Guide to Lot Drainage

Residential Development

September 24, 2019

Table of Contents

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Acknowledgements

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1.0 Introduction

The Guide to Lot Drainage (Guide) provides an overview of lot grading, drainage regulations and processes, and outlines tools and best practices to follow when planning, designing, constructing or maintaining ***Stormwater*** drainage patterns in residential development. Following this Guide will help residential owners and property developers maintain ***Positive Lot Drainage*** and to comply with City of Calgary (City) bylaws, regulations, and guidelines.

1.1 Lot Drainage Features

Since the 1980s, Stormwater design for Calgary neighborhoods has considered a dual drainage system, which includes a public ***Major System*** (roadways, public swales and ditches, stormwater ponds and receiving waters (i.e. rivers), and ***Minor System*** (catch basins, underground pipes and pipe outfalls), (Figures 1 and 2).

The private drainage systems (lot grading, swales, landscaping) and building features (eavestroughs, downspouts) of individual lots interact with the public drainage systems (roadways, catch basins, storm pipes, storm ponds) to protect property, public safety and the environment.

Good planning, design, construction, and maintenance of the drainage features of a lot are critical to managing Stormwater and protecting property during storm events.

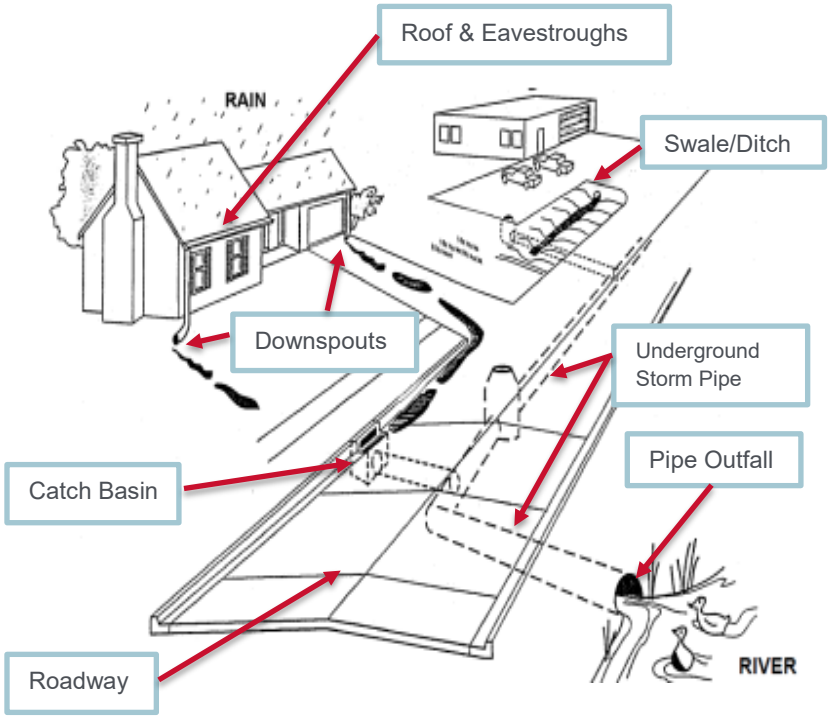


Figure 1 – Drainage System Components. Source: The City of Calgary Stormwater Management Design Manual.

Stormwater *is water that originates during precipitation and snow/ice melt events. The direction that Stormwater flows through and away from a property is called the drainage pattern.*

Positive Lot Drainage *involves contouring the land to direct the flow of surface water away from building foundations toward the street, lane, or Swale without adversely affecting adjacent properties or public infrastructure.*

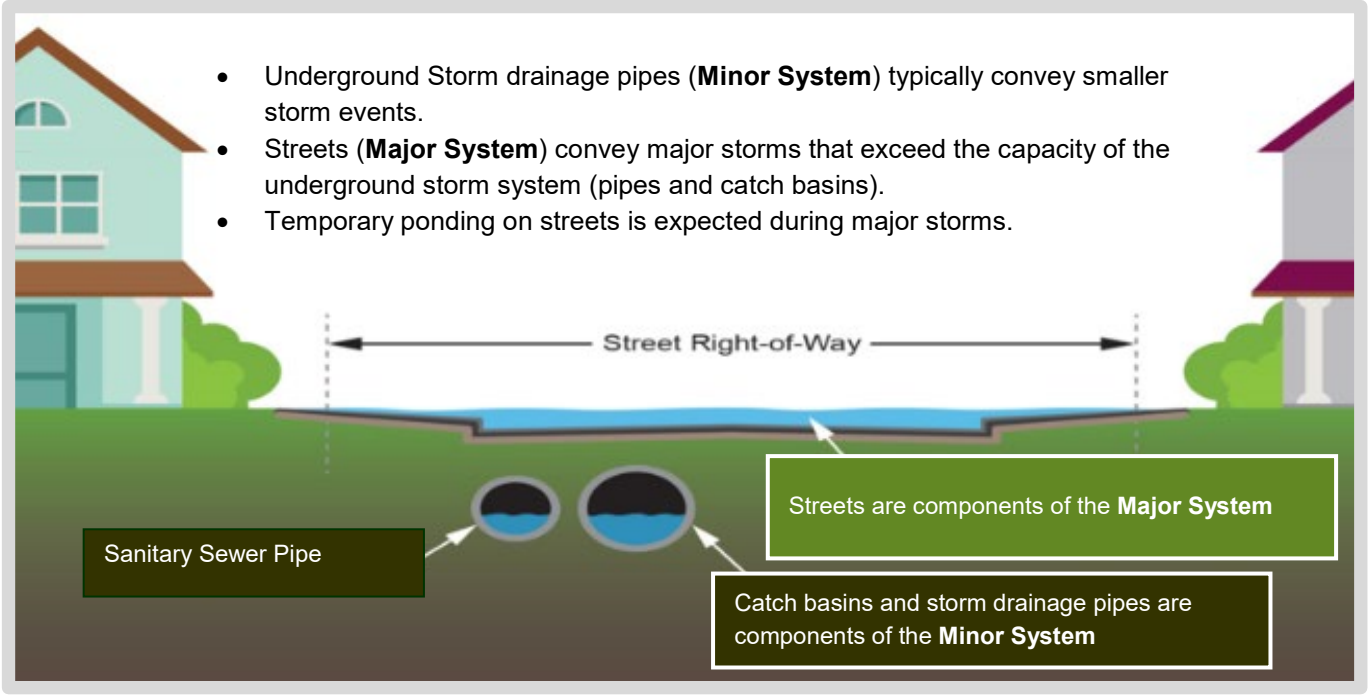


Figure 2 – Dual Drainage Concept. Source: Adapted from The City of Toronto.

*The **Minor System** provides a basic level of service by conveying flows from the more common (low intensity, more frequent) rainstorm events.*

*The **Major System** conveys stormwater from extreme (high intensity, less frequent) rainfall events that are in excess of the Minor System.*

1.2 Positive Lot Drainage

To prevent property damage to residential lots, Stormwater within a lot needs to be properly managed as part of the design, construction and maintenance of a functional drainage pattern that supports Positive Lot Drainage.

Positive Lot Drainage involves contouring the land to direct the flow of surface water away from building foundations and toward the street, lane, or ***Swale*** without adversely affecting adjacent properties or public infrastructure (Figures 3 and 4). Owners are responsible for maintaining Positive Lot Drainage at all times, for the duration of their ownership of that property.

Precipitation in Calgary varies throughout the year and can differ significantly across the City. In addition to this variability, storm intensities have increased (due to a changing climate), resulting in more Stormwater to manage during any one precipitation event. The establishment and maintenance of Positive Lot Drainage is necessary to manage Stormwater and protect properties.

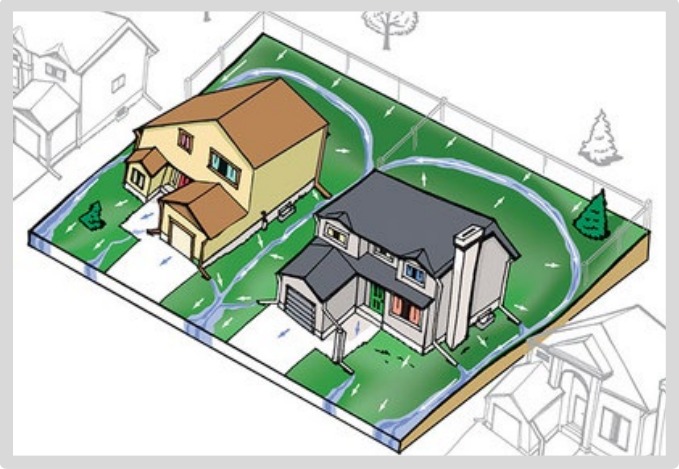


Figure 3 – Positive Lot Drainage to Swales. Source: The City of Edmonton Lot Grading Guidelines, April 2018

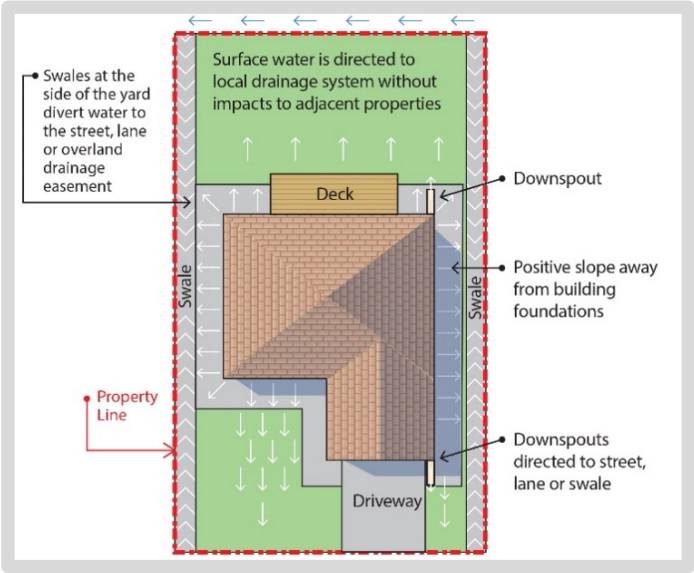


Figure 4 – Positive Lot Drainage. Source: The City of Calgary

*A **Swale** is a shallow channel with gently sloping sides which can be natural or human created (e.g. grass or concrete).*

2.0 Regulations and Requirements

2.1 Applicable Bylaws, Codes, and Guidelines

The following are the applicable codes, acts, bylaws and guidelines which define, govern and guide lot drainage. In addition to the codes and acts established by the Provincial and Federal Governments, The City of Calgary has various bylaws to address issues and concerns of the local community. These bylaws are developed and enforced to protect the environment, public health, public safety, and to maintain an orderly appearance within communities. Lot owners, and any stakeholders involved in the lot development process, are obligated to understand and comply with all applicable requirements.

Alberta Building Code

Alberta Municipal Affairs administers the Alberta Building Code, which includes the requirements that all new construction must follow. These codes govern requirements for building permits.

The City of Calgary ensures that buildings comply with the Alberta Building Code through the building permitting and inspection processes. The Alberta Building Code regulates building elements located strictly within the ***Building Envelope***. While this includes elements required to protect buildings from precipitation and prevent impact to building foundations from improper drainage, the Alberta Building Code and the City's inspection process does not include elements beyond the extents of the Building Envelope such as lot drainage patterns.

New Home Buyers Protection Act

Alberta Municipal Affairs also establishes legislation to protect consumers and home buyers through the Alberta New Home Buyer Protection Act. This act ensures mandatory home warranty protection[1] for all owners of newly constructed homes.

Unless specifically noted, home warranties are generally limited to those elements within the Building Envelope, and that are regulated by the Building Code. This means that lot drainage patterns and features outside the extents of the Building Envelope are usually not covered under warranty.

Drainage Bylaw

The City of Calgary Drainage Bylaw 37M2005[2] came into effect in 2005 to regulate the quality, quantity and means of Stormwater discharge from a lot. With the goal to protect public infrastructure and the health of rivers, this bylaw is applicable to everyone, including lot owners, businesses and employees, as well as the development industry.

Specific to residential lot drainage, the Drainage Bylaw establishes:

- The City's Authority to develop processes, rules, regulations, and requirements.
- The means by which Stormwater can discharge from a lot to public infrastructure.
- The substances that are prohibited from entering the storm drainage system (*The City of Calgary's Here's How it all Flows*[3]).
- The requirement to maintain ***Surface Drainage Features*** which may be covered by an ***Overland Drainage Right-of-way*** free of debris and/or any obstructions.

*The **Building Envelope** is the physical separator between the conditioned and unconditioned environment of a building, including the resistance to air, water, heat, light and noise transfer.*

*An **Overland Drainage Right-of-way (ODRW)** is a right-of-way registered on the land title of a property which is intended to help facilitate proper storm drainage.*

The ***Surface Drainage Features*** of a lot include any features associated with the control of Stormwater. These may include Swales, contouring of land, concrete walkways and gutters, or other structures.

Lot Grading Bylaw

The City of Calgary Lot Grading Bylaw 32M2004[4] came into effect in 2004 and was established to regulate the surface grades of properties by ensuring that grading is complete at the end of construction and is compliant with approved grades. The Bylaw mandates, for both new development and redevelopment:

- The builder submits an as-built plot plan (***As-Constructed Grade Certificate***) within 12 months of occupancy. This document reflects both the proposed (original design) and constructed grades.
- The As-Constructed Grade Certificate (Appendix B – As-Constructed Grade Certificate Requirements) must indicate that grading was completed within acceptable tolerances (as defined in the Lot Grading Bylaw).
- The As-Constructed Grade Certificate must be certified by a professional and reflects the condition of the lot upon completion of the legal survey.

Community Standards Bylaw

The City of Calgary Community Standards Bylaw 5M2004[5] promotes good neighbour relationships and addresses community concerns. Specific to lot grading and drainage, the Community Standards Bylaw includes content to regulate the proper discharge of water between lots:

- Property owners must ensure that water from a hose or similar device, eavestrough or downspout does not enter adjacent premises.
- Property owners must direct any downspout or eavestrough to the front or rear of the property.

Stormwater Management and Design Manual

Stormwater Management in Alberta is regulated provincially via the Environmental Protection and Enhancement Act[6] (EPEA) and the Water Act[7]. The City of Calgary Stormwater Management and Design Manual[8] provides technical design guidance to deliver stormwater management solutions in the City of Calgary land development context, while meeting Provincial regulations. This manual can be referenced for additional guidance on lot drainage best practices.

Design Guidelines for Development Site Servicing Plans

Residential development projects with three or more residential units are required to submit a Development Site Servicing Plan (DSSP). In addition to providing the design for utility servicing, the DSSP identifies how stormwater will be managed for the development. Applicants can refer to the Design Guidelines for Development Site Servicing Plans[9] for requirements and guidance.

*The **As-Constructed Grade Certificate** is a post-construction plot plan which contains the proposed lot elevations as reflected on the Building Permit application as well as the constructed or "as-built" **Surface Grades** of the lot as they exist at the time of legal survey.*

*The **Surface Grades** of a lot reflect the height of the finished ground surface.*

3.0 Development Roles & Processes

3.1 Lot Development Categories

Residential development has different characteristics in a new community than in an established (fully developed) community, and this is reflected in the City's approach to development reviews and approvals (refer to The City of Calgary Approvals Coordination Website[10]). Maintaining Positive Lot Drainage is equally important across all development categories; however, the development conditions and processes differ as described below.

Infill Development

An infill development is the rebuilding of new structures to replace aging homes in communities that are already built out (established or developed neighbourhoods, Figure 5).

If permitted within land use regulations (zoning), infill development may add additional units or subdivide a lot to additional dwellings. An infill can be a single-detached dwelling, a duplex, a semi-detached dwelling, or a multi-residential development, and may be either a permitted or discretionary use (as defined in the Land Use Bylaw 1P2007[11]).

Unlike greenfield areas, where each lot's grading and drainage is considered as part of a larger subdivision plan, infill developments are often completed as individual applications. The builder must provide Positive Lot Drainage for the developing lot, while meeting existing conditions at the property line.

Stormwater management standards have also evolved over time. This presents other unique differences in how stormwater is managed in established communities versus greenfield communities. For communities developed prior to 1988, it wasn't standard practice at the time to consider a dual drainage system (refer to Section 1.1 Lot Drainage Features). This means that for older communities, the public stormwater system will likely have less capacity to convey larger storm events.

Often, as redevelopment occurs, ***Parcel Coverage*** also increases, due to a reduced lot size, increased home size, or both. In addition to increased Parcel Coverage, reduced setbacks and unique roof designs can result in lot grading challenges. However, Positive Lot Drainage can be achieved in established areas through the application of best practices and collaboration between property owners.

Figure 5 – Infill Redevelopment. Source: The City of Calgary

New Development (Greenfield)

Residential lots in greenfield areas (new communities), are delineated through The City's subdivision process (Figure 6), which includes the design and review of lot grading and drainage patterns for both the community and individual lots. Stormwater design in greenfield communities follow current design standards and include the dual drainage concept. As part of the subdivision process, developers are required to:

- Design the Surface Grades, roads and drainage systems to manage Stormwater for the entire subdivision.

***Parcel Coverage** is the ratio of building/structure area to the overall parcel area.*

- Establish individual lot drainage patterns and minimum building grade elevations to provide Positive Lot Drainage and utility servicing to each lot.

Once drainage patterns are established by the developer, builders are required to meet these grades, within allowable tolerances, as defined in the Lot Grading Bylaw.

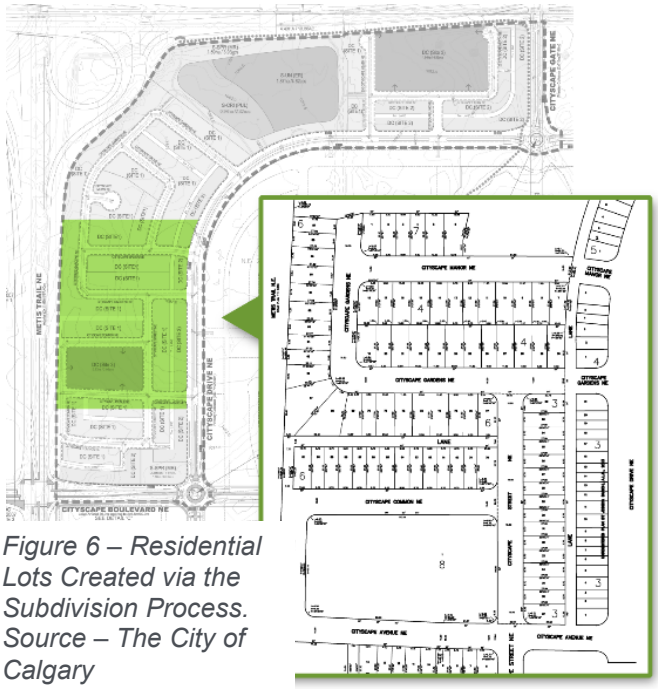


Figure 6 – Residential Lots Created via the Subdivision Process. Source – The City of Calgary

Multi-Residential Development

Multi-Residential development includes three or more residential units within a single lot. Requirements for multi-residential development, including site grading and utility servicing, are outlined in the Utility Site Servicing Bylaw 33M2005[12] and the City of Calgary's Design Guidelines for Development Site Servicing Plans (DSSP)[9].

Floodway or Flood Fringe Development

Special conditions apply to developments located within a Floodway, Flood Fringe or Overland Flow Area along Calgary's rivers and creeks (Figure 7). Properties within these areas as subject to additional regulations described in the Land Use Bylaw and the City of Calgary's Stormwater Management and Design Manual. Property owners can call 311 or visit the City of Calgary's Flood Information Website[13] for information.

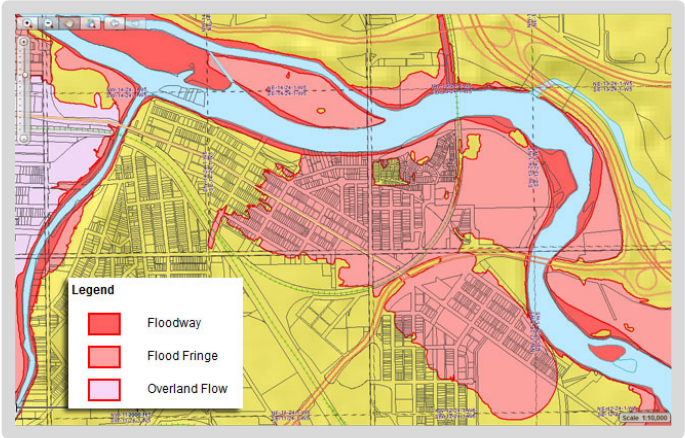


Figure 7 – City of Calgary Regulatory Flood Map identifying areas within the Floodway, Flood Fringe or Overland Flow Areas. Source: The City of Calgary Flood Information Website.

3.2 Roles and Responsibilities

There are four key stakeholders involved in achieving and maintaining Positive Lot Drainage: The City of Calgary, the developer, the builder, and the property owner, though other professionals may assist throughout the process. The lot grading process and related roles will vary depending upon the development category; however, the key principles and good practices required to ensure Positive Lot Drainage remain the same.

The City of Calgary‘s Role

The City establishes processes and guidance and ensures compliance with applicable bylaws and regulations to protect people, the environment, public infrastructure, and property.

Guidance comes in many forms, including statutory requirements (bylaws, regulations and policies), guides, manuals, and information portals (Calgary.ca and 311).

The City approves development applications and performs an oversight and approval role in the development process until occupancy is granted. The development process and requirements will vary depending on the development category and application type. Refer to Appendix A for a process summary. Through the development process, specific to Lot Drainage, The City monitors compliance with all applicable bylaws.

Following the completion of the development process, The City has a limited role in lot grading, unless it relates to a specific bylaw infraction. The City does not mediate neighbour to neighbour disputes between property owners (regarding Lot Drainage or any other matter) or monitor lot grading or landscape modifications once the development process is complete. Property owners with a lot grading issue or a dispute with a neighbour can pursue the actions suggested in Appendix C – Guidelines for Homeowners: Resolving a Lot Drainage Issue.

The Developer’s Role

The developer’s role is generally only applicable in greenfield areas or multi-residenital development. There may be cases where the developer and the builder are the same entity, in which case, their roles are combined.

During subdivision, the developer is responsible for the overall site grading and drainage design of the entire subdivision to ensure functional drainage from individual lots to the public Stormwater system. The developer is also responsible for the design and installation of all public utility servicing and maintenance of the utilities for a maintenance period until accepted by The City (typically two years).

The developer establishes grades at both the subdivision level and the individual lot level to ensure functional drainage and utility servicing for each lot. The developer also oversees builder applications to certify alignment with the approved subdivision plans.

The Builder’s Role

The builder is responsible for the design and construction of individual lot grades and drainage, in compliance with applicable bylaws. In greenfield areas, the builder must comply with the elevations established by the developer in the approved subdivision plans.

For infill redevelopment, it is the builder’s responsibility to design and construct lot grades to ensure that existing elevations are met at the property line and Positive Lot Drainage is provided without adverse impacts to adjacent lots or public property. The builder’s responsibilities on the lot continues until an occupancy permit has been granted by The City after the building inspections are complete. The builder is also responsible to submit the As-Constructed Grade Certificate to The City (Water Resources) within 12 months of issuance of occupancy.

The As-Constructed Grade Certificate must be certified by a Professional Land Surveyor, Engineer or Registered Architect, and must indicate that grading tolerances and minimum Slopes have been met.

Ultimately, the property owner is responsible for all activities on the lot. The legal property owner is responsible to ensure that the As-Constructed Grade Certificate is completed by the builder within 12 months of occupancy permit.

Homeowners should expect the builder to provide any maintenance materials for Stormwater management features or equipment installed on the lot, such as backflow preventers or sump pumps.

The Property Owner's Role

The property owner is responsible for all activities on the lot, which includes activities conducted by those they have delegated or contracted, such as their builder or contractor. Property owners are responsible for surface water management on their lot and maintaining the drainage patterns established by the builder. The property owner is responsible to ensure that Positive Lot Drainage is maintained by directing water away from buildings and neighbouring properties.

Property owners are responsible for:

- Working with neighbours to resolve drainage issues between private properties.
- Ensuring that discharges from downspouts and sump pump hoses:
  - ✓ Are directed away from neighbouring properties, structures, driveways and sidewalks.
  - ✓ Are directed towards absorbent (resilient) landscape features.
  - ✓ Are a minimum of 2 m (6.56 ft) away from any public infrastructure (i.e., sidewalks, streets, lanes) to avoid ice build-up in winter or algae formation in summer.
- Routinely inspecting and maintaining eavestroughs and downspouts to ensure they are clear of debris to collect and direct Stormwater away from structures.
- Understanding any drainage rights-of-ways on their lots including their locations and extents.
- Keeping any Swales and Overland Drainage Right-of-Ways (ORDWs) clear of debris, soil, garbage, ice, snow or other material that could impede flow or limit capacity during a storm event.
- Inspecting their lots and grading around structures on a regular basis. Fill any depressions or settlement around the perimeter of structures with compacted materials to maintain Positive Lot Drainage.
- Maintaining the intent of the original drainage patterns while providing Positive Lot Drainage.
- Obtaining any required permits for renovations or additions.
- Ensuring that any landscaping or grading improvements, whether completed independently or by a contractor, meet the requirements of all applicable bylaws and maintain Positive Lot Drainage patterns.

Reference Information for Property Owners:

Refer to the ***Good Neighbour Practices Reference Guide***[14] and ***Guidelines for Homeowners: Resolving a lot Drainage Issue***[15] *for more information (**Appendix C**)*

3.3 The Lot Grading Process & Key Plans

The sections below describe the key plans that inform the lot grading process.

Building Grade Plan (BGP)

A ***BGP*** is only required as part of the greenfield subdivision process and is prepared by the developer's consulting Engineer. When a new development is proposed, a BGP identifies the proposed drainage system for the subdivision and will identify the overland drainage patterns. The BGP sets the elevations for the streets, public rights-of-ways, drainage Swales, and lots.

Grade Slip

A ***Grade Slip*** is a document issued to a builder which identifies available utility servicing locations and depths, and the minimum building entrance elevations (where applicable) to protect the property from overland Stormwater flooding.

- In **greenfield development**, the developer is responsible for issuance of Grade Slips to builders.
- For **infill or redevelopment** sites, The City issues Grade Slips to builders. Based on the Grade Slip information and existing surface grades of the lot, the builder is responsible for developing a lot grading design to provide Positive Lot Drainage while maintaining existing elevations at the property boundaries.

Building Permit

For both greenfield and infill residential construction, builders are required to obtain a ***Building Permit*** from The City and are required to submit a Plot Plan/ Site Plan as part of the Building Permit application.

The Plot Plan / Site Plan

For both greenfield and infill redevelopment scenarios, the builder is required to design and construct the lot grades and drainage pattern for each lot so that runoff drains independently to the street, lane, or Swales without adversely impacting buildings or adjacent lots. The lot grading design is reflected in the ***Site Plan (or Plot Plan)***, as prepared by the builder, and must meet the requirements of all applicable bylaws.

- In **greenfield developments**, the builder follows the approved BGP, subdivision plans, and individual lot grades and elevations established by the developer's consulting Engineer. The builder plots grade information for each residential lot on a ***Plot Plan,*** which is required to respect the design elevations and drainage patterns as set out in the BGP so that the lot drains to the appropriate Swale, street, lane, or other drainage infrastructure. The developer confirms plot plan compliance with the BGP.
- For **infill redevelopment** sites, builders submit a Site Plan with the building permit application. The ***Site Plan*** indicates the lot elevations at each of the lot corners, building corners and the adjacent backs of sidewalks and curbs, minimum design slopes, and locations of any Swales or other surface drainage features.

Development Site Servicing Plan (DSSP)

For multi-residential developments (greater than two units), the developer or builder is required to submit a ***DSSP*** in compliance with The *City of Calgary's* *DSSP Guidelines*. This plan indicates the locations and elevations of buildings, utilities and any significant Surface Drainage Features for the lot. It will also identify any Stormwater storage, Stormwater quality management or flow restriction devices (where required).

AS-Constructed Grade Certificate (AGCG)

The ***As-Constructed Grade Certificate (ACGC)*** is a post-construction ***Plot Plan*** which contains the proposed lot elevations as reflected on **Site Plan / Plot Plan** as well as the constructed or "as-built" lot elevations (Appendix B). The purpose of the ***ACGC*** is to certify that acceptable tolerances between the two elevations have been met at the point in time the survey was completed. This plan requires certification by a Professional Land Surveyor, Professional Engineer, or a Registered Architect, to ensure that site elevations at the time of legal survey comply with approved grades and allowable tolerances (as defined in the Lot Grading Bylaw). The Builder directs completion of the legal survey and the ACGC.

4.0 Lot Drainage Rules and Best Practices

There are several general rules that apply to every lot and which outline the basic parameters for directing drainage on and off the lot. Regardless of the Development Category, the following are rules and best practices applicable to residential lot grading.

4.1 General Rules

Topography

Slope and ***Topography*** describe the 3-dimensional shape and relief (amount of elevation difference (highs and lows) within a particular area) of land. Lot grading should direct runoff away from permanent structures toward the street, lane or Swale. Whenever possible, best practice involves grading the lot so that runoff is directed toward landscaped areas (e.g., grass or gardens) where the water can be absorbed first before draining to the front and back of the property.

There are three types of residential lot surface drainage patterns that can be established:

1. Rear-to-Front (as shown in Figure 8)
2. Split (drains to both front and back, (as shown in Figure 9)
3. Front-to-Back (drainage to the rear of the lot will be directed to a Swale and/or an alley or lane).

In greenfield areas, the overall Topography and drainage pattern of a lot is determined as part of the development process. Lot Topography is determined by the developer's consulting Engineer at the time the Building Grade Plan is designed for the subdivision. The builder is then responsible to develop a grading plan for each lot that complies with the Building Grade Plan.

Established areas of the city may not have applicable subdivision drawings to refer to, and there may not be a clearly defined surface drainage pattern. In these cases, the Topography of the lot is influenced by the elevations of the adjacent lots, and the ***Geodetic Elevations*** at the property corners and boundaries. The geodetic elevations can be located on the As Constructed Grade Certificate (if one exists) or possibly the original subdivision drawings. If neither exist, a land survey can be conducted to confirm the geodetic elevations.

Often in established areas, the original grading design may not have adequately considered Positive Lot Drainage, or the interaction between adjacent lots (the slope of the lot may be quite flat). In these cases, to accomplish Positive Lot Drainage when redeveloping, the elevation of the home may need to be increased to provide a positive slope. Lot grading should be designed to contain Stormwater runoff within the lot that generates it and direct it to the front or the back of the property.

Slope *describes both the direction and steepness, or, the change in elevations over a certain distance.*

Topography *is a measurement of elevations.*

A ***Geodetic Elevation*** *refers to a specific coordinate system and a set of reference points, used to locate places on earth based relative to a reference point (such as sea level). A lot in an established area will be required to maintain the Geodetic Elevations during redevelopment.*

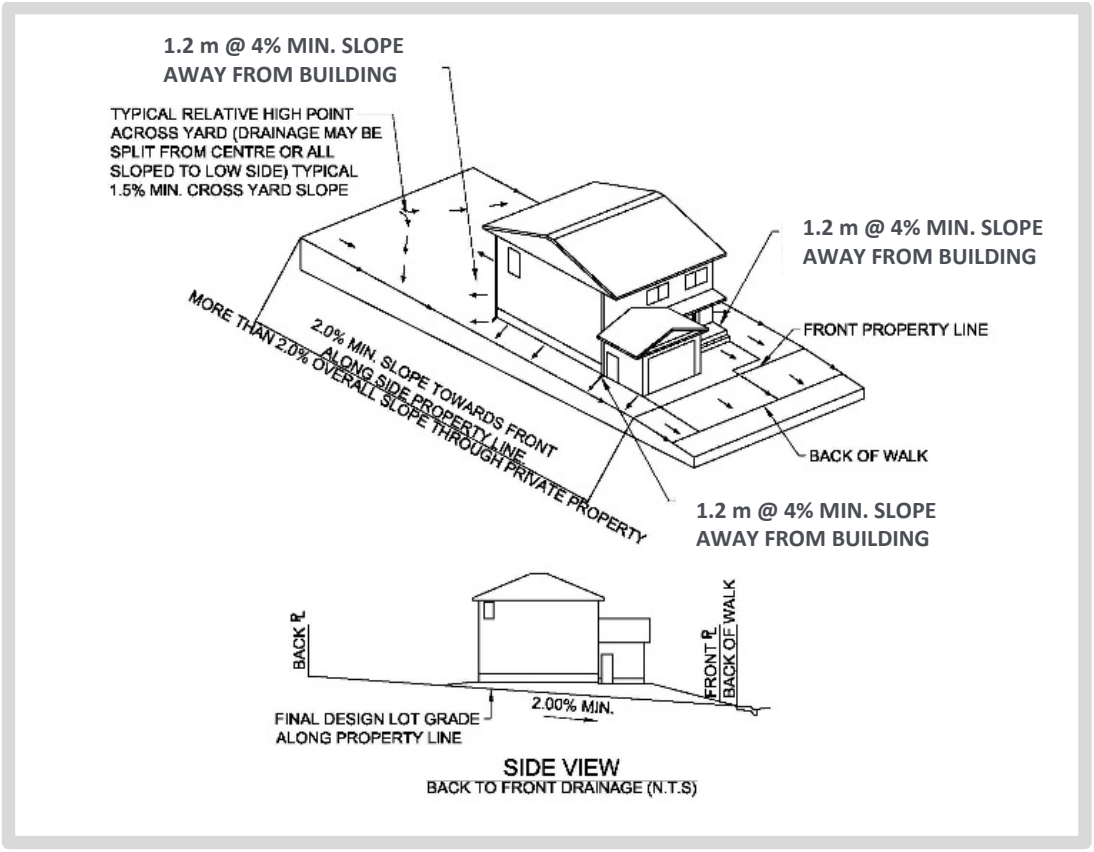


Figure 8 – Rear-to-Front Drainage. Source: The City of Calgary

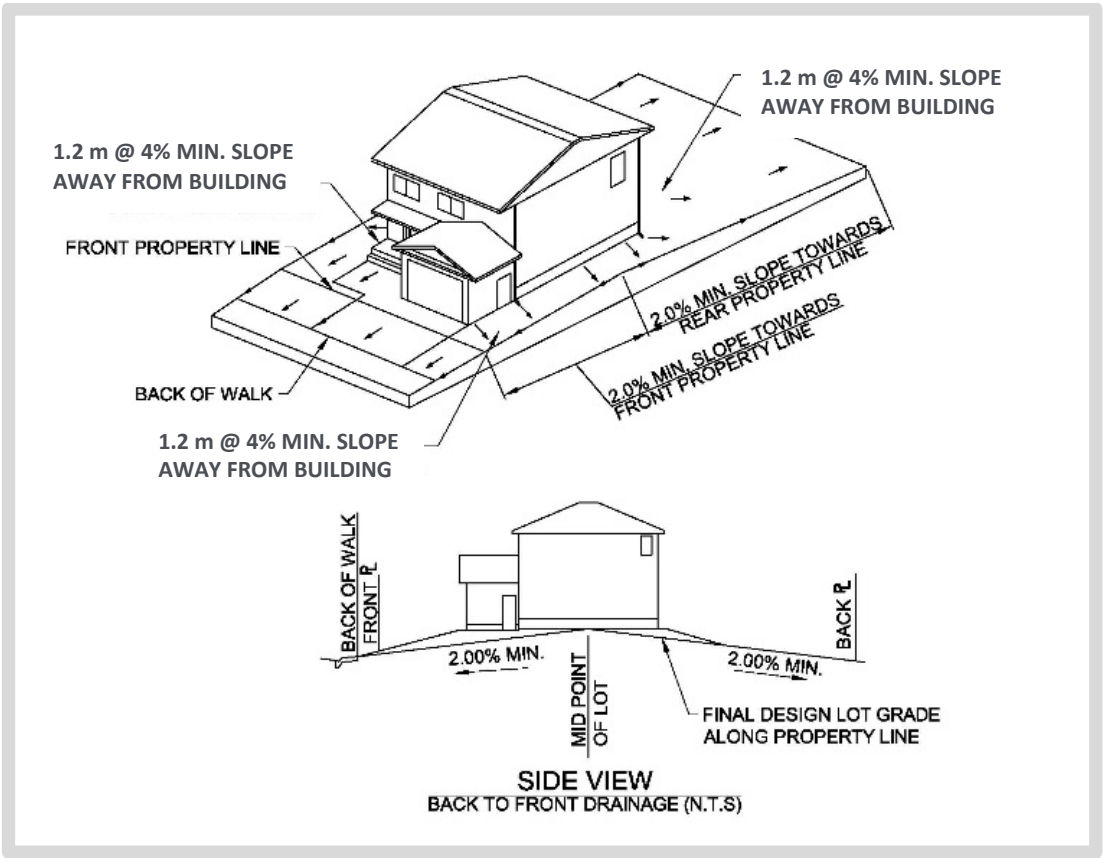


Figure 9 – Split Drainage. Source: The City of Calgary

Minimum Slopes

Slope describes both the direction of flow and the steepness, or, the change in elevation over a certain distance. A sloped surface is required to drain water away from buildings and permanent structures and towards the street, lane or Swale (Figures 8-11). When adequate Slope is not provided, water can sit close to building foundations which can cause seepage issues and premature deterioration of the concrete foundation walls.

In addition to the minimum Slopes (e.g., 2%) required to achieve Positive Lot Drainage (Figure 11), there are also limits to maximum Slopes to prevent erosion. The earth material (soil) conditions on a lot can vary in different areas of the city and can also be influenced by groundwater conditions. Maximum slopes adjacent to structures should always be established under the consultation of a Professional Engineer.

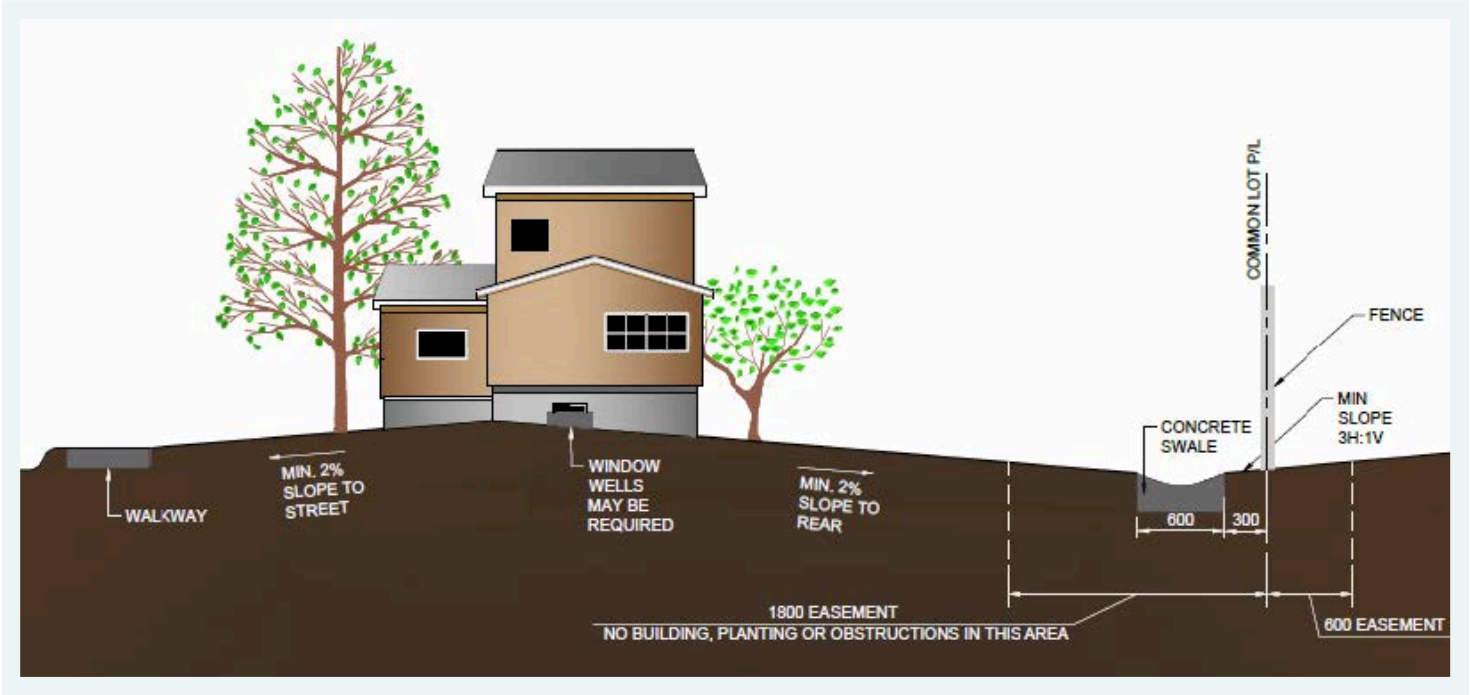
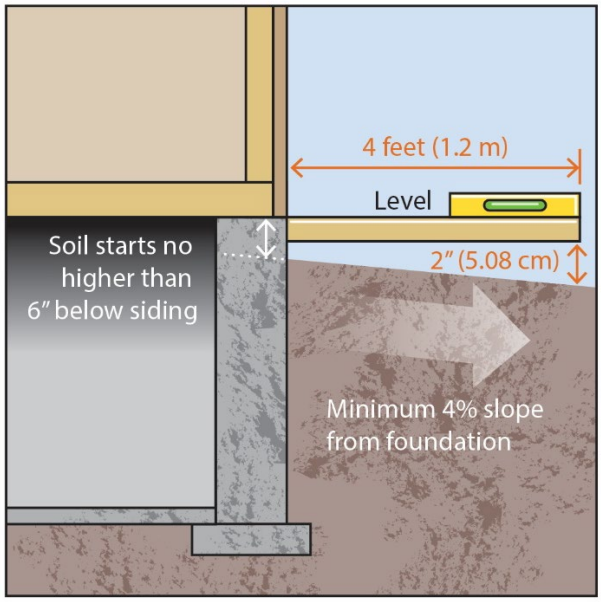


Figure 10 – Positive Lot Drainage with a Rear Yard Concrete Swale. Source: The City of Calgary

Slope Rules

- ✓ Provide a minimum 4% slope (the equivalent of 4.8 cm (1.89 inches) elevation fall within 1.2 meters (3.93 ft.) of a building foundation wall.
- ✓ Provide a minimum 2% slope (equivalent of 5 cm over 1.2 m (0.25 inches over 1 foot)) in grassed, landscaped areas, or vegetated Swales to allow runoff to drain away effectively.
- ✓ Provide a minimum 0.6% slope in concrete Swales.
- ✓ Slopes shall not exceed 33% (the equivalent of 1 m (3.28 ft.) of elevation difference over 3 m (9.84 ft.). Retaining walls shall be provided to limit maximum grade differentials.

Refer to the City of Calgary Lot Grading Bylaw for more information.



How to Measure Slope. Minimum 4% Slope adjacent to foundations. Source: The City of Calgary

Minimum 0.6% Slope in Concrete Swales. Source: The City of Calgary

Minimum 2.0% Slope in grassed/vegetated Swales. Source: The City of Calgary.

Figure 11 – Slope Examples

Parcel Coverage and Impervious Area

Parcel Coverage is the percentage of area of structures (home, garage, etc.) located on the lot (parcel) compared with the total lot area. Lots with higher Parcel Coverage will have greater amounts of ***Impervious Area***.

Impervious Area can include man-made surfaces such as roof shingles, concrete, asphalt, or naturally impervious surfaces such as certain highly compacted soils (clay). In addition to the roof area on a lot, features like decks, sheds, walkways, and driveways add more Impervious Area. Lots with higher Impervious Area will result in a higher volume of Stormwater runoff draining from the lot to the street, lane, or Swale.

In contrast, maximizing ***Permeable*** (pervious) areas on a lot, including landscaped areas, grass, gardens, and Permeable soils (gravel), provides opportunities for Stormwater to be absorbed and filtered by the land. Greater Permeable area on a lot encourages ***Evapotranspiration,*** reducing the impact of Stormwater discharge from a lot on the adjacent lots, public infrastructure and downstream rivers, creeks and wetlands (Figure 12).

Building, grading, and landscaping features that use or mimic natural processes resulting in infiltration, evapotranspiration, or the use of Stormwater are referred to as ***Low Impact Development (LID) practices***.

LID practices can reduce the volume of Stormwater runoff from a lot, provide Stormwater quality treatment benefits, as well as provide a natural water source to sustain landscape features without the use of potable water. Refer to the *City of Calgary's LID Modules*[16] for more information.

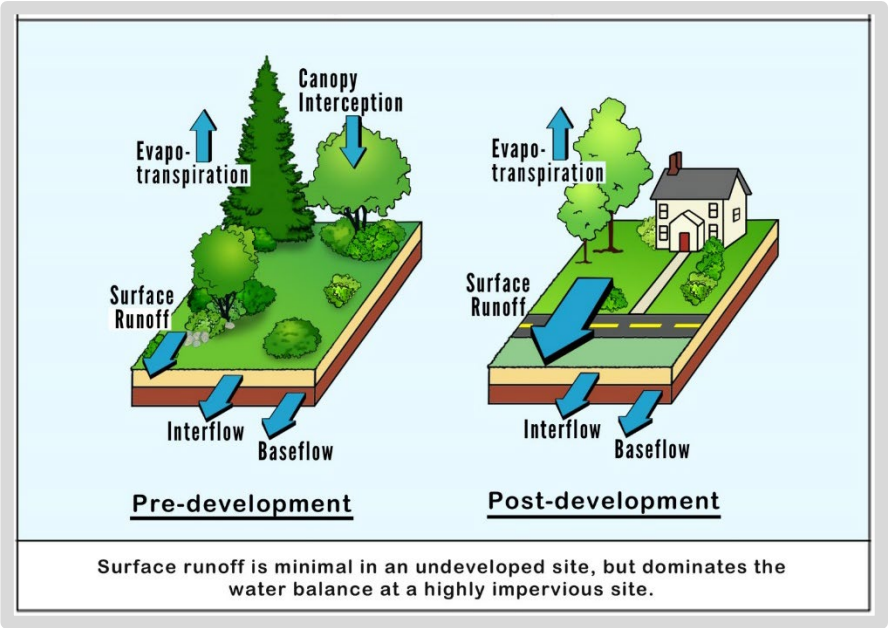


Figure 12 – Construction of Pervious Surfaces on a lot impacting stormwater run-off. Source: Schueler, 1987.

Low Impact Development *is the practice of building, grading and landscaping features that use or mimic natural processes resulting in Infiltration, Evapotranspiration, or the use of Stormwater.*

Impervious Areas are surfaces that do not allow precipitation to infiltrate (soak) into the ground (e.g. concrete driveways, patios or walkways).

Permeable areas are surfaces that allow materials, like liquids, to pass through and infiltrate (soak) into the ground.

Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces, and by ***Transpiration*** from plants.

Transpiration is the process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapour and is released to the atmosphere.

Overland Drainage Rights-of-Ways (ODRW)

Lots may be delineated by a street at the front of the lot and a lane (or alley) at the back. In communities without rear lanes (alleys), concrete Swales often run along the backyard, and occasionally the side yard, of the property to facilitate Stormwater conveyance for individual lots. The concrete Swales may direct runoff from and over multiple lots within a subdivision to a catch basin or public street or lane. In situations where individual lot drainage relies on discharge into a Swale that crosses multiple lots, these drainage Swales will be protected by an Overland Drainage Right-of-Way (ODRW).

Lot owners should confirm the location and exact dimensions of any ODRW impacting their lot by checking their ***Real Property Report (RPR)*** or land title. When a concrete Swale is located in an ODRW, the width of the ODRW will extend beyond the actual Swale limits (Figure 13).

ODRW Rules:

- ✓ The maintenance of ODRWs is the property owner's obligation.
- ✓ Swales located within ODRWs must be protected from damage and kept clear of debris or blockage (including snow and ice) at all times.
- ✓ The grade (or Slope) of the land within the ODRW is not to be changed.
- ✓ Contouring should be designed and maintained so that water can easily enter the ODRW and follow drainage path to the appropriate storm drainage infrastructure.
- ✓ Swales need to be functional at all times, as they act as an emergency drainage route during high intensity storm events.
- ✓ If a Swale is blocked or water is unable to enter the Swale via the ODRW, any blockages located on the property should be removed by the property owner.
- ✓ If a downstream blockage is suspected, lot owners are encouraged to cooperate with neighbours to maintain the drainage Swales in their subdivision. If attempts to do so are unsuccessful, the issue can be reported to The City by calling 311.

Real Property Report (RPR) is a legal document that clearly illustrates the location of significant visible improvements relative to property boundaries.

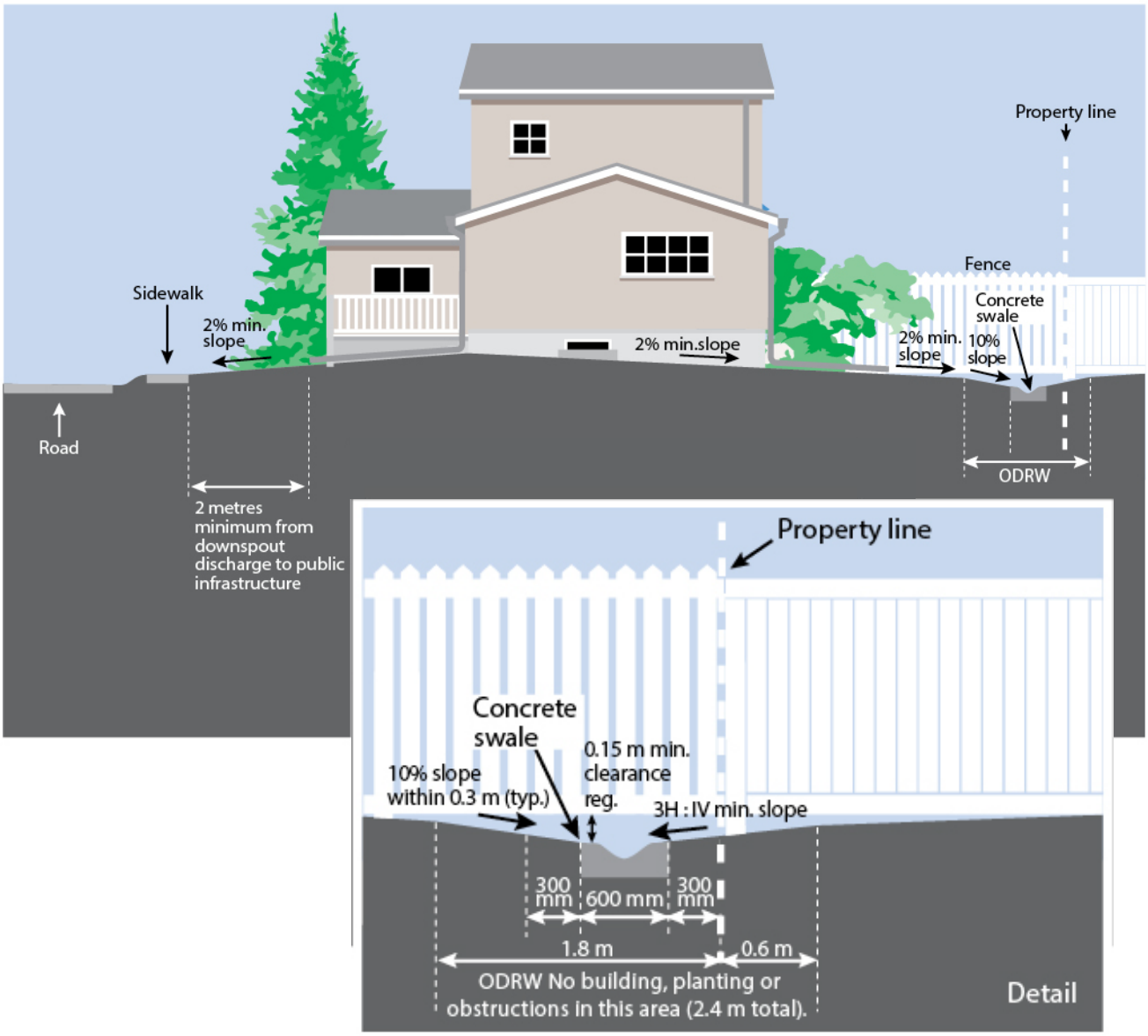


Figure 13 – Typical ODRW at Property Line / Fence. Source: The City of Calgary.

Adjacent Properties

In designing and maintaining Positive Lot Drainage, the interface with adjacent lots needs to be considered. Drainage paths should be designed to direct runoff away from all permanent structures (including homes, garages, and retaining walls) through landscaped areas and towards the street, lane, or Swale. The side yard will require enough clearance to accommodate the runoff from the lot in this manner.

When redevelopment occurs in established communities, Stormwater can inadvertently flow into a neighbour's property. This happens for number of reasons:

- Redevelopment may introduce reduced setbacks, creating steeper side yard slopes where grading may have historically been flat.
- Redevelopment may introduce greater Parcel Coverage (e.g., building structures), higher imperviousness (e.g., concrete) and therefore more Stormwater runoff volume that must drain to a smaller surface area.

In addition to changes introduced by a redeveloping lot, the condition and drainage patterns of adjacent, established lots may compound drainage issues for the following reasons:

- Land can settle naturally over time.
- Lot grading and building standards have changed over time. Established lots may have originally been developed with flatter slopes and/or inadequate drainage.

The builder is required to design and build a lot drainage plan that provides a functional drainage solution without affecting the neighbouring lot (Figure 14). These drainage patterns must be maintained by property owners for the length of their ownership.

Best Practices for Minimizing Impacts to Adjacent Lots:

- ✓ Implement side yard Swales, low retaining walls, or other contouring of the land to direct runoff appropriately away from structures (Figures 23-27).
- ✓ Avoid abrupt changes in elevation at the property line.
- ✓ Property owners of established lots may need to consider improvements to their lot grading to improve Slope away from structures if the original lot grading design was flat, or if settlement has occurred over time.

Figure 14 – Infill redevelopment with higher lot elevations than adjacent property manages lot drainage with Swale and Retaining Wall at side yard. Source: The City of Calgary.

Roof Drainage, Eavestroughs & Downspouts

Roof eavestroughs and downspouts are critical components of Stormwater management on a residential lot. Precipitation is collected off the roof by the eavestroughs and directed away from structures to the public Stormwater infrastructure via downspouts.

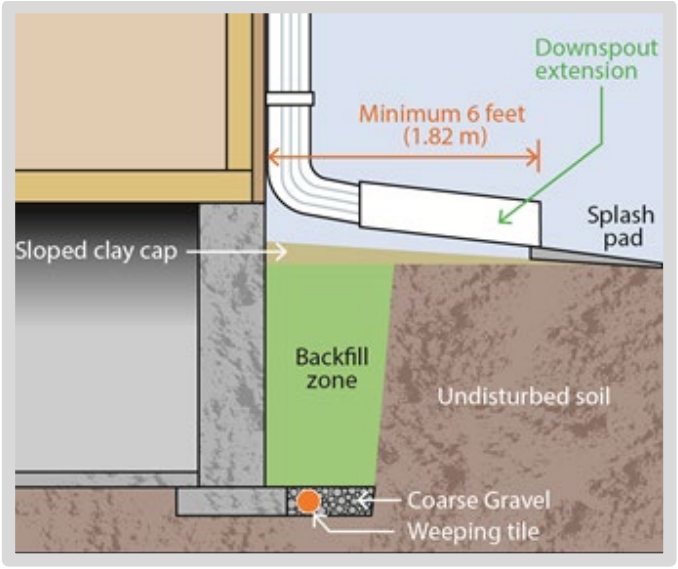


Figure 15 – Extend downspouts a minimum of 4-6 feet (1.21-1.83 m) away from building to prevent recirculation of roof drainage at the foundation. Source: The City of Calgary.

Figure 16 – Splash pad at downspout discharge can prevent erosion. Source: The City of Edmonton Residential Lot Grading Guide

Roof Drainage Rules:

- ✓ The property owner is responsible for regular cleaning and maintenance to remove any debris or blockages in the eavestroughs.
- ✓ Runoff must be directed to the street, lane, or Swale, and not toward an adjacent building or structure.
- ✓ Discharge points must be a minimum of 2 m (6.74 ft.) away from any public infrastructure (i.e. sidewalks, streets, lanes, or Swales).

Best Practices:

- ✓ Downspouts should extend a minimum of 4'-6' (1.21-1.83 m) away from the building foundation so that the runoff does not re-circulate down the foundation wall and into the basement and/or weeping tile system (Figure 15).
- ✓ A splash pad placed at the downspout discharge point will minimize soil erosion (Figure 16).
- ✓ Direct downspouts into landscaped surfaces to maximize the potential for Stormwater infiltration.
- ✓ Large roofs should distribute Stormwater through multiple downspouts, spaced so that they can disperse runoff evenly onto landscaped areas.
- ✓ Downspouts should not be directed toward driveways, sidewalks or other hard surfaces where discharge can cause a safety concern (e.g., slippery sidewalks).
- ✓ Downspout discharge should be designed to avoid erosion and/or undermining of structures adjacent to parks or other public amenities.

4.2 Specific Rules

Minimum Entrance Elevations & Trap Lows

In communities built after 1988, low areas have been intentionally designed into roadways, lanes, and parks. These low areas, or ***Trap Lows***, are specifically designed to act as temporary Stormwater storage (surface ponding) during storm events. To manage drainage on private commercial or multi-family residential sites, Trap Lows may also be designed in parking lots or landscaped areas. The intent is for Stormwater to collect and pond in these low areas to delay release into the underground piped system with installation of a control device in the catch basin/storm drain (Figure 18). This allows runoff to drain at a slower flow rate to the piped storm system so that it will not get overloaded, while also protecting surrounding residential buildings from flooding.

When buildings are located adjacent to Trap Lows, they will be subject to minimum entrance elevations to reduce the risk of flooding ***(Restricted Minimum Grade (RMG),*** Figure 17***)***. Following the storm event, and once capacity is available in the Minor (piped) System, water will discharge from the Trap Low into the piped system.

Surface ponding in Trap Lows can often be misinterpreted as a blockage or failure in the public Stormwater system, however, they are intentional. Trap lows are an important part of the Major (overland) Stormwater conveyance system and are located in areas that are considered public rights-of-ways (roads, lanes or park areas).

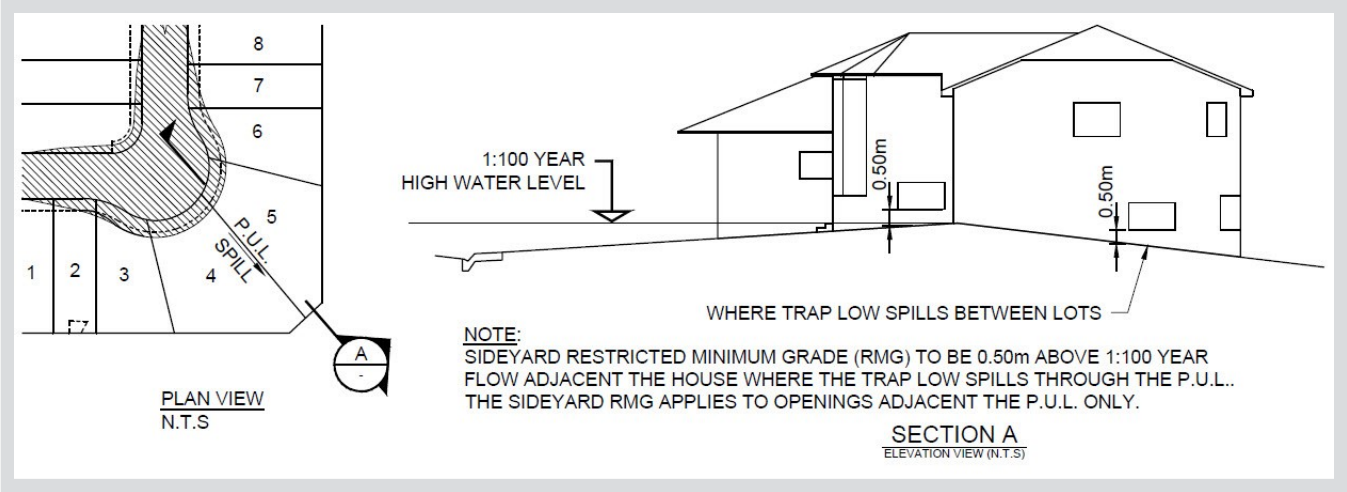


Figure 17 – Lot adjacent to a Trap Low with a Restricted Minimum Grade. Source: The City of Calgary Stormwater Management Guidelines.

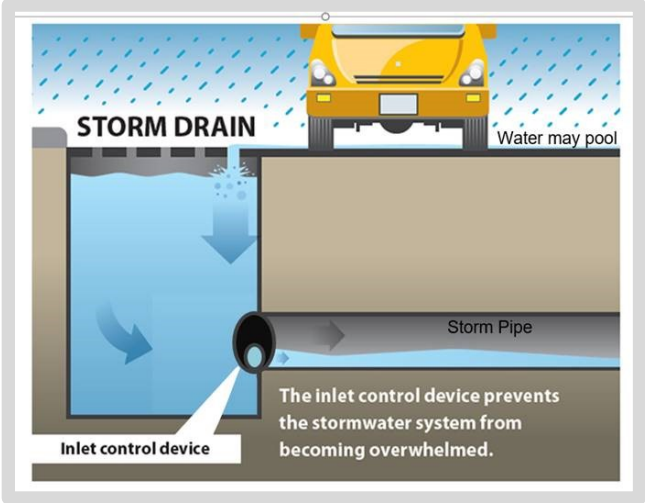


Figure 18 – Inlet control device in a catch basin to restrict flow. Source: The City of Calgary.

*A **Restricted Minimum Grade (RMG)** is a restrictive clause placed on a lot, which includes a registered drainage easement and identifies the minimum opening elevation that must be met for a structure.*

*A **Trap Low** is an intentional sag or depression in a road, parking lot or park, designed with the purpose to provide temporary Stormwater storage via surface ponding during rainfall events.*

It can sometimes take up to two hours following a storm event for the ponded Stormwater to drain from the Trap Low into the piped system. If the Trap Low does not drain within the two-hour window, the drain might be blocked or clogged. Trap Lows that are a part of the street network are cleaned and repaired under regularly scheduled maintenance by the City of Calgary.

The absence of an RMG on the property title does not guarantee that a building will be protected from potential overland flooding. Property owners concerned that their dwelling may be prone to flooding should contact a Professional Engineer or Building Envelope specialist to evaluate the risk of flooding and recommend measures to minimize the potential for overland flow entering their building. The City of Calgary's *Stormwater Management & Design Manual* provides more information about RMGs.

If flooding or ponding in public rights-of-way is an ongoing concern in communities developed prior to 1988, or in areas designed without intentional trap lows, it may indicate a maintenance or design issue that can be reported to The City by calling 311.

Reference Information for Property Owners:

Property owners can identify locations of intentional Trap Lows at the City of Calgary website. Expect these areas to pond during and after a storm event: www.calgary.ca/stormdrains

Rules – Lots Subject to Restricted Minimum Grades (RMG):

- ✓ All building openings must be above the spillover elevation of adjacent or downstream Trap Lows.
- ✓ The RMG will apply to doors, windows, basement windows, garage doors, and any other openings to the building.
- ✓ The RMG will be registered on title for the lot and must be maintained permanently.
- ✓ Property owners are responsible to be aware of and understand any RMGs registered on the title for their property.

Development Site Servicing Plans (DSSPs)

Residential developments with greater than 2 units will be subject to The City of Calgary's Development Site Servicing Plan (DSSP) process. The DSSP quantifies the volume of Stormwater generated on a lot, how and at what rate it will be released from the site, as well as the site grading changes resulting from development.

Stormwater management infrastructure or equipment may be required to meet Stormwater release rate, volume, or quality requirements. Tools available to meet these requirements may include drywells, oil grit separators, Stormwater retention tanks, and absorbent landscaping and other LID features. Refer to The City of Calgary's Development Site Servicing Guidelines for more information.

Zero Lot Lines

A **Zero Lot Line** is a legal provision which allows a building structure to be constructed directly adjacent to the side yard property line (without a setback). Often, Zero Lot Lines will exist in conjunction with a maintenance access right-of-way on the adjacent lot to allow the owner of the lot with the Zero Lot Line to access the adjacent lot for required building maintenance on their home (Figure 19).

Home buyers are obligated to understand the responsibilities of owning a home with a Zero Lot Line, or a lot adjacent to a Zero Lot Line. In addition to the obligation to provide maintenance access, adjacent lots may be impacted from roof or lot drainage from the adjacent home due to the lack of a side yard. Homeowners are required to work together to allow for proper lot drainage and home maintenance.

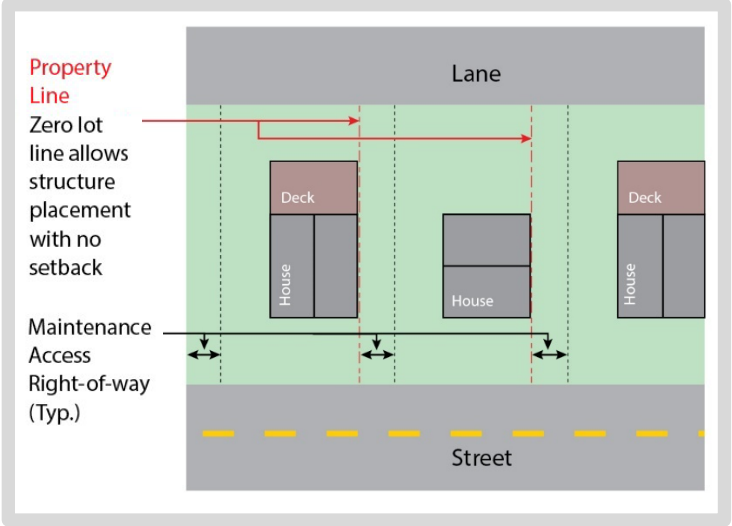


Figure 19 – Zero Lot Line with Maintenance Access Easement. Source: The City of Calgary.

*A **Zero Lot Line** is a legal provision which allows a building structure to be constructed directly adjacent to the side yard property line (without a setback).*

5.0 Lot Drainage Tools

5.1 Building Features

Weeping Tile

A ***Weeping Tile*** system reduces the water pressure exerted on a building foundation and will usually drain to a sump pump or The City's Storm Sewer system (Figure 20).

Some homes that are at lower risk for flooding or were built a long time ago may not have a ***Weeping Tile*** installed. If a home is experiencing basement seepage, the lot owner should confirm that Positive Lot Drainage is provided and maintained and that roof drainage best management practices are applied. If basement seepage problems persist, a Weeping Tile system may be a tool to improve foundation drainage which can be pursued following consultation with a Building Envelope specialist.

The Institute for Catastrophic Loss Reduction[17] and *Intact Centre for Climate Adaptation*[18] can be referenced for tools to reduce the risk of basement flooding.

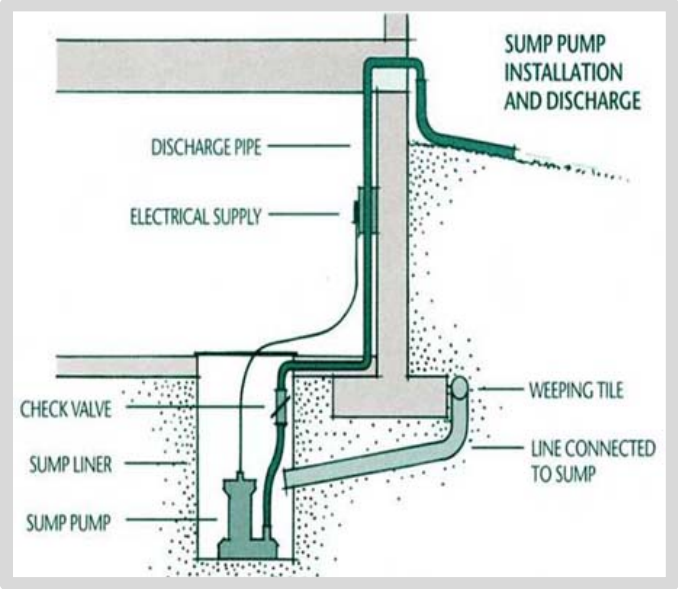


Figure 20 – Weeping Tile with Sump Pump. Source: The City of Edmonton Homeowner's Guide to Flood Prevention.

Weeping Tile *is a perforated pipe installed at the footing of the building foundation, designed to manage subsurface (below the surface) water or ground water, extracting water which may sit near the foundation (Figures 15 and 20).*

Sump Pumps

Sump Pumps may be installed in conjunction with, or independent of Weeping Tile systems. A Sump Pump system will include a basin (or pit) at the lowest elevation of the basement. Subsurface water will collect in the basin, either naturally through soil seepage under the foundation, or through a piped system such as Weeping Tile. The Sump Pump acts to extract (pump) water from the basin area to the exterior of the home (Figure 20).

Discharge from a Sump Pump must be directed in such a way to avoid recirculation into the basement foundation, a neighbouring property, or cause adverse effect to a public space.

*A **Sump Pump** is a motorized mechanical device that keeps basements dry by pumping excess water from a sump (pit or depression) to the surface.*

Sump Pump Rules & Best Practices:

- ✓ Foundation drainage cannot be discharged into The City's Sanitary Sewer System. It must discharge to the surface or to The City's Storm system.
- ✓ When sump pumps discharge to the surface:
    - Direct discharge away from buildings, through landscaped areas, to the front or rear of the property, to the street, lane or Swale.
    - Avoid direct discharge to hard surfaces to prevent slippery conditions. Allow discharge to be absorbed into landscaped areas first.
    - Prevent freezing of discharge pipes in the winter to avoid blockages. Refer to The City's Stormwater Management & Design Manual for more information.
- ✓ Always provide supplementary back-up power. Provide a separate electrical circuit, with the operating switch located above the designated flood level (if applicable).
- ✓ Ensure Sump Pumps are sized appropriately.
- ✓ Home owners should understand and fulfill ongoing testing and maintenance requirements.
- ✓ Specific rules apply when building within the Flood Fringe or Floodway (see page 31).

Window Wells

Due to their elevation, basement windows can be susceptible to impacts from ground water and surface water runoff. When a basement window is at or below the adjacent ground level, a **Window Well** will be required to provide adequate egress (when required) and to prevent soil and water infiltration into the window (Figure 21).

Figure 21 – Window Well in Side Yard. Source: The City of Calgary

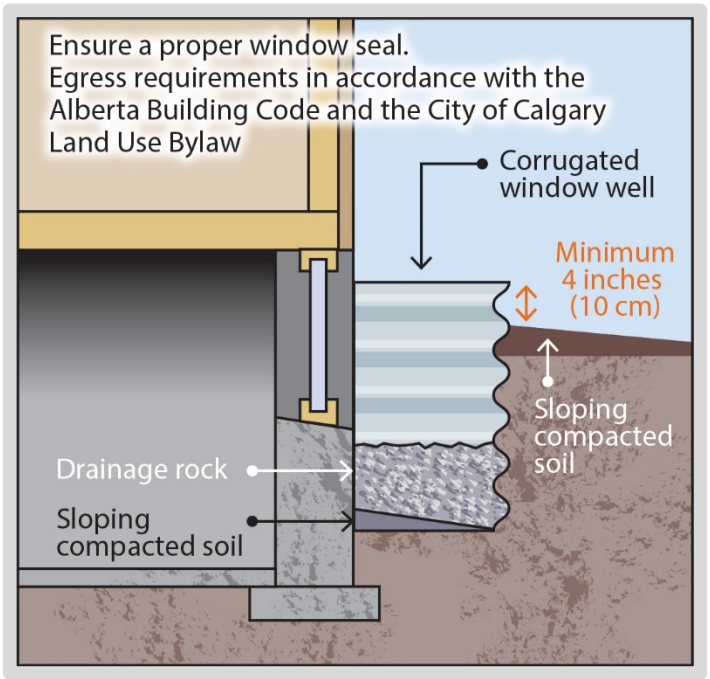


Figure 22 – Window Well grading. Source: The City of Calgary

A ***Window Well*** *is space maintained between a below grade window and the surrounding soil. The Window Well provides drainage around the window and, in some case, an egress route (safe exit) from the building.*

Window Wells – Best Practices:

- ✓ The elevation of the top of the Window Well should be a minimum of 4" (10.16 cm) above the adjacent ground level, unless a RMG is registered on Title. In this case, the RMG will dictate the window well height (Figure 22).
- ✓ Ensure a tight waterproof seal around the window.
- ✓ The Alberta Building Code and The City of Calgary Land Use Bylaw should always be referenced for additional window well requirements relating to egress and property setback dimensions.

Building Within the Flood Fringe or Floodway

Special conditions apply to developments located within a Floodway, Flood Fringe or Overland Flow Area (Figure 7). Properties within these areas are subject to additional regulations described in the Land Use Bylaw and The City's Stormwater Management & Design Manual.

The Bow River, Elbow River, Nose Creek and West Nose Creek have distinct rules and regulations for development. Property owners can call 311 or visit The City of Calgary's flood information website[13] to determine if their property is subject to special flood regulations.

Reference Information for Property Owners:

Property owners can visit the City of Calgary's flood information website to determine if their property is subject to special flood regulations:

https://www.calgary.ca/UEP/Water/Pages/Flood-Info/Flood-Information.aspx

Rules – Building in the Flood Fringe or the Floodway:

- ✓ Any Sump Pump discharge must be above the most recent flood inundation model elevations.
- ✓ All electrical and mechanical equipment within a building must be constructed at or above the most recent flood inundation model elevations; contact 311 for the elevations.
- ✓ No primary living spaces (e.g. bedrooms) should be located below the most recent flood inundation model elevations.
- ✓ Building structures and basement designs must consider the potential for elevated groundwater during flood events, which will impact foundation dewatering.
- ✓ Basements should not be utilized for storage of immovable or hazardous materials that are flammable, explosive or toxic.
- ✓ Backflow prevention valve(s) on sanitary sewer service lines can be considered in areas with elevated groundwater levels or those at risk of flooding. This can prevent sewage back-up into the home during times of elevated groundwater. Installation should be directed by a qualified plumber.

5.2 Site Terrain

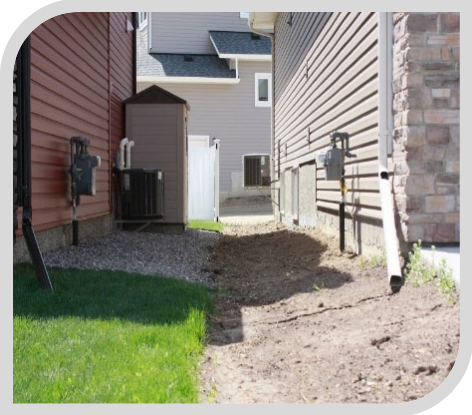
Site grading is the most effective method for directing and containing Stormwater within a lot. It directs runoff from hard surfaces, including roofs, driveways, patios, and sidewalks, to absorbent landscapes such as planting beds, Rain Gardens, lawns, and other permeable areas.

Side Yard Swales

In both greenfield and redevelopment scenarios, side yard Swales can be used to direct runoff away from structures and to the street, lane, or Swale. A common (shared) side yard Swale can be an effective drainage path between adjacent homes (Figure 23), and can be constructed with concrete, grass or other landscaping materials.

If site terrain, or timing of development will not support a common Swale, the developing lot may need to install a short retaining wall or concrete curb or Swale for the side yard Swale to be effective without impact to the adjacent lot (Figures 24-27).

When minimum Slopes are hard to achieve, other solutions such as variable depth Swales, retaining walls, or French Drains may be potential solutions.



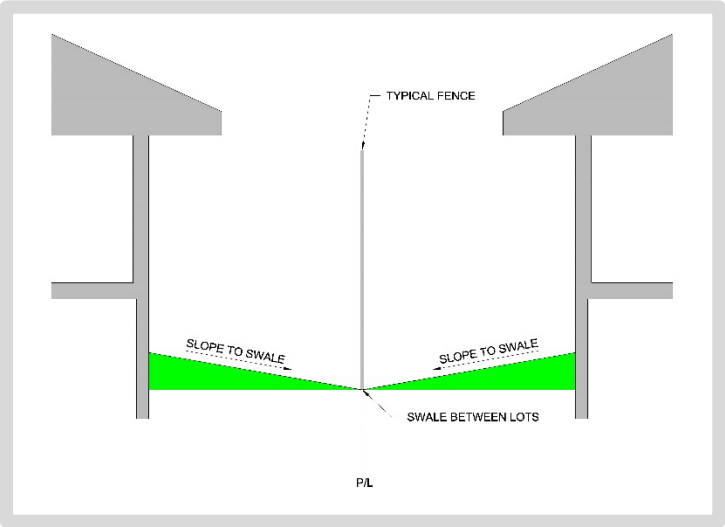


Figure 23 – Common (Shared) Side Yard Swale. Source: The City of Calgary.

Swales – Best Practices:

- ✓ Drainage from one lot shall not enter onto another unless confined to a common (shared) Swale, or if the impacted lot is subject to a Registered Access or Drainage Easement.
- ✓ Both property owners share responsibility for maintaining a Swale when it is located along the property line.
- ✓ Swales should be designed to have enough depth and width to contain the runoff from the lot.
- ✓ Provide a minimum 2% slope toward the front or back of the lot for landscaped Swales, and a minimum 0.6% slope for concrete Swales.
- ✓ Swales should ideally drain to elements in the landscape to filter the Stormwater before it leaves the lot.
- ✓ Side yard Swales can be constructed of concrete, sod, gravel, or mulch. More porous materials help to slow water down and allow for more absorption.

Figure 24 – Concrete Swale at Side Yard. Source: The City of Edmonton Lot Grading Guidelines

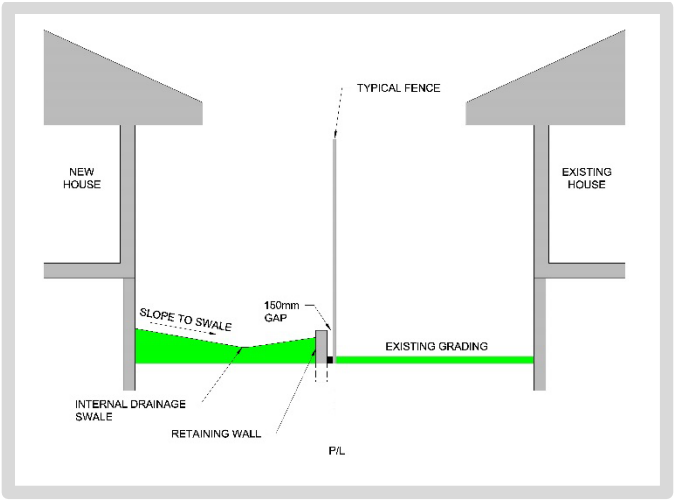


Figure 25 – Side Yard Swale and Low Retaining Wall. Source: The City of Calgary

Retaining Walls & Terracing

A ***Retaining Wall*** is generally required in situations where there are significant elevation changes within or between adjacent lots or where there is not enough space to accommodate an elevation change to facilitate drainage. Retaining Walls should be identified on the Plot Plan, Site Plan or DSSP, whichever is applicable.

Specific requirements for retaining wall permits and approvals are outlined on the City's website -- (see *Fences and Retaining Walls*[19]). Retaining Walls may require an engineered design and should be constructed in accordance with applicable standards and guidelines for long-term stability.

Retaining Walls, when used in combination with side yard Swales, are effective tools to maintain independent drainage on adjacent lots when a common Swale is not possible (Figures 25-27).

Fences are not designed to act as retaining walls and retaining walls cannot be supported by fences. In some situations, a fence can be placed above or behind the top of a retaining wall. Refer to Figure 26 for examples of placement of fences.

Figure 26 – Examples of Low Retaining Wall at Side Yard. Source: The City of Calgary

Retaining Walls are rigid walls which support soil laterally at different elevations on either side of the wall. These structures are designed to restrain soil to a Slope that it would not naturally maintain.

Retaining Walls Best Practices:

- ✓ Build the wall within the confines of the property that triggers the wall requirement. That property owner will be responsible for ensuring that the wall is designed, constructed, and maintained in a way that minimizes any adverse effect to neighbouring properties.
- ✓ Engage with neighbours ahead of time to discuss the design, construction, and maintenance.
- ✓ Consider lifecycle and maintenance requirements when selecting retaining wall materials.
- ✓ Conduct regular visual inspections of the wall to check for cracking, surface deterioration, or leaning.
- ✓ If access is required to a neighbouring property in order to construct the retaining wall or perform regular inspection or maintenance, a maintenance easement and a restrictive covenant (agreement) should be in place on the titles of both properties.
- ✓ A fence can be placed above or behind the top of a retaining wall, if considered as part of the engineered design.
- ✓ Direct runoff away from retaining walls to prevent standing water against the wall, which can cause premature deterioration.
- ✓ Sub-surface drainage systems, perforated pipes (Weeping Tile) or French Drains may need to be installed at the base of or adjacent to the retaining wall to keep moisture away from the wall.

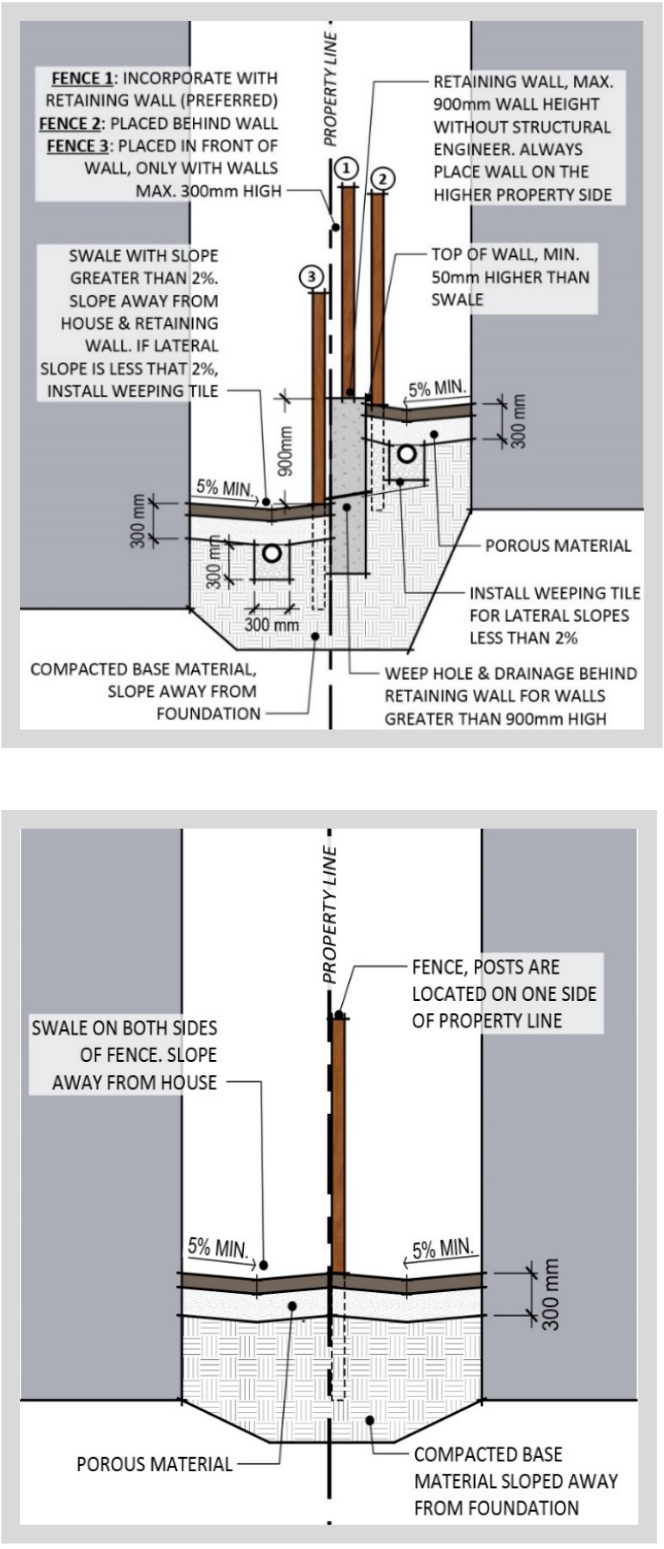


Figure 27 – Examples of Retaining Wall and Fence placement at Side Yard. Source: The City of Calgary.

5.3 Conveyance and Storage

French Drains

When a minimum surface grade slope cannot be achieved, a ***French Drain*** can help to collect the surface water and convey it away from building foundations (Figure 28).

French Drains need to be constructed to allow the end of the drain to release the water at a safe location (that does not cause adverse effect to adjacent lots or City infrastructure). Homeowners should consult with a Professional Engineer or landscaper for guidance in designing and constructing a French Drain.

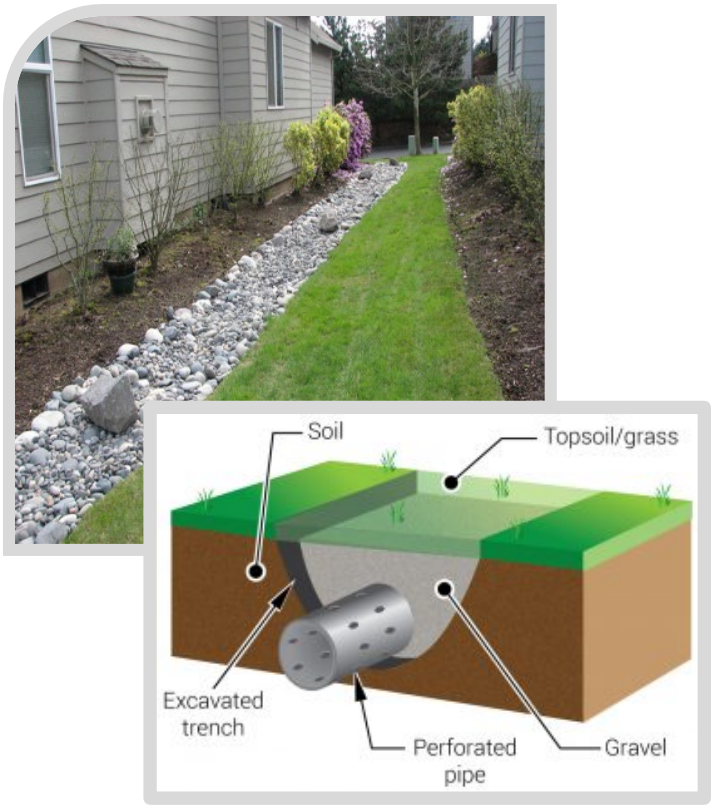


Figure 28 – French Drain Details. Sources: Neave Stormwater and engineeringclicks.com

*A **French Drain** is a trench with a perforated pipe (holes), or series of pipes wrapped in filter cloth inserted below the ground surface. The trench is backfilled with sand or gravel to allow surface water to drain easily into and along the perforated piping while filter cloth cleans it as it drains down to the outlet.*

***Dry Wells** (or soakaways) are features that trap and hold water underground before infiltrating into the ground.*

Dry Wells

Dry Wells may be considered as a temporary solution (in areas where soil conditions are suitable) until piped storm servicing becomes available (refer to The City of Calgary's *Stormwater Management & Design Manual* for more information).

It is recommended that property owners consult with an Engineer or other Professional to get advice regarding the application of Dry Wells on their property. Site topography and soil conditions can impact the effectiveness of this tool.

Dry Wells can be of any shape (i.e. round, square, or linear) and are constructed in the form of a porous pipe or box, a gravel-filled hole, or gravel-filled trench (Figure 29). They can be filled with clean gravel or camouflaged with plants or decorative rock. They can also be placed below permeable pavers or other hard surfaces. When placed near driveways or along sidewalks, they provide good open areas for depositing and storing snow, which helps to manage runoff during snow melt.

Dry Wells can also be designed in conjunction with a rain barrel (rain barrel draining to dry well area) or Rain Garden. They are generally easy to construct and require very little maintenance.

Figure 29 – Drywell Installation. Copyright, David Buchanan, City of Bend

Rainwater Harvesting and Reuse

Rainwater Harvesting is the process of capturing and using rainwater. Property owners can use harvested rainwater to irrigate lawns, gardens, and planters, or even clean patios and driveways. This tool not only reduces the use of potable water for irrigation, but supports effective Stormwater management. Property Owners can refer to *The City of Calgary's Yard Smart – Rain Barrels*[20] for more information.

A Rainwater Harvesting system adds value to a home, not just because it allows the occupants to make use of a free resource, but also because it increases resiliency during times of restricted fresh water supplies and a changing climate. Rainwater collected from a rooftop can be a high-quality water source, as it contains no chlorine, needs little (if any) purification or disinfection for use in the garden, is the perfect temperature for plants when stored in a tank, is naturally soft, has no sodium, and is virtually mineral free.

Rainwater Harvesting systems can vary in complexity, infrastructure, and cost. Rainwater harvesting could be as simple as using a rain barrel, or can also include larger storage cisterns and pumps (Figures 30 and 31).

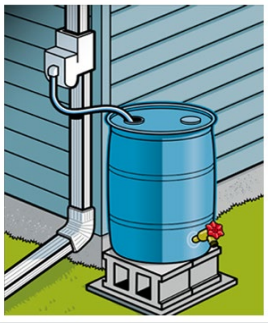


Figure 30 – Rain Barrel Placement to Capture Roof Drainage.

Figure 31 – Placement of multiple barrels in series can provide additional storage. Source: The City of Calgary Yard Smart.

Rainwater Harvesting is the process of capturing and using rainwater.

Rainwater Harvesting Best Practices:

- ✓ Rain barrels should be placed:
  - In areas where the grade slopes away from the foundation of the house.
  - Next to the garden or in close proximity to planters whenever possible.
  - Where there is appropriate surface to direct the overflow. The driveway, a pathway, or other hard surface is not appropriate. Discharge in these locations can cause freezing in the winter and slippery conditions in the warmer months.
- ✓ The rain barrel overflow system should be directed away from the home and toward the lawn, planted areas, a rain garden, or another absorptive landscape element to prevent flooding.
- ✓ Rainwater running off the garden shed or garage can also be captured and re-used by installing rain barrels next to these structures.
- ✓ A soaker hose can be connected to the rain barrel for slow drip irrigation, or a small pump can be connected to distribute the water at a controlled rate for lawn or garden irrigation.

5.4 Resilient Landscaping and Low Impact Development (LID) Tools

In residential development, the landscape features of a lot can be an effective tool in the overall Stormwater management plan. Conversely, if applied correctly, Stormwater can be used as a tool to maintain and create ***Resilient Landscaping***, and to reduce potable water consumption for irrigation purposes.

Resilient (Absorbent) Landscaping

Resilient Landscaping is a broad term that can apply to a variety of soft landscaping practices that use the absorbent nature of the landscape to filter and capture Stormwater runoff from hard surfaces (Figure 32). Absorbent landscaping is often used interchangeably with the Resilient Landscaping term.

A deeper layer of topsoil (300 mm (11.8 in.) or more) can help retain the water, allowing it to absorb into the soil for use by vegetation over a long period (typical lawns have 100 to 150 mm (3.94-5.91 in.) of topsoil).

Resilient Landscapes act like a sponge, soaking up, storing, and slowly releasing Stormwater runoff back into the ground. This mimics undisturbed soils that exist in nature prior to development. Increasing a soil's storage and infiltration capabilities can significantly reduce runoff volume.

Resilient Landscaping *is a broad term that can apply to a variety of soft landscaping practices that use the absorbent nature of the landscape to filter and capture Stormwater runoff from hard surfaces.*

Sub-grade Scarification *is the roughing and opening up of the tightly packed base soil prior to placement of loam. This increases permeability of the sub-grade soil, allowing water to flow freely from the loam to sub-soils, providing better root penetration and improved plant health.*

Resilient Landscaping Best Practices:

- ✓ Include plant species that are proven to thrive in Calgary's climate.
- ✓ Incorporate native species that will support native birds, butterflies, bees, and other animals.
- ✓ Use large planting beds and limited lawn areas to reduce or eliminates the need for extra water for irrigation.
- ✓ Apply mulch to help conserve moisture and moderate soil temperature.
- ✓ Prior to landscaping, the sub-grade soil material should be ***Scarified*** between 100-200 mm (3.94-7.87 in.) in depth.
- ✓ Minimize the amount of hard (Impermeable) surface materials.
- ✓ Avoid the use of artificial turf. Due to its impervious nature, this material is not encouraged from a Stormwater management point of view.

Refer to the *City of Calgary's Low Impact Development Modules* for more information.

Plant Materials and Resilient Landscaping

Plants and soils work together in the natural landscape. Plant roots and soil organisms build soil structure, create channels and pores that soak up and filter water, and improve nutrient and oxygen availability necessary to support an abundance of other plant and animal life. While plants help the soil absorb Stormwater, they also create an attractive landscape.

The advantages of plants, especially native plants, include the following:

- Reduce energy costs by providing summer shading and winter windbreaks.
- Absorb more water than a grassed area during rain events.
- Provide habitat for birds, insects, and other wildlife.
- Improve the air quality around the home by absorbing harmful air pollutants and increasing oxygen production.
- Improve the ability of the soil to treat and absorb Stormwater.
- Provide nutrients for soil micro-organisms that treat pollutants and nutrients in Stormwater.

Water efficient landscaping can produce healthy, visually appealing landscapes while dramatically reducing outdoor water use, particularly during peak summer months. Low Impact Development (LID) techniques, including Resilient Landscaping, ***Vegetated Swales***, and ***Rain Gardens*** support water efficient landscaping.

Figure 32 – Resilient Landscape Example. Source: Alberta Low Impact Development Partnership

Vegetated Swales *are landscape elements designed to concentrate or remove debris and pollution from Stormwater runoff. They are a Swaled drainage course with gently Sloped sides and filled with vegetation.*

Rain Gardens *are shallow, slightly depressed gardens that are designed to collect rain water.*

Reference Information for Property Owners:

Refer to The City of Calgary's YardSmart for tips on gardening and landscaping.

Rain Gardens

Rain Gardens are shallow, slightly depressed gardens that are designed to collect rain water that runs off a roof, driveway, or patio (Figures 33-36). Rain Gardens are easy to construct, and can be planted with any combination of trees, shrubs, grasses, or perennials. Rain Gardens provide an attractive and very effective way to manage Stormwater. Refer to *The City of Calgary's LID Module 2B*, *Rain Gardens in Calgary*[21], *YardSmart - Residential Rain Gardens*[22] and ALIDP Rain Gardens for Resilience[23] for more information.

Figure 33 – Example of Rain Garden. Source: The City of Calgary.

Figure 34 – Residential Rain Garden. Source: City of Calgary Yard Smart

Rain Gardens Best Practices:

- ✓ Rain Gardens are typically 50-100 mm (1.96-3.94 in.) lower than the surrounding area.
- ✓ Loose soil should be placed to a minimum depth of 300 mm (11.8 in.) immediately below the surface to absorb and filter Stormwater.
- ✓ The footprint of the Rain Gardens should be sized to be equal to approximately 25% of the footprint of the hard (Impervious) Areas that would drain into the Rain Gardens.

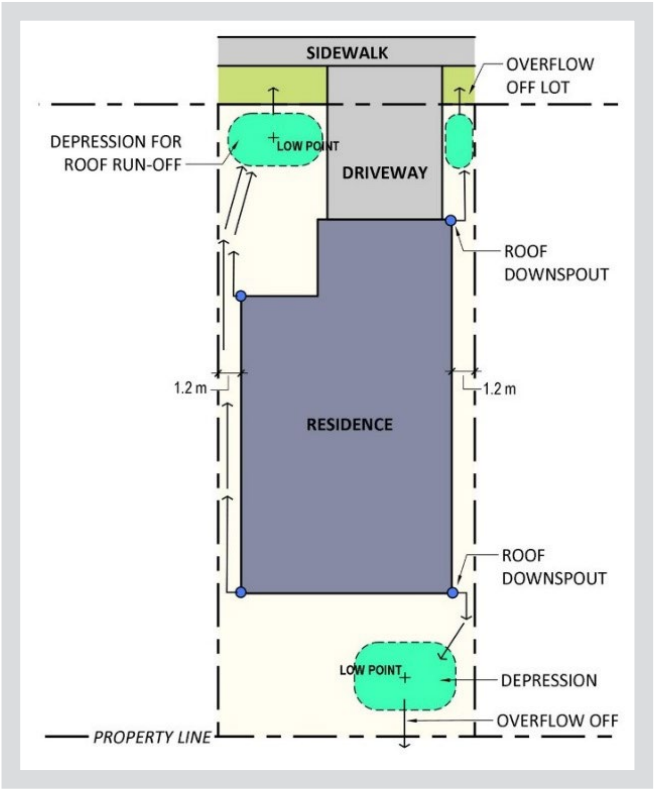


Figure 35 – Rain Garden Placement Example to Support Lot Drainage. Source: The City of Calgary

Figure 36 – Rain Garden Example. Source: Alberta Low Impact Development Partnership

Vegetated Swales

Vegetated Swales are different from Rain Gardens in that their intent is to move water through the system, rather than letting it collect. Their shape is elongated to follow the drainage path, acting as an overland escape route when a major storm event occurs.

Vegetated Swales function to retain and filter Stormwater runoff while conveying water off the property (Figure 37), whereas Rain Gardens hold onto and significantly reduce the volume of Stormwater runoff. Vegetated Swales do allow for some absorption as the Stormwater moves through the Swale, but the majority will move off the property.

Property owners can utilize Vegetated Swales in the same fashion as a French Drain when minimum slopes are challenging to achieve. Contact an experienced grading professional to help with difficult drainage and grading situations. Refer to the *City of Calgary LID Module 2A* for more information on residential Vegetated Swales.

Figure 37 – Vegetated Swale Example. Source: Alberta Low Impact Development Partnership

Permeable Surfaces

The choice of surface materials can affect the volume and quality of runoff draining from the lot. A lot with mostly hard (Impervious) surfaces will generate 10 to 100 times more runoff volume than a lot with soft landscaping (such as grass, trees, and plants) or other permeable surfaces (like gravel or pavers).

Site designs should minimize Impervious Areas wherever possible. The use of permeable pavement (Figure 38), pervious concrete, porous asphalt, interlocking concrete pavers, open-grid concrete lattice pavers and open-grid plastic lattices are all viable options to soften landscaping. Refer to *The City of Calgary's Watersheds and Rivers – Permeable Pavement*[24], and *LID Module 6* for more information.

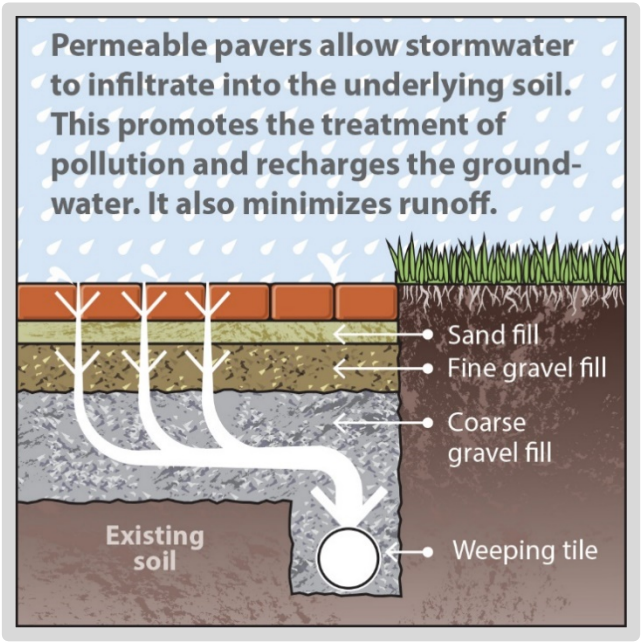


Figure 38 – Permeable Pavement Installation. Source: The City of Calgary.

Green Roofs

Also known as living roofs, landscapes-over-structures, vegetated roofs, or ecoroofs, a ***Green Roof*** is a broad term used to describe contained vegetated spaces on top of a manmade structure at, below or above grade.

The application of a Green Roof in site development can significantly reduce the amount of Stormwater run-off, reduce ambient air temperature (reducing urban heat island effect), and increase the energy efficiency of a structure. Although most commonly applied to commercial developments, there are trending opportunities for application in residential development.

The City of Calgary *LID Module 3* and the *Canada Mortgage and Housing Corporation Green Roofs – A Resource Manual for Municipal Policy Makers*[25] provide additional information on Green Roofs.

***Green Roof** is a broad term used to describe contained vegetated spaces on top of a manmade structure at, below, or above grade.*

6.0 Conclusion

This Guide provides applicable tools and illustrates the importance of the development and maintenance of Positive Lot Drainage for residential lots. Developers, builders and property owners should always consult a trained professional to address concerns or applications for their specific projects.

For more information, visit:
www.calgary.ca/lotgrading

Glossary of Terms

"As-Constructed Grade Certificate" is a post-construction plot plan which contains the proposed lot elevations as reflected on the Building Permit application as well as the constructed or "as-built" surface grades of the lot as they exist at the time of legal survey.

"Building Envelope" is the physical separator between the conditioned and unconditioned environment of a building, including the resistance to air, water, heat, light and noise transfer.

"Dry Wells" are features that trap and hold water underground before infiltrating into the ground.

"Evapotranspiration" is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces, and by Transpiration from plants.

"French Drain" is a trench with a perforated (holes) pipe, or series of pipes wrapped in filter cloth inserted below the ground surface. The trench is backfilled with sand or gravel to allow surface water to drain easily into and along the perforated piping while filter cloth cleans it as it drains down to the outlet.

"Geodetic Elevation" is a specific coordinate system and a set of reference points, used to locate places on earth based relative to a reference point (such a sea level).

"Green Roof" is a broad term used to describe contained vegetated spaces on top of a manmade structure at, below, or above grade. Most commonly applied to commercial developments.

"Impervious Areas" are surfaces that do not allow precipitation to infiltrate (soak) into the ground. (e.g., concrete driveways, patios or walkways).

"Low Impact Development" is the practice of building, grading, and landscaping features that use or mimic natural processes resulting in infiltration, evapotranspiration, or the use of Stormwater.

"Major System" is infrastructure which conveys stormwater from extreme (high intensity, less frequent) rainfall events that are in excess of the Minor System capacity.

"Minor System" is stormwater infrastructure which provides a basic level of service by conveying flows from the more common (low intensity, more frequent) storm events. For public infrastructure, this is normally the underground piped system.

"Overland Drainage Right-of-way (ODRW)" is a right-of-way registered on the land title of a property which is intended to help facilitate proper storm drainage. There are restrictions on what can be placed within an ODRW.

"Parcel Coverage" is the ratio of building/structure footprint area to the overall lot area.

"Permeable Area" are surfaces that allow materials, like liquids, to pass though and soak into the ground.

"Positive Lot Drainage" involves contouring the land to direct surface water away from building foundations toward the street, lane, or Swale without adversely affecting adjacent properties or public infrastructure.

"Rain Gardens" are shallow, slightly depressed gardens that are designed to collect rain water.

"Rainwater Harvesting" is the process of capturing and using rainwater.

"Real Property Report (RPR)" is a legal document that clearly illustrates the location of significant visible improvements relative to property boundaries.

"Resilient Landscaping" is a broad term that can apply to a variety of soft landscaping practices that use the absorbent nature of the landscape to filter and capture Stormwater runoff from hard surfaces.

"Restricted Minimum Grade (RMG)" is a restrictive clause (or agreement) placed on a Lot, which includes a registered drainage easement and identifies the minimum opening elevations that must be met for a structure.

"Retaining Walls" are rigid walls which support soil laterally at different elevations on either side of the wall. These structures are designed to restrain soil to a Slope that it would not naturally maintain.

"Slope" describes both the direction and steepness, or, the change in elevations over a certain distance.

"Stormwater" is water that originates during precipitation and snow/ice melt events .The direction that Stormwater flows through and away from a property is called the drainage pattern.

"Sub-grade Scarification" is the roughing and opening up of the tightly packed base soil prior to placement of loam. This increases permeability of the sub-grade soil, allowing water to flow freely from the loam to sub-soils, providing better root penetration and improved plant health.

"Sump Pump" is a motorized mechanical device that keeps basements dry by pumping excess water from a sump (pit or depression) to the surface.

"Surface Drainage Features" of a lot include any features associated with the control of Stormwater. These may include Swales, contouring of land, concrete walkways and gutters, or other structures.

"Surface Grades" of a lot reflect the height of the finished ground surface.

"Swale" is a shallow channel with gently sloping sides which can be natural or human created (e.g. grass, concrete).

"Topography" is a measurement of elevations.

"Transpiration" is the process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapour and is released to the atmosphere.

"Trap Low" is an intentional sag or depression in a road, parking lot or park, designed with the purpose to provide temporary Stormwater storage via surface ponding during rainfall events.

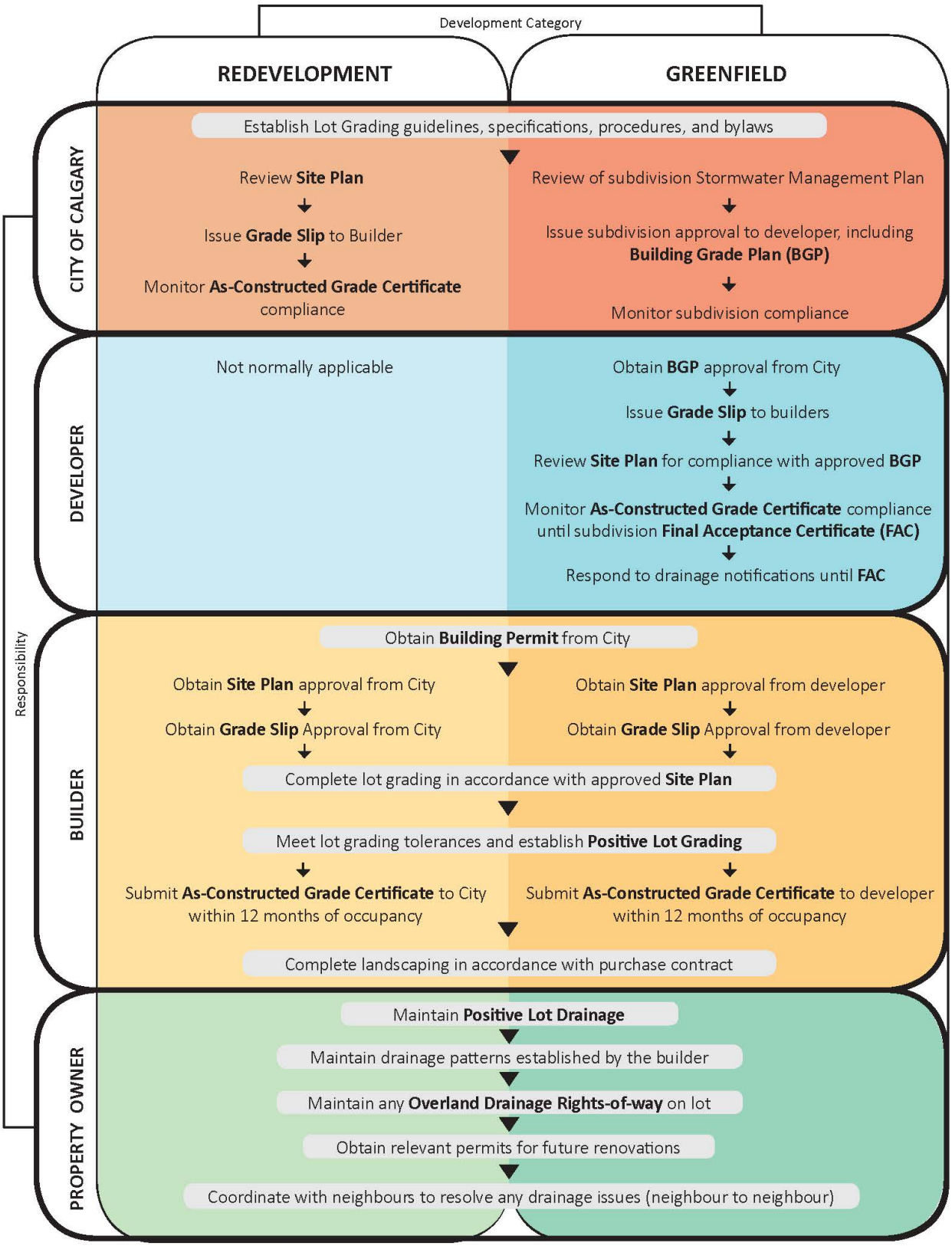
"Vegetated Swales" are landscape elements designed to concentrate or remove debris and pollution out of Stormwater run-off. They consist of a Swaled drainage course with gently Sloped sides and are commonly filled with vegetation and/or rip-rap.

"Weeping Tile" is a perforated (with holes) pipe installed at the footing of the building foundation, designed to manage subsurface (below the surface) ground water, extracting water which may sit near the foundation.

"Window Well" is the space maintained between a below grade window and the surrounding soil. The Window Well provides drainage around the window, and, in some case, a safe exit from the building.

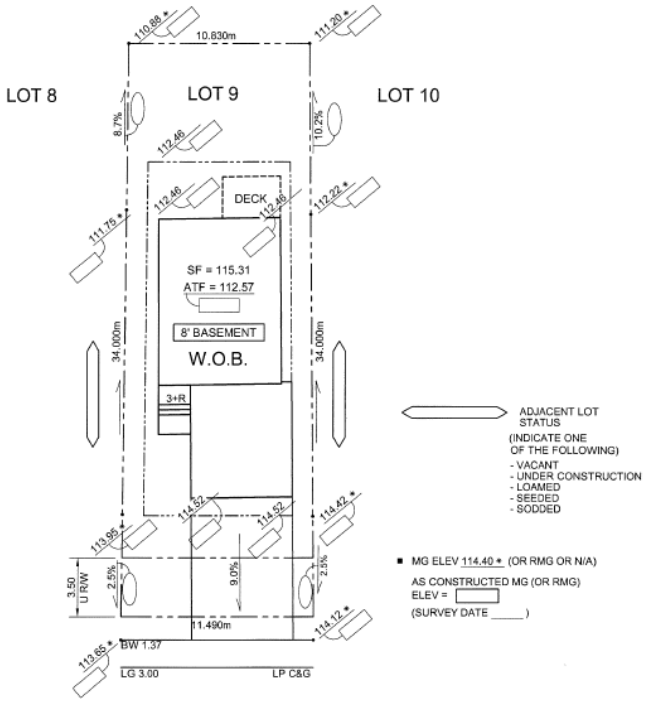
“Zero Lot Line” is a legal provision which allows a building structure to be constructed directly adjacent to the side yard property line (without a setback).

Appendix A – Lot Grading Process & Responsibilities



Appendix B – As-Constructed Grade Certificate Requirements

- The purpose of the As-Constructed Grade Certificate (ACGC) is to validate that the lot grading was completed in compliance with the Lot Grading Bylaw at the point in time that the legal survey was conducted.
- The document validates that the builder's obligations with respect to providing Positive Lot Drainage has been met at that point in time.
- The property owner is responsible for all activities on the lot and ensuring that Positive Lot Drainage is maintained in accordance with the drainage patterns established by the builder.



REQUIRED LOT GRADING CERTIFICATION

All constructed grades and slopes, as noted on the final As Constructed Plot Plan, meet the tolerances as defined by the City of Calgary Lot Grading Bylaw on the survey date indicated.

Minimum house opening elevations

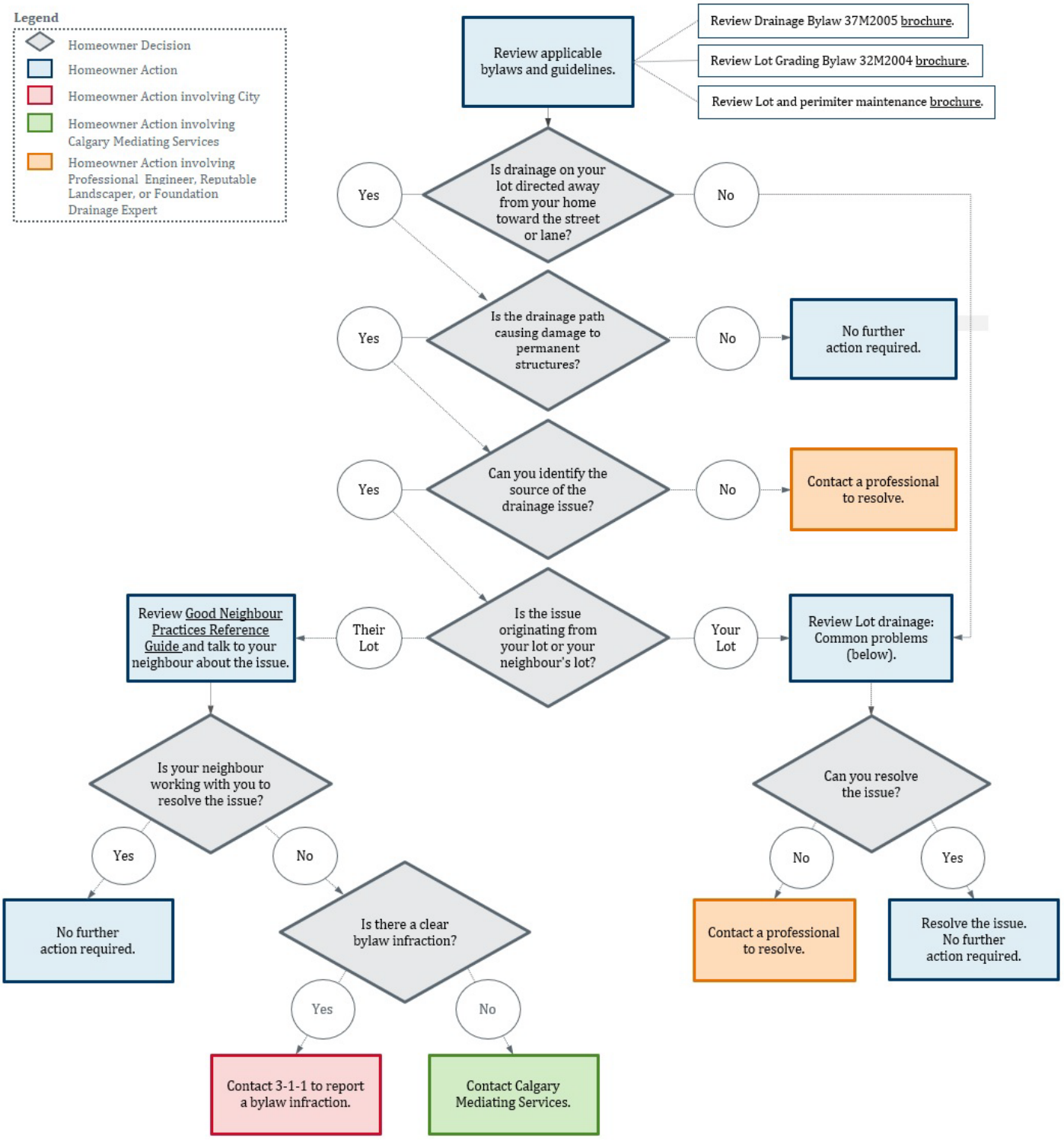
- ☐ Do not apply, or
- ☐ Are above the MG (or RMG) elevation specified by the Developer's Consultant for the lot.

Lot Grading Certificate Requirements:

- ✓ The builder is obligated to submit the **As-Constructed Grade Certificate (ACGC)** within 12 months of Occupancy.
- ✓ The ACGC submission must meet the requirements of The City of Calgary, including an as-built plot plan and certification:
  - Contain the information from both the approved plot plan and the surveyed (as-constructed) plot plan for:
    - Lot elevations
    - Drainage Slopes
    - Lowest top of footing
  - Confirm that the minimum building entrance grades have been met (if applicable).
  - The Certification must validate that grading tolerances have been met.
  - The Certification must validate that positive lot drainage has been provided.
  - The property owner must maintain positive lot drainage patterns in accordance with those indicated on the ACGC.

Appendix C – Guidelines for Homeowners: Resolving a Lot Drainage Issue

Note: This flowchart is for common drainage issues (not flooding events).



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