D1 INTRODUCTION

Sanitary drainage systems shall be designed on the basis of gravity flow under open channel conditions. Any variation from the Design Criteria, the use of pumping stations or siphons, and forcemains may only be considered on a case specific basis where other alternatives are not possible with the permission and approval from the Director of Engineering.

The Consulting Engineer shall design sanitary sewers using the greatest possible flow considering the full range of potential land-uses and densities which could occur in future in the contributing drainage area. All assumptions shall be reviewed with the Director of Engineering before a system is designed. Long term land-uses shall be considered in accordance with the City's Official Plan and approved Secondary Plans.

The following Design Criteria are provided as a guide for the design of typical developments that will contain a variety of users. For specific sites, actual flow requirements shall be determined where high water uses are expected.

D2 SANITARY SEWER DESIGN

D2.1 Contributing Drainage Area

Sanitary sewers shall be designed to accommodate sanitary drainage from the proposed development as well as any contributing external areas. An external drainage plan showing the locations and the estimated population shall be prepared in order to clearly define these areas. The Consulting Engineer shall discuss with the Director of Engineering the location, extent, and appropriate land-use for any contributing external areas that should be included in the tributary drainage area.

D2.2 Design Flow Calculation

Design flow calculations shall be completed on the Sanitary Sewer Design Sheet as per City's standard format outlined at the end of this Section. The final Design Sheet shall be included in the Engineering Drawings.

Sanitary sewers shall be sized based on design flows calculated as the sum of the peak design flow and the infiltration component. The Consulting Engineer shall strive to minimize infiltration.

Design Flow 'Q' = Peak Flow + Infiltration Contribution

Where Peak Flow = Average Flow x Peaking Factor

The design flow shall be calculated using the following formula:

$$Q = \frac{M \times q \times P}{86.4} + I \times A$$

Where Q = Design Flow (l/s)

M = Peaking Factor (Maximum M = 4; Minimum M = 1.5)

q = Average Daily Flow (365 l/c/day)

P = Population/1000

I = Infiltration Contribution (0.26 l/s/ha)

A = Gross Drainage Area (ha)

Population

Population shall be calculated on the basis of the following population densities:

Residential Unit Type	People/Unit	People/ha Gross Land Area
Single Family Detached Units	4.0	70
Semi-Detached and Duplex Units	4.0	70
Townhouses (street, block and stacked TH)	3.8	175
Apartments:		475
Bachelor / One Bedroom	2.0	
Two or More Bedrooms	2.5	

Non-residential Land Usage	Equivalent Population
Schools and Institutions	60 people/ha of gross floor area
Light Industrial (no major office component)	70 people/ha of gross floor area
Offices	150 people/ha of gross floor area
Commercial (retail)	100 people/ha of gross floor area
Heavy Industrial	95 people/ha of gross floor area. Flows for special and heavy industrial uses shall be calculated from first principles or individual studies
Hotels/Motels	0.5 people/bed
Hospitals	4 people/bed
Parks and Recreation	60 people/ha gross land area

Undeveloped Lands

Future land-use and population shall be based on the City's Official Plan and Secondary Plans for the area. When such information is not available for the land under consideration, the following land-use percentages shall be used:

Undeveloped Lands	Percentage
Open spaces	10%
Residential (use a population density of 86 persons/ha gross land area)	75%
Commercial	5%
Schools and Institutions	10%

Commercial

Average Flow: 180,000 litres/gross land area in ha/day including infiltration and peaking effect, where Gross Floor Area (GFA) is not known.

The area is calculated using the number of gross land area (hectares) included in the commercial block or development. The flow criteria shall apply unless evidence exists which will require additional treatment or the provision of additional volume.

Industrial

Average Flow: 180,000 litres/gross land area in ha/day including infiltration and peaking effect, where GFA is unknown.

The area is calculated using the number of gross land area (hectares) included in the industrial block or development. The flow criteria will apply unless evidence exists which will require additional treatment or the provision of additional volume.

Schools and Institutions

Average Flow: 180,000 litres/gross land area in ha/day including infiltration and peaking effect, where GFA is unknown

Where the total floor area does not exceed the size of the lot, the area is calculated using the number of gross land area (hectares) included in the school or the institutional site. This flow figure will apply unless evidence exists which will require additional treatment or the provision of additional volume.

Average Daily Flow

An average daily flow of 365 litres/capita/day shall be used for all uses.

Infiltration

Infiltration shall be calculated on the basis of 0.26 litres/sec/ha.

Peaking Factor

Peak flows shall be determined by applying the Harmon's Peaking Factor to the average daily flow.

Harmon's Peaking Factor:

$$M = 1 + \frac{14}{4 + P^{0.50}}$$

Where: M = ratio of peak flow to average flow (maximum M = 4.0, minimum M = 1.5)

P = tributary population in thousands (i.e. population/1000)

D3 SEWER CAPACITY

Manning's formula shall be used for determining the capacity of the sewers:

$$Q = \frac{A \times R^{2/3} \times S^{1/2}}{n} \quad \text{or} \quad Q = A \times V; \text{ where V = velocity (m/s)}$$

Where: Q = design flow (m^3/s)

A = sewer cross-section area (m^2) (nominal pipe diameter shall be used for sewer design)

R = hydraulic radius (m)

S = sewer slope (m/m)

n = Manning's roughness coefficient of 0.013 shall be used for all types of pipes

Sanitary sewers within the development shall not surcharge (sewer shall not be more than 85% full).

D4 FLOW VELOCITIES AND SLOPE

Flow velocities shall be determined using the Manning's Equation.

The minimum flowing partially full velocity for circular pipes shall not be less than 0.6 m/s

The minimum flowing full velocity for circular pipes shall not be less than 0.75 m/s.

The maximum flowing full velocity shall not be greater than 3.65 m/s.

Full flow velocity, $V_{full} = 30.527 \times D^{2/3} \times S^{1/2}$ (for n = 0.013, D in meters)

$Q_{full} = 23.976 \times D^{8/3} \times S^{1/2}$ (for n = 0.013, D in meters)

Velocity change from one pipe to another in a maintenance hole shall not exceed 0.6 m/s.

The first leg of all sewers shall have a minimum grade of 1.0% and a maximum grade of 3.0%.

The minimum grade of all sewers shall not be less than 0.5%.

D5 SEWER LAYOUT

D5.1 Location

Sanitary sewers shall be located as shown on the Standard Drawings. This standard location is generally 1.5 m offset from the centre line of the roadway. If sewers are in a common trench, the minimum horizontal separation between two sewers (barrel to barrel) shall be 1.0 m, as shown in the Standard Drawings.

D5.2 Clearances

Clearances between sewers and watermains shall be designed in accordance with the MECP design guidelines (F-6-1). The clearance requirements for normal conditions are summarized below.

Sanitary sewers shall cross under watermains with sufficient vertical separation to allow for proper bedding and structural support of the watermain and sanitary sewer. Where it is not possible for the sewer to cross under the watermain and the watermain cannot be relocated, the sewer shall cross above the watermain with a minimum of 0.5 m between the top of the watermain and the outside face of the sewer. The sewers shall be adequately supported to prevent excessive deflection of joints and settling.

The length of the watermain shall be centered at the point of crossing so that the joints are equidistant and as far as possible from the sewer.

Parallel sewer and watermain installations shall maintain a minimum horizontal clearance of 2.5 m, measured from the nearest edges in accordance with MECP guidelines (F-6-1).

At the crossing of sewers cross, a minimum 0.5 m vertical clearance between the sewers shall be provided.

D5.3 Minimum Size

The minimum size for sanitary sewers shall be 200 mm diameter.

D5.4 Changes in Pipe Size

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

D5.5 Depth

For residential, commercial, and institutional areas, sewers shall be designed with a minimum cover of 2.75 m between the road centre line and the sewers obvert allowing sufficient depth for basement floor drains. It may be necessary to increase this depth of cover in order to accommodate service connection crossings and to meet depth requirements at the street line.

For depths over 6.00 m, a secondary collection system may be required and shall be approved by the Director of Engineering.

D5.6 Limits of Construction

Sewers shall be terminated with a maintenance hole at the Subdivision limits when external drainage areas are considered in the design. The design of the terminal maintenance holes must allow for any possible future extension of the sewer.

Temporary stubs (maximum one pipe length) may be permitted between phases of development.

D5.7 Clay/Collar Plugs

In order to prevent the migration of fines through granular pipe bedding, clay/collar plugs in bedding are required along the pipe at a minimum interval of 40.0 m.

D6 FORCEMAINS

Where forcemain is necessary and the City accepts its requirements on a case specific basis, the termination of forcemain shall be designed in accordance with the “MECP Design Guidelines For Sewage Works” as detailed below:

‘The forcemain shall enter the receiving maintenance hole with a smooth flow transition to the gravity sewer system at a point not more than 0.30 m above the flow line. Corrosion protection shall be provided where corrosive conditions are anticipated due to septicity or other causes. The forcemain length shall be short to reduce dynamic head losses and the production of odours and corrosive gases at initial and design flows, respectively.’

D7 INFILTRATION / INFLOW (I/I) REDUCTION GUIDELINES

The Consulting Engineer shall refer to the I/I Reduction Guidelines, "INFLOW AND INFILTRATION REDUCTION STANDARD FOR SEWERS SERVICING NEW DEVELOPMENT", prepared by York Region, as amended, in addition to the City of Markham's standard criteria given below.

The City of Markham's criteria takes precedence.

- Industrial/Commercial/Institutional (ICI) Properties
  - Maintenance holes shall be located outside the surface ponding areas, preferably on islands or high ground areas.
- Flood Plain Properties
  - Maintenance holes shall be located outside the Regional flood plain.
  - If maintenance holes cannot be located outside the Regional flood plain, then it shall be elevated to minimum 100 Year elevation and the top of maintenance holes shall be sealed and anchored properly so that it cannot be easily displaced or shifted due to high flows.
- Municipal Roads/ROW
  - Maintenance holes shall be placed where storm water does not pond and also away from curb in location as per the Standard Drawings.
  - Self-Leveling frame and cover system, in accordance with standard drawing MS6A, are preferred and encouraged to be used for all maintenance holes within existing and future municipal roads/ROW. If these products are used, manufacturer's specification for installation and maintenance must be followed and included in Engineering detail drawings.
  - The use of modular adjustment units (precast or other materials) is only permitted if accepted by the Director of Engineering in writing, in accordance with standard drawing MS6B. In the event that modular adjustment units are used, they shall be fully wrapped with an approved waterproofing membrane ('Mel-rol' or approved equivalent). The waterproofing membrane shall extend over the top of the adjustment to form a gasket type seal on the underside of the frame.
- Municipal Roads/ROW on High Groundwater Level
  - Self-Leveling frame and cover system, in accordance with standard drawing MS6A, are preferred and encouraged to be used for all maintenance holes within existing and future municipal roads/ROW. If these products are used, manufacturer's specification for installation and maintenance must be followed and included in Engineering detail drawings.
  - The use of modular adjustment units (precast or other materials) is only permitted if accepted by the Director of Engineering in writing, in accordance with standard drawing MS6B. In the event that modular adjustment units are used, they shall be fully wrapped with an approved waterproofing membrane ('Mel-rol' or approved equivalent). The waterproofing membrane shall extend over the top of the adjustment to form a gasket type seal on the underside of the frame.
  - Place/install bituminous seal tape around maintenance hole section joints.
  - Provide clay/collar plugs in bedding (at minimum 40 m intervals).
  - Maintenance holes shall be watertight with a rubber apron gripping the pipe.

D8 MAINTENANCE HOLES

Maintenance holes may be precast or poured / cast-in-place and shall be designed and constructed in accordance with the Standard Drawings and Ontario Provincial Standard Drawings and Specifications. Precast maintenance holes shall conform to CSA A257.4.

Maintenance holes shall be placed at the upstream end of each line, changes in size and material, at pipe junctions, and at changes in grade and horizontal alignment. Self-Leveling frame and cover system, in accordance with standard drawing MS6A, are preferred and encouraged to be used for all maintenance holes within existing and future municipal roads/ROW. If these products are used, manufacturer's specification for installation and maintenance must be followed and included in Engineering detail drawings.

Self-Leveling frame and cover system, as per the manufacturer's specification, is not recommended where it is subject to repetitive heavy loading in landscaped areas (non-asphalt).

The use of modular adjustment units (precast or other materials) is only permitted if accepted by the Director of Engineering in writing, in accordance with standard drawing MS6B. In the event that modular adjustment units are used, they shall be fully wrapped with an approved waterproofing membrane ('Mel-rol' or approved equivalent). The waterproofing membrane shall extend over the top of the adjustment to form a gasket type seal on the underside of the frame.

All maintenance hole joints shall be watertight and wrapped with a waterproof membrane ('Mel-rol' or approved equivalent).

D8.1 Maintenance Hole Details

- Maintenance hole chamber openings shall be located on the side of the maintenance hole parallel to the flow for straight run maintenance holes, or on the upstream side of the maintenance hole at all junctions.
- The change in direction of flow in any maintenance hole shall not be greater than 90°.
- The maximum change in direction of flow in maintenance holes, for sewer sizes over 1050 mm diameter, shall be 45° (see MS 9).
- Where maintenance hole depths exceed 5.0 m, safety grating as per OPSD, shall be incorporated into the maintenance hole. Safety grating shall not be more than 5.0 m apart. Whenever practical, a safety grating shall be located 0.5 m above the drop structure inlet pipe.
- The Obverts on the upstream side of maintenance holes shall not be lower than obvert of the outlet pipe.
- Where the difference in elevation between the obvert of the inlet and outlet pipes exceed 0.6 m, a drop structure shall be provided in accordance with the Standard Drawings
- Maintenance holes shall be benched to the obvert of the outlet pipe on a vertical projection from the spring line of the sewer
- Benching between the channel edge and the inside wall of the maintenance hole shall be a minimum of 250 mm in width
- Maintenance holes shall be located with a minimum of 1.5 m clearance away from the face of curb and / or any other service
- Bituminous/Denso seal tape shall be placed around rings and section joints of maintenance hole to seal and to prevent the migration of fines through the direct inflow
- Maintenance holes shall have rubber apron gripping the pipe

- If storm maintenance hole and sanitary maintenance hole are both located at islands or high ground areas, the top elevation of the storm maintenance hole shall be lower than the top elevation of the sanitary maintenance hole
- Pre-benched maintenance holes, as designed by the Ontario Concrete Pipe Association (OCPA) or equivalent, are acceptable.

D8.2 Location and Spacing

Maintenance holes shall be located at each change in alignment, grade or pipe material, at all pipe junctions, at the beginning or end of radius pipe sections and at intervals along the pipe to permit entry for maintenance to the sewer.

Where a non-standard maintenance hole configuration is required, it shall be designed with reinforced concrete. Such designs shall be detailed on the Engineering Drawings.

Maintenance holes shall not exceed the maximum allowable spacing as outlined on the table below:

Sewer Size	Maximum Allowable Maintenance Hole Spacing
200 mm to < 750 mm	120 m
750 mm and over	150 m
Major trunk sewer	Case by case

D8.3 Drops

For typical sanitary sewer sizes and grades, the following minimum drops shall be provided at maintenance holes:

Change of Direction	Minimum Drop (m)
0°	0.02
1° to 45°	0.05
46° to 90°	0.08

The Consulting Engineer shall ensure that drops through maintenance holes are sufficient to accommodate hydraulic losses.

Where pipe sizes change at maintenance holes, the downstream sewer obvert shall match the upstream obvert or be lower.

Drop structures shall be avoided, if possible. Drop structures shall be provided if drop is more than 0.6 m. Joints and gaskets shall conform to CSA B 182.1 and CSA B 182.2.

For SAN sewers 600 mm or greater, one size larger maintenance hole than required shall be provided.

D8.4 Maintenance Hole Channel

For existing maintenance hole retrofit/repair, precast modular Fiberglass panels are required to be installed in the maintenance hole channel. The Fiberglass panels shall be configured to match the existing orientations found in individual maintenance holes. The selected Fibergalss panels shall be reviewed and approved by the Director of Environmental Services or their designate.

D9 SERVICE CONNECTIONS

For sanitary service connections, refer to Section M – Service Connections.

D10 BEDDING & PIPE SELECTION

The type and classification of sanitary sewer and the sewer bedding type shall be clearly indicated on all plan & profile drawings for each sewer length.

All sanitary sewers shall conform to the requirements of the Canadian Standards Association.

D10.1 Bedding

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

All pipes attached to maintenance holes shall be supported from maintenance hole to the first pipe joint as per OPSD 708.020.

Sanitary sewer bedding shall be as per OPSD-802.010 for flexible pipes and OPSD-802.030 Class 'B' for rigid circular pipes unless otherwise specified by the Geotechnical Engineer.

Sanitary sewer bedding in water bearing sand and silt (wet trench condition) shall consist of 20 mm crusher-run limestone as detailed in the Engineering Drawings. The necessity for implementing these measures can be assessed at the time of trench excavation by a Geotechnical Engineer.

The width of trench at the top of the pipe shall be carefully controlled to ensure that the maximum trench width is not exceeded unless additional bedding or higher strength pipe is used (refer OPSS 514).

D10.2 Polyvinyl Chloride Pipe (PVC)

The maximum allowable deflected pipe diameter is 7.5% of the base inside diameter of the pipe. Deformation gauge (Mandrel) test shall be required for all sewers prior to Acceptance.

For PVC pipe, the initial maximum allowable deflection of PVC pipe under load shall be in accordance with the pipe manufacturer's specifications. The pipe class shall be selected in accordance with the bedding type, depth of sewer, trench width, and soil conditions. The Consulting Engineer may be required to submit pipe loading calculations in support of their design. These calculations shall be based on the Modified Iowa Formula.

Sanitary sewers 375 mm in diameter or smaller shall be constructed either from PVC or concrete. Sewers 450 mm diameter and greater shall be concrete.

PVC gravity sewer and fittings shall conform to CSA B 182.1 or CSA B 182.2. The pipe shall have a maximum Standard Dimension Ratio (SDR) of 35 and a minimum pipe stiffness of 320 kPa. Sanitary sewers (mainline pipe) and the service connection pipe shall be green in colour.

Sewers, fittings, joints and gaskets shall be fabricated in accordance with CSA B182.1, CSA B182.2 and CSA B182.4.

Maximum depth of cover for PVC gravity sewer pipes shall be in accordance with OPSD 806.040.

D10.3 Rigid Pipe

The pipe class (use class 65-D as a minimum) shall be selected in accordance with the bedding type, depth of sewer material, trench width, and soil conditions. The Consulting Engineer may be required to submit pipe loading calculations in support of their design. These calculations shall be based on the Marston Formula.

Non-reinforced concrete sewers and fittings less than 300 mm in diameter shall be fabricated in accordance with CSA-A257.1, minimum Class 3 or latest amendmen unless otherwise noted.

Reinforced concrete sewers and fittings 300 mm in diameter and greater shall be fabricated in accordance with CSA-A257.2 or latest amendment unless otherwise noted.

Joints and gaskets shall conform to CAN/CSA-A257.3.

All Tees and Wyes shall be pre-manufactured.

Oil resistant gaskets shall be specified for sanitary sewers downstream of industrial sewage flows.

Maximum depth of cover for concrete pipes shall be in accordance with OPSD 807.010 and 807.050

D10.4 Other Pipes

Any other sewer materials shall first be submitted to the Director of Engineering and can only be used if accepted by the Director of Engineering.

D11 MATERIALS

D11.1 Maintenance holes

Maintenance holes shall be constructed of poured or precast concrete in accordance with the Standard Drawings. Precast maintenance holes shall conform to CSA A257.4 and OPSS 1351.

Where a non-standard maintenance hole configuration has to be designed, reinforced concrete shall be used. Such designs shall be detailed on the Engineering Drawings.

D12 CONCRETE ENCASEMENT

Concrete encasement of PVC gravity sanitary sewer will be permitted on a site specific basis. The concrete encasement shall be designed to extend from pipe joint to pipe joint.

D13 MECP'S ENVIRONMENTAL COMPLIANCE APPROVALS

MECP's Environmental Compliance Approvals (ECA) for Municipal and Private Sewage Works is required prior to starting any servicing at site. The sumbission is reviewed by the City under the Transfer of Review program.

Refer to Engineering Submissions Required Documents (Annex 1) for details.

SANITARY SEWER DESIGN SHEET

City of Markham

SUBDIVISION/PROJECT NAME _____**(AMANDA NUMBER)**_____ **JOB NO** _____

CONSULTING ENGINEER_____ **SHEET NO** _____ **OF** _____

For Population <1000; $M = 1 + \frac{14}{4 + P^{0.5}}$ M = Harmon Peaking Factor

p = Population/1000

Design Flow $Q = \frac{Mqp}{86.4} + IA$ Q = Design Flow (l/s)

q = Average Daily Flow (365 l/c/day)

I = Infiltration Contribution (0.26 l/s/ha)

A = Gross Drainage Area (ha)

Min. Sewer diameter	= 200 mm
Manning's "n"	= 0.013
Min. Velocity	= 0.75 m/s
Max. Velocity	= 3.65 m/s
Min. Pipe Grade	= 0.5%
Min. H. Peaking Factor	= 2.0
Max. H. Peaking Factor	= 4.0

P.Eng Stamp and Signature/dated

LOCATION			SECTION		CUMULATIVE						ELEVATIONS			PIPE DATA				
STREET	MAINTENANCE HOLE		POP. (no)	AREA (ha)	POP. (no)	AREA (ha)	M	DESIGN FLOW (l/s)	INFIL (l/s)	CUMM. DESIGN FLOW (Qd) (l/s)	M.H. FROM INVERT	M.H. TO		SIZE	SLOPE	FULL FLOW (Qf)	FULL VEL.	% FULL (Qd/Qf)
	FROM	TO										SURFACE	INVERT	(mm)	(%)	(l/s)	(m/s)	

Designed By _____ Checked By _____ Dated: _____