EPCOR

Addendum

DATE: **8/22/2023**

SUBJECT: **Addendum to City of Edmonton Design and Construction Standards Volume 3-02 Stormwater Management and Design Manual. August 2023.**

Purpose:

The August 2023 "Addendum to City of Edmonton Design and Construction Standards Volume 3-02 Stormwater Management and Design Manual" provides an update to Section 5.0 LID Facility Design. The update provides more comprehensive guidance for the design and construction of LID facilities in the City of Edmonton.

Updates:

The entirety of Section 5.0 of Volume 3-02 of the design and construction standards is removed and replaced with the attached update.

A summary of the changes made are noted in the table below.

Current Section:	Changes:	Date
5.0 LID Facility Design	5.2.3, 5.3.2, 5.4.2, 5.5.2, 5.6.2 - Referenced to appropriate section in standard	May 2023
5.2 Design Basis	5.2.7- Changed to be less stringent	May 2023
5.6 Soil Cell Design	5.6.4 – Stipulated Private roof drains "(cannot be directly connected into the LID, must enter a sump or CB prior)"	May 2023
5.6 Soil Cell Design	5.6.5 – Added filter layer and drainage layer sections	May 2023
5.6 Soil Cell Design	5.6.2/ii – Adjusted wording regarding "18mm from the impervious catchment"	July 2023
5.7 Absorbent Landscaping	Added Absorbent Landscaping	May 2023
5.8 Piping and Infrastructure Considerations	5.8 – Changed indexing	May 2023
5.8 Piping and Infrastructure Considerations	5.7.8/viii – Changed to stipulate permeant stub ends and include option for "A 12-gauge stainless steel insert"	May 2023
5.8 Piping and Infrastructure Considerations	5.7.12/xiv – Reference appropriate section in standard instead of providing DRENG contact	May 2023

5.8 Piping and Infrastructure Considerations	5.8 – Added sections xiii & xvi	May 2023
5.9 Signage Considerations	Added Signage Considerations section	May 2023
5.12 Drawing Requirements	5.12 – Changed indexing	May 2023
5.12 Drawing Requirements	5.12.1 – Added requirement to index LID Drawings	May 2023
5.12 Drawing Requirements	5.12.1.2/ii – Separate drawings for each LID facility for each type required, frame and cover type labelled on each CB/MH, and existing infrastructure included in utility drawings.	May 2023
5.12 Drawing Requirements	5.12.1.2/ii – *Landscape* Added "Operations & Maintenance Template to be provided by EPCOR"	May 2023
5.12 Drawing Requirements	5.12.1.3 – Added requirement to include typical special provision information in drawing notes	May 2023
5.12 Drawing Requirements	5.12.1.4/iv – Added requirement to include number of each vegetation type in each LID	May 2023
5.12 Drawing Requirements	5.12.3 – Added drafting style considerations sections	May 2023
5.13 Construction	5.13.1 – Added CCC/FAC Requirements	May 2023
5.14 LID Growing Media Specifications	5.14.1 – Removed Compost and Woodchips sections and adjusted general wording issues	July 2023
5.15 Testing Requirements	5.15.2- Added various Guelph Permeameter testing specifications.	May 2023

The August 2023 addendum to City of Edmonton Design and Construction Standards Volume 3-02 Stormwater Management and Design Manual is considered part of Volume 3-02 of the design and construction standards wherever the design and construction standards are referenced by other documents.

Should any users have any questions regarding this addendum, the user is advised to seek clarification by sending an email to DRENG@epcor.com.

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Enclosures

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5.0 LID FACILITY DESIGN

Unless otherwise specified in this section all requirements of Volume 3 must be followed for LID design, and LID construction. Modifications that are accepted for LID projects only are outlined in this section.

5.1 Site Planning Considerations

Integration of LID into site planning is the key to applying LID facilities holistically. This means strategically placing them with considerations of site grading and soil conditions and satisfying various setbacks from buildings, utilities and road infrastructure. The following should be considered when siting an LID facility:

- Site drainage patterns, topography, and grading;
- Catchment characteristics such as area, land use, and imperviousness; LID facilities should not be sited in areas with high contamination potential such as gas stations;
- LID facility layout and footprint;
- Connection to the drainage system (if applicable);
- Underlying soil permeability and load-bearing capacity;
- Clearance to groundwater table;
- Buffers and setbacks;
- Utility conflicts;
- Integration with the existing/proposed use of space (i.e. streetscaping, impacts to pedestrian movements, etc.) including future use of space;
- Impacts to existing tree plantings;
- Cost implications of system configuration and size; and
- Future operations & maintenance of the facility and surrounding infrastructure.

For large developments that require an Area Master Plan (AMP), an inventory of the physical attributes including a hydrogeotechnical impact assessment and environmental impact assessment is provided as part of the AMP. The AMP and relevant studies (as well as those preceding them as per the Volume 3 Drainage Design and Construction Standards - Vol. 3-01: Development Planning Procedure and Framework) should provide an understanding of the relationship between shallow groundwater and local surface water resources. The AMP should explore the potential of incorporating Low Impact Development (LID) as a best management practice (BMP) for stormwater management. LID should not be viewed as a redundant system, but as a necessary part of the integrated stormwater management system that helps to meet the environmental objectives. Prior to proceeding with LID for large developments the following information must be gathered:

- Proximity to nearby building foundations and roadway infrastructure, and likelihood of a perched water table. The investigation depth is dependent upon site conditions such as presence of sensitive receptors (e.g. surface water bodies) and slopes.
- Interaction between groundwater and surface water near watercourses and in the vicinity of wetlands and marshes to assess slope stability and aid in protecting natural areas from poor-quality runoff and alteration of natural surface water-ground water interactions.
- Potential slope stability issues.
- The direction and rate of groundwater flow (hydraulic gradient and hydraulic conductivity).
- The potential vertical hydraulic conductivity of the soil above the water table (e.g., expected infiltration rates and percolation rates) and horizontal hydraulic conductivity of saturated soils if bioretention gardens are proposed.

Local geotechnical data should be reviewed for smaller infill and redevelopment sites – this can be through previous reports from nearby sites or municipal projects, or can be collected during foundation/other site excavation. The following must be considered prior to construction of LID on a smaller site, however does not need to be field verified.

- Proximity to nearby building foundations and roadway infrastructure, and likelihood of a perched water table.
- Interaction between groundwater and surface water near watercourses and in the vicinity of wetlands and marshes to assess slope stability and aid in protecting natural areas from poor-quality runoff and alteration of natural surface water-ground water interactions.
- Potential slope stability issues.
- Groundwater levels, particularly the seasonally high water level.

The following features must be identified and assessed for all developments (large or small) including:

- The distribution of surficial geological materials and soil types within the development.
- The topography, hydrology (surface watercourses, and storage features, if any) and hydrogeology (groundwater characteristics) including;
  - Watercourses, wetlands, and marshes;
  - Areas of potential groundwater and surface water interaction;
  - Recharge and discharge areas; and
  - The probable depth, direction and rate of groundwater flow (estimated at the reconnaissance or desktop level of planning).
- The geotechnical hazard areas including areas of geological hazards, abandoned coal mines or geotechnical instability of slopes including identifying preliminary setbacks.

5.2 Design Basis

5.2.1 LID facilities shall be designed to retain and store a minimum of 18 mm of rain from their contributing impervious catchment area. The impervious area includes paved surfaces, roofs, and surfaces that do not allow infiltration of water.

5.2.2 The I/P ratio shall not exceed 50:1 where I is the impervious area of the contributing drainage area and P is the surface area of the LID facility. The I/P ratio should be 10:1 or lower for catchment areas having a high sediment or winter salt load. An I/P ratio of 20:1 is common and may be used for roads and parking areas with a lower sediment load, e.g., smaller roads and parking areas and those that do not receive winter sanding loads.

5.2.3 Design storm events for piping infrastructure and maximum surface ponding are the 1:5 year 4 hour event and 1:100 year 4 hour event, respectively.

5.2.4 LID facilities must not be located on top of bank lands. LID facilities should be located at a minimum distance of 50 m from the top of bank or as specified in the geotechnical engineering assessment for the subject lands. If site restrictions for LID facilities are not specifically addressed in the geotechnical report for the subject lands, the location of LID facilities must follow the “Water Feature” setback requirements as identified in the neighbourhood ASP and associated geotechnical engineering assessment.

5.2.5 A minimum setback of 3.0 m from buildings is recommended; however LID facilities must be located a minimum setback of 1.0 m from buildings. An impermeable membrane must be placed within the slopes excavation on the side of the LID adjacent to the foundation and must extend at least half-way through the LID facility. Sub-excavation must not extend below the bottom of the basement’s slab and all Alberta Health, Safety and Environment regulations and building codes must be followed. Where this setback and/or these controls are not possible, site specific analysis and a signed and stamped design by a qualified professional is required.

Impermeable membranes must be linear low-density polyethylene (LLDPE) 20-mil following the minimum specifications identified in Table 5-1. Subgrade should be smooth and devoid of rocks, lumps, depressions and others that may affect the liner’s integrity. Membrane installation must follow manufacturer instructions.

Table 5-1: LLDPE 20-MIL Minimum Specifications

Property	Test	Frequency	Unit	Value
Thickness (min. avg.)	ASTM D-5199	Per roll	mm (in)	0.50 (0.01969)
Sheet Density	ASTM D-1505	90,000 kg (200,000lb)	g/ml	0.939
Carbon Black Content	ASTM D-1603 (3)	20,000 kg (45,000 lb)	%	2.0 - 3.0
Tensile Strength at Break	ASTM D-6693	9,000 kg (20,000 lb)	N/mm (lb/in)	13 (76)
Elongation at Break	ASTM D-6693	9,000 kg (20,000 lb)	%	700
Tear Resistance	ASTM D-1004	20,000 kg (45,000 lb)	N (lb)	50 (11)
Puncture Resistance	ASTM D-4833	20,000 kg (45,000 lb)	N (lb)	124 (28)

- Waterproofing membranes could be applied to the building walls at sites with nearby LID facilities. Use of both impermeable membranes and waterproofing membranes can further reduce setback distances.
- If an impermeable membrane is required for a facility, the designer should consider this when determining plant selection.

5.2.6 The required offsets from utilities vary and are set by the utilities themselves, if applicable utility standards should be followed or utilities should be consulted prior to installing LID facilities over or in proximity to utilities. Proximity to water utilities are covered extensively in the City of Edmonton Volume 4 Water Design & Construction Standards.

5.2.7 Depth to the seasonally high groundwater below the LID facility invert (bottom of the drainage layer) should be no less than 1.0 m to prevent groundwater intrusion. Groundwater levels will fluctuate seasonally and in response to climatic conditions.

- If the distance from the base of the proposed LID to the water table is suspected to be less than 1.0 m, LID designs must be modified to limit groundwater interactions with the LID facility. To accept this variance LID designs must be authenticated by a qualified geotechnical professional.
- Alternatively, fluctuations in groundwater could be monitored for at least a year in the field by installing a borehole/monitoring well as directed by a qualified geotechnical professional when the area is near proposed grade. If groundwater levels are monitored for a year, 0.6 m would be the minimum acceptable separation. To accept this variance LID designs and plans for management of groundwater must be authenticated by a qualified geotechnical professional.
- Trees are not permitted in LID’s that are constructed less than 1.0 m above the water table.Tree selection should be appropriate for the design of the LID, not all trees are suitable even with a minimum 1.0 m buffer.
- Plants should be appropriate for the design of the LID, including depth to groundwater.

5.2.8 For large developments a geotechnical assessment that includes soil type classification and groundwater evaluation is required across the developed site before selecting and implementing the LID facilities. In addition, hydraulic conductivity testing is required for facilities which lack an underdrain system (bioretention gardens), and which drain exclusively to groundwater. LID facilities with an underdrain system (bioretention basins, box planters and soil cells) can be located over any soil type including high plastic clays (CH).

The following is a guide to field work for large developments, but will vary based on the location, size, number and type of LID facility(s), and complexity of the development area. A design report outlining geotechnical characteristics of the development should be prepared, and authenticated by a qualified professional.

- Drilling a network of shallow boreholes placed at approximately 200 m centres to evaluate the potential variation in soil conditions within the development. For a development area of less than 1 ha, one borehole or excavation pit is required. The extent of this effort will largely depend on what information is already available.

- Visual classification of soil types (textures) from soil samples collected during drilling using the Unified Soil Classification System (USCS). The first 3.0 m of depth for LID facility assessments is the most critical soils information to obtain.
- Conducting standard penetration tests (SPTs) to identify zones of changing soil strength and consistency in terms of loose and consolidated soil. These tests aid in defining low permeability barriers that may inhibit infiltration capacity of native soil and suggest certain LID facilities over others.
- Installing a borehole or excavation pit in the area of the LID for some local design information. Larger areas and areas of complex surficial geology may require additional investigation to evaluate groundwater depth.
- Depth to groundwater across the site must be calculated using borehole data. To undertake surface infiltration estimates, use of the following methods: the double ring, the Guelph Permeameter, or the Modified Phillips Dunne permeameter method, provided consideration is given to the specific site conditions and the suitability of each method's application.
- If applicable, the construction details of the geosynthetics used should include hydraulic conductivity and thickness (either as a hydraulic conductivity to achieve designed infiltration rates to support runoff targets, or the hydraulic conductivity required to minimize infiltration, depending upon the criteria that best satisfies the LID objective(s)).
- If a synthetic liner will be used to minimize infiltration, the specifications of the liner material must be provided and supported by the manufacturer's detailed specifications. Recommendations on how to protect the liner from damage during construction and long-term maintenance requirements, if any, shall be provided.
- An assessment of the designed infiltration rates of the infiltration areas and underdrains, and the methods for verifying that these infiltration rates will be achieved post-construction.
- An analysis of the stability of the LID side slopes and surrounding area based on soil type(s) found if applicable.
- Analysis of the impact of percolation and underdrains on the water table, including the potential for impact on roadway infrastructure.
- Recommendations on monitoring and maintenance requirements.
- Test results to demonstrate that permeability between soil media/subgrade drains and the surrounding native soil will promote downward drainage for facilities that are designed for infiltration into native soils.

5.3 Bioretention Garden Design

5.3.1 Definition

Bioretention gardens are a type of LID facility with a shallow depression. On the surface, bioretention gardens may appear similar to flower / shrub beds, however bioretention gardens utilize the specified LID Soil Media (Section ***5.14***) and vegetation to capture and treat rainwater and are located at the low point of a landscape. They use vegetation and specialized soil media to filter and retain stormwater and provide stormwater management by promoting absorption, evapotranspiration, and interception. Bioretention gardens have no underdrain. They consist of pre-treatment, a flow entrance, ponding area, plant materials, soil media, and structural storage layers. Structural storage layers are any man-made component that aids in the storage of water such as a storage tank/pipe, storm chamber, or soil cell structure; this list is not exhaustive and other man-made components could be utilized. A structural man-made storage layer/component is an essential component of bioretention gardens.

Bioretention gardens are at much higher risk of freezing and should have natural underlying permeability rates of greater than 15 mm/hr (hydraulic conductivity greater than $4x10^{-4}$ cm/s) unless designed as a closed system which stores runoff i.e. the structural man-made storage component does not allow infiltration into the native soils. High plastic (CH) soils have permeability less than

15 mm/hr and are susceptible to changes in volume upon changes in moisture content. There is a possibility of swelling if the moisture content of these soils is increased due to saturation and low infiltration rates, and swelling of 50 mm or more is possible in localized areas. This could lift and damage adjacent road and sidewalks. In-situ analysis with the Guelph Permeameter (combined reservoir two head) method using shallow uncased wells up to 1.0 m deep is an alternative to a full geotechnical investigation with conventional monitoring wells and hydraulic conductivity testing.

If a facility does not have a structural man-made storage layer/component it would be classified as a rain garden; for rain garden design guidance refer to the City of Edmonton *Low Impact Development - Best Management Practices Design Guide*.

5.3.2 Sizing Requirements

i. The contributing impervious catchment area is less than 2 ha.

ii. Retain runoff volume through ponding and surface infiltration for 18 mm of rain from its contributing impervious catchment area.

iii. Show that the high water level (HWL) during the 100-year, 4-hour design event does not compromise adjacent structures, i.e. drainage away from the facility is sufficient. Refer to City of Edmonton design and construction standards Vol. 3-02 Section 5.2.3.

iv. Duration of ponded water following a design event (see Section ***5.2***) should be less than 48 hours. EPCOR's LID Calculator can be utilized to demonstrate this if required.

v. See Section **5.2.2** for I/P ratios.

vi. Ponding depth within the bioretention garden is a maximum of 200 mm.

5.3.3 Surface Flow Velocity to prevent erosion

i. Maximum 0.3 m/s in planted areas

ii. Maximum 0.9 m/s in mulched zones

5.3.4 Surface Geometry and Side Slope

i. Flat bottom, with a recommended minimum length / width ratio of 2:1, as applicable. If a bioretention garden is irregularly shaped it should be designed to allow water infiltration throughout the bioretention garden.

ii. For areas adjacent to a sidewalk or shared-use path, the preferred maximum side slope of the bioretention garden is 5:1 (H:V), and the maximum allowable side slope is 3:1 (H:V).

iii. For all other areas the preferred maximum side slope of the bioretention garden is 4:1 (H:V); the maximum allowable side slope is 3:1 (H:V). This only applies to the facility itself, and slopes outside of the facility must meet the requirements of its own land use.

5.3.5 Inlet

i. 0.5 m to 3 m grass filter buffer for non-point source inlets or erosion control at point source inlets, this could also include a filter spreader. Point source inlets can be installed above or below ground with an energy dissipater. Energy dissipaters may include (but are not limited to) rocks, or a drop/ramp between the pavement and grass.

ii. Filter strips to buffer salt impacts are required for collector and arterial roadways, and parking lots. Filter strips are recommended to be 3-5 m in width which may include the sidewalk, if applicable.

5.3.6 Media Layers

i. If a mulch layer is used, the mulch shall be long, fibrous non-floatable organic mulch. Non-floating mulch should composted and a blend of fine and coarse bark and must be aged a minimum of 4-6 months. The depth of the mulch during establishment should be 80 mm or as determined by the designer. A compostable netting may be used to stabilize mulch during establishment of vegetation. Mulch is not required if sufficient ground cover is proposed.

ii. The LID growing soil media shall meet the specifications in Section ***5.14***. The minimum depth is

300 mm.

iii. If used, the granular filter layer within the facility must be a minimum thickness of 100 mm with 14 mm washed rock and less than 0.1% silt. Where situations permit, a greater depth may be applied.

iv. The storage layer must have a man-made structural layer/component that aids in the storage of water (see Section **5.3.1** for additional details).

5.3.7 Geotextile

i. Non-woven geotextiles are NOT recommended within LID facilities between media layers; if space and design allow, using granular filter layers to limit sediment transport is preferred.

ii. If geotextile is used for filtration or sidewall coverage, it should be woven monofilament or non-woven needle punched fabrics. Woven slit film and non-woven heat bonded fabrics should not be used as they are prone to clogging. Geotextile fabric may be placed along the sides of the LID facilities to help direct the water flow downward and to reduce lateral flows if sand seams exist.

iii. If geotextile must be used within the LID to control transport of sediments, the permeability rate should be higher than that of the soil or 3 $m^3/min/m^2$ (75 $gal/min/ft^2$), whichever is greater.

5.3.8 Buffer

i. The facility base must be at least 0.6 m to 1.0 m above the seasonally high groundwater table (see Section ***5.2.7*** for additional details). If required (i.e. if facility is not a closed system and relies on natural infiltration), groundwater mounding calculations must be conducted to ensure mounded groundwater will not affect nearby structures or features.

ii. Horizontal buffers are 3.0 m from building foundations, or closer with the use of engineering controls and as approved by a geotechnical professional (see Section ***5.2.5*** for additional details).

iii. Provide a buffer of at least 0.5 m from sidewalks and 0.6 m from Shared Use Pathways.

Figure 5-1 shows an example of a typical bioretention garden layout, and is for illustrative purposes only, it does not depict every detail that may be required for successful construction, operations, and maintenance. These figures are one variation of the many scenarios that exist and any scenario that meets the requirements of the standards can be proposed. The man-made storage layer/component depicted in ***Figure 5-1*** is simply a placeholder, and actual requirements of the layer are described in Section **5.3.1**

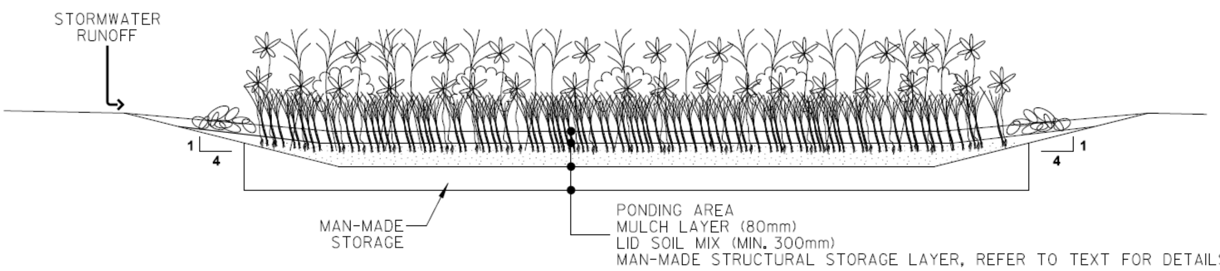


Figure 5-1: Bioretention Garden Cross Section

5.4 Bioretention Basin Design

5.4.1 Definition

A bioretention basin is a type of LID facility that relies on vegetation, specialized soil media and a storage layer to infiltrate, filter, detain, and retain stormwater runoff. Bioretention basins provide stormwater management by promoting absorption, evapotranspiration, and interception. Bioretention basins consist of pre-treatment, flow entrance/inlet, ponding area, plant materials, LID soil media, filter layer, storage layer, underdrain, and overflow outlet.

A bioswale is a type of linear bioretention LID with a small slope to convey water. In order to be considered a bioretention facility, a bioswale requires a minimum of 400 mm of LID soil (reduced from the typical 500 mm minimum), an underdrain connecting to the storm sewer and the surface slope must not be greater than 3%. If the surface slope is 1% or greater, check dams must be used.

5.4.2 Sizing Requirements

i. The contributing impervious catchment area is less than 4 ha.

ii. Retain runoff volume through ponding and surface infiltration for a minimum of 18 mm from the contributing impervious catchment area.

iii. Show that the HWL during the 100-year, 4-hour design event does not compromise adjacent structures, i.e. drainage away from the facility is sufficient. Refer to City of Edmonton design and construction standards Vol. 3-02 Section 5.2.3.

iv. Duration of ponded water following a design event (see Section ***5.2***) should be less than 48 hours.

vii. See Section **5.2.2** for I/P ratios.

v. Ponding depth within the bioretention basin is a maximum of 350 mm.

5.4.3 Surface Flow Velocity to Prevent Erosion

i. Maximum 0.3 m/s in planted areas;

ii. Maximum 0.9 m/s in mulched zones

5.4.4 Surface Geometry and Side Slope

i. Flat bottom, with a recommended minimum length / width ratio of 2:1 as applicable. If a bioretention basin is irregularly shaped it should be designed to allow water infiltration throughout the bioretention basin.

ii. For areas adjacent to a sidewalk or shared-use path, the preferred maximum side slope of the bioretention basin is 5:1 (H:V), and the maximum allowable side slope is 3:1 (H:V).

iii. For all other areas the preferred side slope of the bioretention basin is 4:1 (H:V); the maximum allowable side slope is 3:1. This only applies to the facility itself, and slopes outside of the facility must meet the requirements of its own land use.

iv. For bioswales surface slopes must not be greater than 3%. If the surface slope is 1% or greater, check dams must be used.

5.4.5 Inlet

i. Inlets may include (but are not limited to) curb cuts, CBs, filter strips, flow spreaders, curb cuts with grates or sidewalk grates. Sidewalk grates may only be used in certain applications after other options have been evaluated. If sidewalk grates are to be used they must have firm, stable, slip resistant, and heel-friendly covers; care must be taken to ensure the grates are level with the existing sidewalk.

ii. 0.5 m to 3 m grass filter buffers for non-point source inlets or erosion control at point source inlets are recommended. Erosion control and/or energy dissipation must be appropriate to the type of inlet, anticipated inflow, and the location. Erosion control and energy dissipation methods chosen must be permanent and control erosion throughout the life of the bioretention basin.

iii. Point source inlets can be installed above or below ground with an energy dissipater. Energy dissipaters may include (but are not limited to) rocks, or a drop/ramp between the pavement and grass.

iv. Filter strips to buffer salt impacts are required as follows: 3-5 m width along collectors (may include sidewalk), parking lots, and arterials (if necessary).

v. Pre-treatment is required to capture large particles and debris and prevent the spread of sediments on the surface of the bioretention basin.

vi. Inlets must be situated to allow for maintenance of both the inlet and the erosion control/energy dissipater (if applicable). Inlets should not be situated directly adjacent to overflows to encourage water movement throughout the LID. Proximity of inlets to potential obstructions should be minimized to reduce inlet blockage.

5.4.6 Media Layers

i. If a mulch layer is used, the mulch shall be long, fibrous non-floatable organic mulch. Non-floating mulch should composted and a blend of fine and coarse bark and must be aged a minimum of 4-6 months. The depth of the mulch during establishment should be 80 mm or as determined by the designer. A compostable netting may be used to stabilize mulch during establishment of vegetation. Mulch is not required if sufficient ground cover is proposed.

ii. The LID growing soil media shall meet the specification in Section ***5.14***. The minimum depth is 500 mm unless it is not feasible due to site constraints.

iii. The filter layer is 100 mm depth with 14 mm washed rock with less than 0.1% silt. If used, the granular filter layer within the facility should have a minimum thickness of 100 mm with 14 mm washed rock and less than 0.1% silt. Where situations permit, a greater depth may be applied.

iv. The drainage layer is a minimum of 400 mm in depth with 25 mm - 40 mm angular crushed rock containing less than 0.1% silt.

5.4.7 Geotextile

i. Non-woven geotextiles are NOT recommended within LID facilities; if space and design allow, using granular filter layers to limit sediment transport is preferred.

ii. If geotextile is used for filtration or sidewall coverage, it should be woven monofilament or non-woven needle punched fabrics. Woven slit film and non-woven heat bonded fabrics should not be used as they are prone to clogging. Geotextile fabric may be placed along the sides of the LID facilities to help direct the water flow downward and to reduce lateral flows if sand seams exist.

iii. If geotextile must be used within the LID to control transport of sediments, the permeability rate should be higher than that of the soil or 3 $m^3/min/m^2$ (75 $gal/min/ft^2$), whichever is greater.

5.4.8 Underdrain Perforated Pipe

i. All Piping and Infrastructure Considerations in Section ***5.8*** must be followed.

5.4.9 Buffer

i. The facility base must be at least 0.6 m to 1 m above the seasonally high groundwater table (see Section ***5.2.7*** for additional details).

ii. Horizontal buffers are 3.0 m from building foundations, or closer with the use of engineering controls and as approved by a geotechnical professional (see Section ***5.2.5*** for additional details).

Figure 5-2 shows plan and profile views of a typical bioretention basin layout with curb cut inlets, and are for illustrative purposes only, they do not depict every detail that may be required for successful construction, operations, and maintenance. Another common method of surface water capture are catch basin inlets as shown in ***Figure 5-3***. These figures are two variations of the many scenarios that exist and any scenario that meets the requirements of the standards can be proposed. Please note the figures may not show details required to meet other aspects of the City of Edmonton and EPCOR's Design and Construction Standards such as membranes, filter fabric or clay caps.

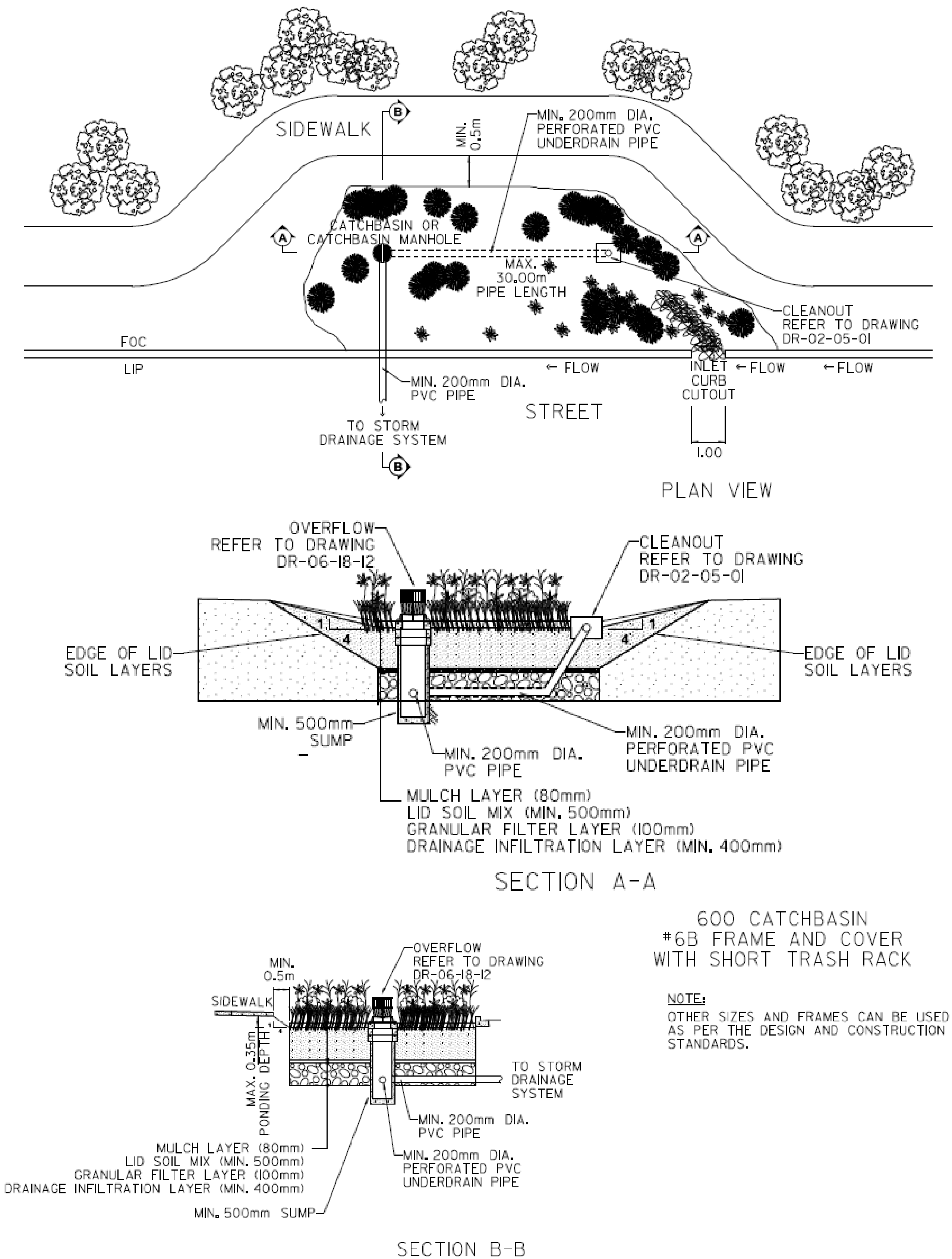


Figure 5-2: Bioretention Basin Plan View and Cross Sections

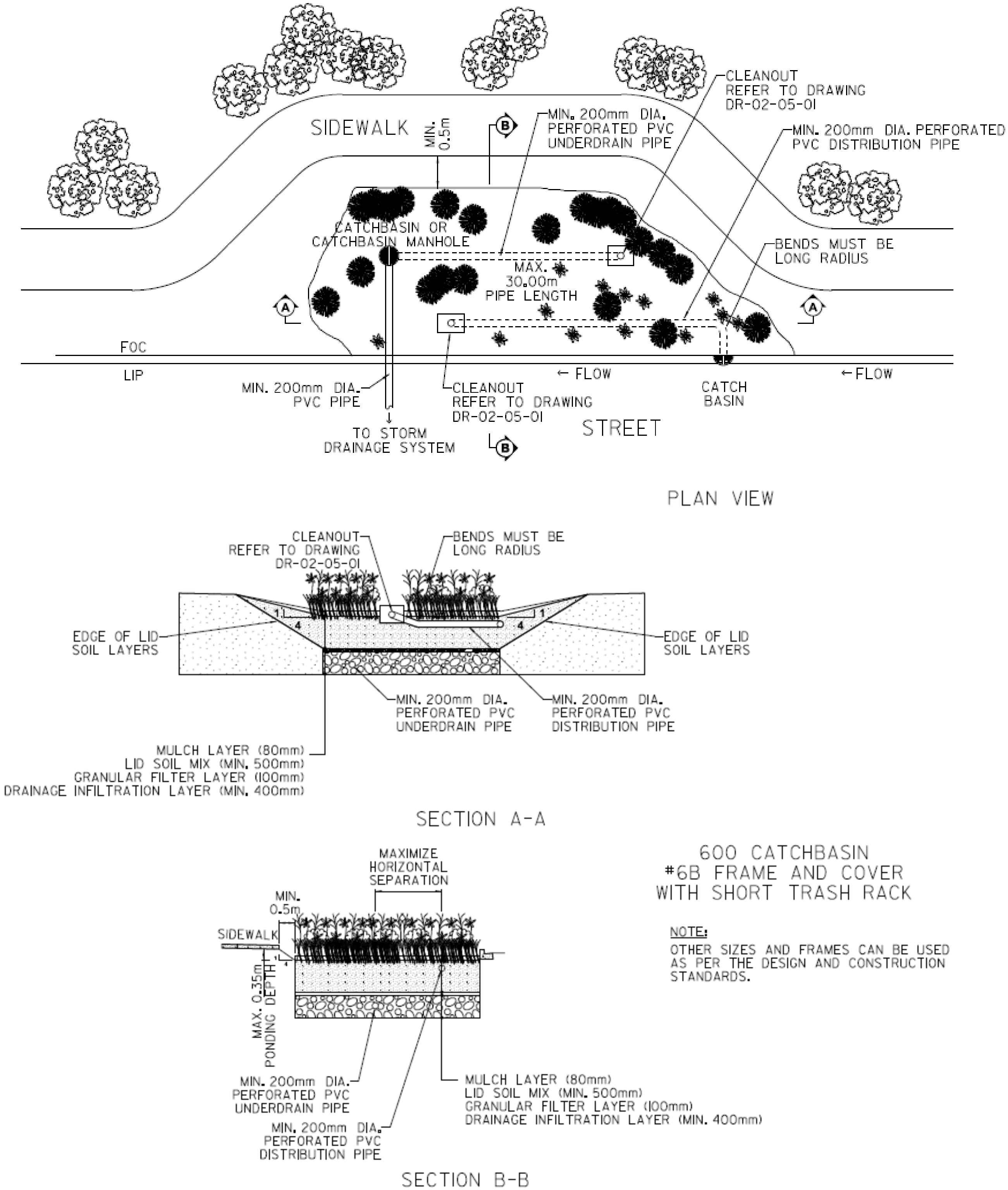


Figure 5-3: Bioretention Basin with Catch Basin Inlet Plan View and Cross Sections

5.5 Box Planter Design

5.5.1 Definition

Similar to bioretention basins, box planters use vegetation and specialized soil media to filter and retain stormwater and provide stormwater management by promoting absorption, evapotranspiration, and interception; however box planters are contained within a box-like structure. Box planters are ideal for areas with small footprints such as downtown as they have smaller footprints (vertical sides) and can be located close to buildings. Box planters can be raised, level with the surrounding area, or depressed below ground. Box planters contain an underdrain pipe and may or may not have a self-containing bottom.

5.5.2 Sizing Requirements

i. The contributing catchment area is less than 0.5 ha.

ii. Retain runoff volume through ponding and surface infiltration for 18 mm of rain from its contributing impervious catchment area.

iii. Show that the high water level (HWL) during the 100-year, 4-hour design event does not compromise adjacent structures, i.e. drainage away from the facility is sufficient. Refer to City of Edmonton design and construction standards Vol. 3-02 Section 5.2.3.

iv. Duration of ponded water following an 18 mm design event (see Section **5.2.3**) should be less than 48 hours.

v. See Section **5.2.2** for I/P ratios.

vi. Ponding depth is a maximum of 350 mm.

5.5.3 Surface Flow Velocity to Prevent Erosion

i. Maximum 0.3 m/s in planted areas

ii. Maximum 0.9 m/s in mulched zones, to prevent erosion.

5.5.4 Planter Material

i. Stone, concrete, brick, clay, or plastic are acceptable materials for the contained planters.

5.5.5 Surface Geometry and Surface Slopes

i. The width of the box planter must be greater than or equal to 450 mm.

ii. Surface slopes less than 0.5%.

5.5.6 Inlet

i. Erosion control and energy dissipaters at inlets. Energy dissipaters may include (but are not limited to) rocks, a downspout impact baffle, or a drop/ramp between the pavement and grass.

ii. Inlets may include (but are not limited to) curb cuts, curb cuts with grates, roof leaders, CBs, or concrete flow spreaders.

iii. Pre-treatment may be required to capture large particles and debris and prevent the spread of sediments on the surface of the box planter.

5.5.7 Media Layers

i. If a mulch layer is used, the mulch shall be long, fibrous non-floatable organic mulch. Non-floating mulch should composted and a blend of fine and coarse bark and must be aged a minimum of 4-6 months. The depth of the mulch during establishment should be 80 mm or as determined by the designer. A compostable netting may be used to stabilize mulch during establishment of vegetation. Mulch is not required if sufficient ground cover is proposed.

ii. The LID growing soil media shall meet the specification in Section ***5.14***. The minimum depth is 500 mm unless it is not feasible due to site constraints.

iii. The filter layer is 100 mm depth with 14 mm washed rock with less than 0.1% silt. If used, the granular filter layer within the facility should have a minimum thickness of 100 mm with 14 mm washed rock and less than 0.1% silt. Where situations permit, a greater depth may be applied.

iv. The drainage layer is a minimum of 400 mm in depth with 25 mm - 40 mm angular crushed rock containing less than 0.1% silt.

5.5.8 Geotextile

i. Non-woven geotextiles are NOT recommended within LID facilities; if space and design allow, using granular filter layers to limit sediment transport is preferred.

ii. If geotextile is used for filtration or sidewall coverage, it should be woven monofilament or non-woven needle punched fabrics. Woven slit film and non-woven heat bonded fabrics should not be used as they are prone to clogging. Geotextile fabric may be placed along the sides of the LID facilities to help direct the water flow downward and to reduce lateral flows if sand seams exist.

iii. If geotextile must be used within the LID to control transport of sediments, the permeability rate should be higher than that of the soil or 3 $m^3/min/m^2$ (75 $gal/min/ft^2$), whichever is greater.

5.5.9 Underdrain Pipe

i. All piping and infrastructure considerations in Section ***5.8*** must be followed.

5.5.10 Buffer

i. The facility base must be at least 0.6 m to 1 m above the seasonally high groundwater table (see Section ***5.2.7*** for additional details).

ii. Horizontal buffers are 3 m from building foundations, or closer with the use of engineering controls and as approved by a geotechnical professional (see Section ***5.2.5*** for additional details). Box planters may be placed adjacent to buildings with engineering controls approved by a geotechnical professional.

Figure 5-4: Box Planter Plan View and Cross Sections shows plan and profile views of a typical box planter layout, and are for illustrative purposes only, they do not depict every detail that may be required for successful construction, operations, and maintenance. These views show the inlet from a curb cut; however these figures are one variation of the many scenarios that exist and any scenario that meets the requirements of the standards can be proposed.

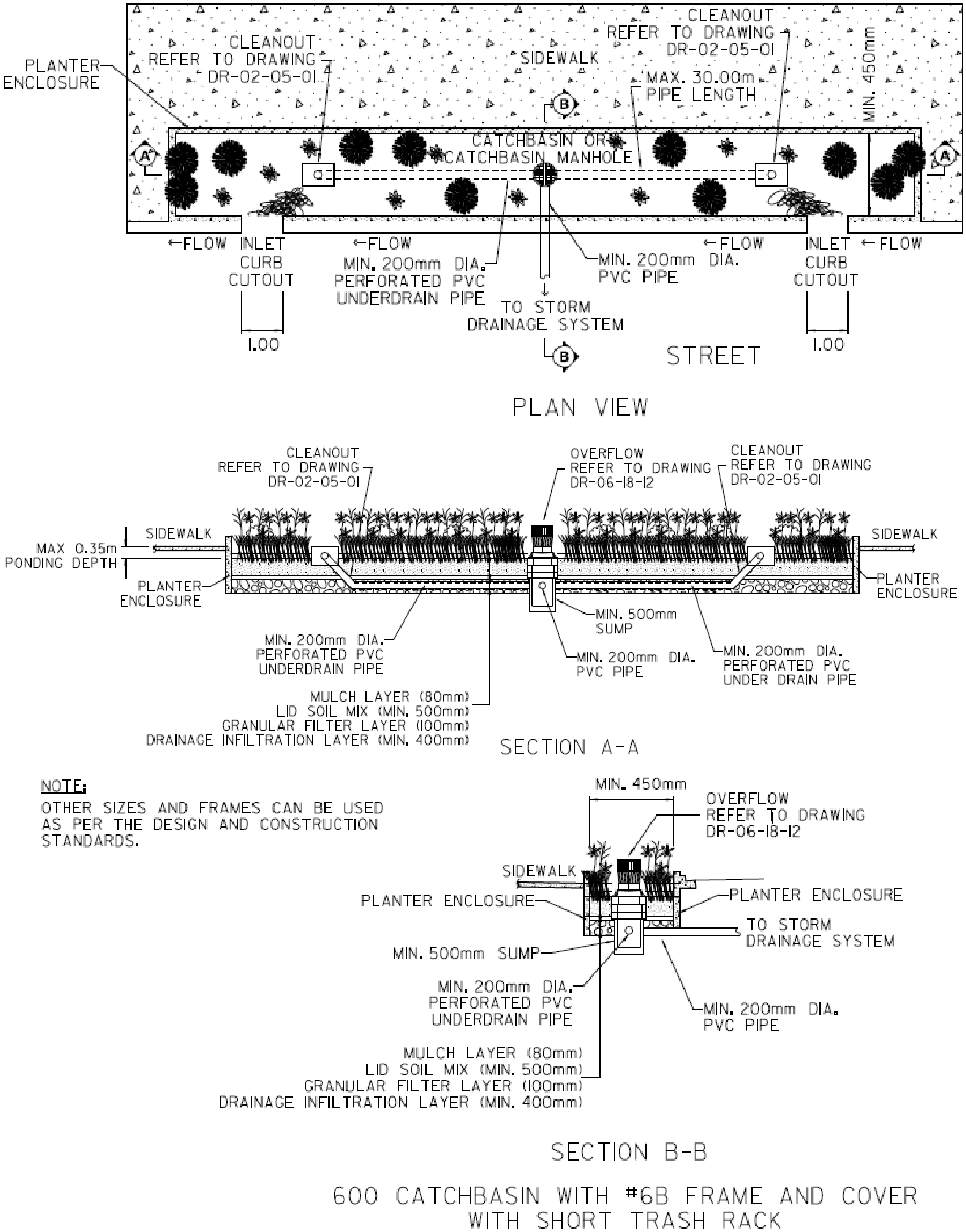


Figure 5-4: Box Planter Plan View and Cross Sections

5.6 Soil Cell Design

5.6.1 Definition

Soil cells provide structural support for sidewalks and roadways while allowing space for specialized soil media to facilitate tree rooting and provide stormwater management by promoting absorption, transpiration, and interception. Stormwater can be directed into the soil cell system through a CB with pre-treatment, roof drain connection, or overland flow through a curb cut.

5.6.2 Sizing Requirements

i. Duration of ponded water following an 18 mm design event (see Section **5.2.3**) should be less than 48 hours, if applicable.

ii. Retain runoff volume through ponding and surface infiltration for a minimum of 18 mm from the impervious catchment area, soil cells can also retain additional volume captured during large events.

iii. Show that the HWL during the 100-year 4 hour design events does not compromise adjacent structures. Refer to City of Edmonton design and construction standards Vol. 3-02 Section 5.2.3.

iv. Meet minimum soil volumes required for trees as per the City of Edmonton Volume 5 Landscape Design and Construction Standard.

5.6.3 Geometry and Loading

i. Installed to the size and dimensions of the structural cell module chosen.

ii. Structural cell modules and corresponding pavement (asphalt, concrete, etc.) must be able to handle required loads (typically of the largest vehicle that would be driving over the soil cell), loading must be reviewed and approved by a structural engineer or following manufacturers' specifications. Note: different products may have different load capacities and testing protocols, protocols should be checked for relevance in local jurisdictions.

5.6.4 Inlet

i. Inlets may include (but are not limited to) CBs, private roof leaders (cannot be directly connected into the LID, must enter a sump or CB prior), trench drains, curb cuts, or pre-treatment devices.

ii. An energy dissipater should be provided if the water flows directly onto the surface of the system. Energy dissipaters may include (but are not limited to) rocks, a downspout impact baffle, or a drop/ramp between the pavement and the soil cell.

5.6.5 Media Layer

i. LID growing soil media shall meet the specifications in Section ***5.14***.

ii. The structural cell module type selected will dictate the media layers required and their corresponding depths and volumes; manufacturer's specifications and recommendations must be followed. Note: soil and media specifications may differ depending on the purpose of the structural cell module. Soil and media must be designed for stormwater retention and detention and to allow tree root growth.

iii. If used, the filter layer is 100 mm depth with 14 mm washed rock with less than 0.1% silt. The granular filter layer within the facility should have a minimum thickness of 100 mm with 14 mm washed rock and less than 0.1% silt. Where situations permit, a greater depth may be applied.

iv. If used, the drainage layer is a minimum of 400 mm in depth with 25 mm - 40 mm angular crushed rock containing less than 0.1% silt.

5.6.6 Distribution Pipe

i. A minimum diameter 200 mm perforated PVC distribution pipe shall be installed as per one of the following specifications:

a) sloped at 0.5% towards a CB or CB-style clean-out;

b) a level pipe set below the CB inlet; or

c) as per manufacturer's specifications.

ii. All Piping and Infrastructure Considerations in Section ***5.8*** must be followed.

5.6.7 Underdrain Pipe

i. A minimum diameter 200 mm perforated PVC underdrain pipe shall be installed within an aggregate blanket that extends the length of the pipe or as per manufacturer's specifications.

ii. The underdrain pipe must slope towards the catch basin/manhole.

iii. All Piping and Infrastructure Considerations in Section ***5.8*** must be followed.

5.6.8 Subbase and Subgrade

i. Subbase and subgrade must be prepared and/or installed as per manufacturer specifications and with consultation and approval of a geotechnical engineer.

ii. The native soil subbase must be compacted to a minimum of 95% Standard Proctor density to support the system load unless a geotechnical engineer has indicated another compaction level.

iii. In certain situations manufacturers may require different soils, materials, or geotextiles immediately adjacent to or within the soil cell installation; all manufacturer's specifications/ recommendations must be followed unless approved by a qualified engineering professional.

5.6.9 Buffer

i. The facility base must be at least 0.6 m to 1.0 m above the seasonally high groundwater table (see Section ***5.2.7*** for additional details) unless approved by a qualified engineering professional.

ii. Horizontal buffers are 3 m from building foundations, or closer with the use of engineering controls and as approved by a geotechnical professional (see Section ***5.2.5*** for additional details).

5.6.10 Backfill Material (Adjacent to Soil Cells)

The backfill material adjacent to the soil cell installation must be clean, compactable, coarse-grained (gravel) fill with less than 30% fines, or as per manufacturer's specifications/ recommendations. Backfill material must be free of organic material, trash and other debris, and free of materials toxic to plant growth. Backfill material should be compacted and placed as per the manufacturer's specifications.

Note, in certain situations manufacturers may require different soils, materials, or geotextiles immediately adjacent to or within the soil cell installation; all manufacturer's specifications/ recommendations must be followed unless approved by a qualified engineering professional.

5.6.11 General Considerations

i. The structural systems must meet the requirements of the Complete Streets Design and Construction Standards for roadways, sidewalks, walkways, paths and/or trails.

ii. The soil cells must be designed and tested for the purpose of growing tree roots, and stormwater filtering, detention, and retention.

iii. Soil cells must be able to be installed to allow installation of utilities through the soil cells, if necessary. Installation of utilities through the spaces within the soil cell frames must be approved by the utility owner/operator. All utility lines installed through the soil cells must be secured and braced within the frames. Where utility lines require that the space between cells is larger than 150 mm, bridging must be designed. Utility design must meet offsets from trees.

iv. Geogrid shall be net-shaped woven polyester fabric with PVC coating; inert to biological degradation; resistant to naturally occurring chemicals, alkalis, and acids; and used to provide a stabilizing force within the soil structure. Geogrid must meet the soil cell manufacturer's specifications.

v. Geotextile shall be composed of high tenacity polypropylene yarns which are woven into a network such that the yarns retain their relative position; be inert to biological degradation; and resistant to naturally encountered chemicals, alkalis, and acids. Geotextiles must meet the soil cell manufacturer's specifications.

vi. If a root barrier is required, the root barrier shall prevent root penetration. The root barrier shall be made of an impermeable and ribbed geotextile. The root barrier must be installed the full depth of the soil cells and as needed around utilities or other obstructions through the soil cells. Root barriers must be continuous or interlocking.

vii. Follow the manufacturer's instructions for installation including locations of drainage lines, utilities, geogrid, geotextile, subgrade preparation, paving, and system layout.

viii. In areas of potential change or expansion, an empty conduit should be installed to facilitate ease of future utility installation.

Figure 5-5: Soil Cell Plan View and Cross Section shows plan and profile views of a typical soil cell (with trees) layout, and are for illustrative purposes only, they do not depict every detail that may be required for successful construction, operations, and maintenance. These views show the inlet from a CB; however these figures are one variation of the many scenarios that exist and any scenario that meets the requirements of the standards can be proposed.

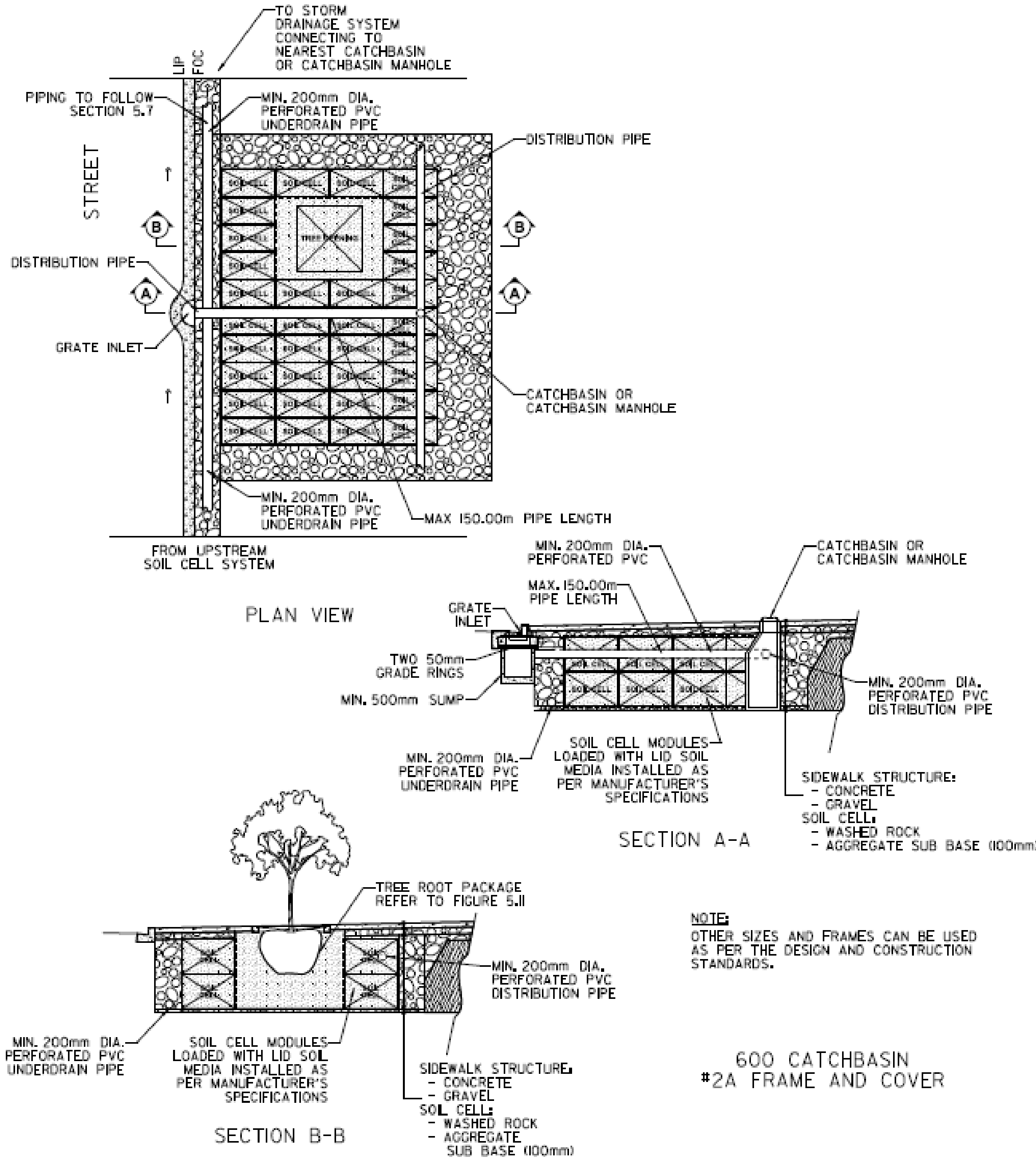


Figure 5-5: Soil Cell Plan View and Cross Section

5.7 Absorbent Landscaping

5.7.1 Definition

Absorbent landscaping is an LID type that incorporates a shallow depression planted with both drought and saturation tolerant vegetation to collect surface flow. These facilities are graded to overflow directly into other LID facilities, or into the storm system. Unlike other LID facilities absorbent landscaping does not typically include underdrains. Plant selection is pivotal to the success of absorbent landscaping facilities and establishing a well-developed root system cannot be understated.

Absorbent Landscaping is being trialled within Edmonton and discussions with EPCOR Drainage should be initiated prior to moving forward with design of absorbent landscaping for any specific site or area.

5.7.2 Sizing Requirements

i. See Section **5.2.2** for I/P ratios. Considering that absorbent landscaping facilities often have I/P ratios between 5/1 and 20/1, a different planting approach may be applied for different impervious intensities. See **Table 5-2: Absorbent Landscaping I/P Ratios*:*** for typical planting approaches and media depth for each range of I/P.

Table 5-2: Absorbent Landscaping I/P Ratios

I/P Ratio	Recommended Growing Media Depth	Recommended Planting Approach
<5/1	300-600mm	No restrictions: trees (as long as soil volume requirements are met), shrubs, etc.
5/1 to 10/1	300mm	Fescue sod or naturalized grasses
10/1 to 20/1	300mm	Naturalized fescue sod, sedges, or wet meadow grasses
>20/1	300mm	Naturalized wet meadow grasses or sedges

5.7.3 Surface Flow Velocity to Prevent Erosion

i. Maximum 0.3 m/s in planted areas;

ii. Maximum 0.9 m/s in mulched zones

5.7.4 Surface Geometry and Side Slope

i. Includes a depression of 25-50 mm. If the facility is irregularly shaped it should be designed to allow water infiltration throughout the facility

5.7.5 Inlet

i. Adequate erosion control or energy dissipation based on site is required at inlets. Energy dissipaters may include (but are not limited to) rocks, a downspout impact baffle, or a drop/ramp between the pavement and grass.

ii. Inlets may include (but are not limited to) curb cuts, curb cuts with grates, or roof leaders.

iii. Pre-treatment may be required to capture large particles and debris and prevent the spread of sediments on the surface of the facility.

5.7.6 Media Layers

i. Fescue sod blend or seed mix is recommended with Kentucky blue grass sod as an alternative.

ii. The LID growing soil media shall meet the specification in Section ***5.14***. The minimum depth is

300 mm.

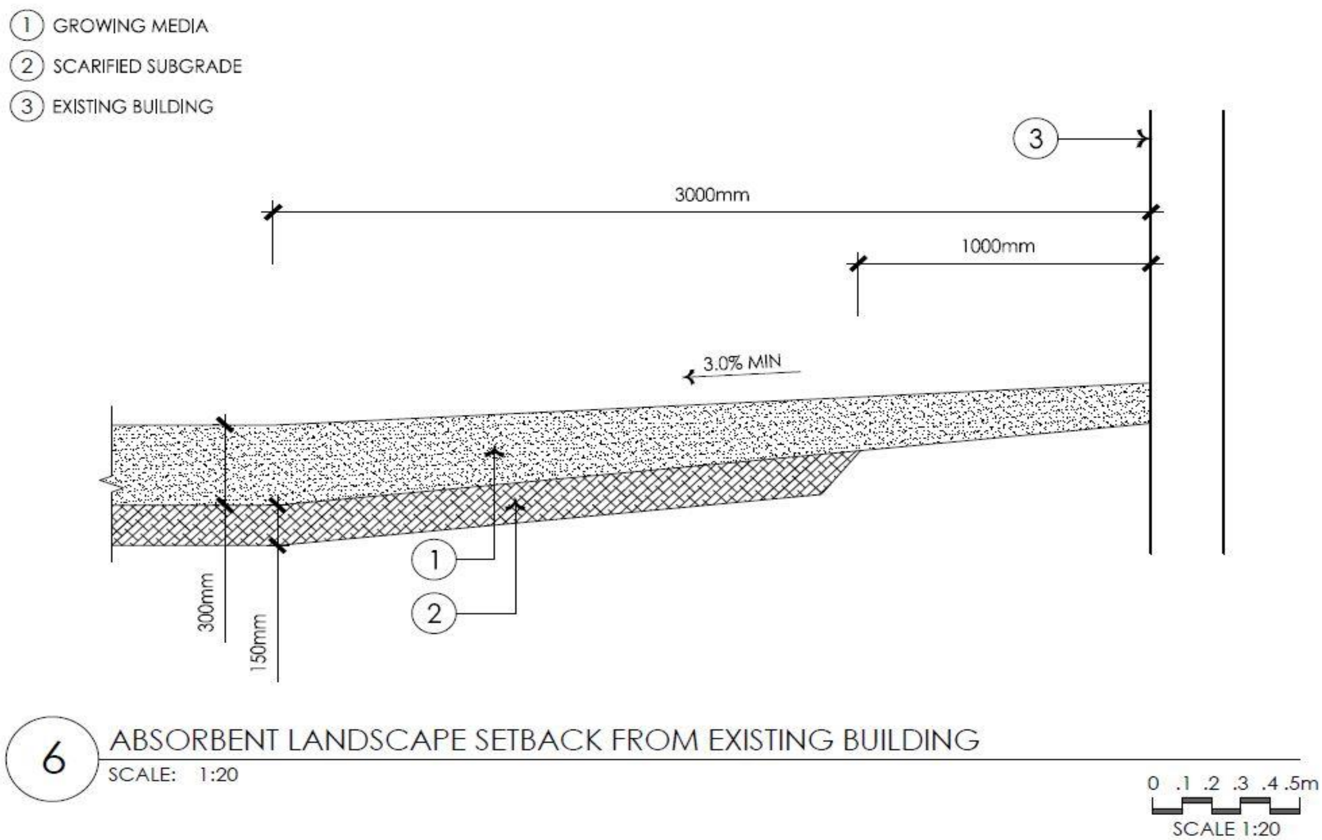
iii. Sub soil to be scarified a minimum of 100 mm unless it is not feasible due to site constraints.

5.7.7 Buffer

i. The facility base must be at least 0.6 m to 1 m above the seasonally high groundwater table (see Section ***5.2.7*** for additional details).

ii. Setback for depressions of at least 0.6 m from adjacent structures and 3 m from existing buildings.

Error! Reference source not found. **Figure 5-6** shows profile views of a few typical absorbent landscaping layouts, and are for illustrative purposes only, they do not depict every detail that may be required for successful construction, operations, and maintenance. Note the figures may not show details required to meet other aspects of the City of Edmonton and EPCOR's Design and Construction Standards such as membranes, filter fabric or clay caps, for example deeper topsoil adjacent to curbs must have a 150 mm clay cap to prevent fines migration and support the sidewalk.



6 ABSORBENT LANDSCAPE SETBACK FROM EXISTING BUILDING

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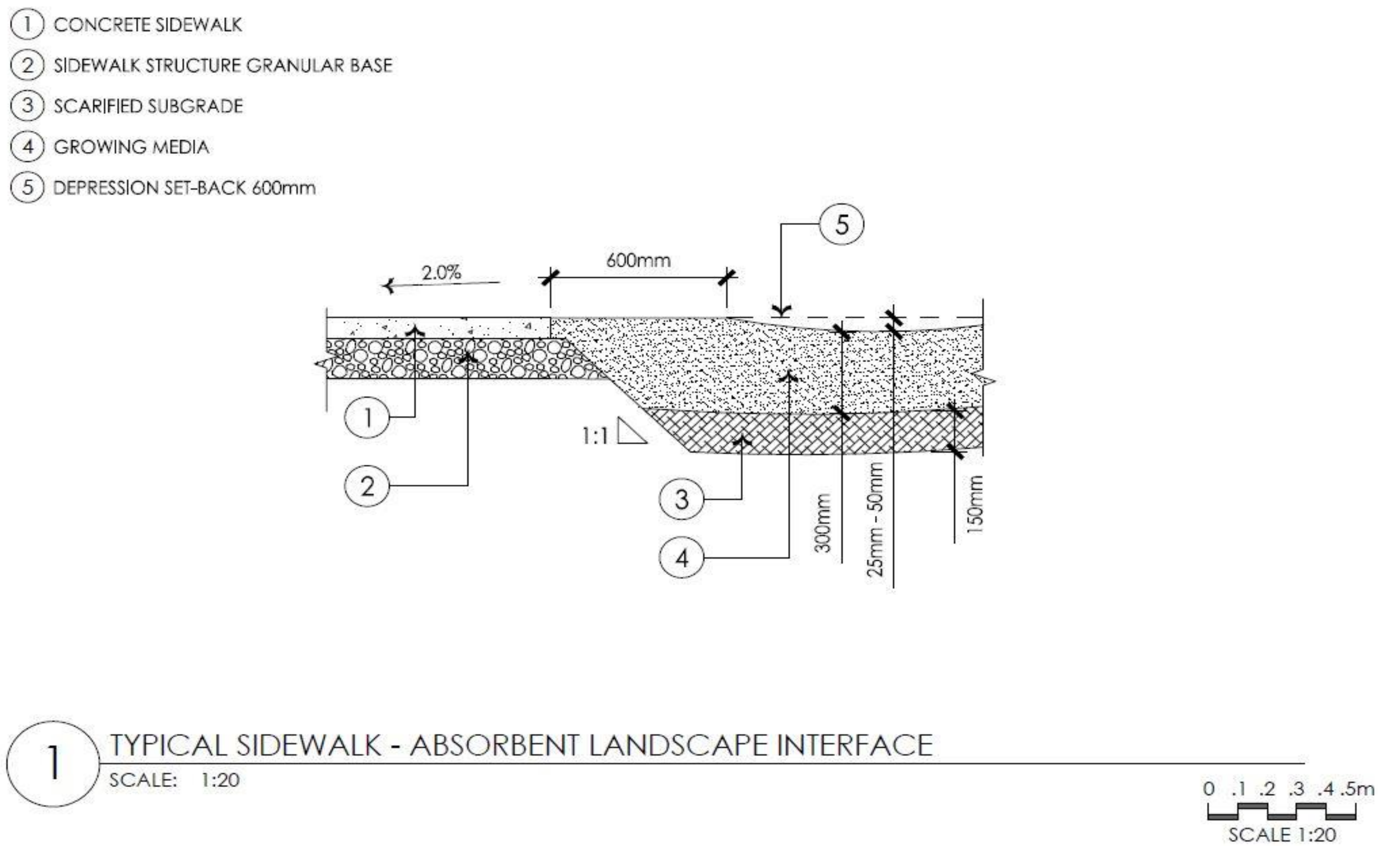


Figure 5-6: Absorbent Landscaping Cross Sections

5.8 Piping and Infrastructure Considerations

i. All piping must be smooth, rigid, PVC pipe with a minimum 200 mm diameter. This applies to distribution piping, underdrain piping, leads, and cleanouts to surface.

ii. If underdrain piping does not require a cleanout at the upstream end (below minimum lengths and bends/junctions as listed below) it must be capped. Perforated distribution piping must either be capped or come to surface as a cleanout. Piping cannot be capped with any type of fabric, and filter fabric should not be placed inside the piping.

iii. Where bends are required, the maximum angle of bends allowed shall be the long radius type of either 22.5°, 45° or 90°, multiple long radius bends may be used to create a steeper incline for cleanouts but must include a minimum length of 400 mm of straight pipe between bends.

iv. Cleanouts may come to surface at an angle or vertically when provided with a single long radius 90 degree bend (minimum radius of 1200 mm). Cleanouts must contain either an underground enclosure box or an element resistant cover when they come to surface. Covers must only be used for vertical cleanouts that breach a hard surface. Covers must be element resistant, resilient and made of brass, iron or other durable material. When an underground enclosure box is to be used for an angled pipe the box must be installed so that the pipe breaks the surface at the box edge closest to the LID facility. See DR-02-05-01 and DR-02-05-02 in Vol. 3-06: Construction Specifications and Standards Drawings.

v. If in-line cleanouts are to be used they must be installed with a barrel cleanout. In-line cleanouts are not preferred and should only be utilized if no other configuration is feasible.

vi. Each separate piping line must include a manhole or CB to allow for cleaning/flushing of the pipe. CB-style cleanouts may also be considered as a piping lines' CB if they are within 4 m of an accessible surface (see vii below). The following must also be adhered to:

   a) The maximum permitted spacing between a manhole or CB and the next manhole or CB is 150 m.

   b) The maximum amount of bends on a piping line is 90°. If more bends are required, a manhole, CB or CB manhole is required before the next section of piping.

   c) The maximum permitted spacing between cleanouts or a cleanout access point (such as a manhole or CB) is 150 m if there are no bends in that section of pipe. If bends are required between the cleanout and cleanout access point, the maximum permitted spacing is 30 m.

   d) If junctions are to be used both piping lines must contain a cleanout and a CB following the spacing outlined above.

   e) See ***Figure 5-7***: Piping Spacing for example layouts.

   f) There must be 400 mm of straight pipe immediately exiting a CB or MH before there is a bend

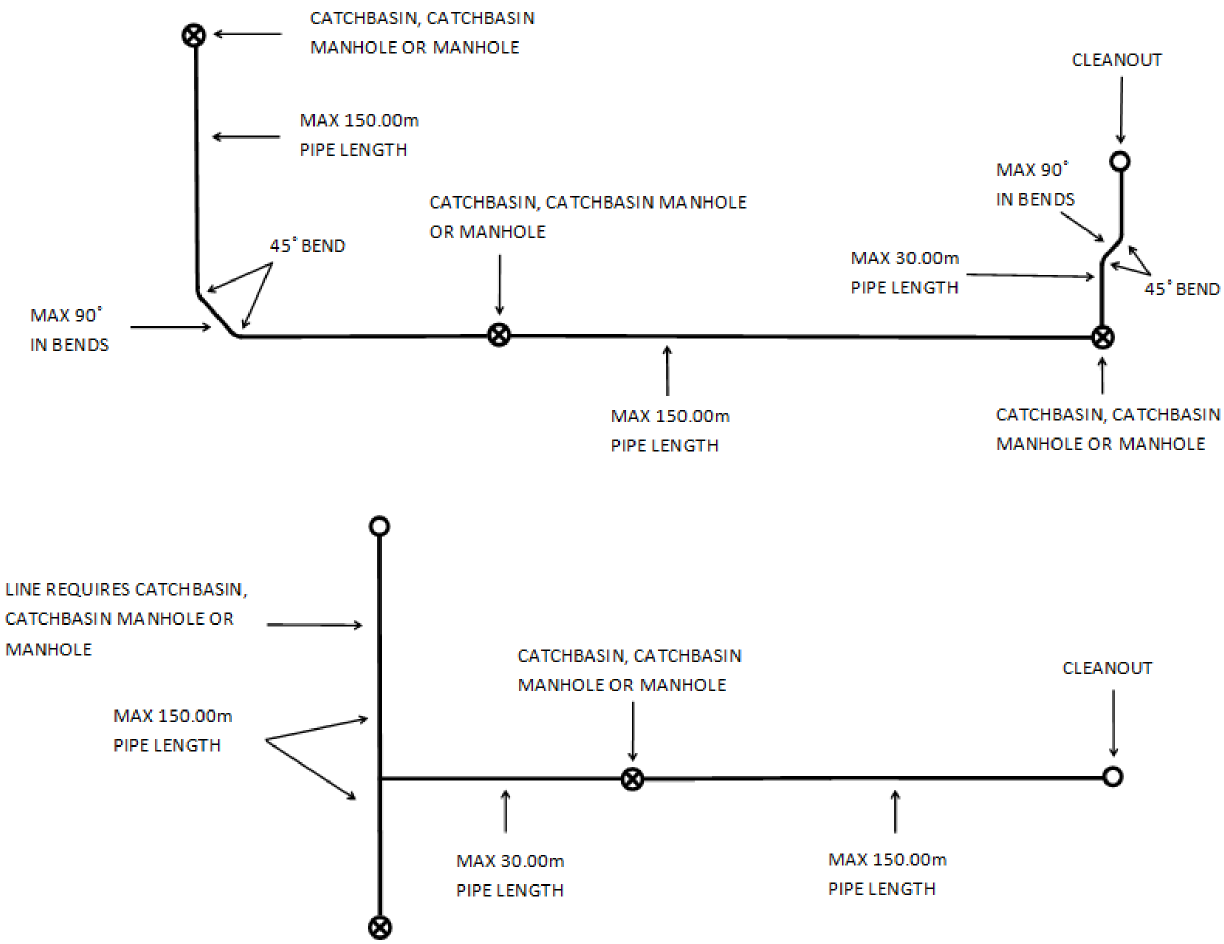


Figure 5-7: Piping Spacing

vii. If a CB (or any access point with a sump) is utilized as the primary cleanout location, the CB must be located within 4 m of a surface kept to emergency access standards, suitable for the use of a vehicle the size of a City of Edmonton fire truck. If feasible, all access points with sumps should be located within 4 m of a surface kept to emergency access standards.

viii. If the minimum required pipe grade is not feasible the following shall apply:

- Piping should be sloped towards the manhole or CB to facilitate drainage of the pipe and allow for proper cleaning/flushing.
- If the sloped pipe would affect the functionality of the LID or is not feasible due to existing infrastructure and grades; piping extending from a manhole or CB must be flat.

ix. If permanent stub ends are to be used, they must be reinforced using one of the following options:

- A stainless steel or galvanized steel cap with a concrete thrust block or approved restrained end cap.
- A 12-gauge stainless steel insert bonded to the inside of a threaded PVC Cleanout plug. The stainless steel insert shall fit tightly inside the Cleanout plug and be bonded using marine epoxy.
- An approved equivalent.

x. Perforated piping must be placed within an aggregate layer. The aggregate layer must be thick enough to protect the soil media from flushing/cleaning operations. Perforated piping must not be installed with the geotextile immediately adjacent to the pipe due to clogging concerns. The aggregate should be sized to ensure it does not fall into the perforated holes. A typical embedment for perforated distribution piping is shown in ***Figure 5-8***: Typical Perforated Distribution Embedment***.*** The embedment shape can be square or circular, this is simply a depiction of one possibility.

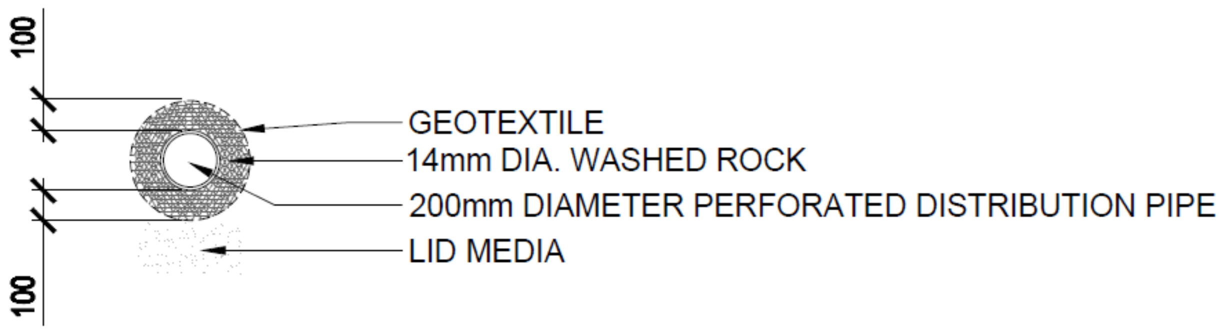


Figure 5-8: Typical Perforated Distribution Embedment

xi. Pipe perforations are to be spaced 125 mm apart and the orientation of the perforations is specified in ***Figure 5-9***: Pipe Perforations below. If the pipe is to be used for a specific purpose such as storage, other perforation configurations can be specified by the designer to meet required performance objectives.

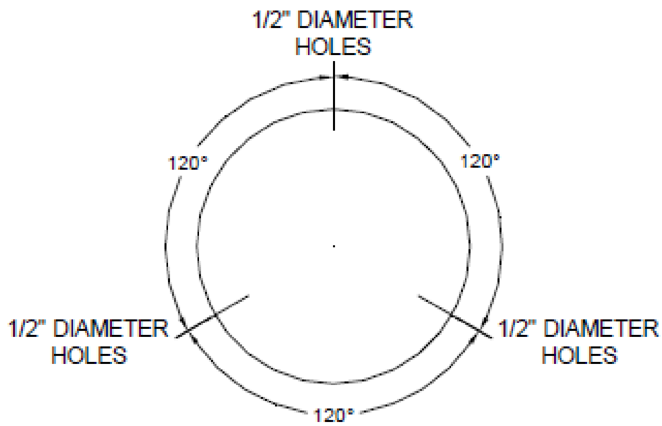


Figure 5-9: Pipe Perforations

xii. LID inlets and outlets utilizing manhole and CBs must meet the frame, cover and barrel size requirements in the Volume 3 Drainage Drawing and Construction Standards. Barrel heights may be adjusted to better suit the LID, however sump requirements must be followed. The specific manhole or CB configuration can be chosen based on the LID facility and the location it is to be installed. For distribution piping only, the grade ring requirement can be reduced to use two-50 mm grade rings. If minimum depths of piping cannot be met due to other restrictions such as groundwater table or LID design this must be indicated in the project-specific drawings and details. If any piping protrudes into the CB or manhole it must not protrude more than 50 mm; if there are multiple pipes protruding into the CB or manhole they must be flush with the barrel. If piping/devices must protrude into the barrel of the CB or manhole a larger barrel size may be required.

xiii. For locations located in longitudinal sags, as well as in areas with flat grades (i.e. adjacent to curb extensions and chicanes), or with obstructions (ie. raised crosswalks) the drainage system must have a standard (non-LID) CB installed downslope of the LID.

xiv. If bioretention basins and box planters contain an overflow, a short trash rack must be installed. See DR-06-18-12 in Vol. 3-06: Construction Specifications and Standards Drawings. Overflow structures must be accessible for maintenance after vegetation has been established. Overflows must be positioned away from inlets, preferably near the middle of the LID facility to encourage water movement and infiltration. If surcharging from the combined sewer system is a possibility flap gates must be installed on the system to prevent combined sewage from entering the LID facility. If flap gates are used, they must be Fontaine SERIES 60 with an RMX mount or equivalent installed on a 1200 mm manhole or catch basin manhole to allow for maintenance and repair of the device. For retrofits a different flap gate including specifications, installation procedures, and maintenance guides must be provided. A smaller diameter CB may be considered if the entire device can be removed and reinstalled from grade for maintenance.

xv. Underground enclosure boxes (including junction boxes and valve boxes) and caps must be labelled appropriately. Underground enclosures boxes or caps should be installed to protect infrastructure coming to surface such as cleanouts. Underground enclosure boxes must be firmly embedded within the LID soil media and not within the mulch to ensure sufficient stability to anchor the box. Underground enclosure boxes and caps must be designed and installed to meet any loadings relative to their location. LID boxes and caps must be engraved with “LID”. Cleanouts and underground enclosure boxes must be clear of trees, buildings, or permanent obstructions within 1 m of the cleanout location (small vegetation is acceptable). If due to site constraints a 1 m radius around the cleanout is not possible, a minimum of 180° of clear space is required.

xvi. For LID CB inlets only, a Type 4A frame and cover can be used on a 600mm barrel. See **Figure 5-10** for a typical LID CB with the approved 4A grate and frame.

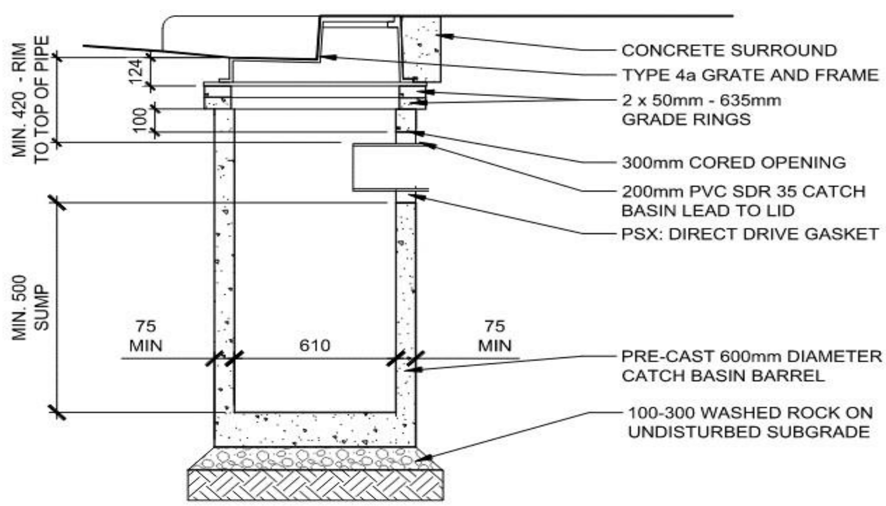


Figure 5-10: Type 4A w/ 600mm Barrel

5.9 Signage Considerations

5.9.1 Cautionary signs are required at all individual LID facilities with softscape. Signs must be installed two to three weeks prior to FAC inspection, signs should not be installed prior to this time. Signs must be as per Figure 5-11 below and must be:

- 12” by 15”
- Holes for the signs to be 3/8” in diameter
- Signs must be aluminum
- Posts should be 12 ga x 8 Foot Steel Galvanized U Channel.
- Holes must be placed 13” apart measured center to center, at the approximate locations of the pink circles shown in Figure 5-11, these must match hole spacing on the posts.

Sign Placement within each LID facility should be shown on the plan view of the drawings.

Figure 5-11: LID Caution Signage

5.10 Cold Climate Design Considerations

5.10.1 De-icing salt loadings to LID facilities should not exceed 1000 mg/L during winter months to avoid salt induced injury to vegetation and soils. LID facilities that will receive higher loadings must be designed with salt tolerant species, highly permeable soils, and underdrains.

5.10.2 Locate snow storage areas away from LID facilities unless vegetation and soil structure is specifically designed to accommodate snow storage. Snow loading calculations must be completed for snow storage areas to ensure the weight of the snow will not affect the soil compaction or cause pipe deformations. Boulevards and other areas can sometimes be used for snow storage, these areas should be designed accordingly. Salt tolerant, non-woody vegetation are recommended for areas that may be used for snow storage. Loading calculations and corresponding design must be signed and stamped by a qualified professional. LID is not recommended for use at dedicated snow storage facilities (i.e. sites that store a large amount of snow from multiple sites).

5.10.3 Size curb cut inlets to prevent blockage by ice and snow during spring runoff. See **Figure 5-12: Typical Curb Cut Opening** below for a typical concrete curb opening approved by the City of Edmonton. Other curb openings may be accepted by the City of Edmonton.

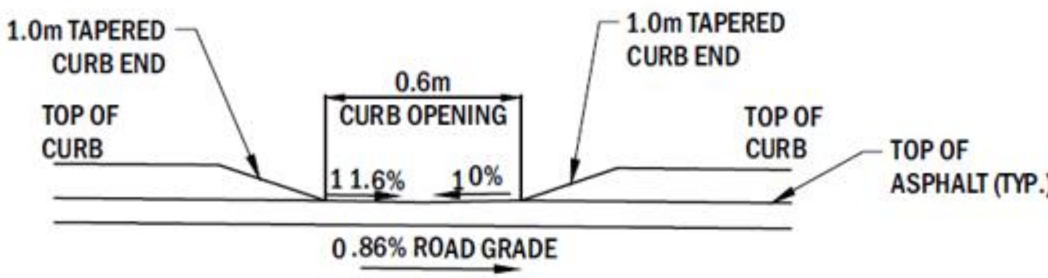


Figure 5-12: Typical Curb Cut Opening

5.11 Vegetation Selection

5.11.1 Select plant varieties that will thrive on the site conditions and that grow well together. Species selection should consider:

- Soil permeability and periodic inundation of the soil;
- LID soil media type (as per Sections ***5.14***)
- Tolerance of seasonal salt loadings depending on facility location;
- Pollutant uptake capacity;
- Maintenance needs, including mowing and pruning;
- Sight lines for facilities on or near roadways;
- Site use, for example in high traffic pedestrian areas plants with an odour may not be appropriate;
- Reduction of water and fertilizer needs after establishment;
- Potential nuisances (i.e. pollen and aroma) in high traffic areas; and
- Resistance to pests.

Recommended native species for LID are listed in **Table 5-3** below. This table is limited to native material only; this list is not fully comprehensive and there are many plants, both native and non-native, that will function in LID facilities that are not represented here. **Table 5-3** is provided for guidance and outlines some of the characteristics and principles of plant selection that we look for when designing LID facilities but, designers have the ability to provide exceptions and expansions to the list. If utilizing the list, designers must still choose plants that are suitable for the location and LID type.

5.11.2 Native species are recommended to be used where possible as native species typically facilitate further ongoing infiltration through development of root structures and are more resistant to changing weather patterns and climate change. Recommended plant species have been included in **Table 5-3** however, vegetation selected for specific LID facilities is still governed by the City of Edmonton Design and Construction Standards, Volume 5: Landscaping and must meet these requirements. Note all recommended plant species may not be suitable for every situation, for example LID facilities near roadways have size restrictions to maintain sight lines.

5.11.3 For soil cells ONLY, a drought tolerant, minimal maintenance blend of grasses can be used over top of the soil cells. This configuration can be used for mature neighbourhood retrofits. Trees and shrubs should be used where possible, to encourage stormwater uptake and ongoing infiltration through development of root structures. **Table 5-3** lists very few trees suitable for soil cells as native species may not be ideal for soil cells in urban environments. A mix of ornamental and native tree species is encouraged for soil cells if possible. Trees selected are still governed by the City of Edmonton Design and Construction Standards, Volume 5: Landscaping and must meet these requirements.

Table 5-3: Recommended Native Plant Species for LID Facilities in Edmonton, Alberta

Common Name	Scientific Name	Plant Type	Establishment Method	Wetland Indicator Status	Drought Tolerance	Salt Tolerance	Soil Moisture	Soil Preference	Succession	Mature Spread (cm)	Mature Height (cm)	Sunlight Preference	Additional Information
Water Sedge	*Carex aquatilis*	Aquatic	Seed	OBL	Low	Low	Moist - Wet	Sand, Clay, Loam	Decreaser		100 - 200	Part Shade - Full Sun	Can be mat forming, in loose or dense colonies.
Golden Sedge	*Carex aurea*	Aquatic	Seed or Live Plant Material	OBL	Low	Low	Moist - Wet	Sand, Loam	Decreaser	60-90	35	Part Shade - Full Sun	Minimum root depth 20 cm; Thrives in shallow water.
Bebb's Sedge	*Carex bebbii*	Aquatic	Seed	OBL	Medium	Medium	Moist - Wet	Sand, Clay, Loam	Increaser	30	30	Full Sun	Forms clumps; Does most of its growing in the spring.
Beaked Sedge	*Carex utriculata*	Aquatic	Seed or Live Plant Material	OBL	Medium	Low	Moist - Wet	Clay, Loam	Increaser		50 -100	Full Sun	Spreads by rhizomes to form clumps.
Common Spike Rush	*Eleocharis palustris*	Aquatic	Seed	OBL	Low	Low	Moist	Sand, Clay	Increaser	30-60	60-100	Part Shade - Full Sun	Mat forming.
Baltic Rush	*Juncus balticus*	Aquatic	Seed or Live Plant Material	OBL	Low	High	Moist - Wet	Sand, Clay, Loam	Increaser	90	30-90	Part Shade - Full Sun	Important nitrogen fixer and has thick rhizomes that bind the soil together.
Small Leaved Pussytoes	*Antennaria parvifolia*	Forb	Live Plant Material	UPL	High	Medium	Dry - Moist	Sand, Clay, Loam	Increaser	30-50	10-15	Full Sun	Responds negatively to severe fires, if conducting controlled burns wet large patches to ensure they remain in the planting.
Yarrow	*Achillea millefolium*	Forb	Live Plant Material	FACU	High	Medium	Dry - Moist	Sand, Loam	Increaser	60	30-90	Full Sun	Spreads by rhizomes which can become aggressive under ideal conditions.
Giant Hyssop	*Agastache foeniculum*	Forb	Seed or Live Plant Material	FAC	Medium	Medium	Moist	Sand	Increaser	150-300	45-90	Part Shade - Full Sun	Self-seeds readily.
Canada Anemone	*Anemone canadensis*	Forb	Live Plant Material	FACW	Medium	Medium	Moist	Sand, Clay, Loam	Increaser	60-75	30-60	Part Shade - Full Sun	Can spread aggressively; Creates uniform ground cover.
Rosy Pussytoes	*Antennaria rosea*	Forb	Live Plant Material	UPL	High	Medium	Dry - Moist	Sand, Clay, Loam	Increaser	30-50	10-30	Part Shade - Full Sun	Responds negatively to severe fires, when conducting controlled burns wet large patches to ensure they remain in the planting.
Meadow Arnica	*Arnica chamissonis*	Forb	Seed or Live Plant Material	FACW	Low - Medium	Low	Moist	Sand, Loam	Increaser	50-100	45-70	Part Shade - Full Sun	Has shallow roots and it is very easy to dig out unwanted plants; Sow the seeds in late fall or late spring directly into the garden; Local availability may be an issue.
Heart-leaved Arnica	*Arnica cordifolia*	Forb	Seed or Live Plant Material	NI	Low	Low	Dry - Moist	Sand, Clay, Loam	Increaser	20-60	20-60	Full Shade - Part Shade	Has low resistance to consistent foot traffic.
Shining Arnica	Arnica fulgens	Forb	Seed or Live Plant Material	UPL	Low - Medium	Low	Moist	Sand, Clay, Loam	Increaser	50-100	50	Part Shade - Full Sun	Sow in fall or stratify to break dormancy; Local availability may be an issue.
Dwarf Milkweed	*Asclepias ovalifolia*	Forb	Seed or Live Plant Material	NI	High	Medium	Dry - Moist	Sand, Loam	Increaser	20-50	20-50	Full Shade - Full Sun	Plant contains latex, a common allergen, so gloves should be worn when handling.
Showy Milkweed	*Asclepias speciosa*	Forb	Seed or Live Plant Material	FAC	Low	Low	Dry - Moist	Sand, Clay, Loam	Increaser	45-150	45-150	Part Shade - Full Sun	Plant contains latex, a common allergen, so gloves should be worn when handling.
Bunchberry	*Cornus canadensis*	Forb	Live Plant Material	FACU	Low	Low	Moist	Sand, Clay, Loam	Increaser	30-60	10-20	Full Shade - Full Sun	Spreads evenly and quickly creating continuous ground cover.
Mountain Shooting Star	*Dodecatheon conjugens*	Forb	Seed	FACU	High	Medium	Moist	Sand, Loam	Decreaser	10-15	20-25	Part Shade - Full Sun	Short-lived perennial.
Tufted Fleabane	*Erigeron caespitosus*	Forb	Seed	NI	High	Medium	Dry	Sand, Loam	Increaser	15-45	10-30	Full Sun	Spreads by short rhizomes and seed with a moderate to fast growth habit.
Smooth Fleabane	*Erigeron glabellus*	Forb	Seed	FACW	High		Dry - Moist	Sand, Loam	Increaser	30-45	30-45	Part Shade - Full Sun	A low maintenance perennial with an upright spreading growth habit.
Wild Strawberry	*Fragaria virginiana*	Forb	Live Plant Material	FACU	Medium	Medium	Dry - Moist	Sand, Loam	Increaser	15-20	15-20	Part Shade - Full Sun	Plants spread horizontally and reproduce through stolons to create a ground cover.
Northern Bedstraw	*Galium boreale*	Forb	Seed or Live Plant Material	FACU	Medium	Low	Dry - Moist	Sand, Loam	Increaser	30-45	60-90	Part Shade - Full Sun	Spreads by seed and rhizomes; ideal for soil stabilization.

Common Name	Scientific Name	Plant Type	Establishment Method	Wetland Indicator Status	Drought Tolerance	Salt Tolerance	Soil Moisture	Soil Preference	Succession	Mature Spread (cm)	Mature Height (cm)	Sunlight Preference	Additional Information
Gumweed	*Grindelia squarrosa*	Forb	Seed or Live Plant Material	UPL	High	High	Dry	Sand, Clay, Loam	Increaser	30-60	20-60	Full Sun	Can be weedy; Plants may be pruned or mowed back to prevent excessive spreading; Plant is biennial and short-lived.
Beautiful Sunflower	*Helianthus pauciflorus*	Forb	Seed or Live Plant Material	NI	High	High	Dry	Sand	Increaser	60	15-35	Part Shade - Full Sun	Plants exude allelopathic chemicals that inhibit the growth of young plants nearby.
Meadow Blazingstar	*Liatris ligulistylis*	Forb	Seed or Live Plant Material	FAC	High	Medium	Dry - Moist	Sand	Increaser	20-40	45-70	Full Sun	Seeds are large and wind dispersed; Collecting and reseeding into the desired area will increase establishment.
Blue Flax	*Linum lewisii*	Forb	Seed	NI	High	Low	Dry - Moist	Sand, Loam	Stable	50-90	30-90	Full Sun	Short-lived perennial; Can become weedy if there is little competition.
Ostrich Fern	*Matteuccia struthiopteris*	Forb	Live Plant Material	FACW	Low	Low	Moist	Sand, Loam	Increaser	100-200	100-200	Full Shade - Part Shade	Clump forming and can become aggressive under ideal conditions.
Wild Mint	*Mentha arvensis*	Forb	Live Plant Material	FACW	Low	Low	Moist - Wet	Clay, Loam	Increaser	100	20-75	Full Shade - Full Sun	Can spread aggressively under ideal conditions; Resistant to browsing from deer; Can be mat forming.
Tall Bluebells	*Mertensia paniculata*	Forb	Seed	FAC	Low	Low	Moist - Wet	Sand, Clay, Loam	Increaser	45	20-80	Full Shade - Part Shade	Regenerates from thick rhizomes.
Wild Bergamot	*Monarda fistulosa*	Forb	Seed or Live Plant Material	FACU	High	Medium - High	Dry - Moist	Sand, Clay, Loam	Increaser	60-90	60-90	Full Sun	Requires occasional maintenance, can spread to form clumps and self seed.
Yellow Coneflower	*Ratibida columnifera*	Forb	Seed	NI	High	Low	Dry - Moist	Sand, Loam	Increaser	30-45	30-90	Full Sun	Will readily self-seed.
Canada Goldenrod	*Solidago canadensis*	Forb	Seed or Live Plant Material	FACU	Medium	Low	Dry - Moist	Sand, Clay, Loam	Increaser	50-100	50-100	Part Shade - Full Sun	Can be aggressive under ideal conditions.
Prairie Goldenrod	*Solidago missouriensis*	Forb	Seed	FACU	Low	Low	Dry - Moist	Sand, Clay, Loam	increaser	30-60	45-90	Part Shade - Full Sun	Spreads by rhizomes and seeds with a moderate to fast growth habit, can become aggressive.
Sticky Goldenrod	*Solidago simplex*	Forb	Seed	FACU	Low	Low	Dry - Moist	Sand, Loam	Increaser	30-45	20-45	Full Sun	Could be used in smaller spaces; can be controlled by deadheading.
Smooth Aster	*Symphyotrichum laeve*	Forb	Seed or Live Plant Material	FACU	Medium	Medium	Dry - Moist	Clay, Loam	Decreaser	30-90	30-90	Part Shade - Full Sun	Can directly seed into plantings, seeds do not require either scarification or stratification.
Purple Stemmed Aster	*Symphyotrichum puniceum*	Forb	Seed or Live Plant Material	OBL	Medium	Medium	Moist - Wet	Clay, Loam	Increaser	60-90	60-150	Full Sun	Can spread rapidly and form large colonies in moist - wet areas.
Heart-leaved Alexanders	*Zizia aptera*	Forb	Live Plant Material	FAC	Medium	Medium	Dry - Moist	Sand, Clay, Loam	Decreaser	45-60	45-90	Part Shade - Full Sun	Low maintenance perennial.
Indian Ricegrass	*Achnatherum hymenoides (Oryzopsis hymenoides)*	Grass	Seed	FACU	High	Medium	Dry - Moist	Sand, Clay, Loam	Stable		25-70	Full Sun	Seeds must be pretreated to break dormancy.
Awned Wheatgrass	*Agropyron subsecundum*	Grass	Seed	FACU	Medium	Low	Dry - Moist	Loam	Decreaser		50-100	Part Shade - Full Sun	Self-seeds, some tillering.
Blue Grama	*Bouteloua gracilis*	Grass	Seed	UPL	High	Medium	Dry	Sand, Clay, Loam	Increaser	45-60	30-35	Full Sun	Tolerates moderate to heavy foot traffic.
Marsh Reed Grass	*Calamagrostis canadensis*	Grass	Seed	OBL	Medium	Medium	Moist - Wet	Sand, Clay, Loam	Decreaser	100-150	100-200	Full Sun	Rhizomes can be pruned in the spring to limit spread.
Tufted Hairgrass	*Deschampsia caespitosa*	Grass	Live Plant Material	FACW	High	Low	Moist	Sand, Clay, Loam	Stable	30	40	Full sun	A clump forming perennial that can provide erosion control with its deep rhizomes.
Canada Wildrye	*Elymus canadensis*	Grass	Seed	FAC	High	High	Dry - Moist	Sand, Clay, Loam	Decreaser	60-90	100-150	Part Shade - Full Sun	Lives 4-5 years, reseeds easily on bare soil.

Common Name	Scientific Name	Plant Type	Establishment Method	Wetland Indicator Status	Drought Tolerance	Salt Tolerance	Soil Moisture	Soil Preference	Succession	Mature Spread (cm)	Mature Height (cm)	Sunlight Preference	Additional Information
Rocky Mountain Fescue	*Festuca saximontana*	Grass	Seed or Live Plant Material	NI	High	High	Dry - Moist	Sand, Loam	Increaser		20-25	Part Shade - Full Sun	Does well in disturbed or polluted areas but does not tolerate heavy foot traffic.
Tall Manna Grass	*Glyceria grandis*	Grass	Seed	OBL	Low	Low	Wet	Clay, Loam	Decreaser		25-60	Full Sun	Spreads by thick rhizomes and stolons; suitable for erosion control.
Sweetgrass	*Hierochloe odorata*	Grass	Live Plant Material	FACW	Low	High	Moist - Wet	Sand, Clay, Loam	Increaser	60	30-60	Part Shade - Full Sun	One of the four sacred plants to Metis and Indigenous people; It grows much better from rhizomes than from seed, and may triple in size within one year.
Junegrass	*Koeleria macrantha*	Grass	Seed or Live Plant Material	FACU	High	Low	Dry - Moist	Sand, Loam	Increaser	30-60	30-60	Full Sun	Seedlings are weak and do not survive moderate to high foot traffic.
Fowl Bluegrass	*Poa palustris*	Grass	Seed	FACW	Low	Low	Moist	Clay, Loam	Decreaser		150	Part Shade	Requires a minimum root depth of 30 cm.
False Melic Grass	*Schizachne purpurascens*	Grass	Seed	FACU	Medium	Low	Dry - Moist	Sand	Decreaser	10-15	40-80	Full Shade - Part Shade	Prefers shadier spots than most grasses making it suitable for treed areas.
Little Bluestem	*Schizachyrium scoparium*	Grass	Seed or Live Plant Material	FACU	High	Medium - High	Dry - Moist	Sand	Increaser	45-60	30-70	Full Sun	Requires burning or mowing with thatch removal every 3-5 years.
Needle and Thread Grass	*Stipa comata*	Grass	Seed	UPL	High	Low	Dry	Sand, Loam	Decreaser	30	40-60	Part Shade - Full Sun	Requires >254 mm of annual precipitation but grows in areas with less; Provides stabilization from erosion; Seed heads are potentially problematic for pet owners in residential areas.
Green Alder	*Alnus viridis*	Shrub	Seed or Live Plant Material	FAC	Low	Low	Moist	Sand, Loam	Increaser		300	Part Shade - Full Sun	Clearance from lowest branches to the ground can be up to 100 cm at maturity
Saskatoon Serviceberry	*Amelanchier alnifolia*	Shrub	Live Plant Material	FACU	Low - Medium	Low	Dry - Moist	Sand, Loam	Decreaser	200-300	300-400	Full Sun	No clearance under the lowest branches could impedes sightlines; Species is a decreaser without proper maintenance.
Bog Birch	*Betula pumila*	Shrub	Live Plant Material	OBL	Low	Low	Moist - Wet	Sand, Loam	Increaser	200-300	100-300	Part Shade - Full Sun	Low maintenance, minimal suckering and has a fast growth rate.
Red Osier Dogwood	*Cornus sericea*	Shrub	Live Plant Material	FACW	Medium	High	Dry - Moist	Sand, Clay, Loam	Increaser	300	300	Part Shade - Full Sun	Low maintenance, may require light pruning.
Beaked Hazelnut	*Corylus cornuta*	Shrub	Live Plant Material	UPL	Medium	Low	Dry - Moist	Sand, Loam	Stable	100-200	100-200	Part Shade - Full Sun	Controlled burn will kill the above ground portion of the shrub, but it readily resprouts.
Castlegar Hawthorn	*Crataegus chrysocarpa*	Shrub	Live Plant Material	FACU	Medium	Medium	Moist - Wet	Loam	Decreaser	400	500	Part Shade - Full Sun	Does not require any significant pruning to maintain its shape; Can be planted to stabilize banks, preventing wind and water erosion.
American Silverberry	*Elaeagnus commutata*	Shrub	Live Plant Material	UPL	High	High	Dry - Moist	Sand, Clay, Loam	Increaser	300	200-400	Full Sun	Recovers slowly from severe fire.
Wolf Willow	*Elaeagnus commutata*	Shrub	Live Plant Material	UPL	High	Medium	Dry - Moist	Clay, Loam	Increaser	200-400	200-400	Full Sun	Readily suckers, thicket forming.
Twinberry Honeysuckle	*Lonicera involucrata*	Shrub	Live Plant Material	FACU	Medium	Low	Moist	Clay, Loam	Increaser	150	300	Part Shade - Full Sun	Naturalizes through self-seeding and can form colonies overtime.
Shrubby Cinquefoil	*Potentilla fruticosa*	Shrub	Live Plant Material	FACW	High	Medium	Dry - Wet	Sand, Clay, Loam	Increaser	50-100	100-150	Part Shade - Full Sun	May require the removal of die back every spring.
Fire Cherry, Pin Cherry	*Prunus pensylvanica*	Shrub	Live Plant Material	FACU	Medium - High	Medium	Dry - Moist	Sand, Clay, Loam	Decreaser	200-300	200-500	Full Sun	Clearance from lowest branches to the ground can be up to 120 cm at maturity, without pruning.
Golden Currant	*Ribes aureum*	Shrub	Live Plant Material	FACU	High	Low	Dry - Moist	Sand, Clay, Loam	Increaser	60-200	100-300	Part Shade - Full Sun	Plant may sucker under ideal conditions.
Wild Rose	*Rosa acicularis*	Shrub	Live Plant Material	FACU	Low	Low	Dry - Moist	Clay, Loam	Increaser	100	100	Part Shade - Full Sun	Requires occasional maintenance and upkeep, best pruned in late winter.

Common Name	Scientific Name	Plant Type	Establishment Method	Wetland Indicator Status	Drought Tolerance	Salt Tolerance	Soil Moisture	Soil Preference	Succession	Mature Spread (cm)	Mature Height (cm)	Sunlight Preference	Additional Information
Beaked Willow	*Salix bebbiana*	Shrub	Live Plant Material	FACW	Low	Low	Moist - Wet	Sand, Clay, Loam	Increaser	100-600	300-1000	Part Shade - Full Sun	Short-lived and fast-growing; Susceptible to insect, disease, and wind damage.
Hoary Willow	*Salix candida*	Shrub	Live Plant Material	OBL	Low	Low	Moist - Wet	Sand, Clay, Loam	Increaser	50-100	50-100	Part Shade - Full Sun	Short-lived and fast-growing; Susceptible to insect, disease, and wind damage.
Under-green Willow	*Salix commutata*	Shrub	Live Plant Material	OBL	Low	Low	Moist - Wet	Sand, Loam	Increaser	50-150	300	Part Shade - Full Sun	Little maintenance required.
Pussy willow	*Salix discolor*	Shrub	Live Plant Material	FACW	Medium	Medium	Wet	Sand, Clay, Loam	Increaser	100-300	200-300	Part Shade - Full Sun	Branches will need maintenance annually.
Drrummond's Willow	*Salix drummondiana*	Shrub	Live Plant Material	FACW	Low	Low	Moist - Wet	Sand, Clay, Loam	Increaser	100-300	200-400	Part Shade - Full Sun	Plant can sucker profusely.
Sandbar Willow	*Salix exigua*	Shrub	Live Plant Material	FACW	Medium	Low	Moist - Wet	Sand, Loam	Increaser	250-400	400-700	Part Shade - Full Sun	Plant can sucker profusely.
Gray leaf Willow	*Salix glauca*	Shrub	Live Plant Material	FACW	Low	Low	Moist - Wet	Clay, Loam	Increaser	200-300	120-200	Part Shade - Full Sun	Plant can sucker profusely.
Shining Willow	*Salix lucida*	Shrub	Live Plant Material	FACW	Low	Low	Moist - Wet	Clay, Loam	Increaser	500-600	500-600	Part Shade - Full Sun	Aggressive roots can exploit soil moisture; Fast-growing, short-lived, and prone to disease and insect damage.
Yellow Willow	*Salix lutea*	Shrub	Live Plant Material	FACW	Low	Low	Moist	Sand, Clay, Loam	Increaser	300	300-600	Full Sun	Fast growing; Some maintenance required.
Meadow Willow	*Salix petiolaris*	Shrub	Live Plant Material	OBL	Medium	Low	Dry - Moist	Sand, Clay, Loam	Increaser	300	300	Part Shade - Full Sun	Low maintenance; Forms dense spreading tidy clumps; Is good for erosion control.
Silver Buffaloberry	*Shepherdia argentea*	Shrub	Live Plant Material	UPL	Medium	High	Dry - Moist	Sand, Loam	Increaser	300	400	Full Sun	Tolerates the poor soils and does well in dry or alkaline situations; Low maintenance and extremely cold- and drought-tolerant.
Canada Buffaloberry	*Shepherdia canadensis*	Shrub	Live Plant Material	FACU	High	Medium	Dry - Moist	Sand, Loam	Increaser	200-300	100-200	Full Shade - Full Sun	Low maintenance. Extremely cold- and drought-tolerant.
White Meadow Sweet	*Spiraea alba*	Shrub	Live Plant Material	FACW	Low	Low	Moist - Wet	Sand, Clay, Loam	Increaser	50-150	100-200	Part Shade - Full Sun	Can sucker under ideal conditions. Remove spent flower clusters to promote additional bloom.
Snowberry	*Symphoricarpos albus*	Shrub	Live Plant Material	UPL	High	Medium	Dry - Moist	Sand, Clay, Loam	Increaser	100-200	100-200	Part Shade - Full Sun	Plants can sucker, prune as needed.
High-bush Cranberry	*Viburnum edule*	Shrub	Live Plant Material	FACW	Low	Low	Moist	Sand, Clay, Loam	Decreaser	200-400	200-300	Part Shade - Full Sun	Thicket forming.
White Birch	*Betula papyrifera*	Tree	Live Plant Material	FACU	Low	Medium	Moist	Sand, Clay, Loam	Increaser	600	1200	Full Sun	A short-lived tree and shade intolerant. Not suitable for a soil cell.
Tamarak Larch	*Larix laricina*	Tree	Live Plant Material	FACW	Low	Low	Moist - Wet	Sand, Loam	Increaser	300	1200	Full Sun	Tree has a shallow root system. Not suitable for a soil cell.
White Spruce	*Picea glauca*	Tree	Live Plant Material	FACU	Medium	Low	Moist	Clay, Loam	Stable	300-600	1000-2000	Full Sun	Clearance from lowest branches to the ground can be up 150 cm at maturity, without pruning. Not suitable for a soil cell.
Lodgepole Pine	*Pinus contorta*	Tree	Live Plant Material	FACU	High	Medium	Dry	Sand, Loam	Increaser	600	3000	Full Sun	Clearance from lowest branches to the ground can be up to 300 cm at maturity, without pruning. Not suitable for a soil cell.
Balsam Poplar	*Populus balsamifera*	Tree	Live Plant Material	FACW	Low	Low	Moist	Sand, Clay, Loam	Increaser	1000	2500	Full Sun	A high maintenance tree that can become invasive. Not suitable for a soil cell.
Trembling Aspen	*Populus tremuloides*	Tree	Live Plant Material	FAC	Low	Medium	Dry - Wet	Sand, Clay, Loam	Increaser	500	1500	Part Shade - Full Sun	Can be an aggressive invader under ideal conditions. Not suitable for a soil cell.
Bur Oak	*Quercus macrocarpa*	Tree	Live Plant Material	FAC	High	Medium - High	Dry - Wet	Sand, Clay, Loam	Stable	1800-2500	1800-2500	Full Sun	Clearance from lowest branches to the ground can be up to 300 cm at maturity, without pruning.

Thatch removal may be required every 3 - 5 years, determined by condition of planting

5.12 Drawing Requirements

5.12.1 Design Stage Requirements

Drawing requirements for all stages of design are outlined below. All LID facilities must be labelled as LID.

Drawing sets should have a drawing index with LID Drawings clearly identified.

5.12.1.1 Concept/Preliminary

- Completed LID Summary Table (see Figure 5-13)
- Plan view of facility locations and catchments with cadastral
- Proposed locations of distribution/subdrain piping and tie into drainage system, including all pipe bends and fittings. All bends must be labelled and drawn to scale.
- Existing constraints for each LID facility

Drainage Area	LID Type	Location Where Runoff Enters to LID	Catchment Area, m^2	Catchment Imperviousness, %	Runoff Volume for Design Rainfall, m^3	LID Surface Area, m^2	LID Capacity, m^3
1	e.g. Bioretention Basin		4315	90%	67	300	75
2	e.g. Soil Cell		2000		31		28
	Sum		6315		98		103

Figure 5-13: LID Summary Table

5.12.1.2 Detailed

- All requirements outlined in **Table 5-4: Drawing Detail Requirements**
- Reference to an LID Soil Testing Plan in the Contract Documents, or a clearly laid out plan on the drawing set
- A separate drawing for each LID facility should be submitted for each drawing type, ie. Utility and landscape. Where this is not practical, it must be clear how the LID facility is split between pages.
- If erosion and sediment control measures are required for construction this should be indicated within the drawing set.

Utility Drawings

- Extent of LID facility
- Proposed locations of distribution/subdrain piping, cleanouts (including all pipe bends and fittings, all bends must be labelled and drawn to scale), tie ins, and CBs/CB Manholes with the frame and cover type labelled
- Flow direction through LID facility and overland drainage route
- Grading in the LID facility and catchment area (if applicable)
- Existing utilities including invert elevations
- Landscaping is not to be shown on utility drawings unless it is the location of existing trees, shrubs, etc. to be maintained.
- Distances to any utilities in proximity to the LID facility or its associated piping and drainage infrastructure.

- Existing infrastructure such as sidewalks, shared use paths, roads, etc.

  Details

- Applicable cleanout details from the standards
- Slope and invert elevation of distribution pipe and underdrain pipe
- Pipe perforations
- Pipe embedment
- Soil cell installation layout and placement of piping within soil cells (if applicable)
- Profile of highest point of distribution and subdrain piping within soil cells (if applicable)
- Inlet and outlet (as applicable) type and location, including a detail, tie-ins, and surface flow velocities, if applicable
- Inline or overflow CB, spillway or other water conveyance details (as applicable)
- Profile of all LID infrastructure tie-ins to existing or proposed drainage infrastructure

  Landscape

- Separate planting plans must be included with every LID plan
- Vegetation maturity, species and quantity summary table
- General layout of distribution and underdrain piping (and other potential utility conflicts) should be shown to gauge proximity to both existing and proposed mature plants and trees. Landscaping is not to be shown on utility drawings with the exception of existing trees, shrubs etc. that may conflict with the work.
- Operations & Maintenance Template to be provided by EPCOR

5.12.1.3 IFT/IFC

- Changes required to detailed drawings as noted during detailed drawing review.
- Specifications and Special Provisions for LID packages are to be standalone documents. If Specifications or Special Provisions for LID will not be developed, information typically found in these documents must be included within the notes on the Drawings. This includes but is not limited to:
  - LID soil mix requirements
  - Testing protocols and requirements
  - Construction methodologies for components not currently in this Standard (i.e. clay check dams)
  - Erosion and sediment control requirements
- Shop Drawings
  - Must be approved by a Professional Engineer at the supplier or manufacturer if design varies from LID Standards
  - Must be provided to EPCOR Drainage and/or all applicable stakeholders for review prior to installation

5.12.1.4 As-Built

- All requirements outlined under Utility Drawings and Details and Landscape in Section **5.12.1.2**, as well as all requirements in Section **5.12.1.3**.
- Completed LID Summary Table, including hydraulic conductivity (see **Figure 5-14**)

Drainage Area	LID Type	Location Where Runoff Enters to LID	Catchment Area, m^2	Catchment Imperviousness, %	Runoff Volume for Design Rainfall, m^3	LID Surface Area, m^2	LID Capacity, m^3	Average Hydraulic Conductivity (from Guelph Permeameter), mm/hr
1	e.g. Bioretention Basin		4315	90%	67	300	75	
2	e.g. Soil Cell		2000		31		28	
	Sum		6315		98		103	-

Figure 5-14: As-Built LID Summary Table

- LID Calculator spreadsheet attached to the as-built drawings as a PDF (to be provided by EPCOR)
- Coordinates of all single point facilities including MHs, CBs, junction boxes, cleanouts, including the depth at which they were installed, pipe inverts, etc.
- Clear distinction between perforated and non-perforated pipes
- Clear distinction between old and new infrastructure
- Number of each type of vegetation planted in each LID, broken down into shrubs, trees, grasses, and forbs

5.12.2 Drawing Details

Required plan view, detail, and profile view drawing details are listed in **Table 5-4** below. All drawing packages are required to have a drawing index.

Table 5-4: Drawing Detail Requirements

Parameter	Plan	Detail	Profile	Description
Summary Table from LID Calculator	x			Include the summary table from the LID calculator which identifies LID Type, Location, Catchment Area (m^2) and imperviousness (%), Runoff Volume for 18 mm (m^3), and LID Capacity (m^3) and surface area (m^2) see Figure 5-13.
Location	x			Aerial extent shown on plan view (bump-outs, municipal reserves, private lots, parks, road ROW, utilities)
Surface area	x			Outlined on plan view drawings, size of surface area of LID facility
Type	x		x	The type of LID (using the four definitions outlined above in ***Sections 5.3, 5.4, 5.5, 5.6, 5.7***) or definitions as per the City of Edmonton *Low Impact Development - Best Management Practices Design Guide*.
Inlet	x	x	x	Shown on plan view and typical detail provided (curb cut, flow spreader, ribbon curb, pre-treatment, CB, etc.)
Slopes (if applicable)	x		x	Side slopes of the LID facilities as well as slope of ground adjacent to LID facility. Grades within the LID facility must be noted.
Materials	x	x	x	Material specifications including depths/thickness and volumes required (LID soil media, filter layer, drainage layer), depth/thickness, hydraulic conductivity, porosity, SPDD as required, and any other material such as geotextiles or soil cells that may be required. Piping size and specifications. There should be at least one profile view outlining all layers and materials within the LID facility, including pipe locations and lengths.

Parameter	Plan	Detail	Profile	Description
Vegetation	x	x		Planting plan and vegetation details (species, mature density, succession plan)
Outlet	x	x	x	Underdrain specification & slope, spill elevation, CB type and grate, weir type and location, inlet control device and overflow details. A site-specific detail.
Catchment	x			Delineated catchment area directed to LID facility, size of catchment area and impervious portion
Flow Arrows	x			From contributing area, into LID facility, and overflow route(s)
Water Depth	x		x	Ponding depth and extent of inundation and water surface elevation during design storm(s) and maximum prior to spill. Water depths for all design storms identified in Section ***5.2*** must be shown.
Erosion Control/ Energy Dissipation	x	x		Outlined location on plan view (inlet, outlet if overland spill) and details, this should include both temporary and permanent measures. Temporary measures include use of rock socks.
Cleanouts	x	x	x	Detailed with all piping details, including cleanout type and dimensions of cleanout boxes
Location of surrounding sewer systems	x			Location(s) shown on plan view. Sewer system type (i.e., sanitary, stormwater or combined) must be specified. Services should also be shown.

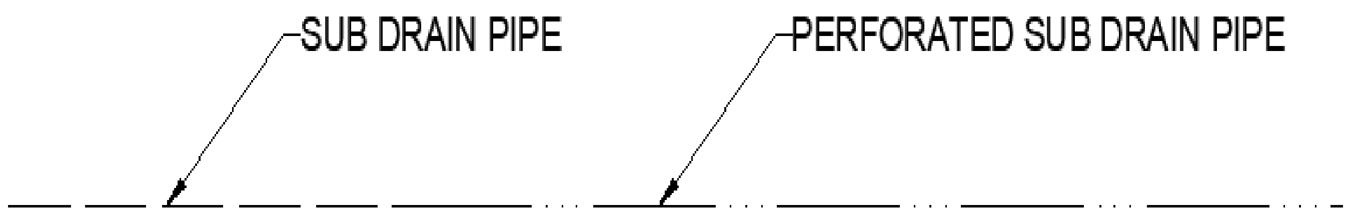
5.12.3 Drawing Considerations

For clarity and ease of review the following drawing aspects should be considered:

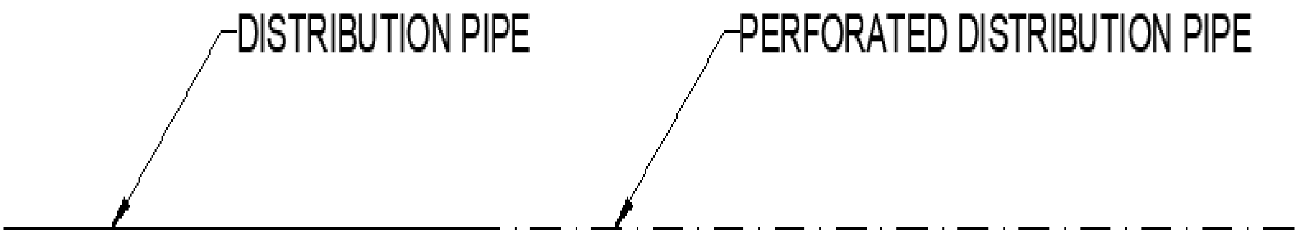
- Ensuring that the distinction between non-perforated and perforated pipe is clearly defined and labelled. Different line styles should be used for each type of piping line. Lengths of piping lines and direction of slope should be clearly labelled.
- For LID infrastructure/utility drawings, ensure piping layouts, inlets and outlets are unobstructed. If existing utilities are shown be sure they are greyed out but still visible.
- Increasing piping lineweight or using colour when pipes in plan view are close to other lines to ensure piping layout is clear.
- Utility offsets should be shown on the drawings (see section ***5.2.6*** for further details).

The following drawings standards should be utilized for LID drafting whenever possible:

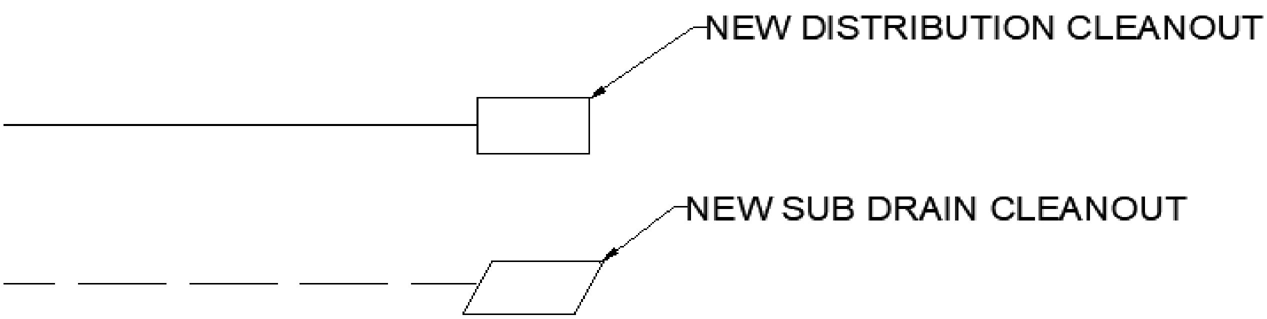
- Subdrain pipes:
- Solid: ISO dash (ACAD_ISO02W100) lines
- Perforated: ISO dash triple dot (ACAD_ISO14W100) lines.



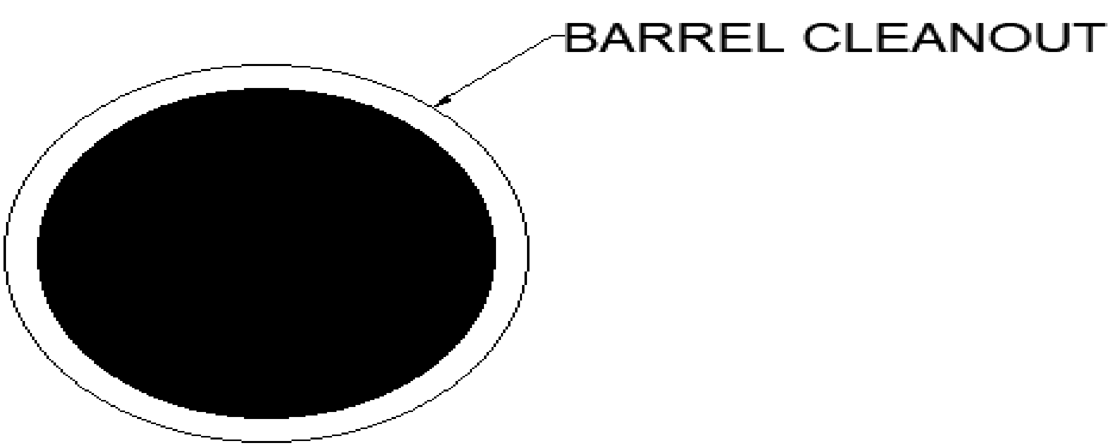
- Distribution pipes:
  - Solid: Continuous solid lines,
  - Perforated: ISO dash dot (ACAD_ISO10W100) lines.



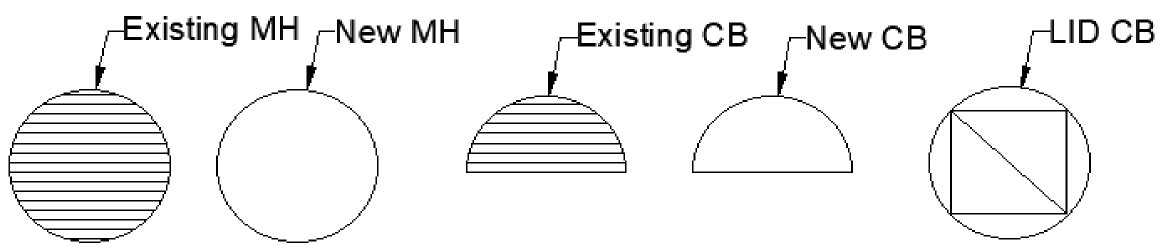
- Junction Box Cleanouts
  - New Distribution: Square boxes with empty fill
  - New Subdrain: Offset square boxes with empty fill



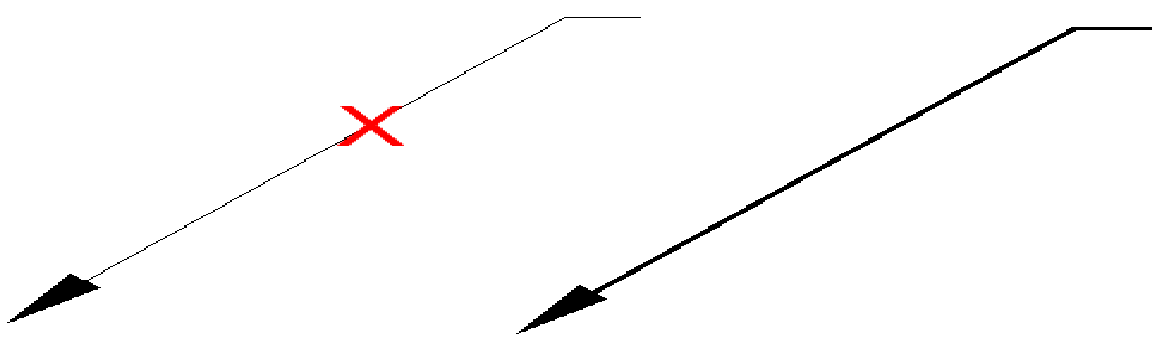
- Barrel Cleanout: Full circle with black fill



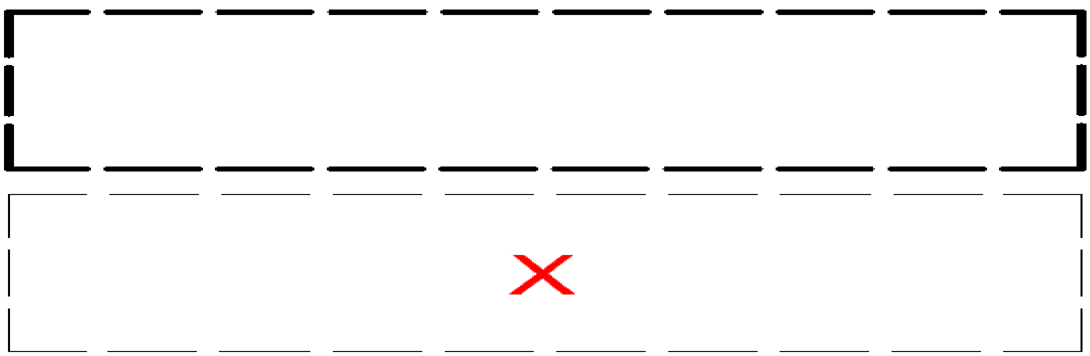
- Catchbasins and Manholes:
  - CB: Semi-Circles
    - empty fill for new additions
    - striped for existing.
  - Full circles
    - empty fill for new MH
    - striped for existing
  - LID CB Inlet:
    - Circle with a square and diagonal line inside it - empty fill



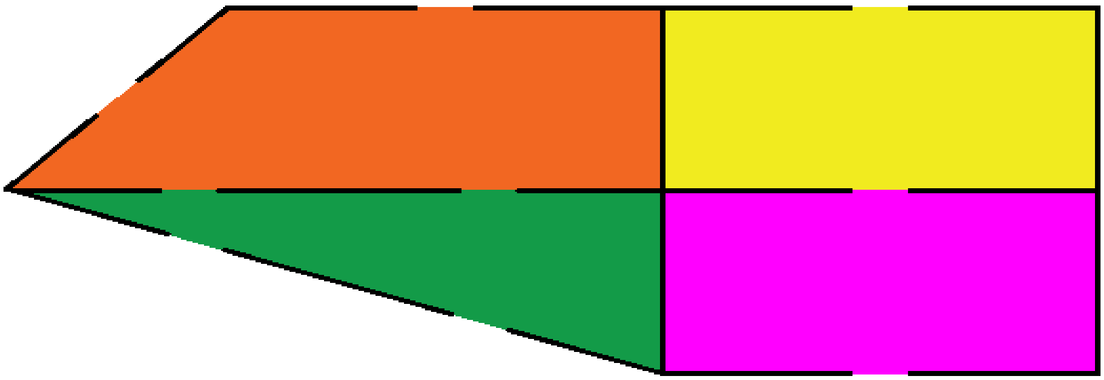
- Linewidth for leaders and pipe to be made clearly visible. Labels for pipe should indicate pipe length.

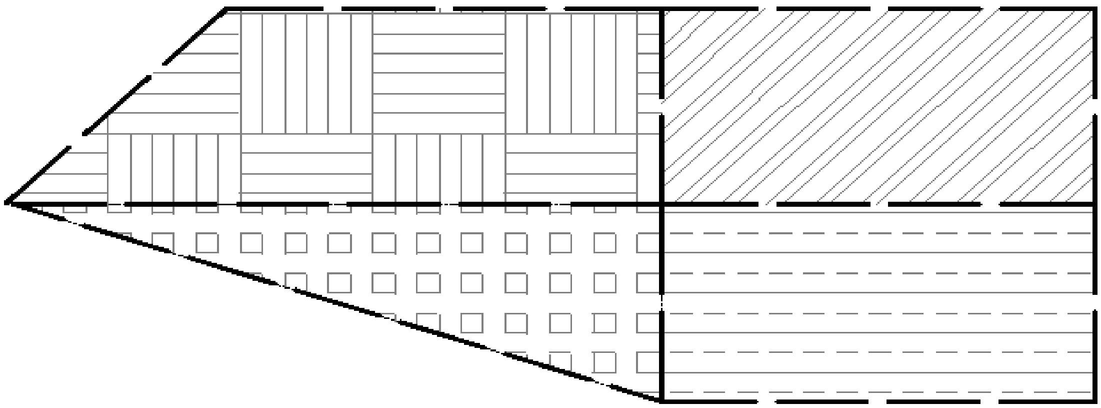


- Boundary lines to be clearly identified and distinct by line weight or color.

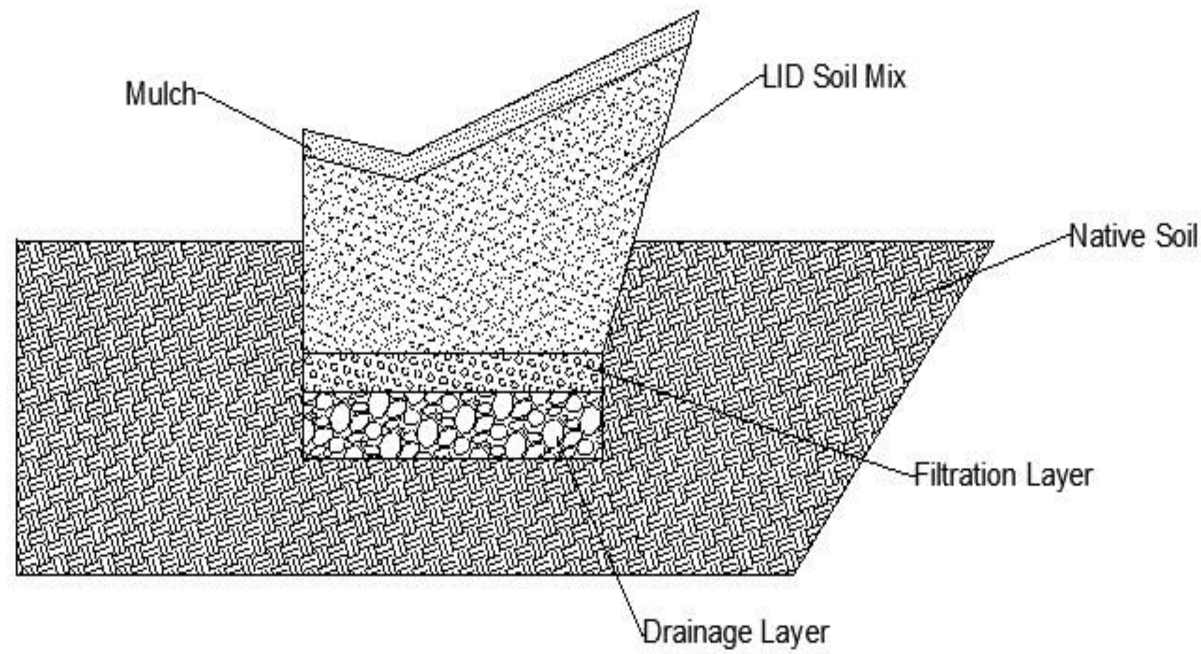


- Distinct coloring, hatching or lineweights to differentiate between catchment areas.

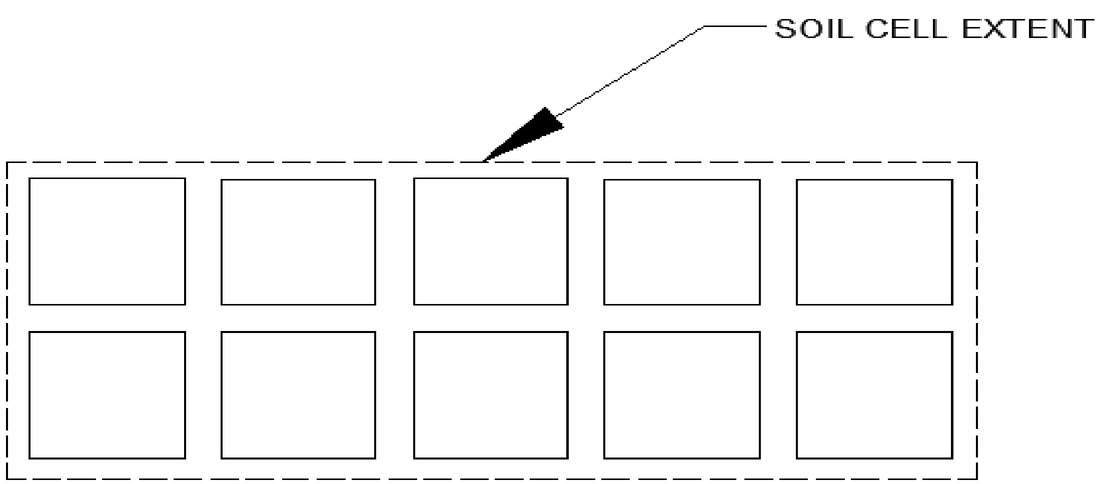




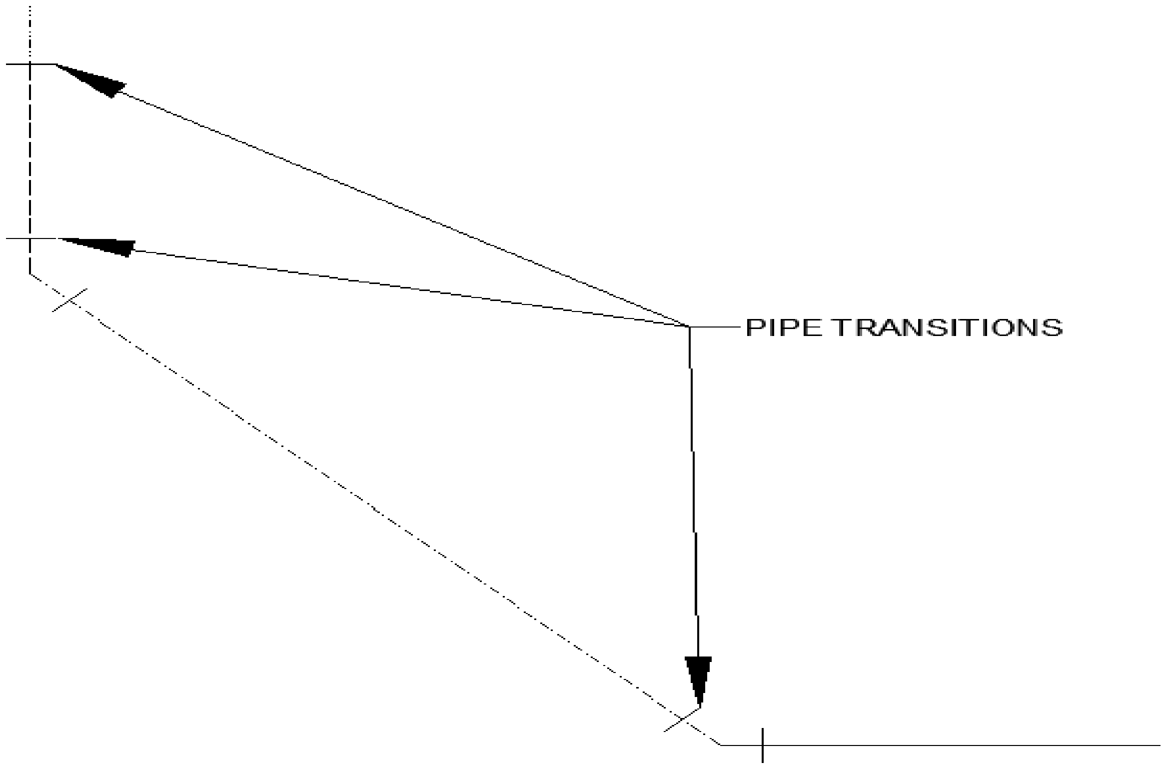
- LID Facility Hatching
  - LID Soil Mix hatched as AR-SAND
  - Native Soil hatched as EARTH
  - Filtration Layer hatched as HEX
  - Drainage Layer hatched as GRAVEL
  - Mulch hatched as DOT



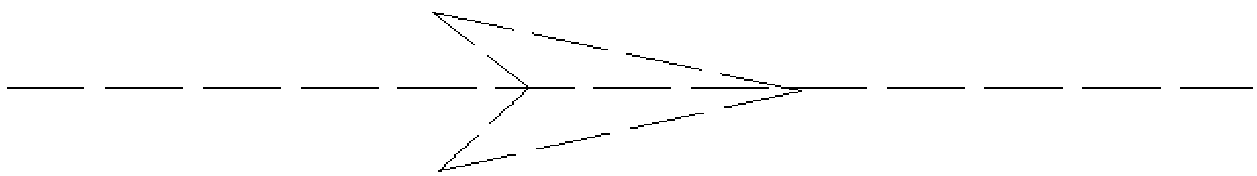
- Soil Cells to be drawn to scale in a grid with trench outline/LID boundaries identified clearly with linewidth or color.



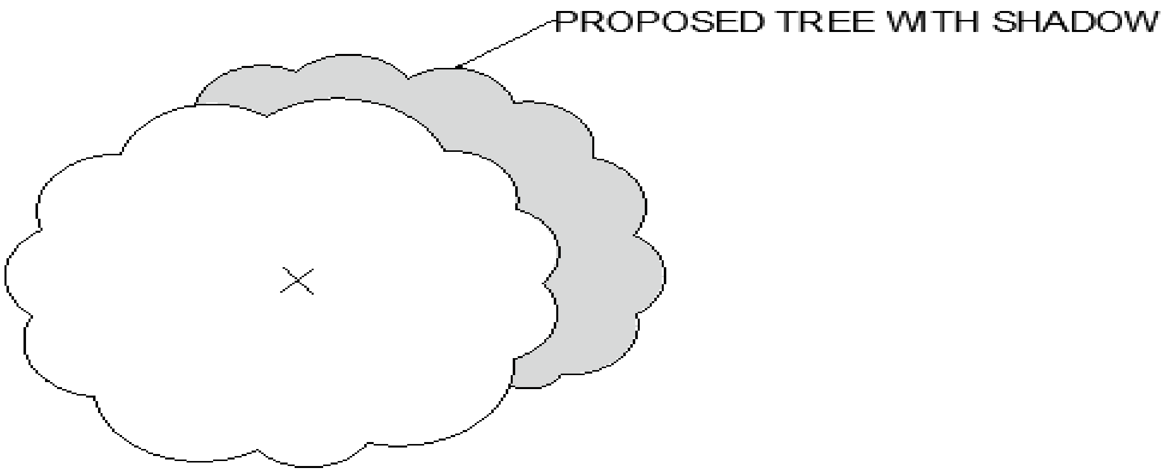
- Pipe transitions including bends and perforation changes will be indicated by tick marks at the locations of pipe joints.

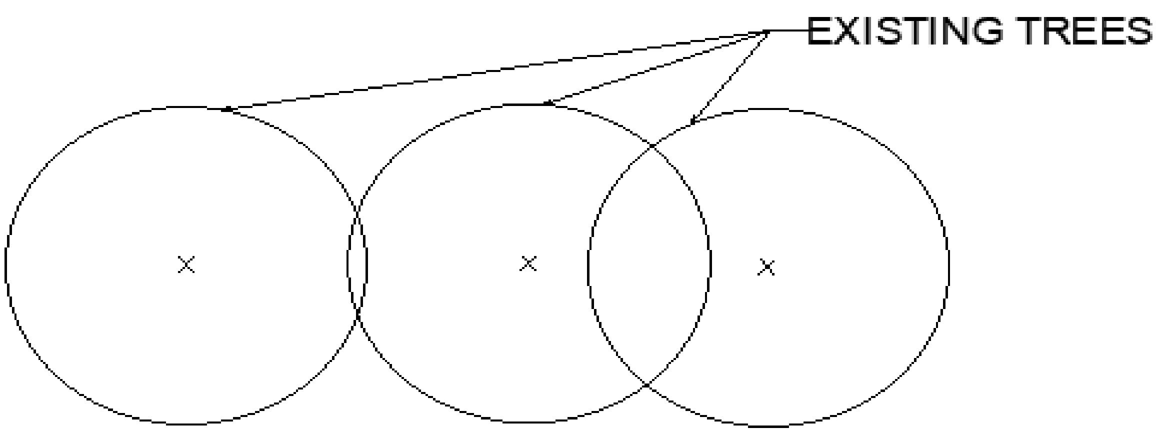


- Flow direction to be denoted using arrows. Slope direction to be identified through labelling ie. 0.5% Northeast

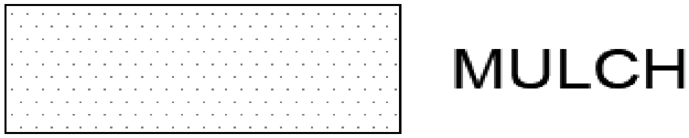


- Proposed trees to include transparent shadows, with existing trees indicated with simple circles.





- LID Planting beds will have GRASS hatching and be clearly differentiated from non-LID planting beds.



5.13 Construction

5.13.1 CCC/FAC Requirements

The following are required at CCC and FAC, unless otherwise noted. Inspections will not be conducted during cold weather, and vegetation must be fully established prior to cold weather to qualify for inspection. The functionality and inspection of the LID cannot be evaluated in frozen ground conditions or if snow cover is present.

- Inspection of drainage infrastructure and landscaping, including grading and slope of the facility.
- One inspection for both drainage infrastructure and landscaping will be conducted and one CCC and one FAC will be issued. If either portion (drainage or landscape) fails the CCC and/or FAC will not be issued.
- Public trees will be inspected by the applicable group at the City of Edmonton and the inspection report shall be provided to EPCOR, prior to CCC issuance and as requested at FAC.
- Soil and hydraulic conductivity testing results , prior to CCC issuance, and additional results as applicable at FAC. Testing results should clearly indicate that they were reviewed/verified by the designing consultant or facility owner.
- CCTV of all pipes, prior to CCC issuance, and as requested at FAC.
- Red-lines or as-builts including updated planting plans, prior to CCC issuance.
- As-builts including updated planting plans, prior to FAC issuance.

5.13.2 Construction Considerations

Project specifications and special provisions should consider the following regarding construction of the LID facility and placement of the soil mix:

i. Construction execution planning should give careful consideration to the sequencing and traffic flow of activities at and around the LID facility to minimize disturbance of the LID site.

ii. The LID facility(s) should be isolated from runoff and sedimentation from the impervious catchment area until vegetation is established and ready to provide treatment as per design. This can be achieved by physically blocking flow with a barrier, using sacrificial sod or geotextiles for ESC control, or installing the LID facility after construction around the site has been completed. This is especially important in highly saline areas such as snow storage areas or adjacent to arterial roadways. If the LID facility cannot be isolated from runoff and sedimentation ESC measure for the catchment must be put into place and thought should be taken to using plantings instead of seed. If an ESC plan is required, protection of the LID facilities must be specifically addressed.

iii. The subsoil, LID growing soil media, filter layer, and granular drainage layer should be inspected by qualified personnel prior to backfill.

iv. If infiltration is part of the stormwater management mechanism for the LID, subgrade excavation should be performed by suitable equipment and construction practices that will minimize compaction to the infiltration area. The use of excavators reaching in from outside the infiltration footprint is preferred. If excavation must be carried out within the footprint, light weight, low ground-contact pressure equipment should be used. In this case, tests should be carried out to ensure the subgrade infiltrations rates meet that of the design prior to backfilling or installation of geotextiles. Tilling operations may be necessary should infiltration tests indicate excessive compaction of the area.

v. If infiltration is part of the stormwater management mechanism for the LID surface of the subgrade may require scarification to provide proper bonding and transition between materials.

vi. The granular drainage layer and granular filter layer should be placed uniformly in 300 mm lifts.

vii. Soil, compost, and/or other amendments should be uniformly mixed prior to placement. Care should be taken to avoid compacting the mixture during the mixing process. For further information on acceptable soil amendment see the City of Edmonton's Volume 5 - Topsoil Specification 02910.

viii. Soil mix should be placed uniformly in 200 mm to 300 mm lifts. Each lift should be water consolidated or compacted using a suitable method as per design specifications. Wet soil should be allowed to dry prior to placement. Soil should not be placed in wet, muddy or frozen conditions.

5.13.3 Safety Factor

When completing hydraulic simulations or calculations utilizing hydraulic conductivity, a minimum safety factor of 2 must be used for the hydraulic conductivity to account for variability in soil and clogging. For example for a soil with a hydraulic conductivity of 40 mm/hour, hydraulic simulations and calculations should be completed using a hydraulic conductivity of 20 mm/hour.

5.13.4 General Inlet and Outlet Considerations

LID facility design should consider the following regarding inlets and outlets:

i. The location of the inlets and outlets must be situated to allow water to fully flow through and percolate into the LID Soil Media.

ii. The overflow outlet must be situated near the center of the LID, between the inlet and the outlet to maximize water flow through the LID Soil Media. If the overflow outlet is located near the inlet flow may short circuit the system and flow directly into the overflow.

iii. Thought should be given to the type of erosion/flow control utilized at the inlets and outlets and the permanence of the installation.

iv. Inlets, outlets, and overflows must be accessible for operations and maintenance. Care should be taken during vegetation selection to ensure that all will still be accessible at peak vegetation size.

5.14 LID Growing Soil Media Specifications

The LID soil media must meet the requirements in Section ***5.14.2*** or the performance-based standards outlined in Section ***5.14.2***. If performance-based standards are chosen, the designer must prove the standards can be met with their design.

5.14.1 Texture and Property

The LID soil media specification in Table 5-5 provides a range of values for each parameter. It is at the discretion of the engineer and the landscape architect to determine the exact value and whether any additional tolerances are allowed outside the standard ranges for a specific project. If ranges outside those listed below are chosen, the design basis must shift to the performance-based standards in Section ***5.14.2.***

For soil cells with trees a more specific media specification is highly recommended to be specified with a lower sand content. Trees often require additional water and a high sand content may hinder a soil’s ability to retain water. For trees in soil cells only, a lower organic matter content may be specified by the project designer.

Table 5-5: LID Soil Media Specification

Parameter	Values
Texture classification	Loamy Sand; Sandy Loam
Sand sized particles, larger than 0.05 mm diameter and smaller than 2 mm diameter	60% – 80%
Silt	10% – 25%
Clay	5% - 15%
Silt and clay combined	Maximum 40%
Organic matter	5% – 10%
pH value	6-8
Available Phosphorus	10 -50 ppm

In-situ Saturated Hydraulic conductivity, at soils specified compaction and moisture	Minimum 40 mm/hr Maximum 300 mm/hr

Notes: All % are in dry weight.

Sand: Sand sized particles shall have a well-graded distribution with a coefficient of uniformity between 4 and 6. Sand shall be free from clay balls and other extraneous materials.

5.14.2 Performance-Based Standards

If a soil mix other than that specified in **Table 5-5** is used the LID facility must be able to retain and store a minimum of 18 mm of rain from the LID facilities impervious catchment area and drain the corresponding standing water within 48 hours. The HWL during the 100-year 4 hour design event must not compromise adjacent structures. Refer to EPCOR design and construction standards Vol. 3-02 Section **5.2.3**. Surface storage, and soil mix shall not allow water from the 18 mm of rain to drain directly into the stormwater system, as this will not provide storage or improvements in water quality.

Alternate soil mixes may be used for any of the layers (mulch layer, growing media, granular filter layer, or drainage infiltration layer) however layers must still meet their respective purposes and the overall performance-based standard. The drainage infiltration (storage) layer must be able to withstand flushing as per **Section *5.8*** Piping and Infrastructure Considerations and must provide adequate support for the specified piping.

Different soil mixes may be used for different areas of the LID facility (i.e. slopes vs. bottoms) if required to promote varied vegetation growth.

If LID facilities are constructed in series, the performance based standards will apply as one facility; that is the facilities working in tandem must be able to retain a minimum of 18 mm and drain the corresponding standing water within 48 hours; each individual LID facility does not need to meet these requirements. If LID facilities are constructed in series, the space between LID facilities must be constructed to facilitate water flow. Spaces between LID facilities should be minimized to discourage use of space as access or crossing locations.

5.14.3 Tree Root Package Soil

The tree root package (that comes with the tree) may contain different soil, however soil media throughout the remainder of the soil cell system must be consistent with the LID Soil Media (Section **5.14**). **Figure 5-15** shows a profile view of a typical tree root package within a soil cell and is for illustrative purposes only, it does not depict every detail that may be required for successful construction, operations, and maintenance. Soil volumes for trees must still meet soil volumes as per the City of Edmonton Design and Construction Standards, Volume 5: Landscaping.

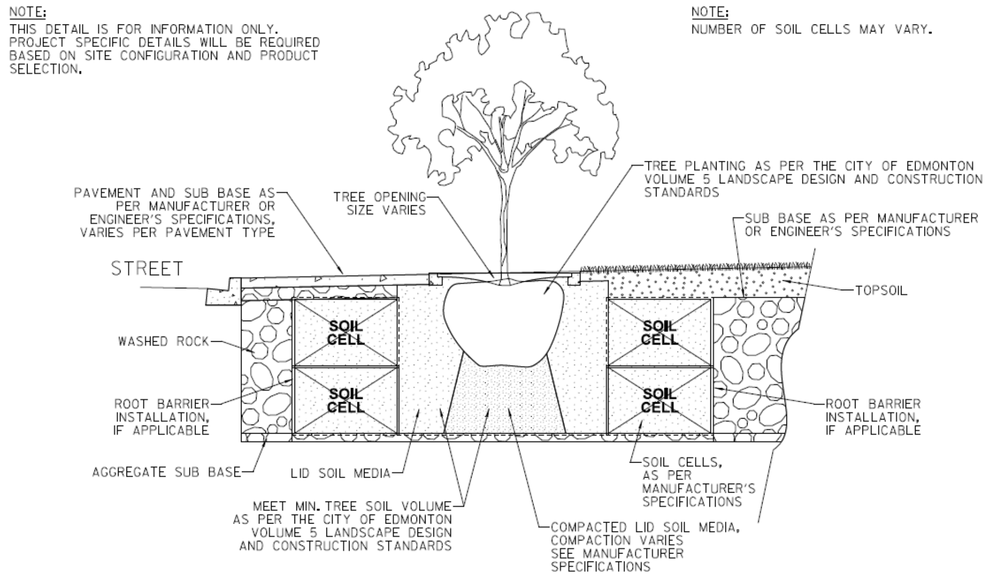


Figure 5-15: Typical Tree Root Package

5.15 Testing Requirements

5.15.1 Soil Sampling and Analysis

Soil media analysis shall be conducted and the results shall be approved by the City/EPCOR prior to:

- soil arriving on site; and
- soil being placed in LID facility

Analyses conducted shall include the following:

- Texture classification by a qualified professional;
- Grain size classification (sieve and/or hydrometer) (%);
- Organic matter (Loss on ignition);
- pH
- Available Phosphorus

Onsite stockpile testing for texture classification, grain size classification and organic matter parameters for LID soil mix that is not purchased premixed and pretested shall follow the Sampling Requirements as outlined in the City of Edmonton Volume 5 - Topsoil Specification 02910. Soil that has been purchased premixed and pretested requires one test per stockpile. Testing for pH, phosphorus and cation exchange capacity is one test per stockpile regardless if the soil is purchased premixed and pretested.

Additional analyses may be requested on a project-specific basis. In the case that written approval is given by the City/EPCOR to the Consultant or Contractor, as applicable, the City reserves the right to conduct in-situ testing after CCC and prior to FAC on the LID soil mix. If these test results show the soil does not meet the parameters in Section ***5.14.1***, and that there is no reasonable wear and tear or adjacent activity that could have altered the soil since it was placed such that is does not meet the requirements set in Section ***5.14.1**,* the City/EPCOR can, at its discretion, require the Developer, Consultant or Contractor, as applicable, to amend or replace the soil to meet the requirements.

5.15.2 LID Soil Compaction and Infiltration

Compaction for the LID soil media is recommended to be specified at a minimum 75%-85% Standard Proctor density depending on the soil type to be used; unless further compaction is required for structural purposes. Soil shall be placed in 200 mm to 300 mm lifts; unless otherwise specified by the designer. Where substrate infiltration is slow (<15 mm/hr) an underdrain must be installed.

Following LID soil placement the following test shall be completed:

- Guelph Permeameter testing
    - Prior to the placement of concrete or planting, saturated hydraulic conductivity testing must be completed. Guelph Permeameter testing must be conducted at a minimum of two locations per LID facility for facilities less than 1000m^2. For facilities greater than 1000m^2, an additional test will be required for every additional 500m^2.
    - A QA/QC test must be completed at a location adjacent to one of the aforementioned tests (within 3m).
    - For facilities with soil deeper than 650mm, the tests shall be conducted at approximately ¼ to ½ depth and ½-¾ of the soil depth. The QA/QC test must be conducted at the same depth as the adjacent test. It is preferred that facilities less than 650mm be tested at the halfway depth of the soil
    - As per the Guelph Permeameter testing manual to ensure accuracy of the test with a highly permeable soil, the test shall use the two head method with combined reservoirs.

At FAC, Guelph Permeameter testing may be required at the request of EPCOR.

Soils with a high organic content should still be lightly compacted to reduce settlement of the soil and LID facility.

When limiting compaction, care must be taken to follow the Construction Considerations located in Section ***5.13.***

5.15.2.1 Additional Subgrade Compaction for Soil Cells

Subgrade and granular base compaction shall be completed prior to soil cell placement to 95% of Standard Proctor density.

5.15.2.2 Additional LID Inspections

All pipes within LID facilities must be CCTV'ed as per the Volume 3 Drainage Design and Construction Standards. CCTV requirements are located in Vol. 3-06: Construction Specifications Section 23 – Inspection Sewers.