COMMITTEE OF THE WHOLE – NOVEMBER 29, 2004

PRINCETON GATE PARK – BARRIER FENCING FOR STORMWATER POND

Recommendation

The Commissioner of Engineering and Public Works recommends:

1. That this report BE RECEIVED for information purposes and that the proposed criteria be accepted as Corporate Policy regarding acceptable standards for Stormwater Management (SWM) Ponds.

Purpose

The purpose of this report is to provide Council with a Corporate Policy regarding acceptable standards for Storm Water Management (SWM) Facilities.

Background - Analysis and Options

Council, at its meeting of October 15, 2001, recommended:

"That staff be directed to develop a Corporate Policy regarding acceptable standards for stormwater ponds."

Accordingly, the Engineering Department released the March 2004 Edition of the Design Criteria & Standard Drawings document on June 30, 2004 (a copy of the section entitled Stormwater Management System is attached for reference) which replaced the May 1993 Design Criteria and the December 2000 Standard Drawings. The document is intended to be the guideline for use in the approval processing, design and construction of all municipal servicing including SWM Facilities. With respect to the stormwater management pond fencing requirements, a 1.5 metre black vinyl chain link perimeter fence is required along the property lines of residential, commercial, industrial or institutional lands where they abut a SWM block. Where walkways, commercial and institutional blocks abut a SWM block, the City may require a 1.8 metre high privacy wood fence in lieu of the chain link fence. While it is the City's objective to integrate SWM facilities as positive and safe amenities within the communities and open space systems, the current practice is not to locate them adjacent to elementary schools or neighbourhood parks.

In addition, the City retained the joint engineering consulting team of Earth Tech Canada Inc. and Clarifica Inc. to complete a detailed inventory of all stormwater management facilities currently assumed by the City. It is the intent of this study to ultimately recommend appropriate assessment and maintenance procedures and protocols that may be implemented by the City. This study is timely, given the existing number of stormwater management ponds currently being assumed by the City and the large number of ponds currently proposed within all recently approved Block Plans. Upon completion of the study, it is the City's intention to implement the recommendations contained therein, with respect to assessment and maintenance procedures.

Relationship to Vaughan Vision 2007

The recommendation is consistent with Vaughan Vision 2007 item 1.1.6 Review the level of enforcement, compliance and monitoring of regulations related to public safety.

This report is consistent with the priorities previously set by Council and the necessary resources have been allocated and approved.

Conclusion

Based on the above, the attached Engineering Department's Design Criteria for Stormwater Management System, currently included in the City's Design Criteria and Standard Drawings document may be adopted as the Corporate Policy regarding acceptable standards for Storm Water Management (SWM) Facilities.

Attachment

1. Engineering Department's Design Criteria for Stormwater Management System

Report prepared by

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Respectfully submitted,

Bill Robinson, P. Eng.
Commissioner of Engineering and Public Works

Michael Won, P. Eng.
Director of Development/
Transportation Engineering

4.0 STORMWATER MANAGEMENT SYSTEM

Urban development has the potential to impact the quantity and quality of stormwater runoff. Accordingly, the stormwater management system is to be designed to limit flooding and minimize hazards under the major storm events. The stormwater management system should also provide a reasonable level of convenience and safety for pedestrians and traffic use by removal of lot and street surface runoff under the minor 5 year storm events. This typically leads to the installation of a storm sewer system designed to minimize the impact of development on water quality and aquatic life.

4.1 STORMWATER MANAGEMENT PLAN

The stormwater management plan shall include the drainage report along with other related information. It provides an integrated means of dealing with the many impacts of urban development on water quality and quantity, erosion, sedimentation and the hydrologic cycle (preservation of groundwater resources). The preparation of a stormwater management plan shall be based on an approved Master Drainage plan, TRCA initiatives or the criteria established by the City and the TRCA. The plan shall outline all tributary areas, the minor and major system design and the stormwater management facility design including an operation and maintenance manual and the impacts of riparian rights. In addition, the plan shall identify and assess the potential environmental impact the proposed development will have on the receiving watershed. The proposed methods for controlling and minimizing erosion and siltation on site and in the downstream areas during and after construction shall also be included in the plan. The Plan shall conform to the "Provincial Urban Drainage Design Guidelines" and the "Provincial Guidelines on Erosion and Sediment Control for Urban Construction Sites".

All drainage reports and designs shall bear the seal, date and signature of the Licensed Professional Engineer under whose direction they were prepared.

4.2 DESIGN LEVELS

The system is to be designed to provide convenience drainage for a variety of storm frequencies through the minor and major system and provide flood protection from the 100 year or regional storms.

4.2.1 Minor System

Storm sewers shall be designed to convey at least a 5 year return frequency storm and shall not surcharge during any storm return frequency event.

4.2.2 Major System

Runoff flows in excess of the design capacity of the minor system shall be conveyed via streets, open channels, storm sewers and walkways to a safe outlet. The combination of the overland flow system and the minor system shall be designed for a 100 year return frequency storm or regional storm, whichever is greater, to prevent flooding of private property with maximum level of road flooding and surface detention as defined below.

4.2.3 Open Channels

Open channels shall be designed:

- for the regional storm or 100 year storm event, whichever is greater, in accordance with City and TRCA policy.
- to prevent erosion damage for all frequency storms.
- to maintain the characteristics and aesthetics of the natural watercourse to the satisfaction of the City, TRCA and MNR.

4.2.4 Stormwater Management Facilities

Stormwater management facilities shall be designed to provide an effective and efficient method of pollutant removal, flow control, augment the effectiveness of source and conveyance controls for both the major and minor systems, reduce increased runoff and provide quality control. Stormwater quality controls shall be implemented to mitigate the impact of increased sediment and pollutant loadings, temperature changes, base flow reductions, habitat changes and ground water effects on the receiving watercourse.

End-of-pipe quality control facilities should only be considered for developments greater than five hectares where source controls are impractical. For developments less than five hectares, a financial contribution in lieu of implementing quality treatment will be required. Funds collected in lieu of quality treatment will be used to finance the retrofitting of existing stormwater management facilities within the watershed.

Stormwater management facilities should generally be located adjacent to valley features and integrated into the natural environment. Tableland facilities shall be integrated with the overall community urban streetscape character.

Where a stormwater management facility is required, it shall be located on lands conveyed to the City by the landowner free of charge and encumbrances. Lands designated for a stormwater management facility shall not be considered part of the

parkland dedication.

Stormwater management ponds shall be designed to encourage safe public access and shall be integrated into the natural or trail system. This can be achieved by consolidating the ponds into larger facilities, thereby creating a larger attraction for the community while also minimizing on-going maintenance costs. The street pattern should also contain significant frontage on the pond.

The following guidelines for the design of stormwater management facilities in the City shall be considered supplementary to the latest version of the MOE Stormwater Management Practices Planning and Design Manual.

4.3 STORMWATER MANAGEMENT FACILITY DESIGN PARAMETERS

4.3.1 Temporary Stormwater Management Facilities

In situations where the ultimate downstream infrastructure or a stormwater management facility is not available, the City will consider the use of a temporary facility. All temporary facilities shall be designed to meet the same guidelines that are applied to permanent facilities. Temporary facilities will not be assumed as municipal services by the City. The Developer shall be responsible for the operation and maintenance until the ultimate facility is constructed.

4.3.2 Emergency Overflow Spillway

Each facility shall be designed with an emergency overflow spillway to allow storm drainage to safely exit the facility in the event that the outlet fails to function or the storm event is greater than the design return period. The spillway shall be designed to convey the highest design flow of the facility, while maintaining a minimum 0.3 metre freeboard around the perimeter of the facility.

4.3.3 Facility Storage Requirements

Storage volume requirements for permanent pool, quality control and extended detention shall be based on criteria established in the MOE Stormwater Management Planning and Design Manual, or site specific requirements as established in an approved Master Environmental Servicing Plan or Master Drainage Plan, or as otherwise established by the TRCA or City.

4.3.4 Outfalls

Outfall structures to proposed stormwater management facilities or existing channels or watercourses shall be designed to prevent erosion or damage in the vicinity of the outfall from maximum design flows. All outfall structures shall be accessible by maintenance equipment. The structures must be designed to stop unauthorized entrance and have appropriate handrails. In so far as possible, outfall structures shall be designed and constructed to blend in with the surroundings so as not to dominate the landscape.

4.3.5 Maintenance Access Roadway

Maintenance access roads are required to all inlet/outlet and emergency overflow spillway structures of the stormwater management facilities. The maintenance access road shall be of a granular dust free surface to provide for all-weather ingress and egress with a minimum width of 4.0 metres and a maximum grade of 12 percent. Access roads as wide as 6.0 metres may be required to provide for large trucks, as determined by the City's Public Works department at the detailed review stage. Curves on an access road shall have a maximum centerline radius of 12.0 metres.

Where these access roads are in high profile locations or within the mow strip zone, a specialized surface treatment is to be used that results in a turf appearance.

A minimum of two removable bollards shall be designed and placed at all locations where the maintenance access road outlets to a municipal right of way to the satisfaction of the City's Public Works Department.

4.3.6 Trails and Walkways

Trails shall be 3.0 metres wide and constructed of a granular dust free stonedust surface or other suitable material. Trails shall be constructed above the maximum extended detention elevation or 5 year return frequency ponding elevation, whichever is greater. A 3.0 metre safety zone shall be provided on either side of the trail. A safety zone shall be interpreted as a space where sightlines are preserved and does not have entrapment zones. The maintenance access road may also be incorporated into the trail system.

4.3.7 Configuration and Grading

Stormwater management facilities shall be design to have curvilinear and natural configuration with varying side slopes between 3:1 and 7:1 with an average slope of 5:1. Natural materials such as ledgerock and armour stone may be used to create naturalized facilities.

Table 4.0 Stormwater Management Facility Design

Design Element	Wet facility	Wetland facility
Permanent Pool	1.0 to 2.0 metres	0.15 to 0.3 metres
Maximum Extended Detention Storage above the permanent pool water level	1.0 metre	1.0 metre
Maximum Quantity Control Storage above the permanent pool water level	2.0 metres	2.0 metres
Maximum Depth of Water	4.0 metres	3.0 metres
Minimum Freeboard above maximum water level	0.3 metres	0.3 metres
Side Slopes	5:1 slope from the bottom of the facility for a minimum distance of 3.0 metres past the extended detention upper water limit; 5:1 average slope elsewhere.	5:1 slope from the bottom of the facility for a minimum distance of 3.0 metres past the extended detention upper water limit; 5:1 average slope elsewhere.

4.3.8 Side Slopes

The grading and landscaping near the pond edges is to be designed to ensure public safety and to maximize the functionality of the pond. Terraced grading shall be implemented along the pond edges, specifically adjacent to the permanent pool, to minimize the potential for the public to fall into the pond. The land where the permanent pool meets the surrounding landscaped area shall be graded at a minimum slope of 5:1 for a minimum distance of 3.0 metres on either side of the permanent pool elevation. The remaining area of the facility shall have varying pond slopes between 3:1 and 7:1 with an average slope of 5:1. Natural materials such as ledgerock and armour stone may be used to create naturalized facilities.

4.3.9 Facility – Length to Width Ratio

The configuration of wet facilities shall be curvilinear to reflect a natural form and have a minimum length to width ratio of 3:1. The configuration of the facility forebay shall also provide a minimum length to width ratio of 2:1. The base of the sediment forebay shall be treated with a hard surface to facilitate future maintenance and the removal of sediments.

4.3.10 Berming

Berming within facilities shall be designed with a minimum top width of 2.0 metres with 3:1 maximum side slopes.

4.3.11 Transition between SWM Facilities and Urban Land Uses

A minimum setback of either 15 metres from the 5 year stormwater elevation in the facility or 3 metres from the 100 year stormwater elevation, whichever is the greater, shall be provided to residential lots and blocks that abut the facility.

4.3.12 Mow Strip

A three metre wide sodded mow strip with a maximum crossfall grade not exceeding 5% is required along the perimeter of the stormwater management facility blocks where they abut residential, commercial or industrial development.

4.3.13 Fencing

A 1.5 metre black vinyl chain link perimeter fencing is required along the property lines of residential, commercial, industrial or institutional lands where they abut a stormwater management facility block. Where walkways, commercial and institutional blocks abut stormwater management facilities, the City may require that a 1.8 metre high privacy wood fence be installed in lieu of the 1.5 m chain link fence. The stormwater management block shall be physically separated from school blocks through the use of fencing.

A no-gate policy for fences along adjacent property lines (regardless of land use) shall be strictly enforced.

4.3.14 Signage

An Information/Warning sign shall be installed near pedestrian traffic routes or walkways located near the perimeter of a stormwater management facilities. The number and placement of the warning signs shall be determined in consultation with the City and shown on the Construction Drawings. Signs shall be in accordance with City Standard Drawing K-6.

Stormwater management facilities which include trails must include signage that identifies the designated routes, key features and promotes community image to the City's satisfaction.

4.3.15 Facility Buffers & Planting

Where a stormwater management facility abuts a road, it is necessary for the first 6 to 8 metres of the pond block to have a more urbanized/manicured landscape treatment to better blend into the community streetscape character and have a maximum 7:1 slope. This urbanized landscape should include plant material above the minimum acceptable standard. There should be a distinction between zones requiring regular maintenance and low maintenance zones. This distinction shall be delineated with a bold line on the appropriate stormwater management facility drawings.

Plant material shall be provided to reinforce the edge between the maintained and low maintenance zones. Plantings shall also be provided to buffer or screen views to significant engineering structures such as outfall weirs, headwall siltation forebays, service access roads, adjacent industrial lands and for safety purposes. The use of large clusters of coniferous trees immediately adjacent to street frontages are not recommended due to pedestrian safety concerns related to visibility from the street. Aquatic plants are to be planted throughout the pond while allowing for infill over a reasonable period of time.

The density of shrub planting, for safety purposes, shall vary depending on the degree of slope. Shrub planting shall prevent public access on all 3:1 slopes.

4.3.16 Topsoil

Topsoil within the entire stormwater management block, outside the permanent pool, is to be a minimum of 450mm in depth. Testing of the topsoil will be required to the satisfaction of the City.

4.4 GENERAL DESIGN PARAMETERS

4.4.1 Approvals

The system shall be designed to meet the requirements of the City of Vaughan, the Regional Municipality of York, the Ministry of the Environment (MOE), Ministry of Natural Resources (MNR), The Toronto and Region Conservation Authority (TRCA), the Ministry of Transportation (MTO), downstream municipalities and other governing authorities having jurisdiction.

4.4.2 Tributary Area Inflows

Allowances shall be made for inflows from geographically tributary adjacent subdivisions or lands in their current and ultimate conditions in accordance with the Official Plan.

4.4.3 Outlet Locations

The exact outlet location for sewers or channels shall be approved by the City.

4.4.4 Design Period

The minor system, containing catchbasins and underground storm sewers, shall be designed to convey the 5 year storm. The major system, encompassing overland flow routes, detention facilities and open channels, shall be designed to convey the 100 year or regional storm, whichever is greater.

4.4.5 Drainage Report

Potential increases in runoff rates resulting from new development shall be controlled in accordance with the approved Master Drainage Plans, TRCA initiatives or other approved criteria, before being discharged to approved outlets.

The drainage report shall demonstrate:

- the manner in which stormwater will be conveyed from the site;
- how the subdivision relates to the surrounding area;
- how it conforms with the approved Master Drainage Plan, TRCA initiatives or other approved criteria;
- how external flows will be accommodated;
- the design capacity of the receiving system(s);

- the appropriate Stormwater Management Practices (SWMPs) to be used to treat stormwater to ensure there will be no negative impacts on the quality and quantity of ground and surface water resources;
- the proposed methods of controlling or minimizing erosion and siltation on-site and downstream areas during and after construction; and
- the stormwater management techniques which may be required to control minor and major flows.

The drainage report shall also include overall grading plans for the subject lands.

In the absence of a Master Drainage Plan, TRCA initiative or other approved criteria, the post-development flows from a 5 year return frequency storm shall not exceed the flows for pre-development conditions. The City may permit a variance from this requirement if it is demonstrated to the satisfaction of the City that uncontrolled flows will not have an adverse effect on the existing system. Similarly for the major system, post-development runoff from a 100 year or regional storm, whichever is greater, shall not exceed the pre-development runoff for the same storm.

4.4.6 Hydraulic Losses

A sufficient drop shall be provided across each maintenance hole to offset any hydraulic losses, the obverts of inlet pipes shall not be lower than obverts of outlet pipes, and drop structures shall be used only when drops of more than 0.6 metres are necessary. Calculations for hydraulic losses shall be included with storm design information.

4.4.7 Roof Leaders

Leaders are to be discharged to the ground surface onto splash pads and flows to be directed away from the building and towards the road where possible and in such a way as to prevent ponding or seepage into the weeping tile.

4.4.8 Foundation Drainage

Foundation drains shall be connected to the storm sewer system only when it can be demonstrated that an acceptable level of protection against basement damage will be provided under major storm conditions. If required, separate foundation drain collectors shall be designed on the basis of a continuous flow rate of 0.075 litres per second per residential lot plus infiltration. The minimum foundation drain collector diameter shall be 200 mm. Material and bedding standards applicable to storm or sanitary sewers shall also be applicable to foundation drain collectors.

4.4.9 Infiltration

Where soils reports have identified that techniques such as lot level controls, infiltration trenches and perforated pipe systems are practical, the implementation of such techniques shall be encouraged.

4.4.10 Roads

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

Location	Constraints
Open Spaces	as required for overland flow outlets
Local Roads	maximum depth of ponding is 0.20 m above the crown of road
Collector and Industrial Road	maximum depth of ponding is 0.10 m above the crown of road
Arterial Roads	maximum depth of ponding is to the Crown of the road

4.4.11 Minimum Flood Protection

Location	100 Year Storm Return Frequency
Private Property, Schools and Parkland	- no structural damage - no basement flooding - positive overland flow to outlets
Public Property	- no structural damage - no erosion

4.4.12 Peak Flow Calculation

Pre-development peak flows shall be computed by the Rational Method or by a unit hydrograph method as described in the MOE Guidelines and MTO Drainage Manual.

Post-development design flows may be determined using the Rational Method only where the design area is less than 40 hectares and runoff control facilities are not considered. Computer models, as outlined in the Provincial Urban Drainage Design Guidelines are acceptable in calculating major and minor systems flows. The engineer is responsible for selecting the most appropriate model to suit the drainage study area.

When the Rational Method is used, the relevant figures are to be entered on the City of Vaughan Standard Storm Sewer Design Sheets and Overland Design Sheets. When computer modeling is used, the report shall indicate model parameters, assumptions used, outflow hydrographs and hydraulic grade line levels where applicable.

Where peak flows from external areas enter a subdivision sewer system, the more critical case based on either the time of concentration including the external area or the time of concentration excluding the external area shall be used. Actual velocities of computed peak flows shall be used to estimate time of concentration

A design evaluation of inlet times must be submitted for prior approval if the design includes inlet times different from those specified above, especially in the cases where the sewer is designed for certain surcharge levels for larger storms and where the sizing is optimized for both situations.

Where the Rational Method is used, the peak rate of runoff, Q, is calculated according to the equation Q = RAIN

Where
- Q = flow in litres per second
- R = runoff coefficient, dimensionless
- A = area in hectares
- I = average intensity in millimeters per hour
- N = conversion factor

Note: where A is in hectares and I is in mm/hr then N = 2.778

4.4.13 Rainfall Intensity

Rainfall intensity-duration equations appear below and the rainfall intensity-duration curves and design storm hyetographs based on these curves are shown in Figures D-1 to D-6.

Table 4.1 Rainfall Intensity

Return Frequency	Intensity
2 years	$I = 647.7 \ (T+4.0)^{-0.784}$ mm/hr
5 years	$I = 929.6 \ (T+4.0)^{-0.798}$ mm/hr
10 years	$I = 1021 \ (T+3.0)^{-0.787}$ mm/hr
25 years	$I = 1100 \ (T+2.0)^{-0.775}$ mm/hr
50 years	$I = 1488 \ (T+3.0)^{-0.803}$ mm/hr
100 years	$I = 1770 \ (T+4.0)^{-0.820}$ mm/hr

Where T = time of concentration in minutes

Where the first leg of a residential storm sewer system is sized using the Rational Method, the initial inlet time shall be 7 minutes for the 5 year storm. The above shall apply where the upstream drainage area does not include large open space areas.

4.4.14 Runoff Coefficients

Runoff coefficients are given by component of surface treatment and proposed land use.

Table 4.2 Proposed Land Use Runoff Coefficients

Residential	Composite R
Single Family, semi-Detached Duplex, Triplex, Quad,	Designer to calculate actual runoff co-efficient (min. 0.45)
Small Lot Singie (9 m),	
Small Lot Semi (7.5 m),	
Street Townhousing (6, 7.5 m)	
Block Development	**Composite R**
Block Townhousing, Stack Townhousing, Apartments	Designer to calculate actual runoff co-efficient (min. 0.55)
Neighbourhood,Commercial, Commercial Centre, Institutional	0.75
Industrial	**Runoff Control Rate**
New Development	180 l/s/ha*
Infill site	site specific

*Note: Municipal storm sewers to be designed to convey the 5 year return frequency storm from the road allowance and 180 l/s/ha from the lots.

Table 4.3 Runoff Coefficients

Open Areas	R
Unimproved Open Space under 7% slope	0.25
Unimproved Open Space overall 7% slope	0.30
Neighbourhood Park, Cemetery	0.45
Community Park	0.75
Sodded area	0.25
Paved and Gravel areas	0.90
Roof area	0.90

For estimating flows using the Rational Method from storms larger than the 5 year return storm the runoff coefficients should be increased to account for the increase in runoff due to saturation of the soil, with the estimate becoming less accurate for larger storms. Coefficients for the larger storms can be derived as follows:

Table 4.4 Coefficients for storms larger than a 5 year return

C 10	= 0.8	C 5 + 0.2	e.g. runoff coefficient for landscape area
C 25	= 0.7	C 5 + 0.3	C100 = 0.5 (0.25) + 0.5
C 50	= 0.6	C 5 + 0.4	C100 = 0.625
C 100	= 0.5	C 5 + 0.5	

4.4.15 Sewer Capacities

Manning's Formulae shall be used to determine the capacity of the sewers:

$$V = \frac{R^{2/3} S^{1/2}}{n} \quad \text{and} \quad Q = \frac{1000\, A\, R^{2/3} S^{1/2}}{n}$$

Units: V (m/s), R(m), S(m/m), Q(l/s), A(m^2)

For concrete or polyvinyl Chloride (PVC) sewer pipe a roughness coefficient of 0.013 shall be used. For corrugated pipe a roughness coefficient of 0.024 shall be used.

For full flow, 0.013 roughness and diameter D(m), the Manning's Formulae becomes:

$$V_{full} = 30.527\ D^{2/3} S^{1/2} \quad \text{and}$$

$$Q_{full} = 23{,}976\ D^{8/3} S^{1/2}$$

5 Year Storm Design

	minimum velocity	maximum velocity
Storm Sewers	0.75 metre/sec. actual flow	5.0 metre/sec. full flow
Channels		1.5 metre/sec.

Energy dissipators at outlets will be designed to reduce velocities to 1.00 metre per second or less.

Refer to figure E-1for self cleansing velocities.

4.4.16 Layout Details

Trunk and Local Sewers

MINIMUM SIZE - The minimum diameter of storm sewers shall be 200 millimetres.

LOCATION - Storm sewers shall generally be located 1.5 metres west or south of the road center line in separate trench or in a common trench. The minimum horizontal clearance between the outside wall of the adjacent sewer pipes shall be 800 millimetres. On crescent roads or roads with numerous bends, the sewer position may generally follow the same relative side of the road allowance.

DEPTH - A minimum depth of 1.2 metres to the top of pipe from the finished road or ground surface elevation, or a sufficient depth for any foundation drains or other connections shall be provided.

CLEARANCES - Minimum clearances between services shall be provided in accordance with MOE guidelines.

ALIGNMENT - Storm sewers shall generally be straight aligned between maintenance holes, however, curvilinear or properly deflected sewer pipes within the manufactures specifications are allowed with the approval of the City.

4.4.17 Maintenance holes

LOCATION - Maintenance holes shall be placed at the top end or dead end of a sewer line or where changes in size, material, alignment, or grade occur.

SPACING - The maximum spacing between maintenance holes shall generally be according to the following:

Table 4.5 Storm sewer maintenance hole spacing

Sewer Diameter	Metres
200 to 900 millimetre dia.	110
975 millimetre dia. and greater	180

DROP MAINTENANCE HOLES - Drop maintenance holes shall be sized in accordance with OPSD 1003.020 and provided for all sewer junctions having an elevation difference in excess of 0.6 metres that cannot be eliminated by changing sewer grades.

MAINTENANCE HOLE COVERS - Where a maintenance hole is located in stormwater detention area or flood plain areas the maintenance hole frame & cover shall be of the sealed variety. Where a maintenance hole is located where the surcharged sewer design hydraulic grade line is higher than the rim elevation, maintenance hole covers shall be perforated type and shall be bolted down. In all other areas standard maintenance hole covers shall be used.

TYPE - Maintenance holes shall be cast in place or precast concrete in accordance with City Standard Drawings and all applicable OPSD details.

4.4.18 Catch basins

LOCATION - At all low points, upstream of pedestrian crossings and not within 1.0 m of curb depressions and residential driveways.

SPACING - Catchbasins should be provided at adequate intervals to ensure that the road drainage can be intercepted up to the capacity of the storm sewer. The spacing will vary with the road width, grade and crossfall and with the design storm frequency. The spacing will also be affected by the location of pedestrian crossing points, intersections, low points, driveway depressions, etc.

In general, for pavement width up to 9.8 m with two per cent crossfall, the maximum spacing should be as follows:

Table 4.6 Catchbasin Spacing

Road Gradient	Maximum Spacing
0.5% to 3%	107 m
3.1% to 4.5%	91 m
over 4.5%	76 m

Stormwater management systems using inlet control catchbasins may use less frequent spacings than those outlined above. In such cases, the designers must justify whatever spacing is used.

LEADS - Minimum 200 mm at 0.7% grade for single catchbasins and 300 mm at 0.7% grade for double catchbasins. Leads shall connect to maintenance holes were possible. Where catchbasins are designed for inlet controls, lead sizes down to 150 mm for singles or doubles can be used where such sizes will limit flows to the gravity capacity of the sewer system and surface flow does not exceed the maximum ponding depth on roads.

REAR YARD CATCHBASINS – Shall be sumpless. The rear yard catchbasin lead shall be a minimum 250 mm diameter, class "A-A" bedding as per applicable OPSD details, located so that the catchbasins is entirely on one lot and the outlet pipe is on the same lot. The catchbasins shall be located 1.0 m clear from property lines. The rear lot catchbasin shall only be placed on a residential lot provided that the stormwater runoff from that rear lot is tributary to the rear lot catchbasin.

4.4.19 Sewer Materials

CONCRETE PIPE SPECIFICATIONS- Complying with CSA Standard A257.1 (Concrete Sewer, Storm Drain and Culvert Pipe), CSA Standard A257.2 (Reinforced Concrete Culvert Storm Drain and Sewer Pipe), and CSA Standard A257.3 (Joints for Concrete Sewer and Culvert Pipe Using Flexible Water Tight Rubber Gaskets), ASTM C14, C76, C655.

POLYVINYL CHLORIDE (P.V.C.) - Can be used for either residential or industrial use conforming to CSA Standard B182.1,ASTM D3034 for pipe size 100 millimetre to 150 millimetre diameter, CSA Standard B182.2, ASTM D3034 for pipe size 200 millimetre to 375 millimetre diameter and CSA Standard B182.4, ASTM F-794 for pipe sizes greater than 450 millimetre diameter or current edition only as approved by the City.

4.4.20 Bedding Materials

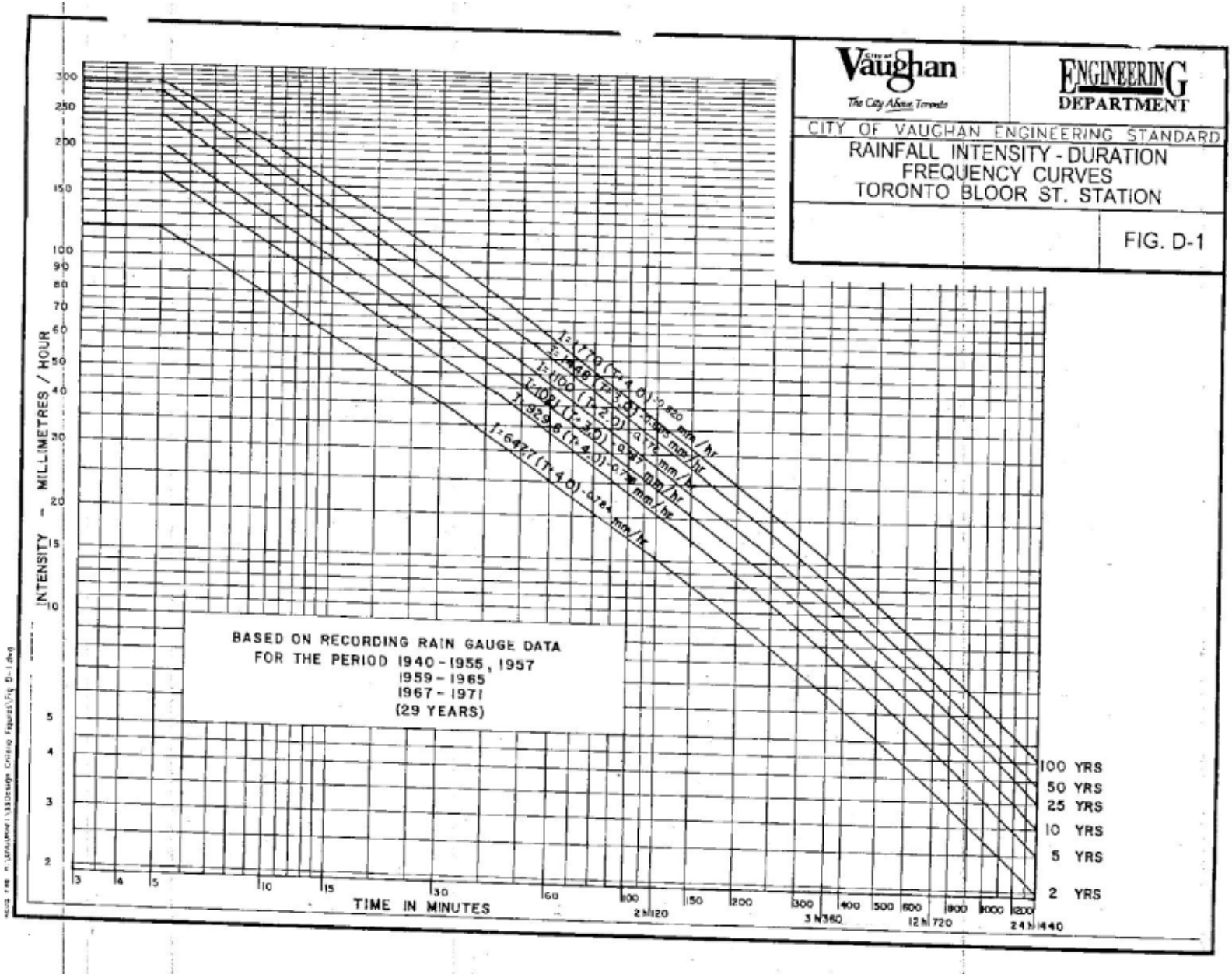
BEDDING AND BACKFILL – Bedding type selection shall be based on depth of sewer, sewer material, trench width and configuration and soil conditions. Pipe loading calculations shall accompany the design submission. Selected native backfill maybe used with the approval of the City.

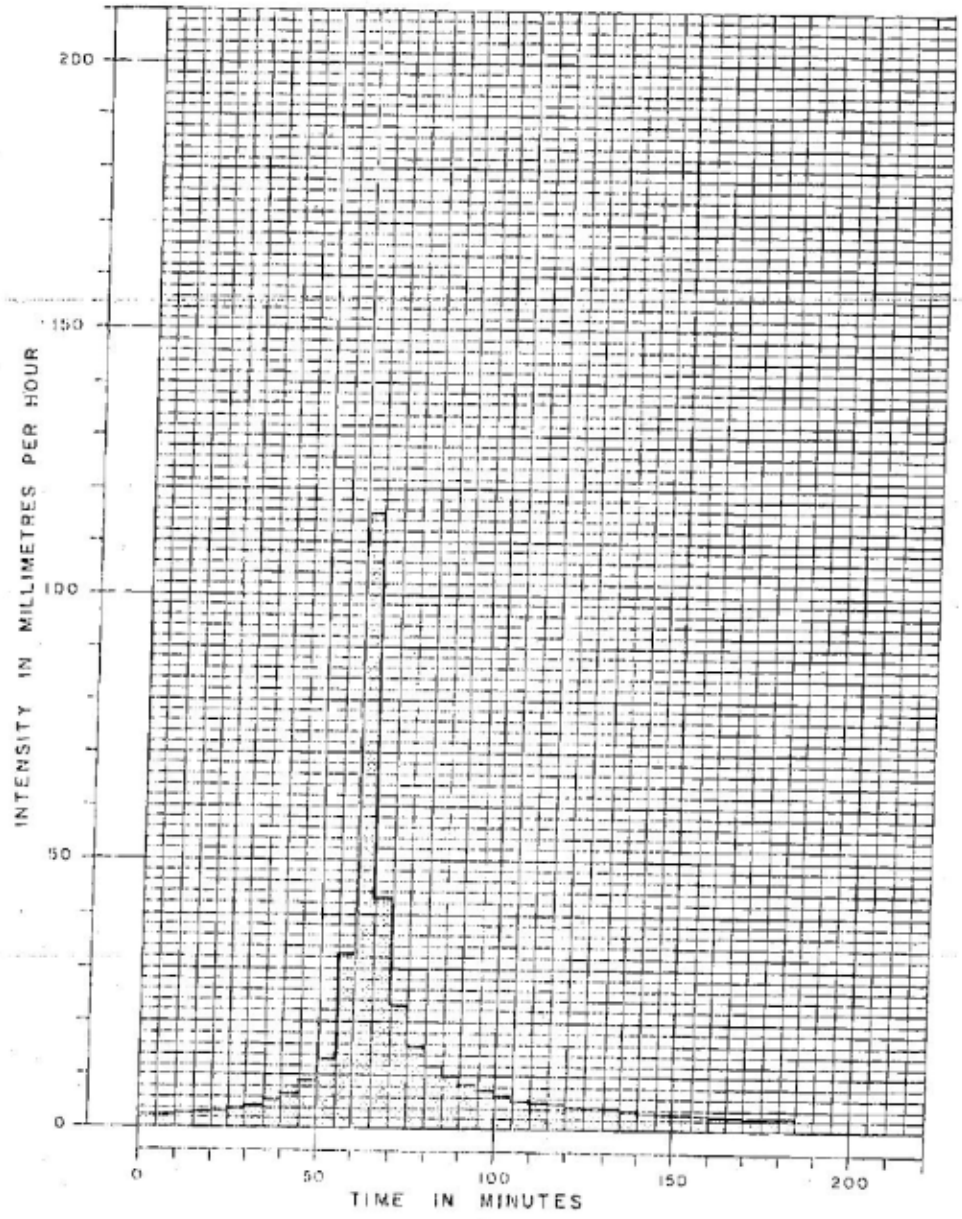
4.4.21 Service Connections

Service connections are to be in accordance with City Standard Drawings I-1, I-2, I-3, I-4 and all applicable OPSD details.

Adjacent lots with greater than 0.2 m basement elevation differences shall not be serviced by double lot storm sewer service connections.

Service connections shall be installed to the centre of the primary frontage of the park block or as otherwise specified by the Urban Design or Parks' Department, in accordance with City Standard Drawings and all applicable OPSD details.


Vaughan
The City Above Toronto
ENGINEERING DEPARTMENT
CITY OF VAUGHAN ENGINEERING STANDARD
RAINFALL INTENSITY - DURATION FREQUENCY CURVES TORONTO BLOOR ST. STATION
FIG. D-1
INTENSITY - MILLIMETRES / HOUR
TIME IN MINUTES
BASED ON RECORDING RAIN GAUGE DATA
FOR THE PERIOD 1940 - 1955, 1957
1959 - 1965
1967 - 1971
(29 YEARS)
100 YRS
50 YRS
25 YRS
10 YRS
5 YRS
2 YRS



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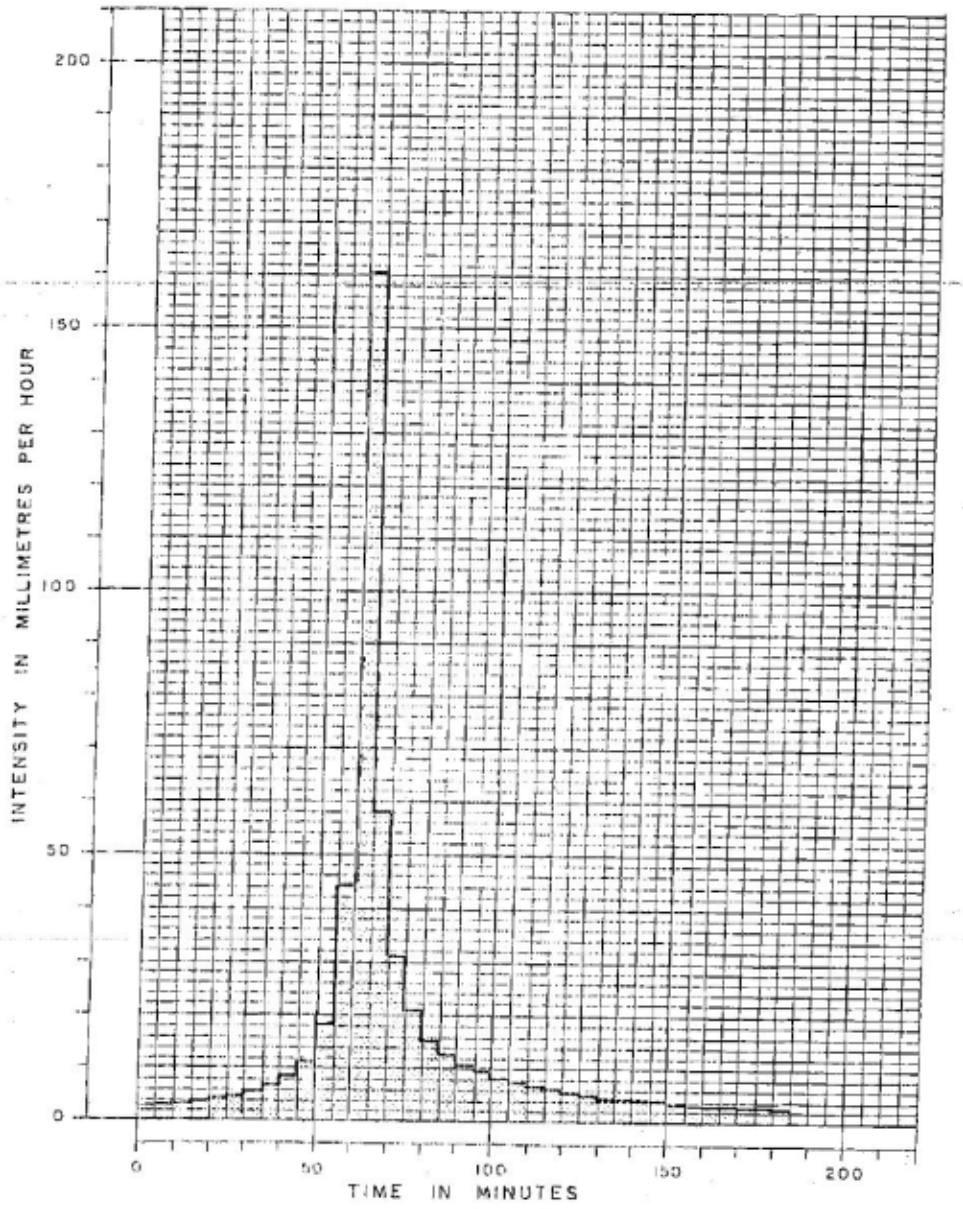
ENGINEERING DEPARTMENT

CITY OF VAUGHAN ENGINEERING STANDARD

HYETOGRAPH OF
2 - YR. DESIGN STORM
TORONTO BLOOR ST. STATION

FIG. D-2



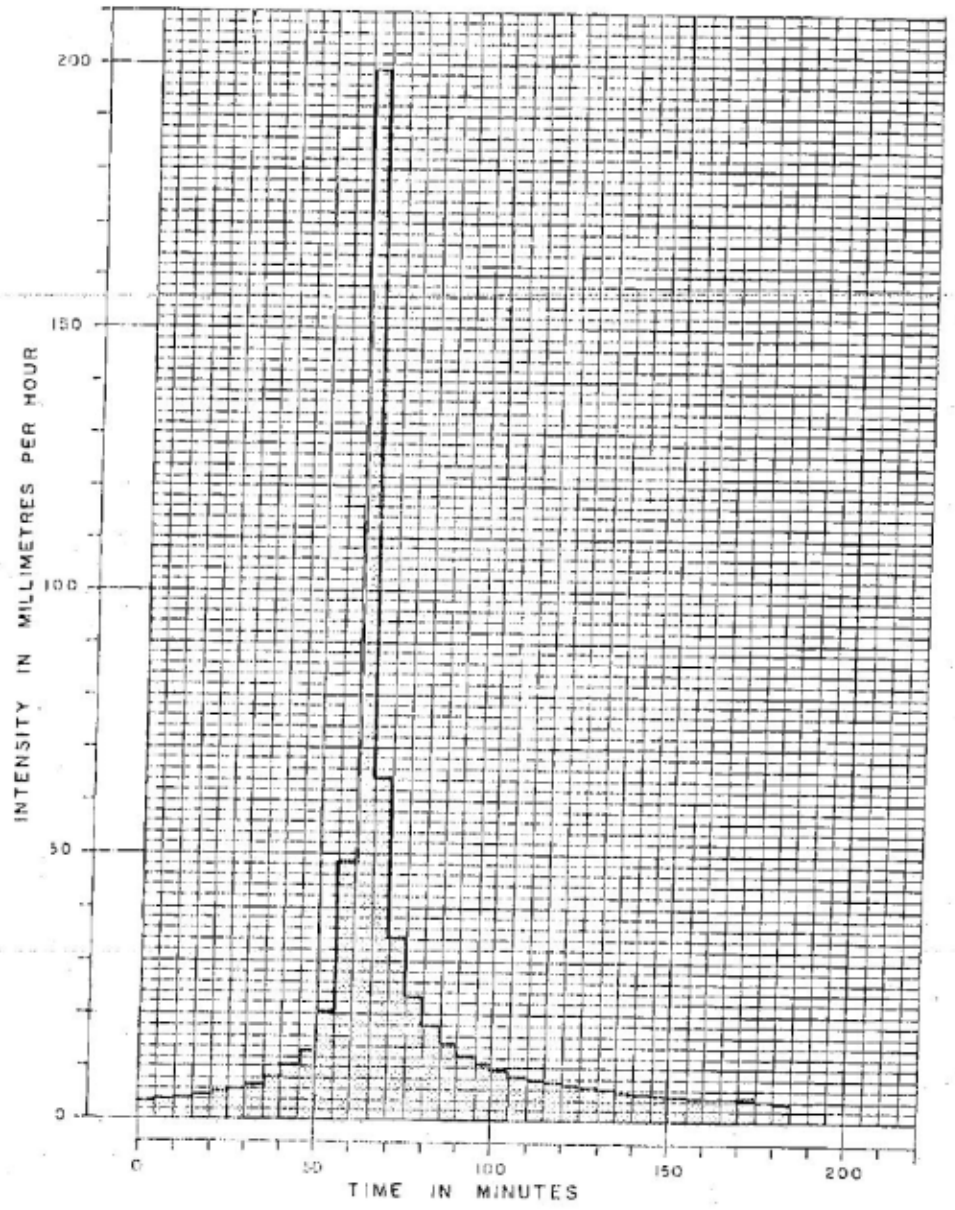
The City Above Toronto

ENGINEERING DEPARTMENT

CITY OF VAUGHAN ENGINEERING STANDARD

HYETOGRAPH OF
5 - YR. DESIGN STORM
TORONTO BLOOR ST. STATION

FIG. D-3



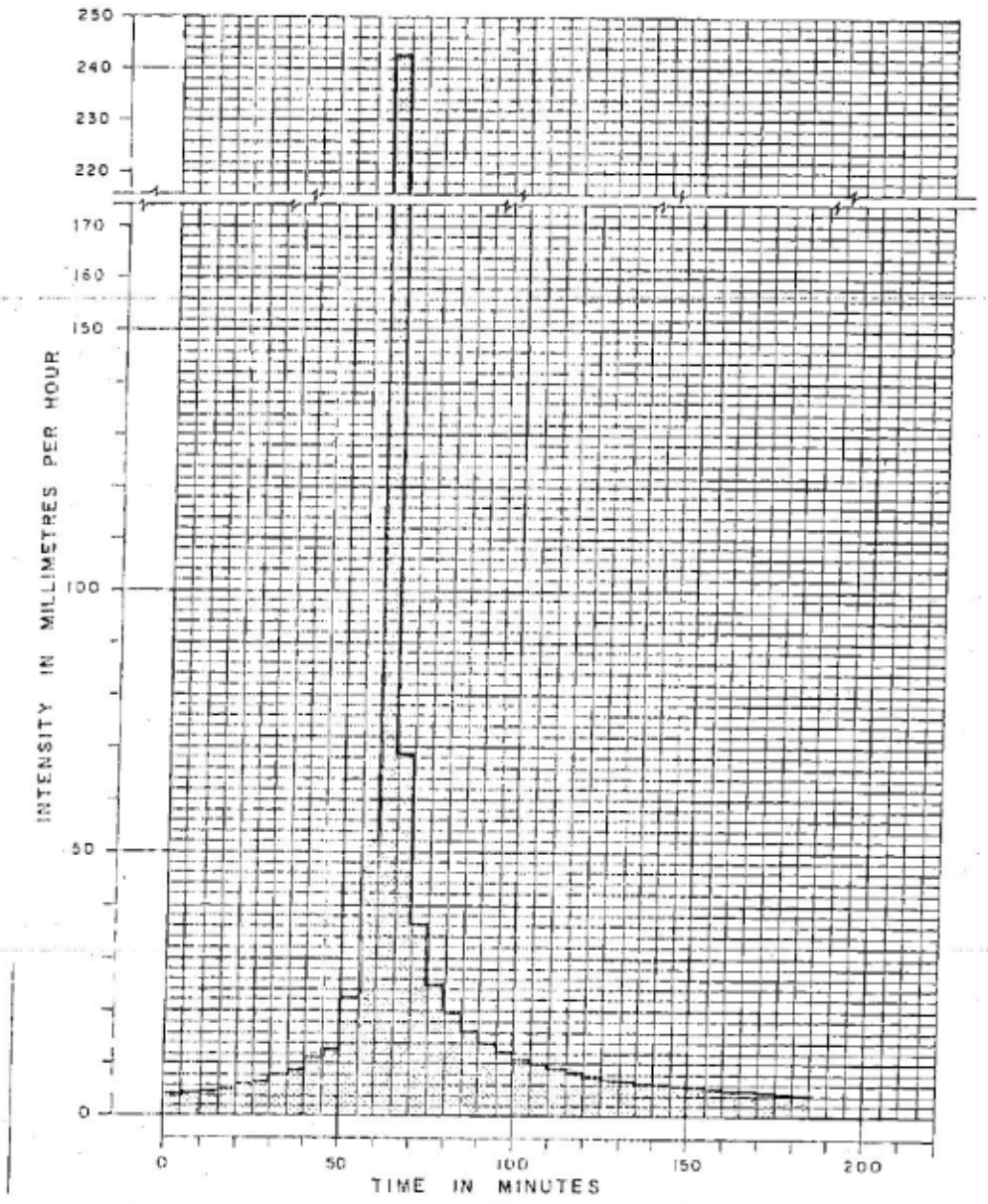
City of Vaughan
The City Above Toronto

ENGINEERING DEPARTMENT

CITY OF VAUGHAN ENGINEERING STANDARD

HYETOGRAPH OF
10 - YR. DESIGN STORM
TORONTO BLOOR ST. STATION

FIG. D-4



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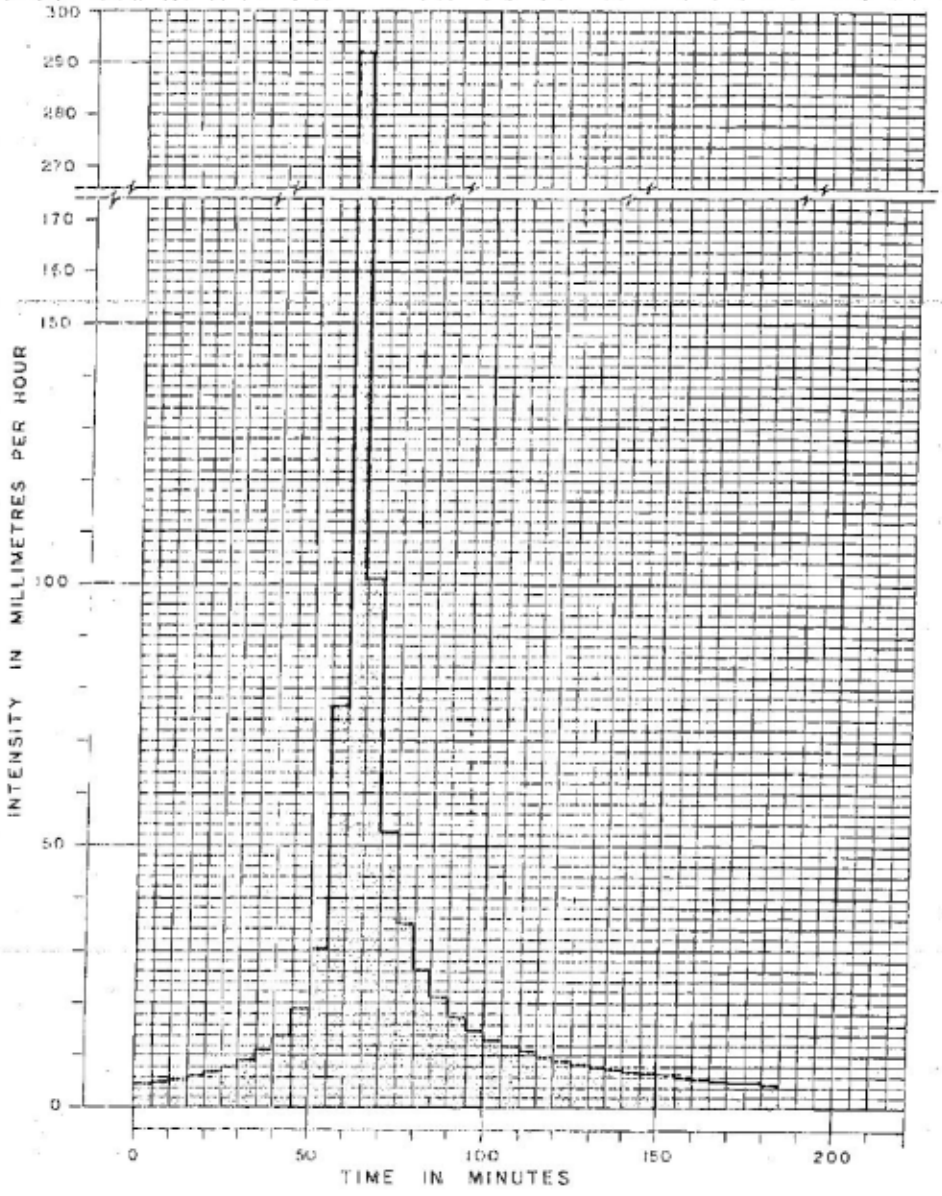
ENGINEERING DEPARTMENT

CITY OF VAUGHAN ENGINEERING STANDARD

HYETOGRAPH OF
25 - YR. DESIGN STORM
TORONTO BLOOR ST. STATION

FIG. D-5



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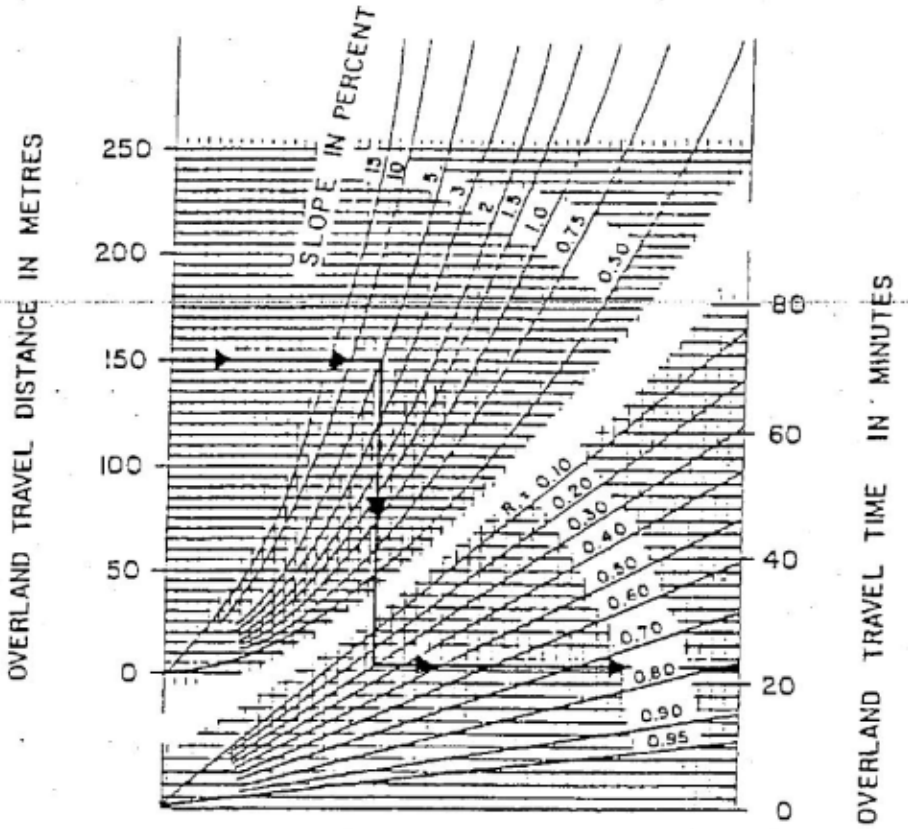
CITY OF VAUGHAN ENGINEERING STANDARD

HYETOGRAPH OF
100 - YR. DESIGN STORM
TORONTO BLOOR ST. STATION

FIG. D-6



RELATION OF OVERLAND TRAVEL TIME TO OVERLAND TRAVEL DISTANCE, AVERAGE OVERLAND SLOPE AND AVERAGE COEFFICIENT R FOR USE IN RATIONAL METHOD.

NOTE: THIS CHART IS INTENDED AS AN AID TO ESTIMATE INLET TIMES FOR SHEET FLOW OVER LARGE PAVEMENT, PARK OR OPEN SPACE AREAS. THIS CHART SHOULD NOT BE USED FOR GUTTER FLOW OR SWALE FLOW

The City of Vaughan — The City Above Toronto	ENGINEERING DEPARTMENT
CITY OF VAUGHAN ENGINEERING STANDARD	
OVERLAND FLOW TIMES	
	FIG. D-7