5 Storm Drainage Systems

5.1 GENERAL

These standards cover the minimum requirements for storm drainage systems. The requirements are to be in accordance with the Town of Lamont Drainage System Assessment (2017). For each storm drainage system development shall be designed for proposed land use and ultimate drainage basin and shall be dependent on the type of development, the drainage area, and the length of surface drainage runs. Drawings relating to the storm drainage system construction, trenching and backfilling are provided in the Municipal Development Standard Drawings.

5.2 STORMWATER MANAGEMENT PLAN

Stormwater runoff generated from within the subdivision shall be routed through a stormwater management facility to regulate the rate of outflow to a controlled rate equivalent to 2.5 liters per second, per hectare (2.5 L/s/ha) or better.

Stormwater management facilities shall be designed in accordance with current Alberta Enviornment Design Standards as published by Alberta Environment.

Prior to submission of any detailed design, a stormwater management plan shall be prepared by the Developer subject to approval by the Town of Lamont. The stormwater management plan shall be consistent with the Standards outlined herein, and shall:

- Be in accordance with the Town of Lamont Drainage System Assessment;
- Identify the impact of the proposed development on the watershed;
- Identify and quantify the amount of upstream drainage entering onto the proposed development lands, including all points of entry;
- Identify all existing flow channels, drainage patterns or routes and containment areas;
- Identify the point(s) of discharge from the lands, as well as the type and calculated capacity of the receiving drainage facility(s), whether natural, man-made or a combination of both;
- Provide details of required stormwater retention/detention facilities;
- Provide details of water quality enhancement facilities;
- Identify all licensing requirements as may be required by Alberta Environment.

5.3 MINOR SYSTEMS

The Minor System shall consist of pipes, open channels and water courses that convey peak flows of a 5-year return period rainfall event with ponding of water to a depth no greater than 300 mm of depression at drainage inlets.

5.4 MAJOR SYSTEMS

- The Major System shall consist of surface flood paths, roadways, parkways and water courses which are designed to convey flows of a 100-year return frequency. The system shall include culverts crossing roadways;
- Major System Conveyance elements shall be designed to accommodate runoff rates and volumes for a 100-year return period rainfall event such that:
    - The depth of peak flows and ponding in developed area streets, conveyance channels and swales are to be limited so that major system flows will not constitute a significant hazard to the public or result in significant erosion or other property damage;
    - The maximum water surface level of surface flows and ponding in streets is below the lowest anticipated landscape grade or opening at any adjacent buildings, with a freeboard provision generally in the order of 300 mm with a minimum of 150 mm;
    - Depths of flow and ponding are less than 300 mm in roadways and other public rights-of-way;
    - For arterial roadways, the water depth at the crown of the road shall not exceed 150 mm.

5.5 DESIGN FLOWS

Design flows shall be computed using one or more of the following methods:

5.5.1 Rational Formula

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

Where Q = Design flow in m3/s
A = Drainage area in ha
I = Rainfall intensity in mm/hr
C = Runoff coefficient

The rational formula is allowable for the minor system storm sewer main design for watersheds (less than 50 ha) which discharge into detention facilities or other outlets approved by the Town of Lamont.

5.5.2 Hydrograph Methods

Computer modelling shall be used for stormwater drainage design for:

- Residential and commercial/industrial development areas greater than 50 hectares in size;
- Any development requiring storage or detention facilities;
- Alternatively, computer modelling may be used for areas smaller than those outlined above;
- Storage or detention facilities shall be sized based on most critical rainfall event, four (4) hour modified Chicago or 24 hour Huff distribution.

Acceptable computer models are the SWMM/XPSWMM or MOUSE models. Other models shall be approved by the Town prior to design.

5.6 COEFFICIENT OF RUNOFF

The coefficients of runoff for return periods shall be taken from Table 5.1:

Table 5.1
Recommended Runoff Coefficients for Storm Drainage Design

	Imperviousness	*Rational Method C*	
Land Use	*%*	*1:5 Year*	*1:100 Year*
Parks/Playgrounds	10	0.25	0.35
Schools/Institutional	40	0.45	0.55
Residential - low density	40	0.45	0.55
Residential - medium density	60	0.60	0.70
Residential - high density (Multi-Family)	70	0.70	0.75
Light Industrial	70	0.70	0.75
Commercial	90	0.85	0.90
Paved Areas	100	0.90	0.95
Grassed Areas	0	0.15	0.30
Agricultural areas	0	0.10	0.30

5.7 RATE OF PRECIPITATION

The most updated rainfall curves available for the area of development should be selected for design purposes.

The 5-year frequency curve shall be used for all minor systems. The 100-year frequency curve shall be used for major systems.

The maximum inlet time shall be ten (10) minutes for residential and commercial land use area and fifteen (15) minutes for industrial land use areas.

5.8 SITE AND LOT GRADING

The following criteria shall be used:

- Each lot shall be graded to drain to the municipal storm drainage system, independently of adjacent lots;
- Areas around buildings shall be graded away from the foundations to prevent flooding. See Standard Drawings for typical grading requirements;
- Lots lower than adjacent roadways are not permissible in urban areas;
- To provide basic positive drainage until a lot is developed, the lot(s) shall be rough graded, allowing for earth balancing of future basement excavation and landscaping;
- Buildings shall be above the Major System hydraulic grade line for a 100-year storm event plus a minimum of 0.6 m freeboard. Note: may not apply to replacement of structures/developments within existing flood plains. In these areas, suitable precautions such as mounting electrical panels above the 1:100 year level shall be taken.
- It is the sole responsibility of the developer to ensure that improvements completed in the proposed area do not negatively impact adjacent land, including private and public property, roadways, and laneways. All impacts to adjacent properties need to be identified and presented to the Town of Lamont, and consent must be given by the Town of Lamont and the impacted landowners prior to completing any work.

5.9 STORM SERVICES

Storm services shall discharge to a storm sewer system. Storm mains shall be designed to collect storm service flows produced from basement sump pump discharge.

Sump pumps in basements shall have a pressure discharge connection to a storm service riser pipe at the outside of the building foundation and a storm service connection pipe from the riser connection at the house to the property line are required, see Standard Drawings. The pressure discharge connection to the gravity storm service riser pipe shall be provided with a cleanout and an overflow discharge to a concrete splash pad. Installation and maintenance of these on-lot components are the responsibility of the homeowner.

The following criteria shall be used:

- Under no circumstances shall a storm service be discharged to the sanitary system;
- Preferably the depth of the storm service should match that of the sanitary sewer service at the property line, 2.85 m from invert to proposed finished grade. Otherwise the minimum depth of the storm service shall be 1.5 m from top of service pipe to finished grade at the property line. If the storm service minimum depth cannot be achieved, a storm servicing plan shall be submitted to the Town for approval;
- Size the storm main to provide the capacity in free flow based on all connected sump pumps operating simultaneously;
- Pipe materials shall be restricted to:

- PSM type PVC to CSA Standard B182.2 PVC Sewer Pipe and Fittings (PSM Type) with locked-in elastomeric ring gasket and integral bell system joint type with a minimum wall thickness as required for Standard Dimensional Ratio 35.

5.10 ROOF DRAINAGE

- Roof drainage from one-family and two-family dwellings shall be discharged to the ground and dispersed via splash pads at the downspouts. No connections to the storm or sanitary service are permitted;
- Roof drainage from apartment buildings and commercial/industrial areas may discharge to the storm sewer where the new and existing systems are designed to accommodate the direct discharge and only if approved by the Town.

5.11 FLOW CAPACITIES

5.11.1 Storm Sewers and Open Channels

Using Mannings Formula $Q = \frac{AR^{0.667} S^{0.5}}{n}$

Where Q = Design flow in m^3/s
A = Cross sectional area in m^2
R = Hydraulic radius (area/wetted perimeter) in m
S = Slope of hydraulic grade line in m/m
n = Roughness coefficient
= 0.013 for all smooth-walled pipe
= 0.024 for corrugated steel pipe (unpaved)
= 0.020 for corrugated steel pipe (invert paved)
= 0.020 for gravel lined channels
= 0.015 for concrete or asphalt lined channels
= 0.05 for natural streams and grassed channels

5.11.2 Culverts

Use the inlet control and outlet control methods referred to in:

- The Handbook of Steel Drainage and Highway Construction Products, by the American Iron and Steel Institute;
- The Handbook of Concrete Culvert Pipe Hydraulics by the Portland Cement Association.

5.12 PIPE LOCATION

- See Standard Drawings for typical location within road right-of-way;
- Storm service connections should be located adjacent to sanitary service connections at property line and shall be as shown on the Standard Drawings;
- Minimum separation of storm sewer from water mains:
    - 3.0 m horizontally;
    - 0.5 m vertically above or below water pipe;
- Minimum separation of storm sewer from sanitary sewer: 3.0 m horizontally.

5.13 MINIMUM DEPTH OF COVER

The minimum depth of cover shall be as follows:

• Storm sewers	minimum 1.8 m to invert for pipes
• Culverts:	minimum 1.0 m to obvert
• Catch basin leads at the catch basin:	minimum 1.4 m to obvert

5.14 MINIMUM PIPE DIAMETER

• Storm Sewers connected to storm services only	200 mm
• Storm Sewers connected to catch basins	300 mm
• Culverts	600 mm
• Catch Basin Leads	250 mm
• Storm Services	100 mm

5.15 MINIMUM VELOCITY AND GRADE

- All storm sewers shall be designed with mean velocities, of 0.90 m/s, and a maximum velocity of 3.0 m/s, based on Manning's formula, when flowing full. Mean velocities below 0.60 m/s will not be allowed.
- Storm sewers with velocities in excess of 3.0 m/s must be designed appropriately to protect against displacement of sewers by erosion or shock.

The minimum grades are as follows; steeper grades are desirable:

Pipe Size mm	*Minimum Grade, %*
200	0.40 (storm services only)
250	0.28 (storm services only)
300	0.22
375	0.15
450	0.12
525	0.10
600 and Larger	0.10

5.16 CURVED SEWERS

For storm sewers aligned in a curve, the minimum slopes shall be permitted for various sewer sizes are as follows:

- Maximum joint deflection shall be as recommended by the pipe manufacturer;
- Curved sewers shall be aligned parallel to the road centreline.

Pipe Size mm	*Minimum Grade, %*
200	0.40 (storm collector mains only)
250	0.31 (storm collector mains only)
300	0.25
375	0.18
450	0.15
525	0.13
600 and Larger	0.10

5.17 MANHOLES

- The obvert of the downstream pipe shall not be higher than that of the upstream pipe;
- A smooth transition will be provided between the inverts of incoming sewers and the outlet sewers. Extreme changes in elevation at manholes will be avoided;
- Minimum drop in invert levels across manholes to account for energy loss:
    - Straight runs – 10 mm drop minimum;
    - Deflections up to 45° - 30 mm drop minimum;
    - Deflections 45° to 90° - 50 mm drop minimum;
- Deflections greater than 90° shall be accommodated using two (2) or more manholes;
- Where drops greater than 1.0 m cannot be avoided, a specifically designed drop manhole will be required to address the hydraulic requirements of the change of elevation. Considerations include:
    - The pipe shall be of sufficient size so that it does not surcharge;
    - A smooth vertical curve shall be formed between the inlet pipe and the drop shaft with no breaks in grade, projections, or edges;
    - The drop shaft diameter shall be equal to or greater in size than that of the largest inlet pipe. For multiple connections, a larger drop shaft shall be supplied;
    - Air vent to be provided at the crown of the outlet pipe downstream of the drop structure to allow removal of air released at the lower connection. This vent is to be located upstream of the point where full flow in the outlet pipe is anticipated under design flow conditions. The air vent may be connected to the shaft vent system;
    - The cover shall be able to withstand pressures from air discharge and surcharging;
    - The outlet shall provide a hydraulic jump basin to dissipate energy, to convert the flow to sub-critical velocity, and to allow for air release;
- Baffled vertical drop shafts are not permitted due to potential maintenance and access problems. Vortex type drop shafts are preferred. Proposals to use vortex type drop shafts must be supported by the appropriate design calculations and approved by the Town.

5.18 MANHOLE SPACING

Manholes shall be provided at the end of each line and at all changes in pipe sizes, grade and alignment.

The maximum distance between manholes shall be 120 m maximum for sewers 900 mm and smaller, and 150 m for sewers larger than 900 mm.

For curved sewers, manhole spacing shall be 90 m maximum for sewers 1200 mm and smaller, and 120 m for sewers larger than 1200 mm.

5.19 CATCH BASINS

- Catch basins shall be of sufficient number and have sufficient inlet capacities and adequate catch basin leads to receive and convey the calculated stormwater flow;
- Catch basins shall be provided to intercept surface runoff and shall be spaced a maximum of every 120 m. The maximum distance to first catch basin shall be 120 m;
- Catch basins shall be a minimum of 900 mm diameter, see Standard Drawings;
- All catch basin bodies shall be poured in place or precast concrete sections conforming to the most recent ASTM specifications and constructed so as to provide a 500 mm sump to trap rocks and gravel;
- Catch basin leads shall be installed to provide a minimum depth of cover, from the design finish grade, of 1.4 m to obvert unless otherwise approved. The minimum slope on catch basin leads shall be 2% and a maximum length of 30 m;
- All catch basin leads shall discharge directly into stormwater manholes;
- Catch basin installation shall be upstream of any crosswalk whenever possible;
- Catch basin leads greater than the 20.0 m in length will use 300 mm diameter pipes;
- Catch basin neck section and catch basin frame shall be installed within 50 mm of plumb with catch basin shaft.

Frame & Cover Type	*Curb Type*	*Min. Barrel Size (mm)*	*Allowable Application*
F-36	Straight Face	900	Catch basins only
F-36A	Straight Face	1200	Catch basin manholes only
F-39 Round Top	No Curb	900	For off roadway locations or temporary inlets on roadways
K7	80 mm rolled face	900	Current preferred inlet for residential areas
DK7	80 mm rolled face	900	Preferred for residential areas where additional capacity is needed
F38	No Curb	900	Lanes, swales, gutters and curb ramps
F51 (no side inlet)	No Curb	900	For situations requiring increased capacity of F36
F51 (with side inlet)	Straight Face	900	Situations requiring increased capacity over F51

5.20 CULVERTS AND DRAINAGE

The minimum allowable ditch grade shall be 0.5%. Ditch grades in excess of 2.0% shall be protected against erosion through rock ditch checks, silt fences, Enviroberm fences and/or erosion control blankets.

The minimum ditch bottom width shall be 1.5 m, sloping away from the roadway at a minimum of 5.0%.

Culvert size requirements shall be determined through the stormwater drainage analysis however, the minimum size culverts shall be as follows:

- Roadway cross culvert 600 mm
- Residential approach culvert 400 mm
- Industrial approach culvert 500 mm

Culverts shall be of approved material with a minimum wall thickness of 1.6 mm, or as required by the loading criteria. All culverts shall be installed in accordance with the manufacturer's recommendations and shall be installed complete with bevelled end sections on both the inlet and outlet ends with the invert extended to the toe of the side slope.

Culverts shall be installed to provide a minimum depth of cover of 500 mm or one-half (½) the culvert diameter, whichever is greater, as measured from the finished shoulder grade of the roadway to the top of the culvert.

Riprap shall be placed around the inlet and outlet of all culverts. Riprap material shall consist of rock ranging in size from 150 mm to 350 mm with 50% of the rock material being larger than 200 mm. Typical riprap installations are illustrated in the Standard Drawings.

5.21 PIPE, MANHOLE AND BEDDING MATERIALS AND SPECIFICATIONS

5.21.1 Pipe Materials

Pipe shall comply with the specifications in Table 5.2:

Table 5.2
Acceptable Pipe Materials

Material	*Range (mm)*	*Specification*
Reinforced Concrete	300 and up	CAN/CSA A257 Class 3 min.
PVC	200 to 900 mm	ASTM D3034 Min. Class DR35
Open Profile (PVC)	400 to 900 mm	CSA-B182.4, 320 kPa pipe stiffness AASHO-M-36 (Storm only)
Corrugated Steel Culverts	400 and up	

Pipe shall be jointed with rubber gaskets or gasketed fittings or couplings.

5.21.2 Manholes

- Manholes shall be manufactured using sulphate resistant Type HS cement;
- Manhole sections shall be precast reinforced concrete sections conforming to ASTM C478 and CSA A257.4;
- Manhole steps shall be standard safety type, aluminum forged of 6061-76 alloy having a minimum tensile strength of 200 MPa;
- All joints shall be sealed with rubber gaskets conforming to ASTM C443 and grouted inside and outside with non-shrink grout;
- Manholes shall be fitted with the appropriate cast iron frame and cover conforming to Class 20 ASTM A48 as shown on the Standard Drawings. All castings shall be true to form and dimensions, free from faults, sponginess, cracks, blowholes, or other defects affecting their strength;
- Pre-benched manhole bases shall be used wherever possible with pre-cored connection holes and water tight Duraseal or G-Loc joints or approved equivalent;
- Tee Riser manholes shall conform to CSA 257.2/ASTM C76 (pipe components) and CSA A257.4/ASTM C76 (manhole riser component);
- Aluminum safety platforms shall be required in all manholes with a depth greater than 5.0 m. See Standard Drawings.

5.21.3 Bedding Material

Bedding material shall be Class B sand bedding in accordance with the Standard Drawings and gradation specified under Item 4.14.4.

5.21.4 Outfall Structures

- For all outfalls, it is required that a hydraulic analysis be completed to ensure that the exit velocities will not damage natural watercourses. Final velocities into a natural drainage course shall not exceed 1.5 m/s;
- Appropriate erosion control measures, including energy dissipaters, are to be provided downstream of the outfall to prevent erosion;
- All sewer outlets shall be constructed with lockable grates to allow maintenance but prevent entrance of unauthorized personnel. Where required, guardrails and/or fences shall be installed to provide fall protection;
- Outfall structures shall be designed with consideration of aesthetics, as they are generally located within parks, ravines, and on channels. Concrete surface treatment is recommended.

5.22 MAJOR SYSTEMS

Major stormwater management systems must meet with current Alberta Environment Design Standards as published by Alberta Environment. Prior to final submission to the Town of Lamont for approval, all stormwater management plans need to be submitted to Alberta Environment and all applicable third party approvals must be received and included in the final submission to the Town of Lamont. Refer to the "Application Form and Guide for Registration to Construct and Operate a Municipal Storm Drainage System" as published by the Government of Alberta.

5.23 EROSION AND SEDIMENTATION CONTROL

All storm drainage systems, including storage facilities, pipe outlets and other drainage channel outlets or overflows, shall be designed to control erosion that may result from piped or overland stormwater flows and discharge into the storm drainage system.