detention level up to 2 m beyond the HWL
Maximum Depth	2.0 m for combined Extended Detention and Flood Storage

Other

Slope / Depth	Measurement
Maximum Slopes	3:1 from 2.0 m beyond HWL as required

Design Criteria
Design of sediment forebays at each inlet to the pond, meeting MECP design guidelines in order to maximize sedimentation in the forebays.
A minimum 3.0 m wide platform at a maximum cross slope of 4% provided around the property boundary of the SWM block for the purposes of grass cutting and set back from any residential properties.
A horizontal terrace of 3.0 m required for continuous slope changes in elevation greater than 3.0 m.
Freeboard to top of pond of 0.3 m above the HWL (based on routing of Regional Storm flow). (HWL = maximum water level to convey the Regulatory event through pond).
Emergency overflow weir (to pass the Regulatory event) with capacity of no less than 0.1 $m^3/s/ha$.
Signage (with one sign located at each entrance of the pond and any other locations identified by the Township) shall be placed to educate and advise the public of the purpose, characteristics, and dangers associated with the facility. See Township detail for signage.

Design Criteria
Bollards or gates to discourage vehicular access to the maintenance road.
Pond inlet and outlet pipes are to be equipped with grates per the OPSDs.
Maintenance vehicle access roads shall be paved. Asphalt and granular make up to be suitable to support municipal equipment. See detail for Asphalt Trail.
Berms constructed of suitable material, inspected by a geotechnical engineer and compacted to a minimum 95% Standard Proctor density.
The need for pond liners to be reviewed by a geotechnical engineer and recommendations and liner specifications provided. The Township requirement for pond liner material is geosynthetic. Native clay for the use of pond liners is not permitted.

C2.07 Quality and Quantity Control

C.2.07.1 Quantity Control

Where there is an increase in runoff rates due to new development or an increase in impervious area, pre- to post development control of stormwater shall be provided as required by the Township. Post-development flows from the 2- to 100-year storm events shall not exceed the pre-development flow rates. More stringent downstream constraints may exist as established by the Township or the NVCA. The capacity of the existing downstream system should be reviewed to the extent that it can be proven that the receiving downstream system (sewer, pond, ditch, etc.) has sufficient capacity to ensure a sufficient downstream outlet exists to receive the stormwater runoff from the development and no new negative downstream effects will be experienced as a result of this development. The SWM report shall speak to the downstream constraints and demonstrate how runoff rates will be controlled to satisfy the constraints.

The Township requires on-site stormwater quality and quantity control measures on Industrial, Commercial, Institutional (ICI) developments or re-development projects as part of a "Treatment Train" approach. Consultants

shall specify in FSRs and in detailed designs the required level of quality and quantity control and how it is achieved through appropriate SWM controls.

Backflow preventors on any part of the storm system will not be accepted.

Rooftop Storage
See Site Plan Design Guide in Appendix D.

Parking Lot Storage
Parking lot storage within residential or institutional developments is not permitted.

See Site Plan Design Guide in Appendix D.

Underground Storage
The use of underground storage will be considered by the Township subject to the results and recommendations of a geotechnical investigation. Underground storage systems that incorporate infiltration measures into the design shall be required to complete in-situ infiltration testing to confirm that the infiltration rate of the native soil is adequate. Safety factors are to be applied to the infiltration rate as per the LID SWM Planning and Design Guide prepared by CVCA and TRCA, 2010 – Version 1, or most recent version.

A minimum of 1.0 m separation from the invert of the system to the seasonally high groundwater table is required for systems incorporating infiltration measures into the design. For any underground storage system, approval of the design from a geotechnical perspective (infiltration rates, hydrostatic uplift, cover requirements, etc.) is required from a geotechnical engineer.

Operation and Maintenance (O&M) requirements shall be included in an O&M manual.

C.2.07.2 Quality Control

The selection of Best Management Practices (BMP) for water quality control shall be provided as per the most current NVCA and / or MECP guidelines. The SWM report and design drawings must demonstrate how the required level of water quality control is to be achieved. The BMP selection process shall review all environmental constraints and provide rationale for the selection of alternatives for a specific site.

In all cases, infiltration of stormwater shall be the primary consideration for stormwater quality control. Infiltration areas shall be subject to the

recommendations of a hydro-geological and soils investigation report. Runoff from roadways and parking lots must be treated prior to infiltration or discharge to a watercourse. Where infiltration is not possible or limited, wet ponds shall be considered.

Oil and Grit Separator (OGS) units may be considered as part of a treatment train approach or where it has been demonstrated that other forms of water quality control are not practical. OGS units are to be tested and certified under the Canadian Environmental Technology Verification (ETV) program and follow the most recent CLI-ECA criteria. The OGS design shall be provided and include the contributing catchment area, the percentage of impervious area to size the unit and the particle size distribution (PSD) used to determine the TSS removal rate. The operation and maintenance manual shall be provided for the OGS unit as part of the SWM submission.

Where used as an outlet control, orifice plates shall be stainless steel and a minimum diameter of 75 mm. However, a 100 mm diameter or greater orifice is preferred.

C2.08 Submission Requirements for SWM Design Reports

As a minimum the following list of documentation should be included within SWM design reports submitted to the Township for review. These reports are submitted to support the final design of quality and / or quantity control facilities. These reports shall clearly identify how applicable recommendations from Master Servicing, Functional Servicing, Geotechnical, Environmental, or Hydrogeological Reports have been incorporated into the final design of the facility.

1. Site Location Drawing.
2. Existing and proposed catchment area drawing which delineates internal and external drainage areas, labels areas, applicable coefficients, and catchment reference numbers.
3. Engineering drawings for stormwater facility which should identify the following:

    a) Permanent (normal water level), extended detention level, and highest water level on drawing view and include all ponding levels for various return periods (modeled storm events) in tabular form.

b) Section and details of major overland flow routes.

c) Section and details of maintenance access roads.

d) Section and details of inlet and outlet structures.

e) Section and details of erosion protection at inlet and outlet structure and on spillways.

f) Section and details of sediment forebay and berm, including lining.

g) Location of facility signage.

h) Borehole locations, vertical soil logs (shown on sections) and existing seasonal high groundwater elevation.

i) Existing and proposed grading, and spot elevations and transition slopes.

j) Limits of construction and grading.

k) Details of sediment drying area and / or by-pass pipe for cleaning purposes.

l) Fencing limits.

4. Landscaping / restoration drawings and details.
5. Erosion and sediment control drawings and details.
6. Excerpts from Master and Functional Studies which outline requirements for quantity / quality control and any facility design requirements.
7. Identify any deviations from the Township Engineering Standards including an explanation based on site specific conditions.
8. Pre- and post-development hydrologic modeling schematic to illustrate all components of each model.
9. Table summarizing pre- and post-development catchment parameters (i.e., catchment number, area, percent impervious, curve number (CN) value, etc.).

10. Table summarizing stage, storage and discharge characteristics of the facility.
11. Table summarizing pre and post development peak flows and storage volumes based on output from hydrologic modeling or comparison to volumes and target peak flows identified in Master and Functional Servicing Studies.
12. Table to summarize and compare required permanent pool and extended detention storage requirements to volumes provided in the facility.
13. Table to compare calculated 100-year HGL elevations within storm sewer system to identify if there will be any surcharging of the system.
14. Sample or supporting calculations for the following:

    a) Sediment forebay sizing. Length and width in conformance with MECP manual and estimate of required cleanout frequency.

    b) Extended detention drain down time (hours).

    c) Major system overland flow and velocity to confirm conveyance within ROW and / or defined flow routes.

    d) Erosion control sizing and flow velocity at inlet and outlet structures and spillways.

    e) Overflow spillway capacity.

    f) Outlet control calculations (i.e., orifice sizing, weir sizing, etc.).

    g) Major system inlet capacity (assuming 50% blockage of grating).
15. Hard and digital copies of input / output files from hydrologic modeling (digital files may be provided via e-mail or through a shared file link).
16. Identify erosion and sediment control methods to be implemented before, during, and after municipal servicing construction up to the end of servicing maintenance period, including schedule for implementation / decommissioning and maintenance requirements.
17. Construction sequencing and calculations for sizing of temporary sediment control ponds.

18. Operations and maintenance requirements in accordance with the CLI-ECA (see section below).

C2.09 Operations and Maintenance Manual

A SWMF O&M Manual is to be prepared for the Township by proponents of new SWMFs. O&M activities to be in accordance with the Township's CLI-ECA.

The manual is to describe how each facility operates, and the short-term and long-term inspection and maintenance requirements of the facilities. Any collection system SWM components, such as OGS, infiltration galleries, or infiltration trenches, etc. are to be included in the manual. The manual is to focus on the expected frequency and method of maintenance that will be required in the following specific areas:

- Facility inspection / monitoring program (outline seasonal and annual tasks based on Master / Functional Studies or Draft Plan Approval Conditions).
- Grass cutting.
- Weed control.
- Plantings.
- Trash removal.
- Sediment testing, removal, and disposal.

The SWMF O&M Manual is also to include cost estimates (including labour, equipment, and materials) for the operations and activities described above.

C2.10 Report Format

Once the reports have been reviewed and accepted by the Township, separate digital and hard copies of the report shall be provided. The SWM Design Report and the O&M Manual shall be separate documents, bound with front / back covers, the Development / Subdivision name shall be included on the front covers. ARCH D size drawings included within the reports shall be folded and included in the back of the report in appropriate sleeves.

C2.11 Operational and Maintenance Features

O&M of SWM ponds is to be in accordance with the Township's most current CLI-ECA requirements. The SWM pond designs are to incorporate features that allow the Township to operate and maintain the facility. It is strongly recommended that the design engineer arrange a pre-consultation meeting with the Township once a preliminary pond design has been prepared in order to

discuss maintenance operations and features, specifically clean-out procedures, and sediment management and removal. These features include:

- Provide a primary maintenance access to the facility (minimum 4 m in width of access road, and an additional minimum 3.0 m buffer where adjacent to residential properties) suitable for municipal equipment. Maintenance access to be asphalt with a composition of 50 mm HL4, 150 mm Granular A, and 250 mm Granular B.
- Maintenance vehicle access roads and turn-around areas at sediment forebays, outlet pools, and control structures having a maximum gradient of 10%, minimum width of 4 m, a minimum inside turning radius of 14 m, and including a 10 m long loading platform at the forebay and outlet pool locations. Maintenance roads may be required to other locations within the pond block as determined by the Township. Maintenance roads should have maximum crossfall of 2%. Provide a minimum of 3 m offset of clear space between the maintenance road and any property lines.
- All maintenance vehicle access roads construction shall be structurally designed to support municipal equipment.
- Provision of a drain down pipe leading from the permanent pool to an MH with dewatering sump, if a gravity outlet is not available.
- In order to facilitate sediment removal operations, either of the following may be proposed, and are subject to review and approval of the overall approach to sediment management and removal:
  - A sediment drying space, suitable to contain the volume of sediment and water remaining (after completing pond drain down procedures) shall be provided. Calculations to be provided with assumptions for the volume of sediment removal and area calculations for appropriate drying area sizing. OR
  - Provision of a pond by-pass sewer (sized based on the minor system design criteria) between the inlet and the outlet in order to divert incoming flows around the pond for the duration of clean-out operations (allows for sediment drying in situ).
- The sediment drying area should be sized to provide sufficient storage space for the volume of sediment accumulated over a 10-year period. This can be calculated using the MOE Stormwater Management Planning and Design Manual – Table 6.3. The sediment drying area is to be provided above the extended detention level in the facility. Drainage from the sediment drying

area should return to the pond. Area to be sloped towards the pond at 2% to 5% grade. The drying space is to be designed based on a maximum sediment depth of 0.5m.

- A minimum 3 m wide platform at a maximum cross slope of 4% is to be provided around the property boundary of the stormwater block for the purposes of grass cutting.
- Use of a reverse sloped control pipe, which reduces thermal impacts (wet pond application).
- Provision of flow control devices in maintenance hole structures located in a berm for easy access, maintenance, and cleaning as opposed to a vertical pipe structure located in the pond.
- Minimum orifice size of 75 mm diameter. Orifice plates to be stainless steel. Use of a screened orifice plate or weir plate fixed to a permanent structure to achieve extended detention.
- A gate valve and valve box to enable the normal pond outlet to be closed in case of chemical spills where applicable.
- Provide the following table in the SWM Report, as required in the CLI-ECA

Table 4: Sample Table for SWM Report

Location	Latitude and Longitude or Physical Address (UTM Coordinates can be Provided in Addition)
Watershed / Subwatershed	E.g., Mad River
Receiver of Discharge	E.g., Surface discharge to "Mad River"
Outlet Location	E.g., Latitude and longitude (UTM coordinates can be provided in addition)
Catchment Area	E.g., 10 ha
Level of Treatment for Suspended Solids	E.g., Level 1 or 2 (80 or 70%) Long-term suspended solids removal or specify if other treatment level
Treatment for Other Contaminants, As Required	E.g. Phosphorus, water temperature
Level of Volume Control	E.g., Local 90th percentile rainfall event or local water balance (X mm)
Design Storm	E.g., Quantity: X-year storm; Quality: X-year storm

Location	Latitude and Longitude or Physical Address (UTM Coordinates can be Provided in Addition)
Brief Description	Include model number if equipment is used (E.g., OGS/filters)
Receive Emergency Sanitary Overflows	Y/N; briefly describe
Notes / Additional Information	Provide any additional information relevant to this facility not captured above

C2.12 Landscaping

Landscaping shall be used to enhance the aesthetics and functional aspects of stormwater ponds. Native, non-invasive trees, shrubs, and ground cover are required in a low maintenance landscape design. NVCA policies are to be consulted for a listing of acceptable planting species, topsoil depths and composition and appropriate seed mixtures and application methods.

A detailed outline of landscaping requirements is provided in Section I – Landscaping.

A planting and landscaping drawing prepared by a registered landscape architect is to be submitted to the Township and the NVCA for review and approval. The design is to ensure a minimum 2 m separation from the edge of trails or walkways to trees or shrubs. The drawing is to address the following objectives:

- Provide shade to areas of the permanent pool (minimize thermal impacts).
- Propose vegetation which has high nutrient uptake capability and is planted in shallow ponding areas in the extended detention zones.
- Provide outlooks or viewing features with space suitable for installation of benches and use of asphalt paths to link viewing areas with local walkway or trail systems.
- Provide a low maintenance ground cover that minimizes the area to be mowed on a regular basis.

The Township requires the following minimum standards for trees and shrubs:

- Deciduous trees – minimum 60 mm diameter caliper.
- Coniferous trees – minimum 1.8 m in height.
- Deciduous or coniferous shrubs – minimum 0.9 m in height.

Where tree planting is required, the density of planting is to be such that there is a minimum of one tree per 50 m^2. The selection of shrub species and the proposed density of plantings shall be used to discourage public access where appropriate. These locations include areas of steeper slopes around the edge of the permanent pool and headwalls.

C3.00 Inlets, Outfalls, and Special Structures

Inlet and outfall structures, including headwalls, shall be in accordance with the OPSDs and specifications. Said structures are to be designed, detailed, and stamped by a structural engineer whenever required.

Grates will be provided on all inlet and outlet structures and shall be designed and detailed when standard drawings are not appropriate. Outlet grates will consist of horizontal bars or rods. Spacing of bars or rods shall not exceed 150 mm clear. All metal parts will be adequately protected against rusting.

All drainage works will require sediment control during construction periods, and permanent installations may be required. Facilities shall be located for easy access by maintenance vehicles, and sediment shall be removed whenever the storage volume is reduced to 40% of required volume.

All drainage works shall be designed to control erosion and the impairment of water quality on receiving streams as a result of urban stormwater runoff.

C3.01 Inlets

Inlet structures must be fully designed and detailed on the Engineering Drawings. Inlet grates shall generally consist of inclined parallel bars or rods set in a plane at approximately 18^0 with the top away from the flow.

Gabions, riprap (underlain with geotextile fabric), or concrete shall be provided at all inlets to protect against erosion and to channel flow to the inlet structure.

Precaution must be taken in the design of grating for structures to minimize the risk of entanglement or entrapment of a person.

C3.02 Outlets

The OPSD 804.030 standard headwall shall be used for all storm sewers up to 900 mm in diameter. For sewers over 900 mm in diameter, the headwall shall be OPSD 804.040 or individually designed. All headwalls shall be equipped with a grating over the outlet as per OPSD 804.05.

Gabions, riprap (underlain with geotextile fabric), concrete, or other erosion protection shall be provided at all outlets to prevent erosion of the watercourse and the area adjacent to the headwall.

C3.03 Safety Railings

Safety railings, in the form of Ontario Building Code (OBC) Compliant railings / guards shall be provided for any headwall exceeding 1.0 m of exposed height. Fencing in the form of a 1.2 m high continuous black vinyl chain link fencing shall be provided along the top of all headwalls over 0.6 m in height but less than 1.0 m. Posts shall be cored into the concrete headwall and / or wing walls. Railings may also be required along shorter headwalls where a risk to pedestrian safety has been identified. The site-specific conditions must be reviewed in determining the requirement for safety railings and must have due regard to public health and safety and shall be at the Township's discretion.

C4.00 Stormwater Conveyance

C4.01 General

Urban stormwater conveyance systems may include open channels and swales, storm sewers, MHs and CBs, roadways, and road allowances. The design of stormwater conveyance systems shall follow "dual drainage" principles, which consist of:

- The minor drainage system which conveys runoff from the 5-year return period storm.
- The major drainage system which conveys runoff from storms greater than the 5-year return period up to the 1:100-year storm.

The design of the minor drainage system shall provide unsurcharged conditions up to the 1:5-year storm.

The use of sump pumps is permitted; however, they must discharge over the foundation wall onto a splash pad. The use of direct connections to the storm sewer, or storm services is not permitted.

The design of the major system shall be such that runoff is conveyed within the boundaries of municipal road allowances, or blocks. A continuous overland flow route is to be identified on the engineering drainage drawings, and a suitable outlet is to be identified.

During preparation of the Preliminary Functional Servicing Study prior to Draft Plan approval, the maximum ponding elevations in SWM blocks and the resulting HGL in the storm sewer system is to be determined with sufficient level of detail. An HGL analysis is required to protect structures from flooding and damage during 100-year design storm events. The analysis shall demonstrate that the HGL will not cause unreasonable operating conditions during the 1:100-year design storm conditions, i.e., uplift of MH lids, extended flooding of road base via subdrains, etc.

C4.02 Minor Drainage System Design

The design of the storm sewers shall be computed and shall be included in the drawing set on ISO A1 (594 mm x 841 mm) sheets. A digital (Microsoft Excel or as appliable) version shall also be included in the submission. All storm sewer minor system designs shall be based on a 5-year frequency unless otherwise directed by the Township.

1. All storm sewers shall be designed according to the rational formula where:

   $$Q = 2.778 (ACi)$$

   Where: Q = Runoff quantity in m^3/sec.

   A = Area in hectares (ha)

   C = Runoff coefficient

   i = Average rainfall intensity in mm/hr.

2. The value for rainfall intensity shall be calculated using the MTO IDF Lookup Tool, with IDF intensity values increased by 15% to account for climate change, as described in Section C2.05.

3. Values for the runoff coefficient "C" shall be per the NVCA guidelines and the CLI-ECA Design Criteria.

4. The design for minor water courses, associated culverts, and structures will be designed to a 25-year storm frequency unless otherwise directed by the Township or NVCA.

C.4.02.1 Manning's Formula

Designers shall reference this section of the standards to establish an appropriate inlet time (typically minimum of 15 minutes in small urban areas).

Manning's formula is to be used as a basis for sewer design.

C.4.02.2 Pipe Capacity

The hydraulic capacity of sewers shall be designed according to the Manning equation (for pipes flowing full):

$$Q = 1.00/n \times R^{2/3} \times S^{I/2} \times A$$

and

$$V = 1.00/n \times R^{2/3} \times S^{I/2}$$

Where: Q = flow m^3/sec.

A = Nominal cross-sectional area of the sewer (m^2)

R = Hydraulic radius (m)

S = Slope of pipe (m/m)

n = Roughness coefficient as noted below

C.4.02.3 Roughness Coefficients

The roughness coefficients to be used for storm sewer pipes will be:

a) Concrete pipe: n = 0.013 for all sizes of pipes.

b) PVC pipe: n = 0.013 for all sizes of pipes.

c) Corrugated metal (culverts only): n = 0.024 for all sizes of pipes.

d) HDPE: n = 0.021.

C4.03 Major Drainage System Design

A continuous overland flow drainage route is to be identified on the engineering drawings and grading drawings. The extent of any overland ponding at low points is also to be shown on the grading drawings. The maximum allowable flow depth where vehicle or pedestrian traffic takes place or may be expected is 0.30 m. A minimum freeboard of 0.3 m is also required between overland

flow and the lowest building opening elevation. Any inlet grating associated with the major drainage system is to include a 50% blockage factor in its design.

Overland flow must be limited to road ROWs, SWM blocks, and designated overland flow routes, free of fences and other impediments to flow.

C5.00 Storm Sewer Pipe Design

All storm drainage infrastructure, including sewers, maintenance holes, CBs, etc., are to conform to the design standards outlined herein. Should any provincial standards (i.e., MECP) exceed the Township's standards, those provincial standards shall dictate.

Ditch inlet grate capacities are to be checked against design flows.

Storm service laterals are not permitted. Private direct connections to the storm sewer will not be permitted.

Culvert capacity shall be checked against inlet and outlet control hydraulics and the potential effects of backwater to upstream properties. See further sections for culvert design specifications.

Connection of residential roof leaders to the storm sewer system is not permitted and shall be directed overland. Splash pads must be provided at the discharge location for all roof leaders.

C5.01 Minimum Pipe Sizes

The minimum pipe size for a storm sewer main in residential areas shall be 300 mm in diameter. The minimum size for CB leads including RLCBs is 250 mm.

The minimum pipe size diameter for a storm sewer in industrial and commercial areas shall be 375 mm.

C.5.01.1 Velocity

Minimum = 0.75 m per second

Maximum = 4.5 m per second

Additional protection against erosion, scouring, and pipe displacement must be provided by a licensed engineering practitioner where flow velocities exceed 4.5 m/s.

C5.02 Changes in Pipe Size

Decrease of pipe size from a larger upstream to a smaller downstream will not be allowed regardless of the increase in grade. Exceptions may be considered for Capital Works Projects where the downstream sewer is scheduled for future replacement.

C5.03 Location

The storm sewers shall be located as shown on the standard Township cross-section drawings. Any sewers which are situated in off-road locations shall be contained within blocks.

C5.04 Sewer Alignment

All storm sewers shall be laid in a straight line between MHs unless radial pipe is required.

The minimum diameter for radial pipes, where approved by the Township, shall be 900 mm. A MH is required at the beginning and end of the radial section. The minimum centre line radius allowable shall be in accordance with the minimum radii table as provided by the pipe manufacturers. Curve data must be shown on the drawings.

C5.05 Depth

The minimum depth of cover for frost protection shall be 1.5 m from the springline to the centreline of road. Under certain conditions where sufficient cover is not feasible, shallow insulated pipes may be permitted subject to review by the Township's Public Works Department, in accordance with the OBC, or any other applicable standard.

C5.06 Limits of Construction

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

Provision for future extension of the sewer (any oversizing) will only be considered for lands which are within the limits of the current urban boundary.

C5.07 Pipe Crossings

All sewers and connections shall have a minimum horizontal separation of 2.5 m, where running parallel, and a vertical clearance at crossings of 0.5 m from all watermains and appurtenances. A minimum clearance of 0.25 m shall be provided between the outside of pipes barrels at all points of sewer crossings. In any event, the minimum separation distance requirements shall comply with the current MECP policy. Where clearances cannot be achieved between sewers and watermains the design shall be completed in accordance with MECP Procedure F-6-1.

In cases where the storm sewer crosses a recent utility trench at an elevation higher than the elevation of the utility, a support system shall be designed to prevent settlements of the storm sewer, or alternatively the utility trench is to be excavated and backfilled with compacted crushed stone or concrete to adequately support the storm sewer. When the storm sewer passes under an existing utility, adequate support shall be constructed to prevent damage to that utility.

A minimum clearance of 0.5 m between the obvert of a sanitary sewer and the invert of a storm sewer shall be provided if the sanitary sewer connections are required to go under the storm sewer. The minimum horizontal clearance between the outside walls of adjacent sewer pipes shall be 0.8 m.

C5.08 Pipe Bedding and Backfill

The classes of pipe and the types of bedding shall be selected to suit loading and proposed construction conditions. Details and types of bedding and backfill are illustrated in OPSD 802.01 with Granular A bedding and 802.03 Class "B" with Granular A bedding for concrete pipes unless otherwise recommended by the geotechnical engineer.

Bedding and trench compaction shall be carried out in conformance with OPSS.MUNI 501. The width of trench at the top of the pipe must be carefully controlled to ensure that the maximum trench width is not exceeded unless additional bedding or higher strength pipe is used. The recommendations of a geotechnical engineer will be required in determining strength of pipe required and construction methods to be used.

Fill beneath sewers is to be approved fill compacted to 95% Standard Proctor as directed by a geotechnical engineer.

C5.09 Materials

The type and classification of all storm sewer pipe and the sewer bedding type shall be clearly indicated on all profile drawings for each sewer length. Concrete or plastic pipe will be permitted for storm sewers 375 mm in diameter and smaller. All storm sewer mains 450 mm diameter and over shall be constructed with reinforced concrete pipe.

Concrete pipe shall conform to the requirements of CSA Specification A257-M 1982 for the particular classes as shown below:

- Pipes up to 375 mm – Non-reinforced Concrete Pipe, CSA Standard A257.1 M1982, Classes 1, 2, and 3.
- Pipes 450 mm or greater – Reinforced Concrete Pipe, CSA Standard A257.2-M1982, Strength Classification 50-D, 65-D, 100-D, and 140-D.

All concrete pipes shall be supplied from a pre-qualified plant registered with the Ontario Concrete Pipe Association (OCPA).

PVC pipe is permitted for sewers up to 375 mm diameter. PVC products shall conform to the requirements of CSA B182.1, CSA B182.2, ASTM D3034, ASTM F1760, and ASTM F1336.

All PVC pipes and rubber gasketed joints shall conform to the requirements of OPSS 1841, OPSDs 806.040, and 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.

The pipe must be manufactured with factory assembled spigot gasket and integral bell joints. Externally ribbed pipe will not be permitted. PVC pipe for storm sewers shall be any colour except green.

High density polyethylene (HDPE) pipe is acceptable for use for all development areas (residential and ICI) upon the Township's approval. HDPE pipe shall conform to the requirements of CSA Specification B182.6 with rubber gasketed bell and spigot joints, OPSS 1840 and OPSD 806.020, and shall have a smooth inside and outside wall with minimum pipe stiffness of 320 kPa.

Storm sewer leads from CBs shall be constructed with PVC DR35, HDPE, or concrete pipe. All RLCB leads, if not concrete, shall be concrete encased.

Watertight bell and spigot connections will be required for all pipe joints.

C6.00 Ditches and Culverts

Ditches and culverts shall be sized to take the total expected storm runoff calculated by a recognized design method. Acceptable methods for culvert calculations and ditch sizing are detailed in the MTO Drainage Design Manual. Where tailwater elevations impact hydraulic capacity, the method used must respect this tailwater condition. Acceptable hydrologic calculations include, Rational Method, SWMHYMO, OTTHYMO, SWMM5, as appropriate based on the assumptions of the method.

C6.01 Ditches

Where permitted, open ditches shall be graded to the alignment and grades as shown on the plan and profile drawings.

The area between the edge of the road shoulder and the street line shall be graded and the ditches cut with side slopes of 3:1 from the edge of the shoulder to the bottom of the ditch and from the bottom of the ditch to the original ground. In fills over 1.5 m, measured vertically from the edge of shoulder to the toe of slope, the fill slope shall not be steeper than 2:1. The ditch shall be located at the toe of the fill slope. In fills over 3.0 m, measured vertically from the edge of boulevard to the toe of slope, guide rails shall be installed conforming to the OPSD and MTO protection warrants.

Ditches shall be constructed as follows:

1. Distance centre to centre of ditches to be as required for the depth of ditch and side slopes.
2. Depth below finished centerline grade:
   Maximum 1.20 m (or as approved by the Township)

   Minimum 0.75 m
3. Ditch Grade:
   Maximum 6.0%

   Minimum 0.5%

   Where needed, sub-drains shall be bedded in a 300 mm x 300 mm clear stone trench below the swale and shall conform to OPSS 405. Sub-drains shall be installed a minimum of 0.5 m below C/L of ditch to avoid maintenance damage

and must have a positive outlet to a ditch or storm drainage structure. Sub-drains are to be inspected post-utility installation.

Where drainage is conveyed from the roadside ditch to a suitable outlet through a block, it shall be piped using ditch inlets and grates. Storm sewer pipe material shall be concrete or PVC or PE, minimum size 300 mm diameter. Concrete pipe material must be ES or Class III. PVC or PE pipe material must be 320 kPa pipe stiffness complete with bell and spigot connections.

The minimum ditch protection on all ditches shall be 150 mm of topsoil with No. 1 nursery sod, staked when slopes are 3:1 in residential, commercial, or industrial areas. In rural reconstruction areas, ditch back slopes may exceed 3:1 and must be protected for erosion. Erosion protection methods (e.g., erosion mats, etc.) along with seeding may be considered by the Township as an alternative to sod in rural areas. All topsoil shall be from a source approved by the Township Public Works Departments.

C6.02 Culverts

C.6.02.1 Entrance Culverts

Refer to MTO standards for culvert sizing.

Normal entrance culverts shall be installed where required as follows:

1. Length: Minimum length of 7.5 m.
2. Size: Minimum of 450 mm diameter.
3. Material: BOSS 2000 HDPE preferred; standard galvanized corrugated steel pipe (CSP) will be considered in cases where HDPE is not an option.
4. Gauge: As recommended by manufacturer for CL-625 ONT loading, minimum 2.0 mm thickness for CSP.
5. Joining systems shall only be used where the length of proposed culvert exceeds the shippable length of pipe. Joining systems shall be water-tight, Type 1 (75 kPa) joints as per CSA B182.8.
6. Cover: 450 mm minimum at the shoulder of the road.

7. Bedding: Culverts to be bedded and backfilled with granular material in accordance with OPSS.

8. End Protection:

   a) In subdivisions and areas where the posted speed limit is 50 km/hr or less, all road driveway and walkway culvert ends shall be protected with prefabricated concrete stone block walls and filter cloth as per Township Standard Details.

   b) In areas where the posted speed limit is greater than 50 km/hr, culverts shall have sufficient length to provide a minimum 5.0 m entrance width plus stable side slopes (minimum 2:1). Riprap to be provided where steep slopes may make erosion a concern.

9. Where it is necessary to construct culverts under roadways or driveways larger than the minimum size, the culvert shall be designed in accordance with a method recognized by the MTO. Detail drawings and calculations shall be submitted for review and acceptance to the Township's Public Works Department.

10. Driveway entrance culverts for each residential lot shall be installed by the Developer, minimum size 450 mm diameter HDPE, minimum 320 kPa stiffness and minimum length 7.5 m. No driveway or culvert shall be placed closer than 1.5 m to any water valve, curb stop, lot line, transformer, or utility pole.

11. Where culvert ends are spaced less than 3 m, they shall be joined as one, having regard for maximum length of pipe.

12. Where culvert ends are spaced more than 3 m, they shall not be joined as one.

13. Culverts are to be installed at all fire hydrants, Hydro transformer pads, and community mailboxes in rural areas.

14. Where fill depth over the culvert exceeds 4 m, concrete pipe material is required.

15. In locations where the culvert acts as a fish barrier, an effort shall be made to eliminate the fish barrier in consultation with NVCA.

16. Notwithstanding the specification of minimum sizes, culverts shall be designed to convey the minor storm peak flow rate in accordance with the provisions of these standards.

C.6.02.2 Road Crossing Culverts

Road crossing culverts shall be installed where required as follows:

1. Length: Minimum required from centre of ditch to centre of ditch.

2. Size: Minimum of 600 mm diameter.

3. Material: BOSS 2000 HDPE preferred; standard galvanized corrugated pipe (CSP) will be considered in cases where HDPE is not an option.

4. Gauge: As recommended by manufacturer for CL-625 ONT loading, minimum 2.0 mm thickness for CSP.

5. Joining systems shall only be used where the length of proposed culvert exceeds the shippable length of pipe. Joining systems shall be water-tight, Type 1 (75 kPa) joints as per CSA B182.8.

6. Cover: 450 mm minimum at the shoulder of the road.

7. Bedding: Culverts to be bedded and backfilled with granular material in accordance with OPSSs.

8. Where it is necessary to construct culverts under roadways larger than the minimum size, the culvert shall be designed in accordance with a method recognized by the MTO. Detail drawings and calculations shall be submitted for review and acceptance to the Township Public Works Department.

9. The Township Public Works Department shall require guide markers to be placed to mark the ends of road crossing culverts.

10. Where fill depth over the culvert exceeds 4 m, concrete pipe material is required.

11. In locations where the culvert acts as a fish barrier, an effort shall be made to eliminate the fish barrier in consultation with NVCA.

12. Notwithstanding the specification of minimum sizes, culverts shall be designed to convey the 25-year storm peak flow rate in accordance with the provisions of these standards.

C7.00 Maintenance Holes

C7.01 Location

MHs (including CBMHs where applicable) shall be located at each top end or dead end of a sewer line, 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 an MH at the beginning and end of the curvilinear section. MHs shall be located as per Township Standard Road Cross-section Drawings.

MHs located outside of the roadway should be provided with an MH identification sign for locating purposes.

C7.02 Maximum Spacing of Maintenance Holes

Spacing of MHs shall be in accordance with the following table:

Table 5: Maintenance Hole Spacing

Pipe Diameter	Desirable Spacing	Maximum Allowable Spacing
300 mm to 975 mm inclusive	100 m	110 m
1,050 mm to 1,350 mm inclusive	120 m	130 m
1,500 mm and above	150 m	160 m

C7.03 Maintenance Hole Types

The minimum size for an MH shall be 1200mm in diameter.

All MHs are to be supplied as precast concrete structures. The type, size, and depth of all MHs shall be indicated on the plan and profile engineering drawings. The standard MH details as shown on the OPS Drawings shall be used for MHs.

All standard specified MHs, up to 3600mm in diameter, to be pre-cast as per latest OPSD 701.010 to 701.015 and OPSD 701.030 to 701.080. MH sizing shall be based on pipe opening and benching, as per latest OPSD 701.021.

In cases where the standard drawings are not applicable, the MHs shall be individually designed and detailed. The consulting engineer shall analyze individually each application of the standards related to soil conditions, loading, and other pertinent factors to determine structural stability. Shop drawings shall be stamped by a structural engineer and submitted to the Township for review and approval.

Precast MHs shall conform to CSA A257.4 specifications.

C7.04 Maintenance Hole Design

The direction of flow in any MH shall not be permitted at acute interior angles. The maximum change in direction of flow shall be 90º for sewers up to 900 mm in diameter and 45º for sewers over 900 mm in diameter.

Safety gratings shall be provided in all MHs in accordance with OPSD 404.020, when the depth of the MH exceeds 5.0 m. The maximum spacing between safety gratings shall not exceed 4.5 m. Detailed base designs shall be provided when the MH depth exceeds 9.0 m.

When the difference in elevation between the invert of the inlet and outlet pipes exceeds 0.9 m, a drop structure shall be placed on the inlet pipe, as per OPSD 1003.030 or 1003.031 and Township's approval.

All storm sewer MHs shall be full height benched in accordance with current OPSD.

Frost straps are to be provided between the upper section through to the base of the MH section as per OPSD 701.100. All holes in concrete are to be rotary drilled and sealed watertight using a polyurethane or silicone caulking.

C7.05 Grades for Maintenance Hole Frames and Covers

All MHs located within the travelled portion of a roadway shall have the rim elevation set flush with the surface of the base course of asphalt. A maximum of three concrete modular rings to a maximum total thickness of 300 mm shall be permitted on MHs in new subdivisions.

The concreting and setting of the frame and cover shall be in accordance with OPSS and OPSD details. Prior to the placement of the surface course asphalt the MH frame shall be adjusted to the finished grade of asphalt using concrete modular rings. Steel and / or plastic adjusting rings may be permitted on a case

by case basis with consultation and approval by the Township. No concrete shall extend over the edge of the MH.

C7.06 Head Losses Through Maintenance Holes

Suitable drops shall be provided across all MHs to compensate for the loss of energy due to the change in flow velocity and for the difference in the depth of flow in the sewers.

The minimum drops across MHs shall be as follows:

Table 6: Minimum Maintenance Hole Drops

Change of Direction	Minimum Drop
Straight Run	0.030 m
1º to 45º	0.050 m
46º to 90º	0.080 m

C8.00 Catchbasins

C8.01 Location and Spacing

CBs shall be selected, located, and spaced in accordance with the conditions of the design. The design of CB locations and type shall take into consideration the lot areas, the lot grades, pavement width, road grades, and intersection locations. The maximum ponding depth at CBs in sag points of the roadway shall not exceed 0.3 m or impact private property under any circumstances.

CBs shall be generally located upstream of sidewalk crossings at intersections and upstream of all pedestrian crossings. CBs shall not be located in driveway or sidewalk curb depressions. Additional CBs may be required at road intersections, curves, and cul-de-sacs to facilitate satisfactory drainage. Double CBs shall normally be required when the CB intercepts flow from more than one direction and at sag points.

Table 7 summarizes the recommended maximum spacing for CBs:

Table 7: Maximum Catchbasin Spacing

Road Grade	Maximum Spacing
0.5% to 3.0%	90 m
3.1% to 5.0%	75 m
5.1% to 6.0%	60 m

All CBs at street intersections shall be located on the tangent of the curb at a minimum of 0.6 m distance from the beginning or the end of the radial portion of the curb.

The maximum drainage area for any CB shall be 2,000 m^2 of paved area or 5,000 m^2 of grassed area.

C8.02 Catchbasin Types

CB design shall be per the OPSDs using precast type. Single CBs shall be 600 mm x 600 mm complete with cast iron frame and grate (OPSD 705.01). Double CBs shall be 600 mm x 1,450 mm completed with cast iron frame and grate (OPSD 705.020).

Special CBs and inlet structures shall be fully designed and detailed by the consulting engineer. Shop drawings shall be stamped by a structural engineer and submitted to the Township for review and approval.

C8.03 Catchbasin Connections

All CB connections are to have a minimum of 1.2 m cover over the pipe barrel.

Table 8: Catchbasin Connections

Type of Connection	Minimum Size of Connection	Minimum Grade
Single CB	250 mm	1.0%
Double CB	300 mm	1.0%
Rear Lot CB	250 mm	1.0%

C8.04 Catchbasin Frame and Grate

Standard single CB grate as per OPSD 400.010 and double CB grate as per OPSD 400.020 are required.

In general, "bike-proof" CB grates shall be used in the roadway or walkway areas. Frames shall be set to finished grade and ramped with asphalt such that drainage to the CB is not prevented, until the top course of asphalt is placed.

In cases where CB inlet capacity is a special consideration, grates may be proposed which provide increased capture of stormwater and are suitable for traffic loading, subject to the Township's review and approval.

Design capacity is to be as per the MTO Drainage Maintenance Manual (Design Chart 4.04, 4.14, 4.19) for CBs including those on continuous grade and on sag points. 50% blockage of the inlets is to be considered for capacity calculations at sag points.

C8.05 Rear Lot Catchbasins (RLCBs)

The use of RLCBs is not preferred and is to be avoided by way of appropriate lot grading design (rear to front lot grading design). The use of rear lot systems will only be considered by the Township when alternate drainage solutions are not feasible. Where more than four lots are draining to a common swale, a RLCB and piped system is required. A maximum of eight lots may drain to one RLCB.

RLCBs and associated leads shall be located entirely within one lot, with the lead offset of 0.5 m from the property line, within a minimum 3.0 m wide side or rear lot easement. See Township Standard Details. House footings are to be extended to below the level of the sewer adjacent to the dwelling. All in accordance with OPSDs.

RLCBs shall be per OPSD 705.030 without sumps and shall be connected to the trunk storm sewer by a maintenance hole structure, except where the trunk sewer size exceeds 450 mm diameter, in which case the lead may be connected directly to the main sewer with manufactured tees. RLCBs are to be sumpless. RLCB grates to be 'bird cage' style as per OPSD 400.120.

The lead shall be 250 mm minimum in diameter and concrete encased or concrete pipe from the RLCB to the street line.

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

C9.00 Easements and Blocks

Where underground services, drainage, or utilities are placed outside road allowances or blocks of land under the ownership of the Township, permanent easements or blocks are required. All municipal infrastructure shall be located in blocks. Local overland drainage such as rear yard and side yard swales that

do not contain below ground subdrain or pipes do not require an easement. Major overland flow routes such as a pond outlet are to be located in blocks.

Rear yard drainage systems, particularly those requiring piping and structures, shall be avoided by using back to front lot drainage in lieu of split drainage, wherever possible. Rear yard drainage systems will only be accepted if back to front lot drainage is not possible.

The Developer will obtain at no expense to the Township a block for drainage through lands other than its own. The Township shall be protected or indemnified by the Developer from all claims or actions arising from the use of such lands until such time as the services installed become assumed by the Township. Apart from easements required for RLCBs and associated leads, any easements or blocks proposed for utilities, storm sewers, sanitary sewers, and watermains shall be reviewed with the Township prior to the first submission. Where they cannot be avoided, piped rear yard drainage systems shall be in an easement. All other infrastructure including storm sewers, sanitary sewers, and watermains shall be within appropriately sized blocks.

C9.01 Rear Yard Catchbasin Leads

Easements will be required for all RLCB leads. All CB leads and the RLCB are to be located on one lot. Easement widths shall be a combined minimum of 3.0 m wide, 1.5 m on each property for leads with a maximum cover of 2.7 m. "Hourglass easements" will be permitted with the width of the easement decreasing between the dwellings based on the side yard setbacks permitted for the dwellings (typically 1.5 m minimum). The easement width beyond the house envelope based on minimum front and rear yard setbacks shall be the standard 3.0 m width. See Township Standard Details.

For leads being constructed with cover deeper than 2.7 m, the easement widths shall be increased based on consultation with the Township.

C9.02 Storm Sewer Blocks

All pipes with a diameter of less than 900 mm constructed within blocks between side lot lines shall be concrete encased, or concrete pipes, as set out below. All pipes 900 mm or larger in diameter constructed between side lot lines shall be increased in strength by one class from that required based on the earth loading.

The bearing capacity of native soils must be preserved for all pipes being constructed between proposed buildings. This shall be achieved by:

- Extending the building foundations to the depth of the underside of pipe adjacent to the building.
- Placing the pipe in a sleeve constructed by tunneling.
- Installing the pipe by vertical trenching with steel sheeting left in place and cut off 0.3 m above the building foundation. The depth of the steel sheeting below the pipe invert is to be determined by a geotechnical engineer. Sufficient struts are to be left in place to ensure that the steel sheeting does not move during the backfilling operation.

The trench excavation and reinstatement or tunneling operation is to be monitored by a geotechnical engineer and certification will be required that the soils have the required bearing capacity to support the building being proposed adjacent to the pipe installation.

C9.03 Concrete Encasement

Concrete encasement shall have a square cross-section with a concrete thickness of not less than 0.150 m. The concrete shall be 15 MPa strength and vibrated in place.

C10.00 Service Connections

C10.01 Residential

Storm services for single family, semi-detached, and townhouse units are not permitted. Direct connections to foundation drains are not permitted. Sump pumps shall discharge over the foundation wall to a splash pad, and conveyed overland through side yard swales to an appropriate outlet.

C10.02 Industrial / Commercial / Institutional

Storm service connections for ICI will be considered on an individual basis by the Township. Non-standard locations are subject to the Township's approval and must be detailed on the plan and profile and utility coordination drawings.

The service connections for ICI areas shall be sized individually according to the intended use. The minimum size of service pipe shall be 200 mm in diameter. The minimum grade is to be 2%. 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 ICI blocks shall require the installation of an inspection MH located on private property immediately adjacent to the property line.

C11.00 Testing

The following sections outline the testing requirements applicable to all developments upon completion of the storm drainage system including MHs, roadway CBs, RLCBs and leads, and ICI service connections. Testing must be completed prior to the placement of concrete curb and gutter and base course asphalt. Any sections of sewer or service connections which fail to meet the requirements shall be repaired or replaced at the direction of the Township.

All testing must be witnessed by Township Public Works staff. Pre-testing by the Developer is recommended prior to contacting Township staff to attend for witnessing. A minimum of 48 hours' notice (working days) is to be provided to ensure Township staff's availability.

C11.01 Deflection Testing

All newly installed PVC and Polyethylene storm sewers shall be subjected to deflection testing in accordance with OPSS 410. Deflection testing is not required for concrete storm sewers.

The deflection test by the Developer 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.

C11.02 CCTV Inspection

All newly constructed storm sewers, CB leads, rear lot systems, and storm laterals shall undergo a Closed Circuit Television (CCTV) inspection in accordance with OPSS 409 following satisfactory completion of all other testing, prior to the Township's issuance of Acceptance of Underground Works (Initial Acceptance) and prior to the placement of surface course asphalt.

A permanent record in colour video form shall be supplied, illustrating a continuous record of the sewer installations, service connection, MHs, etc. A

report, which shall identify any unusual or substandard conditions shall also be submitted including recommendations on how issues identified have or will be rectified and associated timelines.

All CCTV work shall be performed by a Township approved video camera testing company, with a camera equipped with a full-swivel head capable of examining lateral connections, MH interiors, and other key features of the sewer installation.

The Township will require certification from the Developer's consulting engineer that they have reviewed the videos and have found the sewers to be acceptable and free of all defects. Any deficiencies should be clearly identified in the engineer's letter and confirmation that all deficiencies have been rectified must be included with the certification.

The CCTV inspection shall be carried out by an operator certified by NAAPI (or equivalent to the satisfaction of the Township), and shall be carried out in accordance with OPSS 409.

All video records, reports, and data provided from these inspections shall become the property of the Township.

An additional video inspection and report shall be required prior to assumption.

If Work is being carried out in an existing ROW, with existing storm or sanitary infrastructure that is to remain in place, CCTV inspection of the existing infrastructure is required before and after construction, to confirm the existing infrastructure has not been damaged during construction.

C11.03 Visual Inspection

All storm sewer structures shall be visually inspected by the Township for deficiencies. The visual inspection by the Township shall not be conducted until the system has been thoroughly flushed and cleaned and a minimum 30 days following backfill of pipe as per OPSS 410.07.15.05. Any deficiencies identified must be rectified prior to the commencement of the maintenance period for the applicable phase or the overall development.