Hamilton

Comprehensive Development Guidelines and Financial Policies Manual

2019

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A. SUBDIVISION

A.1. GENERAL

All requests for subdivision development shall strictly conform to all processes provided by provincial regulations, statues and policies that may apply to any land use proposal. A list of related legislation pertaining to land use planning can be found online.

A.1.1. The Planning Act & Approval Authority

The approval process for subdivisions is governed by Section 51 of the Planning Act and Ontario Regulation 544/06.

The City of Hamilton is the approval authority for a Plan of Subdivision.

A.1.2. Purpose of Subdivision Control

A subdivision is created when land is divided into two or more lots or blocks for the purpose of sale, and to establish new public streets. A Plan of Subdivision is a legal survey which shows how the property has been subdivided. It also includes further information and conditions regarding how a parcel of land may be developed. Lots or blocks created by a Plan of Subdivision can be used for various purposes (i.e. residential, commercial, etc.) based on the designation of the land within the Official Plan and Zoning By-law.

Subdivision approval ensures that:

- The land is suitable for its proposed new use;
- The proposal conforms to all local planning documents and Provincial legislation;
- The community is protected from development which is inappropriate or might put an undue strain on facilities, services or finances; and,
- No adverse impacts are foreseen by the development that may negatively affect the health, welfare or the environment of the community or adjacent lands.

A.1.3. Subdivision Agreement

Upon approval of lands through a Draft Plan of Subdivision, the Growth Management Division shall, upon request from the Proponent, prepare the City of Hamilton Subdivision Agreement.

A.2. PRE-SUBMISSION CONSULTATION

A Pre-submission Consultation also known as a Formal Consultation shall be required for all persons making an application to the City under the Planning Act as per By-Law No. 08-297.

The purpose of such Formal Consultation is to review a draft development proposal for the lands affected by the proposed application(s) and identify the need for and the scope of other information and materials considered necessary by the City and other affected agencies to allow full consideration of the development application. In the course of the review process for an application which has been deemed to be a complete application, additional reports, studies and drawings not identified in a pre-consultation meeting may be required.

Refer to Section A.7 - Reports and Studies for details on reports and studies which may be required.

A.3. DRAFT PLAN PROCESS

The application process summarised herein can be found in detail in the City's Guide to Application for Approval of a Draft Plan of Subdivision or Condominium Description.

A.3.1. Application

The complete submission shall include (all measurements to be in metric units):

- The application fees as indicated in the City's Fee Schedule;
- One (1) electronic copy of the completed application form without signatures (native PDF locked file format);
- 35 copies of the completed application form with signatures (including two (2) with original signatures);
- 35 copies of the draft plan (25 for condominium), folded to 8½" x 11";
- 20 reduced copies of the draft plan on 8½" x 11" paper;
- Five (5) copies of all information / reports / plans and native PDF locked file versions identified in a Formal Consultation Document as required information to deem an application complete; and,
- Five (5) copies of the information / reports / plans, and native PDF locked file versions, indicated as needed when completing Sections 10.2 and 11 of the application form.

A Draft Plan of Subdivision application may be completed and submitted to the Planning and Economic Development Department whenever land is to be divided into two or more parcels or lots or a new public street is to be established. This Plan must be prepared by an Ontario Land Surveyor. A Draft Plan of Subdivision is a proposal to subdivide property. It generally shows the proposed lots and streets; topographic information; natural heritage features, such as creeks and vegetation; and infrastructure such as Stormwater management ponds.

Upon receiving the Draft Plan of Subdivision application, the City will process the application. The application process includes opportunities for public input. Following the completion of this process, if a Draft Plan of Subdivision is approved by City Council, the approval will include a number of conditions that must be fulfilled by the applicant. The applicant will be required to sign a Subdivision Agreement with the City that outlines all of the conditions of approval. Once the conditions have been fulfilled and the Subdivision Agreement has been signed, the subdivision can be registered and it is known as a Registered Plan of Subdivision.

A Draft Plan of Subdivision approval is valid for three years. If three years elapses and the Draft Plan of Subdivision has not been registered, the applicant must apply for an extension of Draft Plan Approval for up to three years. Additional or up to date conditions of Draft Approval may apply.

A.3.2. Circulation

Within 15 days of an application being deemed complete, a notice of the application for a Draft Plan of Subdivision and a preliminary circulation is sent to the prescribed persons (owners within 120 m of the site), public bodies, relevant internal departments and the Ward Councillor (response requested within 21 days). Public input is requested and only written responses received prior to preparation of the report will be published as part of the staff report. The report will identify the public issues raised, staff comments on the issues and any other outstanding issues.

A.3.3. Neighbourhood Information Meeting

If significant public interest or opposition related to the proposed amendment is apparent, an informal community information meeting with the neighborhood may be requested or arranged. The Ward Councillor may also initiate community information / ward meeting prior to the formal public meeting.

A.3.4. Staff Report for Draft Approval

Public input is requested and only written responses received prior to preparation of the report will be published as part of the staff report. The report will identify the public issues raised, staff comments on the issues and any other outstanding issues.

A.3.5. Public Meeting

At the meeting, Development Planning staff will present their recommendation on the Draft Plan of Subdivision Application. A staff report containing the staff recommendation and any required conditions of approval will be presented. Any member of the public has the opportunity to voice their concerns or opinions regarding the proposed Draft Plan of Subdivision at this meeting. They must express their opinions at the Public Meeting if they wish to appeal the case to the Ontario Municipal Board (OMB) after Council makes a decision. The applicant may also address the Committee. In accordance with the Planning Act, a Public Meeting is held by the Planning Committee, consisting of Councillors. A recommended decision on the application will be made to Council at this meeting. At the Public Meeting, the Committee will either recommend

approval of the Draft Plan and conditions of approval, deny the application or refer it back to staff for further review.

A.3.6. Resolution of Issues

Once notice has been given, all eligible persons (those who made written or oral submissions on the application) or the applicant, may appeal the decision of Council, or conditions of the approval, to the OMB within 20 days. An appeal must be made by a written notice to the Secretary of the OMB and to the Clerk of the City of Hamilton. The OMB's decision is final and may not be appealed unless there is an error in law and the proponent requests a judicial review.

A.3.7. Post Draft Approval

If the application was approved by Council, and no appeals are received, then the Draft Plan of Subdivision is considered to be approved the day after the last day of appeal.

A.3.8. Modifications to Draft Plan

If the Proponent deems it necessary to make a modification to the draft plan they are required to file for a “Request for Modifications” through the Planning Department. The Proponent will prepare a submission with the proposed modifications and will include the following information:

- A letter describing any Modifications made to the draft plan;
- The appropriate number of copies of the modified plan as requested by the City;
- A digital copy of the modified submission; and,
- Modification fees provided to the City of Hamilton and the appropriate Conservation Authority.

The modified submission would then follow the same process as a Draft Plan of Subdivision in Section A.3 - Neighbourhood Information Meeting.

A.3.9. Street Naming

The naming of streets in the new development shall adhere to the Street Naming and Renaming Policy and Guidelines. Final Engineering drawings should include the final names of all streets.

A.4. PRELIMINARY GRADING REQUEST

Prior to the start of any preliminary grading, Proponents shall have an executed Subdivision Agreement with the City. Refer to Part 3 – Prior to Preliminary Grading which outlines all requirements.

A.5. SERVICING REQUEST

Prior to the start of any servicing construction Proponents shall have an executed Subdivision Agreement with the City. Refer to Part 4 – Prior to Servicing which outlines all requirements.

A.6. RELEASE FOR REGISTRATION

Release for Registration shall comply with the Subdivision Agreement, Part 6 – Release of the Agreement.

A.7. REPORTS AND STUDIES

A.7.1. Planning Justification Report

Proponents should contact the Planning Department for the requirements of this report.

A.7.2. Environmental Impact Statement (EIS)

The need to complete an EIS will be identified at a pre-consultation meeting. The study shall be prepared in consultation with the Environmentally Significant Areas Impact Evaluation Group (ESAIEG) and to the satisfaction of the City and the appropriate Conservation Authority.

A.7.3. Geotechnical Investigation and Soils Report

Soil test borings shall be placed at intervals not exceeding 150 m and to a depth of not less than 3.5 m below the proposed pavement grade or refusal to rock.

Prior to the submission of detailed design two boreholes with nested monitoring wells shall be drilled and monitored for three seasons in the vicinity of each proposed Stormwater management pond. The proponent shall consult with City staff regarding the borehole location and monitoring process.

Soil classification and water levels shall be recorded and noted on the plans and profiles submitted.

The geotechnical consultant shall provide recommendations on the proposed pavement structure, including confirming the minimum pavement design requirements outlined in Section C.3 - Road Pavement Design are satisfactory.

Recommendations shall also be prepared for the bedding material and cover of sewers.

One paper copy of the geotechnical report shall be submitted together with an electronic copy in native PDF format.

A.7.4. Servicing Design Brief or the Preliminary Servicing Report

During the Formal Consultation process, the need for a Preliminary Engineering Report (referred to as Functional Servicing Report (FSR)) will be identified. For more details on Planning Applications please refer to City's website.

The Consulting Engineer shall review and reference any existing servicing studies, traffic studies, secondary plans class EA documents, master servicing plans, master drainage plans, watershed and sub-watershed studies that pertain to the project. A complete up-to-date listing shall be provided by the City upon written request.

A Preliminary Engineering Report, if required, shall be submitted to the City Planning and Economic Development Department with the relevant application. It shall include, but not be limited to, the following:

Contour Plan

Existing ground contours at sufficient intervals to permit assessment of surface drainage patterns. This plan should be at a scale not smaller than 1:1000, and in the case of a subdivision application, can be combined with a draft plan of subdivision.

Sanitary Sewer System

- Existing sanitary sewer outlet information (size, slope, location);
- Drainage areas complete with existing ground contours at sufficient intervals to permit assessment of surface drainage patterns;
- Proposed flows and functional design of sanitary sewers; and,
- Identification of potential constraints, if any, and how they have been addressed. Any mitigation measures proposed shall be detailed.

Storm Drainage System

- Existing storm sewer outlet information (size, slope, location);
- Drainage areas complete with existing ground contours at sufficient intervals to permit assessment of surface drainage patterns to a minimum of 15 m beyond the limits of the subject lands;
- Proposed flows and functional design of storm sewers;
- Designation of major and minor drainage systems, assessment of any storm water management facilities together with functional design; and,
- Identification of potential constraints, if any, and how they have been addressed. Any mitigation measures proposed shall be detailed.

Watermain Distribution System

- Existing watermain information (sizes, locations, looping, pressure boundaries);
- Functional watermain distribution system design; and,

- Identification of potential constraints, if any, and how they have been addressed.

Roadways

- Identification of collector roads where additional pavement widths and special pavement design is warranted;
- The need for assessment of the impact of the development on any adjacent roads;
- Location of sidewalks;
- Road geometry at key location (horizontal and vertical);
- Identification of safe routes to schools and parks using roadways or paths;
- Identification of traffic calming features (i.e. Livable Roads as per the Transportation Master Plan) ; and,
- Identification of potential constraints, if any.

On-Street Parking Plan

- The location of driveways, driveway ramps and curb openings for all lots; and,
- The location of utilities: concrete transit pads, community mailboxes pads, and fire hydrants; where the location has been determined by the appropriate authorities.

A.7.5. Design Review Panel – Urban Design Brief

The Design Review Panel (DRP) is a voluntary technical panel established to provide expert and impartial design advice to Planning Division staff on urban design matters. The panel is strictly an advisory body and makes recommendations, it does not have the authority to approve or refuse projects or make policy decisions, or recommendations on land use. DRP applies to complex Zoning By-law Amendment (rezoning) and Major Site Plan applications, civic projects, new policy initiatives, and studies with urban design components in the following Design Priority Areas: The Downtown Hamilton Secondary Plan Area, Areas of Major Change and Corridors of Gradual Change within the Setting Sail Secondary Plan Area, and Primary Corridors as identified in the Urban Hamilton Official Plan. Additionally the Director of Planning and Chief Planner may refer any transformational project that requires fundamental changes to the land use and has the potential to significantly impact the physical environment functionally and aesthetically. Outside of these options, anyone can opt into the DRP if they wish.

DRP review is requested at the Formal Consultation Stage. For rezoning applications, this review occurs after a complete application is made. For site plan applications, this review must occur before the Development Review Team meeting to ensure concerns are identified as early in the process as possible. Please refer to the DRP section on the City of Hamilton website at https://www.hamilton.ca/develop-property/policies-guidelines/design-review-panel for information regarding the submission requirements, timing, contacts, etc.

A.7.6. Watermain Hydraulic Analysis Report

The report shall address water distribution systems, pressure zones, water consumption – estimated consumption, current capacities of trunk systems, phasing, net impact due to the proposed change in land use or development, need for expansion and upgrades. The requirements for this report are outlined in detail in Appendix A – Watermain Hydraulic Report.

In the case where there are unknowns (such as form of development, type of construction, etc.) the Consulting Engineer will clearly state what assumptions were made in the preparation of the appropriate study. As decisions are made and variables become known, the Consulting Engineer will be required to verify that the assumptions made in preparing the studies are still representative of the development. The study will have to be revised if the assumptions are no longer valid.

The report shall also include fire flow requirements calculated using the Fire Underwriters Survey (FUS 1999). Proponents should be aware that this can impact the form of development and / or the type of construction. It is recommended that Proponents undertake this study as early as feasibly possible in the approval process.

A.7.7. Stormwater Management (SWM) Report

Refer to Section G.8.1.5 - Functional Stormwater Management Report which provides generic terms of reference.

A.7.8. Hydro-geological Studies

In general, the report, prepared by a qualified professional shall address impacts of the proposed development in accordance with subwatershed and master drainage plan study recommendations on: ground water levels, flow paths, and recharge and discharge zones; karst features; and, water balance / water budget.

The report shall also provide recommendations to mitigate groundwater impacts, including monitoring, and a groundwater contingency plan to ensure that an appropriate mitigation strategy is available to be implemented in the cases where:

- An aquifer is breached during excavation;
- Groundwater is encountered during any construction within the subdivision, including but not limited to house construction;
- Sump pumps are found to be continuously running; and,
- Water supply and sewage disposal systems and any surface and groundwater related infrastructure are negatively impacted.

For rural areas, a hydro-geological report shall be submitted in accordance with City of Hamilton Guidelines For Hydro-Geological Studies and Technical Standards for Private Services.

A.7.9. Traffic Impact Study (TIS)

A Traffic Impact Study shall be submitted, where required, in accordance with City of Hamilton Traffic Impact Study Guidelines.

Traffic Impact Studies assess potential impacts of traffic changes caused by proposed development on municipal roads and to identify any infrastructure improvements or mitigation measures needed to ensure the road network will operate acceptably and safely upon completion of the proposed development.

They may vary in scope and complexity depending on the type and size of the proposed development and typically consider all modes of travel including cars, trucks, transit, cyclists and pedestrians. Recommendations from a study shall be consistent with the City's goals as expressed in the Strategic Plan, Transportation Master Plan and other planning documents.

A.7.10. Environmental Site Assessment (ESA)

The requirement for the submission of an ESA shall be determined at the Formal Consultation meeting. The purpose of the ESA is to:

- Identify any potentially contaminating activity in the area;
- Identify areas of potential environmental concern on the property; and,
- Determine if a Phase Two Environmental Site Assessment is needed (for some types of property uses and circumstances, a Phase Two Environmental Site Assessment is mandatory).

The study shall be prepared in consultation with the Environmentally Significant Areas Impact Evaluation Group (ESAIEG) and in compliance with Ontario Regulation 153/04.

A.7.11. Archaeological Assessment

The City shall request an Archaeological Assessment as required, which shall make reference to the City's Archaeology Management Plan and be prepared in compliance with the Ministry of Tourism, Culture and Sport standards. The archaeological assessment must clear the subject site prior to the commencement of grading or servicing installation when an assessment is part of the Draft Approval Conditions. The need for an Archaeological Assessment will be determined at the pre-consultation stage.

A.7.12. Tree Protection

The City shall request a Tree Protection Plan as required, which shall make reference to the City's Tree Protection Guidelines. The need for a Tree Protection Plan may be identified as a draft condition that must be cleared prior to the commencement of grading or servicing installation when included in the Draft Conditions of Approval. The need for a tree protection plan will be evaluated at the pre-consultation stage.

The Tree Protection Guidelines require the applicant to provide information and analysis of trees early in the planning process, to ensure that trees worth retaining are identified. This evaluation will then be used along with Engineering and grading information to guide the layout of the development proposal.

The Guidelines apply to privately-owned lands subject to Planning Act approvals, (such as draft plans of subdivision / condominium, site plan approvals, part lot control, and consent applications), and/or Niagara Escarpment Plan permit. There is a four-step process to ensure tree protection for Planning Act applications proposed within regulated areas:

1. General Vegetation Inventory (GVI) - required for all portions of the site;
2. Tree Protection Plan (TPP) - required only for lots and blocks containing existing quality vegetation that requires further study as identified and approved by the City during the General Vegetation Inventory;
3. Implementation (installing tree protection measures during construction and monitoring); and,
4. Landscape Plan (re-planting and transplanting).

The applicant has the option of submitting the full TPP at the time of application, eliminating the need to prepare and submit a GVI. The City may accept this approach, as it provides detailed information on trees early in the Formal Consultation process and allows grading and servicing plans to reflect tree protection requirements. However, if the TPP is submitted at the time of application, it should be understood that, despite the amount of work already completed by the applicant, it is still possible that the City will request changes to the site layout. At the time Formal Consultation, City staff and the applicant would discuss using this approach to determine if it is feasible for that particular site.

The Proponent must employ a recognized tree management professional (e.g. certified arborist, registered professional forester, or landscape architect who will assess and evaluate the vegetation on a proposed development site. Depending on the nature of the vegetation and the development proposal, an application may not be required to go through all four steps.

A.7.13. Heritage Impact Assessments and Conservation Plan

A Cultural Heritage Impact Assessment (CHIA) is a report that documents a clear and traceable evaluation of the effects of a proposed new development or redevelopment on cultural heritage resources and/or their setting. The need for a Heritage Impact Assessment will be determined at the pre-consultation stage which should be prepared to the satisfaction of the Development Planning, Heritage and Design Division.

Reference should be made to the Official Plan, the City of Hamilton Info-sheet: Cultural Heritage Impact Assessments, March 2014, which is available from the Cultural Heritage Planner in the Development Planning Section of the Planning Division.

A.7.14. Noise Impact Report

Where it is a requirement of final clearance of the Draft Plan for the Proponent to undertake a noise study for submission to, and approval by the City, and where an approved noise study requires mitigation measures that will affect the grading of the Land, the Proponent shall include the specific measures to be implemented on the Final Grading Plan.

All Noise Studies shall be prepared by a qualified noise consultant. Refer to Section C.20 - Noise Attenuation for detailed requirements.

A.8. ENGINEERING SUBMISSIONS

A.8.1. First Submission

The first Engineering submission shall consist of:

- Two (2) copies of the final survey plan;
- One electronic set of drawings (native PDF format);
- Three (3) sets of detailed Engineering drawings;
- Two (2) sets of sanitary sewer and storm sewer calculation sheets;
- Two (2) copies of a Stormwater management report and a digital copy of the model (if applicable);
- One (1) paper copy and one electronic copy (native PDF format) of a geotechnical report;
- Two (2) copies of any other relevant reports or drawings (traffic impact, noise impact, archaeological assessment, tree preservation, EIS, hydro-G, etc.);
- A checklist showing how the draft plan conditions have been addressed;
- Payment of Stage 2 City Subdivision Processing Fees, based on current fee at the time of Engineering submission (see User Fee Bylaw);
- Schedule in Gantt chart format outlining expected timelines for approval and servicing; and,
- Other plans that may be required through the process such as SWM facility landscape and streetscape plans – three (3) sets.

The design of municipal services shall be based upon the specifications and standards in effect at the time the Engineering drawings are approved. The City's Planning and Economic Development Department, Development Engineering Section, shall approve all Engineering drawings but such approval shall in no way relieve the Engineer of the responsibility to design adequate and safe services. The original marked up first submission City copy of the Engineering drawings shall be returned to the proponent.

All sanitary sewers, storm sewers, watermains and their appurtenances and all roadways being constructed within the City of Hamilton, shall conform to the City of Hamilton Standard Specifications.

A.8.2. Second and Subsequent Submissions

Upon review of the first submission of Engineering drawings and reports by the City, the Engineer shall amend the drawings and reports to incorporate the comments and shall submit:

- Three (3) complete sets of revised Engineering drawings as outlined in first submission; Note: the revision block on all drawings is to be updated to include the revision number, comment about the revision and the revision date.
- Two (2) sets of street lighting drawings, if available at second submission;
- Two (2) sets of draft (unsigned) composite utility plans, if available at second submission;
- Two (2) paper copies of the watermain hydraulic analysis;
- Original marked up First Submission City copy;
- A draft copy of the Engineering Cost Estimates (Schedule of Works);
- Two signed (2) copies of the Alteration to Drinking Water System Form I application and supporting documentation;
- Two (2) signed copies of the Environmental Compliance Approval (ECA) application packages plus a full digital submission of the ECA application that includes a copy of all required supporting drawings, information, and calculations;
- Copies of all available approvals (MTO, HCA, MNR, NEC) and/or whatever is applicable; and,
- The consultant shall submit a letter accompanying the drawings indicating the extent of the changes and which drawing(s) have been changed. This letter, signed and stamped by an Engineer, must certify that there are no other design changes. City to provide comments in electronic format to assist with resubmission.

A.8.3. Final Submission

- Four (4) sets of the construction drawings (full size, paper, rolled);
- One (1) set of construction drawings in native PDF format;
- Two (2) set of the construction drawings (reduced to 11” x 17”, paper);
- Two (2) copies of the general services plan (full size, paper) folded and one (1) digital* copy of the General Services Plan (in .DWG/DXF format);
- One (1) digital* copy of the grading plan, general services plan, storm and sanitary drainage area plans (in .DWG/DXF format) and in PDF format (as a native pdf, not a scanned copy) and the storm and sanitary sewer calculation sheets (in Excel format), signed and sealed by the Consulting Engineer;
- One (1) set of the storm and sanitary drainage area plans (full size, paper) folded;
- One (1) set of the storm and sanitary sewer calculations (paper);
- One (1) copy of the unpriced contract documents and form of tender;
- One (1) copy of the priced and signed contract documents and form of tender;
- Six (6) copies of final plan of subdivision (M-Plan reduced to 8.5” x 11”);

- Four (4) copies of the grading plan (include any other sheets that may have grading related details, notes, etc., on them) folded; and
- One (1) digital copy of the Storm Water Management Report and the Operations and Maintenance Manual (as a native pdf, not a scanned copy) if applicable.* - on separate disc, signed and sealed by the Consulting Engineer.

A.8.4. "As-Constructed" Submission

All Engineering drawings included in the final design drawings (except lot grading plans) shall be up-dated to incorporate the following as-constructed information:

Sewers

- Sewer length measured from centreline to centreline of maintenance hole cover;
- Percent grade of sewer;
- Invert elevations at maintenance holes, plugs and bulkhead and,
- Material type to be specified.

Private Drains

- Location of private drain at main sewer dimensioned (chainage) from a maintenance hole;
- Location of private drain at streetline referenced by a measurement from a lot corner;
- Where risers are used indicate with 'R'; and,
- Material type to be specified.

Watermains

- Chainage of watermain appurtenances (tees, bends, reducers, hydrants, etc.) starting with 0+00 at a main valve or from a hydrant if no main valve;
- Specify manufacturer's name and model number for all valves and hydrants;
- Watermain inverts for 400 mm diameter and larger; and,
- Material type to be specified.

Water Services

- Location of all private water service at the main (mainstop) to be indicated by chainage; and,
- Location of curb stop to be referenced by a measurement from a lot corner.
- Material type to be specified.

Storm Water Management Ponds

- Invert elevations, storage volumes and discharge rates; and,

- Confirm that the SWM facility is not compromised and all discrepancies are indicated on the "As-Constructed" drawings.

General

- Rock profile, where applicable;
- All references to "proposed" to remain on drawings, unless the works were not constructed and the corresponding notes shall be crossed out (it will be assumed that all works were constructed unless otherwise noted); and,
- A certificate to be added to each drawing displaying the following information:

  "This certifies that the work shown on this drawing related to underground works has been completed in the field as required by the City of Hamilton Subdivision Agreement. All underground services shown are as-constructed."

_____ _____

Date Engineer

One (1) copy of the as-constructed drawings shall be submitted to the City for review. Upon acceptance of the information on the drawings, the Engineer shall stamp and sign the drawings and provide Mylar copies of all drawings (including a copy of the original lot grading plan and detail sheets) to the City for its permanent record.

The Engineer shall also provide the drawings in electronic file format (.DWG or .DXF and as a native PDF).

A.8.4.1 Construction Inventory

The City is tracking quantities and costs of works constructed in residential subdivisions throughout Hamilton in order to compile statistical information and establish average construction costs for municipal works. This information will assist in determining average rates for the City's share of servicing costs, forecasting to determine City contributions for future works as part of its Staging of Development Programming and budgeting for future growth requirements under the City's Development Charge Studies. This information is required from the Applicant's Consulting Engineer at the time when the approved engineering drawing package is submitted to the City, prior to start of construction.

The construction inventory sheet is in MS Excel file format. The inventory sheet contains the type and size of municipal works to be inventoried by the City. To complete the inventory sheet simply indicate the total amount (length or number) of an item on the list that is within a development as well as the total cost excluding overhead of that item. Only complete the items on the list that are within a development. All other items on the list may be left blank. A copy of the City's Construction Inventory Sheet in MS Excel may be downloaded from the City's website.

The information provided and all the average work costs will be available to the public in our yearly reports

A.8.5. Other Approvals

Municipal Consent Process for New Development

The Consulting Engineer is also required to co-ordinate the municipal consent process for utility installation on new developments. See Section I.2 - Utility Installation Municipal Consent for the Municipal Consent procedure. Generally, at the time of initial Engineering submission to the City, the Consulting Engineer shall notify the utility companies of the proposed development. Upon the second submission to the City, the Consulting Engineer shall provide Hydro with a set of Engineering drawings. Hydro will complete their plant design and circulate to the other utility companies so that their plant design can be added.

The utility companies shall forward their completed plant design in digital format (.DWG/.DXF) to the Consulting Engineer, who shall prepare a Composite Utility Plan as required with the second submission. This may also be included in the lot grading plans.

MOE-CC Applications for Sewers

The Engineer shall submit MOE-CC application forms for Environmental Compliance Approval for sanitary sewers and storm sewers. Two additional sets of Engineering drawings, individually folded, shall be provided to the City to accompany the MOE-CC application through the Transfer of Review Program between the City and the MOE-CC.

Projects that involve Stormwater management facilities are direct submissions to MOE-CC; i.e. they are not processed through the Transfer of Review Program; however the application forms shall be submitted to the City for signature as the operating authority. The Proponent shall be responsible for any fees payable to the MOE-CC for this review.

For more information and requirements on the Transfer of Review program please refer to the ministry's Guide to Applying for an Environmental Compliance Approval, 2012.

MOE-CC's Municipal Drinking Water Licensing Program (Form 1)

Water servicing approvals are processed under the MOE-CC's Municipal Drinking Water Licensing Program.

Under provincial license, the system provides the municipality with a Municipal Drinking Water Permit from which the municipality issues Drinking Water Works Permit Amendments for the works to be constructed by the Proponent.

For more information and requirements on this program please visit the Ministry of Environment website and the City's Drinking Water Quality management System webpage.

A.9. PLANS AND DRAWINGS

A.9.1. Drafting Requirements

The detailed Engineering drawings submitted by the Proponent's Engineer shall be subject to the following:

- All drawings shall be in metric and shall be neat, legible and completed in ink (if applicable);
- Lettering shall be done using a lettering template with a minimum font size of 8 pt.;
- Sheet size shall be metric A1 (594 mm x 841 mm) or Imperial (24" x 36"). External sanitary and storm drainage area plans for overall catchment areas may be submitted on larger size sheets for convenience of presentation;
- Plan-profile drawings shall be to a scale of 1:500 horizontal and 1:100 vertical, except when drawings for existing roadways are required, when a larger scale would be more suitable;
- All drawings shall contain a key plan, north arrow, title block showing the name of the Engineer together with the sheet title and current revision status;
- All drawings shall be sealed, signed and dated by the Engineer responsible for the design; and,
- All elevations are to relate to a geodetic datum acceptable to the City, and the bench mark shall be described on all the drawings.

The detailed Engineering drawings shall consist of the following:

- Title Sheet;
- General Plan of Services;
- On-Street Parking Plan;
- Pre-Grading Plan (if applicable);
- Grading Plan;
- Water Distribution Plan;
- Phasing Plan (if applicable);
- Erosion and Sedimentation Control Plan;
- Plan-Profile Drawings;
- Composite Utility Plan (subsequent submissions only);
- Sanitary Drainage Area Plan (including external areas);
- Storm Drainage Area Plan (including external areas); and,
- Other drawings as required; e.g.: tree protection plan, street tree planting plan, SWM facility details, roundabout details, street lighting plan, pavement marking, signalization, traffic calming.

A.9.1.2 Title Sheet

A Title Sheet shall be included for every subdivision that includes more than one street that is being constructed as part of the plan of subdivision. All Title Sheets shall contain the following information:

- Name of Municipality (City of Hamilton);
- Key Plan showing the location of the proposed development;
- Name of the Development including 25T number;
- Name of the Owner;
- Name of the Engineer; and,
- List of drawings.

A.9.1.3 General Plan of Services

A General Plan of Services shall be prepared for every Engineering submission that includes construction of more than one street as part of a development application.

If possible, the plan should be presented on one page, ideally at a scale of 1:500 shall be used. For larger subdivisions, an appropriate scale shall be selected, but in no case shall the scale be smaller than 1:1000.

The following information shall be shown on the General Plan of Services:

- All road allowances, lots and blocks in the plan of subdivision and those immediately neighbouring the subdivision;
- Proposed sanitary and storm sewers including diameter of pipe and direction of flow, maintenance holes, culverts, road catch basins and rear yard catch basins (if applicable);
- Proposed watermains (including diameter of pipe) and appurtenances;
- Proposed curbs and sidewalks;
- Existing services surrounding the subdivision, including length, size and type, and their relation to the proposed work;
- Description of the nearest geodetic benchmark. Site benchmarks should also be shown and described;
- General Notes describing the construction of services - for larger subdivisions it is preferable to have the notes on a separate page. These notes are constantly being updated and the Engineer should use only the notes applicable to the subdivision that are current at the time of design and construction. The most recent OPSD and City Specifications shall be referenced in the notes;
- Typical road cross-sections with pavement design; and,
- Waste container placement in public spaces shall comply with Accessibility for Ontarians with Disabilities Act (AODA) requirements and collection service accessibility.

A.9.1.4 On-Street Parking

New residential development shall provide adequate, convenient on-street parking within the right-of-way for all residences with direct access, while ensuring road safety, in accordance with the following criteria.

The Proponent shall submit an On-Street Parking Plan for all lots or blocks within the plan intended for street-fronting residential development. Submission of the On-Street Parking plans is subject to the following timing:

- Prior to Draft Approval (part of what's deemed as a Complete Submission); and,
- Post Draft Approval (the final parking plan is approved as part of approval of the Engineering submission).

The On-Street Parking Plan shall show the following:

- The location of proposed spaces;
- The location and width of driveways, driveway ramps and curb openings for all lots and blocks; and,
- The preliminary location of approved above-ground utilities (street furniture): concrete transit pads, community mailboxes pads, and fire hydrants (where the location has been determined by the appropriate authorities).

A.9.1.5 Pre Grading Plan

The pre grading plan shall be prepared on a standard metric A1 size sheet or an Imperial 24" x 36" sheet at a scale of 1:500. This plan will display the elevations prior to final grading, it will be stamped and signed by a professional Engineer and shall show the following:

- Elevations of all lots and blocks of the lands to be developed;
- Elevations of adjoining lands for a minimum of 15 m beyond the limit of the lands to be developed;
- Proposed pre grade elevations at the corners of each lot and block and at intermediate point of change in grade;
- The overland flow route design and calculations are to be shown to understand impacts on the proposed and surrounding lands during this stage;
- Proposed pre grade elevations at 15 m spacing along the frontage of large blocks and at a reasonable spacing along the sides and rear of the block;
- Proposed pre grade elevation along the centerline of the road at 15 m spacing;
- The location of all existing trees, septic tanks and tile fields, wells, above ground utility structures (street furniture) and other structures as necessary;
- A key plan showing the proposed development and, for larger subdivisions, the location of the lots on the sheet in relation to the overall development; and,
- Description of the nearest geodetic benchmark.

A.9.2. Grading Plan

The overall grading plan shall be prepared on a standard metric A1 size sheet or an Imperial 24" x 36" sheet at a scale of 1:500, stamped and signed by a professional Engineer and shall show the following:

- All lots and blocks of the lands to be developed as well as adjoining lands for a minimum of 15 m beyond the limit of the lands to be developed and further if necessary to determine future and proposed drainage patterns;
- Existing contours at 0.5 m intervals over the entire development including sufficient area of adjacent lands to establish the overall drainage pattern. If the parcel is flat or 0.5 m contours do not adequately show topography, 0.25 m contour spacing should be provided;
- Proposed elevations at the corners of each lot and block and at intermediate point of change in grade;
- Proposed elevations at 15 m spacing along the frontage of large blocks and at a reasonable spacing along the sides and rear of the block;
- Proposed centre line road elevations at:
  - All changes in grade; and,
  - Opposite lot corners of the lands to be developed;
- The location of all existing trees, septic tanks and tile fields, wells, above ground utility structures (street furniture) and other structures as necessary;
- The location of existing and proposed retaining walls with proposed top and bottom elevations at appropriate intervals with sections and sub drain outlet locations (if required);
- The location of drainage ponds or swales, and direction of surface drainage on each proposed lot and block and on all adjoining lands;
- The location of rear yard catch basins and inlets, top of grate elevations and overland flow routes;
- Proposed building envelopes with the following information:
  - Front of house apron elevation (garage floor elevation);
  - Back of house apron elevation, if different from front;
  - Minimum basement floor elevation (shall be calculated based on the elevation of the sanitary private drain); and,
  - Roof leaders shall discharge onto splash pads, satisfactory to the City Engineer and then to a grassed or landscaped area at a minimum distance of 0.60 m away from the building face;
- Adjacent lots having a combined side-yard setback totalling 2.0 m or less shall have roof leaders restricted to front or rear yard discharge locations with drainage directed away from the house to minimize erosion and ponding;
- A key plan showing the proposed development and, for larger subdivisions, the location of the lots on the sheet in relation to the overall development;
- Description of the nearest geodetic benchmark;

- Typical lot drainage patterns; and
- Noise attenuation with details.

A.9.2.1 Water Distribution Plan

The water distribution plan shall illustrate water distribution methods (watermain system throughout the development) and pressure zones based on the estimated water consumption. This plan will display all valves and hydrants as well as all service connections to each lot. Ideally at a scale of 1:500 shall be used, but for larger subdivisions, an appropriate scale shall be selected; in no case shall the scale be smaller than 1:1000.

A.9.2.2 Phasing Plan

The phasing plan shall illustrate the staging of works (linear infrastructure, lot grading, all temporary works) as required for each stage of the works. A phasing plan will be required if all dwellings shall not be constructed in the same time frame. Every phase of construction must be clearly defined and adequate interim Stormwater management and traffic control practices must be described. All phasing plan drawings shall be prepared at a scale of 1:1000.

A.9.2.3 Erosion and Sedimentation Control Plan

The Erosion and Sedimentation Control Plan prepared in accordance with the "Erosion & Sediment Control Guideline for Urban Construction" dated December 2006 may be submitted with the Final Grading Plan or as a separate plan.

If possible, the plan should be presented on one page, ideally at a scale of 1:500 shall be used. For larger subdivisions, an appropriate scale shall be selected, but in no case shall the scale be smaller than 1:1000.

It shall show details of controls for road and rear yard catch basins and location of sediment control fencing. Further it will indicate the location of topsoil stock piles including the height, volume and slope.

Any special measures required on a site specific basis to mitigate sediment contamination of affected creeks, adjacent properties, storm sewer systems and storm water management facilities shall be detailed. Consultation with the Conservation Authority is recommended when draining surface run-off to areas regulated under the Conservation Authorities Act.

A.9.2.4 Plan Profile Drawings

Plan profile drawings shall be prepared for all existing and proposed streets, walkways and easements where sewers, watermains and/or road construction is required as a consequence of the proposed development and include:

- All plan-profile sheets for proposed streets shall be drawn at a scale of 1:500 horizontal and 1:100 vertical;

- Plan-profile sheets for reconstruction or construction on existing roads within an urban area may be drawn at a scale of 1:250 horizontal and 1:50 vertical, at the discretion of the Engineer, depending on the detail required to be shown on the drawing;
- The profile portion of the drawing shall be a vertical projection of the plan portion, wherever possible;
- All road allowances, lots, blocks, easements, reserves are to be shown and identified in accordance with the notation on the Final Survey Plan. Lot and Block frontages and bearings are to be shown and must correspond with the Final Survey Plan;
- Dimensions of the road allowance and at least one set of dimensions from the property lines to proposed curbs, sidewalks, sewers, and watermains shall be shown on each sheet;
- A key plan identifying the land to be developed and the relationship of the proposed street within the land shall be provided; and,
- Two short streets may be shown on one plan-profile drawing.

a) Plan View Requirements:

- The street name or easement number shall be prominently centered over the top of the plan portion of the drawing;
- Generally, the plan view shall be drawn such that the north arrow is pointing towards the top of the page and/or to the right of the page;
- All existing sewers, watermains, curbs, sidewalks, etc. shall be shown and labelled as "existing". All proposed sewers, watermains, curbs, sidewalks, etc. need not be labelled as "proposed" but shall be distinguished from the existing services by line type and size / style of lettering;
- Only the size and type of the proposed and existing sewer and watermain shall be labelled (e.g. 250 mm Sanitary);
- Where connecting to an existing watermain 400mm dia. And larger, elevation of the watermain and material type shall be identified prior to tender.
- Where intersecting streets (or easements) are shown in plan view, only the size and type of sewer and direction of flow of the intersecting sewers shall be shown;
- All sewer maintenance holes shall be numbered. Sanitary maintenance hole numbers shall be distinguished from storm maintenance holes by the suffix or prefix "A", (e.g. MH A2);
- Road catch basins and connections shall be shown. Rear yard catch basins and connections shall be shown with adequate details regarding top of grate elevation, location of catch basins and connection in relation to rear and side property lines, standard drawing detail, inverts, length and grade of connection;
- Hydrants, valves and other appurtenances on the watermain shall be shown and labelled with details regarding standard drawing details and location;

- Locations of sanitary private drains and storm private drains (if applicable) and private water services for each lot and block created by the development application shall be shown;
- Details and specifications for the proposed curbs and sidewalks shall be shown. All transitions from different types shall be properly labelled and dimensioned. Curb radii at intersections shall be shown and curb radius and angle of intersection of other horizontal curves shall be adequately indicated;
- Match lines for continuation of the street shall be clearly marked;
- Borehole locations and numbers shall be shown;
- Cross reference drawing numbers of adjoining plans; and,
- Cross reference to general notes drawing number.

b) Profile View Requirements

The following profiles shall be shown:

- Existing ground over centerline of road / easement;
- Proposed centerline road / easement;
- Sanitary and storm sewers;
- Watermains;
- Proposed sewers shall be detailed for each section including size and type of sewer, length and grade, pipe material specifications and class of bedding;
- Maintenance holes shall be numbered and distinguished to correspond to the numbering in plan view. Maintenance hole details such as standard drawing number and any required information such as diameter of base, top of maintenance hole cover elevation, drop-pipe requirements, safety gratings shall be shown. Construction details are to be referred to the applicable City of Hamilton Drawings or Ontario Provincial Standard Drawings (OPSD);
- Proposed watermains 300 mm diameter and smaller shall include all related appurtenances, and shall specify size and pipe material. For 400 mm diameter and larger mains, chainages, invert, length and grade of each section, size, pipe material and a schematic detail of each valve chamber showing the orientation of appurtenances shall be provided;
- All sewer inverts at maintenance holes shall be given and adequately described;
- Proposed centerline road grade, chainages of P.V.I.s, intersections, and vertical curve data shall be adequately shown and described;
- Borehole logs shall be plotted with brief description of soils and water level, as well as rock elevations (if applicable). If the borehole log interferes with other details such as a maintenance hole, the exact location of the borehole may be altered sufficiently for clarity; and,
- 5 and 100 year hydraulic grade line (HGL) elevation shall be plotted on the profile.

A.9.2.5 Sanitary Drainage Area Plan

The Sanitary Drainage Area Plan shall be drawn at the same scale as the General Plan of Services. It shall include the following information:

- All streets, lots, blocks, easements and other lands within the plan of subdivision;
- Proposed sanitary sewers, including size, length and grade, maintenance holes, maintenance hole numbers, direction of flow, and details of the receiving sewer;
- The drainage areas within the lands to be subdivided or developed and the limits of external areas draining into the proposed system. The area contributing to each maintenance hole shall be clearly outlined and the area in hectares and population density in persons per hectare, shall be indicated on all drainage areas;
- If the contributing area to a maintenance hole is made up of areas with different population densities, the sub-areas showing the individual area in hectares and the population density shall be clearly shown; and,
- If the external drainage area is large, it may necessitate the preparation of a separate external drainage area plan. External drainage area plans may be prepared at a smaller scale, but shall show the existing ground contours to beyond the limit of the drainage area. Planned street patterns (if available) shall be shown to determine the route of the future sewers.

A.9.2.6 Storm Drainage Area Plan

The Storm Drainage Area Plan shall be drawn at the same scale as the General Plan of Services and shall include the following:

- All streets, lots, blocks, easements and other lands within the plan of subdivision;
- Proposed storm sewers, including size, length and grade, maintenance holes, maintenance hole numbers, direction of flow, major over land flow routes, and details of the outlet sewer or receiving watercourse and/or Stormwater management facility;
- The drainage areas within the subdivision and the limits of external areas draining into the proposed system. The area contributing to each maintenance hole shall be clearly outlined and the area in hectares and runoff coefficient shall be indicated on all drainage areas;
- If the contributing area to a maintenance hole is made up of areas with different runoff coefficients, the sub-areas showing the individual area in hectares and the runoff coefficient shall be clearly shown;
- If the external drainage area is large, it may necessitate the preparation of a separate external drainage area plan. External drainage area plans may be prepared at a smaller scale, but shall show the existing ground contours to beyond the limit of the drainage area. Planned street patterns (if available) shall be shown to determine the route of the future sewers; and,
- Contour lines to adequately show drainage patterns with a minimum of 1 metre contours.

A.9.2.7 Composite Utility Plan

In order to ensure that conflicts are avoided among utilities, street trees, municipal services and driveways, the Consulting Engineer shall be responsible for coordinating the preparation of the Composite Utility Plan (CUP). The CUP shall indicate the location of all underground and aboveground services, and utilities. In lieu of a separate CUP plan, these services may be included in the lot grading plan.

The CUP shall be prepared at a scale of 1:500. The following utilities, services and appurtenances shall be shown on the CUP:

- Catch basins including RLCB and maintenance holes in the road ROW; and,
- Valve chambers and hydrants.

Underground boulevard services, such as:

- Rear yard catch basin leads; and,
- Utility Crossings.

Aboveground services, structures and utilities such as:

- Bridges, culverts;
- Curb and gutter;
- Driveway locations;
- Hydro poles and light standards (poles);
- Traffic signals;
- Transformers;
- Pedestals, junction boxes, major utility hubs / vaults, street light disconnection boxes, flush to grade handwells and handholds;
- All utility related easements;
- Community mailboxes
- Retaining walls; and,
- Walkways and sidewalks.

A.9.3. Digital Engineering Submissions / “As-Constructed” Drawings

The digital as-constructed submission shall be provided to the City in digital format with all drawings in georeferenced coordinates. Vector format .DXF or .DWG files will be required.

Constructed sewer information which is georeferenced shall be provided to the City either as a .SHP file, an alternate digital format agreeable to the City or on a spreadsheet format which may be easily integrated into the City’s asset management software.

A.9.4. Geodetic Control

All design and construction shall be referenced to a minimum of two benchmarks. The Consulting Engineer shall contact the City to obtain a description of current benchmarks adjacent to the proposed work. Benchmarks used during construction shall be clearly identified on the design drawings with the number and the Benchmark Elevation.

All drawings are to be prepared in UTM NAD83 (Original) Coordinate System, Zone 17, and Central Meridian 81 West Longitude to simplify the eventual digital submission requirements.

A.10. CONSTRUCTION

A.10.1. Road Closure

Any anticipated road and lane closures required for underground or above ground works shall be identified by the Engineer at the initial submission of the Engineering drawings. Temporary Road Use Permit Application information can be found on the City's website.

The Development Engineering Section shall confirm the feasibility of road and lane closures and any requirements that are necessary, including temporary works, the preparation of detour routes and sign boards, and notification. The approval of a road closure is subject to the approval of the General Manager, Public Works. The cost of implementing a road closure shall be borne by the Proponent.

A.10.2. Asphalt Overlays on Existing Roads

If multiple road cuts are required on existing roadways for construction of underground services, the Proponent can expect to provide full reconstruction of the pavement structure as a condition of development approval, unless it can be demonstrated that servicing can be completed without adversely affecting the service life of the road. As a minimum, a full width overlay of asphalt will be required where there are three or more service trenches including rear lot catch basin leads.

When overlaying an existing road (edge of pavement to edge of pavement) the roadway shall be milled and overlaid from 1.0 m past the first cut to 1.0 m past the last cut.

If a service trench is required for a service parallel to the road, then the entire road shall be overlaid from 1.0 m past the start of the service trench to 1.0 m past the end of the service trench. If the service being installed is off-set from the centerline of the road such that the service trench affects only a portion of the road, then the City may, at its discretion, allow half the road to be overlaid. For extra wide roads, the minimum asphalt overlay shall be one lane width.

The decision to reconstruct or mill the entire roadway or to put an asphalt overlay shall be site specific depending on the grade and condition of the existing road.

A.10.3. Requirements for Tendering

The Engineer shall call tenders for the works (if requested by the City) and shall analyse the bids received and make recommendations to the Proponent and the City regarding the awarding of the works to the Contractor.

Where the City of Hamilton is responsible for the payment of items that include a “City Share” of the cost that is not based on a "Flat Rate" basis for sanitary and storm sewers and watermains and the "New Roads Servicing Rate" for roadworks, the following tendering procedure shall be used:

Any project where the City’s share of the cost is in excess of $50,000.00 + HST shall be tendered by an open tender (i.e. public notice in the Spectator). Where there is a City share component for the project the Proponent should not tender the Works subject to the funding by the City until given authorization by the Development Engineering Section. The City will not pay for increase in costs arising from incomplete designs.

The tenders shall close at the Consultant's office (if local) or at City Hall if the Consultant is from out of town. The out-of-town Consultant shall make arrangements to book a room at City Hall for the tender opening. A City representative will be present at the opening of the tenders to witness the bids received and shall be provided with copies of the Schedule of Quantities of the three low bidders immediately.

The Proponent may select the Contractor of his choice for the project, but the City will pay for its share of the works only on the basis of the overall low bidder (unless there is a justified reason to choose another bid e.g. disqualification of bidder due to no bid bond, known bad track record, etc.).

The Engineer will prepare and certify on the City's Share of the Works, based on the prices submitted by the low bidder that has been accepted by the City.

A.10.4. Pre-Construction

The Engineer shall arrange for a pre-construction meeting to be held prior to start of construction. A checklist (ref. Appendix B – Pre-Construction Meeting) of items to be covered at the pre-construction meeting shall be provided. At this time, the City shall be provided with the following documents:

- One (1) priced and signed copy of the contract documents and Form of Tender;
- One (1) blank copy of the contract documents and Form of Tender (without prices);
- Two (2) copies of the General Plan of Services;
- Three (3) complete sets of construction drawings;
- Mud Tracking & Construction Access Plan; and,
- Rodent Control Plan (see A.10.10).

The Consulting Engineer shall obtain a Construction Schedule from the Contractor and provide the City with a copy. The City shall be regularly informed as to the progress of construction and of any deviation from the original schedule.

A.10.5. Compaction and Material Testing

Compaction testing for trench backfill, road sub-grade, granular courses and asphalt including material testing of concrete, asphalt, granular materials etc., is required for all development projects in the City of Hamilton. It shall be the Proponent's responsibility to provide material and compaction testing by a qualified geotechnical testing company.

The geotechnical consultant shall certify to the City that works have been carried out as specified. In the event of a deviation from specifications, the geotechnical consultant shall provide an explanation and make recommendations to the City for either acceptance or any mitigation measures that could be carried out. The participating parties shall perform all necessary tests and comply with the following regulations to ensure the integrity of the design of all road works:

- Sieve analysis of granular base material for compliance with specifications;
- Granular base course material supplier shall be approved by the City prior to use;
- Compaction tests on the subgrade, granular base courses and asphalt courses to assure satisfactory compaction has been achieved. Asphalt mix designs and supplier shall be approved by the City prior to use;
- Confirmation of the sub-grade elevations prior to construction of road base. No Base course material shall be placed on the sub-grade until approval is given by the City. Such approval will only be given when:

The degree of compaction has been achieved as per City of Hamilton Form 900 in the City of Hamilton Construction and Material Specification Manual.

  - The sub-grade has been graded to within 13mm of the proposed cross-section; and,
  - The Proponent's Consultant has taken sufficient elevations and provide written certification for grades and for all area compaction levels to the City;
- "Proof rolling" of the sub-grade prior to the placement of the granular road base courses. All soft and spongy sections shall be excavated and filled with suitable material. Upon completion of excavation and grading operations, the sub-grade shall be thoroughly rolled with a loaded try axle or an alternative as recommended by the Geotechnical Consultant. Any minor irregularities or depressions developing under such rolling shall be corrected at the contractor's expense;
- Concrete tests (air, slump, and compressive strength) shall be performed to assure concrete meets specifications. Concrete supplier shall be approved by the City prior to use;
- Initial visual inspection of the road works; and,
- A final visual inspection of the road works prior to the expiration of the Guaranteed Maintenance Period.

Notwithstanding the aforementioned requirements, the Geotechnical Consultant shall not be relieved in any way from full responsibility to carry out any further tests which may be required to assure services meet specifications.

In cases where blast rock is proposed as a backfill material, for which test results cannot be obtained, the Proponent shall engage a qualified geotechnical soils consultant to be present on a full-time basis to monitor the compaction procedures during backfill, and provide the City with a written certificate at the completion of backfill operations that an equivalent of 95% Standard Proctor Density has been achieved for the backfill of the trenches.

All imported fill to a site shall meet MOE-CC Ontario Regulation 153, Table 1 for residential sites.

A.10.6. Interim Water Quality

In order to verify proposed DWS alterations through the Form 1 process, the Owner Representative must have assurance that the proposed design will ensure adequate interim water turnover and water quality during construction phasing. To address potential concerns, below are options to mitigate problems:

- Performance Based Flushing;
- Temporary Pipe Looping; and,
- Automatic Flushing Station Installation.

Should the Performance based Flushing option be implemented, the following conditions will apply:

- Flushing and testing will commence once the new watermain has been connected to the network. It will be carried out at a frequency based on performance and to ensure water quality requirements;
- The Proponent will pay invoices for flushing and testing based on actual costs incurred by the City. Such costs shall be based upon rates established by the Hamilton Water Division; and,
- Flushing and testing will cease once tests confirm that water quality requirements have been met as per the Safe Drinking Water Act.

Temporary pipe looping and automatic flushing station implementation shall be discussed with the City and implemented on a case by case basis.

A.10.7. Spill Management Reporting

Reference shall be made to the City of Hamilton Emergency Preparedness Plan Spills Notification Protocol. It is the responsibility of the person having control of the spilled Substance(s) or the person who causes or permits the Spill to immediately notify and provide the required information to:

- City of Hamilton – Assigned Construction Inspections Coordinator;
- City of Hamilton – Environmental Monitoring Enforcement Section – 905-540-5188; and
- Ontario Ministry of Environment – Spills Action Centre – 1-800-268-6060.

A.10.8. Mud Tracking & Construction Access Plan

A mud mat will be required at each point of access to the construction site, and will be composed 200 mm clear stone material or an approved equivalent. The mud mat's dimensions shall be at a minimum 3.0 m wide, 15.0 m long and 300 mm thick.

The Proponent or the Engineer will submit a plan describing the following applicable criteria:

- Location of all new or existing accesses to be used throughout construction;
- Impact of appropriating / modifying an existing entrance;
- Identify lane closures or restrictions and their expected duration;
- Secondary method of removing mud and dirt from vehicles entering or leaving construction site;
- Method and timing of cleaning up any mud and dirt that is tracked onto public right-of-way;
- Culvert sizing to preserve existing drainage; and,
- The locations of nearby hydrants intended to be accessed for the purposes of road cleaning.

The Proponent shall be responsible for all the removal of all mud and debris that is tracked onto the roadways from vehicles entering or leaving construction sites. The Proponent shall, upon verbal and/or written request by the City, immediately proceed with clean-up operations at their expense. Should the Proponent fail to maintain the road as directed, the City will have the cleaning carried out, draw on the Proponent's security for costs and/or lay charges.

A.10.9. Standing Water

City of Hamilton By-Law 03-173 prohibits and regulates the accumulation of standing water at specified times of the year. Standing water on construction sites is an area of concern by the City and all development projects will be monitored by the City for compliance of the By-Law.

Proponents should ensure that standing water does not accumulate on the land between April 1 and October 31 of each year.

A.10.10. Rodent Control Plan

Prior to preliminary grading, the Owner agrees at his sole cost to prepare a pest control plan, focusing on rats and mice which shall be developed and implemented for any demolition, and for the construction / development phase of the project and continue until the project is complete. The plan must outline steps involved in the potential control of vermin during all the development / construction and must employ integrated pest management practices. The plan must be formulated by a professional exterminator licensed by the MOECC and shall include monitoring, removing potential food and water

sources, and eliminating or preventing areas for harbourage. The plan can include trapping and / or baiting but special consideration should be aimed at ensuring any / all bait stations are tamper resistant and deceased rats are removed to prevent secondary poisoning of other animals. The plan is to be implemented when work activity at the site begins including but not limited to demolition, bush clearing, grading etc. This requirement is made under Section 26 of the Hamilton Property Standards By-law, No. 10-221 and to the satisfaction of the Medical Officer of Health.

A.11. RELEASE OF BUILDING PERMITS

For houses in new subdivisions, building permits will not be issued by the City for any lot, block, unit or severed parcel within the Land by the City:

- Until the Plan of Subdivision, has been registered;
- Until such time as the Engineer has certified that sewers and watermains, including fully serviceable and operative fire hydrants, together with a roadway, which includes granular base and base asphalt, have been installed in accordance with municipal standards to the satisfaction of the City;
- Until such time as the Engineer has certified that the lots, blocks, units or severed parcels have been pre-graded in accordance with the requirements of the Subdivision Agreement for pre-grading;
- Until a Detailed Grading Plan (Plot Plan) indicating the building foot print, the main floor and top of foundation wall elevations, and the proposed grading according to the Overall Grading Plan has been prepared by an Ontario Land Surveyor or a qualified Professional Engineer and filed with the Director of Building Services, or designate;
- All trees to be preserved on the lot, block, unit or severed parcel have been satisfactorily protected in accordance with the standards established by the City; and,
- Unless otherwise prescribed in the Subdivision Agreement.

Notwithstanding the forgoing provisions of this section, a building permit may be issued in accordance with the Model Home By-Law 03-163, provided the Engineer certifies that:

- An approved grading plan;
- An existing charged hydrant is located within 150 m; and,
- An acceptable street access has been provided to within 90 m, of the construction site's property boundary.

A.12. INSPECTIONS AND TESTING

A.12.1. Lot Grading Inspection and Certification

The City of Hamilton’s approval process to achieve final approval and release of securities held for the lot grading involves the following procedures:

- Plot Plans are prepared by an Ontario Land Surveyor, Architect, Landscape Architect or Engineer in accordance with the approved subdivision grading plan as part of the building permit process;
- Once footings have been placed or formed, an Ontario Land Surveyor shall certify in a suitable form, and make available to the City, that:
  - The top of footing elevation(s) conforms with the top of footing elevation(s) shown on the approved Plot Plans;
  - The foundations are sited entirely on the correct lot; and,
  - The building setbacks conform to the zoning by-law;
- Foundation elevations will be considered 'non-conforming' if they differ from design elevations by more than 150 mm. Non-conforming foundation elevations shall be brought to the attention of the City for further direction/discussion prior to proceeding with any further construction;
- After at least one winter has passed and the lot has been sodded, an Engineer shall submit an as-built plot plan and certify in writing, that the lot is in general conformance with the overall grading shown on the approved grading plan, in accordance with Section A.9.1.4 - Pre Grading Plan. Grading certification shall include water service inspection and rear yard catch basin inspection. Video inspection of rear yard catch basin lead shall take place after houses on both adjacent lots are constructed. Following acceptance of the certification, the City inspector provides new homeowners with an information package including the Lot Grading and Drainage Brochure;
- Following certification of all lots, a security reduction request can be submitted for reduction of securities collected under 'First Stage' amounts with the initial application approval process, in accordance with Section A.13.3 - Disconnection of Services and A.14.6 - Lot Grading Securities for Subdivision Agreements;
- For Lots which cannot be certified due to poor grading or changes in house style, the Engineer will notify the City, Proponent, and Builder in writing. An Engineer, on behalf of the Proponent, will prepare a new over-all grading plan to address the lots which have not been built according to the original plan, and will submit a revised plan to the City with the required review fees;
- An Engineer will re-inspect any deficient lots or for those lots which cannot be certified by a visual inspection and prepare a revised as-built grading plan, in order to obtain lot certification. If necessary, the builder will be instructed to address any deficiencies in order to have the particular lots certified. If the builder will not correct the work as instructed by the Engineer, this responsibility will fall directly upon the Proponent;
- The 'Stage 2' security (A.14.6 - Lot Grading Securities for Subdivision Agreements) deposit will be retained by the City to ensure completion of final lot grading and sodding and will only be released upon the City's acceptance of a final lot grading certificate, including an as-built plot plan, water service verification and video camera inspection, in accordance with the approved grading and plot plans; and,
- All remaining grading securities are released in accordance with the conditions of the Development Agreement.

A.12.2. Erosion and Sediment Control Inspection

All on site Erosion and Sediment Control Facilities are to be inspected by the Consultant on a regular basis. Refer to Section G.7.1 - On-Site Reporting Requirements.

A.12.3. Disconnection of Services

For rehabilitation of sewer services see Appendix C – Disconnection of Services Information Sheet.

Should the owner of a building decide to disconnect the services due to removal, the owner shall obtain a video inspection of the main sewer.

A.12.4. Video Camera Inspection

The Proponent is responsible to provide a video inspection of the sanitary sewers. The City shall be provided with 48 hours' notice as to when the video inspection is being carried out so that they may witness the video inspection.

The video inspection shall be carried out in accordance with City of Hamilton Construction and Materials Specifications – Form 500 Specification for Sewer Pipe Materials and CCTV Inspection. A copy of the initial video inspection and deficiency list, if any, shall be made available to the Consulting Engineer and the City when the testing company has completed the video inspection. The Consulting Engineer shall take the necessary steps to have any deficiencies rectified.

Prior to the expiration of the Maintenance Period, the Proponent shall initiate a second video inspection of the sanitary and storm sewers. All rear lot catch basin leads shall be video inspected at the time of grading certification.

A.13. INSPECTION

A.13.1. General

The Proponent's Consulting Engineer has full responsibility for the actions of the Contractor and the quality of the work. The Proponent's Engineer is responsible for providing full time inspection services during the construction of all municipal services in the project.

City staff shall only provide a part-time monitoring of the construction activities to ensure general conformance to the Subdivision Agreement and the City's policies and standards.

Employees, contractors or agents of the City may, at any time and from time to time prior to assumption of the Works by the City, enter upon the Land without notice to the Owner to:

- Inspect any of the Works. Such inspection by the City shall in no way relieve or replace the City's requirement for the Owner's Engineering Consultant to provide full time inspection of the Works under this Agreement;
- Conduct any tests that in the opinion of the Senior Director of Growth Management Division are necessary to confirm or verify quality of materials and construction; and,
- Make emergency repairs in the event the Works do not function or do not function properly, or in the opinion of the Senior Director of Growth Management Division, require necessary immediate repairs to prevent damage or hardship to any persons or to any property. Such undertaking of repairs by the City shall in no way be deemed as acceptance or assumption of the Works by the City.

A.13.2. Definitions

Underground works includes:

- Sanitary sewers and associated appurtenances;
- Watermains and associated appurtenances (valves, hydrants, water boxes);
- Storm sewer and associated appurtenances;
- Infiltration systems;
- Base asphalt; and,
- Curb and Gutter.

Aboveground works includes:

- Surface asphalt;
- Driveway ramps;
- Islands and roundabouts including sodding;
- Boulevards including sodding;
- Sidewalks;
- Fences;
- Entrance features;
- Street lighting;
- Storm water management facilities;
- Utilities;
- Grading;
- Retaining walls;
- Walkway blocks; and,
- Noise barriers.

A.13.3. Initial Inspection of Municipal Servicing

The initial visual inspection of the sewers shall consist of inspecting of all maintenance holes and catch basins to assure the structures are complete (i.e. ladder rungs, correct frame and cover, temporary bulkheads removed, silt controls in catch basins), and free of debris.

The initial visual inspection of the watermains shall consist of the inspection and operation of all main valves, hydrants and secondary valves. All valves and hydrants shall be left in the “open” position, unless noted otherwise. Valves 400 mm and larger shall be operated by Public Works – Hamilton Water.

The City will provide one field inspection to confirm correction of deficiencies, however subsequent inspections may be invoiced to the Proponent on an hourly basis.

A.13.4. Acceptance of Works – Start of Maintenance

The "Start of Maintenance" date shall be established by the City and the services placed on the maintenance period providing the following conditions have been satisfied:

- The plan of subdivision has been registered;
- The construction of services has been certified as substantially complete;
- Geotechnical reports confirming acceptable compaction testing and materials;
- The Engineer has submitted as-constructed information in a form satisfactory to the Growth Management Division; and,
- The required inspections reveal that there are no major deficiencies in the sewer and watermain systems constructed under the Subdivision Agreement.

Maintenance periods will be established for the following phases of construction:

- Completion of all underground services; and,
- Completion of above ground works (after placement of the surface course asphalt).

The Proponent shall maintain all underground services for a period of not less than two years from the date of "Acceptance of Works" as issued by the City. Should the Proponent be required to repair or replace a portion of the underground works, the City, at its sole discretion may require that the full two year period will commence from the date of the accepted repair or replacement.

The Proponent shall maintain all above ground works for a period of not less than one year from the date of "Acceptance of Works" as issued by the City. The one year maintenance period shall not commence until the placement of the surface course asphalt.

A.13.5. Obligations during Maintenance Period

The Proponent shall make good in a permanent manner satisfactory to the City, any and all damage to the work during the maintenance period. Any deficiencies or defects noted during the maintenance period are the responsibility of the Proponent and all complaints and concerns will be deferred to the Consultant for resolution.

Should the Proponent fail to carry out these repairs within the required time frame of being notified in writing, the City may have the required repairs carried out and the Proponent shall be invoiced for the works.

Obligations are outlined in the Subdivision Agreement.

A.13.6. Assumption of Works

Prior to assumption of the underground works by the City, a final visual inspection and CCTV inspection shall be conducted. In addition, a mandrel test shall be performed by the Contractor on all PVC sewers (sanitary and storm) in accordance with OPSS 410.07.15.05.

The final visual inspection of the watermain works shall consist of inspecting and operating all main valves, hydrants and secondary valves. Valves 400 mm and larger shall be operated by the City Waterworks Section. In addition the Proponent is required to conduct a connectivity test for PVC watermains.

The final visual inspection of the sewers shall consist of inspecting all maintenance hole and catch basins and their adjustments.

Prior to the "end of the maintenance" period for the **above ground works**, the Engineer shall request a final visual inspection with the City. When all deficiencies have been corrected to the satisfaction of the City, the assumption date will be established.

The assumption of the above ground works shall also include any Stormwater management facilities servicing the development. Assumption of the Stormwater management facilities shall not occur before 95% build-out of the catchment area. The request for assumption of the Stormwater management pond shall be accompanied by:

- Topographic survey of the pond after clean-out and certification of volumes by a professional Engineer;
- Certification of planting materials by a landscape architect;
- Copy of Operation and Maintenance Manual and inspection reports;
- Other requirements of the ECA;
- Copy of MOE-CC ECA Approval Letter; and,
- The visual inspections shall be conducted by the Contractor, accompanied by the Engineer and the City.

A.14. FEES AND SECURITIES

The security deposit(s) required by the Subdivision Agreement shall be issued by a financial institution in the form of an irrevocable letter of credit, cash or such other equivalent security satisfactory to the City Solicitor.

The Proponent may apply for a reduction in securities held by the City (ref. Appendix D – Security Reduction Requests), once the works have been constructed. Each request for security reduction will be accompanied by a Certificate from the Engineer, outlining the value of the completed works as well as the value of incomplete works. The value of the incomplete works shall be estimated on the basis of the signed Contract of Works for the project.

Any interim requests for reduction in securities shall be accompanied by a proof of payment to the Contractor based on the latest payment Certificate issued by the Engineer to certify the value of incomplete works. A security reduction processing fee will be applied after the third security reduction.

After satisfactory completion of **all on-site works** and receipt of **all required certifications,** the total amount of the security held by the City shall be released, **except for landscaping which shall be held until June following the end of the first growing season.**

a. Reductions of security held under Site Plan Agreements are permitted to an amount equal to the total value of the works outstanding, but not less than 10% of the total value of the works required under the Agreement;

b. Security reductions / releases are dealt with on a request basis;

c. A Two Hundred and Eighty Dollar ($344.65) administration fee (2017 fee schedule) is required for each security ***reduction*** request;

   Note: The administration fee is not charged for a one-time full release of securities. Refer to the current fee schedule.

d. Reduction / release requests are reviewed and processed by the Growth Management Division upon the production by the Applicant, at the Applicant's sole expense, of an Engineer's Certificate, as per Appendix "XX", which indicates:

   i. a description of what works have been completed;
   ii. a detailed list of incomplete work and associated estimate of the cost to complete the work.

Note:

- Reductions of security held under Site Plan Agreements are permitted to an amount equal to the total value of the works outstanding, plus 10% of the total value of the works required under the Agreement.

- The engineer and/or landscape architect shall certify all works completed (see Appendix P – Site Works Certification Form for Landscape Works).

- The items listed in Appendix Q – Site Works Certification Form for Engineering are meant to serve as a starting point and in no way represent a standard for any particular site plan. The professional engineer and/or landscape architect must complete these forms in the manner that best reflects the application.

A.14.1. Cost Estimate

The Engineer shall prepare a cost schedule for inclusion in the City's Subdivision Agreement (Schedule of Works - Estimate of Costs and Description of Works to be carried out by the Owner). This cost schedule shall identify all the works required to service a Proponent's proposed plan, the estimated cost of the works and the City's share of that cost in accordance with the City's approved Financial Policies.

A.14.2. Engineering Fees

All fees associated with design review, Agreement preparation, construction supervisions, and security reductions are outlined in the Planning & Economic Development Department, Growth Management – User Fees and Charges. Design review fee applies to each and all phases of the draft plan of subdivision.

A.14.3. Parkland Dedication - Cash in Lieu

Parkland Dedication and cash-in-lieu thereof, is governed by By-law 09-124.. For commercial land uses the parkland dedication requirement is 2% of the Net land area. For low density residential uses at less than 20 units/ha and other uses such as institutional, the parkland dedication requirement is 5% of the Net land area. For residential uses at densities above 20 units/ha, the parkland dedication is calculated based on a density formula; 1 ha/300 units for densities between 20 and 75 units/ha, 0.6 ha/300 units for densities between 75 and 120 units/ha, and 0.5 ha/300 units for densities above 120 units/ha (except in Hamilton's downtown core where 5% of Net land area applies). Industrial uses are exempt from parkland dedication.

Where no parkland has been dedicated previously or cash-in-lieu of parkland dedication paid for the property on which a development is proposed, and the site is improved with one or more buildings that are proposed to be demolished or have been recently demolished, the parkland dedication/cash-in-lieu for the proposed development may qualify to be partially offset based on the building floor area or number of residential units demolished. See section 3(2) of the By-law for details.

For additional information, refer to By-law 09-124.

A.14.4. Insurance

Before construction may commence, a Proponent is required to enter into a standard form, Subdivision Agreement with the City as well as meet required financial and insurance obligations specified in the Agreement.

A.14.5. Security Requirements

A Proponent is required to enter into a, Subdivision Agreement which specifies the security requirements for the works. Security requirements will be based on estimates from A.14.1 Cost Estimate and are currently defined as:

- 100% - Erosion Sediment Control;
- 50% - Grading;
- 75% - Estimated Construction and Engineering Costs; and,
- 100% of external works (External Works and Consent Agreements).

Additionally, special features such as retaining walls or landscaping may be secured exclusively and have unique criteria governing the reduction of securities.

In no case shall the amount of the security be reduced to less than:

- The cost of the uncompleted Works or deficiencies as estimated by the Engineering Consultant, plus ten percent (10%) of the estimated cost of Works;
- Outstanding as constructed drawings valued at $5,000 per sheet initially and reduced to $1,000 per sheet upon submission of preliminary as-built information;
- Value of the OLS certificate; and,
- In no case will the value be less than $10,000, until final release of securities.

A.14.6. Lot Grading Securities for Subdivision Agreements

Security for lot grading under Subdivision Agreements and Consent Agreements will be administered according to the following procedure.

First Stage

The developer will be held responsible for final grading as per section 1.26 of the subdivision agreement. Securities held under the subdivision agreement will not be reduced to less than $5,000 per uncertified lot or $10,000.

Second Stage Fees: Security Collected under Building Permit Application

A cash security deposit of $1,500 will be collected as a condition of building permit application from the owner of each lot within a development. The security deposit will be

retained by the City to ensure completion of final lot grading and sodding. The security will only be released upon the City's acceptance of a final lot grading certificate, including an as-built plot plan.

A.14.7. Lot Grading Securities for Severance Applications

First Stage Fees: Security Collected under Initial Application Approval Process

A lump security deposit of $10,000 will be collected from the Proponent under the appropriate development Agreement (i.e. Consent Agreement).

The security deposit will be retained by the City to ensure completion of final lot grading and sodding and will only be released upon both the City's acceptance of a final lot grading certificate.

Second Stage Fees: Security Collected under Building Permit Application

A cash security deposit of $1,500 per lot will be collected from the owner of each lot within a development as a condition of building permit application. The security deposit will be retained by the City to ensure completion of final lot grading and sodding and will only be released upon the City's acceptance of a final lot grading certificate.

A.15. EASEMENTS

As a general principle, the City discourages installation of municipal works on private property through easements. In the instance where a municipal sewer or watermain must be located on private property, the Consulting Engineer shall obtain approval from the City during the preliminary Engineering stage of development. The sewer or watermain shall be located within an easement in favour of the City free of any legal encumbrances and the Proponent shall carry out all steps necessary to transfer the easement to the City. The intention is to maintain reasonable access to maintain and repair infrastructure.

Minimum easement width requirements are:

- 9 m for one sewer (sewer centered on the easement);
- 12 m for dual sewer installation;
- 6 m for a watermain (watermain centered on the easement);
- 10 m for one sewer with a watermain (3 m easement limit to watermain, 2.5 m clearance between watermain and sewer and 4.5 m sewer to easement);
- 12 m for dual sewer installation with a watermain; and,
- Minimum of 4.5 m for significant swales (see Section G - Stormwater Management).

The above easement widths are minimum requirements and may be increased depending on the depth and size of the pipes within the easement and/or soil conditions, topography or operational needs.

In general, the City shall not require easements for private catch basin connections or private sewers and watermains.

B. SITE PLANS

B.1. GENERAL

Site Plan Approval is a required process that must be followed for most Industrial, Commercial and Institutional (ICI) and multi-residential developments including major building renovations or additions. It is the development review process, authorized under Section 41 of the Planning Act, and involves the city's review and approval of detailed plans for site development that address issues such as landscaping, grading, servicing, building elevations, and location of access driveways and parking lots. For major developments, this process often includes an Agreement between the city and the landowners that requires the landowner to provide land (i.e. road widening, daylighting tringles) or services to the city. The first step in site plan approval is the submission of a complete application after consultation with the Planning Division. An optional formal consultation will help determine the scope of the application and what materials need to be submitted for review (i.e. site plan, elevations, grading plan, studies, reports, etc.) when moving forward with the site plan.

Applicants shall refer to the City's Site Plan Guidelines.

B.2. FORMAL CONSULTATION

All Site Plan applications, except for those within the Design Priority areas will be automatically exempt from the Formal Consultation requirement, unless in the opinion of the Manager, Development Planning, Heritage and Design, Formal Consultation is warranted. A Formal Consultation exemption letter will not be required.

B.2.1. Design Review Panel – Urban Design Brief

The Design Review Panel (DRP) is a voluntary technical panel established to provide expert and impartial design advice to Planning Division staff on urban design matters. The panel is strictly an advisory body and makes recommendations, it does not have the authority to approve or refuse projects or make policy decisions, or recommendations on land use. DRP applies to complex Zoning By-law Amendment (rezoning) and Major Site Plan applications, civic projects, new policy initiatives, and studies with urban design components in the following Design Priority Areas: The Downtown Hamilton Secondary Plan Area, Areas of Major Change and Corridors of Gradual Change within the Setting Sail Secondary Plan Area, and Primary Corridors as identified in the Urban Hamilton Official Plan. Additionally the Director of Planning and Chief Planner may refer any transformational project that requires fundamental changes to the land use and has the potential to significantly impact the physical environment functionally and aesthetically. Outside of these options, anyone can opt into the DRP if they wish.

DRP review is requested at the Formal Consultation Stage. For rezoning applications, this review occurs after a complete application is made. For site plan applications, this review must occur before the Development Review Team meeting to ensure concerns are identified as early in the process as possible. Please refer to the DRP section on the

City of Hamilton website at https://www.hamilton.ca/develop-property/policies-guidelines/design-review-panel for information regarding the submission requirements, timing, contacts, etc.

B.3. SITE PLAN APPROVAL PROCESS

Applicants shall refer to the City's Site Plan Guidelines – Appendix 5 Site Plan Control Process Flow Chart. Site Plan Approval submissions shall be prepared in accordance to Submission Requirements and Application Form for Site Plan Control.

Further to the existing City of Hamilton Site Plan control documents, applicants must adhere to the following requirements:

- Conform to regulation under the current Condominium Act, where relevant;
- Schedule a pre-consultation meeting with City Staff;
- Disclose and rationalize all non-compliant Engineering and/or design elements. Proposed non-compliant Engineering and/or design solutions shall be stamped/signed by a professional consultant; and,
- Follow the City of Hamilton's current submission requirements and submit complete applications, which include all required Engineering reports and drawings.

B.4. CONDITIONS REQUIRED FOR ISSUANCE OF SITE PLAN APPROVAL

Conditions for Site Plan Approval will be issued as part of the Conditional Site Plan approval process. Refer to Submission Requirements and Application Form for Site Plan Control.

B.5. SECTION 41 DEVELOPMENT AGREEMENT / SITE PLAN APPROVAL

Site plan approval is a development review process authorized under Section 41 of The Planning Act, R.S.O., 1990 c.P. 13 and implemented by municipal Bylaw 15-176. Conditional approval will be granted by the Manager of Development Planning, Heritage and Design by the Planning division after a full review and evaluation of the proposal.

Refer to Submission Requirements and Application Form for Site Plan Control.

B.6. BUILDING PERMITS

Building permits will be issued after Site Plan Approval has been granted and may require the posting of securities. As part of the Concurrent Review Process, there is a waiver that must be signed, see Appendix N – Acknowledgement for Concurrent Building Permit Review Process. Refer to Submission Requirements and Application Form for Site Plan Control.

B.7. HERITAGE IMPACT ASSESSMENTS AND CONSERVATION PLANS

A Cultural Heritage Impact Assessment (CHIA) is a report that documents a clear and documented evaluation of the effects of a proposed new development or redevelopment on cultural heritage resources and/or their setting. The need for a Heritage Impact

Assessment will be determined in consultation with the Cultural Heritage Planner and should be prepared to the satisfaction of the Development Planning, Heritage and Design Division.

Reference should be made to the Official Plan, the City of Hamilton Info-sheet: Cultural Heritage Impact Assessments, March 2014, which is available from the Cultural Heritage Planner in the Development Planning Section of the Planning Division.

Section 2.4 Heritage Resources of the Site Plan Guidelines provides further discussion.

B.8. ENGINEERING REQUIREMENTS FOR SITE PLAN APPROVAL

B.8.1. Report Formats / Submission Requirements

Submission requirements will vary between sites and projects depending on the scale and context of the proposal. The requirements are outlined on the site plan control application and will be determined in consultation with the Development Planning, Heritage and Design Division. Complete submissions shall be accompanied by a covering letter prepared by a qualified professional indicating where deviations from City Standards or policies have occurred, the cause for the deviation and the efforts made to uphold the intent of the policy.

B.8.2. Purpose

These guidelines will assist designers, Proponents and builders as well as the public agencies which are involved in the site plan application review process. The guidelines will provide clarity for the development process, and ensure that all developments are mutually supportive of Hamilton's desire to create an attractive, liveable and functional community.

B.8.3. Engineer's Qualifications

Drawings and reports shall be prepared by a qualified professional in accordance to Submission Requirements and Application Form for Site Plan Control.

B.8.4. Coordination of Drawings

It is imperative that the consulting Engineer is responsible for co-ordinating all related drawings, details and specifications through the prime consultant to ensure they are compatible with the approved site plan, architectural plans, and landscaping plans, etc. Drawings that are not compatible with the other disciplines may result in undue delays in clearing the conditions of the Site Plan Approval.

B.8.5. Submission Requirements

Submission requirements will vary between sites and projects. Additional requirements may be determined by the Formal Consultation. Unconventional requirements should be discussed with Formal Consultation staff prior to submission.

B.8.6. Site Servicing Plan

Site servicing design drawings shall be prepared in accordance with Sewer & Water Permit Process.

B.8.7. Grading and Drainage Control

Site grading must consider relationships with adjacent properties. Changes to site grades must not adversely impact adjacent properties, especially with respect to drainage.

- Site grading should match the grades of adjacent properties. If grading on adjacent properties is required, consent of that owner is required.
- Site grading and drainage should produce zero negative impacts on adjacent properties, roads and ditches. Site grading must prevent uncontrolled Stormwater from draining onto adjacent properties. In addition all site grading and drainage shall conform to the Drainage Act and any associated regulations.

B.8.8. Environmental Impact Statement (EIS)

The requirement for the submission of an EIS shall be determined at the Formal Consultation meeting. The study shall be prepared in consultation with the Environmentally Significant Areas Impact Evaluation Group (ESAIEG) and to the satisfaction of the City and appropriate conservation authorities.

B.8.9. Stormwater Management (SWM)

Uncontrolled Stormwater runoff may result in flooding, soil erosion and pollution of watercourses. Stormwater management is practiced throughout Hamilton to control runoff using on-site techniques, off-site Stormwater management facilities or a combination of practices. The type of Stormwater management approach required will vary throughout the City depending upon the project location, size of the site and project type, as well as the need to control Stormwater quantity, velocity or quality of runoff.

Stormwater management shall be designed in accordance with Section G - Stormwater Management.

General Standards

- Drainage must remain internal to the site unless otherwise approved.
- Every parking area, where storm sewers are available, shall be drained in accordance with Section 9 of By-Law No. 06-026.
- Townhouses, commercial and industrial buildings cannot connect roof leaders to the storm sewers unless the applicant provides a site design, including an appropriate Stormwater management study prepared by a qualified Engineer (City of Hamilton Site Plan Control, Draft Grading Plan Requirements).

B.8.10. Environmental Site Assessment (ESA)

The requirement for the submission of an ESA shall be determined at the Pre-Submission Consultation meeting. The study shall be prepared in consultation with the Environmentally Significant Areas Impact Evaluation Group (ESAIEG) and to the satisfaction of the City and appropriate conservation authorities.

B.8.11. Geotechnical Investigation

The requirement for the submission of a Geotechnical Investigation shall be determined at the optional Pre-Submission Consultation meeting or the Formal Consultation meeting.

Where pipes within private property are to be conveyed to the City and constructed within an easement, a geotechnical investigation shall be required to make recommendations on pipe bedding and backfill.

B.8.12. Fire Flow Analysis

The requirement for a hydrant flow test will be identified at the Formal Consultation. Fire Flow calculations for the development shall be prepared in accordance with the Fire Underwriters Survey, 1999 to the satisfaction of the City.

Additionally, a fire flow test is required at all new private fire hydrants.

B.8.13. Water and Wastewater Generation Assessment

A report must be prepared in accordance with Ontario Building Code, Chapter 8.

Wastewater Generation Calculation is to include calculations for any existing uses; plus calculations for any future uses, all based on the Ontario Building Code (OBC), Part 8 Guide for Sewage Systems.

C. ROADS

C.1. GENERAL

For development purposes, when designing, roads consideration must be given to the City of Hamilton Urban Official Plan and Transportation Master Plan. The following road classifications shall apply:

Arterial Road — Describes a road, which functions as a strategic link in the overall road network of the City. Arterial roads carry relatively large volumes of short and long distance traffic in and through the City and provide some access to abutting properties.

Collector Road — Describes a road whose function is to provide a connecting road link between arterial and local roads. Collector roads generally carry lower traffic volumes then arterial roads and may provide direct access to abutting properties.

Local Road — Provides direct access to abutting properties and carries traffic predominantly of a local nature.

Classification of roads as major or minor collectors and local residential roads shall be identified in the City's Official Plan or the Secondary Plan for each planning neighbourhood. Where no Secondary Plan has been prepared, the General Manager of Planning and Economic Development shall determine the classification of the roadways, based on the function of the proposed roadway within the neighbourhood as described above.

All residential roads within the urban boundary of the City of Hamilton shall be designed and constructed to urban standards with full municipal services: i.e. concrete curbs with subdrains, asphalt on granular pavement, concrete sidewalks, catch basins, storm sewers and street lighting. Residential roads within Urban Settlement Areas may not have full municipal services and therefore would not be required to be fully urbanized.

Emergency Accesses are not considered to be suitable secondary accesses.

C.2. GEOMETRIC STANDARDS

The geometric design of municipal roads in the City of Hamilton shall conform generally with the standards set out in the latest edition of the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads.

Arterial roads except for those roads under provincial jurisdiction are the responsibility of the City of Hamilton, and all geometric design elements should correspond to the TAC Geometric Design Guide for Canadian Roads. The City's Development Engineering Section should be contacted to verify design criteria for arterial roads.

Horizontal and vertical alignment shall conform to the minimum geometric standards outlined below; however, the design shall be checked for conformity with the TAC Geometric Design Guide for Canadian Roads.

Vertical curves are required for changes in grade greater than 2.0% for local roads and minor collector roads and 1.0% for major collector roads (except at the crown of the road through intersections and at the point where the crossfall of the through road meets with the grade of the intersecting stop street). The minimum length of each grade shall be 6 m. Cul-de-sacs shall be designed such that there is a minimum 0.75%* gutter grade around the longest curb.

*If it is not achievable please outline the rationale in your original submission.

For intersection grading, the 2% pavement cross-fall on the through roadway shall be maintained through the intersection. The crown and cross-fall on the intersecting roadway shall match the projected gutter line pavement elevation of the through roadway. For intersections where both roads are either arterial or collector roads, a minimum crossfall and crown shall be maintained on all approaches.
The minimum curb return radii at intersections shall be 9 m. Larger radii may be required to accommodate transit and truck traffic at selected intersections. (I.e. major collector, truck route)

The Consulting Engineer shall design road grades taking into consideration the existing (and/or proposed) grades of adjoining properties, lot grading patterns, existing and/or proposed sewer profiles, major overland flow routes and elevations of intersecting streets, etc.

As a requirement of final clearance, the Consulting Engineer may be required to incorporate traffic-calming (Section C.4 - Traffic Calming / Closures) methods in the design of the roadways. These shall be discussed on an individual basis with the City Planning and Economic Development Department and shall be discussed in Traffic Impact Studies or Formal Consultation.

Collector and Arterial Roads will be designed in accordance with any applicable Environmental Assessment and in consultation with the City.

Detail of curb line radii and driveway access locations should be indicated on plans.

The following Table C.1 outlines the Geometric Road Design criteria for various urban and residential road classifications. It should be noted that the minimum right of way will be 20 m and be designed in accordance with PED100.01

Table C.1- Geometric Road Design Table

Geometric Detail	Local Road Urban Residential	Minor Collector Urban Residential	Major Collector Urban Residential
Min. ROW (m)	20	20	26

Geometric Detail	Local Road Urban Residential	Minor Collector Urban Residential	Major Collector Urban Residential
Design Speed (km/hr)	50	50	60
Posted Speed (km/hr)	50	50	60
Min. Visibility Curves in Sag (K)	12	12	15
Min. Visibility Curves on Crests (K)	8	8	12
Min. Horizontal centreline Road Radius (m) **	90	95	160
** Except at 90° corners at crescents and courts, unless otherwise required for traffic calming.			
Min. curb radius at intersection (m)	9	9	12
Pavement asphalt Width (m) Residential	8.0	8.0	11.0
Sub-grade cross-fall	3%	3%	3%
Pavement cross-fall	2%	2%	2%
Min. Grade (%)	0.75%	0.75%	0.75%
Max. Grade (%)	6.0%	6.0%	5.0%
Max. Grade for Through Roads at Intersections (%)	3.5%	3.5%	3.0%
Max. Grade at Stop Roads at Intersections (%)	2.5%	2.5%	2.0%
Intersection Angle (degrees)	80 to 90	85 to 90	85 to 90
Min. Tangent Length approaching intersections **	20 m	20 m	30 m
** From curb line of intersecting street, unless otherwise required for traffic calming.			
Cul-de-sacs Pavement	18.0 m Radius (with sidewalk required around bulb) 13.0 m Radius		

Geometric Detail	Local Road Rural Residential Crescents and Cul-de-sacs	Minor Collector Rural Residential Straight-through Roads	Major Collector Rural Residential
Min. ROW (m)	20	20	26

Geometric Detail	Local Road Rural Residential Crescents and Cul-de-sacs	Minor Collector Rural Residential Straight-through Roads	Major Collector Rural Residential
Design Speed (km/hr)	50	60 to 80	80 to 100
Posted Speed (km/hr)	50	50 to 70	60 to 80
Min. Visibility Curves in Sag (K)	12	18	25
Min. Visibility Curves on Crests (K)	130	175	250
Min. Horizontal centreline Road Radius (m) **	100	150	2000
** Except at 90° corners at crescents and courts, unless otherwise required for traffic calming.			
Minimum edge of pavement radius at intersection (m)	9	12	15
Pavement asphalt Width (m) **	6.7 plus shoulders	6.7 plus shoulders	9.0 plus shoulders
** Rural roads to be designed with roadside ditches for drainage. No curb and gutter required.			
Sub-grade cross-fall	3%	3%	3%
Pavement cross-fall	2%	2%	2%
Min. Grade (%)	1.0%	1.0%	1.0%
Max. Grade (%)	6.0%	6.0%	5.0%
Max. Grade for Through Roads at Intersections (%)	3.5%	3.0%	3.0%
Max. Grade at Stop Roads at Intersections (%)	2.5%	2.0%	2.0%
Intersection Angle (degrees)	80 to 90	80 to 90	85 to 90
Min. Tangent Length approaching intersections	20	20	30
Cul-de-sacs ROW Pavement	 18.0 m Radius 13.0 m Radius		

Geometric Detail	Local Road Industrial/Commercial Crescents and Cul-de-sacs	Minor Collector Industrial/Commercial	Major Collector Industrial/Commercial
Min. ROW (m)	26	26	26
Design Speed (km/hr)	60	60	60
Posted Speed (km/hr)	50	50	60
Min. Visibility Curves in Sag (K)	12	15	15
Min. Visibility Curves on Crests (K)	8	12	12
Min. Horizontal centreline Road Radius (m) **	110	160	160
** Except at 90° corners at crescents and courts, unless otherwise required for traffic calming.			
Pavement asphalt Width (m) Industrial	9.25	11.0	14.0
Sub-grade cross-fall	3%	3%	3%
Pavement cross-fall	2%	2%	2%
Min. Grade (%)	0.75%	0.75%	0.75%
Max. Grade (%)	6.0%	6.0%	5.0%
Max. Grade for Through Roads at Intersections (%)	3.5%	3.5%	3.0%
Max. Grade at Stop Roads at Intersections (%)	2.0%	2.0%	1.5%
Intersection Angle (degrees)	80 to 90	80 to 90	85 to 90
Cul-de-sacs ROW Pavement	 20.75 m Radius 15.0 m Radius		

C.3. ROAD PAVEMENT DESIGN

The following table summarizes the minimum requirements for pavement structure for different road classifications:

	Top Course Asphalt	Binder Course Asphalt or Concrete Base	Granular "A" (mm)	Granular "B" (Type II) (mm)
RESIDENTIAL ROADS (RURAL AND URBAN)				
Local	40mm Superpave 9.5, (Traffic Category C), PG 58-28 asphalt cement	80mm Superpave 19.0, (Traffic Category C), PG 58-28 asphalt cement	150	300
Collector	40mm Superpave 9.5, (Traffic Category C), PG 58-28 asphalt cement	100mm Superpave 19.0, (Traffic Category C), PG 58-28 asphalt cement in two lifts	150	300
COMMERCIAL/INDUSTRIAL ROADS				
Local	50mm Superpave 12.5 FC1, (Traffic Category D), PG 58H-28 asphalt cement	110mm Superpave 19.0, (Traffic Category D), PG 58H-28 asphalt cement, in two lifts	150	375
Collector	50mm Superpave 12.5 FC1 or FC2, (Traffic Category D), PG 58H or V-28 cement	110mm Superpave 19.0, (Traffic Category D), PG 58H-28 asphalt cement, in two lifts	150	450
ARTERIAL ROADS				
Arterial	50mm Superpave 12.5 FC1 or FC2, (Traffic Category D or E), PG 58H or V-28 asphalt cement	110mm Superpave 19.0, (Traffic Category D or E), PG 58H or V-28asphalt cement, in two lifts	150	450

The final asphalt course on any roadway shall not be placed until:

- Written approval from the Development Engineering Section is received;

- A minimum of one year has passed after the placement of the binder course asphalt;
- At least 80% of the dwellings in the land are constructed;
- Deteriorated base asphalt and/or granular base and concrete curbs and gutters have been repaired and/or replaced to the satisfaction of the City; and,
- The base course shall be power swept and/or power flushed and free of mud and debris.

When the surface course is to be placed on a previously laid binder course a tack coat shall be applied immediately prior to placing the surface course asphalt.

Generally, surface course asphalt shall not be placed before the first day of May or later than the first day of November. Any deviation of this date shall require the prior approval of the Manager of Construction (Growth Management Division). Use of warm mix asphalt is strongly encouraged.

C.4. TRAFFIC CALMING / CLOSURES

C.4.1. Road and Lane Closures

Any anticipated road and lane closures required for underground or above ground works shall be identified by the Engineer at the initial submission of the Engineering drawings.

The Development Engineering Section shall confirm the feasibility of road and lane closures and any requirements that are necessary, including temporary works, the preparation of detour routes and sign boards, and notification. The approval of a road closure is subject to the approval of the General Manager, Public Works. The cost of implementing a road closure shall be borne by the Proponent.

C.4.2. Traffic Calming

The intent of traffic calming measures is to improve the well-being of the community, the environment, and the economy.

As a requirement of final clearance, the Engineer may be required to incorporate traffic calming methods in the design of the roadways. Traffic calming measures shall be discussed on an individual basis with the City Planning and Economic Development Department as early in the application process as possible and discussed in Traffic Impact Studies.

The subject roadway must be a local or minor collector roadway. All traffic calming measures proposed should be identified and recommended within the Traffic Impact Study for the project site. The Proponent should refer to the City of Hamilton Policy PW07150a for needs and justification and appropriate methods of Traffic Calming.

When traffic calming is to be implemented, the following general guidelines should be adopted:

- "Through traffic" should be deterred from local streets and routed to major collectors and/or arterial roads;
- Traffic calming features should be included where the roadway(s) are within in 200 m of a school or park (i.e. raised crosswalks, bump outs, speed humps);
- Emergency vehicle access must be preserved; and,
- Automobile access should be maintained on all streets. Neighbourhood traffic calming projects should encourage and enhance pedestrian, bicycle and transit access to neighbourhood destinations.

All traffic calming measures proposed shall be in compliance with the Transportation Association of Canada (TAC) Manual and will be subject to City approvals.

C.5. ROUNDABOUTS

A roundabout is a type of circular intersection at which traffic enters a one-way stream around a central island incorporating splitter islands at each leg of the intersection. The splitter islands guide traffic into and out of the roundabout and provide a refuge for pedestrians. Its primary functions are for traffic calming, allocation of right-of-way and increased traffic capacity. Generally, roundabouts are used to connect collectors and/or arterial roads; however, in some instances they can be used at the junction of a local road with a collector or arterial road.

The City of Hamilton's "Installation of Modern Roundabouts Policy, 2008" states that if new signals are being considered for an intersection, the potential for a roundabout must also be examined. Reference to this policy shall be made with regards to screening criteria.

Modern roundabouts will be installed wherever possible, where a study confirms they are feasible, appropriate and advantageous in terms of traffic flow, traffic safety, community design functions or environmental considerations, under the following conditions:

- Capacity or safety problems have been identified at existing intersections necessitating substantial improvements;
- Traffic signals or all-way stops are warranted or expected to be warranted in the near future at existing or proposed intersections;
- As part of a larger capital project, suitable intersections are identified as potential sites; and,
- When, through planning approvals, new intersections are to be created.

Additional design and procedure information can be found in NCHRP Report 672 - Roundabouts: An Informational Guide prepared by the National Cooperative Highway Research Program (NCHRP). All designs for proposed roundabouts shall be in compliance with the NCHRP Report 672. For typical layout of a roundabout intersecting collector roads refer to Figure C-1. All roundabouts shall include provision for an irrigation system including but not limited to the water service and electrical service. All roundabouts shall be landscaped. Colorado Spruce is the preferred option when

planting evergreen trees. Additionally all plant materials shall be salt tolerant. Clump plantings shall comprise of one species. Soil depth in planting shall be 300mm-500mm.

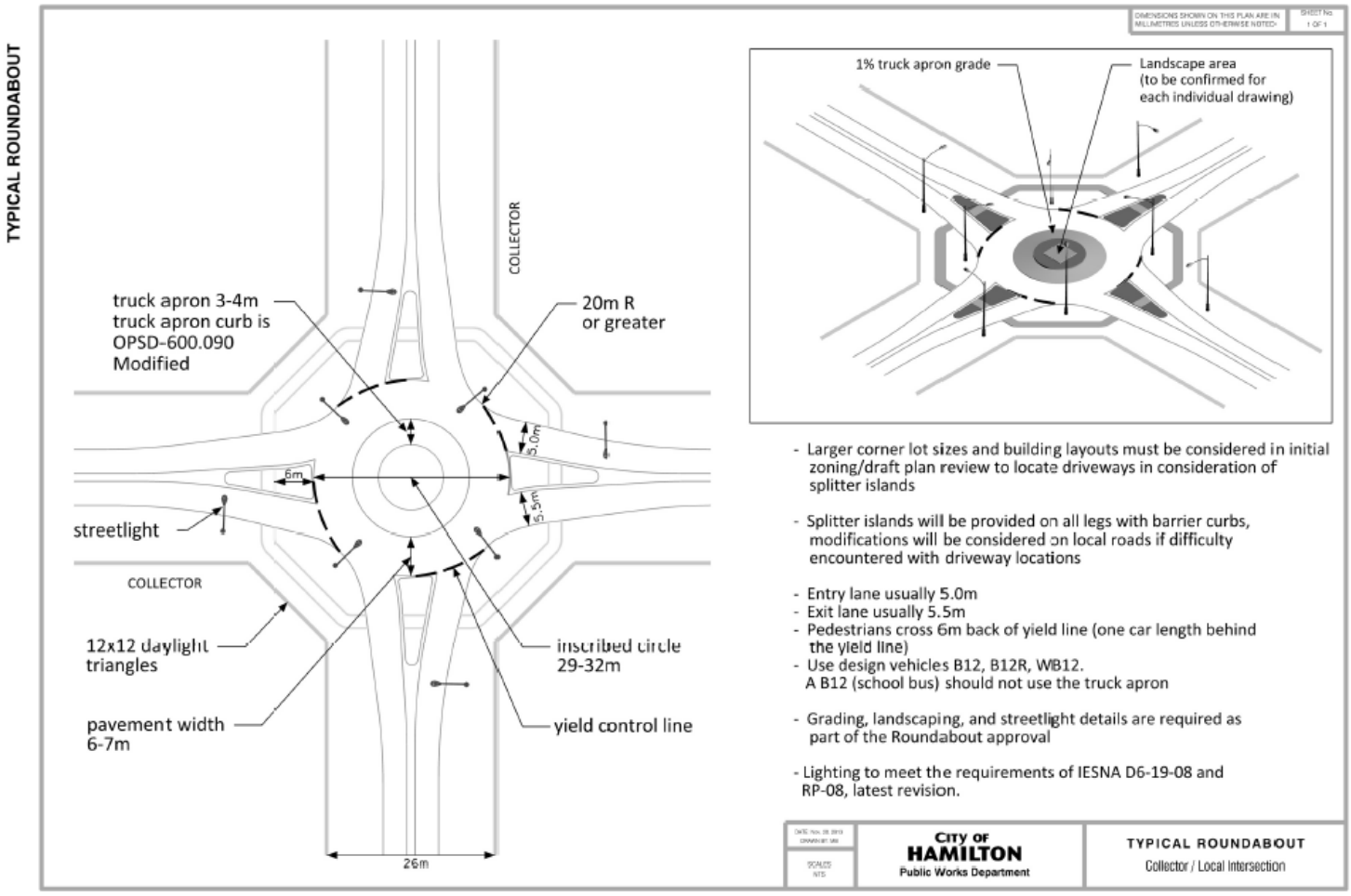


Figure C-1 Typical Roundabout RIGHT-OF-WAY CROSS SECTION

Right-of-way cross sections for municipally assumed roads shall conform to standard drawings from the Construction & Material Specifications Manual.

C.6. ROAD SUBDRAINS

Subdrains shall be installed continuously below the curb unless soil conditions warrant otherwise. Any request for reduced subdrain installation shall be accompanied with a geotechnical report outlining the soil conditions and what impact the reduction of subdrains shall have on the life of the pavement.

C.7. DAYLIGHT TRIANGLES AND ROAD WIDENING

The City has adopted through its Official Plan designated road allowance widths which accommodates space for vehicular, pedestrian, transit and cycling movements, and utilities. A road allowance widening is an acquisition of land adjacent to an existing road when added to its present road allowance establishes its designated road allowance

width as stated in the City's Official Plan. Land required for road allowances are typically a requirement of development approval as a condition of Site Plan, Consent, or Plan of Subdivision.

The Official Plan also requires the conveyance of property for appropriate daylight triangles and corner rounding on existing roads when a property is to be developed or redeveloped, as a condition of site plan approval, consent, or plan of subdivision approval. In accordance with City Standards based on the intersecting roadways of the functional road classification, daylight triangles at intersections shall generally be as follows:

- Local to local roads: 4.5 m x 4.5 m triangle;
- Collector to local or collector Roads: 9 m x 9 m triangle;
- Arterial to collector or arterial (Urban): 12 m x 12 m triangle; and,
- On various major road corridors 15 m x 15 m triangles are required.

C.8. CURBS

All roadways shall be constructed with barrier curb and gutter (OPSD 600.040 or OPSD 600.070) in accordance with current City Standards.

In the event that weather conditions do not permit concrete curb and gutter construction, a wider paved roadway will be permitted. The width of the roadway shall be extended a minimum of 0.5 m on each side. The cross section of the widened pavement shall conform to the cross section of the roadway. Curb and gutters shall be constructed within one year of the completion of the binder course asphalt. A minimum of 1.0 m of the paved roadway shall be removed upon installation of the curb and gutter (i.e. minimum 0.5 m asphalt repair adjacent to curb and gutter) and binder asphalt placed to the specified thickness.

Curb depressions are required at every driveway and at each intersection for wheelchair ramps. Curbs shall not be cut by mechanical means to provide a curb depression. Temporary curb cuts provided during construction of dwellings using mechanical means shall be removed prior to installation of final asphalt course and replaced with a proper driveway curb depression. Should any driveway depressions be improperly located, then repairs may be made by removing those sections and replacing them with required curb and gutter sections. The concrete capping of a depressed curb shall not be permitted.

Generally, concrete curbs and gutters shall not be placed after November 15th. Any deviation of this date shall require the prior approval of the Manager of Construction (Growth Management Division).

C.9. BOULEVARDS

All boulevards areas will be sodded with No. 1 nursery sod including a minimum thickness of 150 mm preferred of topsoil. The topsoil shall be screened clear of all stones in excess of 25 mm, debris and woody material and shall be free of noxious

weeds, etc. to the satisfaction of the City. The topsoil overlaid with sod will provide a total topsoil / turf thickness of approximately 175 mm and maintain a 2% cross-fall within the boulevard.
Sod shall comprise Fine Fescue / Kentucky Bluegrass nursery sod containing 60% - 70% Kentucky Bluegrass and 30% - 40% Creeping Red, Chewings or Hard Fescue as specified by the Nursery Sod Growers Association of Ontario (NSGAO). Sod shall be placed with sufficient density such that surface soil is not visible and shall be placed to match existing adjacent elevations at all edges. All sod shall be machine rolled after placement.

C.10. SIDEWALKS

Concrete sidewalks shall conform in composition and dimensions to the City of Hamilton Construction and Material Specifications Manual and the current Ontario Provincial Standards. The sidewalk width shall be in accordance with the City's Pedestrian Mobility Plan, Table 16 - Context Area Sensitive – Recommended Sidewalk Clear-Zone Widths, with maximum cross-fall of 2%. Refer City of Hamilton Standard Drawing RD-103. In no instance should sidewalk widths be less than 1.5 m.

Sidewalks are required on both sides of all roads in accordance with City Policy and Hamilton Pedestrian Mobility Plan.

Generally, concrete sidewalks shall not be placed after November 15th. Any deviation of this date shall require the prior approval of the Manager of Construction.

C.10.1. Sidewalk Transitions

On continuation of existing streets where sidewalks have already been installed at a different location, the City's Development Engineering Section shall be consulted to determine the off-set from the curb and transition between sidewalks. Proponent must comply with the most current wheel chair ramp and curb ramp requirements and include tactile warning surfaces

C.10.2. Private Sites

Sidewalk design for private sites shall incorporate the following design elements:

Barrier-Free Design and Urban Braille

- Sidewalks shall have a minimum 1.5 m unobstructed width to allow for people in wheelchairs to move easily and for snow accumulation in winter months;
- Pedestrian routes shall be level and have non-slip and non-glare textured surfaces. It is preferable to have grades on pedestrian routes between 1% and 3%;
- Pedestrian crossings shall be flush with the adjoining sidewalk and marked with bright white lines or made with contrasting materials and colours;
- Ramped curbs and ramped building entrances should be avoided and minimized through attention to grade changes in site design;

- Ramps shall be provided to Ontario Building Code requirements where grade changes cannot be avoided. A clear pathway shall be provided with handrails and a non-slip surface;
- Shall be constructed with 125 mm Concrete and 150 mm Granular 'A' base; and,
- Sidewalks shall be constructed as per City of Hamilton Standard Drawing RD-103 and shall comply with the City's Barrier Free Design Guidelines.

Site Circulation

A well-defined and continuous pedestrian system shall be developed on each site with connections to the public street, parking areas, surrounding buildings and pedestrian amenity areas. Primary pedestrian connection shall be distinguished from secondary pedestrian connections through such measures as differing sidewalk widths and paving materials.

Multiple Units

Sidewalks shall typically be included along both sides and at minimum one side of the internal road and lead to the municipal sidewalk.

Refer to City of Hamilton Site Plan Guidelines, 2003 for more information.

C.11. WALKWAYS

Public walkways shall be identified at the time of draft plan of subdivision and shall be conveyed to the City as a public highway. They shall be constructed within the limits of the project by the Proponent. The minimum width of a public walkway right-of-way shall be 6m.

Walkways typically shall consist of a 2.0 m wide concrete sidewalk centered in the walkway right of way. Remaining portions between the sidewalk and fence shall be sodded. If the walkway also acts as a major overland flow route and/or access to a SWM facility, requirements, including right-of-way width, shall be to the satisfaction of the City.

All public walkways shall have a 1.5 m high black vinyl coated heavy duty commercial grade (9 gauge metal) chain link fence placed 100 mm inside the City property line. Separating the walkway from private property, in accordance with OPSD 972.130 with a mesh size of 38 mm where it abuts single family dwellings.

Vehicle barriers shall be installed at each end of the public walkway as per City and Public Works Department Standards to discourage vehicular traffic through the walkway. The vehicle barrier would be a bollard. Generally, there are two bollards at each end of the walkway.

Walkway lighting, where required, shall be designed and installed in accordance with Appendix R – Sidewalk and Roadway Lighting Guideline.

C.12. MULTI-USE TRAILS

Development Guidelines and Maintenance Standards for multi-use trails are provided in the Hamilton Recreational Trails Master Plan with focus on 2.3 Trail Design Construction Considerations, 2.7 Trail Hierarchy and Surfacing, and 3.4 Managing Trails and Maintenance Expectations. These standards are intended to apply to City of Hamilton sponsored and co-sponsored "off-road" multi-use recreation trails. Where trails are operated by Hamilton trails systems partners, the standards which apply will be those developed and approved by that partner. The partners will be encouraged to utilize the City of Hamilton standards where appropriate to ensure integration of both systems.

The Proponent has the option to design, Engineer and construct all Multi-use trails, including finished surfacing, which have been identified in the approved Draft Plan of Subdivision.

Multi-use trails shall be graded and constructed for that stage of the subdivision by the Proponent within one year of registration or servicing whichever occurs first.

The Proponent shall ensure that all tree protection fencing and siltation control fencing is located in such a manner as will allow the grading, construction and surfacing of the Multi-use trails as an integral part of the subdivision grading process.

- All detailed grading and construction details for Multi-use trails shall be approved by the City;
- Multi-use trails are primarily a recreational facility but can be used as a non-vehicular traffic route providing city wide, off road transportation routes for walking and cycling;
- Multi-use trails shall be fully accessible and barrier free where possible;
- Multi-use trails connect parks and open space within subdivisions and provide connections to other neighbourhoods of the city;
- Multi-use trails also serve as maintenance vehicle access routes through parkland; and,
- These trails shall be located throughout the City, including Parks, Stormwater management lands or other lands which facilitate the development of the city wide community trail system. Trails shall be identified for all new development, as approved by the City.

The trails shall be designed in accordance with the following requirements:

Grade

- 5% maximum (8% may be allowed for limited distances of steep slopes); and,
- Primary accessible trail routes shall be 5% maximum.

Cross Slope

- 2% preferred;
- 2% maximum where trail grade exceeds 4%, and,
- 4% maximum.

Width

- Class A – trail width of 6.0 m;
- Class B – trail width of 3.0m to 4.0 m;
- Class C – trail width under 2.0 m; and,
- 1.0 m grassed shoulder shall be provided on either side of the trail.

Excavation

The existing topsoil layer shall be removed to the depth required to reach underlying granular or other soils which can be compacted to a minimum of 95% Standard Proctor Density. A minimum excavation depth of 300 mm is required to provide for granular base course material installation. Soil deemed unsuitable by the City shall be removed to additional depths as required and replaced with Engineered fill, compacted to 95% Standard Proctor Density. Excavation shall not be permitted in woodlands or other areas where damage to tree roots or other vegetation would occur in accordance with applicable approvals. Filling ~~only~~ with an approved trail surfacing detail may be acceptable in some unique scenarios and will be considered on a case by case basis.

Drainage

Concentrated surface runoff shall not be directed across or along the trail surface. Swales or culverts shall be provided within the trail corridor.

Surfacing

Trail surfaces have been classified in three categories as follows:

- Type 1 – asphalt concrete (Year-Round Use);
- Type 2 – granular/limestone on granular (Seasonal Use); and,
- Type 3 – native soil/woodchips (Seasonal Use).

Typical Pavement Designs (Design Guide for Bikeways, Page 14)

Table C.2- Multi-Use Trail Design Table

Type 1	Type 2
50 mm HL3 asphalt 150 mm Granular 'A' 150 to 300 mm Granular 'B' as required OR 100 mm Concrete 100 mm Granular 'A'	40 mm limestone screening 100 mm Granular 'A' 300 mm Granular 'B' as required OR 2 aggregate lifts on surface treatment binder 100 mm Granular 'A' 150 to 300 mm Granular 'B' as required

Signage

All Multi-use trails shall be provided with signage acceptable to the Public Works Department.

Barriers

Short staggered swing gates and standard park gates are required at all intersections with roadways or other vehicle routes to control traffic and promote user safety.

C.13. PRIVATE ROADS

When private roads are required which will not be dedicated to the City in the future, the following standards shall apply:

The following minimum standards apply to private road pavement structures:

Table C.3- Private Road Design Table

	Residential	Commercial
Asphalt	40 mm Surface Asphalt 50 mm Binder Asphalt 300mm Granular 'A' base	40 mm Surface Asphalt 100 mm Binder Asphalt 300 mm Granular 'A' base
Concrete	125 mm Concrete 150 mm Granular 'A' base	200 mm Concrete 150 mm Granular 'A' base

Geotechnical report recommendations will supersede the above minimum standards only in the event that recommendations are equivalent to or greater than the above minimum pavement structures.

Drainage shall be intercepted in advance of the public right-of-way.

Fire Access

The geometric design of private roads shall conform to standards set out in the Ontario Building Code. Specifically with respect to fire access, the following key parameters can be found in Section 3.2.5.6 “Access Route Design” of the Ontario Building Code:

A portion of a roadway or yard provided as a required access route for fire department use shall:

- Have a clear width not less than 6 m, unless it can be shown that lesser widths are satisfactory;
- Have a centerline radius not less than 12 m;
- Have an overhead clearance not less than 5 m;
- Have a change of gradient not more than 1 in 12.5 over a minimum distance of 15 m;
- Be designed to support the expected loads imposed by firefighting equipment and be surfaced with concrete, asphalt or other material designed to permit accessibility under all climatic conditions;
- Have turnaround facilities for any dead-end portion of the access route more than 90 m long; and,
- Be connected with a public thoroughfare.

All standards of the Ontario Building Code shall apply to the design of private roads and compliance with all elements of the Ontario Building Code is required for private road design.

Emergency Access is not considered to be a suitable secondary access.

Waste Collection

In order to receive municipal waste collection service, private roads in the City must be a minimum of 6.0 m wide and have the necessary road surface strength to accommodate waste collection vehicles. Road layout must be designed to permit the continuous forward movement of collection vehicles, including the radius of a cul-de-sac turning circle. Collection vehicles will not operate in reverse to collect waste from individual stops.

The Proponent is to employ all means reasonable to accommodate municipal waste collection to the proposed development. Municipal waste collection requirements and minimum standards can be found in the Solid Waste Collection Design Guidelines for Developments. The site function accommodating waste collection vehicles must be proven utilizing AutoTurn or similar software. In addition, all city by-laws and provincial regulations must be adhered to.

C.14. BIKE LANES (DELINEATED ON ROAD)

Bicycle lanes shall have the same structural standard as the road base. Bicycle lanes have a variety of design consideration including buffers, marking options, etc. For typical cross-section refer to Ontario Traffic Manual Book 18.

For additional details relating to bike lane design and planned routes refer to the City of Hamilton Cycling Master Plan.

C.15. CUL-DE-SACS

The maximum number of dwelling units that will be allowed to be serviced with one road access is 100. If a proposed plan of subdivision is for more than 100 dwelling units (including potential units in multi-residential blocks). A road providing secondary access shall be provided to the satisfaction of the City.

The minimum gutter grade is to be 0.75%. The design road grade on the cul-de-sac shall be such that the drainage is directed away from the end of the cul-de-sac and towards the beginning of the bulb area unless otherwise approved by the City. If this is not achievable, Proponent needs to outline the rationale and submit with the first engineering submission.

All cul-de-sac construction works that are temporary in nature are to be constructed to a permanent standard.

For details and specifications regarding cul-de-sacs, refer to Section C.2 - Geometric Standards.

All local roads which permanently terminate at one end (dead end streets) shall be provided with a turning circle (cul-de-sac) of sufficient area to enable the turning of garbage trucks, snow removal equipment and emergency vehicles. For residential purposes, an 18.0 m minimum radius is required for road allowance with a minimum pavement radius of 13.0 m. For industrial and commercial purposes, a 20.75 m minimum radius is required for road allowance with a minimum pavement radius of 15.0 m.

For typical layouts refer to City of Hamilton Standard Drawings RD 116.01-116.04.

C.16. INTERSECTIONS & PEDESTRIAN CROSSINGS

In accordance with the Barrier – Free Design Guidelines (Sections 6.5 and 5.1.5), wherever possible, crosswalks shall have suitable wheelchair curb ramps at each end of the crosswalk as per OPSD 310.030. In addition, tactile warning strip requirements at wheelchair curb ramps are required as per the Ontario Traffic Manual, Book 15.

The crosswalk shall not contain maintenance hole covers, storm gratings or other obstacles that limit free movement and where catch basins are necessary they should be positioned wherever possible on the upstream side of the crosswalk.

Pedestrian crossings shall be designed in accordance with the Ontario Traffic Manual, Book 15.

C.17. ON-STREET PARKING REQUIREMENTS

New residential development shall provide adequate, convenient on-street parking within the right-of-way for all residences with direct access, while ensuring road safety, in accordance with the following criteria.

The Proponent shall submit an On-Street Parking Plan for all lots or blocks within the plan intended for street-fronting residential development. Submission of the On-Street Parking plans are subject to the following timing:

- Prior to Draft Approval (part of what's deemed as a Complete Submission); and,
- Post Draft Approval (the final parking plan is approved as part of approval of the Engineering submission).

Temporary signage shall be erected by the Owner prior to first occupancy to indicate the locations of all on-street parking restrictions on all municipal streets.

Number of On-Street Parking Spaces

The number of parking spaces shall reflect land use efficiency. It shall be of a minimum ratio of 0.4 parallel on-street parking spaces for every one residential unit and for each phase of development, while providing reasonable walking distance. Parking space plans shall be disclosed and provided at the draft plan stage. Consideration will be given to adjusting the minimum ratio when there are double wide driveways for single family dwellings.

Location of On-Street Parking Spaces

Parking spaces should be located at the prescribed ratio in accordance with the following to ensure road safety and efficient land use:

- Within the street block containing the units and/or on either side of an abutting intersection street within the flankage of the corner lot;
- On one side of the street only;
- A minimum of 0.5 m setback from either side of the driveway ramp / curb opening;
- A minimum of 9 m from an intersection (15 m where there are traffic signals), as measured from the point of intersection formed by the projection of the curb lines or edges of pavement where there is no curb;
- Not permitted across from a "T" intersection;
- Not permitted within 1 m of a bus stop;
- Not permitted within 3 m of a fire hydrant;
- Not permitted along school frontages;

- Not permitted along park frontages; and,
- Not permitted in front of a midblock pedestrian walkway or trail which continues on the opposite side of the street.

Size of On-Street Parking Spaces

On-Street parking spaces shall be shown in accordance with the following:

- The width of each parking space shall be 2.4 m;
- Where there are two or less tandem parking spaces provided, the length of each on-street parking space shall be 5.5 m; and,
- Where there more than two tandem parking spaces provided, the length of each internal on-street parking spaces shall be 6.7 m.

Alternatives to the Provision of On-Street Parking

In cases where the required parking cannot be achieved, the following alternatives will be taken in consideration:

- Increasing lot size;
- Increasing the length of driveways (may include lots with detached garages);
- More high-density development with its own parking facilities;
- Community parking area;
- Proximity to transit; and,
- Walkability.

C.18. TRAFFIC CONTROL – SIGNS & PAVEMENT MARKINGS

C.18.1. Street Name Signs

The Owner shall pay the cost of all street name signs required for each street intersection created by registration, or stage of registration, of the Draft Plan. The City shall supply and erect all street name signs at locations satisfactory to the City.

C.18.2. Signage

The City of Hamilton shall install all signs on all roads within the City. The Proponent will be required to make cash payment for signs in the Subdivision Agreement.

The 2017 fees are $1,600.00 per intersection for all way stop signage. For a neighbourhood traffic circle the fee is $7,500.00 and for single lane roundabouts the fee is $15,500.00. These fees are subject to change without notice. The fees include both traffic and nameplate signs.

C.18.3. Open Space Signs

Open Space signs shall be provided as required in conformance with the Parks & Open Space Development Guide.

C.18.4. Pavement Markings

Unless otherwise agreed to by the City, the Proponent is responsible for all costs associated with design (base road surveying, Engineering, traffic signal design and pavement marking) and construction of intersections controls for development related projects.

C.18.5. Traffic Signals

The City's Traffic Signals Systems staff, will supply and install signal hardware including signal utility poles, signal heads, arms, controller, wiring, pavement markings and signs. The cost of this labour and materials is the applicant's responsibility.

For subdivision requiring the design of traffic signals and pavement markings the consultant retained shall be to the satisfaction of the City's Public Works Department and will be responsible to complete the design submission to approximately 85% completion at which point the City staff will finalize the design. Pavement markings shall be prepared to the satisfaction of the Manager of Traffic Operations and Engineering.

Refer to City of Hamilton Traffic Signal and Pavement Marking Design Drawings (2009).

C.19. DRIVEWAY ENTRANCES

Driveway aprons shall be concrete throughout the subdivision.

Driveway curb depressions shall be built to accommodate the driveway width plus 0.45 m on each side of the driveway measured at the gutter line. The maximum width of the curb depression, measured at the gutter line, shall be 4.5 m for a single driveway and 7.0 m for a double driveway.

The maximum permissible design grade for any driveway shall be 7.0%. The minimum driveway grade shall be 2.0%.

The following minimum standards apply to driveway entrances within the Municipal Right-of-Way:

Table C.4- Driveway Apron Design Table

	Residential	Commercial
Concrete	125 mm Concrete 150 mm Granular 'A' base	200 mm Concrete 150 mm Granular 'A' base

The above standards shall be provided at all driveway entrances located within the Municipal Right-of-Way unless otherwise specified in a geotechnical report. Geotechnical report recommendations will supersede the above minimum standards

only in the event that recommendations are equivalent to or greater than the above minimum pavement structures.

Driveway entrances to multi-family blocks and commercial entrances shall be in accordance with City access permit requirements and shall be asphalt as per City Standard Drawings. Non-residential driveway approaches shall have:

- A depressed curb along the road and the entire width of the approach;
- Sidewalks shall be poured through the driveway approach;
- Concrete curb returns on the sides of the asphalt approach are not permitted in the road allowance; and,
- Minimum 6.0 m curb return radius.

On arterial roads that have not been constructed to the ultimate urban cross-section at the time of approval of the Engineering drawings, there shall be a provision for the installation of a driveway culvert at the roadside ditch. The minimum length of driveway culvert shall be 9.0 m for single driveways and 11.0 m for double driveways and the minimum diameter shall be 450 mm.

Sidewalks are poured through driveways unless it is a signaled intersection. Driveways must not be located within intersections or possible crosswalk locations.

Refer to standard drawings RD-106 – RD-109.

C.20. NOISE ATTENUATION

C.20.1. Requirements for Approval of Noise Attenuation

Where it is a requirement of final clearance of the Draft Plan for the Owner to undertake a noise study for submission to, and approval by the City, and where an approved noise study requires mitigation measures that will affect the grading of the Land, the Owner shall include the specific measures to be implemented on the Final Grading Plan.

All Noise Studies shall be prepared by a qualified noise consultant, who upon request by the City, may be required to demonstrate the following:

- Demonstration of thorough knowledge/understanding of MOE-CC NPC-300 requirements (e.g. certificate showing that the individual has successfully completed a Ministry of Environment (MOE-CC) course in Acoustical Technology in Land Use Planning, or its equivalent);
- Sample of three substantive Noise Studies completed by the individual within the last two years, preferable for sites in the City of Hamilton, demonstrating knowledge of appropriate study content, calculation methods, and noise attenuation recommendations;
- Thorough knowledge of the Noise Assessment Policy for Roads;
- Proof that the individual is a Professional Engineer (P. Eng.), or Registered Professional Planner (R.P.P.); and,

- Proof of Professional Liability Insurance carried by the consultant in an amount satisfactory to the City, as amended from time to time.

It is the responsibility of the individual consultant to advise the City of any change in status related to the above qualifications.

Where the requirement for a Noise Study is identified a traffic volume forecast shall be based on a minimum forecast of ten years after the construction of the development, with the intent being ten years post occupancy of the homes impacted by road noise.

A Noise Study shall include the following:

Table C.5- Noise Study Report Requirements

Required Item:	Required Content:
Title Page	▪ details of Proponent ▪ location of site ▪ development application reference number(s) for the site ▪ "Prepared by" (including signature) ▪ qualification to submit report (e.g. P.Eng.)
Table of Contents	▪ list of sections ▪ list of figures and tables ▪ list of appendices, which should include: General Procedures and Adjustments, Sample Sound Calculations, Road Traffic Data / Level of Service Volumes
Introduction	▪ purpose of study ▪ location of site ▪ development application reference number(s) for the site ▪ brief description of the proposal including lot layout, lot numbers, and unit numbers ▪ surrounding / abutting land uses ▪ overview of physical features ▪ identification of all potential noise sources (the noise consultant is responsible for confirming the noise sources identified by the City at the Formal Consultation Meeting and identifying any additional sources) ▪ scaled plan showing all noise sources noted above
MOE-CC Criteria	▪ sound level criteria as noted MOE-CC Publication NPC-300 Noise Assessment Criteria in Land Use Planning (for OLA's and indoor areas)
Detailed Noise Analysis	▪ all assumptions used in the Noise Study to calculate noise levels (traffic data, posted speed, # of lanes, etc.) ▪ noise prediction method (e.g. follow MOE-CC requirements) ▪ a table and a concise summary of predicted noise levels for outdoor and indoor living areas at appropriate

Required Item:	Required Content:
	receiver locations (shown on plan) with and without noise mitigation ▪ recommendations concerning the need for noise attenuation measures, such as, noise barriers, central air, forced heating and other building components, as required by unit / block ▪ recommendations concerning of the need for noise warning clauses
Assessment of Non-Barrier Alternatives (if required)	▪ identification and assessment of non-barrier alternatives ▪ rationale for proposing non-barrier methods
Noise Mitigation Requirements (if proposed)	▪ If a barrier is proposed for noise attenuation: ▪ rationale for proposing a noise barrier instead of non-barrier alternatives ▪ economic, planning and Engineering justification for the use of a wall or berm ▪ barrier height table ▪ typical and worst-case cross-sections, at an appropriate vertical and horizontal scale, which clearly show the barrier, the noise source, the noise receiver, and property limits ▪ cross-sections must clearly show that the proposed noise wall ▪ a plan of the area subject to noise attenuation measures, showing location of cross-sections, final grades, and elevations of the edge of pavement, noise source, noise receiver and noise attenuation features ▪ drainage details that could affect the implementation of noise control measures ▪ specification of the type, surface density and location of the proposed barrier ▪ consideration of the impact on existing trees from construction of a noise wall or berm (e.g. damage to root zone, trees destroyed) and reference to a related Tree Saving Plan ▪ If indoor noise attenuation measures are proposed: ▪ provide building component, acoustic insulation, window glazing tables
Warning Clauses (if required) NPC300	▪ If required, provide recommendations for the inclusion of warning clauses on title (as per standard wording as provided in Section 14.1 in the MOE-CC Publication Noise Assessment Criteria in Land Use Planning: Requirements, Procedures and Implementation (October 1997) or any amendment thereof.
Implementation Requirements	▪ dictated through the approval process ▪ may entail a certification from the noise consultant that the required noise mitigation measures are in the

Required Item:	Required Content:
	building plans and are installed appropriately
Conclusions and Recommendations	▪ summary of all recommendations required for noise attenuation ▪ statement indicating the feasibility of the implementation
Figures	▪ Figure – location of site ▪ Figure – plan, subdivision / site plan ▪ Figure – identify site in relation to noise control lines for John C. Munro Hamilton International Airport ▪ Figure – identification of receptors, proposed mitigation (noise barriers) on subdivision plan / site plan that includes proposed final grading details ▪ Figure – details of noise barrier (s) / cross-sections

When the need for a Noise Study is identified, a minimum of four copies of the noise study shall be submitted by the Proponent.

When the Noise Study is considered acceptable by the City, the owner / applicant will be notified and the appropriate conditions will be identified by City staff through the development application approval process.

The recommendations of an approved Noise Study submitted prior to registration of a Plan of Subdivision will be considered relevant for three years. If the subdivision plan is not registered within that time, the Proponent will be responsible for re-evaluating noise levels using current data and updating the Report prior to registration.

C.20.2. Noise Barriers

Noise barriers shall be implemented as a condition of development approval and supported by the completion of an approved noise study in accordance with MOE-CC requirements. Noise barriers can be constructed with earth berms (preferable), walls / fences, or a combination of the two. If the required height of the barrier exceeds 3 m, it is recommended that a berm / wall combination be used. Material specifications for noise control require that the minimum surface density be 20kg/m3 be of continuous construction and be free of gaps and cracks within or at the ends.

Barriers required as a condition of development approval adjacent to the LINC or Red Hill Valley Expressway must be constructed using Durisol brand barriers if walls are being proposed; whereas walls adjacent to provincial freeways must be a concrete type of material. Noise barriers abutting other City roads can be made of wood.

Noise barrier design shall consider the materials used in adjacent developments along the corridor.

All noise barriers with the exception of barriers along the LINC and Red Hill Valley Expressway shall be placed on private property.

Recognizing the complementary function of noise barriers (i.e. for privacy), a minimum effective noise barrier height of 1.8 m shall be required by the City, unless otherwise approved.

The following criteria shall be used to determine the location of a noise barrier unless otherwise justified:

- Where the noise barrier is a wall, it shall be located entirely on private property;
- Where the noise barrier is a berm or a berm / wall combination, it will be located entirely on private property, unless otherwise approved by the City;
- Side slopes of berms adjacent to a roadway will have a boulevard side slope no steeper than 3:1 (horizontal : vertical) unless otherwise approved by City staff, and,
- Where noise attenuation structures are interrupted, such as in the case of a walkway and/or property line, staggering of the barrier and/or barrier returns are required with a minimum two to one length to opening ratio.

The materials, design and detailed location of any proposed barrier shall be to the satisfaction of the City. Environmental Services Division, Public Works Department shall approve all plant material and irrigation systems.

Where a noise wall(s) is to be located adjacent to the Redhill Valley Parkway or the Lincoln M. Alexander Parkway, it shall be located within the City road allowance and shall be of a concrete type material.

Where a noise wall(s) is located adjacent to a Provincial highway, the noise wall shall be of a concrete type material.

A noise barrier(s) shall be installed prior to occupancy to the satisfaction of the City, unless otherwise approved.

C.21. ENTRANCE FEATURES

Entry features shall be implemented according to any relevant Secondary Plans, Neighbourhood Guidelines, and/or other Area Specific Guidelines. A Proponent may submit for approval a design proposal for entrance features which may consist of walls, gates, fences, trees, shrubs, flowers and other related components. The Proponent will be required to enter into an Agreement with the City for the construction and maintenance of entrance features within the Subdivision Agreement. Such Agreement shall include perpetual maintenance fee to reflect future costs. It is highly recommended to install entry features on private property.

The Proponent shall maintain the entrance feature indemnifying the City for all claims until the development has been assumed or as otherwise specified in the Agreement.

The Proponent shall provide a payment for perpetual maintenance fees and securities in accordance with the Subdivision Agreement for entrance features on public land.

The City reserves the right to remove all or any element of the entrance feature at its discretion.

Entrance features shall be located within the public road allowance in centre median islands, or on private property where located adjacent to daylighting triangles. The features shall be designed to maintain proper sight distances and turning movements at driveway assesses and intersections. The design of the entrance shall be submitted for approval to the City.

All tree planting for entrance features will meet all tree and soil habitat zone requirements identified in the Forestry By-Laws pertaining to Street Tree Planting, as well as the specifications for trees, shrubs & flowers located in Appendix E – List of Approved Plant Species.

C.22. FENCING

Fencing shall conform to the City of Hamilton Fence By-law, By-law No. 10-142. Fencing details shall be provided in accordance with the City of Hamilton Site Plan Guidelines, Appendix 18 – Fencing Details, 2003.

Where required as a condition of development approval, the Proponent shall construct a 1.5 m high black vinyl coated heavy duty commercial grade (9 gauge metal) chain link fence adjacent to City owned property. The fence shall be installed so that the fence posts are located approximately 100 mm within City owned property and private property and shall be in accordance with OPSD 972.130 with a mesh size of 38 mm where it abuts single family dwellings.

Fences required to provide a separation between private and public property include:

- Parks, Open Space, Woodlots, ESAs, creek blocks, etc.;
- Walkways;
- Public Infrastructure (i.e. Pumping stations); and,
- Fencing regulation and requirements for the protection of public infrastructure take priority over other types of fencing.

Storm Water Management Facilities:

- All facilities between private and public property; and,
- All temporary facilities must be fenced.

Privacy/Decorative Fences

Fencing shall generally be required as condition of approval:

- Privacy fences where Residential lands abut commercial or industrial lands, or institutional developments; and,
- Decorative Fence where Residential lands with reverse frontages or “window” roads abutting arterial roads.

Every fence on a corner lot:

- Within a front yard shall have a maximum height of 0.91 m (3 ft);
- Within an interior side yard shall have a maximum height of 2.44 m (8 ft);
- Within an exterior side yard or rear yard shall have a maximum height of:
  - 0.91 m (3 ft) if less than 1.5 m (5 ft) from the exterior side lot line or less than 4.0 m
    (13 ft) from the nearest edge of the travelled portion of the road;
  - 1.82 m (6 ft) if at least 1.5 m (5 ft) from the exterior side lot line but less than 4.57 m
    (15 ft) from the exterior side lot line;
  - 2.44 m (8 ft) if at least 4.57 m (15 ft) from the exterior side lot line;
- Within a corner visibility triangle or driveway visibility triangle shall have a maximum height of; and,
- Shall not be located or constructed so as to block access to private or public driveways and parking spaces.

C.23. STREETSCAPE AND LANDSCAPING

For private sites refer to the City of Hamilton Site Plan Guidelines, 2003 for the relevant policies, otherwise streetscape shall be based on standard R.O.W sections and the City of Hamilton Street Tree Planting Policy.

Requirements from approved Secondary Plans and Special Policy Areas may specify additional details.

C.24. BUS STOP LANDING PAD

All bus stop landing pads, where required shall meet the Transit Bus Stop Accessibility Criteria Guidelines.

C.25. STREET FURNITURE

All street furniture shall meet the criteria outlined in the Co-ordinated Street Furniture Guidelines.

D. WATERMAINS

D.1. DESIGN GUIDELINES

D.1.1. General Requirements

All watermains and appurtenances shall be designed and constructed in accordance with the current City Standards, MOE-CC guidelines, Ontario Provincial Standards and Specifications and American Water Works Association standards and specifications. Should conflict between these specifications and these guidelines occur the Manager of Development Engineering will determine the applicable standard.

Available information regarding existing pressures and flows at key nodes in the neighbourhood shall be made available to the Consulting Engineer by the City. A request for this information shall be made to the Development Engineering Section.

D.1.2. Location

Generally, watermains shall be located in the pavement 1.0 m from the edge of asphalt. Property line off-set for watermains shall be in accordance with the City's approved road cross-section. In all normal cases, the watermain should be located such that there is a minimum of 2.5 m horizontal separation from the nearest sewer.

Under unusual conditions, where a significant portion of a watermain will be in rock, or where it is anticipated that severe dewatering will occur or where congestion with other utilities will prevent a clear horizontal separation of 2.5 m from a sewer, the City's Development Approvals Section should be consulted to obtain permission to install the watermain closer to the sewer and to confirm process for approval. Under such conditions, the elevation of the crown of the sewer must be a minimum of 0.5 m below the invert of the watermain. Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and joints that are equivalent to watermain standards of construction and shall be pressure tested in accordance with Section D.4 - Commissioning / Acceptance and Assumption Process.

D.1.3. Size and Layout

The following are the minimum size requirements:

Residential Areas – 150 mm diameter minimum (50 mm diameter copper around cul-de-sac)

Industrial Areas – 200 mm diameter minimum

Developments, and phases of developments, shall provide two watermain feeds where practical. Generally, if more than 100 lots are serviced by one watermain feed, a second watermain feed shall be required. The watermain distribution layout shall be discussed

with the City's Development Engineering Section prior to finalizing the Engineering submission. The City may waive this requirement where two watermain feeds are not practical (or cost prohibitive).

A watermain hydraulic analysis report will be required in accordance with MOE-CC's Watermain Design Criteria to confirm acceptable sizing of watermains, along with duly filled "Watermain Design Checklist" available from the City's Public Works Department. The Consulting Engineer shall also complete Part 2 of Form 1.

The report shall also identify and put in place interim procedures to maintain water quality prior to full build out. The procedures may consist of the following (as described in Section A.10.6 - Interim Water Quality):

- Temporary looping;
- Temporary flushing station; and,
- Maintenance flushing program.

D.1.4. Depth of Cover

The minimum depth of cover for all new watermains shall be 1.6 m measured from the top of the pipe to the road elevation. For rural cross-sections, where the watermain may be located near the roadside ditch, the design shall be reviewed to ensure that there is a minimum of 1.6 m cover over the watermain. The maximum depth of cover allowed for existing or proposed watermains is 3.0 m. Depth of cover at valves shall be reviewed on an individual basis to ensure that the operation of the valves is not compromised by excessive depth.

D.1.5. Domestic and Fire Flows Demand Design Flow

The domestic demand design flows shall conform to the latest edition of the Ontario Ministry of the Environment's "Guidelines for the Design of Water Storage Facilities, Water Distribution Systems, Sanitary Sewer Systems and Storm Sewers".

Fire flows shall be determined in accordance with the Fire Underwriters Survey (FUS 1999).

D.1.6. System Pressures

The maximum operating pressure shall not exceed 700 KPa. Where pressures in localized areas are above this level, pressure reducing valves shall be installed.

The distribution system shall be sized to meet peak demands. Under simultaneous maximum day and fire flow demands, the pressure shall not drop below 140 KPa.

D.1.7. Sewer Conflicts and Crossings

Generally, the watermain shall cross above sewers with sufficient vertical separation (250mm minimum) to allow for proper bedding and structural support including gap for maintenance.

When there is conflict with the elevation of the sewer and the watermain such that the

watermain cannot pass over the sewer, then the watermain shall be designed such that

it passes under the sewer subject to the following conditions:

- Minimum vertical separation of 500 mm between the bottom of the sewer pipe and the top of the watermain;
- The watermain shall be lowered below the sewer using vertical thrust blocks and restrained joints;
- The length of the watermain pipe shall be centred at the point of crossing so that
- the joints are equidistant and as far as possible from the sewer; and,
- The sewer shall be adequately supported to prevent joint deflection and settling, a detail or specifications shall be provided.

D.1.8. Thrust Blocks and Mechanical Joint Restrainers

All horizontal and vertical bends, tees and plugs shall be restrained with concrete thrust blocks in accordance with City Standard drawings.

Concrete for thrust blocks shall be 30 MPa laid to undisturbed ground. Where thrust blocks cannot be laid to undisturbed ground due to excessive sewer excavation or fill conditions, mechanical joint restrainers may be used in conjunction with concrete thrust blocks.

Mechanical joint restrainers shall be used on all pipe that have not been pressure tested.

All fittings and valves shall be restrained for a minimum of 18 m in each direction. All fittings at dead ends shall be restrained for a minimum of 18 m.

All fittings on water services 100 mm diameter or greater shall be restrained for a minimum of 18 m and shall extend to the property line.

D.1.9. Hydrants

All hydrants shall be three-way hydrants and shall be spaced in accordance with the Fire Underwriter Survey (FUS). Generally hydrants will be spaced a maximum of 150 m apart on streets with low density development, and at 110 m spacing on collector streets, high density residential streets, commercial and industrial streets. On cul-de-sacs, the fire hydrant shall be located within 75 m of the dwelling lot furthest from the street entrance. In the event that a hydrant is located on the long side of the watermain,

it may be required to have a secondary valve close to the watermain as well as one at the hydrant.

On rural roads hydrants shall be spaced at a maximum 150 m distance apart unless specifically identified on the FUS. Hydrant connections (with secondary valves and blind flanges) may be installed only where the lands have not been developed.

Hydrants shall be located within the City's road allowance at the extension of the lot line between two lots to avoid potential conflicts with driveways. If the location of driveways has been determined in advance, the hydrant location shall be reviewed in conjunction with any driveway locations to ensure that conflicts do not occur. All hydrants shall:

- Be in accordance with the approved watermain materials list;
- Be three-way, two nozzles which are 180° to each other and parallel to the street and a 100 mm pumper "STORZ" connection facing the street;
- Open counter-clockwise (left);
- Have a 25 mm top operating nut size;
- Be painted red (barrel, bonnet and hose nozzle caps) and the "STORZ" connection painted black;
- Be controlled by a secondary valve close-coupled to the hydrant;
- Where a hydrant is located on the opposite side of the road as the watermain, an additional valve shall be required on the hydrant lead at the watermain;
- Be installed plumb in accordance with the City Standard drawing WM-203.01;
- If an extension is required to adjust the length of the barrel, it shall be placed between the lower section of the barrel and the boot connection; and,
- Be complete with anti-tampering device.

D.1.10. Valves

The number of gate valves required shall be based on the layout of the development. At an intersection, the number of gate valves required is generally one less than the intersecting watermains, i.e. if there is a four-way cross, at least three valves shall be installed. On long stretches of watermain without intersections, a valve should be installed for every 100 units serviced or with maximum distance between two valves being no more than 600 m whichever is lessor, and shall be located on the projection of a lot line. At intersections, the valve shall be located at the projection of the intersecting street line. All gate valves shall:

- Be in accordance with the approved watermain materials list;
- Open clockwise (right) in the Hamilton District;
- Open counter-clockwise (left) in the Ancaster, Dundas, Flamborough, Glanbrook and Stoney Creek Districts;
- Be installed in chambers if 400 mm and larger; and,
- Have a 25 mm operating nut size in Hamilton district and 50 mm in the Ancaster, Dundas, Flamborough, Glanbrook and Stoney Creek.

Chambers are not required for main line gate valves and tapping valves off mains smaller than 400 mm diameter (even if located within the road pavement). All gate valves 400 mm and larger and tapping valves off mains 400 mm and greater shall be installed in a concrete chamber in conformity with current City Standards.

Air valves and blow-off valves shall be installed in a chamber, regardless of size except for temporary dead-end blow-offs.

Valve chambers shall contain a sump and drained by a 150 mm diameter storm drain to the storm sewer, where possible. An approved backwater valve or approved equivalent shall be installed on the storm drain. If there are no storm sewers or where the storm sewer is not deep enough to drain the valve chamber, a 600 mm diameter sump shall be installed in the bottom of the valve chamber.

The top of valve boxes and valve chamber covers shall be set flush with the finished grade. For chambers and valve boxes located in shoulders of roads, an asphalt paved shoulder shall be constructed in accordance with RD-111.

For proposed water services 100mm in diameter and greater, which will be connected to the municipal watermain on the opposite side of the street of the property being serviced, defined as “long side” servicing, an additional gate valve must be installed on the service at the municipal main. This is in addition to the valve required at the property line and is in accordance with the requirements of Form 400 of the City’s Construction and Material Specifications Manual.

D.1.11. Tapping Valves and Sleeves

Connection of a new watermain to the existing water distribution system shall be made using a tee and sleeve. In the event that the water distribution system cannot be taken out of service, a tapping valve and tapping sleeve shall be utilized, subject to approval by the City. The City’s Development Engineering section shall confirm if the water distribution system can be taken out of service.

Tapping valve and tapping sleeve shall be in accordance with the approved watermain materials list.

D.1.12. Backflow Prevention

In accordance with the City of Hamilton Backflow Prevention By-law 10-103, a backflow prevention device must be installed and maintained on all existing and/or proposed water services to industrial, commercial, high-rise institutional and multi-residential buildings to prevent the flow of contaminants into the municipal drinking water system.

Selection of the required backflow prevention device, specific to a property, is to be determined through a “Cross Connection Survey”, carried out by a qualified individual, under the terms and timelines, as described within the By-law.

Backflow prevention devices must be installed no more than 3.0 m downstream of the ~~a~~ properties water meter, or in the case of a fire protection system, where the fire protection service enters the building and in a location acceptable to the City. Where a

water meter is installed with an underground chamber, due to Water By-law requirements, the backflow preventer must also be located within the 3.0 m maximum spacing which may necessitate the installation of an additional chamber or secure structure to house the device. It must be noted where a “reduced pressure” type backflow device is specified for use, through the survey process, it must not be located within a chamber due to its workings.

Where a fire protection system exists or is proposed within a building, the service must also be protected against backflow in accordance with the CSA standards, and the backflow device must be either a double check detector assembly or a reduced pressure detector assembly with a detector meter which is capable of measurements in cubic meters.

Proposed backflow prevention devices to be installed within buildings will be reviewed and approved under a Permit issued by the City of Hamilton Building Department. Installation of devices within chambers etc., outside the building structure, will be approved under the Water Permit issued by the Growth Management Division.

All Backflow Prevention Devices must be selected and maintained in accordance with the City of Hamilton's Backflow Prevention By-law # 10-103, the manufacturer’s specifications, and the guidelines set out in the most recent version of the AWWA Canadian Cross Connection Control manual and the CSA. B64.10 / 07 / B64. 10.1-07 Standards. A general note to this effect should be included on all plans submitted for Water Permit issuance through the Growth Management Division.

D.1.13. Cul-de-sac and Dead-end Mains

Permanent cul-de-sacs shall provide for looping of the watermain in accordance with details shown in PED-110.01. It is recommended that fire hydrants are located at the end of temporary dead-end mains; however, a 50 mm blow-off is an acceptable alternate. The Proponent should provide a Fire Hydrant Flushing and Monitoring Program for Interim Water Quality Maintenance. For your convenience a template letter is provided as Appendix O - Fire Hydrant Flushing and Monitoring Program for Interim Water Quality Maintenance.

D.1.14. Water Services (Public Portion)

Water services for single detached residential lots shall be a minimum of 25 mm diameter unless otherwise determined by Ontario Building Code calculations, Type K copper pipe located 1.0 m to the left of the centerline of the lot. Water services shall be separated from sanitary and storm private drains by a minimum distance of 2.5 m.

All private water services shall be connected to a main stop at the watermain and shall be terminated at the street line with a curb stop and box, all in compliance with the Waterworks By-Law No. R84-026.

Water services shall be installed perpendicular to the watermain, where possible.

Final inspection of water service shall be completed and be included in the lot grading certification.

Depth of cover shall be minimum 1.6 m including dips at ditches and connections at main.

D.1.15. Pumping Station Design

Where a development will require a booster pumping station, or an elevated tank for functional servicing on a permanent or temporary basis, it should be brought to the attention of Development Engineering as soon as possible.

Where facilities of this nature are included in developments they will be subject to the same design standards as applied to projects undertaken by the City. It is expected that the all facilities, including those required to support phasing, will be designed for long-term, permanent operation. Relaxed criteria for temporary facilities will not be given consideration.

D.2. MATERIAL SPECIFICATIONS

D.2.1. Pipe Material and Bedding

Acceptable material for watermains shall be in accordance with current City of Hamilton Construction and Material Specification Manual.

For PVC mains a continuous #12 gauge solid TWU tracer wire must be supplied along the full length of the pipe to provide electrical continuity for purposes of locating the main and cathodic protection of metallic fittings in accordance with Form 400.

Substitution of pipe material from the approved drawings must be approved by the City and Engineer prior to use.

Transition from one pipe material to another shall be made of a fitting (i.e. tee bend).

D.2.2. Bedding Requirements

- Ductile Iron Granular A (WM-200.02)
- PVC-Granular A (WM-200.01)
- Copper-Type K Soft Granular D (WM-200.01)

D.3. CONSTRUCTION SPECIFICATIONS

For Construction Specifications refer to City's Construction and Material Specifications Manual. The following inspection and testing works shall be carried out during construction of both municipal services and private services intended to service multi-unit developments:

- Sieve analysis of pipe bedding material for compliance with the specifications. Representative samples are to be obtained by the Geotechnical consultant during

water operations. Pipe bedding material supplier shall be approved by the City prior to use;

- Compaction tests shall be performed to assure that pipe bedding and backfill material has been compacted properly. (Refer to Section A.10.5 - Compaction & Material Testing);
- Regular inspection of work in progress of the watermain installation and noted defects corrected immediately; and,
- Ensuring that hydrants that are not fully operational are black-bagged.

D.4. COMMISSIONING / ACCEPTANCE AND ASSUMPTION PROCESS

The following shall be conducted in accordance with the City's Construction and Material Specifications Manual.

D.4.1. Charging and Testing of New Watermains

All new watermains shall be tested prior to connection to existing watermains, using temporary caps or plugs.

All connection points between the new watermain and the existing water distribution system must be kept physically separated until the watermain has successfully passed bacteriological tests.

D.4.1.8 Temporary Charging of New Watermains

A reduced pressure zone backflow preventer is required on the temporary supply line used for filling and flushing of all watermains. The City will provide a hydrant adapter and backflow preventer with the permit from Public Works, Hamilton Water.

D.4.1.9 Testing of New Watermains

New watermains shall be tested in accordance with Form 400 in the following sequence:

- Pressure and leakage test;
- Swabbing; and,
- Disinfection and bacteriological testing to the satisfaction of the City prior to connection to existing watermains.

D.4.1.10 Pressure and Leakage Testing

Prior to the pressure and leakage test, the contractor may elect to swab the main to assist in the removal of air pockets.

The test pressure shall not be less than 1035 KPa (150 psi) for ductile iron and PVC pipe.

The leakage allowance shall be less than 0.128 L/mm of pipe diameter/km of pipe/2 hour period within the shortest valved section. The duration of the pressure test shall not be less than two hours.

D.4.1.11 Swabbing

All new watermains shall be cleaned by passing a minimum of three polyethylene swabs through the pipe. Additional swabbing will be required if the water is not clear after the third swab.

D.4.1.12 Disinfection and Bacteriological Testing

The Consulting Engineer shall ensure that the Contractor assists City staff in the testing of the watermain. The Contractor is to provide all materials, equipment and personnel for pressure and leakage testing, swabbing, and disinfection and bacteriological testing of the watermains. City staff shall arrange for water samples to be collected and tested for potability at the City lab.

After pressure and leakage testing, and swabbing of the new main, disinfection of the new main shall proceed. Sodium hypochlorite or other approved chlorine compound in sufficient quantity to obtain an initial free chlorine residual of minimum 50 mg/L and a minimum of 25 mg/L 24 hours after introduction into the pipe.

After successfully disinfection, the main shall be flushed. Chlorinated water may be discharged into the sanitary sewer system. In rural areas where no sanitary sewers are available, chlorinated water must be de-chlorinated and tested prior to discharging into a ditch or watercourse.

After final flushing and a “sitting period” of 24 hours, water samples for bacteriological testing will be collected by the City and submitted for testing by the City Laboratory at Woodward Avenue. Samples will only be accepted by the City lab Monday through Friday from 8:30 a.m. to 3:30 p.m.

Samples shall be collected at the end of each branch or stub, at 350 m intervals, and a minimum of two samples taken for each main twice, 24 hours apart. When the samples prove satisfactory, the mains may be placed in service and connection to the existing water distribution system can be arranged. The Consulting Engineer shall co-ordinate connection of new watermains to the water distribution system with the City. All affected properties must be given a minimum of 48 hours advance notice by the Consulting Engineer prior to the disruption of the water distribution system.

D.4.2. Acceptance and Assumption of Watermains

Prior to acceptance the following shall be required:

- Receipt of approved as-constructed drawings;
- A conductivity test shall be performed on all tracer wire for PVC watermain installations; and,

- After the completion of the roadworks (minimum base course asphalt) an initial visual inspection of the watermain works shall be completed with the Contractor, Consulting Engineer and City. A report outlining deficiencies shall be provided by the City.
- The Engineer has submitted as-constructed information in a form satisfactory to the Growth Management Division.

Prior to assumption the following shall be required:

- Receipt of approved as constructed drawings;
- Final visual inspection of the watermain works shall be completed. A pre-inspection by the Consulting Engineer of the water valves and dewatering of valve chambers is necessary, before the City will inspect the works;
- A conductivity test shall be performed on all tracer wire for PVC watermain installations;
- The Engineer has submitted as-constructed information in a form satisfactory to the Growth Management Division; and,
- Removal of anti-tampering devices.

E. SANITARY SEWERS

E.1. DESIGN GUIDELINES

E.1.1. General Requirements

The following criteria are recommended minimum requirements for the design of sanitary sewers within the City. Sound Engineering judgment of the Consulting Engineer shall always prevail in the actual design.

Sanitary sewers shall be designed to service the lands within the Plan of Subdivision including all external drainage areas. Foundation drains, weeping tiles and roof drainage are not permitted to be discharged into the sanitary sewer.

In the case where the outlet is a combined sewer, sewers within the development lands shall be designed for separate sanitary and storm sewers and an inter-connection shall be made at the limit of the development. In all instances where the outlet for development is a combined sewer, the Consulting Engineer shall contact the City's Planning and Economic Development Department during the preliminary Engineering stage to determine the constraints, if any, that may limit discharge into the combined sewer system.

The Engineer shall submit sanitary sewer design sheets in accordance with the sample design sheet attached as Appendix F – Storm Sewer Design Sheet / Combined Sewer Design. All sanitary sewer design sheets must be stamped and signed by a Professional Engineer. An electronic copy of the spread sheet in Excel format shall be submitted to the City upon approval of the design.

E.1.2. Location

Municipal sanitary sewers shall be located within the City's public right-of-ways. In the instance where a municipal sewer must be located on private property, the Engineer shall obtain approval, for such alternative location, from the City's Planning and Economic Development Department during the preliminary Engineering stage of development and the sewer shall be located within an easement in favour of the City.

The sanitary sewer shall normally be centered within the road allowance or easement. When sanitary and storm sewers are constructed in a common trench, the designer shall demonstrate that the storm and sanitary sewers can meet operational and maintenance requirements and in no case shall there be less than 450 mm separation. Designers should ensure sufficient clearance between the storm maintenance hole and the sanitary pipe.

E.1.3. Depth of Sewer

The minimum depth of cover for sanitary sewers shall be 2.75 m below the centerline elevation of the proposed road; however, the Consulting Engineer shall investigate the profile of the sanitary sewer to the upper reaches of the sanitary drainage area, taking

into consideration potential conflicts with storm sewer crossovers and possible future road profiles along the route of the future sanitary sewer.

If the profile of the sanitary sewer necessitates placement of fill in excess of 0.6 m on lands outside the proposed development, the Consulting Engineer shall be required to demonstrate that reasonable care has been taken to ensure that the design of the sanitary sewer has been optimized so as to minimize the impact of fill on those lands.

E.1.4. Design Flows

The design flow for sanitary sewers shall be based on the following formula:

Design Flow = Average Dry weather flow x Peak Factor + Infiltration Allowance

Sanitary sewers shall be designed for 360 litres per day per capita. The average dry weather flows for sanitary sewers shall be based on the population densities of the area serviced by the sewer. The Engineer shall obtain the current neighbourhood secondary plans for the catchment area and assign densities based on the designations for the lands in the neighbourhoods. If no secondary plans are available for future external areas, the Consulting Engineer shall, in consultation with the City Planning and Economic Development Department, assign average densities that reflect a probable development pattern for the future lands.

The following guidelines are provided for the use of the Consulting Engineer in assigning densities:

Single detached	60 ppha
Semi-detached	75 ppha
Townhouses and Maisonettes (30 upha)	110 ppha
Medium Density apartments (60 upha)	250 ppha
High Density apartments (100 upha)	varies (subject to detailed plans)
Parks	12 to 25 ppha
Schools and Institutional Uses	75 to 125 ppha
Commercial	varies 125 to 750 ppha
Industrial and Central Business Districts	varies 125 to 750 ppha

E.1.5. Peak Sanitary Flow Factor

The peak factor shall be obtained using the Babbitt Formula:

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

where M = peak factor where 2<M<5

P = number of persons in thousands contributing to the sewer

E.1.6. Infiltration Allowance

An allowance shall be made in the sanitary sewer design for infiltration into the sewer system.

For areas where the weeping tiles of the dwelling are designed to be drained by gravity, or where a separate foundation drain collector sewer is proposed, the infiltration factor shall be 0.4 litres per second per hectare.

For areas where there are no storm sewers, or shallow storm sewers which require the weeping tiles of the dwelling to be drained by sump pump, the infiltration factor shall be 0.6 litres per second per hectare.

E.1.7. Capacities, Velocities and Sizes

Sanitary sewers shall be designed to flow at a maximum of 75% full design capacity of the pipe for sizes up to and including 450 mm diameter. Pipes shall be designed to capture all external catchment areas. Trunk sanitary sewers (525 mm diameter and above) shall be designed to flow at a maximum of 60% full design capacity of the pipe.

Manning's formula shall be used in determining the capacity of the sanitary sewers as follows:

$$Q = AV$$

and

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$$R = \frac{A}{P}$$

where

Q = Capacity of the pipe flowing full (m3/sec)

V = Velocity (m/sec)

R = Hydraulic radius (m)

A = Cross-sectional Area of pipe (m2)

P = Wetted perimeter (m)

S = Gradient of pipe (m/m)

n = Manning's factor = 0.015 for pipe sizes less than 600 mm diameter

= 0.013 for pipe sizes equal or greater than 600 mm diameter

The minimum design velocity for the sanitary sewer shall be 0.75 m/sec flowing full and maximum velocity shall not exceed 2.75 m/sec. However, the Engineer shall investigate the actual velocity in the sewer for instances where the design flows are low (example: in cul-de-sacs), and make a reasonable attempt to obtain self-flushing velocities.

The minimum sanitary sewer size shall be 250 mm diameter. A size of 200 mm diameter may be permitted on the last run of sanitary sewer, where there will be no further upstream contribution, such as in cul-de-sacs or crescents. A minimum grade on a 200 mm sanitary sewer shall be 0.75%.

For **Industrial or Commercial** applications the minimum size for the sanitary sewer shall be 375 mm.

Generally, no decrease of pipe size from a larger upstream pipe to a smaller downstream pipe shall be allowed, regardless of increase in grade, velocity and capacity. The design of the sewers shall be such that there is no decrease in velocity and capacity from the upstream pipe to the downstream pipe. In cases where this is unavoidable, care should be taken to ensure that an appropriate drop is incorporated in the maintenance hole to dissipate the excess energy.

E.1.8. Maintenance holes

Maintenance holes shall be provided at each change in pipe alignment (vertical and horizontal), and at any change in pipe size or material and where the maximum distance between maintenance holes has been reached. Generally, maintenance holes shall not be located in road sags (low points); where it is necessary, a water-tight maintenance hole frame and cover shall be used.

Generally, the maximum distance between maintenance holes shall be as follows:

- 120 m for pipe sizes 200 mm to 1050 mm diameter; and,
- 150 m for pipe sizes 1200 mm diameter and larger.

The maximum change in direction from upstream to downstream pipes for pipe sizes 675 mm and larger is 45°. Where the change in direction is greater than 45°, additional maintenance holes shall be required to reduce the angle.

For maintenance holes constructed at the end of a line that is to be extended in the future, proper bulkheads shall be designed. The size of the bulkhead shall be specified on the Engineering drawings.

If the sanitary sewer is intended to be extended in the future and the spacing of the maintenance holes does not allow for the optimum use of the maintenance holes, then a temporary maintenance hole shall be constructed at the end of the sanitary sewer main line with a notation that it will be removed and relocated with the future extension of the sanitary sewer.

Maintenance holes may be constructed with either precast or poured in place concrete. The size of the maintenance holes shall be based on the pipe size, the deflection angle of the pipes and the number of pipes at the junction maintenance hole (see OPSD 701.021). When any dimension of a maintenance hole differs from the standards, the maintenance hole shall be individually designed and detailed.

Where possible, pre-benched maintenance holes should be specified. Benching details for non-standard cases shall be detailed on the plan-profile sheets. Generally, the benching shall be brought to the spring line of the outlet pipe in accordance with OPSD 202.021.

The upstream pipe(s) obvert shall generally not be lower than the pipe obvert on the downstream side of the maintenance hole.

Suitable drops shall be provided across maintenance holes to compensate for loss in energy due to change in flow velocity and for the difference in depth of flow in the sewers. In order to reduce the amount of drop required, the Engineer shall try to restrict the change in velocity between the inlet and outlet pipes to less than 0.6 m/sec.

The minimum drops across maintenance holes shall be as follows:

Alignment Change	Drop Required
0°	grade of sewer
1° to 45°	0.03 m
45° to 90°	0.06 m

The maximum drop allowed across a maintenance hole is 0.6 m calculated from the invert of the upstream pipe to the invert of the downstream pipe (in accordance with OPSD 1003.01). In junction maintenance holes where there is a pipe entering the side of the maintenance hole, the drop shall be calculated from the invert of the higher pipe to the top of the benching in the maintenance hole. For drops greater than 0.60 m a drop structure is required as per OPSD 1003.01. Generally, the size of the drop pipe shall be one size smaller than the connecting sewer with a minimum size of 200 mm and a maximum size of 300 mm. The invert of the drop pipe shall be shown on the plan-profile sheet and shall be a min. of 0.06 m higher than the invert of the lowest pipe.

Safety gratings shall be installed in maintenance holes that are greater than 5.0 m in depth from the top of the maintenance hole grate to the lowest invert and shall conform to OPSD 404.020.

Maintenance hole frames and covers shall conform to OPSD 401.010 (closed cover) except where watertight covers are required, then OPSD 401.030 shall be used.

E.1.9. Sanitary Laterals (Public)

Sanitary laterals connections shall be individual services. Shared sanitary laterals within the road allowance shall not be permitted. Sanitary laterals shall be located 1.5 m to the right of the centre of a single detached residential lot. Locations for semi-

detached, street townhouses, and maisonettes units shall be specified by the Consulting Engineer.

The connection to the mainline sewer shall be made with an approved prefabricated wye or an approved saddle for larger diameter sewers. For connections required to an existing sanitary mainline sewer, the main sewer shall be cored and an approved saddle used.

The minimum size for sanitary laterals shall be 150 mm diameter. Sanitary Service connections for multiple residential, commercial, industrial and institutional blocks shall be sized individually.

The sanitary lateral shall be extended from the mainline sewer to 1 m beyond the street property line. A stake, painted black, shall be placed at the end of the sanitary lateral, extending 1.0 m above grade.

The colour of the sanitary lateral shall be any colour except white. (White shall be used for storm laterals only).

The top of the sanitary lateral at the street line shall be minimum 2.2 m below the centerline elevation of the road at that point.

In cases where dual (i.e. sanitary and storm) laterals are installed, the storm lateral shall be located north or east of the sanitary lateral.

In cases where the main line sewer is a combined sewer, dual lateral connections shall be installed as specified in SEW-301.

Bedding and cover for PVC laterals shall be granular A as per SEW-302. For sewers deeper than 3.7 m, a riser shall be installed to an elevation of 2.75 m below the final road elevation in accordance with SEW-300. The riser shall be encased in 15 MPa wet concrete to a height of 1 metre above the main sewer.

E.1.10. Pumping Station & Vertical Assets

Where a development will require a pumping stations for functional servicing on a permanent or temporary basis, it should be brought to the attention of the City as soon as possible.

Where facilities of this nature are included in developments they will be subject to the same design standards as applied to projects undertaken by the City. It is expected that all facilities, including those required to support phasing, will be designed for long-term, permanent operation. Relaxed criteria for temporary facilities will not be given consideration.

E.2. MATERIAL SPECIFICATIONS

E.2.1. Pipe Materials, Classification and Bedding Requirements

Acceptable material for sanitary sewers shall be in accordance with the current City's Construction and Materials Specification Manual – Approved Products List.

Substitution of pipe material from the approved drawings must be approved by the City and Consulting Engineer prior to use.

Transition from one pipe material to another must be made at a maintenance hole or with an approved coupler.

The class, type of pipe and pipe bedding shall be indicated on the profile for each section of the sanitary sewer.

The class of pipe and the type of bedding shall be selected to suit loading and proposed construction conditions. Bedding as per OPSD 802.010, 013, and 014 for flexible pipe and OPSD 802.030, 031, 032, 033 and 034 for rigid pipe shall be used in all new construction and the class of pipe shall be selected to suit this bedding detail and characteristics.

Bedding and cover material to be granular A compacted to 95% SPMDD. Maximum depth of cover shall be in accordance with OPSD 806.06, 807.01, and 03.

E.3. CONSTRUCTION SPECIFICATIONS

For Construction Specifications refer to City's Construction and Material Specifications Manual. The following inspection and testing works shall be carried out during and after construction of both municipal services and private services intended to service multi-unit developments:

- Sieve analysis of pipe bedding material for compliance with the specifications. Representative samples are to be obtained by the Geotechnical consultant during sewer operations. Any material that does not meet the City Standard must be removed from the site;
- Compaction tests shall be performed to assure that pipe bedding and backfill material has been compacted properly. (Refer to Section A.10.5 - Compaction & Material Testing); and,
- Sewer installation shall be regularly inspected and noted deficiencies must be corrected immediately

E.4. COMMISSIONING / ACCEPTANCE AND ASSUMPTION PROCESS

E.4.1. General Requirements

The following shall be conducted in accordance with the City's Construction and Material Specifications Manual.

Prior to acceptance the following shall be required:

- Receipt of as constructed drawings;
- All sewers and maintenance holes must be flushed and cleaned prior to testing. A mandrel test shall be performed on all flexible pipe sewer mains in accordance with OPSS 410 which consists of a successful pass of the mandrel ("pig") pulled through the main. Notwithstanding OPSS 410, allowable deflections shall be a maximum of 5% for all pipe diameters tested;
- Video inspection of all sewer mains to assure no defects exist. (Refer to Section A.12.4 - Video Camera Inspection);
- After the completion of the roadworks (minimum base course asphalt) an initial visual inspection of the sewer works shall be completed with the contractor, Consulting Engineer and City. A report outlining deficiencies shall be provided by the City; and,
- Unique to Sanitary Sewers, infiltration / exfiltration testing will be carried out on all sanitary sewers, using either water or low air pressure in accordance with OPSS 410.07.15.02.

Prior to assumption the follow shall be required:

- Second mandrel test (and flushing) will be required prior to assumption;
- TV camera inspection for all sewers; and,
- Final visual inspection for all sewers.

F. STORM SEWERS

F.1. DESIGN GUIDELINES

F.1.1. General Requirements

Storm sewers shall be designed to service all the lands within a proposed development as well as any external drainage areas that are dependent on the sewers within the proposed development.

In the case where the outlet sewer is a combined sewer, the development shall be designed for separate sanitary and storm sewers and an inter-connection shall be made at the limit of the development. In all instances where a development discharges into a combined sewer, the Consulting Engineer shall contact the City Planning and Economic Development Department during the preliminary Engineering stage to determine the constraints, if any, that may limit discharge into a combined sewer system.

The Consulting Engineer shall submit storm sewer design sheets in accordance with the sample design sheets attached as Appendix F – Storm Sewer Design Sheet / Combined Sewer Design. All storm sewer design sheets must be stamped and signed by a Professional Engineer. An electronic copy of the spread sheet in Excel format shall be submitted to the City upon approval of the design.

F.1.2. Location

Storm sewers shall normally be constructed in a common trench with the sanitary sewer and shall be located parallel to and to the north and west of the sanitary sewer wherever possible. When sanitary and storm sewers are constructed in a common trench, the designer shall ensure sufficient clearance between the storm maintenance hole and the sanitary pipe. Designers shall demonstrate that the storm and sanitary sewers can meet operational and maintenance requirements and in no case shall there be less than 450 mm separation.

F.1.3. Depth of Sewer

The cover of storm sewers shall be dependent on the storm sewer outlet. Generally, unless specified otherwise in the Functional Servicing Report (FSR), the minimum depth of cover over the storm sewer shall be 2.75 m below the centerline of the proposed road elevation (unless a more shallow minimum depth is justified in the FSR), for storm sewers designed to provide standard urban servicing.

However, as in the case with the sanitary sewer design, the Consulting Engineer shall investigate the profile of the storm sewer to the upper reaches of the storm sewer catchment area, taking into consideration potential conflicts with sanitary sewer crossovers and possible future road profiles along the route of the storm sewer.

If the profile of the storm sewer necessitates the placement of fill in excess of 0.6 m on lands outside the development, the Consulting Engineer shall be required to

demonstrate that reasonable care has been taken to ensure that the design of the storm sewer has been optimized so as to minimize the impact of fill on those lands.

F.1.4. Design Flows

The design flow, in each maintenance hole length of sewer, shall be computed on the standard City of Hamilton design sheet according to the Rational Method equation as follows:

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

Where

Q = Peak rate of runoff (m3/s)

C = Coefficient of imperviousness

i = Rainfall Intensity (mm/hr)

A = Drainage Area (ha)

The Drainage Area (A) shall be determined from the largest scale contour maps available for the area. The Consulting Engineer shall obtain from the City's Planning and Economic Development Department, the overall storm drainage area maps that were used for the design of the trunk storm sewer systems. These maps shall then be refined based on existing development patterns that have evolved since the trunks were installed and on any additional detailed information available for the area.

The Rainfall Intensity (i) shall be based on the 5 year IDF relationship for the Mount Hope rainfall gauge, (ref. Appendix G – IDF Curves / Design Storms). The rainfall intensity is to be determined using:

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

Where

A, B, C = constants provided within Appendix G – IDF Curves / Design Storms

Storms;

i = rainfall intensity (mm/hr)

t_C = time of concentration in minutes

The Initial Time of Concentration t_C shall be 10 minutes, and the time for conveyance of storm flows shall be based on full pipe flow velocities. To calculate the initial external time of concentration for external lands that are scheduled for future development, the Consulting Engineer shall obtain the current neighbourhood secondary plans for the catchment area and determine the proposed street pattern and the most probable route of the storm sewer.

The top end of the storm sewer system shall then be assigned an initial time of concentration of ten minutes and the time for conveyance of the storm flows shall be determined using an average velocity in the storm sewers system of 2 m/sec. unless circumstances require a higher velocity.

All external areas shall be designed on the basis of developed conditions unless otherwise advised by the City's Planning and Economic Development Department.

Coefficient of imperviousness shall be determined from the types of land uses within the drainage area. Recommended values are as follows:

Table F.1- Coefficient of Imperviousness Table

Land Use	Recommended Coefficient
Parks	0.25
Single Family Residential	0.50 – 0.65
Semi Detached Residential	0.65
Townhouses, Maisonettes, Row Houses, Apartments etc.	0.75
Institutional	0.75
Industrial and Central Business District	0.80
Commercial	0.90
Paved Areas	0.90 – 1.00

For Blocks of land within a plan of subdivision where a site plan has not been proposed at the time of design, the Engineer shall use a conservative assumption for the land use and coefficient of imperviousness.

For external areas, the Consulting Engineer shall assign coefficients based on the current neighbourhood secondary plans. If no secondary plans are available for future external areas, the Consulting Engineer shall, in consultation with the City Planning and Economic Development Department, assign average coefficients that reflect a probable development pattern for the external area.

Sound Engineering judgement shall always prevail in the actual design.

F.1.5. Storm Sewer Pipe Design

New storm sewers shall be designed to flow at a maximum of 85% full design capacity of the pipe. Pipes shall be designed to capture all external catchment areas.

Manning's formula shall be used in determining the capacity of the storm sewers as follows:

$$Q = AV$$

and

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$$R = \frac{A}{P}$$

where Q = Capacity of the pipe flowing full (m^3/sec)

V = Velocity (m/sec)

R = Hydraulic radius (m)

A = Cross-sectional Area of pipe (m^2)

P = Wetted perimeter (m)

S = Gradient of pipe (m/m)

And n = Manning's factor = 0.013

The minimum design velocity for the storm sewer shall be 0.8 m/sec flowing full and maximum velocity shall not exceed 3.65 m/sec.

The minimum size of the storm sewer main shall be 300 mm diameter.

A minimum separation of 150 mm will be required between sanitary and storm sewer pipes where one sewer pipe crosses over the other.

Generally, no decrease of pipe size from a larger upstream pipe to a smaller downstream pipe shall be allowed, regardless of increase in grade, velocity and capacity.

F.1.6. Maintenance holes and Catch Basins

Maintenance holes shall be provided at each change in pipe alignment (vertical and horizontal), and at any change in pipe size or material and where the maximum spacing for a pipe run has been reached.

Generally, the maximum spacing for maintenance holes shall be as follows:

- 120 m for pipe sizes 300 mm to 1050 mm diameter; and,
- 150 m for pipe sizes 1200 mm and larger.

The maximum change in direction from upstream to downstream pipes for pipe sizes 675 mm and larger is 45°. For 675 mm and larger size of pipes where the change in direction is greater than 45°, additional maintenance holes shall be required to reduce the angle.

For maintenance holes constructed at the end of a line that is to be extended in the future, proper bulkheads shall be designed and the size of the bulkhead shall be specified on the Engineering drawings.

If the storm sewer is intended to be extended in the future and the spacing of the maintenance holes does not allow for the optimum use of the maintenance holes, then a temporary maintenance hole shall be constructed at the end of the storm sewer main line with a notation that it will be removed and relocated with the future extension of the storm sewer.

Maintenance holes may be constructed with either precast or poured in place concrete. The size of the maintenance holes shall be based on the pipe size, the deflection angle of the pipes and the number of pipes at the junction maintenance hole (see OPSD 701.021). When any dimension of a maintenance hole differs from the standards, the maintenance hole shall be individually designed and detailed.

Benching details for non-standard cases shall be detailed on the plan-profile sheets. Generally, the benching shall be brought to the spring line of the outlet pipe in accordance with OPSD 202.021.

The obvert of the upstream pipe(s) shall generally not be lower than the obvert of the pipe on the downstream side of the maintenance hole. If the cover over the storm main is being compromised because of this rule, then the design shall be on the basis of the 0.8 x diameter of the pipes are at the same elevation.

Suitable drops shall be provided across maintenance holes to compensate for the loss in energy due to the change in flow velocity and for the difference in the depth of flow in the sewers. In order to reduce the amount of drop required, the Consulting Engineer shall try to restrict the change in velocity between the inlet and outlet pipes to less than 0.6 m/sec.

The minimum drops across maintenance holes shall be as follows:

Alignment Change	Drop required
0°	grade of sewer
1° to 45°	0.03 m
45° to 90°	0.06 m

The maximum drop allowed across a maintenance hole is 0.6 m calculated from the invert of the upstream pipe to the invert of the downstream pipe (in accordance with OPSD 1003.01). In junction maintenance holes where there is a pipe entering the side

of the maintenance hole, the drop shall be calculated from the invert of the higher pipe to the top of the benching in the maintenance hole. For drops greater than 0.60 m a drop structure is required as per OPSD 1003.01. Generally, the size of the drop pipe shall be one size smaller than the connecting sewer with a minimum size of 200 mm and a maximum size of 300 mm. The invert of the drop pipe shall be shown on the plan-profile sheet and shall be a min. of 0.06m higher than the invert of the lowest pipe.

Safety gratings shall be installed in maintenance holes that are greater than 5.0 m in depth from the top of the maintenance hole grate to the lowest invert and shall conform to OPSD 404.020.

Maintenance hole frames and covers shall conform to OPSD 401.010 (open cover).

Roof water Leaders Discharge

All single-detached and semi-detached residential dwellings shall have roof water leaders that discharge to the ground via splash pads.

F.1.7. Storm Laterals (Public)

Storm laterals in the City of Hamilton shall be subject to the same criteria as sanitary laterals, as detailed in Section E.1.9 – Sanitary Laterals (Public).

The minimum size of storm laterals shall be 150 mm diameter. Shared storm laterals within the road allowance shall not be permitted.

In cases where dual sanitary and storm laterals are installed, the storm lateral shall be located to the north or east of the sanitary lateral. Locations for semi-detached, street townhouse and maisonette units shall be specified by the Consulting Engineer.

Storm service connections for blocks within a plan of subdivision (for commercial, institutional, industrial or multi-family block townhouses) shall be designed by the Engineer based on the specific land use of the block.

Freehold housing units in townhouse blocks or similar shall have individual private storm drains.

The storm lateral shall be extended from the main line sewer to 1 m beyond the street property line and a stake placed at the end of the lateral.

Laterals shall be white in colour to distinguish them from sanitary laterals, which can be any colour except white.

All underside footing elevations must be located a minimum of 0.30 m above the 100 year hydraulic grade line. In cases where the above criteria cannot be met, sump pumps shall be specified for each lot so affected. Foundation drains that connect into sump pumps shall discharge directly into the storm sewer.

The hydraulic grade line shall be plotted on all plan and profile drawings. Also refer to Section G - Stormwater Management of the Guidelines.

F.1.8. Catch Basins and Connections

Catch basins shall be designed to take into consideration the lot areas draining on to the roadway, the pavement widths, road grades and intersection drainage.

Catch basins shall be generally located upstream of any pedestrian sidewalk crossings, and if possible, should be avoided in driveway curb depressions. Double catch basins shall be installed at all the low points in a road. However, at intersections where the cross-fall of one road creates a low point on the other intersecting minor road, the back-fall shall be provided on the minor road to the end of the curb return radii to facilitate proper drainage of the intersection. Single catch basins only shall be required at the end of the curb return for drainage in this case. Catch basin maintenance holes are not permitted within the road right of way.

Catch basins spacing shall be determined as follows, unless prescribed otherwise by a detailed Stormwater management design:

Pavement Width	Maximum Spacing
8.5 m or less	90 m
9 m to 11m	75 m
11.5 m or greater	60 m

Where the road grades are between 3% and 5% the maximum spacing shall be reduced by 15% and for road grades between 5% and 6%, the maximum spacing shall be reduced by 30%.

Single / double catch basins as per OPSD 705.010 / 705.020 respectively. With a goss trap and a 250 mm diameter connection frame and cover for catch basins shall conform to OPSD 400.100 for local and collector roads and OPSD 400.070 for arterial roads.

F.1.9. Rear Yard Catch Basins

Rear yard catch basins receiving drainage from rear yard swales are deemed private and the ownership and maintenance is the responsibility of the property owner. The rear yard catch basin and lead shall be located on one lot and not on the lot line. All rear yard catch basins shall be sumpless with no goss trap. Rear yard catch basins shall conform to OPSD 705.010 with a beehive grate and connect to the storm sewer with a 250mm diameter lead. Where the rear yard catch basin drains future external land, the catch basin and lead is deemed public. A minimum 9 m easement is required in favour of the City of Hamilton and discharge pipe shall be designed as a storm sewer.

F.1.10. Pumping Station & Vertical Assets

Where a development will require a pumping station for functional servicing on a permanent or temporary basis, it should be brought to the attention of Development Engineering as soon as possible.

Where facilities of this nature are included in developments they will be subject to the same design standards as applied to projects undertaken by the City. It is expected that the all facilities, including those required to support phasing, will be designed for long-term, permanent operation. Relaxed criteria for temporary facilities will not be given consideration.

F.2. MATERIAL SPECIFICATIONS

F.2.1. Pipe Materials, Classification and Bedding

Acceptable material for storm sewers shall be in accordance with the current Pipe Material and Bedding Specifications, refer to City's Construction and Material Specifications Manual – Approved Products List.

Substitution of pipe material from the approved drawings must be approved by the City and Consulting Engineer prior to use.

Transition from one pipe material to another must be made at a maintenance hole or with an approved coupler at the discretion of the City.

The class, type of pipe and pipe bedding shall be indicated on the profile for each section of the sanitary sewer.

The class of pipe and the type of bedding shall be selected to suit loading and proposed construction conditions. Bedding as per OPSD 802.010, 013, and 014 for flexible pipe and OPSD 802.030, 031, 032, 033 and 034 for rigid pipe shall be used in all new construction and the class of pipe shall be selected to suit this bedding detail and characteristics.

Bedding and cover material to be granular A compacted to 95% SPMDD. Maximum depth of cover shall be in accordance with OPSD 806.06, 807.01, and 03.

F.3. CONSTRUCTION SPECIFICATIONS

For Construction Specifications refer to City's Construction and Material Specifications Manual. The following inspection and testing works shall be carried out during and after construction of both municipal services and private services intended to service multi-unit developments:

- Sieve analysis of pipe bedding material for compliance with the specifications. Representative samples are to be obtained by the Geotechnical consultant during sewer operations. Any material that does not meet the City Standard must be removed from the site;
- Compaction tests shall be performed to assure that pipe bedding and backfill material has been compacted properly. (Refer to Section A.10.5 - Compaction & Material Testing); and,
- Sewer installation shall be regularly inspected and noted deficiencies must be corrected immediately.

F.4. COMMISSIONING / ACCEPTANCE AND ASSUMPTION PROCESS

The following shall be conducted in accordance with the City's Construction and Material Specifications Manual.

F.4.1. General Testing Requirements

Prior to acceptance the following shall be required:

- Receipt of as-constructed drawings;
- All sewers and maintenance holes must be flushed and cleaned prior to testing. A mandrel test shall be performed on all flexible pipe sewer mains in accordance with OPSS 410 which consists of a successful pass of the mandrel ("pig") pulled through the main. Notwithstanding OPSS 410, allowable deflections shall be a maximum of 5% for all pipe diameters tested;
- Video inspection of all sewer mains to assure no defects exist. (Refer to Section A.12.4 - Video Camera Inspection); and,
- After the completion of the roadworks (minimum base course asphalt) an initial visual inspection of the sewer works shall be completed with the contractor, Engineer and City. A report outlining deficiencies shall be provided by the City.

Prior to assumption the follow shall be required:

- Second mandrel test (and flushing) will be required prior to assumption;
- TV camera inspection for all sewers; and,
- Final visual inspection for all sewers.

G. STORMWATER MANAGEMENT

G.1. INTRODUCTION

Stormwater management design criteria contained in this document has been developed as a companion document to the City's Storm Drainage Policy best management practices, and relevant Provincial standards.

G.2. STORMWATER MANAGEMENT DESIGN CRITERIA

G.2.1. Minor System

The minor storm drainage system shall be designed to convey stormwater runoff from the one in five year return period according to the design principles and criteria outlined in Section F.1.4 – Design Flows and F.1.5. – Storm Sewer Pipe Design; thereby providing safe and convenient use of streets, lot areas, and other areas. Components of the minor storm drainage system could include swales, subsurface inceptor drains, curb and gutters, catchbasins, maintenance holes, pipes or conduits and service lateral lines in those areas where a piped storm drainage system is required.

G.2.1.1 Storm Sewers

Approved Master Drainage Plans (MDP's) which have established storm sewer sizing criteria other than one in five year standard will govern (Figure G-1). In the absence of approved MDP's, storm sewers shall be designed to a minimum one in five year, unsurcharged standard (i.e. 85% of pipe capacity). For any storm sewer to be assumed by the City the minimum allowable pipe diameter is 300 mm.

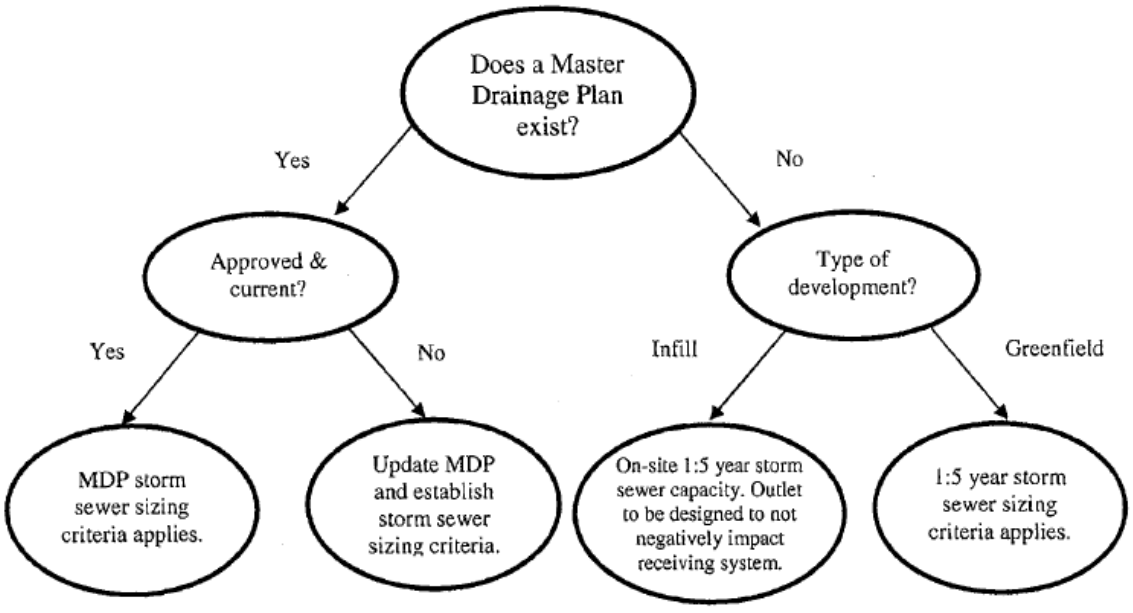


Figure G-1 Storm Sewer Sizing Criteria Decision Tree

Interfacing between new storm sewers designed to the minimum one in five year, unsurcharged standard and existing storm sewers of variable sizing standard shall

require hydraulic analysis of the existing and proposed storm sewers. Flow capacity of the proposed storm sewer shall be determined based on the receiving existing sewer remaining unsurcharged. The proposed storm sewer flow capacity would either be the one in five year standard or designed to allow the existing storm sewer to remain unsurcharged. Should the proposed storm sewer flow capacity be required to be less than the one in five year standard, to prevent downstream surcharging, inlet capacity for the storm sewer shall be designed accordingly. Should the existing downstream system be already surcharged, the proposed upstream storm sewer should not increase the level of surcharging downstream.

Hydraulic analysis of the proposed and existing storm sewer system shall provide hydraulic grade lines for the inlet capacity and/or one in five year standard and one in 100 year standard. Hydraulic analysis should demonstrate that no negative impact on the receiving storm sewer system results from the proposed storm, sanitary or combined sewer. The extent of the downstream off-site analysis needs to be verified with City staff prior to initiation, to ensure that downstream conditions are adequately accounted for in the analysis. The City shall provide the consultant with the 100 year hydraulic grade line for the existing storm infrastructure system when available. The designer has to prove that the downstream receiving system has capacity.

The 100 year HGL in the storm sewer system is to remain below the surface to ensure that there is no interference with the overland flow system as a result of surcharge from the storm sewer system. If it is demonstrated that it is not feasible to ensure the 100 year HGL remains below surface, for example as a result of a shallow system subject to physical constraints, a dual drainage model will be required to demonstrate that the minor and major system is capable of conveying the 100 year design flows ensuring protection of private property from flooding and limiting flow depths to ensure public safety and reasonable access.

Should downstream storm sewer surcharging be a concern under existing conditions, the Proponent may be required to restrict inlet capacity to ensure no negative impact on the receiving system. In addition, the Proponent is to ensure that adequate overland flow capacity is available in the development and in the receiving major system, incorporating the influence of the restricted inlet capacity of the storm sewer system.

G.2.1.2 Combined Sewers

Existing combined sewers may need to be upgraded when it is demonstrated that deficient capacity exists and/or the sewer requires capital maintenance. Discussions with City of Hamilton staff would be required prior to consideration of any combined sewer upgrades.

Interfacing between the existing (original) combined sewers and the upgraded combined sewer should be designed to the one in ten year, unsurcharged standard (i.e. 85% of pipe capacity) using the Rational Method. Hydraulic analysis should demonstrate that no negative impact to the receiving combined sewer system would result from the proposed combined sewer upgrades to the satisfaction of City staff.

G.2.1.3 Inlet Systems – Catch Basins

The minor system shall be designed so that conveyance capacity complements inlet capacity. Undersizing the inlet capacity can lead to under-utilized storm sewers and frequent roadway flowing, whereas oversizing the inlet capacity can lead to sewer system surcharging and possible basement flooding or floor fractures. As a minimum requirement, the City requires that double catch basins be installed at all low points in the road and single catch basins at low grade points.

In older, existing developed areas, catch basins may over-capture storm runoff which can result in flooding. In these potential retrofit cases, the drainage design for redevelopment should consider the use of inlet control devices to reduce the risk of system surcharge, or upgrade the hydraulic capacity of the system. Analysis of the storm sewer and overland flow system, in conjunction with discussions with the City, will determine if inlet control devices or upgrades to the system hydraulic capacity, shall be required, in order that the inlet capacity more closely matches the storm sewer capacity.

G.2.1.4 Foundation Drains

Foundation drains should be connected to a storm sewer or a combined sewer where present, but never a sanitary sewer.

Where no sewer outlet is available the Proponent should reference existing Watershed Studies, Subwatershed Studies and Master Drainage Plans for foundation drain requirements for the proposed development area. Should a Proponent propose that sump pumps discharge to the surface the City of Hamilton would require the following criteria to be met to its satisfaction:

- When the side yard has less than 1% grade, the foundation drain shall be directed to the storm sewer;
- That discharge to the surface would occur when a minimum of 1.8 m between the house and side lot line, with the exception of existing homes with less than 1.8 m available, via discussion with the City;
- Positive drainage from the rear of the house to the rear of the lot would exist (i.e. two way drainage); and,
- That positive adequate drainage be provided on the lot to convey sump pump discharge.

The Proponent should provide supporting hydraulic analysis for gravity foundation drains connected to the storm sewer to the satisfaction of the City. The Proponent should establish the basement floor elevation, a minimum of 0.3 m above the 100 year hydraulic grade line using hydraulic analysis techniques described in Section G.5.2 - Hydraulic Capacity. The City shall provide the consultant with the 100 year hydraulic gradeline for the existing storm infrastructure system when available. Foundation drains using sump pumps shall use a ‘gooseneck’ connection, in situations where the foundation drain at its highest elevation is placed above the foundation wall, no hydraulic grade line analysis is required in this instance.

G.2.1.5 Roof Leaders

All roof leaders shall be discharged to the surface.

G.2.2. Rear Yard Catch Basins

The City may elect to maintain rear yard catch basins and connections of 375 mm minimum diameter at 0.5% or sewers with a flow capacity of 130 l/s considered to be the minimum sized storm infrastructure requiring City access on Private property. Where the City elects not to maintain rear yard catch basins, those catch basins will be deemed private and the ownership and maintenance requirements are registered on title as part of the Development Agreement process. The catch basin and drain should be located on one lot and not on the lot line.

In order to protect private property and public safety in situations where the lead from rear lot catch basins may have collapsed or where the catch basin has become obstructed or plugged, the proposed lowest adjacent opening elevation (i.e. basement window sill) shall always be above the maximum ponding level above the catch basin, at which point there would be overland relief. Maximum desirable ponding level above a rear lot catch basin is 0.33 m, subject to rear lot grading. Where it is demonstrated that it is not feasible to limit ponding to 0.33 m it shall be demonstrated that full capture of runoff from the 100 year event or a safe overland flow route can be achieved.

G.2.2.1 Outlet Treatment

New storm sewer outfalls, which discharge into a natural watercourse, shall be designed to prevent erosion. They shall also be blended into the natural surroundings, in an aesthetically pleasing manner to the extent possible, given the size and location.

An access road with a minimum width of 4 m and cross fall of 2% should be provided to outfalls. Should the outfall be within a fenced area, gate access shall be provided.

Outfalls shall be provided with safeguards to prevent entry by unauthorized personnel into the outfall. Current City Standards use the Ontario Provincial Standard Drawings (OPSD), which should be followed to determine what outfall sizes require grating to prevent unauthorized entry.

The invert of the outlet, if possible, shall be located at, or above, the normal low flow (baseflow) water elevation of the natural watercourse (seasonally high baseflow, i.e. spring period). This can be determined through physical reconnaissance during the spring period and/or hydraulic calculations based on recorded or simulated spring baseflow. Pipe exit velocities shall not impart additional erosion potential to the streambed or banks. In addition, the outfall shall be adequately protected from erosive forces in the receiving watercourse to prevent scouring and undermining.

Although Conservation Authorities have not established outlet setback requirements for outfalls, the Proponent should position the outlet to minimize the outlet angle to normal creek flow and the outlet should be, if possible, located flush with the creek bank for

minor creeks with no valley flow and at the intersection of the overbank area / valley wall for major creeks.

Storm sewer outfalls to regulated watercourses require a permit from the respective Conservation Authority, who must be consulted on this matter. Storm sewer outfall design is to be submitted to the City as part of the full Engineering submission.

As the City of Hamilton borders Lake Ontario, storm sewer outfalls will at times be located at the lakefront. The design of these storm outfalls should consider the potential problem of dynamic breaches (ref. Ontario Ministry of Natural Resources Natural Hazard Technical Guidelines, March 2003) and the potential obstruction of the outlet. The outfall's invert should be located above the 100 year lake elevation if possible. The Proponent shall be required to consult with a professional coastal Engineer and provide appropriate protection measures. Storm sewer outfall design is to be submitted to the City as part of the full Engineering submission, and may require the appropriate Conservation Authority approval.

G.2.2.2 Swales

The maximum runoff typically allowed in a swale between two buildings and within rear lot swales is based on the grading guidelines in Section J - Lot Grading. Any swale deemed "significant" by the City staff, which require future maintenance, may be acquired as a permanent easement by the City and designated as an overland flow route. Swales conveying 0.70 m3/s or more for the 100-year storm shall be considered significant by the City. This flow rate is based on a 1.0 m wide grassed swale with 3:1 side slopes flowing at a depth of 0.33 m at a slope of 1%. The City, on a case-by-case basis, may consider a swale to be significant. Easements should be a minimum width of 4.5 m, when swales are considered significant, to allow the City access for maintenance.

G.2.3. Major System

G.2.3.1 Roadway Conveyance

Major roadways and local streets often convey runoff during severe storm events and, as such, shall be incorporated as elements of the major drainage system. For new development, road grades shall be constructed to provide positive conveyance to major watercourses or storm sewer inlets. The depth and extent of street flooding in new developments shall be limited in order to protect property and public safety, and allow emergency vehicle access, and shall not exceed flood depths according to the following road classification for the governing 100-year storm event as follows:

1. Arterial and Emergency Routes – 0 mm depth above road crown; and,

2. All other road classifications – 150 mm depth above road crown.

The roadway major system interface between existing and proposed development shall, whenever possible, be positively graded to convey roadway overland drainage to the flow capacity of the existing roadway system while maintaining roadway flooding depths

to the foregoing standards. Should overland flows from the proposed development be above the receiving existing overland flow system, storage of overland flow or other methods of reducing flows to the receiver flow capacity will be required. Should a positively graded major system interface not be possible under normal site grading conditions, as demonstrated by the Proponent, then alternative grading and/or methods of conveying the overland flow, such as, but not inclusive to, sag roadways (saw tooth grading), overland relief points and enlarged storm sewers, shall be reviewed with the City. It shall be demonstrated to the City that street flooding depths are maintained at/or below the foregoing roadway standards. Swale flooding depths are also to be maintained within these guidelines and the proposed minor system is to be designed as per these guidelines, such that the downstream major and minor storm systems are not negatively affected.

Road reconstruction projects within the City of Hamilton should not negatively impact the existing overland flow system. Should road reconstruction projects propose to increase pavement area resulting in overland flow depths above acceptable guidelines, alternative forms of Stormwater management should be investigated such as minor system or off-line storage.

G.2.3.2 Overland Flow Routes

All overland flow from rear yards shall be conveyed to roadways via swales or rear yard catch basins with connecting leads. The overland flow routes, through and from lots, shall be designed such that water levels remain below the finished grade adjacent to the swale. Swales located within the areas other than residential land use shall be designed to convey the 100 year event within the confines of the overland easement and shall maintain flow velocities below the erosion threshold for the swale.

Roads that are proposed to be used as an overland flow route shall be designed as stated within the foregoing Section G.2.3. In all situations the City would prefer overland flow compared to total capture into the storm sewer however, there will be instances where capture of the major system may be required. For example, overland flow routes crossing arterial roads, considered unacceptable. In these cases, (for arterial roads) it must be demonstrated that major system flows up to Regional event can be captured and conveyed either through a culvert or storm sewer to an approved outlet location. Regional storm flow overtopping depth and velocity on roads should be considered in accordance with Ministry of Natural Recourses and Forestry's "Technical Guideline-River & Stream Systems: Flooding Hazard Limit.

Overland flow routes such as natural channel systems shall adhere to the criteria outlined within Section G.2.4 – Natural Watercourse Systems.

G.2.3.3 Roadway Crossings

New roadway culverts and bridges should have sufficient conveyance to pass the Regulatory flow (larger of Hurricane Hazel or 100 year event), in order to avoid adverse backwater effects (ref. MTO Directive B-100). If, due to economics or other mitigating circumstances, this is not feasible, a backwater analysis must be undertaken to

determine the limits of upstream flooding and provide necessary mitigating design modifications.

Arterial and collector roadways in new developments should be, where possible, the only road classifications permitted to cross a watercourse having a drainage area in excess of 125 ha. Spacing and location of roadway crossings other than arterial or collector roads may be considered by the City when documented within the Stormwater Management Plan.

Freeboard and clearance (as defined in the governing Ministry of Transportation Ontario (MTO) manuals and the Ontario Bridge Code) requirements for watercourse crossings should be based on current MTO criteria.

Where a permit is required from a Conservation Authority, watercourse crossings will not be permitted to increase upstream flooding on private lands, unless appropriate waivers can be secured.

Allowable Regional storm event (Hurricane Hazel) flooding depths on roadways should be determined based on the standards within the Ontario Ministry of Natural Resources, River & Stream Systems: Flooding Hazard Limit Technical Guidelines, latest revision.

G.2.4. Natural Watercourse Systems

Where watercourse alterations are proposed as part of a development, the design of such alterations shall incorporate and consider the following:

G.2.4.1 Design Approach and Principles

- Channel design is to be based on natural channel forming processes to achieve a dynamically stable system. The channel evaluation methodology and design approach is to be consistent with the most current Provincial guidelines (ref. Ontario Ministry of Natural Resources, River & Stream Systems: Flooding Hazard Limit Technical Guidelines, March 2006, and Adaptive Management of Stream Corridors in Ontario. MNR, 2001);
- Alteration to a regulated watercourse will require a permit from the respective Conservation Authority (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses) and potentially clearance / authorization from the Federal Department of Fisheries and Oceans (Fisheries Act) and Ontario Ministry of Natural Resources (Lakes and Rivers Improvement Act);
- Remedial works shall incorporate fish habitat protection / mitigation or compensation in accordance with the requirements of the Federal Department of Fisheries and Oceans (DFO) and Ontario Ministry of Natural Resources (MNR), related to stream type and significance; and,

- Remedial works shall incorporate the requirements of the governing Official Plan, as well as the requirements of provincial Ministries and other public agencies for protection of associated natural features such as:

  Environmentally Significant Areas (E.S.A.)
  - City of Hamilton
  - Conservation Authorities

  Niagara Escarpment
  - Niagara Escarpment Commission (NEC)

  Heritage Sites
  - Ontario Ministry of Tourism, Culture and Recreation

G.2.4.2 Setbacks

Conservation Authorities have established various watercourse setback policies which regulate development boundaries. The Proponent should always verify that the most current Conservation Authority's setback policies are being adhered to. Each of the four Conservation Authorities, Hamilton Conservation Authority (HCA), Niagara Peninsula Conservation Authority (NPCA), Grand River Conservation Authority (GRCA), and Conservation Halton (CH), requires development to adhere to their specific setback policies.

The size of setbacks from the watercourse edge to developable lands is typically a function of the significance of the valley form, the sensitivity of the watercourse and the type of development (building or other).

The Conservation Authorities may establish setbacks using Understanding Natural Hazards, MNR, 2001 to define the erosion hazard limit using stable slope allowances. Proponents should be aware that watercourse setbacks will typically be established by a Conservation Authority using the greater of the fisheries, valley and floodplain setbacks.

G.2.4.3 Access / Maintenance

- Creek block dedications adjacent to private land in new developments shall be fenced to prevent human access and encroachment. Fencing shall be on public property, 150 mm from the property line. Private access gates to creek block areas are not allowed; and,
- Natural channel design shall consider channel and utility maintenance requirements by incorporating access routes. Access routes may be located within the appropriate top of bank setback limit or adjacent to the low flow area in appropriately designated areas.

G.2.5. Stormwater Quantity and Quality Controls

Current Stormwater management practice advocates the consideration of Stormwater Management Practices (SWMP's) on a hierarchical basis, whereby more pro-active

techniques are considered first. The SWMP's are grouped under the following headings in order of preferred application:

- Lot Level Techniques, Source Controls and Alternative Development Standards;
- Transport or Conveyance Controls; and,
- End-of-Pipe Controls.

The philosophy behind this hierarchy is that Stormwater management techniques are usually more effective when applied at the source. The City of Hamilton supports Source Water Protection and Water Balancing using available appropriate Stormwater management techniques, such as infiltration technologies cited herein.

The City of Hamilton supports the progressive implementation of a wide range of Stormwater management techniques. This range is expected to increase and change over time, as long-term monitoring results indicating the level of success of various techniques, become available.

The City of Hamilton supports the integration of Stormwater management facilities with passive recreational opportunities, where the intended function of either is not impaired in accordance with the Parkland Dedication Policy. Where proposed, a review of the potential for integration of such facilities with recreational use will be required through consultation between the City of Hamilton, the general public and the Development Proponent.

Table G.1 and G.2 provide the current perspective of the City of Hamilton regarding available Stormwater management practices, as well as special supporting documentation which is required for implementation of each technique.

Table G.1 – Comprehensive List of Available SWMP's

Stormwater Management Technique	City of Hamilton Perspective	Special Supporting Documentation Required to Verify Suitability
Lot Level Techniques, Source Controls, and Alternative Development Standards		
▪ Alternative Development Standards (i.e. Green roofs, biofilters)	On a case-by-case basis	Yes
▪ Reduced lot grades	Not currently endorsed (ref. Lot Grading Standard)	N/A
▪ Roof leader discharge to surface	Encouraged	Address winter icing concerns
▪ Roof leader discharge to soakaway pits ▪ Rear yard ponding	Discouraged in residential land use due to maintenance and impacts on use of rear yards, including WNV	Geotechnical and on-site soil assessment

Stormwater Management Technique	City of Hamilton Perspective	Special Supporting Documentation Required to Verify Suitability
▪ Rooftop storage	Discouraged, due to lack of municipal control. Green roofs can be discussed with the City.	Maintenance Agreement and Restrictive Covenant with owner to prevent alteration to system
▪ Parking lot storage	Only where in Municipal control	Maintenance Agreement and Restrictive Covenant with owner to prevent alteration to system. Easements to be included in covenant with owner.
▪ Porous pavement	Porous pavement applicable in specialized applications. Subject to proper documentation by the Proponent.	Technical documentation required
▪ Pervious pavement	Pervious paving stone applicable in mitigation for thermal impacts; typically appropriate in low volume areas such as overflow parking	Technical documentation required

Table G.2 – Comprehensive List of Available SWMP's

Stormwater Management Technique	City of Hamilton Perspective	Special Supporting Documentation Required to Verify Suitability
Conveyance Controls		
▪ Pervious pipe systems	Pervious pipe applicable in specialized applications, subject to proposed documentation by the Proponent	Geotechnical and on-site soils assessment
▪ Pervious catch basins	Pervious catch basins applicable in specialized applications. subject to proposed documentation by the Proponent	Geotechnical and on-site soils assessment
▪ Grassed swales (semi-urban road sections)	Encouraged where applicable (ref. Official Plan)	N/A
▪ Oversized pipes (Superpipes)	Appropriate in redevelopment of existing areas	Need to demonstrate no other suitable alternative
▪ End-of-Pipe Controls		
▪ Structural		
▪ Wetlands ▪ Hybrids ▪ Wet ponds	Applicable for water quality/quantity treatment	N/A
▪ Dry ponds	Applicable for water quantity	N/A

Stormwater Management Technique	City of Hamilton Perspective	Special Supporting Documentation Required to Verify Suitability
	control only	
▪ End-of-Pipe Controls		
▪ infiltration basins	Limited applicability in the City of Hamilton	Geotechnical and on-site soil assessment
▪ infiltration trenches	Limited applicability in the City of Hamilton	Geotechnical and on-site soil assessment
▪ filter strips	Part of 'Treatment 'Train' only	N/A
▪ buffer strips	Part of 'Treatment 'Train' only	N/A
▪ sand filters	Limited application	Geotechnical and maintenance assessment
▪ oil/grit separators	Applicable primarily for Commercial / industrial land use, shall not be used as a stand-alone SWMP	Maintenance Agreement with City
▪ Non-Structural		
▪ Cash-in-Lieu of On-Site Stormwater Management	Appropriate and supported particularly for infills and in watersheds of low environmental significance	Regional or site specific study of receiver sensitivity and available retrofit opportunities in accordance with DC-By-Law.

G.2.5.1 Source Controls

As noted, the City of Hamilton supports the implementation of source controls where feasible. The feasibility and overall benefit to be derived from implementing source controls would typically be determined in a Subwatershed Study or other form of Master Plan. Where such studies do not exist or are not applicable to the proposed development, the Proponent shall consider the application of source controls as a Best Management Practice (BMP).

Alternative Development Standards (ADS)

ADS are supported by the City of Hamilton on a case-by-case basis. The City of Hamilton Stormwater Master Plan, Class Environmental Assessment Report (City-wide), 2007 supports ADS, such as green roofs, biofilters, and pervious pipe systems. Proponents proposing ADS should consult with the City of Hamilton prior to the detail design stage.

Reduced Lot Grading

The City of Hamilton currently does not endorse reduced lot grading.

Roof Leader Discharge to Surface

Roof leader discharge to rear yard ponding areas is discouraged within the City of Hamilton due to West Nile Virus. Soakaway pits are applicable where infiltration is promoted. Subwatershed Studies on Master Plans may establish the feasibility of soakaway pits and should be followed in establishing subdivision detail design to the satisfaction of City staff. Soakaway pits identified within Subwatershed Studies or Master Plans may be used to serve single residential lots and typically only roof drainage, therefore, no pre-treatment is required.

Rooftop Storage

Rooftop storage has been used extensively in other jurisdictions for large flat roof topped commercial, industrial and institutional buildings for reducing post-development flow rates to storm sewer systems. The City of Hamilton discourages rooftop storage for new and infill development due to the lack of municipal control with a preference to other end-of-pipe controls such as Stormwater management facilities, but shall consider it based on discussion with the respective Development Proponent. The City of Hamilton would require rooftop storage designs be completed in accordance with MOE-CC 2003 guidelines and that the Proponents, agree to a restrictive covenant with the City of Hamilton. Green roof technologies may be discussed with City staff, but it should be noted that this technology is not considered typical rooftop storage.

Parking Lot Storage

Commercial, industrial and institutional developments have used parking lot storage to control post development flows to receiving storm sewer systems. The control structure be located within the development property boundary. Parking lot storage design shall be in accordance with the MOE-CC 2003 guidelines, although ponding depths shall be limited to 0.25 m. Ponding depths within loading bay areas should be designed to a preferred maximum of 0.30 m, although consideration for pond depths up to 1.0 m will be provided by the City due to site hydraulics, as long as the proposed ponding is not detrimental to the site conditions or adjacent properties.

Ponding on parking lot during frequent storms (up to five year) should be avoided.

Porous and Pervious Pavement

Porous and pervious pavements shall be used only for specialized applications as discussed in the MOE-CC 2003 guidelines. Both porous and pervious pavements have the benefit of improving infiltration and reducing thermal impacts of runoff. The Proponent shall provide design documentation to the satisfaction of City staff. A flow restrictor pipe shall be considered for all outlet control structure designs. An orifice plate can also be considered where a standalone restrictor pipe cannot meet flow target.

G.2.5.2 Conveyance Controls

Pervious Pipe Systems

The City of Hamilton may permit pervious pipe systems for special applications in accordance with the MOE-CC 2003 guidelines. In the event that pervious pipe systems are approved, Proponent must ensure there is sufficient clearance from the drinking water systems. Further, it has to be proven that the road base will not be affected by trapped water.

Pervious pipe systems exfiltrate water through the pipe wall and improve groundwater recharge. Existing pervious pipe systems in other jurisdictions have been documented as prematurely failing due to clogging, and as such, the Proponent shall provide technical documentation in support of the design, construction and maintenance requirements to the satisfaction of City staff.

Pervious Catch basins

As per pervious pipe systems, the City may allow pervious catch basins when the Proponent provides supporting documentation to the satisfaction of City staff. Pervious catch basins shall be implemented in accordance with the MOE-CC 2003 guidelines.

Enhanced Grassed Swales

The City supports the use of enhanced grassed swales, where applicable, for Stormwater quality treatment, provided that minimum length, velocity, flow depth and slope criteria are met for full functionality. The MOE-CC 2003 guidelines provides design criteria for enhanced grass swales and should be incorporated into the swale design.

Oversized (Super) Pipes

Super pipes provide subsurface storage to reduce post development peak flow rates to receiving storm sewer systems. The City of Hamilton may permit the use of oversized pipes to provide quantity control only for redevelopment, infill areas, and some smaller developments, when no other practical alternative exists. The Proponent shall incorporate the MOE-CC 2003 guidelines into the super pipe design.

G.2.5.3 End-of-Pipe Techniques

Wetlands

Constructed wetlands based on suitable soil conditions are suitable for providing Stormwater quality control / enhancement for drainage areas 5 ha or greater in size. The MOE-CC 2003 guidelines shall be adhered to in developing the wetland design. The application of BMP's would typically be developed through a Subwatershed Study and the detailed design established through a Stormwater Management Plan for proposed development.

Wet Ponds

Wet ponds are similar to wetlands, but typically are less land intensive. Wet ponds also require a minimum 5 ha drainage area to function effectively. Subwatershed plans typically provide the require guidelines for the Stormwater Management Practices in conjunction with the MOE-CC 2003 guidelines, but should a subwatershed plan not exist, the MOE-CC 2003 guidelines shall be followed.

Dry Ponds

Dry ponds require a minimum 5 ha drainage area. Dry ponds only provide erosion and flood control. Dry ponds do not have a permanent pool component, therefore, any water quality protection / enhancement, would only be as function of the facility's detention time and therefore would not be considered as effective as a wetland or wet pond. The MOE-CC 2003 guidelines provide design criteria for dry ponds, which should be incorporated into dry pond designs.

Hybrid Wet Pond / Wetland

Hybrid wet pond / wetlands systems consist of a wet pond, in series with a wetland. The permanent pool is approximately 50% within each element. The hybrid requires a forebay sized only to serve the wet pond. The MOE-CC 2003 guidelines design criteria for hybrid wet pond / wetland systems should be followed.

Oil / Grit Separators

Oil / grit separators are most appropriate for commercial/industrial land use and shall not be used as stand-alone SWMP, but rather as part of a "treatment train" approach to achieve the required quality treatment. Literature review of independent performance testing suggests that the removal efficiencies of oil/grit separators are only attainable under very specific circumstances, which are highly dependent on study design, specific site conditions, particle size distribution the varying flow conditions under which the tests are conducted. In light of this documentation, the City of Hamilton is prepared to accept, based on the US TARP (Technology Acceptance and Reciprocity Partnership) Tier I Conditional Interim Certification by NJDEP (New Jersey Department of Environmental Protection), that stand-alone OGS devise is only capable of achieving a TSS removal efficiency of 50%. It is the Engineering consultant's responsibility to contact the manufacturer to confirm the status of certification provided by NJDEP.

Infiltration Methods (General)

In general, there are relatively few areas within the City of Hamilton where Stormwater infiltration is critical to maintain downstream ecosystem integrity. Furthermore, the database regarding the impact of Stormwater infiltration on groundwater quantity and quality is currently limited. The application of this best management practice would typically be subject of a subwatershed study or other form of detailed local master plan.

Notwithstanding, various plans such as the Community of Stoney Creek Stormwater Quality Management Strategy Master Plan, 2004 outline areas of hydrogeological

sensitivity. Proponents of developments located within such areas shall provide site-specific soils investigations, confirming the potential effectiveness of infiltration techniques and the impacts on groundwater recharge and quality.

In the absence of such studies, the Proponent is encouraged to consider infiltration methods only where soil conditions warrant, and particularly in condominium-style residential developments. In either event, the Proponent propose infiltration methods as part of the Stormwater management plan, the potential impacts to the groundwater shall be clearly demonstrated in terms of quantity and quality; this may require the implementation of a groundwater monitoring program. Proponents should review the Groundwater Resources Characterization and Wellhead Protection Partnership Study available upon request from the Sustainable Initiatives Division of the Public Works Department.

Infiltration Trenches

Subsurface / surface trenches refer to infiltration systems, which typically can be implemented for small drainage areas (<2 ha) and are best suited for residential land use. Infiltration systems are best suited for high density housing such as townhouses, where several homes can drain to one trench. Townhouse condominium complexes will require infiltration trench maintenance requirements and ownership details to be included within the property title Agreement. The City of Hamilton shall require an easement from City property to the infiltration trench(s) to ensure maintenance of the trench is being provided by the townhouse condominium corporation. Soil conditions should provide suitable infiltration capacity. The MOE-CC 2003 guidelines should be incorporated into the infiltration system design.

Filter Strips

Filter strips are only considered appropriate for low-density development, roads and small drainage areas (<2 ha). Vegetated filter strips should be located adjacent to watercourses and drainage swales, as these systems can receive the sheet flow produced by the filter stripe 2003 guidelines should be adhered to in the design of the filter strip.

Buffer Strips

Buffer strips comprise natural areas located between development and the receiving water system or natural area. Buffer strips should be established and define at the subwatershed planning level with input from the Conservation Authority.

Sand Filters

Sand filters shall be limited to a drainage area less than 5 ha. Sand filters shall require a form of pre-treatment and shall not be used as a stand-alone SWMP. The type of filter shall consider the surrounding soil condition and the possibility of being connected to the proposed storm system.

The MOE-CC 2003 guidelines outline the conditions and criteria for filters.

G.2.5.4 Cash-in-Lieu of On-site Stormwater Management

In principle, cash-in-lieu on-site of Stormwater management would involve a Development Proponent providing a designated financial contribution towards off-site Stormwater management infrastructure, elsewhere in the City, in lieu of providing on-site Stormwater management. The prerequisites to such an approach include a low sensitivity receiver, or limited rehabilitation opportunity and typically small or infill development form. The Proponent is to provide a report that outlines where the cash-in-lieu can be applied.

G.2.6. Spill Prevention and Control

Spill prevention and control measures shall be implemented for all industrial and commercial developments that process, store or refine liquid products that would be considered a contaminant within the receiving Stormwater system, to ensure that spills or leaks do not impact downstream water quality. Examples of spill control BMP's used for the prevention of the discharge of pollutants to the Stormwater system are:

- Oil / grit separators;
- Spill containment tanks;
- Stormwater facility shutoff valves;
- Vehicle loading area covering;
- Vehicle loading procedures; and,
- External storage area containment.

Industrial and commercial developments shall develop a spill prevention and control plan incorporating appropriate preventative spill measures, identification of spill areas, material handling procedures and spill response procedures. The Proponent shall outline the methods of spill reporting, assessing, monitoring and coordination of spill clean-ups. In addition, the Proponent should note that the spill control BMP's effluent is regulated by the Sewer Use By-Law. The Proponent shall submit the spill prevention and control plan to the City's Compliance and Regulations Section of the Public Works Department.

G.3. EROSION AND SEDIMENT CONTROL

G.3.1. Erosion and Sediment Control Plan

New urban developments can accelerate natural sediment loading rates to the surrounding water bodies, particularly during construction, when the ground cover has been removed. In order to control the impacts of sediment loading from development (i.e. poor water quality and aesthetics, restricted channel conveyance etc.), it is required that erosion and sediment control measures be instituted.

Some of these measures typically include sediment traps (temporary or permanent), vegetation screens, catch basin filter bags and phased stripping of developable lands. In all cases, it is recommended that sediment loading be controlled as per guidelines published by the local Conservation Authority (ref. Erosion and Sediment Control Guidelines for Urban Construction, GTA Conservation Authorities, 2006) and provincial guidelines (ref. Ontario Guidelines on Erosion and Sediment Control for Urban Construction Sites 1987).

As a minimum, Proponents shall prepare Erosion and Sediment Control Plans that incorporate recommendations and protection measures pertaining to:

- Planning site construction to fit the terrain;
- Construction scheduling / timing of grading;
- Minimizing soil exposure and re-establishment of vegetative cover;
- Provision of temporary cover for stripped areas scheduled to be dormant for over 30 days;
- On-site erosion and sediment techniques (e.g. diversion of runoff away from stripped areas);
- On-site control measures;
- Site Supervision procedures;
- Monitoring and Maintenance;
- Site Restoration; and,
- Special Considerations (i.e. in-stream construction / crossings, fisheries timing constraints.

The foregoing should be clearly defined within both the Functional and Final Design Stormwater Management Reports, as well as on the detailed Engineering design drawings.

G.3.2. Regulation

Topsoil preservation by-laws that were enacted in the former Municipalities have been amalgamated into a common by-law for the City of Hamilton under a Site Alteration By-law No. 03-126. Landowners need to be aware of, and comply with, the most current by-law.

Sediment and Erosion Control Plans, once approved by the City and appropriate Conservation Authority, will form part of the Development Agreement.

The Development Proponent will be required to hire a qualified environmental inspector who will submit monthly status reports to the City's Development Engineering Section until the development is 80% built out. The reports must be signed by a qualified Professional Engineer. Details of the requirements of the inspection report are available in Appendix H – Erosion and Sediment Control Inspection Report. An inspection is also required immediately after (i.e. within 24 hours) a major storm event (considered a 15 mm total rainfall depth over 24 hours or less). Environment Canada through its website

provides daily rainfall amounts for the City of Hamilton. The City will develop a monitoring program with the Proponent and ensure compliance through the Subdivision Agreement. Developments that are less than 1 ha in size are not required to provide monthly status reports to the City. When considering a block development this condition may be covered by the Site Plan.

The City will require a Letter of Credit for erosion and sediment control infrastructure. City inspectors will regularly inspect sites for erosion and sediment control deficiencies.

The requirement for monthly inspection reports may be relaxed or modified under certain conditions (e.g. when the site is dormant over an extended period), provided the Development Proponent can provide adequate justification to City staff to support such a request.

G.3.3. Proponent / Builder Responsibility

Once a development is serviced with utilities and roads (i.e. ready for building contractors), the focus of erosion and sediment control shifts from the general site development to the specific lot-level controls. It is the responsibility of the Proponent, as per the Subdivision Agreement, to ensure that excess sediment is not allowed to be transported off lots and into gutters, catch basins, storm sewers and watercourses, or tracked off-site by vehicles. Inspections and reporting shall be tailored to reflect the changes in construction practices and locations on the site. Inspections and reporting shall be the responsibility of the Proponent, with builders responsible to the Proponent.

G.4. DEVELOPMENT IMPACT MONITORING

G.4.1. Need

All land use change without (and often with) mitigation work, causes an impact to the runoff regime. Stormwater management measures are intended to reduce or eliminate adverse impacts to surface water, groundwater and receiving systems resulting from changes to runoff quality and quantity. The theoretical performance and function of Stormwater management works has been relatively well documented. However, unique conditions are associated with each development, such as: topography, land use, soils, groundwater levels, design approach, construction methods, etc. All of these factors can combine to reduce the predictability of the performance of Stormwater management infrastructure, leading to the need for at least a minimum level of monitoring, prior to, and possibly after, assumption by the City. In that regard, Development Proponent shall submit a Development Impact Monitoring Plan to the City for approval (ref. Sections G.4.2 - Purpose to G.4.6 - What is Monitored?). Conservation Authorities and the Niagara Escarpment Commission, in addition to the City, may have input on Monitoring Plans.

G.4.2. Purpose

The purpose of the Development Impact Monitoring Plan is to:

- Evaluate the performance of the Stormwater and Environmental Management System (i.e. design and Stormwater quantity and quality mitigation techniques). This does not include the storm sewer system; and,
- Provide the necessary information to adjust and/or optimize the plan recommendations through a process of monitoring various environmental parameters established within a Monitoring Plan for a development site. Based on monitoring results, necessary adjustments to the site's environmental management controls would be made to meet the environmental objectives for the site.

G.4.3. Types of Monitoring Plans

Generally, Monitoring Plans are either one or two types. The first is a stand-alone plan prepared for a single development and its associated infrastructure. The details of this type of plan would be part of the Preliminary and Final Stormwater Management Design Reports. The scope is normally limited to direct on-site infrastructure that is part of the development; this is paid for by the Proponent.

The second type of Monitoring Plan would be part of a Drainage Master Planning document, such as a Watershed Plan, Subwatershed Plan or Class Environmental Assessment, usually in support of a major land use change of broader scope. Such a plan is normally administered by the City. Its scope typically includes numerous environmental indicators and infrastructure elements.

G.4.4. Process / Protocol

Each Development Proponent will be responsible to ensure that a Monitoring Plan is in place, satisfactory to the City. In the event that the subject development is part of an area which already has a master Monitoring Plan in place, the Proponent shall document how the subject development and its infrastructure complies with the plan.

Where applicable, monitoring requirements shall comply with those specified in the Master Drainage Plan or the Sub-Watershed. For developments where specific criteria are not outlined the City, in consultation with the appropriate conservation authority, will work with the Proponent to develop a monitoring protocol on a case by case basis. These requirements will be dependent on the specific needs and environmental constraints associated with the receiving watercourse.

Where the subject development is 'non-greenfield' (i.e. typically infill or 'brownfield') and is not part of an area covered by a Drainage Master Plan, the Proponent shall consult with the City staff during the pre-consultation stage to determine if monitoring is required. Should monitoring be required, the Proponent shall prepare a Monitoring Plan as part of the Preliminary and Final Stormwater Management Plan, in consultation with the City. The Monitoring Plan should be established to determine the potential development impacts on-site and within the receiving system to the satisfaction of the

City. It should be noted that the Monitoring Plan for infill development shall not be as extensive as per required for the 'greenfield' development. Costs of the monitoring program would be borne entirely by the Proponent.

Under the 'greenfield' approach, no reporting or direct follow-up involvement with the individual Proponent will be required, as the full share cost of the program will have been secured. Under the 'infill' approach, the Proponent will be responsible to submit annual reports prepared by a qualified Professional Engineer, to demonstrate that the monitoring has been completed to the satisfaction of the City.

G.4.5. Monitoring Periods

Development Agreements will typically provide insight and direction on timeframes for construction, warranties and assumption. Important factors for development impact monitoring include pre-construction, construction and post-construction or substantially developed requirements. During construction, the monitoring requirements would strictly relate to those specified in the Erosion and Sediment Plan (ref. Section G.3 - Erosion and Sediment Control). Hence, development impact monitoring applies only to the pre- and post-construction state, normally considered to come into effect two or three years after start-up of construction. A one year maintenance period typically follows placement of top course asphalt within a development. The securities, typically 10% of construction costs, during the maintenance period would be required to address Stormwater infrastructure deficiencies (this is not in addition to the 10% held by the City currently for maintenance). This timeframe can obviously change depending on market and contractor progress. The specifics will need to be detailed in the associated Stormwater management reporting.

G.4.6. What is monitored?

The actual specifics of what is monitored and the length of the monitoring program, relate largely to the characteristics of the development and in-situ conditions, including the sensitivity of the local receiving system and the availability of existing information. The ultimate decision with regard to monitoring scope requirements rests with the City and commenting agencies, through the review of the Preliminary and Final Stormwater Management Reports. DFO will require Monitoring Plans should a project constitute a Harmful Alteration, Disruption or Destruction (HADD) of fish habitat and are typically a minimum length of two to three years. While not intended to be exhaustive or mandatory, the following general list provides some guidance.

Hydrometerologic

- Rainfall – Continuous
- Streamflow – Storm Response
- Groundwater – Levels
- Baseflow – Flowrate (Spot)
- Water Quantity

- Inflow / Outflow at stormwater management facilities – Wet Event Response, Facility Storage-Discharge Relationship

Water Quantity

- Inflow/Outflow At Stormwater Management Facilities – Wet Event Response Facility Storage - Discharge Relationship

Water Quality & Aquatic Habitat

- Benthic Invertebrates – Community Structure
- Water Temperature – Continuous
- Surface and Groundwater Chemistry Standard Parameters including Nutrients, Metals and Bacteria
- Sediment – Total Suspended Solids
- Fisheries – Electrofish Selected Reaches

Fluvial Geomorphology

- Stream Cross-sections (Controls)
- Sediment Transport (Substrate
- Composition
- Erosion pins (Tractive Force, Critical Shear Stress)
- Bank Properties (Height, Angle, Material, Vegetation, Root Depth, Undercuts and In-situ Shear Strength)
- Long Profile Survey (Energy Gradient, Top and Bottom Riffles, Max Pool Depth)

Natural Heritage System

- Community Structure / Health – Ecological Integrity, Habitat Boundary Integrity, Problem Species, Overall Species and Habitat Diversity, Buffer Effectiveness, Human Activity Impacts Local Hydrology (water levels, soil moisture, etc.)

G.4.7. Enforcement

As part of the requisite development Agreements, the City will hold a portion of the Letter of Credit as security to ensure that the whole of the monitoring program is completed, as detailed in the accompanying Stormwater Management Report. Proponents shall conduct the monitoring program, should the development not be part of a Master Monitoring Plan established within a Watershed Study, Subwatershed Study or Master Drainage Plan. Should the Proponent's annual reporting not be considered appropriate or compliant, the City will exercise the Letter of Credit and have the monitoring program completed by accredited professionals. The 10% securities would be used by the City to adjust the drainage system, as necessary, including channels

and Stormwater management facilities for the monitoring period as defined by the City, the Conservation Authorities and DFO.

G.5. ANALYTICAL METHODS

Analytical methods can be subdivided into two categories, Hydrology and Hydraulics, representing the establishment of flows and flow levels, respectively. Hydrology typically precedes the determination of hydraulics for all new development and redevelopment, as flows are required to establish the hydraulic characteristics of open and closed systems.

For both hydrology and hydraulics, there are numerous available analytical methods. The analytic methods provided in this document represent established techniques that are considered acceptable by the City of Hamilton. The Proponent is not limited to the methods herein, although discussion with the City of Hamilton and review agencies would be required to confirm the appropriateness of using alternative hydrologic and hydraulic analytical techniques prior to their use.

G.5.1. Hydrology

G.5.1.1 Rainfall

Intensity – Duration – Frequency (IDF)

The IDF Curves / Hyetographs for the former municipalities' design storm events have been replaced with new IDF Curves / Hyetographs, based on current rainfall information. Rainfall data from both the Hamilton Airport and Royal Botanical Gardens (RBG) has been reviewed. Based on maintaining simplicity, the more conservative Hamilton Airport IDF relationship has been adopted (ref. Appendix G – IDF Curves / Design Storms). Notwithstanding the foregoing, both Hamilton Airport and RBG rainfall data should be considered for Watershed, Subwatershed and Master Drainage Plans, but not for design of storm sewer infrastructure.

Table 1 in Appendix I - Current Streamflow and Rainfall Monitoring in Hamilton Harbour Watershed provides the location of current City of Hamilton rainfall gauges, specifying the duration of rainfall record for each gauge. The table also provides stream flow monitoring locations. In addition to the stream flow monitoring locations in Table 1, water levels within the Binbrook Reservoir (Wetland River) are continuously monitored by the NPCA.

Temporal Distributions

Typically, there is not a single temporal distribution that should be used exclusively within the City. Each distribution has its own unique characteristics, which can be used to fulfill different hydrological analysis requirements. It is the responsibility of the Proponent to establish which distribution should be employed in establishing the design events for a development of redevelopment to the satisfaction of the City. Consideration should be given to the drainage area(s) size, characteristics and objective functions when determining which temporal distribution to use. To this effect, a document

containing various design storms and temporal distributions considered acceptable for use within the City of Hamilton is available upon request. The City will approve the selected rainfall distribution at the Functional Design Stage. A document outlining various durations of the AES, SCS and Chicago design storms is also available upon request.

The SCS storm distributions utilize mass rainfall curves to derive the design storm. SCS Type II design storms typically provide the highest peak flow for rural catchments in comparison to the Chicago distribution. The Chicago distribution developed from an Intensity-Duration-Frequency (IDF) relationship generally provides greater peak flows for urban areas than the SCS Type II distribution.

The AES 1-Hour Strom Distribution can be used in developing a hyetograph with knowledge of the total rainfall, time to peak and decay constant. This storm distribution is not as widely used as the SCS Type II and Chicago storm distributions and should be compared to the other distributions in determining the controlling storm design.

The selection of the duration of the rainfall event should also consider the drainage area characteristics and Stormwater management approach. In addition, approval agencies other than the City of Hamilton should be consulted in determining both the type of temporal distribution and the storm event duration. The City of Hamilton will have to approve the selected temporal distribution based on a sensitivity analysis before finalizing the functional SWM report.

G.5.1.2 Rational Method

The Rational Method of determining design flows should only be used as an approximation of flows for relatively small drainage areas (i.e. less than 5 ha) due to the conservativeness of the approach. Flows determined using the Rational Method are typically higher than those resulting from complex hydrologic models.

The Rational Method can be used for storm sewer design regardless of the total contributing area, using the City of Hamilton's storm sewer design sheet and the new IDF relationship for Mount Hope Airport rainfall gauge (ref. Appendix G – IDF Curves / Design Storms).

G.5.1.3 Event Based Hydrologic Models

A list of event based hydrologic models considered appropriate has been provided within Appendix J – List of Approved Hydrologic and Hydraulic Models. The list will be periodically reviewed (every 5 years) to include either new hydrologic models or models considered appropriate at the time of preparation. Should a Proponent wish to use another model, documentation as to the validity of the model should be provided to City staff for review prior to use.

Both the Flood Plain Management in Ontario Technical Guidelines, Ontario Ministry of Natural Resources, 2001 and the Drainage Management Manual Parts 3 and 4, Ministry of Transportation, 1997 provide general guidelines on the selection of hydrologic models. The Ministry of Transportation document lists the characteristics of each model,

from which the Proponent can evaluate the appropriateness of certain event based hydrologic models.

Sound hydrologic modelling standards of practice should be followed in developing an event based on hydrologic model. The following standards of practice are intended to guide general model preparation for most hydrologic programs and techniques, however, this list should not be considered exhaustive:

- The modeller should provide the purpose for developing the hydrologic model, such as determining flow rates, runoff volumes, flow routing effects for proposed development, existing land use conditions etc.;
- The modeller should provide the study objectives and how they relate to the hydrologic modelling;
- The modeller should provide the basis for the storm design information, outlining how the design storm has been selected;
- The modeller should provide drainage area plans outlining both internal and external catchments, modeling schematics and tables providing drainage area parameters;
- Background information on the selection of the drainage area parameters should be provided to assist the City in understanding on the assumptions leading to the drainage area parameters;
- Background data on overland and minor storm systems should be provided with plans clearly presenting and labelling both systems;
- Data should be provided on routing through natural and manmade storage systems, with detailed plans and calculations outlining how the stage / discharge relationship has been developed;
- Sensitivity analysis should be conducted on a minimum number of parameters which varies with model complexity;
- Verification or validation of results should be provided through various methods such as calibration to recorded streamflow, unit flow rates and runoff volume comparisons using the techniques such as the MTO index method or equivalent. The application of the validation technique (number and type) will depend on the availability of data and the sensitivity of the analysis; and,
- The modeller should provide all input and output details in a logical manner, with an explanation for potential errors.

G.5.1.4 Continuous Models

Continuous models (ref. Appendix J – List of Approved Hydrologic and Hydraulic Models) differ from event based hydrologic models in that rather than using a synthetic design storm based on IDF data, a long term time series of historical meteorological data is used for the input driving function. In addition to historical rainfall data, continuous models typically require seasonal state variables. Continuous models are usually more complex than event based hydrologic models, as typically the models consider more processes including temperature, evapotranspiration, snow conditions and groundwater. Notwithstanding, the modelling standards of practice for event based

on hydrologic models also apply to continuous models. Continuous models are typically used but are not limited to higher level studies such as watershed and subwatershed studies. Continuous modelling may also be used for studies with a scope requiring historical data inclusion.

In addition to the standards of practice for event based hydrologic models, the Proponent should demonstrate that the historical meteorological time series selected has been obtained from the nearest rainfall gauge to the Proponent's study area. This will often lead to a trade-off between duration of record and proximity. Typically, the minimum duration for meaningful continuous simulation is 20 to 25 years. Historical rainfall data is available from the City, Conservation Authorities and Environment Canada.

The Proponent in selecting a continuous hydrologic model usually intends to develop frequency flows for the historical data period. The Proponent should specify the assumptions and methodology for determining the frequency flows and typical year hydrographs. The Proponent should provide validation of the selected probability distribution by using statistical tests.

The Proponent should select the continuous model giving consideration to development and/or redevelopment characteristics to the satisfaction of the City. In addition approval agencies (i.e. Conservation Authorities, MNR, MTO and others) other than the City should be consulted to determine modelling requirements.

G.5.2. Hydraulic Capacity

Drainage systems can be subdivided into both closed and open systems. The hydraulic capacity of the receiving minor and major storm system is to be determined to verify that drainage can be safely conveyed as proposed. For each system various analytical techniques can be employed. Appendix J – List of Approved Hydrologic and Hydraulic Models lists hydraulic analytical techniques acceptable to the City; however, the list should not be considered exhaustive. The Proponent is not limited to the methods herein, although discussion with the City and review agencies (Conservation Authorities, MNR, MTO and others) would be required to confirm the appropriateness of using alternative hydraulic analytical techniques.

The hydraulic capacity of a storm system can be determined through hydraulic modelling and for certain applications through the use of standard 'hand calculations'. As for hydraulic modelling, standards of practice relate to the use of various techniques. The following standards of practice are intended to provide direction:

- The Proponent should clearly identify the study objectives and how they relate to the hydraulic modelling;
- The Proponent should provide the purpose for the hydraulic modelling;
- The modeller should provide the model selection criteria and how the model matches the criteria;
- The Proponent should provide plans clearly presenting the closed and/or open hydraulic system;

- For plans describing open systems, the Proponent should note cross-sections, study limits, land use, crossing details, spill areas, ineffective flow areas, and flooding limits and elevations for the appropriate design event(s);
- For plans describing closed systems such as storm sewers, the Proponent should note the storm sewer network details including maintenance hole numbers, storm sewer size, length, study limits, land use, slope and sewer and ground elevations;
- For combined hydrologic / hydraulic models such as SWMM, the Proponent should provide plans that not only describe the close system but also the contributing drainage areas and overland flow system;
- For all hydraulic models, the Proponent should provide the downstream and, if applicable, the upstream boundary conditions for each storm modeled and the assumptions used to define the boundary conditions;
- For all hydraulic models, the Proponent should document the parameters established for hydraulic losses such as Manning's 'n', inlet and outlet losses and other appropriate losses;
- The Proponent should summarize the selection of procedures for determining the computer energy grade line and water surface elevations;
- The Proponent should document the hydraulic results in summary form for the relevant storm events;
- The Proponent should prepare the model of an open system such that it fully contains the modelled flows without exceeding the hydraulic cross-section. Should it not be possible to contain the flows within the defined geometry of the open storm system, the Proponent should provide details on the spill characteristics. In the event of a spill, a rationale should be provided on whether or not to include a flow loss in the calculation;
- The Proponent should document potential impacts on existing infrastructure and possible mitigative measures;
- Sensitivity analysis should be conducted on a limited number of parameters depending on the model type and complexity;
- The Proponent should, if possible, verify hydraulic results for an existing closed / open storm system by documenting historical flood elevations for specific storm events and comparing the hydraulic modelling results to the historical data; calibration of losses should be included, if sufficient data exists; and,
- The Proponent should provide the input and output data in a logical manner with an explanation of the potential error.

The hydraulic capacity of storm sewers is to be determined using the City of Hamilton Storm Sewer Design Sheet (ref. Appendix F – Storm Sewer Design Sheet / Combined Sewer Design). The Proponent is required to abide by the relevant hydraulic modelling codes of practice (i.e. specifically No.'s 1,3,6,8, and 9). In addition the Proponent should document, in both plans and text, hydrology for the storm sewer design. The storm sewer design should be conducted using the City of Hamilton's 5 year IDF storm data of the City's approved storm event for the study area (regardless of the return period used previously to size downstream storm sewers).

G.5.3. Stormwater Management Design – Analytic Requirements / Methods

G.5.3.1 Flood Management

All newly developing or redeveloping areas must assess their potential impacts on local and regional flooding, mitigate accordingly. In areas where no watershed plan has been completed, it is the policy of the City of Hamilton to require that runoff peak flows are controlled to pre-development levels or less, unless the Proponent can demonstrate through appropriate modelling and analysis that uncontrolled flow will not cause detrimental impacts on flood conditions on downstream properties and watercourse systems. Before the City will accept any increase in runoff rates, it must also receive endorsement from the agencies having jurisdiction. In certain site-specific circumstances, the City may require that post development flows be controlled to less than pre-development levels. As such, discussion regarding the over-control of post development flows would be required with the City.

Where Watershed Subwatershed or Master Drainage Plans have been completed, the Development Proponent will be required to comply with the recommendations of the specific plan. Any variations will need to be appropriately supported by detailed analysis and also be approved by any agencies having jurisdiction.

In some areas post-development discharge from development areas are required to meet the unitary flow criteria where it has been established through a Subwatershed or Master Drainage Study to ensure protection of any sensitive natural systems. It is incumbent on the Proponent to demonstrate through appropriate modelling methodologies that the design satisfies the unitary flow criteria where applicable.

Sizing flood management controls (i.e. Stormwater management quality control facilities) is typically an iterative procedure. The Proponent should develop a stage / storage / discharge curve for a Stormwater management control facility by determining the required runoff volume to be detained for various storm events.

The procedure for runoff determination typically requires the modeller to use either an event based or a continuous hydrologic model. The modeller should determine which modeling methodology to use. The first step in methodology selection should be whether or not a watershed, subwatershed or similar previous study has been completed and the type of modeling used. If no previous study has established the modeling requirements, the following should be considered in selection of a methodology:

- The sensitivity of the watercourse from fisheries and erosion perspectives;
- The availability of long-term meteorological continuous data;
- The availability of stream flow data; and,
- The potential for Stormwater management long-term monitoring.

For an event based hydrologic model, the Proponent typically stores the volume of the post development flow hydrograph above the pre-development hydrograph. For continuous modeling, the Proponent can size a facility by comparing controlled post

development flows to the pre-development flows using frequency analysis. In addition, the post development continuous model can be compared to the pre-development model for various rainfall events. This requires the modeller to compare the size and shape of a flow hydrograph from a Stormwater quantity facility to the pre-development hydrograph for the same storm events.

In providing the City of Hamilton details on flood management, the Proponent should follow standard codes of practice. The following standards are intended as a guide of requirements; however, this list should not be considered exhaustive:

- The Proponent should provide the background hydrology behind the pre-development post-development and controlled post-development scenarios (ref. hydrologic modelling G.5.1.3. and G.5.1.4);
- The Proponent should provide details on the stage / storage / discharge relationship of the flood control facility. Methodology of determining the relationship shall be provided;
- The Proponent should provide cross-sections of the facility and details of the inlet(s) and outlet(s);
- The facility should have an overflow weir which is typically required for the uncontrolled Regulatory storm event;
- The facility should have a maintenance access for both the inlet(s) and outlet(s); and,
- The Proponent should provide landscaping details.

G.5.3.2 Erosion Control

Depending on the downstream water level and the nature of the soil strata affected, streambanks can be subject to increased erosion potential. In these cases the Proponent(s) will be required to provide appropriate protection in accordance with the Watershed, Subwatershed or Master Drainage Plan, as well as the policies of the appropriate Conservation Authorities, and possibly the Niagara Escarpment Commission.

In areas where no Subwatershed Plan exists, it shall be the responsibility of the Development Proponent to provide adequate erosion protection in accordance with Provincial Guidelines, unless it can be demonstrated through appropriate modelling and/or analysis that stream stability will not be adversely affected by the proposed development.

Erosion control and management involves one of the following:

- Extended Detention storage for the Simplified or Detailed Design Approach or the 25 mm storm event as outlined in the Provincial Guidelines (ref. Stormwater Management Planning and Design Manual, MOE-CC, 2003), in the absence of specific direction from a Subwatershed or Watershed Plan;
- Assessment of downstream erosion susceptibility and critical flow values in conjunction with event modelling; and,

- Assessment of downstream erosion critical velocity or shear forces in conjunction with continuous simulation techniques (duration analysis).

In areas where the downstream receiving watercourse is determined to be unstable, or where control/over control of flow rates is ineffective or not feasible, design of channel alterations may be considered, subject to design in accordance with natural channel design principles (ref. Ontario Ministry of Natural Resources, River & Stream Systems: Flooding Hazard Limit Technical Guidelines, March 2006).

Storm sewer outfalls in natural channels should be provided with proper protection against erosion which includes appropriate bank scouring protection on either side of the outfall and creek. When storm sewer outfalls outlet to steep and / or deep valleys, drop structures should be designed in such a manner as to provide integral bank stability. Such local erosion protection measures should be designed so as not to interfere with the natural channel forming processes of the receiving watercourse system.

The Proponent should consider the following standard codes of practice in providing erosion control documentation:

- The Proponent shall provide the rationale and background information for the methodology used in assessing the required erosion controls;
- The Proponent should provide downstream erosion threshold parameters based upon field investigation and background information;
- The Proponent should demonstrate how the erosion controls have adequately addressed downstream erosion conditions;
- The Proponent should, in the case of an erosion control Stormwater management facility, provide:
  - Stage-storage-discharge details and calculations;
  - Outlet control details;
  - Facility plan and cross-sections; and,
  - Watercourse configuration at outlet; and,
- The Proponent should document any proposed mitigation measures and provide the calculations performed in determining the measures.

G.5.3.3 Quality Management

Water quality treatment performance shall conform to Provincial requirements (ref. Stormwater Management Planning and Design Manual, MOE-CC, 2003; Water Management Policies, Guidelines Provincial Water Quality Objectives (Blue Book), MOE-CC, 1994), City of Hamilton and Conservation Authority Requirements. For areas where a Watershed, Subwatershed or Master Drainage Plan has been prepared and approved, the guidelines and criteria cited within the plan shall be adopted by the Development Proponent.

Specific guidelines for SWMP application have been developed by the Province based on the type of fisheries habitat downstream of the proposed development. Three levels

of protection are given, with the goal of maintaining or enhancing existing aquatic habitat, based on the suspended solids removal performance developed through continuous simulation modeling for the different end-of pipe Stormwater management facilities. These levels of protection are based on a general relationship between the end-of-pipe Stormwater management facilities' long-term suspended solids removal and the lethal and chronic effects of suspended solids on aquatic life. The levels of protection correspond to the following long-term suspended solids removal:

Level 1 - Enhanced protection corresponds to the end-of-pipe storage volumes required for the long-term removal of 80% of suspended solids. Areas outleting to Hamilton Harbour shall provide level 1 treatment.

Level 2 - Normal protection corresponds to the end-of-pipe storage volumes required for the long-term removal of 70% of suspended solids. Areas outleting other than Hamilton Harbour shall provide level 2 treatment.

Level 3 - Basic protection corresponds to the end-of-pipe storage volumes required for long-term removal of 60% of suspended solids.

Proponents shall contact the appropriate Conservation Authority to establish current watershed habitat classifications. Within the City of Hamilton, the following habitat classifications apply:

Table 6.3
Watershed Habitat Classification

Watershed	Conservation Authority	Habitat Classification
Bronte Creek	Conservation Halton	Enhanced
Grindstone Creek	Conservation Halton	Enhanced
Big Creek	Grand River Conservation Authority	Contact GRCA[1]
Fairchild Creek	Grand River Conservation Authority	Contact GRCA[1]
Ancaster Creek	Hamilton Conservation Authority	Enhanced
Battlefield Creek	Hamilton Conservation Authority	Normal
Borer's Creek	Hamilton Conservation Authority	Enhanced
Chedoke Creek	Hamilton Conservation Authority	Enhanced
Fifty Creek	Hamilton Conservation Authority	Normal
Red Hill Creek	Hamilton Conservation Authority	Enhanced
Spencer Creek	Hamilton Conservation Authority	Enhanced
Stoney Creek	Hamilton Conservation Authority	Normal
Sulphur Creek	Hamilton Conservation Authority	Enhanced
Tiffany Creek	Hamilton Conservation Authority	Enhanced
Forty Mile Creek	Niagara Peninsula Conservation Authority	Headwaters - Normal

Table 6.3 Watershed Habitat Classification		
Twenty Mile Creek	Niagara Peninsula Conservation Authority	Main Channels - Enhanced, some Tributaries· Normal
Welland River	Niagara Peninsula Conservation Authority	Main Channels - Enhanced, some Tributaries· Normal
[1] As GRCA does not have subwatershed plans for Big and Fairchild Creeks within the City of Hamilton, projects that may have an impact on fish habitat and/or local water quality or quantity should be submitted to the GRCA for review on a case-by-case basis.		

As a general consideration, maintenance of the natural hydrologic cycle, including infiltration, is encouraged where soil conditions permit. Therefore the use of Stormwater management practices which enhance or maintain infiltration should be considered for each development. Generally, active infiltration measures will be applicable in permeable soils areas only and their use will require supporting soils documentation.

In all cases, the potential for groundwater contamination shall be considered, particularly where infiltration of road runoff is contemplated.

In areas where hydrogeologic concerns are identified and/or critical linkages to fisheries habitat are present, additional study and analysis of the following may be required to determine the appropriate level of mitigation:

- Hydrogeological conditions related to groundwater contributions to watercourse baseflow and potential impacts from proposed development;
- Groundwater recharge areas within and adjacent to proposed development;
- Private wells within and adjacent to proposed development and the potential impacts to private wells remaining following development completion; and,
- Stormwater management measures that may maintain and/or enhance watercourse baseflow conditions.

In areas where (i.e. quantity control), quality management also has standard codes of practice which are used within the water resources management industry. The following should be considered general guidelines in providing Stormwater quality management for the City's review; however, it should not be considered exhaustive:

- The Proponent must provide the background hydrologic data for the Stormwater quality management control being proposed (ref. Section G.5.3 - Stormwater Management Design - Analytic Requirements/Methods ,inclusive of subsections)
- The Proponent must indicate the criteria that the quality management control is being developed from, whether it is Ministry of the Environment 2003 guidelines, a Subwatershed Study or other;

- The Proponent must provide plans of the quality management measure(s) with cross sections of the facility(ies), details of inlets, outlets, maintenance access, berm construction and landscaping;
- The Proponent must provide calculations for Stormwater quality control facilities such as the following:
  - Volumetric sizing;
  - Stage / storage / discharge relationship;
  - Volume calculations at various facility stages;
  - Outlet control calculations - drawdown time;
  - Forebay settling calculations;
  - Forebay dispersion length;
  - Minimum forebay deep zone bottom width;
  - Length / width ratios; and,
  - Maintenance requirements.
- The Proponent must provide dimensions for all facility attributes and provide verification that the facility meets minimum Ministry of the Environment 2003 guidelines;
- The Proponent must provide a landscape plan for all applicable facilities, which would include background text and comparison to Ministry of the Environment 2003 guidelines;
- The Proponent must provide soils information for the facility site and, in the case of proposed infiltration, document the quantity and quality impacts to groundwater recharge;
- The Proponent must minimize external drainage area overland flow impacts on the proposed Stormwater quality control facility;
- The Proponent must indicate proposed flow by-pass conditions and impacts on Stormwater quality;
- The Proponent must provide a maintenance and operation manual with the detail design of the facility, which outlines requirements for the City;
- The Proponent must develop a monitoring program for all applicable Stormwater quality control facilities, which not only fulfills Ministry of the Environment requirements, but also the requirements of the City, Conservation Authorities and other relevant approval agencies; and,
- The Proponent must address winter operations for the proposed Stormwater quality control facility (ref. Stormwater Management Planning and Design Manual, MOE-CC, 2003).

G.5.4. Natural Channel Design

Natural channel design involves numerous disciplines such as certified geomorphologists, water resources Engineers, terrestrial specialists and fisheries biologists to interpret existing channel conditions and to develop, through an integrated design approach, a 'successful' channel design.

The channel design has to incorporate hydrology, stream hydraulics, fluvial morphology and fisheries habitat assessment. Each discipline has to determine design parameters which will be beneficial in the integrated design approach. Design approaches should consider the following characteristics as a guideline (not exhaustive) to developing a natural channel design:

Watershed and Channel Characteristics

- Run-off characteristics;
- Flow regimes; and,
- Channel geometry.

Stream Conditions

- Floodplains
- Alignment and meandering;
- Bed-forms, riffles and pools;
- Stream bank cover;
- Slopes;
- Soils;
- Erosion and tractive forces; and,
- Channel roughness.

Chemical Characteristics

- Sediment load;
- Suspended sediment;
- Oxygen demand;
- Nutrients; and,
- Toxic substances.

There are numerous guidelines which consider the foregoing characterization in developing a natural channel design, such as the following examples:

- 1994 MNR Natural Channel Design Manual;
- Rosgen;
- Annable;
- Newbury;
- 2001 MNR; and,
- Adaptive Management of Stream Corridors in River & Stream Systems: Flooding Hazard Limit Technical Guidelines, March 2006, Ontario Ministry of Natural Resources.

The Proponent should demonstrate that due care has been taken in establishing the natural channel design to the satisfaction of the City.

G.5.4.1 Design Documentation for Natural Channel Design

The following code of practice is considered a minimum for documentation of natural channel design and is not intended to be exhaustive:

- The Proponent should provide the background existing and proposed hydrologic data (ref. Section G.5.3 - Stormwater Management Design - Analytic Requirements / Methods);
- The Proponent should provide plans outlining the following:
  - Existing and proposed plan and profile;
  - Existing and proposed channel sections;
  - Details for proposed typical channel sections;
  - Sediment and erosion controls;
  - Staging plans;
  - Seeding and landscaping plan; and,
  - Floodline delineation - existing and proposed
- The Proponent should document how the proposed natural channel design matches and/or enhances existing channel characteristics;
- The Proponent should document how the proposed channel will function within the watercourse block / valley system;
- The Proponent should document existing and proposed channel hydraulics, including storage discharge relationships;
- The Proponent should, document potential impacts on both the existing terrestrial and fisheries conditions; and,
- The Proponent should provide a monitoring program outlining monitoring requirements for the various design disciplines.

In addition to the natural channel design code of practices, the following should be incorporated into the channel design:

- Access will be required from both ends, 3 m wide with cross fall not to exceed 4%;
- Special consideration must be given to the vegetation; landscape plan must be designed by a member of OALA (Ontario Association of Landscape Architects) in good standing;
- Design must comply with the No Standing Water By-law;
- Area must be posted as naturalized area and wording within the purchase and sales Agreement should reflect this requirement; and,
- No access gates permitted.

G.5.4.2 Stormwater Management Facility Designs

"Greenfield" Development

The following design guidance is considered to complement the MOE-CC Stormwater Management Planning & Design Manual, March 2003. The type of Stormwater management facility to be designed is normally determined through a Master Servicing Plan.

Facility Storage Requirements

Permanent pool volume and quality control (including extended detention) requirements shall be based on the MOE-CC Stormwater Management Planning & Design Manual, or as specified within Master Servicing Plans, Master Drainage Plans or Master Stormwater Management Plans.

Quantity control shall be based on criteria established in Master Servicing Plans, Master Drainage Plans or Master Stormwater Management Plans. Should no documentation exist to establish the level of quantity control, discussion with the City will be required to determine the requirements.

Forebay

The forebay is to be separated from the wet pond/wetland area by a berm. The top of berm is to be 0.3 m above the permanent pond with erosion protection above the permanent pool. The berm is to have a 3.0 m top width, with 3:1 maximum side slopes. The forebay length to width ratio shall be a minimum 2: 1, with length designed in accordance with MOE-CC Stormwater Management Planning & Design Manual, 2003.

Consideration for forebay bottom lining shall be made if groundwater contamination has been determined to be an issue (as recommended by a geotechnical consultant).

The Proponent shall outline that access to the forebay is to be provided for the purpose of maintenance. In addition, the Proponent should determine how sediment removal would be conducted (i.e. equipment, forebay design). Prior to sediment removal, the forebay is to be dewatered. Dewatering procedures shall be provided as part of the Operation and Maintenance Manual.

Length / Width Ratio

The minimum length to width ratio is 3:1. Berming within the Stormwater management facility may be used to increase the flow path to meet this criterion and should only be considered where the physical constraints of the Stormwater management facility clearly limit the facility configuration.

Standard Water Depths

The permanent pool water elevation/level within the facility is considered the normal facility operational water level.

Table G.3- Standard Water Depths

	Wet Pond Facility	*Wetland Facility*

For a hybrid facility, the wet pond and wetland elements use the respective guidelines stated above.

Deeper permanent pool areas at outlet structures will be considered by the City where site specific conditions have identified the requirements for this design consideration. For wetlands, a localized deep pool shall be designed at the outlet structure. The use of extended detention storage for quantity control of the water quality storm event will be allowed by the City.

Side Slopes

Centred on the edge of the permanent pool, the slope shall be a minimum of 3 m width at 7: 1. This width of shelf is considered a minimum requirement as a safety measure to limit the potential for public access to the permanent pool.

Above Planting Shelf: 5:1 max. slope (7: 1 preferred).

Below Planting shelf: 4:1 max. slope.

Berming

Berming around the perimeter of a facility shall be designed with a minimum top width of 3.0 m (where trail or maintenance access is not located on berm). The top of berm elevation shall be established at a minimum 0.3 m above the 100 year storm quantity control water level or the highest water level. Geotechnical considerations should be discussed in the design of the facility berming. Retaining walls within the Stormwater block are typically not acceptable to the City, since the land designated for Stormwater management systems should be established on the basis of no man-made retaining systems, although in special circumstances such as Stormwater management retrofits, the City may consider the use of retaining walls.

Inlet Structures

Minor flows up to the 5 year design storm event should be directed to the sediment forebay of a SWM facility and flows in excess of the 5 year event (major flows) are to

bypass the sediment forebay and discharge to the main cell of the SWM Pond. This practice reduces the re-suspension of deposited sediments within the sediment forebay.

Storm sewer system inlets into the Stormwater management facility shall be designed so that the pipe invert matches the permanent pool elevation. Inlets submerged within the permanent pool may be accepted in scenarios where it can be demonstrated that the system will operate under free flow (non-surcharged) conditions subject to the 5 year storm.

Headwalls and grating shall conform to OPSD, with railings as required.

Erosion protection shall be provided between the inlet headwall and forebay bottom to prevent localized scouring. Erosion protection shall match the headwall width at the inlet and shall extend a minimum 1.5 m on either side of the headwall at the forebay bottom. Protection material shall consist of rip rap or river stone underlain with geotextile. The protection size and depth shall be based on Engineering consultant recommendations and subject to review and acceptance by the City.

Major System Flow Routes

Where flood protection is required, major system flow routes shall be designed to safely convey the 100 year peak overland flow into the facility, but shall not be directed into the sediment forebay area. Overland flow routes shall be flat bottomed channels with maximum 3:1 side slopes, maximum flow depth of 0.3 m and 0.1 m of freeboard. Overland flow routes should be designed using standard hand calculations and/or hydraulic analytical techniques (ref. Appendix F – Storm Sewer Design Sheet / Combined Sewer Design) acceptable to the City. Overland flow route erosion protection shall consist of a soil reinforcement system with a natural vegetated surface treatment, based on the Engineering consultant and/or the City's recommendations, and subject to City approval.

Outlet Structures

Reverse slope pipe and perforated riser pipe outlet structures shall be used for both wetland and wet pond facilities unless the Proponent can demonstrate to the City and approval agencies that alternative outlet structures could be used. For Stormwater management facilities located downstream of areas with a high susceptibility for the occurrence of spills, a shut-off on the outlet structure may be required. Maintenance pipes shall be installed to allow the facility to drain by gravity flow whenever possible. Maintenance access roadways shall provide access to outlet structures.

Headwalls and grating shall conform to OPSD, with railings as required.

A weir outfall / spillway shall be considered for discharge of less frequent events in combination with the ditch inlet type of structure. Spillway erosion protection shall be consistent with attributes described herein. Erosion protection for outfalls shall generally consist of a combination of rip rap or river stone and vegetation, with the size and depth of stone based on consultant and/or City recommendations and subject to City approval. Outfalls to Environmentally Significant Areas may require site-specific

treatment as dictated by the City and/or as stipulated within Master Servicing Plans, and/or Environmental Reports.

Emergency Overflow Spillway

Each Stormwater management facility shall provide an emergency overflow spillway where possible to allow drainage to safely exit the facility should the outfall structure fail to function or should the storm event have a frequency lower than the 100 year or maximum design storm return period. The overflow spillway shall convey the Regional Event or design storm event post-development controlled peak flow. A 0.10 m freeboard to the top of the spillway invert shall be at the facility's 100 year or maximum water level.

The design of the spillway shall be based on calculations provided by the consultant and/or the City and are subject to review and approval by the City. Erosion protection shall be provided on the entirety of the spillway. Erosion protection may consist of a soil reinforcement system with a natural vegetated surface treatment or alternative protection measures as specified within the consultant recommendations and approval by the City. When access roads cross the top of the spillway, the surface treatment and base will be consistent with the maintenance access road design. Side slopes at the top of the spillway shall be 3: 1 maximum and shall be a maximum 10% if used as a roadway.

Maintenance Access Roadways

Maintenance access roadways shall be provided from the City's road allowances to inlet and outlet structures and to the base of sediment forebays. Where feasible, two access points to the City's road allowance shall be provided and access roads shall be looped to access points. Dead end access roads shall be voided and shall be designed with a hammerhead turn around, with a minimum hammerhead width of 17.0 m, roadway width of 4.0 m and 12.0 m centreline turning radius. A turning area of 12.0 m diameter may be provided instead of a hammerhead. The following dimensions should be considered in the maintenance access design:

Min. Roadway Width: 4.0 m	Max. Gradient = 10%
Max. Crossfall = 2%	Min. Centreline Radius = 12.0 m
Min. 300 mm OPSS Compacted	Geotextile underlying Granular ‘B’
Granular ‘B’, Normal (or equivalent)	Granular ‘B’ dressed with screening

Stormwater blocks between residential/commercial/industrial lots for the sole purpose of maintenance access shall have a minimum width of 6.0 m with a 4.0 m wide road surface.

A curb depression shall be provided at the road allowance and removable, lockable, vehicle barriers shall be installed at the right-of-way limit to prohibit public vehicular access.

Setbacks

A minimum setback of 5.0 m (4.0 m without maintenance access) from a Stormwater management facility property line to the commencement of the facility grading shall be established~ Maximum side slopes within the setback areas will be 10:1. Marginal setback area compromises will be allowed to facilitate irregular facility shapes. When a Stormwater management facility is to be located within the Regional storm floodplain, Conservation Authorities may require more than a 5 m setback from the Stormwater management facility grading commencement to property limits.

Sediment Drying Area

A sediment drying area shall be provided immediately adjacent to the maintenance access road and to the sediment forebay to facilitate ease of access for sediment removal from the forebay and sediment storage. The area should be graded to allow partial drainage to the forebay at a minimum slope of 2.0%. The sediment drying area shall be designed to facilitate a 1.0 m maximum storage depth and an angle of repose of 4:1 of the excavated sediment, the volume of which shall be the minimum MOE-CC requirement. The drying area shall be rehabilitated at the time of maintenance.

Fencing

Fencing shall be required where residential areas are located adjacent to the Stormwater management block. Where the Stormwater block abuts open space, ESA lands, industrial and commercial lands, or a right-of-way, fencing will not be required. Fencing will be 1.5 m high, chain link fence, in accordance with City Standards. Fencing shall be located' at an offset of 0.10 m within the Stormwater block. Heavy duty black vinyl fence is City Standard.

Warning Signage

Warning signage shall be installed adjacent to pedestrian traffic routes located within and/or adjacent to the Stormwater management block. The number and location of signs shall be established by the City. Signs will have the wording laid out in figure one and two below, or as per the current Development Engineering Guidelines and will be supplied and installed by the Proponent.

Figure One:

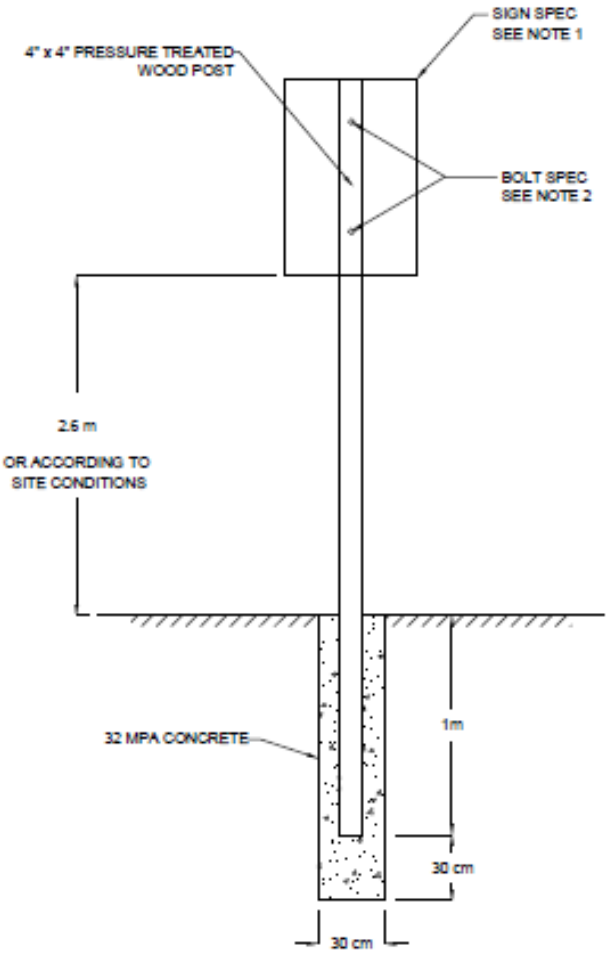
Figure Two*:

*Note: Figure 2 applies to a fenced in area where public access is not allowed.

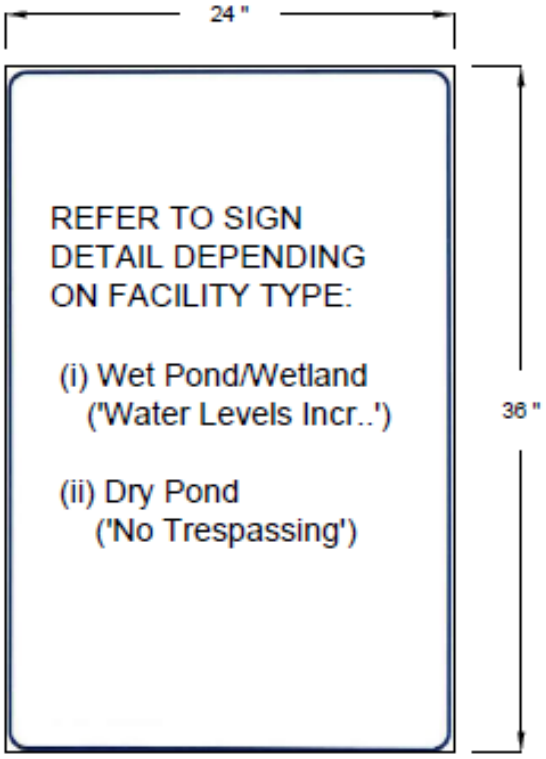
Signage shall conform to the following specifications:

- Measure 24 in by 36 in;
- Lettering size shall be 1.25 in to 3.5 in;
- Colours shall be City of Hamilton Blue & Cream, White, Red and Black;
- Gauge shall be 0.021 mm;
- Shall be laminated; and,
- Stainless steel lag bolt with washer is required 1.5 in into a wood post.

The diagram below is an example of post installation. Requirements may change on a case by case basis and are dependent on environmental conditions.



NOTE 1 SIGN SPEC



SIGN SPECIFICATION NOTES:

-LETTERING SIZE: VARYING 1.25" - 3.5"
-GAUGE: 0.081mm
-LAMINATED

NOTE 2 BOLT SPEC

-STAINLESS STEEL LAG BOLT WITH WASHER
-1.5" INTO WOOD POST

Existing Groundwater Elevation

With the Stormwater block, at least one borehole shall be located near the centre of the block as part of the geotechnical investigation for the development, to assess the nature of existing soils and the groundwater elevation within the Stormwater block. The groundwater elevation shall be compared to the proposed permanent pool water elevation within the facility. Where soil conditions are very permeable and the groundwater elevation is below the permanent pool water level, lining of the permanent pool area with an impermeable material may be required to ensure permanent pool levels are maintained. A liner may also be required when groundwater contamination may be a result of the permeable soils and the water quality within the Stormwater

management facility. The type and thickness of lining material shall be based on geotechnical recommendations.

Where the groundwater elevation is above the permanent pool water elevation, an investigation shall be undertaken to assess the impacts of a localized reduction in groundwater levels, potential impacts to groundwater aquifer systems and flow regimes, watercourse baseflow quantity and temperature, and to assess potential slope stability and groundwater seepage concerns within the facility. The scope of this investigation will be determined based on site specific conditions. The consultant shall consider all feasible design alternatives to limit or negate any impact to local groundwater levels to the satisfaction of the City.

Landscaping

Facility configuration and landscaping shall be designed according to its location within the community (e.g. adjacent to an environmental corridor, community parkland, or trail system, etc.), and the City of Hamilton Storm Water Management Landscape Design Guideline. The facility configuration should augment the surrounding land use and provide an open space feature considered satisfactory to the City. Opportunities to enhance the facility configuration by adjustments to the required setbacks, incorporation of trails and improvements in grading should be discussed with City staff during the preliminary design stage, prior to Draft Site Plan approval. Landscaping should also be reviewed and approved by other appropriate agencies.

For dry ponds, wet ponds and wetland facilities, a landscaping plan shall be prepared by a full member of the Ontario Association of Landscape Architects (OALA) to the approval of the City.

Acceptable plant species for SWM facilities have been provided within Appendix E – List of Approved Planting Species (ref. MOE-CC, 2003). Species have been classified within the categories of deep water, shallow water, shoreline fringe, flood fringe and upland.

Safety Measures

Due to the regular presence of standing water and the potential West Nile Virus concerns (ref. City of Hamilton By-Law No. 03-173) and the occasional large depth of storage associated with most end-of-pipe facilities, the potential safety hazard of these facilities must be properly managed through incorporation of:

- Structural features;
- Public education; and,
- Management and operation.

Structural features, such as limiting steepness of side slopes, slope benching, planting thorny vegetation in areas to discourage public access and controlling public access (pathway, railings), are all recommended features which shall be incorporated into the

design of end-of-pipe facilities to minimize safety risks, while promoting the integration of Stormwater management with recreational opportunities.

Public education may include advisory and educational signage, and other community awareness programs, which will improve the public knowledge of the requirements for Stormwater management, while also informing the public of the potential hazards of the facilities during storm events and under normal conditions due to the presence of the permanent pool.

Stormwater management plans submitted in support of detailed design must discuss the proposed safety features to be incorporated into each facility.

Land Requirements

The City shall require that it maintain a right of easement in any property allocated for flood storage. This is to facilitate maintenance as well as to secure the intended purpose of the facility in the short and long term. In most circumstances, the City would consider ownership of the storage site.

The City prefers the use of centralized end-of-pipe systems rather than smaller distributed systems. However, the feasibility of implementing a centralized system is dependent upon such factors as the need for up-front planning, development phasing, and the cost to small developments.

As-Constructed Requirements

An as-constructed topographic survey incorporated into the Stormwater facility Engineering plans shall be provided along with the Engineering calculations to determine and verify the following:

- Permanent pool volume;
- Active storage volume;
- Berm construction; and,
- Inlet and outfall structure details.

The Proponent's Engineering consultant shall certify that the Stormwater management facility has been constructed and is operating in accordance with the consultant's plans and design report.

G.5.4.3 Temporary Stormwater Facilities

In development situations where the ultimate downstream facilities have not been constructed and/or where trunk sewers have not been completed to convey storm drainage to the ultimate facility, an interim or temporary on-site facility(ies) shall be considered by the City. Temporary facilities shall provide an equivalent level of quality and quantity control as per the ultimate facility but for a smaller area commensurate with the planned development. Temporary facilities shall remain in place until the ultimate facilities and trunk sewers are constructed and approved by the City.

Site plan or Subdivision Agreements will be established to require the Proponents to be solely responsible for maintenance and operation of temporary facilities, as well as any works associated with decommissioning of the temporary facility, including possible disposal of collected sediments according to Provincial guidelines and regulations. The cost for a temporary Stormwater facility including its removal shall be borne solely by the Proponent.
The design criteria may be modified from those for ultimate/permanent facilities, as follows for temporary facilities:

- 3: 1 max. side slopes from facility bottom to top of berm; and,
- Facility perimeter to be fenced with 1.5 m galvanized chain link on all sides with lockable access gate in accordance with OPSD.

Temporary facilities required as part of development staging shall be constructed to the same physical characteristics and grading standards as permanent facilities. This is intended to protect the City and residents in the event that development of the future stage does not occur in a timely fashion.

G.5.4.4 Infills

All new developments, regardless of location or size will have some impact on the runoff regime (quality/quantity). The impacts though can be more or less depending on the sensitivity of the receiver. Medium and large greenfield developments will, in all cases, be accompanied by Stormwater management plans which either prescribe on-site measures or some form of centralized management strategy. Smaller greenfield settings and infill developments within existing urban areas need to consider their location in the drainage network, size relative to the balance of the existing developed area and the nature of the receiving system. These factors tend to direct the Proponent for an infill development to the specific form of Stormwater management.

Proponents are required to meet with City staff prior to initiating the servicing design to discuss opportunities related to Stormwater management. This consultation would be intended to examine the need for on-site controls versus potential opportunities to contribute to a Stormwater fund (Le. cash-in-lieu consistent with the current and future Development Charges By-laws), which would be used to construct more effective retrofit facilities off-site, elsewhere in the community.

Notwithstanding the foregoing, the Proponent, in all cases, would need to assess the impact the development has on the quantity of runoff by way of a capacity assessment. This may impart a requirement for on-site quantity controls, which would be separate from the cash-in-lieu discussed earlier for Stormwater quality. In all cases, the Development Proponent must determine the impact of the development in terms of water quality (i.e. contaminant loading), in order that a reasonable basis can be established for cash-in-lieu. Currently, the Municipality does not have specific guidelines for the size, location or receiver sensitivity, in order to establish the viability of cash-in-lieu for infills. Consultation with the City and respective agencies will be required.

G.6. SEDIMENT AND EROSION CONTROL METHODS

G.6.1. Specific Methods and Local Requirements

Sediment and erosion control measures that can be implemented with the City of Hamilton are consistent with the local guidelines (ref. Erosion and Sediment Control Guidelines for Urban Construction from Source to Solution, GTA Conservation Authorities, 2006) and the provincial guidelines (ref. Ontario Guidelines on Erosion and Sediment Control for Urban Construction Sites, 1987). Implementation details for certain sediment and erosion controls are covered under the Ontario Standard Specifications (OPSS) 577. The following sediment and erosion control measures comprise current City of Hamilton practices and preferences.

G.6.2. Sediment Control

Sediment controls consist of but are not limited to the following:

Mud Tracking Control

Mud tracking control is used for sites typically 1 ha in area or larger where vehicle access and leave a site via municipal road. Should sediment be conveyed to the road, the Proponent will clean the road at their expense;

Mud tracking control (mud mat) shall be placed on sites where vehicles exit the site onto paved public roads. The mud mat will help remove sediment from vehicles, reducing tracking onto the paved surface;

Vegetative Buffer Strip

Sediment control can be provided through the use of existing or proposed vegetation. The Conservation Authorities have minimum vegetation buffer strip widths which are to be incorporated into the site design. Depending on whether the site is located within the Niagara Escarpment Plan, the Niagara Escarpment Commission may need to be consulted on buffer strip requirements. Buffer strips are generally located adjacent to creeks, swales and Stormwater inlets;

Temporary Grading Diversion

Diversion of drainage from steep slopes and disturbed areas through the use of diversion swales should be considered as per the Conservation Authority Guidelines. Drainage should be directed to appropriate sediment control measures;

Temporary Slope Drain

To prevent slope erosion, concentrated drainage may be conveyed down a slope via a temporary slope drain comprising a flexible conduit or ditch liner. Slope drains should employ adequate inlet and outlet protection and should not discharge directly to creeks;

Sediment Control Fence

The Conservation Authorities provide design considerations for sediment control fencing. This measure acts as a barrier to drainage, creating ponding and therefore settling of sediment, rather than filtering the drainage. Sediment control fencing will be placed where there is potential for runoff leaving the construction site. Where sediment control fence is not required, a construction fence will be installed to delineate the work boundary. Sediment control fencing should be properly installed and maintained to ensure it functions as intended;

Sediment Trap

The design and construction of sediment traps should incorporate the Conservation Authorities' guidelines (Erosion and Sediment Control Guidelines for Urban Construction from Source to Solution, GTA Conservation Authorities, 2006) as a minimum. Typically, drainage areas to sediment traps are less than 2 ha. The location of the sediment trap should be out of the floodplain whenever possible to avoid being washed out;

Sediment Control Basin

Similar to sediment traps, sediment control basins should incorporate the Conservation Authorities' guidelines as a minimum. Typically, drainage areas to sediment control basins are over 2 ha. Sediment control basins should be located out of the floodplain;

Compost Berm

A compost berm may be used instead of a sediment control fence. The compost berm should be designed according to manufacturer's guidelines. Unlike sediment control fences, compost berms are able to filter sediment from drainage and do not obstruct flow paths. Compost berms are easily spread out on-site after construction instead of requiring removal as per sediment control fence; and,

Compost Socks

Compost socks provide the function of compost berms, but on steep or paved surfaces. Manufacturers' guidelines should be used in both design and placement of the compost stock

G.6.3. Erosion Control

Erosion controls consist of, but are not limited to the following:

- **Surface Roughening (Scarification)**
  Scarification is a process of roughing the slopes of a site prior to vegetative cover. Typically scarification is for sites with steep slopes up to 2:1. Scarification reduces drainage velocity, quantity and erosion potential;

- **Seeding**
  Vegetative cover is established by seeding a disturbed area. Typically, seeding of disturbed areas is conducted following final grading or for site access where no further construction is scheduled for 30 days, subject to seasonal factors. Seed application typically occurs with straw mulching, hydraulic mulching and erosion control blankets. Sodding may occur in site areas where instant ground is required;

- **Mulching**
  Freshly seeded soils can be protected by spraying on manmade or natural materials. Mulching reduces drainage velocity and therefore the erosion potential of seeded soils. Manufacturer's specifications should be followed in implementing mulch; and,

- **Erosion Control Blankets, Netting and Matting**
  Erosion control blankets, netting and matting are typically biodegradable materials which are placed on relatively steep surfaces to prevent erosion and promote seed growth. Manufacturer's guidelines should be followed in the use of erosion control blankets.

G.6.4. Drainage Protection

Drainage protection should include but not be limited to the following:

Temporary Creek Crossings

Temporary creek crossings consist of a span for the purpose of construction access. Conservation Authorities, MNR and possibly DFO will have individual requirements that should be fulfilled;

Cofferdams

Temporary cofferdams are used to allow dewatering of a construction area to permit work in dry conditions. Design considerations and installation and maintenance considerations are provided within the respective Conservation Authority guidelines. Conservation Authorities, MNR and possibly DFO will have individual requirements that should be fulfilled;

Stream Realignment

Watercourse realignments should be conducted only when necessary to reduce impacts on the natural environment. Stream realignments should be designed according to stream function and form and may require natural channel design principles. Conservation Authorities, MNR and potentially DFO will typically review an application for stream realignments;

Rock Check Dams

Granular material is temporarily placed either in a swale, ditch or watercourse to facilitate settling of sediment. Design of rock check dams will require Conservation Authority's MNR and possibly DFO approval;

Storm Drain Inlet Protection

Storm drain inlet protection may consist of a sediment control barrier, granular material, geotextile and/or ponding area. Specific applications will require different inlet protection designs. Typically, only the City and possibly the Conservation Authorities will comment on inlet protection design; and,

Storm Drain Outfall Protection

For storm drain outfall protection reference Section G.2.2.7 - Outlet Treatment. Outfall protection should be designed according to both the outfall flow velocities and the receiving watercourse flow dynamics. The City, Conservation Authorities and potentially MNR will review an application for a storm drain outfall.

G.7. Topsoil Stockpile Protection

Topsoil stockpiles containing more than 100 m^3 of material shall be located a minimum of 10.0 m away from the roadway, drainage channel or an occupied residential lot, and a minimum of 2.5 m from the property lines, and shall be placed in a location acceptable to the City. The maximum side-slopes for topsoil stockpiles shall be 1.5 horizontal to 1.0 vertical. The stockpiles shall be protected by heavy duty silt fence (OPSD 219.130).

Topsoil Stockpiles can be located on blocks owned by the Proponent. Placement of stockpiles on blocks to be conveyed to the City is rarely permitted an only through prior written approval from the Manager of Parks and Cemeteries, Public Works Department. The topsoil has to be removed and block graded to approved elevations prior to conveyance to the City. Topsoil Stockpiles can also be located on private lands between houses and on rear yards. If remaining for more than thirty (30) days, topsoil stockpiles shall be stabilized by vegetative cover, or by other acceptable means.

G.7.1. On-Site Reporting Requirements

All Erosion and Sediment Control Facilities are to be inspected by the Consultant once a week during active construction, after each rainfall in excess of 25 mm and after a significant snowmelt. Daily inspections are required during extended rainfall or snow melt periods. These inspections are to ensure that the facilities are in proper working condition and all damaged Erosion and Sediment Control facilities are to be repaired and/or replaced within 48 hours of the inspection. A permanent record of these inspections must be maintained on site and made available to the City upon request. An Environmental Monitor (EM) will be hired to ensure that construction activities comply with all environmental provisions set out in this area. The EM will record all relevant information pertaining to the quality control of all erosion and sediment control practices.

All records will be kept on site for a minimum of one (1) year after site construction has been completed.

When there is no active construction on site, the erosion and sediment control facilities will be inspected each quarter.

All inspection notes will require the following information:

- Inspector identification;
- Location of environmental constraints in the area including any relevant details;
- Construction drawings of all ES control devices, updated after every inspection; and,
- Location of any areas requiring attention or repairs and a detailed schedule of the remediation process including a precise timeline.

G.8. DOCUMENTATION

G.8.1. Stormwater Management

A “complete submission” should include a copy of a Stormwater Management Report, detailed stormwater management facility engineering drawings, and an Operations and Maintenance Manual. The Stormwater Management Report shall include the following list of items viewed as a generic list applicable to both functional and detailed stormwater management reports. A more detailed description is found in Appendix M - Stormwater Management Plans.

G.8.1.1 Functional SWM Report

Functional Stormwater Management Reports precede Detailed Stormwater Management Reports and typically are a level of detail below the detailed Stormwater Management Reports. Functional Stormwater Management Reports should be provided for proposed developments with a minimum are of 5 ha. The Proponent, before submitting a Detailed Stormwater Management Report, should receive approval of the submitted Functional Stormwater Management Report from the City. The Functional Stormwater Management Report should include:

Existing Servicing Constraints:

- Hydrology;
- Hydraulics;
- Hydrogeological; and,
- Geological

Design Criteria:

- Quantity;
- Quality;
- Erosion and Sediment; and,

- Major / Minor

Servicing Assessment:

- Quantity Controls (Consider receiving system / existing and post volume balance / flow control stage / climate);
- Quality Controls;
- Erosion and Sediment;
- Major / Minor; and,
- Overall System

Servicing Solution:

- Systems; and,
- Monitoring

G.8.1.2 Detailed SWM Report

In general the Detailed Stormwater Management Report should address all aspects of the Stormwater management design, including:

Plans showing:

- Lot and road layout with land use;
- Elevations at key points (in a contour map);
- Any surveyed constraint lines (e.g. top of bank, floodlines, wetlands);
- Minor drainage system, with storm sewers, maintenance holes and catch basins;
- Major drainage system with overland flow routes at key points;
- Details of Stormwater management practices, e.g. storage facilities; and,
- Erosion and sediment controls.

Descriptions of:

- Receiving system and outlet including confirmation of legal status;
- Classification of site and downstream aquatic habitat per DFO / MNR / MOE-CC guidelines;
- SWM criteria for quantity, quality, flooding and erosion control;
- Hydraulic analysis, as required, to establish the floodplain for major flow elements;
- Design of SWMPs to meet applicable criteria, polices and guidelines;
- Preliminary erosion and sediment control plan describing existing site conditions, erosion potential, down gradient risk assessment, and anticipated erosion and sediment controls, including staging; and,
- Proposed maintenance and monitoring.

Tables showing:

- Hydrologic parameters for existing and future land use;
- Pre and post-development peak flows and volumes at all outlets;
- Post-development flows at all minor system maintenance holes;
- Hydraulic grade line analysis;
- Stage / storage / discharge relationships for SWMPs; and,
- Overland flow depths and velocities at key points on roads and at outfalls.

Figures / Drawings showing:

- General location plan;
- Drainage areas for existing and future land use including all external areas;
- Details of overland flow routes;
- Details of SWMP facility appurtenances (inlets and outlets);
- Details of erosion and sediment controls; and,
- Schematic of computer models.

In addition to the City of Hamilton, the Development Proponent is responsible for obtaining all other necessary permits and approvals from some or all of the following agencies:

- Conservation Authorities (Hamilton, Grand River, Niagara Peninsula, or Halton);
- Ontario Ministry of Transportation;
- Ontario Ministry of the Environment;
- Ontario Ministry of Natural Resources;
- Niagara Escarpment Commission;
- Federal Department of Fisheries and Oceans; and,
- Environment Canada (Federal).

Sample permit applications are available on the Hamilton Conservation Authorities Website https://conservationhamilton.ca/.

G.8.2. Operations and Maintenance Manual

Final Report

The Operations and Maintenance Manual, including commissioning performance data and evaluation, shall be submitted to the satisfaction of the Manager of Construction, prior to the assumption of the facility.

The submission of the Final Design – Stormwater Management Report must be accompanied by an “Operations and Maintenance Manual”, which addresses but may not be limited to the concerns identified in Appendix L – Master Planning (Watershed/Subwatershed).

The Proponent, in addition to reviewing materials herein and the MOE-CC 2003 guidelines, may also review the document Stormwater Management Facility Sediment Maintenance Guide, 1999 by Greenland International Consulting Inc. for typical operations and maintenance requirements. The following provides the minimum requirement for the format and content of the Operations & Maintenance Manual:

- **Design Objectives**
  This concern will have dealt within the Functional Stormwater Management Report. If any changes have been realized because of detailed design, the new objectives shall be noted;

- **Expected Facility Performance**
  The expected quantity and quality performance of the facility under varying conditions such as dry weather conditions, winter conditions, frequent rainstorms and rainfall events exceeding the design capacity, shall be addressed;

- **Safety**
  Safety hazard aspects related to drowning, trapping, contamination, noxious weed growth, West Nile Virus, and odours shall be considered and appropriate measures taken in the design and maintenance program.;

- **Siltation Control**
  This concern shall be addressed for three phases of the proposal:
  - During construction;
  - For the completed facility prior to the City assuming responsibility; and,
  - For continued facility control upon acceptance by the City;
- **Inspections**
  This concern shall consider all phases of operation under every conceivable weather condition, the safety of the public and property damage and the performance of the facility with respect to the Design Objectives. A check-off list of inspection activities including frequency of inspection and action to be taken with respect to certain findings shall be part of the Operations and Maintenance Manual;

- **Scheduled Maintenance**
  A list shall be prepared of each activity and the frequency of regular maintenance to be performed by the City staff. This list shall include but not be limited to:
  - Personnel
    - Estimate the number of man-hours required to perform the scheduled maintenance activities annually;
  - Materials
    - Estimate the quantities of materials such as aggregates, topsoil, plantings, paint, concrete etc.;
  - Parts

  - Estimate the life expectancy and/or identify benchmark parameters, which indicate the time for replacement of parts;
- Specialized Equipment
  - Identify the need and frequency for the use of specialized maintenance equipment;
- Specialized Services
  - Identify the need and frequency for hiring the services of contractors to perform any schedule/maintenance; and,
- Seasonal Preparation
  - Identify any precautionary measures necessary to protect the facility from the elements, such as winterization.

- **Unscheduled Maintenance**
  Although each facility should operate uninterrupted with a comprehensive preventative maintenance program, there are always the unexpected failures. Every effort shall be made to identify potential unscheduled events and plan a strategy of action. This discipline, although general, shall consider each conceivable failure event, determine whether it is to be considered an emergency, identify who should be notified during regular hours and after regular hours and what actions should be taken in the interim;

- **Monitoring and History**
  The "Operations and Maintenance Manual" shall discuss the performance parameters to be monitored, and also outline the equipment requirements and detailed procedure for monitoring the effectiveness of the facility. In addition, the program shall describe the acceptability range of values measured, trigger limit(s) which then exceeded require immediate attention because of regulatory or safety considerations, the format for logging the measured values and methods for analysis of the recorded data. The "Operations and Maintenance Manual" shall discuss the performance monitoring during the specified maintenance period (typically two years duration); and,

- **Cost**
  The "Operations and Maintenance Manual" shall include a breakdown of annual maintenance and operating costs.

G.9. COMMISSIONING / ACCEPTANCE & ASSUMPTION PROCESS

G.9.1. Outlet to Existing Ponds and Development Phasing

Where multiple Proponents are responsible for the maintenance of the same pond, the City will require the Proponents to enter into a Joint Servicing Agreement to maintain the pond until assumption by the City. The Agreement will clearly outline point of contact for emergencies, maintenance requirements, required securities (proportionate to each Proponents share), scheduling and clean out of pond and pipes prior to assumption. A Proponent can apply for reduction of securities as per their Subdivision Agreement, but

the total value of the securities can never be reduced below the level required for the shared pond until such time as the pond is assumed by the City.

Linear Infrastructure

Maintenance of the SWM pond undergrounds forms part of the maintenance of the underground services.

The Commissioning and Assumption of Linear Infrastructure associated with Stormwater Management Facilities shall adhere to the same policies applied to Storm Sewers included in the Underground Works. Make reference to Section A.13 - Inspection and Letter of Credit reduction Process.

G.9.2. Facilities Infrastructure

Acceptance of the facilities infrastructure will also be part of the SWM pond underground work. Inverts and elevations of all structures should be surveyed and summarised in a table provided to the City.

G.9.3. Landscaping

The Proponent shall install all landscaping of SWM areas above the five (5) year storm level in accordance with the approved plan, preferably during the first planting season after occupancy of the first unit. All plantings other than grass seeding can be deferred until after dredging has occurred. The landscaping needs to be certified by a qualified landscape architect prior to assumption. After the landscaping has been certified one year maintenance period will commence.

Initial maintenance of the SWM pond surface works will be inspected and accepted as part of the aboveground works.

G.9.4. Clean-out / Dredging

At 95% build out of the catchment area, the pond must be cleaned out and then surveyed prior to assumption. The estimated cost of this cleanout should be included in a letter of credit.

An as-recorded survey of the SWM pond is required for Initial Acceptance of the SWM pond underground and certification of volumes.

H. STREETLIGHTING

H.1. Approval

The Proponent will obtain consent from the City for installation of the approved street lighting equipment. Designs will be required to adhere to Right of Way Installation and Permit Manual to the satisfaction of Geomatics & Corridor Management Section, Public Works Department. Applications and approvals will be co-ordinated through Development Engineering.

H.2. Design

Street light drawings should be supplied with the second engineering submission and shall include electrical design layouts, distribution schematics and isolux (photometric) layouts prepared by a qualified engineer. The format of submissions shall be in a form which is satisfactory to Geomatics & Corridor Management Section of the Public Works Department.

Street lighting designs shall comply with the latest edition of the Illuminating Engineering Society of North America (IES) RP-8 Recommended Practice for Roadway Lighting and the Transportation Association of Canada (TAC) Guide for the Design of Roadway Lighting.http://tac-atc.ca/sites/tac-atc.ca/files/site/doc/resources/ptm-light06-vol2-examples.pdf

The Proponent shall engage, and enter into an agreement if necessary, with Horizon Utilities Corp. (HUC) or Hydro One Networks Inc. (HONI), depending on jurisdiction, during the street lighting design phase to determine the requirements for new street lighting electrical utility services. Details related to new street lighting electrical utility services should be referenced on the street lighting design drawings, inclusive of all utility reference numbers such as Service Layout Form (SLF) numbers.

Drawings will be submitted to Development Engineering, Planning and Economic Development Department and ultimately approved by Geomatics & Corridor Management, Public Works Department. Proposed streetlight locations shall be shown on the Composite Utility Plans required as part of the Municipal Consent procedureSection I.2 - Utility Installation Municipal Consent.

H.3. Construction

The Proponent is responsible to arrange for the installation of all new street lighting infrastructure and for any alterations to existing infrastructure which is impacted by the construction of the development.
Coordination of and connection to electrical utility services (HUC or HONI) is the responsibility of the Proponent, inclusive of any applicable fees.

The installation of street lighting infrastructure shall conform to the latest rules, regulations and definitions of the Canadian Electrical Code, Ontario Electrical Safety Code and any other applicable Municipal, Provincial and National codes and regulations having jurisdiction in the area where work is being performed.
Securities, if required, for the installation of street lighting shall be lodged with the City of Hamilton.

H.4. Material Selection

Material shall comply with the City's Standards and Approved Products list.

Alternate street lighting equipment, such as ornamental (decorative) street lighting, not appearing on the City's Standards and Approved Products list must be submitted for consideration and approved by the City for use. In area where ornamental (decorative) exists, all new street lighting should match the aesthetic features of the existing equipment.

When ornamental (decorative) street lighting equipment is used, the Proponent shall supply and deliver to the City a minimum of 10% of street light luminaires and bracket arms for maintenance inventory. Materials delivered to the City shall be clearly identified with the development name and provide proof of delivery to and receipt by the City.

H.5. Cost Sharing

In situations where the City cost-shares in the installation of street lighting, the City shall pay the Proponent in accordance with the cost sharing arrangement in the subdivision agreement.

H.6. Acceptance, System Energization and Assumption

Following the completion of the installation of street lighting systems, the Proponent shall notify the City and submit a formal request for system energization including any applicable Electrical Safety Authority (ESA) inspection certificates and certification that the installation conforms to the design intent and defined constructability standards by the Proponent's street lighting design engineer.

After receiving a formal request for system energization, the City will inspect and sign off that the system has been installed to its satisfaction. Any noted deficiencies identified as part of the City's inspection will be reported to the Proponent for rectification and the request for system energization will not be processed until deficiencies are resolved. The City will arrange for system energization and provide notification to the Proponent after completed. The Proponent shall conduct a night-audit to verify that all lighting is operational and will rectify any operational issues. The timeframe from energization between post approved inspection and connection is approximately six to eight weeks and this should be accounted for in the development construction schedule.

The Proponent's two year maintenance period will begin on the date of system energization. The Proponent will be responsible for the maintenance and timely repair of the street lighting system during the maintenance period. The street lighting system will be assumed by the City together with assumption of the above ground works subject to satisfactory final inspection.

I. UTILITIES

I.1. Utility Co-ordination

The Consulting Engineer is also required to co-ordinate the municipal consent process for utility installation on new roads. See Section I.2 - Utility Installation Municipal Consent for the Municipal Consent procedure. Generally, at the time of initial Engineering submission to the City, the Consulting Engineer shall notify the utility companies of the proposed development. Upon the second submission to the City, the Consulting Engineer shall provide Hydro with a set of Engineering drawings. Hydro will complete their plant design and circulate to the other utility companies so that their plant design can be added and compiled on a Composite Utility Plan.

The utility companies shall forward their completed plant design to the Consulting Engineer, who shall check for any conflicts.

The Proponent is responsible for arranging with Horizon Utilities (or Hydro One, depending on the jurisdiction) for the installation of underground hydro and street lighting on all streets within the plan of subdivision. The Proponent shall enter into a separate Agreement with Horizon Utilities (or Hydro One) for the design and installation of these works.

Securities for the installation of street lighting shall be lodged with the City of Hamilton. Horizon Utilities and Hydro One collect a separate security for payment of the underground component of the hydro works.

All utility design shall be prepared in compliance with applicable standards and manuals in use by Engineering Services, Geomatics and Corridor Management.

Communication Light Poles are not permitted on City road allowances.

I.2. Utility Installation Municipal Consent

Development applications will adhere to the Municipal Consent Application to the satisfaction of Geomatics & Corridor Management. Applications for the permit will be coordinated through Development Engineering and shall generally follow:

- Engineer prepares and submits first Engineering submission to:
  - City of Hamilton (Development Engineering) for review; and,
  - All utility companies for information.
- City of Hamilton (Development Engineering Section) reviews the drawings and sends the comments back to the consultant.

- Engineer completes and sends 2nd submission to the City and Hydro.
- City reviews drawings.
- Concurrently, Hydro prepares their design and circulates to all utility companies.
- Utility companies prepare their designs in consultation with the Engineer.
- Utility (including Hydro) companies send utility designs along with two copies of their MC application to the Engineer.
- Upon receipt of utility design the Engineer reviews for conflicts, and compiles a Composite Utility Plan which shows:
  - Plant designed by utilities in right-of-ways (street lights, pedestals, transformers, mail boxes, schematic trench and cable locations, etc.) and connection locations to each dwelling unit;
  - Surface features designed by the landscape architect in right-of-ways (street trees, entrance features, etc.); and,
  - Engineering surface works (roads, hydrants, driveways, catch basins, etc.).
- Composite Utility Plans signed by all utility agencies and two copies of all MC applications to the City (Development Engineering) for review or approval.
- City reviews Composite Utility Plan. If additional revision(s) are required, the Engineer must contact the utility companies to coordinate their designs.
- Additional submissions as required.
- Engineer has to include a statement of conformance of utility design and sign-off on Composite Utility Plans indicating that all conflicts have been noted and eliminated. The MC approval for all utilities shall be submitted to the City at the same time. The following note, signed and dated by the Engineer, shall be present on all development related utility drawings submitted for MC approval:

"*This certifies that we have reviewed the drawings and the proposed utility locations are in accordance with City of Hamilton Standards. There are no conflicts."*

_____ _____

Engineer Date

- The Development Engineering Section forwards two copies of all the MC forms to the City's Utility Right-of-Way Co-ordinator along with the approval of their locations.
- City's Utility Right-of-Way Co-ordinator returns approved MCs to appropriate utility companies.
- All utility companies must be represented at the pre-construction meeting unless the utility company acknowledges (in writing) that its attendance is not warranted. Road construction may not proceed until such time as all the MCs have been approved.

J. LOT GRADING

J.1. Purpose

The overall grading plan shall be prepared in accordance with the following objectives:

- The drainage for the entire development shall be self-contained and directed to a suitable outlet;
- The lot grading plan shall accommodate any external drainage, which is tributary to the development and must prevent ponding on adjacent lands bordering the subdivision; and,
- The establishment of independent and adequate drainage for each lot (this can be provided by either “back to front” drainage or “split” drainage intercepted by a rear yard swale).
- The establishment of lot and house grades which are generally compatible with existing topography and surrounding development including existing trees, and without steep slopes or abrupt changes in grade with minimum terraces.

J.2. GENERAL

J.2.1. Design Criteria for Plans of Subdivision

Design Criteria for grading lots with single detached and semi-detached housing in new developments within the City of Hamilton are as follows:

- “Required backyard” shall be a minimum of 6.0 metres unless otherwise defined in the applicable zoning by-law;
- The maximum slope in the backyard adjacent to the building for a distance equal to the required backyard shall be 5% except for side or rear yard swales, retaining walls;
- Where the 5% restriction on the backyard’s grades results in elevation differences between adjacent properties, retaining wall shall be constructed along the sides and back of the lot;
- Generally, slopes shall be placed on the lower lot, whereas retaining walls shall be placed on the higher lands;
- The 5% restriction does not preclude retaining walls in the required backyards providing the terraces are maintained to the 5% grade as set out above. The intention of this provision is to provide for flexibility of house construction;
- Guards for retaining walls shall be designed and constructed in accordance with the requirements for exterior guards as contained in the Ontario Building Code;
- Back to front drainage shall only be permitted where the combined side yard setback is 2.0m or more, providing a minimum of 2.0m between foundation walls for drainage swales. A 1.2m setback is required on the garage side of the lot;

- Each lot is to be independently drained. Drainage to a nearby street through the rear of an adjacent lot is not permitted. In areas where "zero lot line" zoning is permitted drainage to a nearby street through the rear of an adjacent lot is not allowed;
- All slopes shall be 3:1 or flatter;
- Provisions shall be made to prevent disruption of the natural surface drainage pattern on lands bordering the development both during and after construction;
- If grading is required on lands adjacent to the development, which are not owned by the Proponent, then the Proponent must obtain written permission from the adjacent property owner to allow the Proponent to grade on the adjacent lands, otherwise retaining walls must be used. Such permission must be in a form acceptable to the Senior Director of Growth Management and must be obtained prior to approval of the development application;
- Where a lot is lower in the rear than in the front, a split drainage grading design will be used in order to drain a portion of the lot to street catch basins. No front to rear drainage will be permitted;
- Phasing of development must recognize and account for future lot's grading pattern; and,
- Any lot or block which is not developed within 6 months of completion of after availability of building permits is to be graded to provide positive drainage, top soiled and seeded to City's satisfaction. Fencing and signage may be required at City discretion.

J.2.2. Design Criteria for Infill Developments or Lots of Record

Grading of single or multi-family residential lots that are developed through severance applications shall demonstrate that the proposed development will not adversely affect existing buildings, significantly alter existing drainage patterns, or adversely affect neighbouring properties. Grading Design Criteria shall include:

- Positive drainage away from building should be provided at all times;
- Side and rear yard swales to be located entirely within the infill/severed property, unless permission from the adjacent homeowner is granted to improve and modify existing drainage on both lots, i.e.; proposed swales must be contained within the land parcel being developed; and,
- In some cases, side and rear yard slopes less than 2% may be acceptable, but must be reviewed and approved by City staff on a case-by-case basis.

J.2.3. Design Criteria for Low Impact Development & Rural Lot Grading

Grading for rural estate lots which are part of a Plan of Subdivision, or rural lots created under severance, shall conform to the City of Hamilton design criteria outlined in Section J.2.1 - Design Criteria for Plans of Subdivision. Every attempt shall be made to implement the grading criteria outlined in this section. Elements which cannot conform to the standard criteria shall be reviewed with the City for Agreement on approach; such

as, culvert extensions, finished floor elevations that are lower than the existing roadways, and minimum grades that may not be achievable.

If a proper/acceptable outlet cannot be provided due to topographical or other physical constraints, then the Proponent is to consider and implement other practices to retain the water on site (i.e. infiltration gallery, bioswales, water harvesting, etc.) and ensure that surface runoff does not adversely impact neighbouring properties.

Notwithstanding the above, grading design of low impact developments; such as, rural severances or freehold townhouses fronting a City's right-of-way should be reviewed on a case-by-case basis with the design Engineer and the City's plan reviewer. The Proponent would need to demonstrate that alternative grading designs, from urban design requirements, provide a better grading solution to match the existing grading conditions.

J.3. REAR YARD CATCH BASINS

Rear yard catch basins and connections shall be shown with adequate details regarding top of grate elevation, location of catch basins and connection in relation to rear and side property lines, standard drawing detail, inverts, length and grade of connection.

Catch basins in rear yard swales shall be designated as "private" and shall drain not more than:

- A maximum 50 m of a swale measured along the rear property lines;
- A maximum of four (4) lots on either side of a catch basin on any side of the catch basin. Collection from both sides of the rear lot line is acceptable;
- A maximum residential area of 3600 m^2; and,
- Should not include catchment areas for parkland drainage.

Lots containing rear yard catch basins shall have the final security release withheld until the pipe has passed a video inspection to the satisfaction of the City. The length of pipe connecting the rear yard catch basin to the mainline sewer shall not be inspected before the lot has been sodded.

In the case of step down foundations where the front is higher than the back, there must be an emergency overland flow route which will allow the runoff to drain in order to prevent water entering the dwellings.

J.4. SWALES

Slopes of swales for both "back to front" and "split" drainage shall be no less than 2.0% grade and no greater that 33% grade (3:1 slope).

Side and rear yard swales to be located entirely within the infill/severed property, unless permission from the adjacent homeowner is granted to improve and modify existing drainage on both lots, i.e.; proposed swales must be contained within the land parcel being developed.

When matching to existing properties where 2% slope cannot be achieved, then a 1.5% slope is permitted provided a 150 mm sub-drain is installed below the bottom of the swale and drained to a suitable outlet, with a minimum of 0.30 metre cover over the sub-drain or other mitigation measures.

Minimum slopes for a “wrap around” swale in the back yard shall be 1.0%.

The 5% restriction shall not apply to the sides of a swale along the sides or back of a lot, providing the total width of a swale does not exceed one (1) metre on each lot.

J.4.1. Swales across sidewalks

Where drainage from the rear-yard area is to be directed across a sidelot line and across a proposed or existing sidewalk; only the adjacent lot may be drained.

J.5. ROOF LEADERS AND SUMP PUMPS

J.5.1. Roofwater Leaders

All roof water leaders shall discharge onto splash pads and then to grassed or landscaped areas a min. of 0.6m from the building face. Drainage of the front portion of the dwelling shall be directed to the adjacent street.

J.5.2. Sump Pumps

If the hydraulic grade line criteria cannot be met, then sump pumps with check valves are to be installed in each dwelling to pump the weeping tiles to the storm private drain. The sump outlet shall extend a minimum of 150mm above the proposed grade at the dwelling (basement ceiling) prior to discharging to the storm private drain. Connection to storm drain shall include an overflow. All sump pumps must have back up power to ensure operation during a power outage.

There must be a minimum of 3.0 m separation between a sump pump discharge and any downspout.

J.6. GROUNDWATER

Where the geotechnical consultant determines there are areas of concern, the geotechnical consultant shall provide the minimum underside of footing elevation for those lots, and show the same on the lot grading plan. The report from the geotechnical consultant shall certify the minimum elevations as correct.

Refer to Section A.7.7 - Hydrogeological Report.

J.7. PLOT PLANS

J.7.1. Plot Plan

The plot plan for each lot shall be stamped and signed by a Professional Engineer, Ontario Land Surveyor, Architect or Landscape Architect for approval by the Director of Building and Licensing prior to issuing a building permit and shall show the following:

- Proposed elevations at the lot corners, which must conform to elevations on the approved grading plan;
- Elevations of the proposed back of sidewalk adjacent to the lot, and where no sidewalk is proposed, then the corresponding proposed back of curb elevation and the proposed centreline road elevation. (For infill lots, existing elevations should be provided if no new road-works are proposed.);
- If there is a deviation to the approved plan, than a grading revision to the approved grading plan may be required;
- Ground elevations on all sides of the proposed building and the driveway gradient and elevation at the house;
- Elevations of all swales on the lot, the gradient of the required backyard apron and arrows showing flow to or from adjacent lands;
- Existing and/or proposed private catch basins, road catch basins, hydrants, streetlights, hydro transformers, telephone and cable boxes;
- Underside of footing AND top of foundation wall elevations are to be clearly indicated on each plot plan;
- For infill grading plans and plot plans, the following additional information will be provided:
    - Top of foundation wall and garage floor elevation of adjacent buildings/dwellings;
- Existing elevations, at 5m intervals, shall be indicated for one adjacent lot width or at least 15m beyond the property line boundaries to illustrate the drainage of the lot in relation to the surrounding lands and buildings
    - Additional information may be required depending on the specific characteristics of the site. It is the responsibility of the Designer submitting the plan to ensure that information shown adequately depicts the existing and proposed conditions;
- Grading for rural estate lots which are part of a Plan of Subdivision should conform to the City of Hamilton design criteria outlined in Section J.2.1 - Design Criteria for Plans of Subdivision. In addition, for rural developments, the following shall be shown on the lot grading plans and plot plans (if applicable):
    - Existing elevations, at 5m intervals, shall be indicated at least 30m beyond the property line boundaries to illustrate the drainage of the lot in relation to the surrounding lands and buildings;
    - Location of private sewage disposal systems;
- Location of any private water supply system;

- Driveway entrance culverts, including size, length and location;
- If no positive storm outlet is available, storm runoff retention areas shall be shown;
- Ditch elevation details, including bottom of ditch, top of banks, and general flow direction;
- Location of existing creeks and watercourses; and,
- Location of sump pump and discharge point.

J.7.2. Acceptable Lot Grading – As Constructed

Lot grading shall be acceptable to the City if:

- No portion of any side swale has a grade of less than 1.5%, unless mitigation measures have been put into place or specified on an approved grading plan.
- The "as-built" grading does not impede the intent of the approved overall grading plan. Deviation in excess of 150mm at lot corners will be justified on the final grading certificate.
- No portion of any backyard has a finished grade of less than 1.0% once the lot has been fully sodded. This includes the rear and side yards as well as the front yard, except for areas designated as a driveway.
- A Professional Engineer provides certification, including an as-built plot plan, of lot grading after at least one (1) winter has passed and the sodding of the lots is complete.

The Subdivision Agreement shall remain on title to the lots and blocks within a development in order to ensure that the Proponent and subsequent owners of the lots and blocks within a development shall not be released from the restrictive covenants regarding lot grading and discharge of roof leaders onto the ground.

J.7.3. Lot Grading Certificate

A lot grading certificate shall be submitted by a Professional Engineer, on a form acceptable to the City, including an As-Built Plot Plan, and shall contain either of the following wording:

STANDARD GRADING CERTIFICATE

"This is to certify that we have reviewed the final lot grading for the above mentioned lot and taken elevations where necessary to confirm direction and grade of surface drainage as shown on the as-built plot plan. We therefore certify that the works have been completed in the field and that they conform to the approved overall and detailed grading plans for the subdivision and the City's standards.

We Certify that we have verified the water box is functional and to finished grade.

The rear yard catch basin lead has been videotaped and is operation, additionally the grate is at finished elevation."

GRADING CERTIFICATE – DEVIATION

"This is to certify that we have reviewed the final lot grading for the above mentioned lot and taken elevations where necessary to confirm the direction of surface drainage, as shown on the as-built plot plan. While the final lot elevations do not match exactly the proposed lot grading plan, the basic lot drainage pattern has been adhered to and the intent of the approved overall grading plan has been met. No drainage problems were evident at the time of inspection.

We Certify that we have verified the water box is functional and to finished grade.

The rear yard catch basin lead has been videotaped and is operation, additionally the grate is at finished elevation."

Lots in which grading certificates are submitted will be eligible for reduction of securities collected under 'First Stage' amounts with the initial application approval process.

J.8. MULTI-RESIDENTIAL / CONDOMINIUM

Note: The minimum and maximum grade requirements are currently under review. Until such time that they are finalized, the expectation is that the Proponent comply with the grades outlined in this section.

Grading for multi-residential and condominiums shall conform to the City of Hamilton design criteria outlined in Section J.2.1 - Design Criteria for Plans of Subdivision and the Site Plan Guidelines. Generally the following shall apply:

Table J.1 – City of Hamilton Minimum and Maximum Grades

Minimum Grades	Maximum Grades
• asphalt: 1% • concrete: 1% • gravel: 1% • sodded swale: 2% • gravel swale: 2% • concrete swale: 2% • grassed area: 2%	• grassed areas: 7% • berms/slopes: 33% (3:1) • main entrances/exits within road • allowance – 3% • main entrances/exits within first 7.5 m of • property – 5% • all asphalt surfaces on private property • beyond 7.5m of the property line – 10% • private residential driveways – 7% • sidewalks and boulevards – 2% crossfall

Grading for these sites shall be reviewed and approved by the City. Where private roads are part of the proposed works reference should be made to Section C.13 - Private Roads.

J.9. RETAINING WALLS

Retaining walls are generally not considered acceptable as a first course of action in dealing with grade changes between new development and existing developed areas or open spaces areas (SWM ponds, ESAs, etc.); however, should a retaining wall be required, the top of wall elevations shall be set 150mm above the proposed boundary swales. Along adjoining properties, grades shall meet existing or proposed elevations with sodded slopes (min 4:1 slope) and/or retaining walls as specified. Drainage cannot be directed over walls.

The face of all retaining walls shall be placed a minimum of 0.45m inside the property line. The general preference is to locate retaining wall on lot on the higher side.

All walls equal to or greater than 1.0m in height shall be designed by a qualified Professional Engineer. The installation shall be inspected during construction and certified in writing by the Engineer as to conformity to design and suitability for site conditions. The design shall reflect the appropriateness of the proposed wall for the project site and shall at a minimum, include the following design considerations:

- Geotechnical design parameters;
- Whether onsite materials will be acceptable for backfill between any proposed geogrids or tie-backs, or if soil import is needed for wall construction;
- Recommendations for minimum setbacks from the wall to adjacent structures based on the design parameters of the wall and the requirement for any restrictive easements**;
- Recommendations for restrictions on structures and improvements, including swimming pools, walls/fences and trees, within proximity of the retaining wall and the requirement for restrictive easements**;
- Retaining walls shall be constructed of inert materials only; i.e. timber retaining walls are not permitted; and,
- Walls equal to or greater than 0.6m in height shall have a safety rail or fence constructed at the top of the wall and shall be considered in the wall design.

** Landscape easements should be established over subterranean retaining wall geogrids and tie-backs, and require minimum setbacks to allow for trees to be planted without diminishing the integrity of the geogrid, where necessary.

Areas with building restrictions related to proposed retaining walls shall be clearly identified on the Engineering drawings plans and the appropriate warning clauses and restrictions shall be included in Development Agreements as required.

K. CANADA POST INSTALLATION

All Canada Post Supermailboxes shall be located and conform to the following criteria:

Locations shall be:

- On Commercially designated sites with adequate parking, ingress and egress subject to the property owner's approval;
- Adjacent to any parking lot;
- In front of open spaces (excluding walkways less than 4.5 m in width, parks, playgrounds, schools and crosswalks);
- On the abutting flankage corner lots with flankage lots across the street;
- On the flankage of corner lots;
- On the lot line between adjacent dwellings;
- On the side of the road which has a sidewalk. If no sidewalk, or sidewalk on both sides, install on the right hand side of the road when entering the street (cul-de-sac and crescents);
- On roadways with independent sidewalks and curbs, on the side of the sidewalk opposite the boulevard and roadway adjacent to the sidewalk;
- Where there is no sidewalk, it should face the roadway, set back minimum of 2 meters, with the concrete pad extending from the mailbox to curb;
- Where there is combined sidewalk and curb, face the roadway with the face of mailbox located 0.3 m behind the sidewalk;
- Curb drop for handicapped should be installed at Canada post expense when requested by area resident;
- Where there is no curb, place to suit site requirements with adequate pedestrian access and parking;
- Locate in well-lit areas adjacent to streetlights where possible;
- Locate a minimum of:
  - 7 m from fire hydrants;
  - 15 m from stop signs, cross-walks, intersections and bus stops
  - 1 m from streetlight, hydro transformers and telephone or TV pedestals (measured longitudinally along the street);
  - 30 m away from approach of signalized intersection; and,
  - 20 m downstream from signalized intersection
- If abutting flankage lots, shall be placed at centre of dividing lot line or anywhere from the centre dividing lot line to beside the rear corner of the house depending on rear yard and house configuration; and,
- If on flankage lot abutting frontage lot, should be placed anywhere from $\pm$ 3 m, from the lot line to beside the rear corner of the house of the flankage lot depending on rear yard and house configuration.

Supermailboxes shall not be:

- Adjacent to any school, including nursery schools;
- Adjacent to any hospital or clinic
- Located on arterial or major collector roads;
- Placed in such a way as to cause traffic safety and operational difficulties (to maintain safe pedestrian and vehicular sight distances); and,
- Located in any parks.

L. FINANCIAL POLICIES

L.1. Cost Sharing for Over-sizing of Infrastructures

The term 'over-sizing' in the context of this policy refers to sewers, watermains and road works whose size has been increased (over-sized) to service multiple upstream or downstream lands and therefore the size is no longer local to the development in which the works are constructed. The term 'over-sizing', the over-sizing limits and over-sizing rates within this policy do not apply to municipal capital improvement projects within the City's Development Charge Background Study.

Contribution by the City towards the cost of over-sized services constructed under Subdivision Agreements within this policy is funded from revenues collected by the City through its Development Charge. Payment by the City for over-sizing shall be determined based on the over-sizing rates within the cost estimate schedules approved by the City for the constructed works. Temporary works are not eligible for over-sizing contribution by the City.

L.1.1. Sanitary Sewers, Storm Sewers and Watermains

Residential Development

A Proponent is required to pay the full cost for construction of storm and sanitary sewers, maintenance holes and watermains in residential developments up to and including the following sizes:

SANITARY SEWER	450mm Ø
STORM SEWER	1200mm Ø
WATERMAIN	300mm Ø

For pipes the sizes listed above, the Proponent shall pay the local component of the service cost and the City shall pay the over-size component on a "Flat Rate" basis in accordance with the City's table of rates for over-sized works constructed under Subdivision Agreements, plus applicable overhead fees and HST.

Stipulation

The City's contribution for storm sewer over-sizing shall be applied only to storm sewer systems that provide for drainage and conveyance of runoff arising from storm event designs having a five (5) year return period (minor system). Storm sewers conveying 100 year storm event designs (major system) are not eligible for cost contribution by the City.

Where a Proponent proposes a storm sewer system based on a five (5) year return period (minor system) incorporating large diameter pipes at a shallow depth and grade, where smaller diameter pipes can be utilized at lower depth and steeper grades, then the sewer is not considered over-sized by definition under this policy and therefore is not eligible for cost contribution by the City.

Non-Residential Development

In non-residential development a Proponent is required to pay the full cost for installation of sanitary sewers, maintenance holes and watermains up to and including the following sizes:

SANITARY SEWER	450mm Ø
WATERMAIN	300mm Ø

Note

Over-sizing rates shall be adjusted annually by the City at the time of adjustment of the City's Development Charge By-law using the Non-residential Building Construction Price Index for Toronto.

L.1.2. Roadworks

Residential Development

A Proponent is required to pay the full cost for installation of an 8.0 metre wide (local) residential roadway and minimum 1.50 metre wide concrete sidewalk.

The City of Hamilton shall pay for:

1. The portion of a residential road beyond 8.0 metres in width.

   Exceptions

   - Where an existing local residential road is wider than 8.0 metre and must be extended by development, the Proponent shall pay the full cost for the road extension due to its local road classification; and,
   - Where a turning circle is constructed at the intersection of two local roads, there shall be no cost sharing by the City for any portion of the turning circle or land due to the local road classification;

2. The portion of base course asphalt which is beyond 80mm in depth and/or Granular "A" base beyond 150mm in depth, and/or Granular "B" base beyond 300mm in depth;

3. Lay-bys within or abutting residential subdivision plans, provided the lay-by is mandated by the City for the purpose of servicing a public or community facility. This does not include lay-bys required for private multiple residential sites;

4. The portion of the cost for roundabouts constructed on collector roads, which is over and above the cost of a turning circle for local and collector roads; and,

5. The full cost of splitter islands required for roundabouts, where the City has paid a portion of the round-about cost.

Non-Residential Development

A Proponent is required to pay the full cost for installation of up to an eleven (11) metre wide non-residential road. The City of Hamilton shall contribute towards the portion of non-residential roads, which is determined to be beyond a local width and/or depth of base course asphalt and/or granular bases.

Notes

Where widening of a road surface is necessary to accommodate traffic requirements specific to a development site, there shall be no contribution by the City toward the additional road cost as the widening is local to the development site only.

For both residential and non-residential roads:

- Contribution by the City toward the cost of newly constructed over-sized roads shall be on a "Flat Rate" basis in accordance with the rates shown in the table of rates for over-sized works constructed under Subdivision Agreements;
- The City shall not contribute toward the cost of extra depth asphalt or granular bases required to compensate for sub-soil conditions and/or method of construction; and,
- Contribution by the City toward the cost of upgrading existing roads shall be in accordance with the City's Development Charges Background study and Local Service Policy

L.2. Cost Sharing for Street Frontage

In this policy, aboveground works refers to and includes all of the following:

- Base and surface course asphalt pavement on a granular base;
- Concrete curb and gutter, including sub-drain;
- Sidewalk;
- Catch basins and connections;
- Street lighting; and,
- Utility trenching.

Underground works refers to and includes all of the following:

- Storm and sanitary sewers, including maintenance holes;
- Storm and sanitary private drain connections;
- Watermains, valves and chambers; and,
- Water service connections and hydrants.

L.2.1. New Roads Servicing Rate

The New Roads Servicing Rate is a flat rate representing the average cost of local roads constructed under residential Subdivision Agreements and includes all applicable overheads.

All cost sharing for street frontage by the City for the local component of aboveground works shall be based on the New Roads Servicing Rate. The length of street property frontage and/or flankage, which abut the works, shall be multiplied by the New Roads Servicing Rate and the sum shall be the contribution to be paid by the City as cost sharing for above ground works. This rate shall be adjusted annually by the City at the time of adjustment to the City's Development Charge.

In the case of a cost recovery, where a property owner can demonstrate to the satisfaction of the Senior Director of Growth Management that payment has been previously made to the City for existing road works or part thereof, the New Roads Servicing Rate shall be adjusted accordingly.

L.2.2. City Lands

The City shall contribute toward the cost of aboveground and underground works adjacent to the street property frontage of City land:

i) That has been or will be transferred to the City to satisfy the requirement for parkland dedication under the *Planning Act*. The City's share of servicing cost for aboveground and underground works shall be paid at the time construction of above and underground works is accepted as complete by the City.

Stipulation

Where a Proponent has initiated a neighbourhood and/or draft plan amendment which results in an increase in park street property frontage, the City's contribution toward above and underground works shall be based on the length of park street property frontage before the amendment;

ii) That has been or will be transferred to the City for storm water management ponds, for the portion of street pond frontage beyond the first 8.0 metres in length, where the City has mandated storm pond land with street property frontage.

Stipulation

Where open space lands have been incorporated into the lands of a storm water management pond, the City will not contribute to the underground or aboveground works abutting the street property frontage of the open space portion of the storm pond lands;

iii) Which is vacant and can be developed through a *Planning Act* application. In this particular case, the Proponent shall pay the initial upfront servicing cost adjacent to the vacant City land and this cost shall be identified under a 'Cost Recovery' schedule of the City's Subdivision Agreement for the front-ending

Proponent. Payment for the works which relate to the City land shall be made at the time of final release of a development or subdivision application on the vacant land or, in the case of underground works, when an application is made for a service connection to the underground works; and,

iv) That is currently used for the operation of the City such as fire halls, public works yards, arenas or community centres. The City's share of underground works shall be paid at the time when an application is made for a service connection to the underground works. The Proponent shall pay the initial upfront servicing cost adjacent to the City land and this cost shall be identified under a 'Cost Recovery' schedule of the City's Subdivision Agreement for the front-ending Proponent.

Stipulation

There shall be no contribution by the City toward the cost of aboveground works as the City facility is considered existing development benefiting from previous road access.

Note

The City's contribution towards the cost of underground works shall be calculated by taking the street property frontage of City land as a percent of the total street property frontage abutting the limits of the underground works for the street abutting the City land and applying that percentage to the total cost of the underground works, including all applicable overhead.

Contribution toward the cost of aboveground works by the City on new roads within development plans shall be based on the New Roads Servicing Rate multiplied by the street property frontage of the City land.

L.2.3. Fencing Adjacent to City Lands

Where a development abuts City land or land to be transferred to the City as a condition of development approval and a Proponent is required to install a fence to separate the developed lands from City lands, the Proponent shall pay the full cost of the fence installation. For lands transferred to the City to fulfil the requirement for parkland dedication under the *Planning Act*, the cost to install a fence separating parkland from development land shall be shared equally between a Proponent and the City based on the cost to install a 1.50 metre high chain link fence.

L.2.4. Value of Land for Road Allowances

Where a Proponent is required to dedicate ***more*** than thirteen (13) metres of land to *establish* a new road allowance width, measured from the centerline of the road allowance to one side to its ultimate width, the City shall compensate the Proponent for the value of dedicated land *beyond* 13 metres in width on that side of the road allowance, for the length of the conveyance.

Daylight triangles and daylight radius curves are not included in the calculation to determine over-dedication of land to establish or widen road allowance.

Land value shall be determined by the City's Real Estate Section and shall be funded from the Development Charge Reserve.

L.2.5. Storm Water Management Facilities

- Contribution by the City toward the cost of storm water management facilities will be limited to the 'growth related' component of the capital project cost as outlined in the Development Charges Background Study which includes construction, land and applicable overhead.
- Piping and headwalls for the conveyance system to a storm water management facility are not included in the 'growth related' component of the capital project cost and shall be constructed at the expense of the Proponent unless otherwise stipulated by the City's storm water master plan, master drainage plan or watershed/sub-watershed study and development charge background study.
- Storm water management facilities and on-site open watercourse improvements for non-residential development shall be constructed at the expense of the Proponent unless otherwise stipulated by the City's storm water master plan, master drainage plan or watershed/sub-watershed study and development charge background study.

L.2.6. Availability and Timing of Funding by the City

- Timing of payment for the City's share of servicing costs in any year for works constructed under is subject to availability of funding in the capital budget as approved by the City for that year. Appendix K - Protocol for City Share further outlines the Protocol for Repayment of City Share.
- Any Proponent requesting allocation of funding for the City's share of servicing costs under Development Applications shall do so, in writing to the City's Senior Director of Growth Management, prior to August 1st of previous calendar year. Such requests can apply to completed works or imminently proposed works.
- Any development requiring the City's share of works to be paid beyond the approved Capital Budget amount for that year shall require the approval of City Council. The Senior Director of Growth Management Division may authorize funding to be paid during the year for completed eligible projects not initially allocated funding during the Capital Budget process, subject to the availability of reserved monies funded that year.
- Where the total City's share of servicing cost, before overhead, under the Schedule of Works approved by the City is greater than fifty thousand dollars ($ 50,000) a public tender process must be carried out by the Proponent to award the contract.

Note

- For all works constructed under development applications where a Proponent increases the size and/or length or alters the routing and/or configuration of works in their own interest, then contribution by the City toward the cost of such works, if applicable, shall apply to only the portion of works required by the City's policies, design criteria standards and specifications.

L.3. Cost Recovery Policies

L.3.1. Cost Recovery in favour of Proponent

A Proponent is required to pay the initial up-front cost, less City contribution, of all works required to service land to be developed, including the cost of works which may be required through or adjacent to lands of others, except City owned land as described under this policy.

For further clarity, the Proponent is required to install services at their cost up to the limit of the property.

Works Identified for Cost Recovery

A front-ending Proponent's consulting Engineer shall calculate the estimated cost of works which will benefit the lands of others, identify the benefiting lands and the portion of the cost attributable to the benefiting lands. This information shall be included in the City's 'Cost Recovery' schedule for the purpose of recording future cost recovery obligations of the City in favour of a front-ending Proponent against the benefiting lands.

Temporary works are not eligible for inclusion under the City's 'Cost Recovery' obligation and are described as works which will be removed at the time when the benefiting lands or surrounding lands develop or when the ultimate plan is implemented such as the urbanization of a road. In addition, the City reserves the right to disallow any works from inclusion in the City's 'Cost Recovery' schedule which, in the opinion of the City using reasonable judgment, do not benefit the abutting or surrounding lands.

Where a benefiting land owner is required to resurface or reconstruct a road or remove and replace services identified for recovery under the City's 'Cost Recovery' obligation as a result of development of the benefiting lands, then the cost of the removed item shall be excluded from the City's cost recovery calculation against the benefiting lands.

Determination of Cost Recovery Rates

Upon completion of works identified in the City's 'Cost Recovery' schedule, the front-ending Proponent's consulting Engineer shall provide the City with a certified progress payment certificate detailing the actual cost of the completed works. The City shall use the costs within the payment certificate to calculate the total cost of the constructed works, less any City share of the construction cost, and determine a rate to be applied to the benefiting lands.

Where the actual cost of the works exceeds the estimated cost as approved by the City, by more than ten percent (10%) then, the rate to be applied to the benefiting lands for the purpose of cost recovery shall be based on the approved estimated cost, plus ten percent (10%).

A copy of the City's calculations shall be provided to the front-ending Proponent's consulting Engineer for review. Upon Agreement by the consulting Engineer and City to the actual costs and recovery rate for the works, the rate for the 'Cost Recovery' shall

be set by the City and applied to the frontage and/or flankage of the benefiting lands. The cost of individual sewer and water service connections shall be based on the actual cost of each connection.

In the instance where development of a benefiting property takes place prior to completion of the works, then the cost calculation to determine a recovery rate shall be based on the unit cost of the incomplete item within the signed tender document for the works.

Cost Recovery for New Development

Where the City receives an application under the *Planning Act* to subdivide or develop land, which has been identified in the City's 'Cost Recovery' schedule of an existing Subdivision/External Works Agreement as benefiting from previously constructed works, the City shall impose a condition requiring the benefiting land owner to pay their proportionate share of the servicing cost for the works, prior to final release of the *Planning Act* application.

New development refers to land, or the portion of land, that when subdivided is vacant. Cost recoveries for new development shall apply to the vacant portion of subdivided land only.

Cost Recovery for Existing Development

Where a Proponent is required to construct sewers and/or watermains within roads or easements that are adjacent to existing development, the City will pass a Fees and Charges By-law in accordance with the provisions under the *Municipal Act*, for the purpose of assessing and charging existing property owners for their share of the cost of services to an existing dwelling or building in fulfillment of its 'Cost Recovery' obligation to a front-ending Proponent. The City will recover the assessed cost, prior to issuance of a sewer and/or water service permit to connect an existing building or dwelling to the sewer and/or watermain.

There shall be no cost recovery imposed on existing development for enhancements to or urbanization of existing roads carried out by Proponents as these lands have already derived benefit of road access prior to the road improvement.

Existing development refers to land, or the portion of land as determined by the City, exercising reasonable judgment, where a building or dwelling exists prior to construction of municipal works by a front-ending Proponent which services the existing dwelling or building.

All monies collected by the City from existing and new development in fulfillment of its 'Cost Recovery' obligation under the Subdivision/External Works Agreement shall be forwarded to the Proponent named in the Agreement for the works to which the cost recoveries relate.

Exceptions Include:

- Where an existing dwelling or building is located within a lot or block of a plan of subdivision, then for the purposes of cost recoveries, the frontage/flankage of the lot or block upon which the existing dwelling or building is located shall be included in all cost recovery calculations by the City;
- Where an application to develop or subdivide land requires or results in the demolition of an existing building/dwelling then, for the purposes of cost recoveries, the whole of the land subject to the development application shall be considered vacant and referred to as new development;
- The City reserves the option to limit recovery costs for mainline sewers and watermains abutting existing houses or buildings to the equivalent of a minimum sized pipe;
- Where the lands of an existing house have the potential to be subdivided in the future and where a connection to sewers or a watermain is made to the house only, the City reserves the option to apply a flat rate recovery charge for the existing house based on the total recovery amount owed against the lands divided by the potential number of lots that could be created by subdivision of the lands. The flat rate charge shall be paid to the City prior to issuance of a sewer and/or water service permit. The balance of the outstanding cost shall be recovered by the City as a condition of a *Planning Act* application to subdivide the lands;
- Recovery costs for sewers and watermains identified as municipal capital improvement projects funded partly or wholly by Development Charges abutting existing dwellings or buildings shall be limited to the lesser of either the actual non-growth related portion of the project cost or the sewer/watermain extension flat fee under the City's Tariff of Planning and Growth Management Fees By-law; and,
- There shall be no recovery by the City for the cost of storm sewers installed as part of urbanization of an existing rural road which results in removal of the abutting property's overland storm outlet (ditch).

Limit of 'Cost Recovery' Obligation

The City's obligation to recover servicing costs under the 'Cost Recovery' provision of its Subdivision/External Works Agreements shall be limited to no more than ten (10) years from the date of registration of the subdivision plan which relates to the 'Cost Recovery' works, or in the case of site plan and consent applications, ten (10) years from the date of final release of the application.

L.3.2. Cost Recoveries in favour of the City

Aboveground Works

Where the City has previously paid for construction of aboveground works along 0.30 metre reserves under previous Subdivision Agreements, the City shall recover the cost, less the portion identified as over-sizing, from an abutting landowner prior to removal of the reserve. The City shall multiply the 'New Roads Servicing Rate' in effect at the time of payment by the length of the property frontage/flankage of the lands abutting the 0.30

metre reserve. The sum shall be collected by the City as a recovery for the aboveground works.

Underground Works

In the past where the City has previously paid for construction of underground works (sewers and/or watermains) along 0.30 metre reserves under previous Subdivision Agreements, the City shall recover the cost from an abutting land owner prior to removal of the reserve. The cost to be recovered shall be determined based on the as-constructed cost of the works, less the portion of the cost identified as over-sizing, plus applicable overhead. The as-constructed cost shall be divided by the total frontage of the lands abutting the limits of the underground works in order to determine a recovery rate to be applied to the abutting lands. Cost recoveries along 0.30 metre reserves shall be determined by multiplying the recovery rate of the works by the property frontage/flankage of the lands abutting the reserve and the sum shall be adjusted by the Canada Construction Cost Index (Ontario Series) from the month when the works were accepted by the City as complete to the month when a recovery is made by the City.

L.3.3. Cost Recovery on Corner Lots with Daylight Triangle/Radius

Where a corner lot has a daylight triangle or daylight radius thereby reducing the overall length of street property frontage of the lot, then for the purposes of cost recoveries, the length of the frontage and flankage shall be based on the full width (frontage) or depth (flankage) of the lot as if the daylight triangle or daylight radius did not exist.

Municipal Infrastructure

Where it is known that land under a development application is adjacent to works that will be constructed in the future by the City or other Proponents, the City shall collect a security deposit under its Subdivision or Consent Agreement, as the case may be, to secure payment of the Proponent's share of future aboveground and underground works. Security for future aboveground works shall be based on the New Roads Servicing Rate applied to the frontage and/or flankage of the Proponent's lands adjacent to the future works. Security for underground works shall be estimated based on the pipe size of the future underground services.

Following construction of the future works, the City shall invoice the Proponent for the Proponent's share of the actual cost of the works. Upon receipt of payment from the Proponent the City shall release the Proponent's security deposit held under the Subdivision or Consent Agreement.

Street Tree Planting

Where land is subdivided to create single, semi-detached or street town house development, the City shall collect a cash payment from the Proponent for street tree

planting to be carried out by the City at a rate of one tree for the front yard of each lot and unit created and two additional trees along the side yard of each corner lot. The cash payment shall be collected by the City prior to registration of a subdivision plan or prior to execution of a consent agreement by the city.

L.3.4. Payment for Future Urbanization of Existing Rural Roads

Where land is subdivided, adjacent to an existing road of rural cross section which is located within the Urban Area Boundary as defined by the City's Official Plan, the City shall collect a cash payment representing the Proponent's contribution toward the cost to urbanize existing rural roads including local size storm sewer. The requirement to pay toward future road urbanization shall be imposed by the City as a condition of an application to subdivide land. Payment shall be determined by multiplying the New Roads Servicing Rate in effect at the time of payment by the property frontage of the subdivided land which represents new development as defined under this policy and the sum shall be collected by the City prior to final release of the *Planning Act* application. Development fee tables can be obtained from Planning and Economic Development Department, Growth Management Division.

2017 Rates for Oversized Works Construction Under Subdivision Agreements

WATERMAINS		
Pipe Size	**Rate Per Metre of Pipe**	**Rate Per Combination Gate Valve With Air Valve or Blow-off**
300mm Ø	**- NIL -**	**- NIL-**
400mm Ø	**$ 106.00**	**$ 14,463.00**

NOTES:

1. For 400mm Ø stand-alone air valve/blow-off chambers, the unit price per chamber is **$ 9,488.00**.
2. The City's contribution towards the over-sized portion of pipe sizes beyond 400mm Ø shall be negotiated at the time of approval of the engineering design by the City.

SANITARY SEWERS	
Pipe Size	**Rate Per Metre of Pipe**
450mm Ø	**- NIL-**
525mm Ø	**$ 36.00**
600mm Ø	**$ 90.00**
675mm Ø	**$ 203.00**
750mm Ø	**$ 297.00**
825mm Ø	**$ 380.00**
900mm Ø	**$ 469.00**
975mm Ø	**$ 663.00**
1050mm Ø	**$ 855.00**
1200mm Ø	**$ 1,028.00**
SANITARY MANHOLES	
Manhole Size	**Rate Per Manhole**
1200mm Ø	**- NIL -**
1500mm Ø	**$ 2,118.00**
1800mm Ø	**$ 3,357.00**
2400mm Ø	**$ 7,766.00**
Note: The City will only cost share for over-sized manholes that are used in combination with over-sized sewer pipe.	

STORM SEWERS	
Pipe Size	**Rate Per Metre of Pipe**
1200mm Ø	**- NIL -**
1350mm Ø	**$ 305.00**
1500mm Ø	**$ 676.00**
1650mm Ø	**$ 1,080.00**
1800mm Ø	**$ 1,586.00**
1950mm Ø	**$ 2,057.00**
2100mm Ø	**$ 2,560.00**
Note: Storm sewer over-sizing is applicable on the minor storm system only.	
STORM MANHOLES	
Manhole Size	**Rate Per Manhole**
2400mm Ø	**- NIL -**
3000mm Ø	**$ 4,512.00**
3600mm Ø	**$ 35,484.00**
Note: The City will only cost share for over-sized manholes that are used in combination with over-sized sewer pipe.	

Note:
The City shall pay Construction Inspection fees, Consulting Engineering fees plus HST in addition to the rates described above as detailed in the cost estimate schedules.

ROADWORKS		
Item	**Rate Per m^2**	**Description**
Binder Asphalt and Granular Base	**$ 48.70**	Extra **WIDTH** over 8.0m of: 150mm Granular "A" 300mm Granular "B" 80mm HL-8 Binder Asphalt
Surface Asphalt	**$ 14.15**	Extra **WIDTH** over 8.0m of: 40mm HM-3 Surface Asphalt
	$ 1.14	Full **WIDTH** of: HL-1 Surface Asphalt
Binder Asphalt	**$ 6.75**	Extra **DEPTH** for: 100mm HL-8/HL-8HS Binder Asphalt
	$ 16.57	Extra **DEPTH** for: 120mm HL-8 (HS) Binder Asphalt
Granular Base	**$ 6.21**	Extra **DEPTH** for: 450 mm Granular "B" Base

Note:
The City shall pay Construction Inspection fees, Consulting Engineering fees plus HST in addition to the rates described above as detailed in the cost estimate schedules.

New Roads Servicing Rate Construction Items

ITEM	Rate Per Metre Of Property Frontage
Curbs and Sub-drains	$ 63.59
Street catch-basins and connections	$ 35.49
Asphalt pavement (up to binder course asphalt)	$ 193.71
Asphalt pavement (surface course asphalt)	$ 40.89
Sidewalks (both sides)	$ 91.69
Sidewalk (one side only)	$ 45.85
Street lighting	$ 23.10
Utility trenching	$ 14.09
Local Storm Sewer	$ 113.76

Notes:
1.The City shall pay Construction Inspection fees, Consulting Engineering fees plus HST in addition to the rates described above as detailed in the cost estimate schedules.

New Roads Servicing Rate for Cost Sharing of Road Construction

(represents road cost per metre of property frontage with no storm sewer component)

New Roads Servicing Rate	Flat Rate with No Overhead	Flat Rate with 32.56% Overhead
Sidewalk both sides =	**$ 462.57**	**$ 613.18**
Sidewalk one side =	**$ 416.72**	**$ 552.41**
No Sidewalk =	**$ 370.88**	**$ 491.63**

Notes:
Flat Rate with no overhead should be used under Schedule “F” of the City’s subdivision agreement to determine the City’s share of the net construction cost for each item identified with **City Share** in the schedules. The overhead for City share will be added on the Schedule “F” summary page in the same way as all other items in Schedule “F”.

New Roads Servicing Rate for Cost Recovery (represents road cost per metre of property frontage including local storm sewer component)

New Roads Servicing Rate	Flat Rate with No Overhead	Flat Rate with 32.56% Overhead
Sidewalks both sides =	**$ 576.33**	**$ 764.00**
Sidewalk one side =	**$ 530.50**	**$ 703.20**
No Sidewalk =	**$ 484.65**	**$ 642.45**

Notes:

1. Overhead on the New Roads Servicing Rate (32.56%) represents 13% HST, 6% Construction Inspection and an average of 12% Consulting Engineering Fees plus 13% HST on Consulting Engineering Fee.

2. Flat Rate with 32.56% overhead included represents the rate to be used for all cost **recoveries**.

M. Appendices

M.1. Appendix A - Watermain Hydraulic Report

The report should also include the following information:

- Service pressures under 2015 and 2031 conditions are expected to be within the standard pressure;
- All fire flows can be achieved for the proposed development under 2014 and 2031 conditions;
- Under maximum day plus required fire flows for 2014 and 2031 conditions the PD* distribution system is able to maintain pressures above 140 kPa at ground level at all locations in the district;
- The proposed watermains can withstand transient pressure; and,
- All proposed watermains can achieve a flushing velocity of 0.8 m/s.

*At this point the proponent is to indicate the ID number of the Pressure District in which the watermain(s) being added are located and serviced from.

Typical Table of Contents

Cover Letter

Cover Letter includes Engineer's stamp and seal and declaration "*The analysis documented in this report includes individual hydraulic examination of the Average Day demand, Maximum Day plus fire flow and the Maximum (Peak) Hour demand of the development for the 2011 (present) and 2031 demand conditions.*"

STANDARD DECLARATION

Standard declaration to include the following:

• The service pressures under existing conditions, and ultimate build-out (currently 2031*) conditions are expected to range between ___ kPa and ___ kPa which are within standards established by the MOE-CCC and City of Hamilton Guidelines;

• All required fire flows can be achieved under Maximum Day Demand conditions for the proposed development under existing and ultimate build-out (currently 2031*) conditions;

• Under maximum day plus required fire flows for existing and ultimate build-out (currently 2031*) conditions the PD__ distribution system is able to maintain pressures above 140 kPa at ground level at all points in the district;

• The proposed watermains can withstand transient pressure plus maximum operating pressure;

• All proposed watermains can achieve a minimum flushing velocity of 0.8 m/s; and,

* as amended from time to time as per Official Plan Report Content.

INTRODUCTION

2 CRITERIA
2.1 Domestic Demand
2.2 Fire Flow Demand
2.3 Boundary Conditions
2.4 Subdivision Computer Model

3 ANALYSIS
3.1 System Pressures and Available Fire Flow
3.2 Transient Pressures
3.3 System Flushing

4 CONCLUSIONS

F I G U R E S
Figure xx Subdivision Location Plan
Figure xx Pass/Fail under Maximum Day Demand + Fire Flow

A P P E N D I C E S
Appendix A Demands and system layout
Appendix B Model results
Appendix C Fire Flow Calculations

Common Documentation Screening Criteria

- Part (2) of Form 1 must include street names with from/to limits for all municipal pipes and that this corresponds to Engineering drawings, site plans, etc.;
- Ensure compliance with Official Plan, Secondary Plan, Block Servicing Plan, Draft Plan of Sub-Division, legacy conditions of approval, etc.;
- In consultation with Hamilton Water, seek approval from Development Approvals Section in advance of Form 1 submission where watermains are proposed within easements on private property. Where watermains are on private property, ownership by private owner is required unless it is for network looping between City watermains;
- Where both public and private infrastructure is part of the submission documentation (all drawings, sketches, etc.) be clearly and explicitly differentiated according to City Standards;
- Clear map of the proposed alterations in which all nodes are labelled and all pipes are labelled. All nodes that form part of the analysis must be represented in the mapping and correspond to all other tables and text;
- Street names must be labelled;
- Confirm that the documentation is complete including seal, signature, and license number of the Licensed Professional Engineer;
- Name of subdivision including phase identification and consistency must be the same/current on all documents;
- Check that all content (text and drawings) is legible;

- Confirm scenarios for existing conditions, and condition of ultimate build-out (currently 2031*) have been analyzed and documented;
- Check for additional scenarios, on a case by case basis where unknown/future infrastructure will be built to address future undefined growth, and an interim build-out scenario as identified at Formal Consultation or early Development Application stage consultation;
- For all Hydraulic Analysis documentation must include a description of boundary conditions that were applied;
- Schematics (pipes and nodes) must be consistent with tables in the data/results files;
- References to tables, appendices, and figures are correct (reference to figures that do not exist) consistent use of units (metric, imperial);
- Documentation must include a description of how the hydraulic model/calculations have been **calibrated/validated** and that the model as constructed is appropriate for the Form 1 purpose when modifications/extensions to the City's base model has been made;
- Confirm that **RFF has been included.** All submissions must have a Required Fire Flow-RFF Calculation unless specifically waived at DA/FC circulation stage;
- Confirm where required, that **peak demand estimates are calculated** using the Fixture-Unit Approach as required by Section 3.4.3 of the MOE Design Guidelines for Drinking-Water Systems (2008);
- Triage Reviewer in the Development Approvals Section to ensure all values/variables used in calculations presented in the document do not vary from **reasonable values.** Validate when non-standard values are found; for example it is unlikely that:
  - A commercial/retail building will have non-combustible content; and
  - A residential home will have a total floor area of 3400 $m^{2.}$
- Confirm that the description demonstrating how the **flushing** velocity can be achieved includes **documentation of strategy** for conventional (e.g. One-port, two-ports; multiple hydrants); and/or uni-directional specifying which valves need to be closed;
- RFF calculations follow Fire Underwriter Survey (FUS) Methodology and the Regular Method;
- No reference to ISO method in the Required Fire Flow calculations is permitted;
- Short Method not accepted;
- There cannot be conflicting data. i.e. building floor area in the body of the report, in table, in appendix must be consistent;
- Required Fire Flow in Table must be the same as in Appendix;
- In order to properly assess Required Fire Flow-RFF calculations, the components need to be identified and documented; and

Drawings must illustrate:

- Building foot print and floor area;
- Number of stories;
- Location and fire resistance rating of Fire walls (as per National Building Code of Canada) and;

- Ensure that the documentation supports the fire resistance rating of the vertical openings and exterior vertical communications.

COEFFICIENT OF CONSTRUCTION

- Ensure that the documentation supports the construction coefficient used and;
- Report to confirm that there is documentation that supports the Percentage Credit Claimed for the sprinkler system.

CONTENT FIRE HAZARD/OCCUPANCY

- Verify content combustibility claim

EXPOSURE

- Separation distances and resultant exposure charges must be identified per each side and shown on a plan
- Sum of above cannot exceed 75%

Appendix A.1 - Required Fire Flows contains a typical fire flow calculation based on FUS 1999.

Also, see:

Appendix A.2 - Typical Water Hydraulic Analysis Report Conclusions

Appendix A.3 - Watermain Design Brief Requirements

Appendix A.4 - Guide to Technical Documents Required for Various Applications

The City will provide comments electronically via Appendix A.5 - Enhanced Comments Table.

An electronic version should also be submitted in native PDF format. This is meant to be a fluid working document which flows back and forth between the City and the Consulting Engineer.

M.1.1. Appendix A.1 Required Fire Flows

Fire Flow Calculation* based on Fire Underwriters Survey						
Location	**70 Barton - Block B**					
Footprint (m^2)	1421	(m2)				
Storeys	1					
Floor Area (m^2)	1421	(m2)				
Construction Coefficient	1	(from 0.6 to 1.5)				
NFF = 220*C*(A)**0.5	8293	L/min				
Round to nearest 1000 L/min	8000	L/min				
Occupancy factor	-0.15	(from -0.25 to +0.25)				
NFF adjusted for occupancy	6800	L/min				
Sprinkler adjustment	0	(max. 0.3)				
Sprinkler flow credit	0					
			(from 0 to 0.25 in each direction)			
			N	S	E	W
Exposure adjustment	0.55	max.0.75	0	0.15	0.2	0.2
Exposure flow debit	3740	L/min				
NFF	10540	L/min				
Round to nearest 1000 L/min	11000	L/min		2423	Igal/min	
Available FF of resid.@20psi FL04H030 (16/06/2013)	8,810	L/min		1938	Igal/min	
Available FF of resid.@20psi FL04H098(16/05/2013)	9,406	L/min		2069	Igal/min	
Calculated surplus/deficiency	-19.9%					
(*) Plug data only on the yellow cells						

M.1.2. Appendix A.2 - Typical Water Hydraulic Analysis Report

Standard Declaration Including the Following:

- The service pressures under existing conditions, and ultimate build-out (currently 2031*) conditions are expected to range between __kPa and __kPa which are within standards established by the MOE-CCC and City of Hamilton Guidelines;
- All required fire flows can be achieved under Maximum Day Demand conditions for the proposed development under existing and ultimate build-out (currently 2031*) conditions;
- Under maximum day plus required fire flows for existing and ultimate build-out (currently 2031*) conditions the PD__ distribution system is able to maintain pressures above 140 kPa at ground level at all points in the district;
- The proposed watermains can withstand transient pressure plus maximum operating pressure; and,
- All proposed watermains can achieve a minimum flushing velocity of 0.8 m/s.

*As amended from time to time as per Official Plan Report content.

M.1.3. Appendix A.3 – Watermain Design Brief Requirements

WATERMAIN DESIGN BRIEF REQUIRMENTS – City of Hamilton				
	Required info:	**Design Criteria**	**Requirement**	**Requirement Reference**
1.0	1.1 Maximum day demand estimate based on the proposed density and the City criteria. 1.2 Fire flow estimate based on the Fire Underwriters Survey document " Water Supply For Public Protection 1999". 1.3 Model Output provided in the report 1.3.1 The Consultant should obtain the City wide base model for modeling purposes.	System Pressure	Minimum 140Kpa (20psi) under maximum day plus fire	Section 1.1
2.0	2.1 PVC pipe DR18, surge pressure as result of stopping water column moving at V=0.6m/s (range of 30-40 psi.) 2.2 Ductile Iron Pipe CL52, surge pressure as result of stopping water column moving at V=0.6m/s (range of 72- 112 psi.) 2.3 Consider worst case scenario surge pressure plus maximum pressure in the system.	Transient Pressure	Maximum operating plus surge pressure for V=0.6m/s	Section 2.0
3.0	3.1 Hazen-Williams coefficient assigned to the model must be as per noted values.	Friction Factors	Hazen-Williams coefficient Ø150mm C=100 Ø200-250mm C=110 Ø300-600mm C=120 over 600mm C=130	Section 3.0
4.0	4.1 Provide design drawings	Pipe Diameter	Minimum 150mm servicing hydrants	Section 4.1
	4.2 Provide model output	Flushing Velocity	Minimum 0.8m/s	Section 4.2
5.0	5.1 Provide watermain looping or blow-off as per the City criteria.	Flushing provisions at dead ends	Adequate flushing where dead-end watermain cannot be avoided	Section 5.1
	5.2 Refer to the City of Hamilton criteria to provide min 1.6m cover over the watermain	Depth of cover	Frost cover (1.2m)	Section 5.2
6.0	6.1 Refer to the City of Hamilton specifications for a minimum private service size.	Service pipe diameter	Min 19mm	Section 6.1
	6.2 Refer to the City of Hamilton approved watermain product list.	Service pipe material	Per Building Code/AWWA regulations	Section 6.2
7.0	7.1 Refer to the City of Hamilton approved watermain product list.	Watertmain materials to meet health regulations.	Per AWWA and NSF/ANSI standards	Section 7.1
8.0	8.1 Refer to a Geotechnical Report.	No organic compounds from groundwater to enter into the proposed watermain through pipe, joint materials, O-rings, gaskets, hydrant leads or service pipe.	Verify presence of contaminated groundwater	Section 8.1
9.0	9.1 Loading calculations for PVC pipe as per Unibell Handbook of PVC Pipe-4th Edition, Table 7.4. 9.2. Loading calculations for Ductile Iron Pipe	Pipe materials capable of withstanding loading conditions.	Maximum pipe deflection 50% of manufacturer's recommendations. (Maximum 5%)	Section 9.1

WATERMAIN DESIGN BRIEF REQUIRMENTS – City of Hamilton				
	Required info:	**Design Criteria**	**Requirement**	**Requirement Reference**
	as per "Manual of Water Supply Practices-Ductile Iro Pipe & Fittings", Table 4-5.			
10.0	10.1 Fire hydrant to be installed on a watermain that has sufficient capacity to supply required fire flow.	Fire Hydrants	As per AWWA standard C502. Refer to the City of Hamilton specifications.	Section 11.0
11.0	11.1 Ensure sufficient number of gate valves is proposed at intersection.	Valves	Shall conform to relevant AWWA standards.	Section 12.0
12.0	12.1 Explore the watermain profile to determine need for air/vacum release valve.	Air Valves	Shall conform to AWWA Standard C512.	Section 13.0
13.0	13.1 Avoid chamber in sag points and ensure 150mm PVC drain is provided to the storm outlet.	Valve, Meter and Blow-off Chamber	No subject to submergence; meet standards of connections.	Section 14.0
14.0	14.1 Provide appropriate details and notes on the plan.	Separation	Min horizontal separation 2.5m and 0.5m vertical clearance from storm and sanitary sewer.	Section 15.0
15.0	15.1 Refer to the City of Hamilton Standard Drawings WM-204.1 to 204.13 Revised Sep 30/09	Restrains	Provision of thrust blocks	Section 16.0
16.0	*Interim Water Quality Flushing Commitment Letter (template under development)*	*Water Quality*	*Maintain Chlorine Residual as per Reg.*	

M.1.4. Appendix A.4 - Guide to Technical Documents Required for Various Applications

Water Distribution System Evaluation Criteria for Development			
Type of Development	**Peak Demand Calculation**	**Required Fire Flow (RFF) Calculation**	**Hydraulic Modeling (WaterCAD)**
Parking lots, restaurant patios, street furniture additions, site plans in areas not serviced by municipal water	Not required	Not required	Not required
1-2 Single Family residential or 1 semi-detached unit on an infill lot	Not required; will use assessment, census, MP values for modeling	Not required unless planning documents indicate abnormally large floor area (i.e. monster homes)	Will look at hydrant flow tests in Hansen and identify if there is a low flow/pressure issue; may result in programming a Capital work
Groups of 3-5 single family homes	Not required; will use assessment, census, MP values for modeling	Required; need proponent to identify spacing of units, materials of construction, floor areas	Typically screen RFF at location versus flow tests to determine strength/adequacy of supply Where system is weak (district boundary, extremity of system, older area) may ask for investigation
Subdivision developments in excess of 5 homes (Note this typically means watermain extensions and hence Form 1 application)	Required in order to modify model demands to analyse pre- and post-development	Required; need proponent to identify spacing of units, materials of construction, floor areas	Required to support Form 1 application and demonstrate that no point in district will fall below 140 kPa under Max Day + fire demands
Townhouse Blocks (1 or 2 blocks, 2-4 units/block, separation > 3m)	Required; fixture unit method recommended	Required; need proponent to identify spacing of blocks, materials of construction, total floor areas	Will screen location against flow test results For small townhouse blocks and where system is weak may ask for impact investigation May involve redesign of building to incorporate fire walls, brick exterior to reduce Required Fire flows
Townhouse Blocks (3 or more blocks, 4-8 units/block, separation 3m +/-)	Required; fixture unit method recommended	Required; need proponent to identify spacing of blocks, materials of construction, total floor areas	Will screen location versus flow test results In most cases will ask for demonstration that required flows can be delivered May involve redesign of building to incorporate fire walls, brick exterior to reduce Required Fire flows
Uncertain high density residential or ICI usage associated with Block Servicing	Estimate required which will be compared to submission at site plan stage	Estimate typical of zoning required which will be compared to submission at site plan stage	Hydraulic analysis required based on Block servicing assumptions to establish an upper limit on development. At site plan submission proposal will be compared to assumption and 1. if usage or RFF less than Block servicing assumption no need for further analysis 2. If usage or RFF greater than Block servicing assumption, supplemental analysis required
Nursing homes, senior's residences, dormitories , hotels(new construction and additions)	Required; fixture unit method recommended	Required; need proponent to identify materials of construction, total floor area(addition or entire building depending on fire separation)	Will screen location versus flow test results For small addition separated by 2hr rated fire walls likely no modeling required but where system is weak may ask for impact investigation regardless For larger buildings with <2hr fire separation will ask for demonstration that required flows can be delivered May involve redesign of building to incorporate fire walls, brick exterior to reduce Required Fire flows
Schools, hospitals	Required; fixture unit method recommended number of students, beds, special fixtures (pools, equipment) to be defined	Required; need proponent to identify materials of construction, total floor areas(addition or entire building depending on separation)	Will screen location versus flow test results For small addition separated by 2hr rated fire walls likely no modeling required but where system is weak may ask for impact investigation regardless For larger buildings with <2hr fire separation will ask for demonstration that required flows can be delivered May involve redesign of building to incorporate fire walls, brick exterior to reduce Required Fire flows

Water Distribution System Evaluation Criteria for Development			
Type of Development	**Peak Demand Calculation**	**Required Fire Flow (RFF) Calculation**	**Hydraulic Modeling (WaterCAD)**
Small Commercial Buildings (eg. Neighbourhood shopping, standalone gas stations, garages, residences repurposed for offices)	Need will be determined based on proposed use/occupancy. eg. Store/garage with one washroom estimate not required; dental/medical offices estimate required	Required; need proponent to identify materials of construction, total floor areas(addition or entire building depending on separation), expected occupancy	For low hazard occupancy requiring small fire flows will screen versus flow tests and hydraulic analysis may not be required See note regarding block servicing analysis
Large Commercial Buildings (shopping malls, plazas, warehouses, big box stores, restaurants, theaters, office complexes)	Need will be determined based on proposed use/occupancy. eg. Warehouse with one washroom estimate not required; multi-seat restaurant, theater estimate required	Required; need proponent to identify materials of construction, total floor areas(addition or entire building depending on separation), expected occupancy and function (hazard related)	For low hazard occupancy requiring small fire flows will screen versus flow tests and hydraulic analysis may not be required See note regarding block servicing analysis for large required fire flows hydraulic analysis will be required to determine impact and capacity for flow delivery
Small/Light Industrial Buildings (craft shops, minor fabrication facilities, scrap yards, car wash)	Need will be determined based on proposed use. eg. Dry shop with one washroom estimate not required; water-intensive process estimate required	Required; need proponent to identify materials of construction, total floor areas(addition or entire building depending on separation), expected occupancy	For low hazard occupancy requiring small fire flows will screen versus flow tests and hydraulic analysis may not be required See note regarding block servicing analysis for large required fire flows hydraulic analysis will be required to determine impact and capacity for flow delivery
Large/Heavy Industrial Buildings	Need will be determined based on proposed use/occupancy.	Required; need proponent to identify materials of construction, total floor areas(addition or entire building depending on separation), expected occupancy	See note regarding block servicing analysis for large required fire flows hydraulic analysis will be required to determine impact and capacity for flow delivery
Public and quasi-public facilities such as Churches, Daycares, Municipal service centers, meeting halls, arenas, etc	Need will be based on size of facility	Required; need proponent to identify materials of construction, total floor areas(addition or entire building depending on separation)	Will screen existing record of flow tests and hydraulic analysis may not be required Where system is weak (district boundary, extremity of system, older area) or the facility is large, may ask for investigation depending on an assessment of risk

M.1.5. Appendix A.5 - Enhanced Comments Table

DA-15-xxx <subdivision / phase >, location/community - Watermain Hydraulic Analysis Review
Comment Implementation Tracking Table

Report Title :	<name>, Revision # Watermain Hydraulic Analysis (WHA) for DA-14-xx_<subdivision / phase >, location/community		
Report Number(s) : Author(s) :	###-#####-## (WHA) <name>, P.Eng.	Version Date : Report Consultant(s):	Mmm dd yyyy (WHA) <name> (WHA)
Comments :	Comments issued by Hamilton Water on mmm dd yyyy Response issued by <name> on mmm dd yyyy Response received by Hamilton Water on mmm dd yyyy Comments issued by Hamilton Water on mmm dd yyyy		

Number	Report / Section / Page	Comment (mmm dd yyyy)	Response	Comment (mmm dd yyyy)
1	WSA / Section x Page x of x			

M.2. Appendix B – Pre-Construction Meeting

PRE-CONSTRUCTION MEETING **DATE:**

Attendance

_____

_____

_____

_____

_____

1. Subdivision: _____ File: _____
   25T-_____
2. City Subdivision Agreement Executed: _____
3. Cash & Securities Received: _____
4. Date drawings approved/as noted: _____
5. MOE Certificate No.
   Approval Date:_____
   San. Sewer: _____
   Storm Sewer: _____
   Water: _____
   SWM
6. The following drawings etc. are required to be submitted for construction section:

   a) 1 set const. dwgs. (full size, paper): Date Rec'd: _____

   b) 1 set const. dwgs.(reduced to 11"x17",paper): Date Rec'd: _____

   h) 1 copy of unpriced specs: Date Rec'd: _____
   _____

   i) 1 copy of priced and signed specs: Date Rec'd: _____
7. General Contractor: _____

   24 hours Emergency Telephone Number_____
   (Required if work is to be done within an existing road allowance)

Subcontractor: _____

8. Consultant: _____

9. Construction Schedule: _____

10. List of Materials/Suppliers

Granular:	_____	Concrete:	_____
Asphalt:	_____	San. Sewer:	_____
Manholes:	_____	Valves:	_____
Stm Sewer:	_____	Hydrants:	_____
Watermain:	_____		

11. Access: _____

12. Topsoil Stockpile: _____

13. Proponent's Insurance: _____

14. Contractor's Insurance: _____

15. Soils Consultant: _____

16. Blasting Requirements Pre-blast Survey: _____
Consultant's Letter: _____

If blasted rock is to be used as backfill material, a letter from the soils consultant is required prior to backfilling advising of technique, and that the soils consultant will certify the backfill as meeting City specifications. The soils consultant will be present, full time, on site in order to certify the work. This additional charge is to be borne by the Subdivider.

17. Archaeological Study Received: _____

18. Tree Preservation Plan Received: _____

19. Consultant is to co-ordinate with all utilities.

20. Video inspection is to be requested by the consultant.

21. Contractor will arrange with City inspector for initial underground inspection.

22. For Letter of Credit Reduction the Consultant to provide statements estimating:

Completed and Remaining work along with proof of payment from contractor.

Proof of publication in the "Daily Commercial News" + 45 day time period from that date is required to release the remaining 10% holdback for construction items under the Agreement.

23. If applicable, consultant to provide summary order of tendering, recommending contractor, and breakdown of City's cost sharing based on low bidder.

No payments of City share until plan is registered

24. Consultant to provide inspection for all final measurements. "As Constructed" drawings are to be provided within time frame as specified per the agreement.

    Maintenance will not commence until the Plan is registered and preliminary "As

    Constructed" drawings have been received.

25. It is illegal for the contractor/subdivider to operate any component of the municipal water distribution system without proper authorization from the appropriate municipal officials.

26. The Land Use Sign must be erected prior to any construction or topsoil removal on site. This sign must indicate the location of all proposed sidewalks.

27. Advise the Proponent/consulting engineer/contractor of the Standing Water By-law. They must ensure that the lands are graded and protected in such a manner that standing water does not occur and/or is drained or removed from the site. Enforcement will be done through the Building Department.

28. Receive and/or discuss street cleaning and dust control program.

29. The Contractor shall be in good standing with the Workplace Safety and Insurance Board ("WSIB") throughout the term of the Contract. If requested by the City, the Contractor shall produce certificates issued by the WSIB to the effect that they have paid in full their assessment based on a true statement of the amount of payrolls. If the Contractor is exempt from WSIB coverage, the Contractor shall provide evidence of such exemption satisfactory to the City; and

    The Contractor shall provide such evidence prior to commencing the Work, subsequently with each application for progress payment, and at any time during the term of the Contract when requested by the City.

30. Where site is not balanced and material is either imported or exported, consultant to provide source or destination, all appropriate testing and owner's letter confirming acceptance.

M.3. Appendix C – Disconnection of Services

Hamilton

Mailing Address:
City Hall
71 Main Street West, 5th Floor
Hamilton, Ontario
Canada L8P 4Y5
www.hamilton.ca

Planning and Economic Development Department
Growth Management Division
Physical Address: 71 Main Street West, 5th Floor

DISCONNECTION OF SERVICES (SEWER LATERAL) INFORMATION SHEET

Demolition Permit Requirements for the Abandonment and / or Re-Use of Sewer Service Laterals (Storm and Sanitary - Public Portion)

As per Section 12 of the City's Sewer and Drain By-Law (By-Law No. 06-026); prior to the removal of a building the owner of the building is responsible to have the sewer service lateral **exposed at the property line**, and reasonable notice given to the Growth Management Division so that it may be video inspected and it is determined that the sewer service lateral(s) meets the requirements of the by-law, including but not limited to size and material and is in an acceptable condition for re-use.

Those applying for Demolition Permits are hereby advised that the Growth Management Division will not sign the Disconnection of Services Form until such time as the following protocol has been followed:

If the applicant intends to re-use the existing sewer service lateral(s) a CCTV Inspection is required;

1. A sewer video inspection/review fee of $415.00 (2015 rate) has been paid to the City of Hamilton (to be paid on the 5th floor, City Hall) and arrangements have been made to have the CCTV Inspection completed in the presence of a Growth Management Division Inspector (48-hours' notice is required to book an inspector).

2. A copy of the video is to be submitted to the City for review and our records.

   NOTE: The City will only accept the video on DVD media.

3. Should the sewer service lateral(s) require rehabilitation or complete replacement, *as determined by the City*, the applicant shall obtain the necessary permits and perform all works as required, including a final CCTV Inspection.

If the applicant intends to abandon the existing service lateral(s) and install a new service(s);

The applicant shall hire a contractor, bonded with the City of Hamilton, and obtain a Road Cut Permit (to be paid on the 5th floor, City Hall). The cost of the Road Cut Permit is $532.20 (2015 rate).

The Growth Management Division will sign the Disconnection of Services form once it has been determined the new or rehabilitated service(s) is acceptable for use.

To schedule an inspection please call 905-546-2424 extension 7860.

City of Hamilton,
Growth Management Division

M.4. Appendix D – Security Reduction Request

Planning and Economic Development Department
Development Engineering Division

Hamilton

Revision number: 0	Date of Revision: –	Date of 1st issue: July 12, 2007
Subject:	**Procedure - Security Reduction Request**	

- Developer's Engineer is to submit a written request for a security reduction in the approved City of Hamilton format (attached).

- A complete security reduction request shall include:
  a. Engineer's certificate identifying the construction value of the completed works and estimated value of incomplete works (sample attached)
  b. Copy of the accompanying progress payment certificate
  c. Written statement by the general servicing contractor acknowledging receipt of payment of all invoices due which relate to the progress payment certificate
  d. Administration fee, if applicable (processing fee* will apply upon the fourth and subsequent reduction requests).

- The reduction request will be processed within 20 business days upon receipt of a complete security reduction request, provided that all required inspection and documentation is completed prior to the request for a reduction. Should the Developer's Engineer not follow the procedure or format, the request will not be processed within the allotted time frame or may require a resubmission.

- An Incomplete security reduction request will be returned to the Developer's Engineer within five (5) business days and will be required to resubmit. A copy of this letter will also be sent to the Developer.

- A copy of the processed security reduction will be forwarded to the Developer and the Developer's Engineer.

SUMMARY STATEMENT OF SUBDIVISION SECURITY REQUIREMENTS

REDUCTION NO.1

REGISTERED DEVELOPMENT NAME

FILE: CITY FILE #

				Subdivider's Share		Value of LC Required	
	Security Item	Total Value as per Schedule 'F'	Subdivider Share as per Sched. 'F'	Value of Completed Works	Value of Incomplete Works	Holdback - 10% of Completed Works	Value of Incomplete Works
Sch "F"	1a Sewers	$ -	$ -				$ -
	1b Hydrant Removal & Relocation	$ -	$ -				$ -
	1c Catchbasins and Connections	$ -	$ -				$ -
	1d Curbs and Gutters	$ -	$ -				$ -
	1e Final Roads	$ -	$ -				$ -
	1f Sidewalks	$ -	$ -				$ -
	1g Removals	$ -	$ -				$ -
	2 Private Drain Connections	$ -	$ -				$ -
	3 Water Service Connections	$ -	$ -				$ -
	4 General and Administration	$ -	$ -				$ -
	5 Fencing	$ -	$ -				$ -
	6 Sodding	$ -	$ -				$ -
	7 Pre-Grading and Final Grading	$ -	$ -				$ -
	8 Traffic Management	$ -	$ -				$ -
	9 Traffic Signals	$ -	$ -				$ -
	10 Streetlighting	$ -	$ -				$ -
	Total of Above Items	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	13% HST	$ -	$ -	$ -	$ -	$ -	$ -
	Subtotal	$ -	$ -				**$ -**
	10% Maintenance Incl. HST	$ -					$ -
	10% Holdback Incl. HST						$ -
	11. Engineering Fees	$ -	$ -				$ -
	12 Replace SIB	$ -	$ -				$ -
	13 Pregrading	$ -	$ -				$ -
	14. Final Grading	$ -	$ -				$ -
	15. As constructed Drawings	$ -	$ -				
	16. Street Trees	$ -	$ -				$ -
	Street Trees Maintenance (30%)	$ -	$ -				$ -
	TOTAL SCHEDULE "F"	-					**$ -**

				Value of LC Required
		Total Value as per Schedule 'H'	Value of Completed Works	Value of Incomplete Works
Sch "H"			$ -	$ -
	TOTAL SCHEDULE "H"	$ -	$ -	$ -
	TOTAL SECURITY REQUIREMENTS			**$ -**

Deficiencies (Specify)

Registered Owner:

The processing fee will not be applied on the first three (3) security reductions. The applicable processing fee will be applied on security reductions thereafter.

Approved by: Date:

REQUEST FOR SECURITY REDUCTION REQUIREMENTS

The items listed in this document are meant to serve as a starting point and in no way represent a standard for any particular project. The professional engineer must complete these forms in the manner that best reflects the application.

Request on company letterhead
Addressed to L. Rez, Development Clerk
City of Hamilton
71 Main Street West, 6th floor
Hamilton, ON L8P 4Y5
Identifying:

- Registered Project Name
- Registered Plan Number
- Current Security Value
- Value of reduction being requested
- Signed by Engineer

Accompanied with the following when applicable:

- Progress Certificate prepared by consultant identifying construction value of completed works
- Summary Statement of Securities required including estimated value of incomplete works (see attached template)
- Statement from the Contractor on their letterhead acknowledging receipt of payment of all invoices due which relate to the constructed works identified in the Progress Certificate
- Written verification that Hydro has been paid for installation of street lighting
- Written statement signed by the consultant on their letterhead acknowledging receipt of payment for any engineering fees for which a reduction is being requested
- Receipt of a Certificate of Substantial Completion as published in accordance with the Construction Lien Act for the works related to the development (required for release of hold back)
- Certificate of Completion for works signed by Consulting Engineer (required prior to Assumption being issued by the City)
- Letter from City assuming subdivision
- Letter from City approving “As-constructed” drawings
- Ontario Land Surveyor (OLS) Certificate
- Processing fee (only required for the 4th or subsequent request)

NOTE: the 10% maintenance amount is not eligible for reduction until a letter of Assumption has been issued by the city. Prior to assumption of above ground works trees, sodding and final grading must be completed.

M.5. Appendix E – List of Approved Plant Species

PLANT SPECIES

Planting Zones (Based on 2003 MOE Stormwater Management Planning & Design Manual, Appendix 'E')

Deep Water > 0.5 m
Shallow Water < 0.5 m
Shoreline Fringe – zone of frequent wetting Flood Fringe – zone of infrequent wetting Upland

Scientific Name	Common Name Deep Water
Ceratophyllum demersum	Coontail
Elodea canadensis	Common waterweed
Myriophyllum sibiricum	Northern water milfoil
Myriophyllum verticillatum	Bracted water milfoil
Nuphar variegatum	Yellow pond lily
Nymphaea odorata	White water-lily
Potamogeton gramineus	Variable-leaved pondweed
Potamogeton natans	Floating-leaved pondweed
Potamogeton pectinatus	Sago pondweed
Scirpus validus	Softstem bulrush
Utricularia vulgaris	Common bladderwort
Vallisneria americana	Tape grass, Eel grass

Note: Choose Submergent and floating plants.

Shallow Water

Acorus americanus	Sweet flag
Alisma plantago-aquatica	Water plantain
Call palustris	Water arum
Carex lacustris	
Carex utriculata	
Equisetum fluviatile	Water horsetail

Scientific Name	Common Name
Shallow Water (cont'd)	
Glyceria borealis	Northern manna grass
Polygonum amphibium	Water smartweed
Pontederia cordata	Pickerel weed
Ranunculus reptans	Creeping buttercup
Sagittaria latifolia	Broad-leaved arrowhead
Sagittaria rigida	Stiff arrowhead
Scirpus acutus	Hardstem bulrush
Scirpus fluviatilis	River bulrush
Scirpus pungens	Common three-square
Scirpus validus	Softstem bulrush
Sparganium americanum	American bur-reed
Sparganium eurycarpum	Common bur-reed
Typha angustifolia	Narrow-leaved cattail
Typha latifolia	Broad-leaved cattail
Zizania aquatica	Wild rice

Note: Choose robust, broad-leaved and narrow-leaved plants.

Shoreline Fringe – Near Permanent Pool	
Asclepias incarnata	Swamp milkweed
Aster puniceus	Swamp aster
Bidens cernua	Nodding bur-marigold
Calamagrostis canadensis	Canada bluejoint grass
Carex bebbii	
Carex comosa	
Carex crinita	
Carex hystericina	
Carex pseudo-cyperus	
Carex stipata	
Carex stricta	
Carex vulpinoidea	
Cicuta maculata	Water hemlock
Decodon verticillatus	Swamp loosestrife
Dulichium arundinaceum	Three-way sedge
Eleocharis obtusa	Spike rush
Eleocharis smallii	Spike rush
Eupatorium maculatum	Joe pye-weed
Glyceria striata	Fowl manna grass
Iris versicolor	Wild blue flag iris

Scientific Name	Common Name
Shoreline Fringe – Near Permanent Pool (cont'd)	
Juncus articulatus	Jointed rush
Juncus balticus	Baltic rush
Juncus canadensis	Canada rush
Juncus effusus	Soft rush
Juncus pelocarpus	Brown-fruited rush
Juncus torreyi	Torrey's rush
Leersia oryzoides	Rice cut-grass
Lobelia cardinalis	Cardinal flower
Lycopus americanus	Water horehound
Lysimachia terrestris	Swamp candles
Mimulus ringens	Monkey flower
Osmunda regalis	Royal fern
Potentilla palustris	Marsh cinquefoil
Rumex orbiculatus	Great water dock
Scirpus atrovirens	Green bulrush
Scirpus cyperinus	Wool grass bulrush
Scirpus pendulus	Pendulus bulrush
Scutellaria galericulata	Marsh skullcap
Sium sauve	Water parsnip
Thelypteris palustris	Marsh fern
Triadenum fraseri	Marsh St. John's Wort
Shrubs	
Alnus incana	Speckled alder
Cephanlanthus occidentalis	Buttonbush
Cornus stolonifera	Red osier dogwood
Ilex verticillata	Winterberry
Lonicera oblongifolia	Swamp fly honeysuckle
Myrica gale	Sweet gale
Nemopanthus mucronatus	Mountain holly
Rhamnus alnifolia	Alder-leaved buckthorn
Ribes triste	Swamp red currant
Rosa palustris	Swamp rose
Rubus pubescens	Dwarf raspberry
Salix bebbiana	Beaked Willow
Salix exigua	Sandbar willow
Salix lucida	Shining willow
Salix petiolaris	Slender willow
Spirea alba	Meadowsweet

Scientific Name	Common Name
Shoreline Fringe – Near Permanent Pool (cont'd)	
Trees	
Acer saccharinum	Silver maple
Quercus bicolor	Swamp white oak
Salix nigra	Black willow
Shoreline Fringe – Near Flood Fringe	
Aster novae-angliae	New England aster
Aster umbellatus	Flat topped aster
Bidens frondosa	Common beggar-ticks
Cyperus esculentus	Yellow nutsedge
Equisetum arvense	Field horsetail
Eupatorium perfoliatum	Boneset
Impatiens capensis	Spotted touch-me-not
Impatiens pallida	Pale touch-me-not
Juncus tenuis	Path rush
Lilium michiganense	Michigan lily
Lysimachia ciliata	Fringed loosestrife
Osmunda cinnamomea	Cinnamon fern
Urtica dioica	Stinging Nettle
Shrubs	
Aronia melanocarpa	Black chokeberry
Cornus foemina	Grey dogwood
Lindera benzion	Spicebush
Physocarpus opulifolius	Ninebark
Potentilla fruticosa	Shrubby cinquefoil
Ribes americanum	Wild black currant
Salix amygdaloides	Peach-leaved willow
Salix discolor	Pussy willow
Salix eriocephala	Woolly headed willow
Sambucus canadensis	Elderberry
Vaccinium myrtilloides	Velvet-leaf blueberry
Viburnum trilobum	Highbush cranberry

Scientific Name	Common Name
Shoreline Fringe – Near Flood Fringe (cont'd)	
Trees	
Abies balsamea	Balsam fir
Larix laricina	Tamarack
Platanaus occidentalis	Sycamore
Populus balsamifera	Balsam poplar
Thuja occidentalis	Eastern white cedar
Ulmus americanum	American elm
Flood Fringe	
Vines	
Smilax hispida	Bristly greenbrier
Shrubs	
Crataegus crus-galli	Cockspur thorn
Lonicera hirsuta	Hairy honeysuckle
Prunus virginiana	Choke cherry
Viburnum lentago	Nannyberry
Trees	
Acer rubrum	Red maple
Betula alleghaniensis	Yellow birch
Carya cordiformis	Bitternut hickory
Populus deltoides	Eastern cottonwood
Quercus macrocarpus	Bur oak

Many of the species listed under Shoreline Fringe – Near Flood Fringe may be appropriate near the inside edge of the flood fringe. Flooding near the outside edge of the zone may be extremely rare such that the conditions for upland species will exist. The listed species are tolerant of intermediate moisture conditions.

Scientific Name	Common Name
Upland	
Trees	
Acer saccharum	Sugar maple
Betula papyrifera	Paper birch
Crataegus spp.	Hawthorn
Pinus banksiana	Jack pine
Pinus strobus	Eastern white pine
Populus tremuloides	Trembling aspen
Quercus alba	White oak
Tsuga canadensis	Eastern hemlock
Shrubs	
Amelanchier alnifolia	Service-berry
Amelanchier arborea	Juneberry
Amelanchier sanguinea	Round-leaved serviceberry
Amelanchier spicata	Shadbush serviceberry
Arctostaphylos uva-ursi	Bearberry
Ceanothus americanus	New Jersey tea
Cornus rugosa	Round-leaved dogwood
Corylus americana	American hazelnut
Corylus cornuta	Beaked hazelnut
Diervilla lonicera	Bush honeysuckle
Hamamelis virginiana	Witch hazel
Lonicera dioica	Wild honeysuckle
Prunus pensylvanica	Pin cherry
Ribes cynosbati	Prickly gooseberry
Rhus aromatica	Fragrant sumac
Rhus typhina	Staghorn sumac
Rosa blanda Rubus	Smooth wild rose
allegheniensis	Common blackberry
Salix humilis	Upland willow
Shepherdia canadensis	Buffalo-berry
Symphoricarpos albus	Snowberry
Viburnum acerifolium	Maple-leaved viburnum
Viburnum rafinesquianum	Downy arrow-wood
Zanthoxylum americanum	Prickly ash

M.6. Appendix F –Sanitary Sewer Design Sheet / Combined Sewer Design

SITE PLAN

CONSULTANT

DRAINAGE AREA PLAN No.

CITY OF HAMILTON

STORM DRAINAGE DESIGN CHART

FOR CIRCULAR DRAINS FLOWING FULL - 5 Year Storm

SHEET 1 OF 1 DATE:

Revised:

DESIGNED BY Revised:

Location	from u/s MH	to d/s MH	Area Aa (ha)	Runoff Coefficient Ca	Aa x Ca	Accumulative Area Drained by Section A = ΣAa (ha)	Accumulative Area times Runoff AxC=ΣAa.Ca	Flow Time to Section T.t (min)	Initial Time of Concentration T.ci (min)	Time of Concentration tc=tci+tc (min)	Intensity of Rainfall I (mm/hr)	Quantity of Flow Q=AxC/360 (m3/sec)	Type of Pipe	Manning's Roughness Coefficient n	Slope S %	Pipe Diameter D (mm)	Length of Section L (m)	Velocity of Flow (full) V (m/sec)	Capacity of Pipe (full) Q (m3/sec)	Pipe Invert at upstream MH (Optional) (m)	Pipe Invert at downstream MH (Optional) (m)	Time of Flow in Section t=L/v(60) (min)

$I\ (mm/hr) = A/(t_c + B)^C$

Mount Hope 5 Year Intensity (mm/hr) $I_5 = 1049.5/(t_c + 6.0)^{0.803}$

SITE PLAN

CONSULTANT

DRAINAGE AREA PLAN No.

CITY OF HAMILTON

COMBINED SEWER DRAINAGE DESIGN CHART

FOR CIRCULAR DRAINS FLOWING FULL - 10 Year Storm

SHEET 1 OF 1 DATE:

Revised:

DESIGNED BY

Revised:

Location	Station U/S	To d/s MH	Area Ad (ha)	Runoff Coefficient Ca	Ad x Ca	Accumulative Area Drained by Section A = Ad (ha)	Accumulative Area times Runoff AxC=AdxCa	Flow Time to Section t = l / (min)	Initial Time of Concentration t c l (min)	Time of Concentration tc=t(1)+t(2) (min)	Intensity of Rainfall I (mm/hr)	Quantity of Flow Q=ACI/360 (m3/sec.)	Type of Pipe	Manning's Roughness Coefficient n	Slope S %	Pipe Diameter D (mm)	Length of Section L (m)	Velocity of Flow (full) V (m/sec.)	Capacity of Pipe (full) Q (m3/sec.)	Pipe Invert at upstream MH (Optional) (m)	Pipe Invert at downstream MH (Optional) (m)	Time of Flow in Section t=L/vsec (min)

I (mm/hr) = $A/(t_d + B)^C$

Mount Hope 10 Year Intensity (mm/hr) $I_{10} = 1343.7/(t_d + 9.0)^{0.814}$

M.7. Appendix G – IDF Curves / Design Storms

TABLE 1.1
INTENSITY-DURATION-FREQUENCY VALUES
MOUNT HOPE

Duration (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
5	102.7	140.1	165.0	196.3	219.6	242.4
10	72.1	100.4	119.1	142.8	160.4	177.8
15	58.4	81.2	96.3	115.4	129.5	143.6
30	39.6	55.2	65.6	78.6	88.3	97.9
60	24.7	36.2	43.8	53.4	60.6	67.7
120	15.0	22.2	26.9	33.0	37.4	41.9
360	6.6	9.4	11.3	13.6	15.3	17.0
720	3.7	5.2	6.2	7.5	8.4	9.3
1440	2.2	3.0	3.5	4.2	4.6	5.1

TABLE 1.2
INTENSITY-DURATION-FREQUENCY VALUES
ROYAL BOTANICAL GARDENS

Duration (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
5	94.6	122.2	140.6	163.7	180.9	198.0
10	68.3	89.2	103.2	120.8	133.8	146.7
15	55.7	74.3	86.7	102.2	113.8	125.2
30	36.2	47.2	54.5	63.7	70.5	77.3
60	22.1	27.6	31.2	35.7	39.1	42.5
120	14.3	18.6	21.4	25.0	27.7	30.4
360	6.0	8.5	10.2	12.3	13.9	15.4
720	3.5	4.9	5.8	7.0	7.8	8.6
1440	2.1	2.8	3.3	3.8	4.3	4.7

TABLE 2.1
IDF PARAMETERS - MOUNT HOPE

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

TABLE 2.2
IDF PARAMETERS – ROYAL BOTANICAL GARDENS

Parameter	2	5	10	25	50	100
A	595.5	688.2	748.0	867.0	947.3	1036.1
B	6.0	5.0	4.5	4.5	4.5	4.5
C	0.778	0.753	0.740	0.737	0.733	0.733

Rainfall Intensity I (mm) = $A/(t_d+B)^C$

PLEASE NOTE THE FOLLOWING:
The City of Hamilton has adopted the Mount Hope IDF relationship. The Royal Botanical Gardens IDF relationship has been provided in addition to the Mount Hope IDF relationship for the purpose of Watershed and Subwatershed Studies and Master Drainage Plans.

TABLE 3.1
3 HOUR CHICAGO DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	2.85	3.90	4.57	5.46	6.03	6.61
20	3.20	4.41	5.20	6.23	6.89	7.57
30	3.67	5.10	6.04	7.26	8.04	8.89
40	4.32	6.07	7.23	8.74	9.69	10.77
50	5.29	7.55	9.06	11.02	12.24	13.70
60	6.93	10.08	12.20	14.96	16.65	18.78
70	10.32	15.37	18.80	23.26	25.95	29.53
80	21.58	32.79	40.38	50.04	56.09	63.97
90	73.99	103.04	122.29	146.10	164.61	181.81
100	22.24	33.80	41.62	51.58	57.82	65.94
110	10.92	16.31	19.98	24.74	27.61	31.44
120	7.38	10.77	13.06	16.04	17.86	20.17
130	5.64	8.09	9.72	11.85	13.16	14.76
140	4.60	6.51	7.76	9.41	10.44	11.62
150	3.91	5.47	6.48	7.82	8.66	9.59
160	3.42	4.73	5.58	6.70	7.42	8.17
170	3.04	4.18	4.91	5.87	6.49	7.13
180	2.75	3.75	4.39	5.24	5.79	6.33

TABLE 3.2
6 HOUR CHICAGO DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	1.39	2.10	2.41	2.83	3.12	3.35
20	1.68	2.22	2.56	3.01	3.31	3.56
30	1.77	2.36	2.72	3.20	3.53	3.81
40	1.89	2.52	2.91	3.43	3.78	4.09
50	2.02	2.70	3.13	3.70	4.08	4.42
60	2.17	2.92	3.39	4.02	4.43	4.81
70	2.35	3.18	3.71	4.40	4.86	5.28
80	2.58	3.50	4.09	4.87	5.38	5.87
90	2.85	3.90	4.57	5.46	6.03	6.61
100	3.20	4.41	5.20	6.23	6.89	7.57
110	3.67	5.10	6.04	7.26	8.04	8.89
120	4.32	6.07	7.23	8.74	9.69	10.77
130	5.29	7.55	9.06	11.02	12.24	13.70
140	6.93	10.08	12.20	14.96	16.65	18.78
150	10.32	15.37	18.80	23.26	25.95	29.53
160	21.58	32.79	40.38	50.04	56.09	63.97
170	73.99	103.04	122.29	146.10	164.61	181.81
180	22.24	33.80	41.62	51.58	57.82	65.94
190	10.92	16.31	19.98	24.74	27.61	31.44
200	7.38	10.77	13.06	16.04	17.86	20.17
210	5.64	8.09	9.72	11.85	13.16	14.76
220	4.60	6.51	7.76	9.41	10.44	11.62
230	3.91	5.47	6.48	7.82	8.66	9.59
240	3.42	4.73	5.58	6.70	7.42	8.17
250	3.04	4.18	4.91	5.87	6.49	7.13
260	2.75	3.75	4.39	5.24	5.79	6.33
270	2.51	3.41	3.98	4.73	5.22	5.70
280	2.32	3.13	3.64	4.32	4.77	5.18
290	2.15	2.89	3.36	3.98	4.39	4.76
300	2.01	2.69	3.12	3.69	4.07	4.40
310	1.89	2.52	2.92	3.44	3.79	4.10
320	1.79	2.37	2.74	3.23	3.56	3.84
330	1.69	2.24	2.59	3.04	3.35	3.61
340	1.61	2.13	2.45	2.88	3.17	3.41
350	1.54	2.03	2.33	2.73	3.01	3.23
360	1.47	1.93	2.22	2.60	2.86	3.07

TABLE 4.1
3 HOUR CHICAGO DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

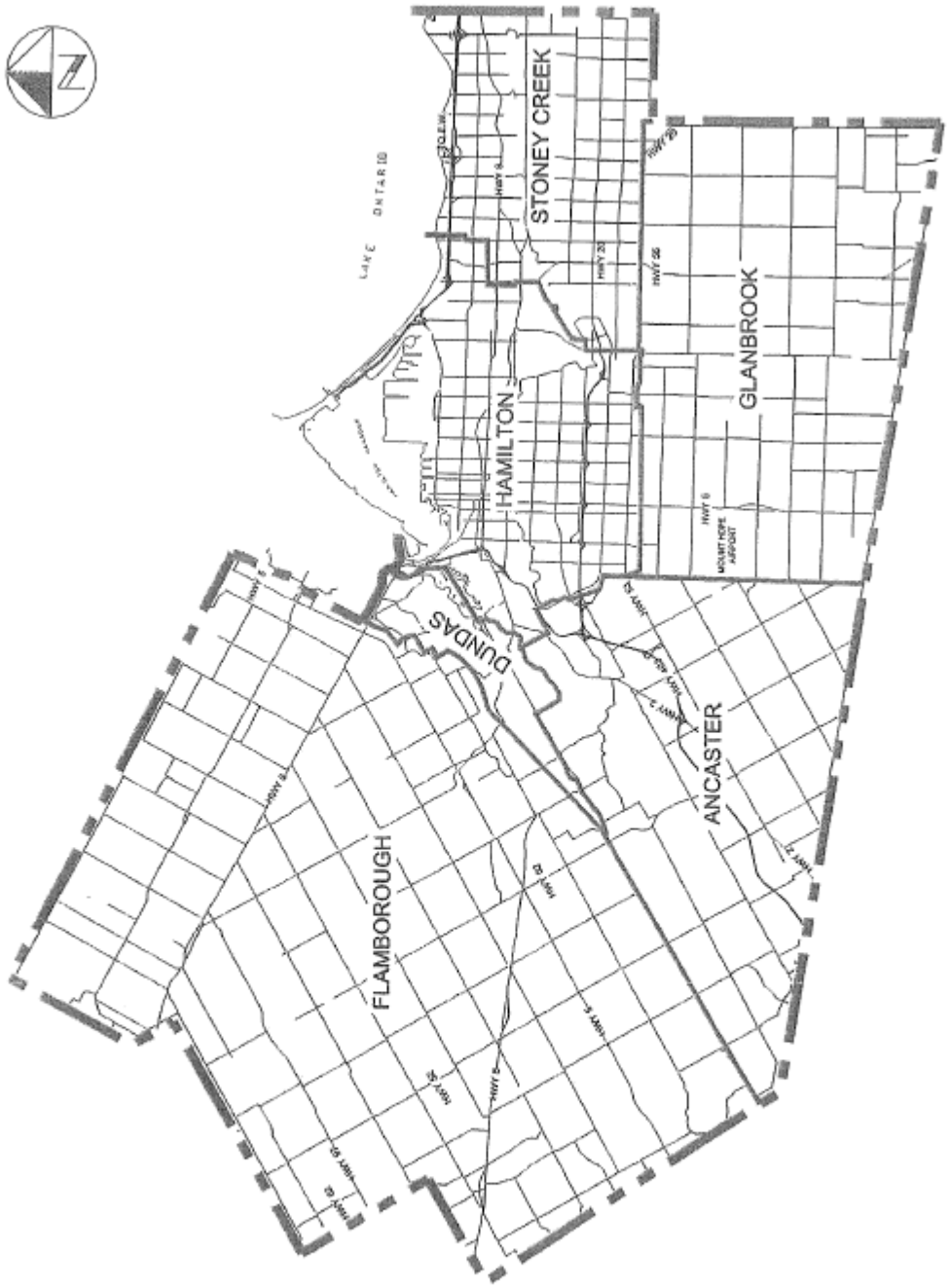
Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	2.70	3.85	4.66	5.55	6.27	6.86
20	3.04	4.30	5.19	6.17	6.97	7.62
30	3.47	4.88	5.87	6.97	7.87	8.61
40	4.09	5.69	6.81	8.08	9.12	9.97
50	5.00	6.88	8.19	9.71	10.94	11.96
60	6.54	8.86	10.46	12.38	13.92	15.23
70	9.71	12.84	14.97	17.69	19.84	21.70
80	20.22	25.81	29.53	34.75	38.75	42.38
90	68.88	89.56	103.39	120.81	133.42	145.92
100	20.84	26.57	30.38	35.74	39.84	43.58
110	10.28	13.54	15.76	18.62	20.87	22.82
120	6.96	9.39	11.06	13.09	14.71	16.09
130	5.33	7.31	8.68	10.29	11.58	12.67
140	4.36	6.04	7.22	8.57	9.66	10.56
150	3.70	5.19	6.23	7.40	8.35	9.13
160	3.24	4.57	5.50	6.54	7.39	8.08
170	2.88	4.10	4.95	5.88	6.65	7.27
180	2.61	3.72	4.51	5.37	6.07	6.64

TABLE 4.2
6 HOUR CHICAGO DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	1.51	2.22	2.72	3.24	3.68	4.02
20	1.59	2.33	2.86	3.41	3.86	4.23
30	1.69	2.46	3.01	3.59	4.07	4.45
40	1.79	2.61	3.19	3.80	4.31	4.71
50	1.92	2.78	3.39	4.04	4.58	5.01
60	2.06	2.98	3.63	4.33	4.90	5.36
70	2.24	3.22	3.91	4.66	5.27	5.77
80	2.44	3.50	4.25	5.06	5.72	6.26
90	2.70	3.85	4.66	5.55	6.27	6.86
100	3.04	4.30	5.19	6.17	6.97	7.62
110	3.47	4.88	5.87	6.97	7.87	8.61
120	4.09	5.69	6.81	8.08	9.12	9.97
130	5.00	6.88	8.19	9.71	10.94	11.96
140	6.54	8.86	10.46	12.38	13.92	15.23
150	9.71	12.84	14.97	17.69	19.84	21.70
160	20.22	25.81	29.53	34.75	38.75	42.38
170	68.88	89.56	103.39	120.81	133.42	145.92
180	20.84	26.57	30.38	35.74	39.84	43.58
190	10.28	13.54	15.76	18.62	20.87	22.82
200	6.96	9.39	11.06	13.09	14.71	16.09
210	5.33	7.31	8.68	10.29	11.58	12.67
220	4.36	6.04	7.22	8.57	9.66	10.56
230	3.70	5.19	6.23	7.40	8.35	9.13
240	3.24	4.57	5.50	6.54	7.39	8.08
250	2.88	4.10	4.95	5.88	6.65	7.27
260	2.61	3.72	4.51	5.37	6.07	6.64
270	2.38	3.42	4.15	4.94	5.59	6.12
280	2.20	3.17	3.85	4.59	5.19	5.68
290	2.04	2.96	3.60	4.29	4.86	5.31
300	1.91	2.77	3.39	4.03	4.57	5.00
310	1.80	2.62	3.20	3.81	4.32	4.72
320	1.70	2.48	3.03	3.61	4.10	4.48
330	1.61	2.36	2.89	3.44	3.90	4.27
340	1.53	2.25	2.75	3.28	3.73	4.07
350	1.46	2.15	2.64	3.14	3.57	3.90
360	1.40	2.06	2.53	3.02	3.42	3.75

TABLE 5.1
6 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	1.59	2.26	2.70	3.26	3.68	4.09
20	1.59	2.26	2.70	3.26	3.68	4.09
30	1.59	2.26	2.70	3.26	3.68	4.09
40	2.38	3.39	4.06	4.90	5.51	6.14
50	2.38	3.39	4.06	4.90	5.51	6.14
60	2.38	3.39	4.06	4.90	5.51	6.14
70	2.38	3.39	4.06	4.90	5.51	6.14
80	2.38	3.39	4.06	4.90	5.51	6.14
90	2.38	3.39	4.06	4.90	5.51	6.14
100	3.97	5.65	6.76	8.16	9.19	10.23
110	3.97	5.65	6.76	8.16	9.19	10.23
120	3.97	5.65	6.76	8.16	9.19	10.23
130	4.76	6.78	8.11	9.79	11.03	12.28
140	4.76	6.78	8.11	9.79	11.03	12.28
150	4.76	6.78	8.11	9.79	11.03	12.28
160	23.82	33.90	40.56	48.96	55.14	61.38
170	42.88	61.02	73.01	88.13	99.25	110.48
180	61.93	88.14	105.46	127.30	143.36	159.59
190	8.73	12.43	14.87	17.95	20.22	22.51
200	8.73	12.43	14.87	17.95	20.22	22.51
210	8.73	12.43	14.87	17.95	20.22	22.51
220	3.97	5.65	6.76	8.16	9.19	10.23
230	3.97	5.65	6.76	8.16	9.19	10.23
240	3.97	5.65	6.76	8.16	9.19	10.23
250	3.18	4.52	5.41	6.53	7.35	8.18
260	3.18	4.52	5.41	6.53	7.35	8.18
270	3.18	4.52	5.41	6.53	7.35	8.18
280	2.38	3.39	4.06	4.90	5.51	6.14
290	2.38	3.39	4.06	4.90	5.51	6.14
300	2.38	3.39	4.06	4.90	5.51	6.14
310	1.59	2.26	2.70	3.26	3.68	4.09
320	1.59	2.26	2.70	3.26	3.68	4.09
330	1.59	2.26	2.70	3.26	3.68	4.09
340	1.59	2.26	2.70	3.26	3.68	4.09
350	1.59	2.26	2.70	3.26	3.68	4.09
360	1.59	2.26	2.70	3.26	3.68	4.09



CRITERIA AND GUIDELINES FOR STORMWATER INFRASTRUCTURE DESIGN

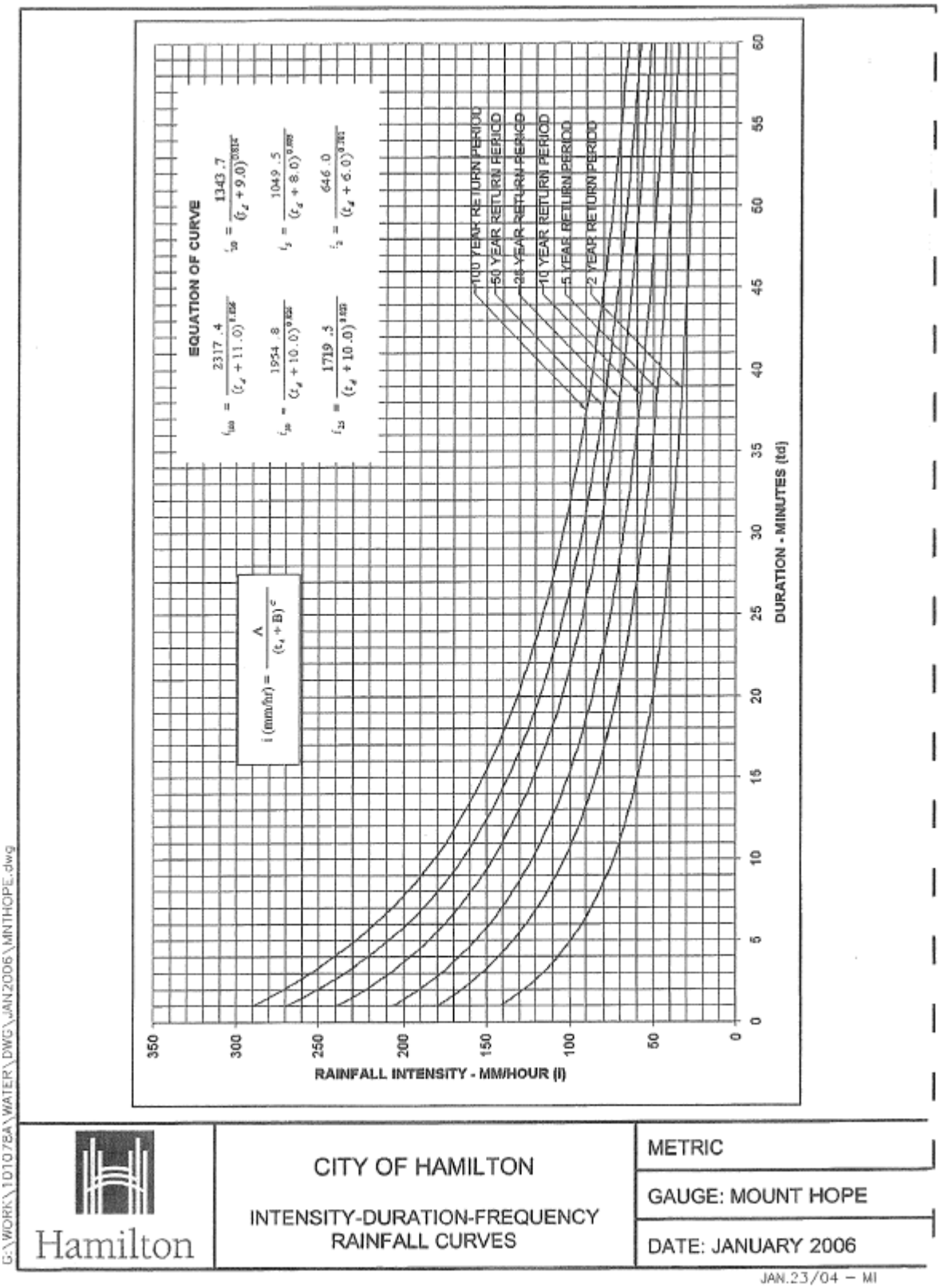
CITY OF HAMILTON

FORMER MUNICIPAL BOUNDARIES

PHILIPS ENGINEERING

Project No.	101078A
Date	JANUARY 2006
Scale	1:25,000
Drawing No.	1

JAN.23/06 – MI



Hamilton

CITY OF HAMILTON

INTENSITY-DURATION-FREQUENCY
RAINFALL CURVES

METRIC

GAUGE: MOUNT HOPE

DATE: JANUARY 2006

JAN.23/04 – MI

G:\WORK\1D1078A\WATER\DWG\JAN2006\MNTHOPE.dwg

TABLE 5.2
12 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	1.11	1.57	1.87	2.24	2.52	2.80
20	1.11	1.57	1.87	2.24	2.52	2.80
30	1.11	1.57	1.87	2.24	2.52	2.80
40	1.11	1.57	1.87	2.24	2.52	2.80
50	1.11	1.57	1.87	2.24	2.52	2.80
60	1.11	1.57	1.87	2.24	2.52	2.80
70	1.11	1.57	1.87	2.24	2.52	2.80
80	1.11	1.57	1.87	2.24	2.52	2.80
90	1.11	1.57	1.87	2.24	2.52	2.80
100	1.11	1.57	1.87	2.24	2.52	2.80
110	1.11	1.57	1.87	2.24	2.52	2.80
120	1.11	1.57	1.87	2.24	2.52	2.80
130	1.34	1.88	2.24	2.69	3.03	3.36
140	1.34	1.88	2.24	2.69	3.03	3.36
150	1.34	1.88	2.24	2.69	3.03	3.36
160	1.34	1.88	2.24	2.69	3.03	3.36
170	1.34	1.88	2.24	2.69	3.03	3.36
180	1.34	1.88	2.24	2.69	3.03	3.36
190	1.78	2.50	2.98	3.59	4.04	4.48
200	1.78	2.50	2.98	3.59	4.04	4.48
210	1.78	2.50	2.98	3.59	4.04	4.48
220	1.78	2.50	2.98	3.59	4.04	4.48
230	1.78	2.50	2.98	3.59	4.04	4.48
240	1.78	2.50	2.98	3.59	4.04	4.48
250	2.67	3.76	4.48	5.38	6.05	6.73
260	2.67	3.76	4.48	5.38	6.05	6.73
270	2.67	3.76	4.48	5.38	6.05	6.73
280	3.56	5.01	5.97	7.18	8.07	8.97
290	3.56	5.01	5.97	7.18	8.07	8.97
300	3.56	5.01	5.97	7.18	8.07	8.97
310	5.34	7.51	8.95	10.76	12.11	13.45
320	5.34	7.51	8.95	10.76	12.11	13.45
330	5.34	7.51	8.95	10.76	12.11	13.45
340	21.36	30.05	35.81	43.06	48.43	53.81
350	40.05	56.34	67.14	80.73	90.81	100.89
360	58.74	82.63	98.47	118.40	133.19	147.97
370	8.01	11.27	13.43	16.15	18.16	20.18
380	8.01	11.27	13.43	16.15	18.16	20.18
390	8.01	11.27	13.43	16.15	18.16	20.18
400	3.56	5.01	5.97	7.18	8.07	8.97
410	3.56	5.01	5.97	7.18	8.07	8.97
420	3.56	5.01	5.97	7.18	8.07	8.97
430	2.67	3.76	4.48	5.38	6.05	6.73
440	2.67	3.76	4.48	5.38	6.05	6.73
450	2.67	3.76	4.48	5.38	6.05	6.73
460	2.67	3.76	4.48	5.38	6.05	6.73
470	2.67	3.76	4.48	5.38	6.05	6.73
480	2.67	3.76	4.48	5.38	6.05	6.73
490	1.56	2.19	2.61	3.14	3.53	3.92
500	1.56	2.19	2.61	3.14	3.53	3.92
510	1.56	2.19	2.61	3.14	3.53	3.92
520	1.56	2.19	2.61	3.14	3.53	3.92
530	1.56	2.19	2.61	3.14	3.53	3.92
540	1.56	2.19	2.61	3.14	3.53	3.92
550	1.56	2.19	2.61	3.14	3.53	3.92
560	1.56	2.19	2.61	3.14	3.53	3.92
570	1.56	2.19	2.61	3.14	3.53	3.92
580	1.56	2.19	2.61	3.14	3.53	3.92

TABLE 5.2
12 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
590	1.56	2.19	2.61	3.14	3.53	3.92
600	1.56	2.19	2.61	3.14	3.53	3.92
610	0.89	1.25	1.49	1.79	2.02	2.24
620	0.89	1.25	1.49	1.79	2.02	2.24
630	0.89	1.25	1.49	1.79	2.02	2.24
640	0.89	1.25	1.49	1.79	2.02	2.24
650	0.89	1.25	1.49	1.79	2.02	2.24
660	0.89	1.25	1.49	1.79	2.02	2.24
670	0.89	1.25	1.49	1.79	2.02	2.24
680	0.89	1.25	1.49	1.79	2.02	2.24
690	0.89	1.25	1.49	1.79	2.02	2.24
700	0.89	1.25	1.49	1.79	2.02	2.24
710	0.89	1.25	1.49	1.79	2.02	2.24
720	0.89	1.25	1.49	1.79	2.02	2.24

TABLE 5.3
24 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	0.58	0.79	0.93	1.10	1.23	1.35
20	0.58	0.79	0.93	1.10	1.23	1.35
30	0.58	0.79	0.93	1.10	1.23	1.35
40	0.58	0.79	0.93	1.10	1.23	1.35
50	0.58	0.79	0.93	1.10	1.23	1.35
60	0.58	0.79	0.93	1.10	1.23	1.35
70	0.58	0.79	0.93	1.10	1.23	1.35
80	0.58	0.79	0.93	1.10	1.23	1.35
90	0.58	0.79	0.93	1.10	1.23	1.35
100	0.58	0.79	0.93	1.10	1.23	1.35
110	0.58	0.79	0.93	1.10	1.23	1.35
120	0.58	0.79	0.93	1.10	1.23	1.35
130	0.69	0.93	1.09	1.30	1.45	1.60
140	0.69	0.93	1.09	1.30	1.45	1.60
150	0.69	0.93	1.09	1.30	1.45	1.60
160	0.69	0.93	1.09	1.30	1.45	1.60
170	0.69	0.93	1.09	1.30	1.45	1.60
180	0.69	0.93	1.09	1.30	1.45	1.60
190	0.69	0.93	1.09	1.30	1.45	1.60
200	0.69	0.93	1.09	1.30	1.45	1.60
210	0.69	0.93	1.09	1.30	1.45	1.60
220	0.69	0.93	1.09	1.30	1.45	1.60
230	0.69	0.93	1.09	1.30	1.45	1.60
240	0.69	0.93	1.09	1.30	1.45	1.60
250	0.85	1.15	1.35	1.60	1.78	1.97
260	0.85	1.15	1.35	1.60	1.78	1.97
270	0.85	1.15	1.35	1.60	1.78	1.97
280	0.85	1.15	1.35	1.60	1.78	1.97
290	0.85	1.15	1.35	1.60	1.78	1.97
300	0.85	1.15	1.35	1.60	1.78	1.97
310	0.85	1.15	1.35	1.60	1.78	1.97
320	0.85	1.15	1.35	1.60	1.78	1.97
330	0.85	1.15	1.35	1.60	1.78	1.97
340	0.85	1.15	1.35	1.60	1.78	1.97
350	0.85	1.15	1.35	1.60	1.78	1.97
360	0.85	1.15	1.35	1.60	1.78	1.97
370	1.06	1.44	1.68	2.00	2.23	2.46
380	1.06	1.44	1.68	2.00	2.23	2.46
390	1.06	1.44	1.68	2.00	2.23	2.46
400	1.06	1.44	1.68	2.00	2.23	2.46
410	1.06	1.44	1.68	2.00	2.23	2.46
420	1.06	1.44	1.68	2.00	2.23	2.46
430	1.06	1.44	1.68	2.00	2.23	2.46
440	1.06	1.44	1.68	2.00	2.23	2.46
450	1.06	1.44	1.68	2.00	2.23	2.46
460	1.06	1.44	1.68	2.00	2.23	2.46
470	1.06	1.44	1.68	2.00	2.23	2.46
480	1.06	1.44	1.68	2.00	2.23	2.46
490	1.43	1.94	2.27	2.69	3.01	3.32
500	1.43	1.94	2.27	2.69	3.01	3.32
510	1.43	1.94	2.27	2.69	3.01	3.32
520	1.43	1.94	2.27	2.69	3.01	3.32
530	1.43	1.94	2.27	2.69	3.01	3.32
540	1.43	1.94	2.27	2.69	3.01	3.32
550	1.70	2.30	2.69	3.19	3.56	3.93
560	1.70	2.30	2.69	3.19	3.56	3.93
570	1.70	2.30	2.69	3.19	3.56	3.93
580	1.91	2.38	3.03	3.59	4.01	4.42

TABLE 5.3
24 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
590	1.91	2.58	3.03	3.59	4.01	4.42
600	1.91	2.58	3.03	3.59	4.01	4.42
610	2.44	3.30	3.87	4.59	5.12	5.65
620	2.44	3.30	3.87	4.59	5.12	5.65
630	2.44	3.30	3.87	4.59	5.12	5.65
640	3.29	4.45	5.22	6.19	6.91	7.62
650	3.29	4.45	5.22	6.19	6.91	7.62
660	3.29	4.45	5.22	6.19	6.91	7.62
670	5.10	6.89	8.08	9.58	10.69	11.80
680	5.10	6.89	8.08	9.58	10.69	11.80
690	5.10	6.89	8.08	9.58	10.69	11.80
700	22.09	29.87	35.03	41.52	46.34	51.13
710	40.36	54.57	63.99	75.85	84.66	93.40
720	58.62	79.27	92.96	110.18	122.99	135.68
730	7.65	10.34	12.12	14.37	16.04	17.70
740	7.65	10.34	12.12	14.37	16.04	17.70
750	7.65	10.34	12.12	14.37	16.04	17.70
760	3.93	5.31	6.23	7.39	8.24	9.09
770	3.93	5.31	6.23	7.39	8.24	9.09
780	3.93	5.31	6.23	7.39	8.24	9.09
790	0.74	1.01	1.18	1.40	1.56	1.72
800	0.74	1.01	1.18	1.40	1.56	1.72
810	0.74	1.01	1.18	1.40	1.56	1.72
820	4.35	5.89	6.90	8.18	9.13	10.08
830	4.35	5.89	6.90	8.18	9.13	10.08
840	4.35	5.89	6.90	8.18	9.13	10.08
850	1.59	2.15	2.53	2.99	3.34	3.69
860	1.59	2.15	2.53	2.99	3.34	3.69
870	1.59	2.15	2.53	2.99	3.34	3.69
880	1.59	2.15	2.53	2.99	3.34	3.69
890	1.59	2.15	2.53	2.99	3.34	3.69
900	1.59	2.15	2.53	2.99	3.34	3.69
910	1.59	2.15	2.53	2.99	3.34	3.69
920	1.59	2.15	2.53	2.99	3.34	3.69
930	1.59	2.15	2.53	2.99	3.34	3.69
940	1.59	2.15	2.53	2.99	3.34	3.69
950	1.59	2.15	2.53	2.99	3.34	3.69
960	1.59	2.15	2.53	2.99	3.34	3.69
970	0.96	1.29	1.52	1.80	2.01	2.21
980	0.96	1.29	1.52	1.80	2.01	2.21
990	0.96	1.29	1.52	1.80	2.01	2.21
1000	0.96	1.29	1.52	1.80	2.01	2.21
1010	0.96	1.29	1.52	1.80	2.01	2.21
1020	0.96	1.29	1.52	1.80	2.01	2.21
1030	0.96	1.29	1.52	1.80	2.01	2.21
1040	0.96	1.29	1.52	1.80	2.01	2.21
1050	0.96	1.29	1.52	1.80	2.01	2.21
1060	0.96	1.29	1.52	1.80	2.01	2.21
1070	0.96	1.29	1.52	1.80	2.01	2.21
1080	0.96	1.29	1.52	1.80	2.01	2.21
1090	0.96	1.29	1.52	1.80	2.01	2.21
1100	0.96	1.29	1.52	1.80	2.01	2.21
1110	0.96	1.29	1.52	1.80	2.01	2.21
1120	0.96	1.29	1.52	1.80	2.01	2.21
1130	0.96	1.29	1.52	1.80	2.01	2.21
1140	0.96	1.29	1.52	1.80	2.01	2.21
1150	0.96	1.29	1.52	1.80	2.01	2.21
1160	0.96	1.29	1.52	1.80	2.01	2.21
1170	0.96	1.29	1.52	1.80	2.01	2.21
1180	0.96	1.29	1.52	1.80	2.01	2.21

TABLE 5.3
24 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
1190	0.96	1.29	1.52	1.80	2.01	2.21
1200	0.96	1.29	1.52	1.80	2.01	2.21
1210	0.64	0.86	1.01	1.20	1.34	1.47
1220	0.64	0.86	1.01	1.20	1.34	1.47
1230	0.64	0.86	1.01	1.20	1.34	1.47
1240	0.64	0.86	1.01	1.20	1.34	1.47
1250	0.64	0.86	1.01	1.20	1.34	1.47
1260	0.64	0.86	1.01	1.20	1.34	1.47
1270	0.64	0.86	1.01	1.20	1.34	1.47
1280	0.64	0.86	1.01	1.20	1.34	1.47
1290	0.64	0.86	1.01	1.20	1.34	1.47
1300	0.64	0.86	1.01	1.20	1.34	1.47
1310	0.64	0.86	1.01	1.20	1.34	1.47
1320	0.64	0.86	1.01	1.20	1.34	1.47
1330	0.64	0.86	1.01	1.20	1.34	1.47
1340	0.64	0.86	1.01	1.20	1.34	1.47
1350	0.64	0.86	1.01	1.20	1.34	1.47
1360	0.64	0.86	1.01	1.20	1.34	1.47
1370	0.64	0.86	1.01	1.20	1.34	1.47
1380	0.64	0.86	1.01	1.20	1.34	1.47
1390	0.64	0.86	1.01	1.20	1.34	1.47
1400	0.64	0.86	1.01	1.20	1.34	1.47
1410	0.64	0.86	1.01	1.20	1.34	1.47
1420	0.64	0.86	1.01	1.20	1.34	1.47
1430	0.64	0.86	1.01	1.20	1.34	1.47
1440	0.64	0.86	1.01	1.20	1.34	1.47

TABLE 6.1
6 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	1.45	2.05	2.45	2.95	3.32	3.70
20	1.45	2.05	2.45	2.95	3.32	3.70
30	1.45	2.05	2.45	2.95	3.32	3.70
40	2.18	3.08	3.67	4.43	4.99	5.54
50	2.18	3.08	3.67	4.43	4.99	5.54
60	2.18	3.08	3.67	4.43	4.99	5.54
70	2.18	3.08	3.67	4.43	4.99	5.54
80	2.18	3.08	3.67	4.43	4.99	5.54
90	2.18	3.08	3.67	4.43	4.99	5.54
100	3.63	5.13	6.12	7.38	8.31	9.24
110	3.63	5.13	6.12	7.38	8.31	9.24
120	3.63	5.13	6.12	7.38	8.31	9.24
130	4.36	6.16	7.34	8.86	9.97	11.09
140	4.36	6.16	7.34	8.86	9.97	11.09
150	4.36	6.16	7.34	8.86	9.97	11.09
160	21.78	30.78	36.72	44.28	49.86	55.44
170	39.20	55.40	66.10	79.70	89.75	99.79
180	56.63	80.03	95.47	115.13	129.64	144.14
190	7.99	11.29	13.46	16.24	18.28	20.33
200	7.99	11.29	13.46	16.24	18.28	20.33
210	7.99	11.29	13.46	16.24	18.28	20.33
220	3.63	5.13	6.12	7.38	8.31	9.24
230	3.63	5.13	6.12	7.38	8.31	9.24
240	3.63	5.13	6.12	7.38	8.31	9.24
250	2.90	4.10	4.90	5.90	6.65	7.39
260	2.90	4.10	4.90	5.90	6.65	7.39
270	2.90	4.10	4.90	5.90	6.65	7.39
280	2.18	3.08	3.67	4.43	4.99	5.54
290	2.18	3.08	3.67	4.43	4.99	5.54
300	2.18	3.08	3.67	4.43	4.99	5.54
310	1.45	2.05	2.45	2.95	3.32	3.70
320	1.45	2.05	2.45	2.95	3.32	3.70
330	1.45	2.05	2.45	2.95	3.32	3.70
340	1.45	2.05	2.45	2.95	3.32	3.70
350	1.45	2.05	2.45	2.95	3.32	3.70
360	1.45	2.05	2.45	2.95	3.32	3.70

TABLE 6.2
12 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	1.07	1.47	1.74	2.09	2.34	2.59
20	1.07	1.47	1.74	2.09	2.34	2.59
30	1.07	1.47	1.74	2.09	2.34	2.59
40	1.07	1.47	1.74	2.09	2.34	2.59
50	1.07	1.47	1.74	2.09	2.34	2.59
60	1.07	1.47	1.74	2.09	2.34	2.59
70	1.07	1.47	1.74	2.09	2.34	2.59
80	1.07	1.47	1.74	2.09	2.34	2.59
90	1.07	1.47	1.74	2.09	2.34	2.59
100	1.07	1.47	1.74	2.09	2.34	2.59
110	1.07	1.47	1.74	2.09	2.34	2.59
120	1.07	1.47	1.74	2.09	2.34	2.59
130	1.28	1.77	2.09	2.50	2.81	3.11
140	1.28	1.77	2.09	2.50	2.81	3.11
150	1.28	1.77	2.09	2.50	2.81	3.11
160	1.28	1.77	2.09	2.50	2.81	3.11
170	1.28	1.77	2.09	2.50	2.81	3.11
180	1.28	1.77	2.09	2.50	2.81	3.11
190	1.70	2.36	2.79	3.34	3.74	4.14
200	1.70	2.36	2.79	3.34	3.74	4.14
210	1.70	2.36	2.79	3.34	3.74	4.14
220	1.70	2.36	2.79	3.34	3.74	4.14
230	1.70	2.36	2.79	3.34	3.74	4.14
240	1.70	2.36	2.79	3.34	3.74	4.14
250	2.56	3.53	4.18	5.00	5.61	6.22
260	2.56	3.53	4.18	5.00	5.61	6.22
270	2.56	3.53	4.18	5.00	5.61	6.22
280	3.41	4.71	5.58	6.67	7.48	8.29
290	3.41	4.71	5.58	6.67	7.48	8.29
300	3.41	4.71	5.58	6.67	7.48	8.29
310	5.11	7.07	8.36	10.01	11.22	12.43
320	5.11	7.07	8.36	10.01	11.22	12.43
330	5.11	7.07	8.36	10.01	11.22	12.43
340	20.45	28.27	33.46	40.03	44.88	49.73
350	38.34	53.01	62.73	75.06	84.15	93.24
360	56.23	77.75	92.00	110.09	123.42	136.75
370	7.67	10.60	12.55	15.01	16.83	18.65
380	7.67	10.60	12.55	15.01	16.83	18.65
390	7.67	10.60	12.55	15.01	16.83	18.65
400	3.41	4.71	5.58	6.67	7.48	8.29
410	3.41	4.71	5.58	6.67	7.48	8.29
420	3.41	4.71	5.58	6.67	7.48	8.29
430	2.56	3.53	4.18	5.00	5.61	6.22
440	2.56	3.53	4.18	5.00	5.61	6.22
450	2.56	3.53	4.18	5.00	5.61	6.22
460	2.56	3.53	4.18	5.00	5.61	6.22
470	2.56	3.53	4.18	5.00	5.61	6.22
480	2.56	3.53	4.18	5.00	5.61	6.22
490	1.49	2.06	2.44	2.92	3.27	3.63
500	1.49	2.06	2.44	2.92	3.27	3.63
510	1.49	2.06	2.44	2.92	3.27	3.63
520	1.49	2.06	2.44	2.92	3.27	3.63
530	1.49	2.06	2.44	2.92	3.27	3.63
540	1.49	2.06	2.44	2.92	3.27	3.63
550	1.49	2.06	2.44	2.92	3.27	3.63
560	1.49	2.06	2.44	2.92	3.27	3.63
570	1.49	2.06	2.44	2.92	3.27	3.63
580	1.49	2.06	2.44	2.92	3.27	3.63

TABLE 6.2
12 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
590	1.49	2.06	2.44	2.92	3.27	3.63
600	1.49	2.06	2.44	2.92	3.27	3.63
610	0.85	1.18	1.39	1.67	1.87	2.07
620	0.85	1.18	1.39	1.67	1.87	2.07
630	0.85	1.18	1.39	1.67	1.87	2.07
640	0.85	1.18	1.39	1.67	1.87	2.07
650	0.85	1.18	1.39	1.67	1.87	2.07
660	0.85	1.18	1.39	1.67	1.87	2.07
670	0.85	1.18	1.39	1.67	1.87	2.07
680	0.85	1.18	1.39	1.67	1.87	2.07
690	0.85	1.18	1.39	1.67	1.87	2.07
700	0.85	1.18	1.39	1.67	1.87	2.07
710	0.85	1.18	1.39	1.67	1.87	2.07
720	0.85	1.18	1.39	1.67	1.87	2.07

TABLE 6.3
24 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	0.58	0.79	0.93	1.10	1.23	1.35
20	0.58	0.79	0.93	1.10	1.23	1.35
30	0.58	0.79	0.93	1.10	1.23	1.35
40	0.58	0.79	0.93	1.10	1.23	1.35
50	0.58	0.79	0.93	1.10	1.23	1.35
60	0.58	0.79	0.93	1.10	1.23	1.35
70	0.58	0.79	0.93	1.10	1.23	1.35
80	0.58	0.79	0.93	1.10	1.23	1.35
90	0.58	0.79	0.93	1.10	1.23	1.35
100	0.58	0.79	0.93	1.10	1.23	1.35
110	0.58	0.79	0.93	1.10	1.23	1.35
120	0.58	0.79	0.93	1.10	1.23	1.35
130	0.69	0.93	1.09	1.30	1.45	1.60
140	0.69	0.93	1.09	1.30	1.45	1.60
150	0.69	0.93	1.09	1.30	1.45	1.60
160	0.69	0.93	1.09	1.30	1.45	1.60
170	0.69	0.93	1.09	1.30	1.45	1.60
180	0.69	0.93	1.09	1.30	1.45	1.60
190	0.69	0.93	1.09	1.30	1.45	1.60
200	0.69	0.93	1.09	1.30	1.45	1.60
210	0.69	0.93	1.09	1.30	1.45	1.60
220	0.69	0.93	1.09	1.30	1.45	1.60
230	0.69	0.93	1.09	1.30	1.45	1.60
240	0.69	0.93	1.09	1.30	1.45	1.60
250	0.85	1.15	1.35	1.60	1.78	1.97
260	0.85	1.15	1.35	1.60	1.78	1.97
270	0.85	1.15	1.35	1.60	1.78	1.97
280	0.85	1.15	1.35	1.60	1.78	1.97
290	0.85	1.15	1.35	1.60	1.78	1.97
300	0.85	1.15	1.35	1.60	1.78	1.97
310	0.85	1.15	1.35	1.60	1.78	1.97
320	0.85	1.15	1.35	1.60	1.78	1.97
330	0.85	1.15	1.35	1.60	1.78	1.97
340	0.85	1.15	1.35	1.60	1.78	1.97
350	0.85	1.15	1.35	1.60	1.78	1.97
360	0.85	1.15	1.35	1.60	1.78	1.97
370	1.06	1.44	1.68	2.00	2.23	2.46
380	1.06	1.44	1.68	2.00	2.23	2.46
390	1.06	1.44	1.68	2.00	2.23	2.46
400	1.06	1.44	1.68	2.00	2.23	2.46
410	1.06	1.44	1.68	2.00	2.23	2.46
420	1.06	1.44	1.68	2.00	2.23	2.46
430	1.06	1.44	1.68	2.00	2.23	2.46
440	1.06	1.44	1.68	2.00	2.23	2.46
450	1.06	1.44	1.68	2.00	2.23	2.46
460	1.06	1.44	1.68	2.00	2.23	2.46
470	1.06	1.44	1.68	2.00	2.23	2.46
480	1.06	1.44	1.68	2.00	2.23	2.46
490	1.43	1.94	2.27	2.69	3.01	3.32
500	1.43	1.94	2.27	2.69	3.01	3.32
510	1.43	1.94	2.27	2.69	3.01	3.32
520	1.43	1.94	2.27	2.69	3.01	3.32
530	1.43	1.94	2.27	2.69	3.01	3.32
540	1.43	1.94	2.27	2.69	3.01	3.32
550	1.70	2.30	2.69	3.19	3.56	3.93
560	1.70	2.30	2.69	3.19	3.56	3.93
570	1.70	2.30	2.69	3.19	3.56	3.93
580	1.91	2.58	3.03	3.59	4.01	4.42

TABLE 6.3
24 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
590	1.91	2.58	3.03	3.59	4.01	4.42
600	1.91	2.58	3.03	3.59	4.01	4.42
610	2.44	3.30	3.87	4.59	5.12	5.65
620	2.44	3.30	3.87	4.59	5.12	5.65
630	2.44	3.30	3.87	4.59	5.12	5.65
640	3.29	4.45	5.22	6.19	6.91	7.62
650	3.29	4.45	5.22	6.19	6.91	7.62
660	3.29	4.45	5.22	6.19	6.91	7.62
670	5.10	6.89	8.08	9.58	10.69	11.80
680	5.10	6.89	8.08	9.58	10.69	11.80
690	5.10	6.89	8.08	9.58	10.69	11.80
700	22.09	29.87	35.03	41.52	46.34	51.13
710	40.36	54.57	63.99	75.85	84.66	93.40
720	58.62	79.27	92.96	110.18	122.99	135.68
730	7.65	10.34	12.12	14.37	16.04	17.70
740	7.65	10.34	12.12	14.37	16.04	17.70
750	7.65	10.34	12.12	14.37	16.04	17.70
760	3.93	5.31	6.23	7.39	8.24	9.09
770	3.93	5.31	6.23	7.39	8.24	9.09
780	3.93	5.31	6.23	7.39	8.24	9.09
790	0.74	1.01	1.18	1.40	1.56	1.72
800	0.74	1.01	1.18	1.40	1.56	1.72
810	0.74	1.01	1.18	1.40	1.56	1.72
820	4.35	5.89	6.90	8.18	9.13	10.08
830	4.35	5.89	6.90	8.18	9.13	10.08
840	4.35	5.89	6.90	8.18	9.13	10.08
850	1.59	2.15	2.53	2.99	3.34	3.69
860	1.59	2.15	2.53	2.99	3.34	3.69
870	1.59	2.15	2.53	2.99	3.34	3.69
880	1.59	2.15	2.53	2.99	3.34	3.69
890	1.59	2.15	2.53	2.99	3.34	3.69
900	1.59	2.15	2.53	2.99	3.34	3.69
910	1.59	2.15	2.53	2.99	3.34	3.69
920	1.59	2.15	2.53	2.99	3.34	3.69
930	1.59	2.15	2.53	2.99	3.34	3.69
940	1.59	2.15	2.53	2.99	3.34	3.69
950	1.59	2.15	2.53	2.99	3.34	3.69
960	1.59	2.15	2.53	2.99	3.34	3.69
970	0.96	1.29	1.52	1.80	2.01	2.21
980	0.96	1.29	1.52	1.80	2.01	2.21
990	0.96	1.29	1.52	1.80	2.01	2.21
1000	0.96	1.29	1.52	1.80	2.01	2.21
1010	0.96	1.29	1.52	1.80	2.01	2.21
1020	0.96	1.29	1.52	1.80	2.01	2.21
1030	0.96	1.29	1.52	1.80	2.01	2.21
1040	0.96	1.29	1.52	1.80	2.01	2.21
1050	0.96	1.29	1.52	1.80	2.01	2.21
1060	0.96	1.29	1.52	1.80	2.01	2.21
1070	0.96	1.29	1.52	1.80	2.01	2.21
1080	0.96	1.29	1.52	1.80	2.01	2.21
1090	0.96	1.29	1.52	1.80	2.01	2.21
1100	0.96	1.29	1.52	1.80	2.01	2.21
1110	0.96	1.29	1.52	1.80	2.01	2.21
1120	0.96	1.29	1.52	1.80	2.01	2.21
1130	0.96	1.29	1.52	1.80	2.01	2.21
1140	0.96	1.29	1.52	1.80	2.01	2.21
1150	0.96	1.29	1.52	1.80	2.01	2.21
1160	0.96	1.29	1.52	1.80	2.01	2.21
1170	0.96	1.29	1.52	1.80	2.01	2.21
1180	0.96	1.29	1.52	1.80	2.01	2.21

TABLE 6.3
24 HOUR SCS DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
1190	0.96	1.29	1.52	1.80	2.01	2.21
1200	0.96	1.29	1.52	1.80	2.01	2.21
1210	0.64	0.86	1.01	1.20	1.34	1.47
1220	0.64	0.86	1.01	1.20	1.34	1.47
1230	0.64	0.86	1.01	1.20	1.34	1.47
1240	0.64	0.86	1.01	1.20	1.34	1.47
1250	0.64	0.86	1.01	1.20	1.34	1.47
1260	0.64	0.86	1.01	1.20	1.34	1.47
1270	0.64	0.86	1.01	1.20	1.34	1.47
1280	0.64	0.86	1.01	1.20	1.34	1.47
1290	0.64	0.86	1.01	1.20	1.34	1.47
1300	0.64	0.86	1.01	1.20	1.34	1.47
1310	0.64	0.86	1.01	1.20	1.34	1.47
1320	0.64	0.86	1.01	1.20	1.34	1.47
1330	0.64	0.86	1.01	1.20	1.34	1.47
1340	0.64	0.86	1.01	1.20	1.34	1.47
1350	0.64	0.86	1.01	1.20	1.34	1.47
1360	0.64	0.86	1.01	1.20	1.34	1.47
1370	0.64	0.86	1.01	1.20	1.34	1.47
1380	0.64	0.86	1.01	1.20	1.34	1.47
1390	0.64	0.86	1.01	1.20	1.34	1.47
1400	0.64	0.86	1.01	1.20	1.34	1.47
1410	0.64	0.86	1.01	1.20	1.34	1.47
1420	0.64	0.86	1.01	1.20	1.34	1.47
1430	0.64	0.86	1.01	1.20	1.34	1.47
1440	0.64	0.86	1.01	1.20	1.34	1.47

TABLE 7.1
1 HOUR AES (30%) DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Duration (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	48.91	71.68	86.72	105.73	119.99	134.05
20	65.21	95.57	115.63	140.98	159.98	178.73
30	22.23	32.58	39.42	48.06	54.54	60.93
40	8.89	13.03	15.77	19.22	21.82	24.37
50	2.96	4.34	5.26	6.41	7.27	8.12
60	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 7.2
12 HOUR AES (30%) DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	5.79	8.14	9.70	11.66	13.12	14.57
20	5.79	8.14	9.70	11.66	13.12	14.57
30	5.79	8.14	9.70	11.66	13.12	14.57
40	5.79	8.14	9.70	11.66	13.12	14.57
50	5.79	8.14	9.70	11.66	13.12	14.57
60	5.79	8.14	9.70	11.66	13.12	14.57
70	12.02	16.90	20.14	24.22	27.24	30.27
80	12.02	16.90	20.14	24.22	27.24	30.27
90	12.02	16.90	20.14	24.22	27.24	30.27
100	12.02	16.90	20.14	24.22	27.24	30.27
110	12.02	16.90	20.14	24.22	27.24	30.27
120	12.02	16.90	20.14	24.22	27.24	30.27
130	8.01	11.27	13.43	16.15	18.16	20.18
140	8.01	11.27	13.43	16.15	18.16	20.18
150	8.01	11.27	13.43	16.15	18.16	20.18
160	8.01	11.27	13.43	16.15	18.16	20.18
170	8.01	11.27	13.43	16.15	18.16	20.18
180	8.01	11.27	13.43	16.15	18.16	20.18
190	7.57	10.64	12.68	15.25	17.15	19.06
200	7.57	10.64	12.68	15.25	17.15	19.06
210	7.57	10.64	12.68	15.25	17.15	19.06
220	7.57	10.64	12.68	15.25	17.15	19.06
230	7.57	10.64	12.68	15.25	17.15	19.06
240	7.57	10.64	12.68	15.25	17.15	19.06
250	5.79	8.14	9.70	11.66	13.12	14.57
260	5.79	8.14	9.70	11.66	13.12	14.57
270	5.79	8.14	9.70	11.66	13.12	14.57
280	5.79	8.14	9.70	11.66	13.12	14.57
290	5.79	8.14	9.70	11.66	13.12	14.57
300	5.79	8.14	9.70	11.66	13.12	14.57
310	4.01	5.63	6.71	8.07	9.08	10.09
320	4.01	5.63	6.71	8.07	9.08	10.09
330	4.01	5.63	6.71	8.07	9.08	10.09
340	4.01	5.63	6.71	8.07	9.08	10.09
350	4.01	5.63	6.71	8.07	9.08	10.09
360	4.01	5.63	6.71	8.07	9.08	10.09
370	0.890	1.252	1.492	1.794	2.018	2.242
380	0.890	1.252	1.492	1.794	2.018	2.242
390	0.890	1.252	1.492	1.794	2.018	2.242
400	0.890	1.252	1.492	1.794	2.018	2.242
410	0.890	1.252	1.492	1.794	2.018	2.242
420	0.890	1.252	1.492	1.794	2.018	2.242
430	0.010	0.445	0.626	0.746	0.897	1.009
440	0.010	0.445	0.626	0.746	0.897	1.009
450	0.010	0.445	0.626	0.746	0.897	1.009
460	0.010	0.445	0.626	0.746	0.897	1.009
470	0.010	0.445	0.626	0.746	0.897	1.009
480	0.010	0.445	0.626	0.746	0.897	1.009
490	0.000	0.000	0.000	0.000	0.000	0.000
500	0.000	0.000	0.000	0.000	0.000	0.000
510	0.000	0.000	0.000	0.000	0.000	0.000
520	0.000	0.000	0.000	0.000	0.000	0.000
530	0.000	0.000	0.000	0.000	0.000	0.000
540	0.000	0.000	0.000	0.000	0.000	0.000
550	0.000	0.000	0.000	0.000	0.000	0.000
560	0.000	0.000	0.000	0.000	0.000	0.000
570	0.000	0.000	0.000	0.000	0.000	0.000
580	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 7.2
12 HOUR AES (30%) DISTRIBUTION DESIGN STORM HYETOGRAPHS
MOUNT HOPE

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
590	0.000	0.000	0.000	0.000	0.000	0.000
600	0.000	0.000	0.000	0.000	0.000	0.000
610	0.000	0.000	0.000	0.000	0.000	0.000
620	0.000	0.000	0.000	0.000	0.000	0.000
630	0.000	0.000	0.000	0.000	0.000	0.000
640	0.000	0.000	0.000	0.000	0.000	0.000
650	0.000	0.000	0.000	0.000	0.000	0.000
660	0.000	0.000	0.000	0.000	0.000	0.000
670	0.000	0.000	0.000	0.000	0.000	0.000
680	0.000	0.000	0.000	0.000	0.000	0.000
690	0.000	0.000	0.000	0.000	0.000	0.000
700	0.000	0.000	0.000	0.000	0.000	0.000
710	0.000	0.000	0.000	0.000	0.000	0.000
720	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 7.1
1 HOUR AES (30%) DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Duration (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	43.76	54.65	61.78	70.69	77.42	84.15
20	58.34	72.86	82.37	94.25	103.22	112.20
30	19.89	24.84	28.08	32.13	35.19	38.25
40	7.96	9.94	11.23	12.85	14.08	15.30
50	2.65	3.31	3.74	4.28	4.69	5.10
60	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 7.2
12 HOUR AES (30%) DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
10	5.54	7.66	9.06	10.84	12.16	13.47
20	5.54	7.66	9.06	10.84	12.16	13.47
30	5.54	7.66	9.06	10.84	12.16	13.47
40	5.54	7.66	9.06	10.84	12.16	13.47
50	5.54	7.66	9.06	10.84	12.16	13.47
60	5.54	7.66	9.06	10.84	12.16	13.47
70	11.50	15.90	18.82	22.52	25.25	27.97
80	11.50	15.90	18.82	22.52	25.25	27.97
90	11.50	15.90	18.82	22.52	25.25	27.97
100	11.50	15.90	18.82	22.52	25.25	27.97
110	11.50	15.90	18.82	22.52	25.25	27.97
120	11.50	15.90	18.82	22.52	25.25	27.97
130	7.67	10.60	12.55	15.01	16.83	18.65
140	7.67	10.60	12.55	15.01	16.83	18.65
150	7.67	10.60	12.55	15.01	16.83	18.65
160	7.67	10.60	12.55	15.01	16.83	18.65
170	7.67	10.60	12.55	15.01	16.83	18.65
180	7.67	10.60	12.55	15.01	16.83	18.65
190	7.24	10.01	11.85	14.18	15.90	17.61
200	7.24	10.01	11.85	14.18	15.90	17.61
210	7.24	10.01	11.85	14.18	15.90	17.61
220	7.24	10.01	11.85	14.18	15.90	17.61
230	7.24	10.01	11.85	14.18	15.90	17.61
240	7.24	10.01	11.85	14.18	15.90	17.61
250	5.54	7.66	9.06	10.84	12.16	13.47
260	5.54	7.66	9.06	10.84	12.16	13.47
270	5.54	7.66	9.06	10.84	12.16	13.47
280	5.54	7.66	9.06	10.84	12.16	13.47
290	5.54	7.66	9.06	10.84	12.16	13.47
300	5.54	7.66	9.06	10.84	12.16	13.47
310	3.83	5.30	6.27	7.51	8.42	9.32
320	3.83	5.30	6.27	7.51	8.42	9.32
330	3.83	5.30	6.27	7.51	8.42	9.32
340	3.83	5.30	6.27	7.51	8.42	9.32
350	3.83	5.30	6.27	7.51	8.42	9.32
360	3.83	5.30	6.27	7.51	8.42	9.32
370	0.852	1.178	1.394	1.668	1.870	2.072
380	0.852	1.178	1.394	1.668	1.870	2.072
390	0.852	1.178	1.394	1.668	1.870	2.072
400	0.852	1.178	1.394	1.668	1.870	2.072
410	0.852	1.178	1.394	1.668	1.870	2.072
420	0.852	1.178	1.394	1.668	1.870	2.072
430	0.010	0.426	0.589	0.697	0.834	0.935
440	0.010	0.426	0.589	0.697	0.834	0.935
450	0.010	0.426	0.589	0.697	0.834	0.935
460	0.010	0.426	0.589	0.697	0.834	0.935
470	0.010	0.426	0.589	0.697	0.834	0.935
480	0.010	0.426	0.589	0.697	0.834	0.935
490	0.000	0.000	0.000	0.000	0.000	0.000
500	0.000	0.000	0.000	0.000	0.000	0.000
510	0.000	0.000	0.000	0.000	0.000	0.000
520	0.000	0.000	0.000	0.000	0.000	0.000
530	0.000	0.000	0.000	0.000	0.000	0.000
540	0.000	0.000	0.000	0.000	0.000	0.000
550	0.000	0.000	0.000	0.000	0.000	0.000
560	0.000	0.000	0.000	0.000	0.000	0.000
570	0.000	0.000	0.000	0.000	0.000	0.000
580	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 7.2
12 HOUR AES (30%) DISTRIBUTION DESIGN STORM HYETOGRAPHS
ROYAL BOTANICAL GARDENS

Time Step (min)	Rainfall Intensity (mm/hr)					
	2	5	10	25	50	100
590	0.000	0.000	0.000	0.000	0.000	0.000
600	0.000	0.000	0.000	0.000	0.000	0.000
610	0.000	0.000	0.000	0.000	0.000	0.000
620	0.000	0.000	0.000	0.000	0.000	0.000
630	0.000	0.000	0.000	0.000	0.000	0.000
640	0.000	0.000	0.000	0.000	0.000	0.000
650	0.000	0.000	0.000	0.000	0.000	0.000
660	0.000	0.000	0.000	0.000	0.000	0.000
670	0.000	0.000	0.000	0.000	0.000	0.000
680	0.000	0.000	0.000	0.000	0.000	0.000
690	0.000	0.000	0.000	0.000	0.000	0.000
700	0.000	0.000	0.000	0.000	0.000	0.000
710	0.000	0.000	0.000	0.000	0.000	0.000
720	0.000	0.000	0.000	0.000	0.000	0.000

M.8. Appendix H – Erosion and Sediment Control Inspection Report

Hamilton

EROSION AND SEDIMENT CONTROL
INSPECTION REPORT

Date _____

Permittee _____

Superintendent/Representative _____

Property Address _____

Subdivision _____ Lot _____ Block _____

Plan No. _____ Concession _____

REASON FOR INSPECTION

- ☐ Initial
- ☐ Routine (Monthly Report)
- ☐ Complaint (details) _____
- ☐ Final

CONTROL CHECK LIST

Control(s) installed or implemented per approved Sediment and Erosion Control plan?

☐ Yes ☐ No ☐ N/A

Comments

_____

_____

_____

_____

_____

Control (s) installed properly? (silt fence trenched in/bales staked and keyed, soil roughened, etc.).

☐ Yes ☐ No ☐ N/A

Comments

_____

_____

_____

_____

_____

Control(s) operating effectively? (sediment retained on site)

☐ Yes ☐ No ☐ N/A

Comments

Street, sidewalk and flow-lines clean? (no visible mud, dirt, stockpiles, construction supplies and materials, roll-offs, dumpsters, portable toilets, etc.).

☐ Yes ☐ No ☐ N/A

Comments

Are there any erosion problems? (rill, gully, or sheet)

☐ Yes ☐ No

Comments

Are there any sediment problems? (sediment transported/tracked to adjacent properties, ROW's, easements)

☐ Yes ☐ No

Comments

_____

_____

_____

_____

_____

_____

Are there any drainage problems? (ponding, flooding, structural damage)

☐ Yes ☐ No

Comments

_____

_____

_____

_____

_____

_____

Attach photograph documentation for all sediment and erosion controls (or lack of).

The controls have been installed properly and are implemented on this site per the approved Erosion and Sediment Control Plan and will be maintained and/or re-evaluated to operate effectively throughout construction. Any erosion or sediment control problems that may arise during construction will be remediated within five (5) calendar days or as weather permits. I understand that failure to comply with the requirements of the City of Hamilton's sediment and control requirements, may require the Letter of Credit to be drawn upon to rectify the sediment and erosion controls to the satisfaction of the City of Hamilton and/or issuance of a **STOP WORK ORDER**.

Superintendent/Rep: _____
(print)

Phone #: _____

Cell #: _____

Inspector: _____
(print)

Phone #: _____

Cell #: _____

Signed: _____ Title: _____ Date: _____

(Signature of qualified Professional Engineer required for Inspector).

M.9. Appendix I – Current Streamflow and Rainfall Monitoring

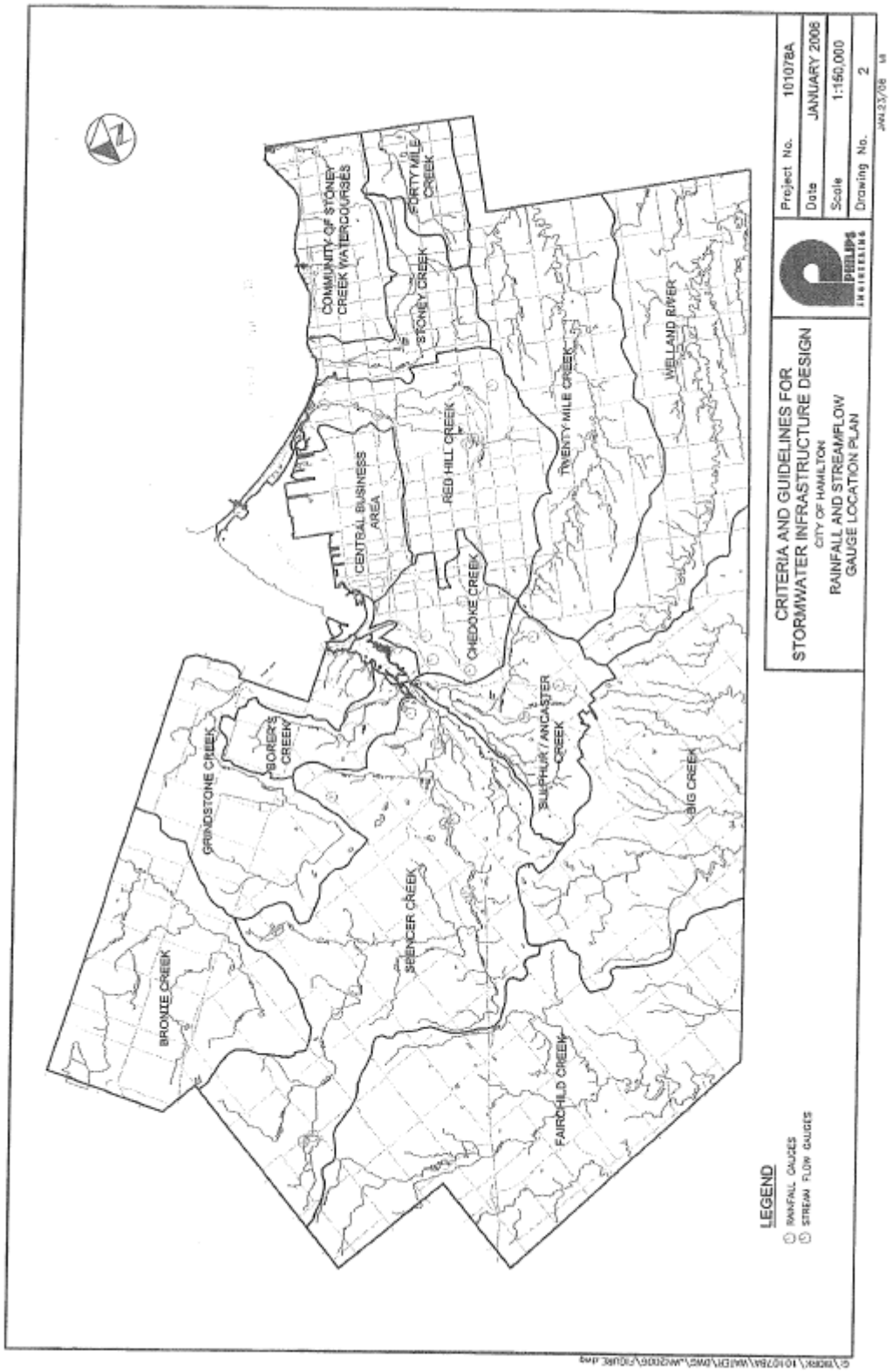


Table.1 Current Streamflow and Rainfall Monitoring in Hamilton Harbour Watershed

Watercourse /Location	No. of Stations	Frequency of Monitoring	Length of Record	Agency
Streamflow Monitoring				
Spencer Creek	3	Flow measurements are taken every 15 minutes	1959 – present	HCA[1], WSC[2]
Ancaster Creek	1	Flow measurements are taken every 15 minutes	1986 – present	HCA, WSC
Red Hill Creek	1	Flow measurements are taken every 15 minutes	1977 - present (due for removal in Sept. 2003)	HCA, WSC
Red Hill Creek	1	Flow measurements are taken every 15 minutes	1989 – present	HCA, WSC
Valens Reservoir	1	Water level measurements are taken every 15 minutes	1988 – present	HCA, WSC
Christie Reservoir	1	Water level measurements are taken every 15 minutes	1987 - present	HCA, WSC
Grindstone Creek	2	Flow measurements are taken every 15 minutes	1963 – present	CH[3], WSC
Rainfall Monitoring				
Woodley's Lane Rain Gauge in Dundas	1	Tipping bucket rain gauge, hourly rainfall depth	1959 - present	HCA
Highway 5 in Spencer Creek	1	Tipping bucket rain gauge, hourly rainfall depth	1987 - present	HCA
Westover in Spencer Creek	1	Tipping bucket rain gauge, hourly rainfall depth	1971 - present	HCA
Christie Reservoir	1	Tipping bucket rain gauge, hourly rainfall depth	1987 - present	HCA
Mount Albion in Red Hill Creek	1	Tipping bucket rain gauge, hourly rainfall depth	1989 - present	HCA
Mohawk Rd in Chedoke Creek	1	Tipping bucket rain gauge, hourly rainfall depth	1985 - present	HCA
Millgrove	1	Tipping bucket rain gauge, hourly rainfall depth	1983 – present	EC-MSC[4]
Valens Reservoir	1	Tipping bucket rain gauge, hourly rainfall depth	1968 – present	EC-MSC
Hamilton Municipal Lab	1	Tipping bucket rain gauge, hourly rainfall depth	1967 - present	EC-MSC

Notes:
[1] Hamilton Conservation Authority
[2] Water Survey of Canada
[3] Conservation Halton
[4] Meteorological Service of Canada, Environment Canada
[5] City of Hamilton

Table.1 (cont'd) Current Streamflow and Rainfall Monitoring in Hamilton Harbour Watershed

Watercourse /Location	No. of Stations	Frequency of Monitoring	Length of Record	Agency
Hamilton Psych Hospital	1	Tipping bucket rain gauge, hourly rainfall depth	1968 – present	EC-MSC
Royal Botanical Garden	1	Tipping bucket rain gauge, hourly rainfall depth	1962 - present	EC-MSC
Dundas Valley	1	Time of every tip of rain gauge recorded	1989 – present	EC-MSC, City[5]
Royal Avenue	1	Time of every tip of rain gauge recorded	1989 – present	City
Harmony Hall	1	Time of every tip of rain gauge recorded	1989 – present	City
Daffodil Court	1	Time of every tip of rain gauge recorded	1989 – present	City
Garth Street Reservoir	1	Time of every tip of rain gauge recorded	1989 – present	City
Highland Road	1	Time of every tip of rain gauge recorded	1989 – present	City
Chedoke Works Yard	1	Time of every tip of rain gauge recorded	1989 – present	City
Royal Botanical Garden, Children's Garden	1	Time of every tip of rain gauge recorded	1989 – present	City
Ancaster Reservoir	1	Time of every tip of rain gauge recorded	1989 – present	City
Dundas Blower Building	1	Time of every tip of rain gauge recorded	1989 – present	City

Notes:
[1] Hamilton Conservation Authority
[2] Water Survey of Canada
[3] Conservation Halton
[4] Meteorological Service of Canada, Environment Canada
[5] City of Hamilton

M.10. Appendix J – List of Approved Hydrologic and Hydraulic Models

LIST OF APPROVED HYDROLOGIC MODELS

1. SWMHYMO/OTTHYMO
2. VISUAL HYMO
3. SWMM
4. XP-SWMM
5. MOUSE (DHI)
6. HSPF
7. MIDUSS

LIST OF APPROVED HYDRAULIC MODELS

1. XP-SWMM
2. MOUSE (DHI)
3. SWMM
4. HEC-RAS (If HEC-2 used, it should be converted to HEC-RAS)
5. Culvert Master

M.11. Appendix K – Protocol for Repayment of City Share

Protocol for Repayment of City Share

All of City's share of the cost of municipal works to be constructed under the subdivision agreement are subject to the following:

i) Council approved capital budget for the works;

ii) The subdivision agreement must be registered;

iii) There shall be no outstanding liens related to the works that are subject to payment to the City's share; and,

iv) Prior to repayment the consulting engineer, who must be a Professional Engineer licensed to practice in Ontario, for the developer must submit a complete submission consisting of:

1) A letter of request for payment of the City's share of construction cost for the related development certified by the developer's consulting engineer;

2) A progress payment certificate to the City broken down in the same format as the approved "Schedule of Works" related to the subdivision agreement with each request for payment of the City share of construction. The payment certificate must show the approved as-constructed cost of completed works which require payment by the City; and,

3) Proof of payment from the contractor who installed the works that are subject to payment by the City.

v) Invoice on developer's letterhead and signed by developer, including all taxes and HST registration number.

M.12. Appendix L – Master Planning (Watershed / Subwatershed)

B.1 Master Planning (Watershed/Subwatershed)

B.1.1. Report Content

(a) Assessment of baseline environmental conditions;

(b) Assessment of water quality/quantity control requirements for flood and erosion control and stormwater quality management in accordance with Provincial habitat protection requirements;

(c) Screening and evaluation of various stormwater management approaches;

(d) Preferred stormwater management approach including: assessment of potential use of on-site and conveyance control Best Management Practices (site gathered geotechnical information may also be required to support conclusion within the report); and

(e) Assessment of general location for proposed stormwater management infrastructure.

B.1.2 Site plans showing:

(a) watershed and development in relation to it;
(b) topography, watercourse, wooded areas, etc.;
(c) present land use;
(d) proposed land use;
(e) proposed major drainage system, including external drainage areas;
(f) schematic of computer model showing linkages;
(g) Regulatory floodlines, where necessary;
(h) points of current active erosion, flooding or water quality problems; and
(i) elevations, existing and proposed, of key points.

B.1.3 Tables showing:

(a) subwatershed characteristics, pre- and post-development;
(b) details of existing watercourse crossings (culverts, bridges, roads);
(c) details on watercourse and valley reaches;
(d) simulated flood flows at key points, pre- and post-development;
(e) calculated flood elevations at all sections, pre- and post-development;
(f) alternative solutions, elevation criteria; and
(g) sizes of SWM facilities proposed for alternative solutions.

B.1.4 Figures showing:

(a) pre- and post-development flows, uncontrolled and proposed controlled at key points; and
(b) water quality, erosion and flood control works dictated by constraints and forming alternative solutions.

M.13. Appendix M - Stormwater Management Plans

B.2 Stormwater Management Plans (Functional and Detailed Design)

B.2.1 Report Content

The level of information required with the stormwater management plan will vary depending on the following factors:

- Stage of design (i.e. Preliminary or Detailed)
- Existence of Master Drainage Plan and or Watershed/Subwatershed Plan
- Site specific issues and constraints to be identified through consultation with the City of Hamilton.

The foregoing should be completely documented to the satisfaction of the City.

Generally Stormwater Management Reports completed to support the Detailed Subdivision/Site Plan Design shall include the following information:

(a) Baseline Conditions (where no Subwatershed or MDP exists):

(i) Assessment of water quality/quantity control requirements for flood and erosion control and stormwater quality management in accordance with Provincial habitat protection requirements;

(ii) Screening and evaluation of various stormwater management approaches (where no Subwatershed or MDP exists) including: an assessment of potential use of on-site and conveyance control Best Management Practices. (Site gathered geotechnical information may also be required to support the conclusion of the reports);

(b) Preferred Stormwater Management approach;

(c) Site Location Plan

(d) Road and Lot layout;

(e) Generalized major/minor system layout including location of storm sewers, location of major flow paths and assessment of major system flow capacity;

(f) Details of stormwater facilities including location and size of stormwater management facilities operating water levels (normal and maximum), integration of recreation opportunities with stormwater management facilities;

(g) Determination of Regulatory flood level (where necessary);

(h) Hydrologic modelling which includes: figures illustrating subcatchment areas and computer model schematic, predevelopment and post-development (controlled and uncontrolled) flow rates for the full range of design storm events. Reporting to include digital copy of all input and output files as well as hardcopy of sample input/output file with full summary table of results and summary description of parameter used in the analysis (even when Subwatershed plan/Master Drainage Plan exists);

(i) Preliminary Erosion and Sediment Control Plan to be implemented for all stages of municipal servicing up to the end of the maintenance period. Plan should include an implementation/decommissioning schedule and maintenance requirements;

(j) Hydraulic modelling which includes determination of regulatory flood elevations, verification of roadway culvert/bridge performance and assessment of channel hydraulics;

(k) Channel design and supporting documentation (where necessary); and

(l) Details of proposed safety features to be incorporated into each SWM (i.e. signage, benching, planting);

(m) Discussion of operation and maintenance requirements in summary, a separate operation and maintenance report shall be submitted;

(n) Discussion of SWM facility monitoring in summary, a separate monitoring report shall be submitted.

B.2.2 Site plans showing:

(a) Drawing to be completed in Metric (SI Units) to a measurable scale

(b) Geodetic Benchmark

(c) Legend

(d) North Arrow

(e) Municipal Address

(f) Professional Engineers's seal (signed and dated)

(g) Key Plan

(h) Legal Property Description

(i) Property lines and all applicable bearings and distances of each property line

(j) Street Names

(k) Lot and road layout with land use;

(l) Minor drainage system with storm sewers, manholes, catchbasins and road grades and sub-drainage areas and catchbasins requiring inlet controls;

(m) Major drainage system with overland flow routes for 1:100 year design storm (or Regulatory flood if greater) at key points including outfalls to other components of the major system;

(n) Details of storage facilities including:

- permanent, extended detention, highest water levels on plan view and include all ponding levels for various return periods in tabular profile;
- section/details of major overland flow routes;
- section/details of maintenance access roads;
- section/details of erosion protection at inlet/outlet structures and on spillways;
- fencing limit detail;
- location/detail of facility signage;
- borehole location and existing groundwater elevation;
- existing and proposed grading elevations and transition slopes;
- sediment forebay details including lining and separation berm;
- details of sediment drying area, where implemented;
- section/details of inlet/outlet structures.

(o) Schematics of computer model;

(p) Proposed erosion and sediment control plan;

(q) Elevations of key points; and

(r) Landscaping and trails to promote passive recreational use of stormwater management facilities.

B.2.3 Tables showing:

(a) Imperviousness ratios for sub-drainage areas;

(b) Post-development flows at each manhole for the minor system design storm;

(c) Elevation of hydraulic grade line at each manhole for the minor system design storm;

(d) Calculation of flows captured by minor system during 1:100 year design storm or other historic storm if weepers are connected to the storm sewer;

(e) Elevation of hydraulic grade line at each manhole for captured flows during 1:100 year design storm or other historic storm (also plotted on detailed design drawings), if weepers are connected to the storm sewer, with determined freeboard to basement floor slab;

(f) Controlled discharges from SWM facilities for whole range of storms, compared to pre-development flows for same storm frequencies, with the respective quantity control volumes for each storm;

(g) Facility stage/storage and discharge characteristics;

(h) Facility permanent pool and extended detention in volume comparison to required volumes; and

(i) Overland flows, depths and velocities at key points on roads and at outfalls to major system for 1:100 year design storm.

B.2.4 Calculations showing:

(a) Extended detention drain downtime;

(b) Stage/storage/discharge characteristics of the facility;

(c) Major system overland flows and velocities to confirm conveyance within City right-of-way and/or defined flow routes;

(d) 100 year hydraulic grade line to confirm basement protection;

(e) Erosion control sizing and flow velocity at inlet/outlet structures and spillways;

(f) Sediment forebay length and width in conformance with MOE SWMP & Design Manual, 2003.

(g) Major system inlet grating sizing (assuming 50% blockage).

B.2.5 Figures showing:

(a) Pre- and controlled post-development drainage areas and hydrographs at outfalls and at outlets from SWM facilities;

(b) Modified Regulatory flood levels upstream of channel or valley constrictions and at SWM ponds (should be plotted on detailed design drawings);

(c) Hydraulic grade lines in storm sewer system during 1:100 year design storm (should be plotted on detailed design drawings), if weepers are connected to storm sewers;

(d) Details of outfalls of storm sewer system (should form part of detailed design drawings);

(e) Details of overland flow routing on roads and outfalls to major drainage system (should form part of detailed design drawings);

(f) Details of erosion and sediment control measures (should form part of detailed design drawings); and

(g) Details of control structures and ponds (should form part of detailed design drawings).

B.2.6 Report Format

Report shall be bound with a front/back cover. The 25 file number shall be included on the front cover. A-1 size plans included within the report shall be folded and bound into the report. Once the report has been reviewed and accepted by the City, a digital copy of the report shall be provided in one file in an adobe acrobat (v5.0 or lower) .pdf format.

B.2.7 Site Plan and Infill Developments

For site plan and infill developments where conventional stormwater quality wetpond facilities are not feasible or recommended, the submission should be adjusted to reflect the end-of-pipe quality treatment proposed and any on-site quantity storage utilized (i.e. depression storage, parking lot, etc.).

M.14. Appendix N - Acknowledgement for Concurrent Building Permit Review Process

Acknowledgement for Concurrent Building Permit Review Process

The Applicant,_____, acknowledges and agrees to the following:

1. The Concurrent Building Permit Review Process is being made available by the City of Hamilton to Applicants for developments only within the Industrial, Commercial and Institutional (ICI) Sector. Participation in this process is solely at the discretion of the Applicant.

2. The selection by an Applicant to participate in the Concurrent Building Permit Review Process:

   (a) Does not guarantee final Site Plan approval;

   (b) Does not guarantee final Building Permit approval; and

   (c) Is not an approval of any other application related to this Building Permit Application.

3. The time period within which a Building Permit is issued or refused will not start until the application requirements of the Ontario Building Code have been met.

4. The Applicant acknowledges that changes made through the Site Plan process could result in changes requiring a re-submission of the Building Permit Application. **Anyone choosing to be subject to the Concurrent Building Permit Review Process does so at their own risk and cost, including the potential for additional fees if a revised Building Permit Application is required following final Site Plan approval.**

By signing below, you are indicating that you have requested that the Concurrent Building Permit Review Process apply to your Building Permit Application and that you acknowledge and agree to the foregoing statements:

Signed by Applicant: Date:

Signed by Witness: Date:

M.15. Appendix O - Fire Hydrant Flushing and Monitoring Program for Interim Water Quality Maintenance

<Proponents Letterhead>

<Date>

City of Hamilton
Planning and Economic Development Department
Development Engineering Division
71 Main Street West
Hamilton, ON. L8P 4Y5

Attn: < Growth Management Staff Representative Name>

Re: <name of subdivision> - <Form 1 identification number *F1YYYY###*> - Fire Hydrant Flushing and Monitoring Program for Interim Water Quality Maintenance

Dear < name>,

Please be advised, that <company name of proponent>, the owner of <subdivision name> in the City of Hamilton, herein agrees to reimburse the City of Hamilton ("City") for all costs for performance based flushing in City infrastructure subject to the above Form 1 limits, conducted by the City forces, to address water quality issues due to insufficient turnaround of water, at the above noted project after charging and during construction of buildings, until such time the City is satisfied with the chlorine residual testing results.

<company name of proponent> shall pay to the City all invoices based on actual costs incurred by the City plus an administrative fee. For each hydrant to be tested, the cost will be based on the current standard City of Hamilton hourly rate x 2 hours per hydrant. This rate is based on one operator, a vehicle charge and travel time to and from the project site for work completed during regular working hours. Work completed outside regular working hours will be charge extra.

The hydrant testing frequency is based on field evidence starting weekly to establish a baseline for chlorine decay then adjusted increased or decreased to ensure adequate chlorine residual going forward. Testing frequency will be adjusted accordingly based on the chlorine residuals.

Please mail all invoices to the following address:

< company name of proponent>
Attention: <name of proponent representative>
<mailing address for invoices>
<phone number for invoices>

Yours truly,

M.16. Appendix P – Site Works Certification Form for Landscape Works

SITE WORKS CERTIFICATION FORM
ON LANDSCAPE ARCHITECT/DESIGNER LETTERHEAD

DA/SPA/MDA-00-000 Date:

Project Name
Project Address
I, _____ of _____

Certify to the City of Hamilton that all Landscape works in connection with the above project have been satisfactorily completed as per the approved landscape drawings.

Works:	Date of Completion/ Inspection	Total Value of Work ($)	Value of Incomplete Works ($)
1. PLANTING SPECIES			
2. FINE GRADING/SODDING/SEEDING			
3. LANDSCAPE STRUCTURES			
4. LANDSCAPE PAVING MATERIALS			
5. IRRIGATION SYSTEM			
6. SURFACE WORKS			
TOTAL VALUE OF INCOMPLETE WORK			

NOTE: All deviations from the approved plans are to be detailed and justified below. Additional details or revised drawings may be required prior to the City accepting certification.

Landscape Architect/Consultant

Signature: _____ AFFIX SEAL

Date: _____

cc: Owner
Engineer/Consultant

M.17. Appendix Q – Site Works Certification Form – Engineering

Appendix "XX"

SITE WORKS CERTIFICATION FORM

ON PROFESSIONAL ENGINEER/CONSULTANT LETTERHEAD

DA/SPA/MDA-00-000 Date:

Project Name
Project Address

I, _____ of _____

Certify to the City of Hamilton that the following Site Works have been implemented and constructed in accordance with all approved site plans, grading plans, stormwater management plans, site servicing plans, applicable policies and guidelines of the City of Hamilton.

Works:	Date of Completion/ Inspection	Total Value of Work ($)	Value of Incomplete Works ($)
7. GRADING			
a) Rough Grading			
b) Erosion/Siltation Control			
c) Final Grading			
d) Fencing			
e) Retaining Wall			
f) Sod			
8. STORMWATER MANAGEMENT			
a) Quantity Control – pond, orifice, cistern, inlet/outlet structure, roof top			

storage device, rip-rap, other.			
b) Quality Control – infiltration ponds/swales, oil/grit separator, other.			
9. SERVICING			
a) Storm Sewer Servicing			
b) Sanitary Sewer Servicing			
Works:	Date of Completion/ Inspection	Total Value of Work ($)	Value of Incomplete Works ($)
c) Water Servicing			
10. SURFACE WORKS			
a) Asphalt pavement (including granular base)			
b) Concrete pavement (including granular base)			
c) Concrete sidewalk			
d) Line Painting			
e) Other			
11. CURBING			
TOTAL VALUE OF INCOMPLETE WORK			

NOTE: All deviations from the approved plans are to be detailed and justified below. Additional details or revised drawings may be required prior to the City accepting certification.

Professional Engineer/Consultant

Signature: _____ AFFIX SEAL

Date: _____

cc: Owner
Landscape Architect/Consultant

M.18. Appendix R – Sidewalk and Roadway Lighting Guideline

City of Hamilton
Public Works | Engineering Services
Geomatics and Corridor Management
77 James Street North, Suite 320
Hamilton, ON L8R 2K3

Sidewalk and Roadway Lighting Guideline

1. Description and Purpose

In its simplest form, lighting is required to improve visibility during the hours of darkness. Research and analysis confirms that when applied to the context of sidewalks and roadways, lighting can play a key role in relation to topics such as improving safety, security, and City image. Therefore, it is important that the parameters to which lighting is applied are defined such that it may be designed and installed appropriately in order to ensure that the benefits can be achieved.

The objective of this guideline is to provide the necessary streetlight parameters needed to design and apply lighting for sidewalks and roadways that will directly benefit, but not limited to, the following:

- Pedestrian-Vehicular safety (Pedestrian road crossings)
- Safety and Security - Real
- Safety and Security - Perceived
- Commercial and City of Hamilton image enhancement
- Vehicular Road Safety (Vehicle-vehicle conflicts)

This guideline is to define the City of Hamilton's general streetlight design criteria for the design and application of sidewalk and roadway lighting contained within the public right-of-way.

The Street lighting systems along public Right-of-ways including Urban and Rural areas and Miscellaneous Right-of-ways (e.g. sidewalks, walkways) shall be in accordance with this guideline, the City Policy, the Illuminating Engineering Society of North America's (IESNA) Recommended Practices, and the Electrical Safety Authority (ESA).

This document is not intended to be a complete instruction manual for the design of street lighting system and must be read in conjunction with the latest release of these manuals and documents, as produced by the Illuminating Engineering Society (IES) and the Transportation Association of Canada (TAC):

- ANSI /IES RP-8 — American National Standard Practice for Roadway Lighting.
- ANSI/IES RP-16 — Nomenclature and Definitions for Illuminating Engineering.
- ANSI/IES DG-4 — Design Guide for Roadway Lighting Maintenance.
- IES DG-19-08 — Design Guide for Roundabout Lighting
- RTAC/ARTC — Guide for the Design of Roadway Lighting.
- RTAC/ARTC — Illumination of Isolated Rural Intersections.

The Design Engineers are encouraged to refer to the referenced publications for additional information.

2. Scope

This guideline is intended to be used by City Staff, the public, lighting engineers/designers and developers to govern the basis for the design and application of sidewalk and roadway lighting projects contained within the public right-of-way. The fundamental purpose of the guideline is to provide a uniform structure for the ongoing provision of lighting across the City carried out by the City, developers and other applicable parties.

3. Definitions

The following is a partial list of more commonly used definitions associated with sidewalk and roadway lighting:

3.1 Lighting Terminology

- **Light** – Light is radiant energy in the visible (to the human eye) part of the electromagnetic spectrum between 380-770nm.
- **Lux (lx)** – A unit of measurement for illuminance in the International System of Units (SI). It is defined in terms of lumen s per meter squared (lm/m^2). The imperial equivalent of lux is the footcandle (fc).
- **Intensity (Candlepower)** – Intensity (Candlepower) refers to the concentration of light in a particular direction, while lumens represent a total quantity of light emitted. Intensity is expressed in candelas (cd). The concentration of light will normally change for each direction of light emission. This is not required for a lighting calculation; however it is an important lighting fundamental.
- **Illuminance** – When light is incident upon a surface it will create "illuminance" on that surface. Illuminance is a measure of the light landing on a defined area. The more lumens on a given surface area, the higher the level of illuminance will be. The human eye does not see illuminance or the light incident on a surface; it sees only the proportion of the light reflected from the object back into the eye. Illuminance is measured in lux.
- **Luminance** – Luminance is the concentration of light (intensity) reflected towards the eyes per unit area of surface. Luminance represents the amount of illumination reflected into the eyes of the viewer and is dependant upon the reflectivity of the object that the light is reflecting from. Luminance is measured in candelas per square meter (cd/m^2).
- **Uniformity** – Uniformity is the evenness of the light over a given area. Even lighting throughout an area would have a uniformity ratio of 1:1. A high degree of uniformity of roadway lighting has generally been accepted as desirable. As lighting calculations consist of a series of grid points with calculated luminance or illuminance levels, uniformity is expressed as the ratio of the average-to-minimum levels and/or the maximum-to-minimum levels.
- **Veiling Luminance** – Veiling luminance is a numeric evaluation of un-desirable (or disability) glare. Because of contract reduction by disability glare, visibility is decreased and therefore un-desirable. Increasing luminance levels will counteract this effect by reducing the eye's contract sensitivity. As glare limits visibility, veiling luminance is an important, however often omitted, consideration. Veiling luminance must be considered as a design criterion along with illuminance or luminance levels and uniformity. Veiling luminance is calculated in terms of a ratio of the maximum veiling luminance experienced by the observer to the average pavement luminance and is expressed as a ratio value.
- **Colour Rendering Index (CRI)** – Colour rendering index, is a measurement of a light source's accuracy in rendering different colours when compared to a reference light

source with the same correlated colour temperature. It generally ranged from 0 for sources light low-pressure sodium lamps, which is monochromatic, to 100, for a source like an incandescent light bulb. Achieving a high CRI (70+) assists in visibility and many other factors associated with what would be deemed as a 'well lit environment'.

- **Correlated Colour Temperature** – Colour temperature is a description of the warmth or coolness of a light source. By convention, yellow-red colours (like the flames of a fire) are considered warm, and blue-green colours (like light from an overcast sky) are considered cool. Confusingly, higher Kelvin temperatures (3600-5500K) are what we consider cool and lower temperatures (2700-3000K) are considered warm.

- **Light Trespass** – Light trespass is the amount of light that leave a specific site and enters another site. IES TM-11-00 (R2011) Light Trespass: Research, Results, and Recommendations, provides guidelines on the limitations for light trespass.

- **Sky Glow** – Sky glow is the luminance that is created in the night sky by light scattered within the atmosphere directed back towards an observer, thereby diminishing or completely obscuring the view of the night sky.

- **Glare** - Glare is the uncomfortable brightness of a light source which effects human visionand can cause annoyance, discomfort, or loss of visual performance and visibility when viewed against a dark background. It is subdivided into two components, disability glare, and discomfort glare. Disability glare is the glare that results in reduced visual performance and visibility. Discomfort glare is the glare producing a sense of annoyance or pain.

3.2 Land Classifications

- **Urban** – Areas within the boundaries of a city, municipality, town or village where the area is built-up with residential or commercial development and has active pedestrian traffic are classified as urban. The classification of urban typically includes a reasonable level of nighttime activity, the presence of sidewalks and roadways with curb and gutter (curb and gutter are not always associated with urban) and a mix of commercial, industrial and residential development in the area. Commercial and residential development in urban areas is typically denser when compared to rural or semi-rural areas. Residential development includes single-family and multifamily developments and apartments. Commercial development includes retail businesses and shops, shopping malls, etc., where pedestrians can travel between local destinations via sidewalks.

- **Rural** – Rural areas are outside of urban areas, with little or no commercial development and little or no nighttime pedestrian traffic. Typically rural roadways have gravel shoulders with open ditches and no sidewalks. Rural areas include farmland and greenfield areas with little or no commercial or residential development. Most Provincial freeways and highways will have a rural classification, except where they run through an urban area.

- Further elucidation of the above noted land classifications in the vicinity of City of Hamilton, the designer shall refer to the latest Urban Hamilton Official Plan and Rural Hamilton Plan.
  https://www.hamilton.ca/city-planning/official-plan-zoning-by-law/rural-hamilton-official-plan
  https://www.hamilton.ca/city-planning/official-plan-zoning-by-law/urban-hamilton-official-plan

3.3 Miscellaneous Right-of-Way Definitions

- **Sidewalk** - The portion of the right-of-way intended for pedestrian use, normally adjacent to a roadway and separated by a curb. Sidewalks commonly consist of a linear paved slab-on-grade concrete construction.

- **Walkways** – Walkways serve the same purpose as sidewalks but are not normally directly adjacent to a roadway. In the context of sidewalk and roadway lighting, walkways interconnect one roadway to another roadway.

- **Bikeways** – Bikeways are any streets, roads, separate bike path, shared lanes, wide outside lane, shoulder being open to bicycle travel.

3.4 Miscellaneous Right-of-Way Definitions

- **High Pedestrian Activity** – Areas with significant numbers of pedestrians expected to be on the sidewalks during the hours of darkness are designated as high pedestrian activity level areas. Examples are commercial urban areas, downtowns or city centers with high nighttime activity. A high pedestrian activity area will have 100 or more pedestrians over the one-hour period with the highest average annual nighttime pedestrian volume.

- **Medium Pedestrian Activity** – Areas where fewer pedestrians are expected to be on the sidewalks during the hours of darkness are designated as medium pedestrian activity level areas. Typically, these are urban commercial or industrial areas, and have some or all of the following types of development: multifamily residential, community buildings, neighborhood shopping and transit lines. A medium pedestrian activity area will have 1 to 100 pedestrians over the one-hour period with the highest average annual nighttime pedestrian volume.

- **Low Pedestrian Activity** – Areas where very few nighttime pedestrians are expected to be on the sidewalks during the hours of darkness are designated as low pedestrian activity level areas. This level of activity can occur in any of the cited roadway classifications. However, it is typical of small urban streets with single-family homes and very low density residential developments (e.g., residential subdivisions). A low pedestrian activity area will have 10 or fewer pedestrians over the one-hour period with the highest average annual nighttime pedestrian volume.

3.5 Roadway Type Classification

- **Freeway** – A freeway is defined as a fully-controlled access roadway for through traffic, with a classification of RFD or UDF (see Table 3.4.1 – Roadway Classification Designation Matrix). Freeways are typically characterized by the presence of interchanges which allow motorists to enter and exit the freeway in a fully controlled fashion onto local, collector and arterial roads. Typical interchange configurations include diamond, cloverleaf, parclo, trumpet and rotary. Freeways are typically high-speed facilities with a posted speed of 90 km/h or greater. Pedestrians and cyclists are restricted from using freeways. Freeway can be further categorized into Freeway Class A and Freeway Class B

    i) Freeway Class A – These generally exist in urban areas and are generally classified as Roadways with great visual complexity and high traffic volume. Usually this type of freeway will operate at or near design capacity through some of the early morning or evening hours of darkness.

    ii) Freeway Class B - These generally exist in non-urban area and are all other divided roadways with full control of access.

- **Expressway-Highway** – Expressway-highway is defined as a roadway for through traffic with full or partial control of access via interchanges, intersections or roundabouts. Classifications include REU, RED, UEU or UED (see Table 3.4.1 – Roadway Classification Designation Matrix). An expressway-highway may have at-grade signalized or un-signalized intersections or roundabouts. In some cases an expressway-highway may have interchanges similar to those for freeways.

- **Arterial** – An arterial is defined as a roadway primarily for high volume through traffic with classification of RAU, UAU or UAD (see Table 3.4.1 – Roadway Classification Designation Matrix). An arterial will typically have partially-controlled access via traffic signals or roundabouts or non-controlled access via intersections or driveways and sidewalks on both sides of the roadway. The routes connect areas of principal traffic generation and important rural roadways entering and leaving the city.

- **Collector** – A collector is defined as a roadway feeding an arterial classification of RCU, RCD, UCU or UCD (see Table 3.4.1 – Roadway Classification Designation Matrix). A collector will typically have partially-controlled access via traffic signals or roundabouts or non-controlled access via intersections or driveways and sidewalks on both sides of the roadway.

- **Local** – A local is defined as a roadway feeding a collector or arterial, with classification of RLU or ULU (see Table 3.4.1 – Roadway Classification Designation Matrix). A local roadway will typically have partially-controlled access via traffic signals or roundabouts or non-controlled access via intersections or driveways and sidewalks on one side of the roadway.

- Further elucidation of the above noted Roadway classifications in the vicinity of City of Hamilton, the designer shall refer to the latest Urban Hamilton Official Plan and Rural Hamilton Plan.
  https://www.hamilton.ca/sites/default/files/media/browser/2015-01-19/ruralhamiltonofficialplan-volume1-schedulec-roadclassification.pdf

- **Alleyway** – An alleyway is defined as a non-controlled access roadway located along the rear of, or between, buildings for servicing or access purposes. Alleyways typically connect to local or collector roads

First Letter		Second Letter		Third Letter	
R	Rural	L	R	Rural	L
U	Urban	C	U	Urban	C
-	-	A	-	-	A
-	-	E	-	-	E

Table 3.4.1 – Roadway Classification Designation Matrix

3.6 Reference Standards Organizations

- **Illuminating Engineering Society of North America (IESNA)** – The IESNA is a not-for-profit organization that produces a large number of recommended practice and design guides used for in the North American lighting industry. The organization also provides education programs and certifications. The IESNA has committees made up on engineers, manufacturers, City and Government staff, and others who commonly practice within the lighting industry who author their documents. The IESNA is considered the foremost leader and most respected organization in regards to lighting in North America and much of their research and recommendations form the basis for many lighting standards.

- **Transportation Association of Canada (TAC)** – TAC is a national association with a mission to promote the provision of safe, secure, efficient, effective and environmentally and financially sustainable transportation services in support of Canada's social and economic goals. The association is a neutral forum for gathering or exchanging ideas, information and knowledge on technical guidelines and best practices. In Canada as a whole, TAC has a primary focus on roadways and their strategic linkages and inter-relationships with other components of the transportation system. In urban areas, TAC's primary focus is on the movement of people, goods and services and its relationship with land use patterns.

4. Design Criteria

Sidewalk and roadway lighting, contained within the public right-of-way, is required to be designed and applied as described by this guideline.

Lighting and electrical designs must be undertaken by qualified and competent individuals who are knowledgeable in municipal sidewalk and roadway lighting and electrical engineering as it applies. Finalized designs being submitted to the City shall be stamped and sealed by an electrical engineer licensed by Professional Engineers of Ontario.

The following is a list of minimum design criteria and also supplemental and/or highlighted contents of referenced standards that the City believes to be important considerations:

- ANSI/IESNA RP-8 Recommended Practice for Roadway Lighting (latest edition).
- Specific to residential subdivisions shall also adhere to the latest version of the Comprehensive Development Guidelines and Financial Policies Manual: *https://d3fpllf1m7bbt3.cloudfront.net/sites/default/files/media/browser/2016-05-09/comprehensive-development-guidelines-financial-policies-manual-2016.pdf*
- Designs shall be respectful of and adequately incorporate Pedestrian conflicts levels, Land/Area Classification, Pavement Classification and Roadway Type classifications.
    a) For Roadway Type classification reference to section 3.5 and conform to the latest edition of RP-8 Section 2.0 and TAC Chapter 2 supplement – Vision and Fundamental Concepts and TAC Chapter 4 Supplement - The Planning and Design Process.
    b) For Pedestrian Conflict Area classification reference section 3.2 and conform to the latest edition of RP-8, TAC Chapter 2 supplement – Vision and Fundamental Concepts and TAC Chapter 2Supplement - The Planning and Design Process.
    c) For Pedestrian Walkway, Sidewalk and Bikeway Classifications reference section 3.3, and conform to the latest edition of IES RP-8 Section 2.0. Walkways and Bikeways are additionally classified in IES DG-5 Sections 2 and 3.
    d) For Pavement classifications, reference the latest edition of IES RP-8, TAC Chapter 2 supplement – Vision and Fundamental Concepts.
- Only the 'luminance design method' shall be used for calculating roadway lighting levels. Exceptions allow for the use of the Illuminance design method for curved road sections, sidewalks, and intersections. Both of these methods shall be prescribed as contained within ANSI/IES RP-8-14, American National Standard Practice for Roadway Lighting. Lighting designers shall meet the luminance criteria set forth in Table 4.3.1 – Urban Roadway Luminance Levels.

- The design should address security and safety of the pedestrian and drivers, limit the amount of light spill, energy efficient and should comply with City of Hamilton Sidewalk and Roadway Lighting Policy(reference appendix A of report PW11041): http://www2.hamilton.ca/NR/rdonlyres/F0274015-1988-4B32-BC1F-E79A53895C93/0/Sep04EDRMS_n348977_v1_8_2_1_PW11041.pdf

- Luminaire/Pole placement shall be in conformance with latest edition of ANSI/IES RP-8, TAC Chapter 4 Supplement – The Planning and Design Process, Chapter 5 Supplement - Systems Components and Common Design Elements and Chapter 9 Supplement – Roadways and Interchanges. Specific to these documents, designs shall consider:

  a) One arrangement shall be used along the entire length of the roadway.

  b) The Design Engineer shall minimize placement of multiple lights on a single lot (i.e. balance homeowner concerns and street lighting design).

  c) Streetlight poles are typically to be installed on the property line and in between residential lots based on the offset as specified in Right of Way x-section detail.

  d) A minimum clearance of 3.0 m shall be required from the center of the streetlight to the center of a fire hydrant.

  e) A minimum clearance of 3.0 m shall be required from the center of the streetlight to the center of street trees.

  f) If there is an available hydro pole line on one side of the street, they should be utilized to mount street light.

- Designs shall adhere to Right of Way Installation and Permit Manual: https://d3fpllf1m7bbt3.cloudfront.net/sites/default/files/media/browser/2015-04-22/right-of-way-manual.pd

4.1 Sidewalks

Lighting is required to allow pedestrians to safely navigate sidewalks as it provides increased visibility, allowing them to see where they are going and mitigating physical hazards associated with tripping and falling. Additionally, it allows those in motor vehicles to view pedestrian activity on the sidewalks which can reduce the potential for pedestrian-vehicular incidences. Lighting enhances the safety of pedestrians as it is a natural crime deterrent and it allows law enforcement, pedestrians and roadway users to observe and report any criminal activities through the increase in general visibility. Unrealistic perceptions of reduced safety and security can be alleviated as lighting creates a positive feeling of comfort and security. This can enhance the City's image and promote economic development.

Application of Lighting:

Sidewalk lighting is required to be designed and installed using the *illuminance* method and as listed in Table 4.1.1 – Sidewalk Illuminance Levels.

Pedestrian Activity Level	Maintained Average Horizontal Illuminance E_{avc} (lux)	Average-to-Minimum Horizontal Uniformity Ratio	Minimum Maintained Vertical Illuminance (lux)
High	≥20.0	≤4:1	≥10.0
Medium	≥5.0	≤4:1	≥2.0
Low	≥3.0	≤6:1	≥0.8

Table 4.1.1 - Sidewalk Illuminance Levels

Where sidewalk lighting is planned which includes new or existing trees (at all stages of maturity) the following is recommended to be evaluated and taken into consideration to mitigate the physical obstructions that would be considered detrimental to light distribution:

- Locate luminaires outside of the full growth lines of the species of tree along the roadway;
- When in close proximity to trees, adjust the luminaire light loss factor (LLF) an additional 10% to 20%;
- Reduce pole-to-pole spacing by a factor of 20% to 30%.

4.2 Urban Walkways – Connecting a Roadway to a Roadway

Urban walkways (connecting a roadway to a roadway) are by function, identical to a sidewalk with the exception that they are not directly adjacent to a roadway. Based upon this, the explanation of sidewalk lighting is recommended for urban pedestrian pathways.

Application of Lighting:

Urban walkway lighting is recommended to be designed and installed using the *illuminance* method and as listed in Table 4.1.1 – Sidewalk Illuminance Levels.

4.3 Urban Roadways

Studies and research over the last 50 years has shown that properly designed roadway lighting directly and indirectly reduces the number and severity of collisions (vehicle-vehicle, vehicle-pedestrian and vehicle-cyclist) as it aids in improving urban roadway user's visibility, making objects on the roadway as well as other vehicles, pedestrians and cyclists easier to identify. Similarly to sidewalk lighting, roadway lighting can enhance City image and promote economic development by increasing positive feelings of comfort and perceptions.

Application of Lighting:

Urban roadway lighting is recommended to be designed and installed using the *luminance* method and as listed in Table 4.3.1 – Urban Roadway Luminance Levels.

Road Area and Pedestrian Activity		Average Luminance cd/m^2	Average-to-Minimum Uniformity Ratio	Maximum-to-Minimum Uniformity Ratio	Maximum-to-Average Veiling Luminance Ratio
Road Type	Pedestrian Activity				
Expressway - Highway	High	≥1	≤3	≤5	≤0.3
	Medium	≥0.8	≤3	≤5	≤0.3
	Low	≥0.6	≤3.5	≤6	≤0.3
Arterial	High	≥1.2	≤3	≤5	≤0.3
	Medium	≥0.9	≤3	≤5	≤0.3
	Low	≥0.6	≤3.5	≤6	≤0.3
Collector	High	≥0.8	≤3	≤5	≤0.4
	Medium	≥0.6	≤3.5	≤6	≤0.4
	Low	≥0.4	≤4	≤8	≤0.4
Local	High	≥0.6	≤6	≤10	≤0.4
	Medium	≥0.5	≤6	≤10	≤0.4
	Low	≥0.3	≤6	≤10	≤0.4

Table 4.3.1 – Urban Roadway Luminance Levels

Where urban roadway lighting is planned which includes new or existing trees (at all stages of maturity) the following is recommended to be evaluated and taken into consideration to mitigate the physical obstructions that would be considered detrimental to light distribution:

- Locate luminaires outside of the full growth lines of the species of tree along the sidewalk;
- When in close proximity to trees, adjust the luminaire light loss factor (LLF) an additional 10% to 20%;
- Reduce pole-to-pole spacing by a factor of 20% to 30%.

4.4 Urban Intersections

Studies and research shows that urban intersection lighting reduces the number and severity of collisions (vehicle-vehicle, vehicle-pedestrian and vehicle-cyclist) as it aids in improving urban roadway user's visibility. The lighting of urban intersections is crucial in increasing the safety of pedestrians as they utilize intersections to cross roadways and are therefore inherently at a higher risk for vehicle-pedestrian incidences. A well-lit urban intersection supplements integral vehicle lighting (headlamps) and allows drivers to view pedestrians, and other objects, on the roadway further in advance. In addition, lighting allows pedestrians to safely navigate sidewalks, sidewalk ramps, and roadway crossings as it provides increased visibility, allowing them to see where they are going and mitigating physical hazards associated with tripping and falling.

- The intersection design for placement of lights, maintaining minimum maintained average illuminance, average illuminance level and uniformity shall conform with ANSI/IES RP 8-14 standard in conjunction with TAC manual Chapter 10 – Intersections. The illumination for al intersections must meet or exceed the listed criteria in Table 4.4.1 – Urban Intersection Illuminance Levels.

- For a new development, it is the design engineer responsibility to illuminate any existing intersection abutting on to the new development. If the existing road connected to the new development is not illuminated, then it is the responsibility of the designer to illuminate the intersection and the existing roadway up to 100m on all sides of the intersection.

- No poles shall be installed on frangible bases in areas where a pedestrian traffic is expected.

Application of Lighting:

Urban intersection lighting is recommended to be designed and installed using the *illuminance* method and as listed in Table 4.4.1 – Urban Intersection Illuminance Levels. The highest and most uniform portion of the lighting design should be within the marked pedestrian crossings.

Roadway Classification	Average Maintained Illuminance at Pavement by Pedestrian Conflict (lux)			Average-to-Minimum Uniformity Ratio
	High	Medium	Low	
Arterial/Arterial	34.0	26.0	18.0	≤3.0
Arterial/Collector	29.0	22.0	15.0	≤3.0
Arterial/Local	26.0	20.0	13.0	≤3.0
Collector/Collector	24.0	18.0	12.0	≤4.0
Collector/Local	21.0	16.0	10.0	≤4.0
Local/Local	18.0	14.0	8.0	≤6.0

Table 4.4.1 – Urban Intersection Illuminance Levels

4.5 Rural Roadways

Though research shows benefit in rural roadway lighting, due to much lower pedestrian activity levels and lower driver workloads, when compared to urban roadways, the overall benefit of lighting on rural roadways is greatly reduced. With minimal pedestrians, driver guidance becomes the governing factor on rural roadways. In most instances, integral vehicle lighting (headlamps), retro-reflective pavement markings and signage serve as an adequate method of enhancing driver guidance and therefore a successful business case cannot be shown from a cost benefit standpoint. In special cases (such as complex horizontal/vertical roadway geometry or sections of roadways with a recorded history of a high night to day collision ratio) where it is determined that rural roadway lighting is required to supplement pre-existing pavement markings and signage it is therefore deemed applicable. The requirement for rural roadway lighting should be based upon a comprehensive review of all factors and by utilizing nationally recognized evaluation systems.

Application of Lighting:

When deemed as being required, rural roadway lighting is recommended to be designed and installed using the *luminance* method and as listed in Table 4.5.1 – Rural Roadway Luminance Levels.

Roadway Classification	Average Luminance cd/m2	Average-to-Minimum Uniformity Ratio	Maximum-to-Minimum Uniformity Ratio	Maximum-to-Average Veiling Luminance Ratio
Arterial	≥0.6	≤3.5	≤6	≤0.3
Collector	≥0.4	≤4	≤8	≤0.4
Local	≥0.3	≤6	≤10	≤0.4

Table 4.5.1 – Rural Roadway Luminance Levels

4.6 Rural Intersections

Studies and research have indicated that the benefits of lighting are typically much greater in the urban areas than in rural areas, with the exception being at rural intersections. The lighting of rural intersections can significantly reduce collisions, specifically late-night/early-morning crashes (by approximately 34 percent). Considering that the majority of rural roadways are not lighted, rural intersection lighting is utilized to identify or 'delineate' the exact location of intersections as they can be seen from greater distances. Additionally, lighting enhances rural roadway user's safety by improving visibility to other vehicles, pedestrians and road-side hazards.

Application of Lighting:

All rural intersections are required to have delineation lighting. The Transportation Association of Canada document: Illumination of Isolated Rural Intersections – *"Warrant for Illumination of Isolated Rural Intersections"* is recommended to be used to determine the requirement, design and installation of full, partial or delineation lighting. All luminaires installed at rural intersections are recommended to be the cobra head type or an approved equivalent that is visible to roadway users at a distance – therefore acting as a visual way-finder.

4.7 Roundabouts

The explanation for the lighting of roundabouts is similar to the reasoning for the requirement of lighting on urban roadways, sidewalks and urban intersections (refer to section 5.1 – Sidewalks, section 5.3 – Urban Roadway and section 5.4 – Urban Intersections) as they share similar operational and geometrical characteristics. However, there are also some characteristics that are completely isolated to roundabouts and as a result have unique lighting requirements and objectives. It has been identified by the Illuminating Engineering Society of North America and the Transportation Association of Canada that the lighting of roundabouts can substantially enhance the safety of pedestrian, roadway users (cyclists and drivers) and also supports steady and efficient traffic flow in nighttime operations. Lighting of roundabouts provides enhanced visibility of pedestrians (in crosswalks and intending to use crosswalks) to approaching and exiting vehicles. Additionally, lighting assists in guidance for roadway users as, due to the circular geometry of a roundabout, vehicle headlights are tangential to the roadway and are therefore not pointed in the intended path of travel. Therefore, lighting is a key component that greatly assists in regards to nighttime navigation.

Application of Lighting:

Roundabout lighting is recommended to be designed and installed as prescribed by the Illuminating Engineering Society of North America – DG-19-08 Design Guide for Roundabout Lighting and in conjunction with the Transportation Association of Canada – Guide for the Design of Roadway Lighting, Part 11 - Roundabouts.

In rural areas where continuous lighting is not present and a roundabout is planned, transitional type lighting is recommended to be designed and installed to mitigate roadway user light adaptation issues. In urban areas, transitional lighting is generally not required unless there is a drastic difference between the existing continuous lighting approaching the roundabout compared to the required lighting levels within the roundabout. The intersecting roads shall be illuminated for at least 80m past the limits of the roundabout and no poles shall be installed on frangible bases in areas where a pedestrian traffic is expected.

4.8 Protected Crosswalks

At present, the only protected crossings are at traffic signals. In the future, the Ontario Traffic Manual Book 15 may permit signed crossings as well. Protected crosswalks are by function, nearly identical to urban intersections, as roadway users are typically controlled by traffic signals, with the exception that they can be located mid-block (between intersections). Based upon this, the explanation of urban intersection lighting is recommended to be used at protected crosswalks.

Application of Lighting:

Protected crosswalk lighting is recommended to be designed and installed using the *illuminance* method and as listed in Table 4.4.1 – Urban Intersection Illuminance Levels and in conjunction with the Transportation Association of Canada – Guide for the Design of Roadway Lighting, Part 12 – Mid-block Crosswalks.

5. Obtrusive Light and Light Pollution

Obtrusive light (sometimes referred to as light pollution) can present serious physiological and ecological problems and has been an increasing concern for the general public. Light pollution incorporates Light Trespass, Sky Glow and Glare. Addition of light shield is recommended to reduce light trespass or glare to adjacent area. The criterion used for roadway lighting to address disability glare is limiting the veiling luminance ratio of a lighting system.

All lighting systems shall be designed to minimized light pollution as outlined in the following publications:

- IES RP-8, Annex C: Glare contains a more detailed definition of glare and provides useful information and methodology for glare assessment and glare reduction
- IES TM-10: Addressing Obtrusive Light (Urban Sky Glow and Light Trespass) in Conjunction with Roadway Lighting
- IES TM-11: Light Trespass: Research, Results, and Recommendations
- Design consideration shall be undertaken in accordance with Chapter 2 Supplement – Vision and Fundamental Concepts and Chapter 3 Supplement – Obstructive Light of the current edition of the Transportation Association of Canada (TAC) Guide for the design of Roadway Lighting.

6. Design Drawings Submission Requirements

In order for City of Hamilton to review the proposed design, the submitted designs shall adhere to/provide the following criteria:

a) Meet or contact the City Street Lighting staff prior to beginning design.

b) Provide street lighting plans in both printed and electronic formats. The electronic format shall be AutoCad (DWG) or Microstation (DGN).

c) Each final version of the printed sheet shall have an up-to-date title block and must be signed and stamped by a registered professional engineer.

d) The Lighting designer shall provide calculations (AGI32 files) electronically when requested.

e) Lighting design drawings shall show all civil drawing information such as curbs, sidewalks, property lines, utilities, landscaping, entrance features and all physical features that may impact the lighting design, as well as the lighting infrastructure.

f) Lighting drawings shall fully describe the proposed installation and all related existing lighting for project with all existing electrical.

g) The detailed information required on the drawings shall include the following: Plan at a scale of 1:500 showing pole locations and any future pole locations.

h) Drawings shall include sufficient street name and lot or block location information to identify particular sections of road referenced in the lighting design summaries.

i) Details of proposed luminaires, poles, luminaire arms, pedestal including detail elevation view of assembly should be included in the set of design drawings.

j) Drawings shall include legend describing luminaire and any electrical furniture along with their quantities, Load calculation summary, and any construction related note; luminaire wattage's should be shown on the drawings.

k) The drawings should include roadway calculation summary table for all roadways types, different intersections, roundabout and other region specific to the drawings. The table should compare the recommended listed values in ANSI/IES RP-8-14 to actual designed values in a comprehensive manner.

Hamilton CITY OF HAMILTON
LUMINANCE COMPARISON CHART

LUMINANACE TABLE - 20.0m ROW					
STREET CLASSIFICATION	LOCAL				
PEDESTRIAN CLASSIFICATION	LOW				
STREET NAME		JOHN ST EAST			
	REQUIREMENT PER IES RP-8-14/CITY	DESIGN RESULTS EASTBOUND	DESIGN RESULTS WESTBOUND	DESIGN RESULT	MEETING CRITERIA (YES/NO)
AVERAGE LUMINANCE (CD/m²) (MIN)	≥0.3	0.58	0.57		YES
Average-to-Minimum Uniformity Ratio	≤6	2.9	2.85		YES
Maximum-to-Minimum Uniformity Ratio	≤10	6.5	7		YES
Maximum-to-Average Veiling Luminance Ratio	≤0.4	0.38	0.37		YES
SIDEWALK ILLUMINANCE - NORTH (lux)	≥3.0			3.7	YES
SIDEWALK ILLUMINANCE - SOUTH (lux)	≥3.0			3.2	YES

Table 5.1 – Luminance Comparison Chart

l) The drawings should include details of the calculation summary, luminaire mounting height and luminaire schedule, light loss factor, as provided by the lighting design software (For example AGI32).

m) The street light design drawings should also show the Luminance grid, Veiling Luminance grid, Illuminance grid. The criteria for selecting an Illuminance, Veiling or Luminance grid should comply with ANSI/IES RP 8-14 standard.

n) The placement of the grid should be in parallel to the direction of travel and the grid values should be perpendicular to the geometry of the road.

o) The calculation grid for the roadway including the location of calculation points, luminaires and observer for illuminance, luminance and veiling luminance should comply with ANSI/IES RP8-14.

p) Nomenclature for luminaires should be in compliance with RP-16-05 and addenda, "Nomenclature and Definitions for Illuminating Engineering" (The Consortium may eventually add its own Glossary / Definitions section.)

q) The wiring shall be sized to provide a maximum voltage drop of 2% from the utility service point to the panel and a maximum voltage drop of 3% from the panel to the light farthest from the panel on each circuit. Provide a copy of the voltage drop calculation with the lighting plans sheets.

r) The construction drawing should have the following characteristics:

1. Cover Sheet
2. Electrical Design Drawings.
3. Photometric Design Drawings.
4. Streetlight standard and detail drawings.

7. Material and Equipment

- Materials and equipment proposed shall conform with the latest approved design materials and products in conjunction with the material specification approved product list that can accessed from City of Hamilton website: https://d3fpllf1m7bbt3.cloudfront.net/sites/default/files/media/browser/2014-12-19/construction-material-specifications-approved-product-list-may-24-2016.pdf

- All street lighting systems in the City of Hamilton shall be 120-240 volt. All components of street lighting systems for roadways in the City shall be CSA approved and meet the requirements of the Ontario Electrical Safety Code.

- The use of Light Emitting Diodes (LED) is standard street lighting practice. Although some documents may still specify the use of High Pressure Sodium (HPS) lamps, HPS is NO longer standard for street lighting projects.

- For internal residential street lighting, the design engineer shall contact the City of Hamilton to obtain an approval for the proposed decorative fixture. The list for type of decorative luminaire used in the City of Hamilton can be located on City's website: https://d3fpllf1m7bbt3.cloudfront.net/sites/default/files/media/browser/2014-12-19/construction-material-specifications-approved-product-list-may-24-2016.pdf

8. Associated and Supplemental Documents

The following is a list of resource material used in the development of this guideline document.

- Transportation Association of Canada – Guide for the Design of Roadway Lighting;
- Transportation Association of Canada – Illumination of Isolated Rural Intersections;
- ANSI/IES RP-8-00 – American National Standard Practice for Roadway Lighting;
- IESNA DG-19-08 – Design Guide for Roundabout Lighting;
- City of Hamilton – Public Works Comprehensive Outdoor Lighting Study

9. Appendices

APPENDIX "A": List of Approved LED Cobra-Head Luminaire

APPENDIX "B": List of Approved LED Decorative (Coach) Luminaire

APPENDIX "A"

List of Approved LED Cobra-Head Luminaire

- For lighting Roadways, City of Hamilton is single sourcing General Electric (GE) Evolve LED Roadway luminaire as standard equipment for Cobra-head style street lights. The wattage selection ranges from D1A-D6A and from E1-E6 as noted in table below:

Project Type Designation:	Manufacturer/Product Name:	Catalogue Number:	Drive Current:	System Wattage:	Design LLF:
D1A	General Electric Evolve - ERLH	ERLH-0-10-E1-40-A-GRAY-LR	590ma	90 W	0.82
D2A	General Electric Evolve - ERLH	ERLH-0-11-E1-40-A-GRAY-LR	700ma	108 W	0.82
D3A	General Electric Evolve - ERLH	ERLH-0-13-E1-40-A-GRAY-LR	825mA	125 W	0.82
D4A	General Electric Evolve - ERS2	ERS2-0-16-E1-40-A-GRAY-LR	450mA	132 W	0.82
D5A	General Electric Evolve - ERS2	ERS2-0-19-E1-40-A-GRAY-LR	555mA	162 W	0.82
D6A	General Electric Evolve - ERLH	ERLH-0-13-D1-40-A-GRAY-LR	825mA	125 W	0.70

Project Type Designation:	Manufacturer/Product Name:	Catalogue Number:	Drive Current:	System Wattage:	Design LLF:
E1	General Electric Evolve - ERL1	ERL1-04-A1-30-A-GRAY-LR	275mA	32 W	0.833
E2	General Electric Evolve - ERL1	ERL1-04-E1-30-A-GRAY-LR	275mA	32 W	0.833
E3	General Electric Evolve - ERL1	ERL1-05-A1-30-A-GRAY-LR	350mA	41 W	0.833
E4	General Electric Evolve - ERL1	ERL1-05-E1-30-A-GRAY-LR	350mA	41 W	0.833
E5	General Electric Evolve - ERL1	ERL1-06-D1-30-A-GRAY-LR	435mA	53 W	0.79
E6	General Electric Evolve - ERL1	ERL1-06-E1-30-A-GRAY-LR	425mA	53 W	0.79

APPENDIX "B"

List of Approved LED decorative Luminaire:

- The design engineer should refer to the following link for the list of approved decorative luminaires:
  https://d3fpllf1m7bbt3.cloudfront.net/sites/default/files/media/browser/2014-12-19/construction-material-specifications-approved-product-list-may-24-2016.pdf

10. Revision History

Revision History – Sidewalk and Roadway Lighting Guideline				
No.	**Revision**	**Developed By**	**Approved By**	**Date**
1	Rev.00	Dipankar Sharma	Mike Field	March, 2017