

TOWN OF CHESTERMERE
POLICY HANDBOOK

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PURPOSE AND INTENT


The Integrated Stormwater Master Plan sets out a vision for dealing with stormwater in the 2009 annexation areas prior to a regional stormwater solution being implemented.

POLICY

Attached

Adopted by Council:

Resolution Number: 3.017.061515
190-15




MAYOR



CAO

REPORT



**Integrated
Stormwater
Master
Plan
City of Chestermere**

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May 2015

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FINAL

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INTRODUCTION

1.1 Background

Urban Systems Ltd. was retained by the City of Chestermere to develop an Integrated Stormwater Master Plan (ISMP) for new annexation areas within City limits.

The primary intent of the Integrated Stormwater Master Plan is to align stormwater solutions with regional drainage planning as well as City's policies and sustainability vision, set guidelines for future urban development, ensure that regulatory and environmental objectives are met, and that stormwater master planning process is integrated with the City's land use planning process. Since the long-term off-site servicing solution is still uncertain, the plan includes both interim and long-term servicing considerations.

1.2 Project Scope

The scope of project included two main components, Technical Evaluation and Plan Development, and Planning Process Review.

Technical Evaluation and Plan Development was intended to bring together all relevant information and develop a comprehensive context for stormwater master planning in Chestermere. It included the following activities:

- Review of all available information, including previous approved stormwater studies and plans, the planning information for the area, and all current City of Chestermere policy documents to determine potential implications to stormwater master planning
- Catchment characterization and assessment study, including delineation of catchment areas, compilation of existing stormwater infrastructure information
- Definition of high level stormwater service delivery goals
- Definition of stormwater targets
- An overview and assessment of Low Impact Development Strategies suitable for application in the City of Chestermere, and development of LID applicability and performance matrix development of LID and stormwater reuse approach
- Recommendations for interim and long-term stormwater servicing strategies

Planning Process Review focused on the review of City's planning process and development of specific stormwater management requirements for each step in the land use planning. It also included the development of submission checklists.

1.3 Background Documents

As part of the ISMP project, many reports, studies and policy documents were reviewed and relevant provisions were included within the Plan. The key documents include:

Chestermere Documents:

- Chestermere Utilities Master Plan, 2010
- Various approved Area Structure Plans and Neighbourhood Plans
- Various approved relevant Staged Master Drainage Plans
- Chestermere Wetland Assessment, 2013
- Chestermere Wetland Policy, 2013
- City Bylaws and Development Guidelines

Regional Watershed Plans and Regional Drainage Studies:

- Bow River Basin Watershed Plan - Phase 1 (2008, Bow River Basin Council)
- Bow River Basin Plan - Phase 2 (2012, Bow River Basin Council)
- Shepard Regional Drainage Plan, AECOM , 2010
- Shepard Drainage Strategies (Westhoff, 2008)
- CSMI Engineering Assessment, (MPE Engineering, 2014)
- West Creek Basin Drainage Studies (Various)

Regulatory Documents and Guidelines:

- Stormwater Management Guidelines for the Province of Alberta (1999, AESRD)
- Municipal Policies and Procedures Manual (2001, AESRD)
- Stormwater Management and Design Manual (2011, The City of Calgary Water Resources)

Low Impact Development Documents:

- Stormwater Source Control Practices Handbook (2007, City of Calgary)
- Low Impact Development and Best management Practices Design Guide (2011, City of Edmonton)
- Stormwater Reuse in the City of Edmonton (2011, City of Edmonton)
- Residential LID Subdivision Study (City of Calgary, 2010)

1.4 Service Delivery Goals

The Integrated Stormwater Master Plan represents the City of Chestermere's commitment to respond to land development pressures, the diverse stresses on the environment resulting from urbanization, and to protect current and future infrastructure and the population at large.

The following are the key ISMP goals:

- ▶ **Protect community from flooding and erosion.** The stormwater infrastructure is critical to serving the demands of a growing community and protecting property from flooding and erosion. In addition to providing servicing options

for new development areas, the ISMP should ensure that there are no adverse impacts on existing development within old City boundary. This is especially relevant for communities along the West Creek drainage channel.

- ▶ **Support regional watershed planning initiatives.** The integrity of the WID system as well as the Bow River watershed can only be protected if all stakeholders in the region work together on implementation of watershed planning actions.
- ▶ **Respond to future regulations and policies proactively.** The existing regulatory environment for watershed management and pollutant discharges is continually evolving. The ISMP recognizes this and provides the recommendations for the City to remain at the forefront of emerging regulatory and environmental trends.
- ▶ **Facilitate sustainable community growth.** Chestermere is one of the fastest growing small municipalities in Canada. The ISMP will support orderly and sustainable growth that balances the long-term environmental objectives and watershed health. This will be achieved through emphasis on sustainable and cost-effective stormwater management strategies and LID implementation.
- ▶ **Consider both interim and long-term servicing options.** The City of Chestermere is working with regional stakeholders on the development of long-term stormwater servicing options using regional drainage systems. Due to the development pressures, however, interim drainage strategies need to be considered to allow some land development to proceed in the absence of off-site drainage options.

At the project initiation meeting the project team, including both the City of Chestermere and Chestermere Utilities Incorporated, discussed several factors that can influence stormwater planning in Chestermere. These factors, summarized below, were taken into consideration in the development of the ISMP:

- Implementation of sustainable stormwater management practices and Low Impact Development (LID) is generally supported by the project team, however both construction costs and operational and maintenance costs need to be considered when choosing the LID approach.
- Stormwater reuse, a very effective practice for stormwater volume reduction, is generally supported for widespread implementation, however, the practice may have regulatory and cost considerations that can limit its use.
- Bylaw changes are seen as potentially effective and low cost to implement, however it is acknowledged that enforcement may become too onerous for City's limited resources.
- Development industry would be supportive of better stormwater management options and LID implementation, but the increased cost is a big consideration. This includes both construction cost and approval process delays. A balance between environmental protection and development costs should be considered in the planning process.

2.0 STUDY AREA AND CONSTRAINTS

2.1 Study Area

The study area, shown on Figure 1, includes over 2,500 hectares of land annexed from the Rocky View County in 2009. Current land use within the annexed lands consists primarily of intensive agriculture, with smaller areas of county residential development. The topography is relatively flat and is dominated by wetlands, depressions, and sloughs. There is no conventional stormwater system within the area; the existing low density developments utilize a rudimentary drainage system based on culverts, ditches, and some natural conveyance systems.

The existing development areas within the 2004 City boundary drain directly to Chestermere Lake. The study area generally drains south to the Western Headworks (WH) irrigation canal on the west side, and the Secondary A Canal on the east side. The area south of Chestermere Lake and the irrigation canals drains south towards the Shepard Slough complex. The west annexation area receives off-site flows from a significant catchment area (West Creek basin). These flows will need to be managed through the development process.

Due to the long-standing moratorium to stormwater drainage to Western Irrigation System (WID), stormwater servicing in the area has been a concern for over two decades. The City has worked with regional stakeholders on two initiatives that identified potential servicing options; the Shepard Regional Drainage Plan (2010) and the Co-operative Stormwater Management Initiative (2014). Both of these alternatives are described in the following sections. Although both options were reviewed by the City staff and Council, no decision was made on the preferred option for implementation until uncertainties related to financing and governance mechanisms and regional infrastructure timing are resolved.

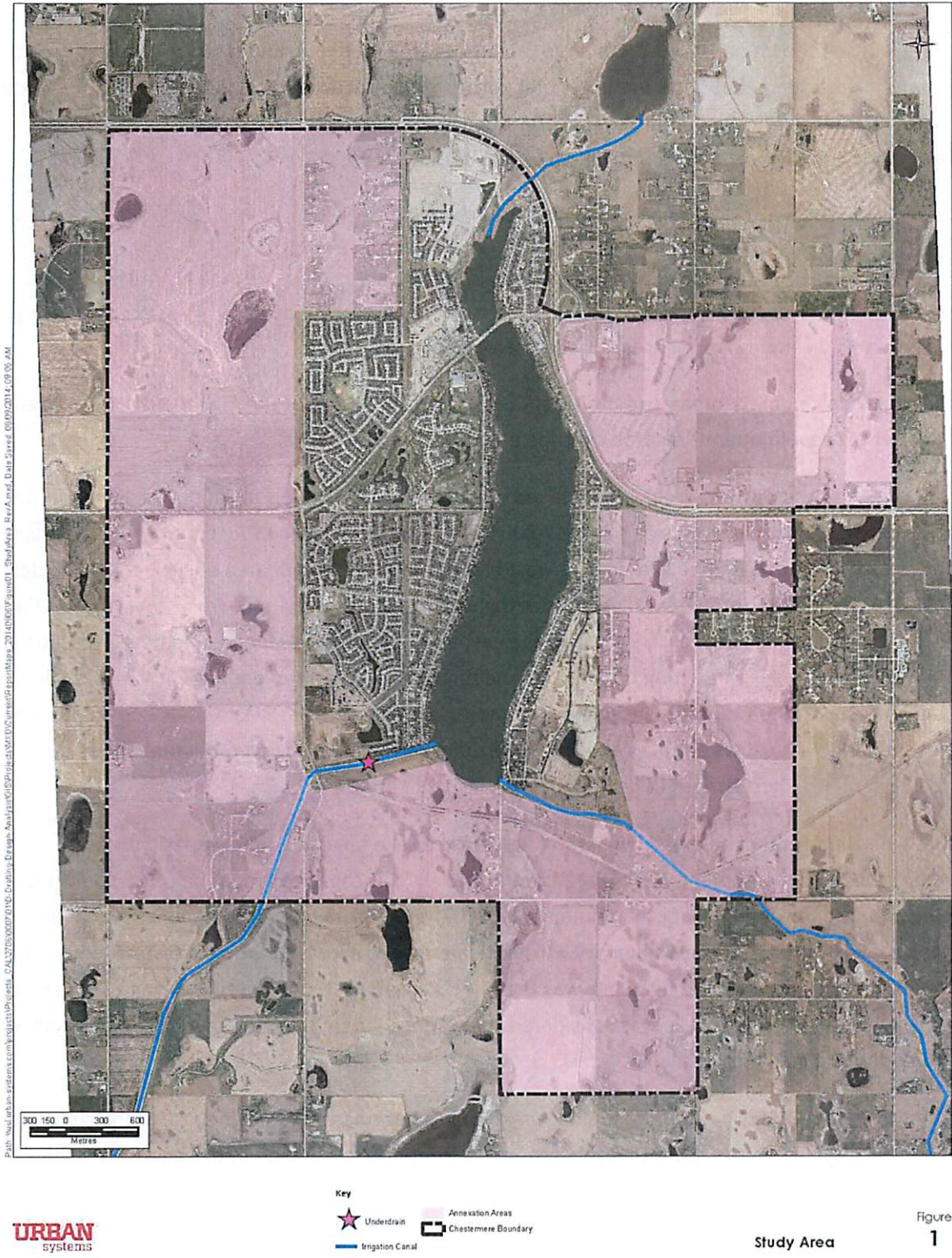


Figure 1 - Study Area

2.2 West Creek Basin Flows

The West Creek Basin, shown on Figure 2, is a large catchment area that contributes runoff to West Creek, an intermittent drainage course that flows in the general north-south direction from Rocky View County, through the City and discharges to Chestermere Lake. Several studies, completed in the last 10-15 years, have characterized the catchment area and predevelopment hydrology of West Creek:

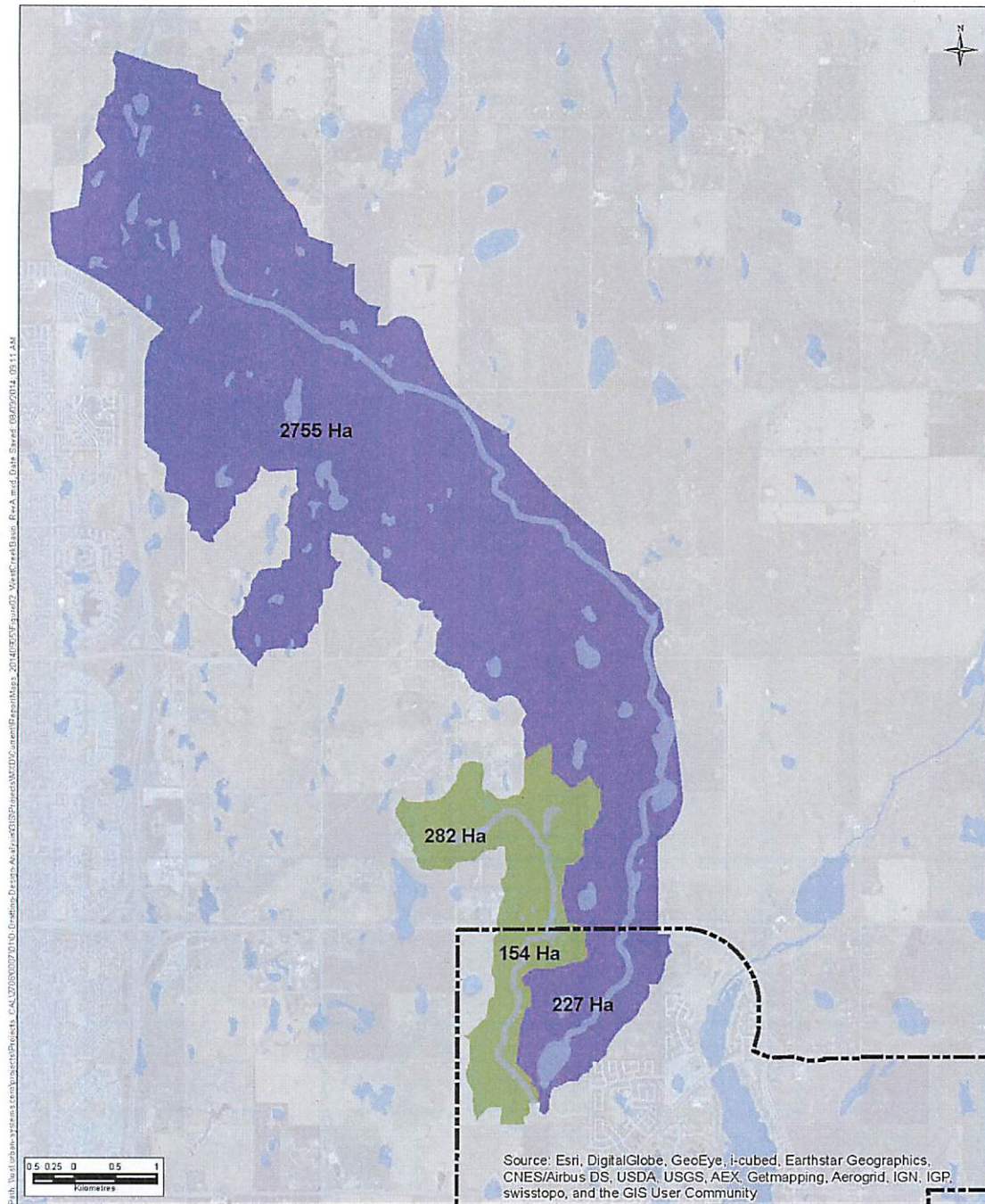
- Determination of Predevelopment Peak Runoff Flow of the West Creek Basin at the Irrigation Canal, Southwell Trap, 2000
- West Creek Drainage Study, Southwell Trap, 1997
- West Chestermere Stormwater Master Drainage Plan, Stantec, 2010
- West Creek Basin Stormwater Outfall plan, Eclipse Engineering, 2006

These studies provide varying estimates of the West Creek Basin area north of the City boundary (2,300 to 3,000 hectares) and set predevelopment flow rate over the entire basin to 1.6 l/s/ha.

As shown on Figures 2 and 3, West Creek is comprised of two drainage channels north of Chestermere. The east branch has a contributing catchment area of over 2,700 hectares and enters the City boundary via existing culverts under Highway 1 and Rainbow Road. The west branch has a catchment area of close to 300 hectares and enters the City boundary through a culvert under Highway 1. The east channel drains to a large wetland within the study area. Downstream of this wetland the east and west channels merge and flows continue east under Rainbow Road through an existing box culvert, and through a naturalized drainage system that flows through several residential communities including Westmere, Lakeside Greens, West Creek, and Rainbow Falls. After leaving Rainbow Falls, flows enter an existing underdrain and then a bypass outfall that allows the drainage to discharge to Chestermere Lake without entering WH Canal.

The Rainbow Falls underdrain and piped bypass to Chestermere Lake have adequate capacity to fully accommodate peak predevelopment West Creek flow. However, this capacity cannot be utilized in a post-development scenario for drainage of urban runoff. The 2007 WID Stormwater Guidelines state that urban development outside of the 2004 City boundary will not be permitted access to the WID system, unless the stormwater is highly treated and managed in a way that meets criteria listed in the Guidelines. Drainage of West Creek flows to Chestermere Lake was considered an interim solution only, until such time that regional drainage infrastructure becomes available.

It is important to note that this naturalized drainage system has become a valued amenity for the surrounding communities. The City wishes to ensure that this system will continue to function as designed, after the development of west annexation area. Regardless of which long-term servicing option is chosen, proper management of West Creek flows must be considered to reduce the long-term risk to the City.



Key

- West Creek Basin - East Channel
- West Creek Basin - West Channel
- Study Area Boundary

West Creek Basin

Figure
2

Figure 2 - West Creek Basin

2.3 WID System

Stormwater runoff from the study area generally drains south to Western Irrigation District (WID) canal system through a series of natural drainage courses. In the past, discharges of untreated stormwater, primarily from the City of Calgary, have caused significant problems with the operation of WID system and negatively impacted water quality in Chestermere Lake.

In 1980, Alberta Environment and Sustainable Resource development (AESRD) imposed a moratorium on stormwater drainage to WH Canal. The conditions of the Moratorium state that no new stormwater outfalls to the WH Canal will be approved, and no increase in volume or discharge rate over the 1980 levels will be allowed. The restrictions of the Moratorium are applied over the entire length of WH Canal.

In 2005, the City of Chestermere and WID, who own the Chestermere Lake and the Secondary A and B/C Canals, signed the Use of Works agreement that specifies conditions under which the City may discharge stormwater to Chestermere Lake, including the maximum allowable flow rate and volume and minimum water quality standards. Essentially, this agreement applies to the area within the 2004 municipal boundary.

AESRD established the WID as the stormwater approving authority for development areas that drain to WID system. In 2007, WID released Western Irrigation District Stormwater Guidelines that set very high water quality standards and restrictive operating conditions for all new urban developments that intend to discharge stormwater to WID system. These standards cannot be achieved by typical stormwater treatment options, such as wet stormwater facilities or Low Impact Development (LID) practices. According to the WID Guidelines, no urban runoff outside of 2004 City boundaries may discharge to WID system unless these stringent water quality objectives are met, regardless of past agreements.

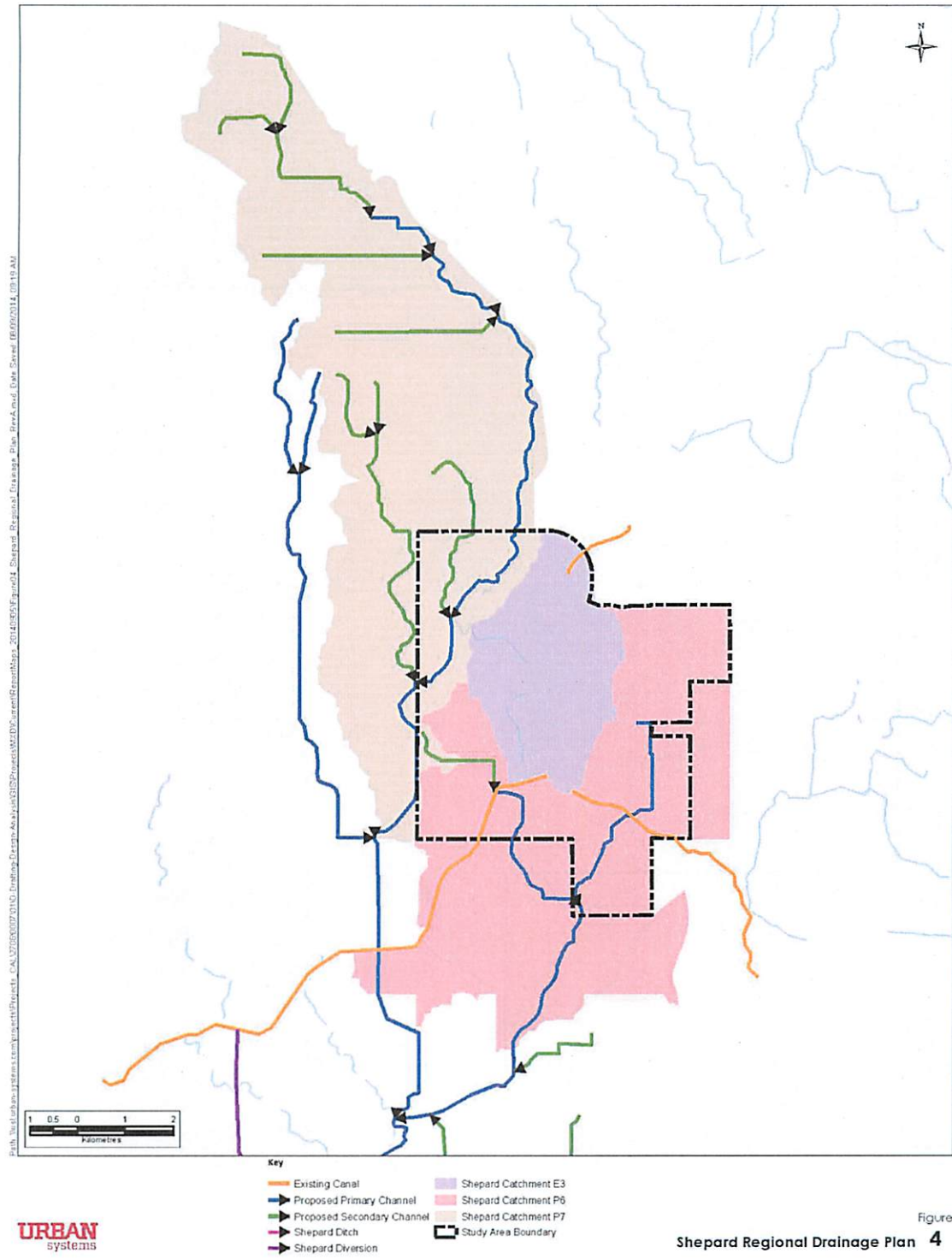
3.0 REGIONAL WATERSHED CONTEXT

3.1 Shepard Regional Drainage Plan

The City of Chestermere has been working with the City of Calgary and Rocky View County on the development and implementation of the Shepard Regional Drainage Plan (SRDP). Phase 1 of the Plan, which was completed in 2010, identified a technical stormwater solution for the Shepard Regional Drainage Corridor, consisting of a series of primary and secondary regional drainage channels that convey stormwater under the WID system to Shepard Ditch and ultimately the Bow River. This is shown on Figures 4 and 5. The Plan also established stormwater rate and volume targets (a maximum allowable post-development release rate of 0.8 l/s/ha and target volume control of 40mm to 90mm of average annual runoff) and a preliminary assessment of LID practices proposed for the Plan area. Large-scale implementation of LID practices and stormwater reuse is expected within the Plan area to achieve stormwater targets. The Plan does not provide allowance for any additional discharge to WID system or Chestermere Lake. The review of the Plan has identified several issues that should be considered if the Plan is to be adopted for implementation:

- ▶ Under the SRDP, the West Creek flows, as well as post-development flows from the study area, are to be conveyed south through naturalized drainage channels as shown in Figures 4 and 5. Through review of topography, it was determined that the eastern West Creek channel cannot drain overland to its proposed primary conveyance channel identified in the SRDP without the aid of pumping. The SRDP and City of Chestermere guidelines both discourage pumping of stormwater.
- ▶ Conveyance of West Creek flows south, in accordance with the SRDP, would impact the operation of the naturalized drainage system and wet ponds in residential communities of Westmere, West Creek and Rainbow Falls. Of note, this system was designed to convey predevelopment West Creek flows of 1.6 l/s/ha. As mentioned in Section 2.2, The City and residents of these communities value the amenities and wish to have them preserved.
- ▶ Previous drainage studies have established predevelopment flow rate for West Creek basin at 1.6 l/s/ha, which is significantly higher than post-development release rate of 0.8 l/s/ha. This means that conveyance of West Creek flows south, as presented in the SRDP, would result in higher than permissible flow rates through the study area until full build-out of upstream catchments (even if downstream regional infrastructure and outlet to the south are in place). Storage and management of these flows in the interim would result in significant risks for both City and area developers.
- ▶ The SRDP proposed a new underdrain west of the existing underdrain that conveys West Creek flows to Chestermere Lake. The existing underdrain has more than adequate capacity (1.6 l/s/ha for the entire West Creek basin) for flows determined under SRDP and should be utilized to reduce infrastructure costs.
- ▶ The regional partners (Rocky View County, the City of Calgary and the City of Chestermere) have expressed concerns with the high cost and timing of downstream SRDP infrastructure, and are actively looking at other alternatives, such as the CSMI plan.

While the implementation of the Shepard Regional Drainage Plan has been effectively suspended since 2013, the City's 2011 Design Guidelines require all new developments within the study area to demonstrate compliance with the Plan in the long term and provide adequate oversize or Right-of-Way allowances.



Figure

Figure 4 - Shepard Regional Drainage Plan

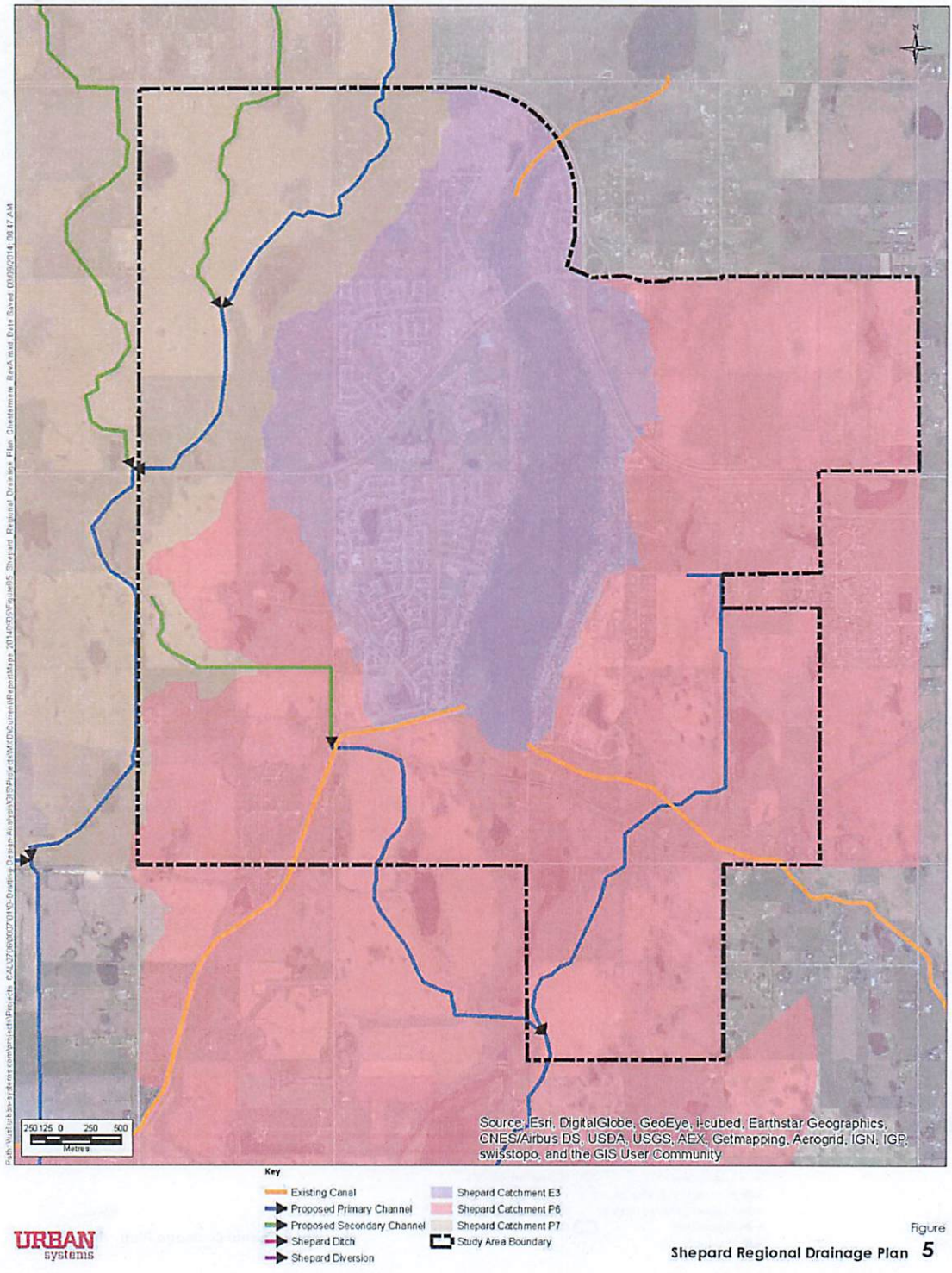


Figure
Shepard Regional Drainage Plan 5

Figure 5 - Shepard Regional Drainage Plan (Chestermere Detail)



3.2 Co-operative Stormwater Management Initiative Plan

The Cooperative Stormwater Management Initiative (CSMI), formed in 2011, is a partnership between WID and municipalities in the region with an interest in developing a practical stormwater management solution that would protect the integrity and operability of WID system and allow for regional growth and development. The CSMI partners include:

- Calgary Regional Partnership
- Chestermere Utilities Incorporated (also representing City of Chestermere)
- City of Calgary
- Rocky View County
- Town of Strathmore
- Wheatland County
- Western Irrigation District (WID)

The CSMI partners identified a number of potential stormwater options, taking into consideration the current stormwater technology as well as individual partners' needs. In May 2014, CSMI completed a more detailed engineering assessment of stormwater alternatives and a short term infrastructure staging strategy that provide WID with a long-term sustainability for their irrigation system, and municipalities with implementable stormwater servicing strategies for both interim and long-term situation. These options and their implications to the City of Chestermere are described in this section.

Essentially, three options for stormwater conveyance within the CSMI area were considered:

- In-Canal during the irrigation season, requiring the developments to meet specific water quality targets
- In-Canal during the off-season
- Out-of-Canal

The options were evaluated and compared based on water quality impacts, project capital costing, and an evaluation matrix that included economic, functionality, environmental, and community criteria. The preferred option was determined to be the Out-of-Canal option, where all stormwater runoff resulting from urban development is diverted away from the irrigation system, treated as necessary through wet pond/ LID systems, and eventually released into a natural water course. The Out-of-Canal alternative reduces the risk to irrigation infrastructure as compared to the In-Canal alternative, and does not require strict water quality guidelines to be met by developments. Runoff generated by events above the 1:100 year precipitation event is allowed to surcharge to the irrigation system, providing an emergency escape route for flood flows.

For the study area, the Out-of-Canal option includes the following conveyance routing, shown on Figures 6 and 7, which eventually discharges to Serviceberry Creek:

- The runoff from West Chestermere catchment is collected in a regional conveyance pipe north of WH Canal, then routed through a new proposed underdrain under the WH Canal, to a regional conveyance pipe around the south tip of Chestermere Lake to Secondary A Canal.
- A new underdrain is proposed to convey the pipe flows under the Secondary A Canal to a regional conveyance pipe along the north side of A Canal.
- The pipe discharges to a regional conveyance channel adjacent to A Canal, which takes the flows to Langdon Ditch, then to Weed Lake and Hartell Coulee to Serviceberry Creek.

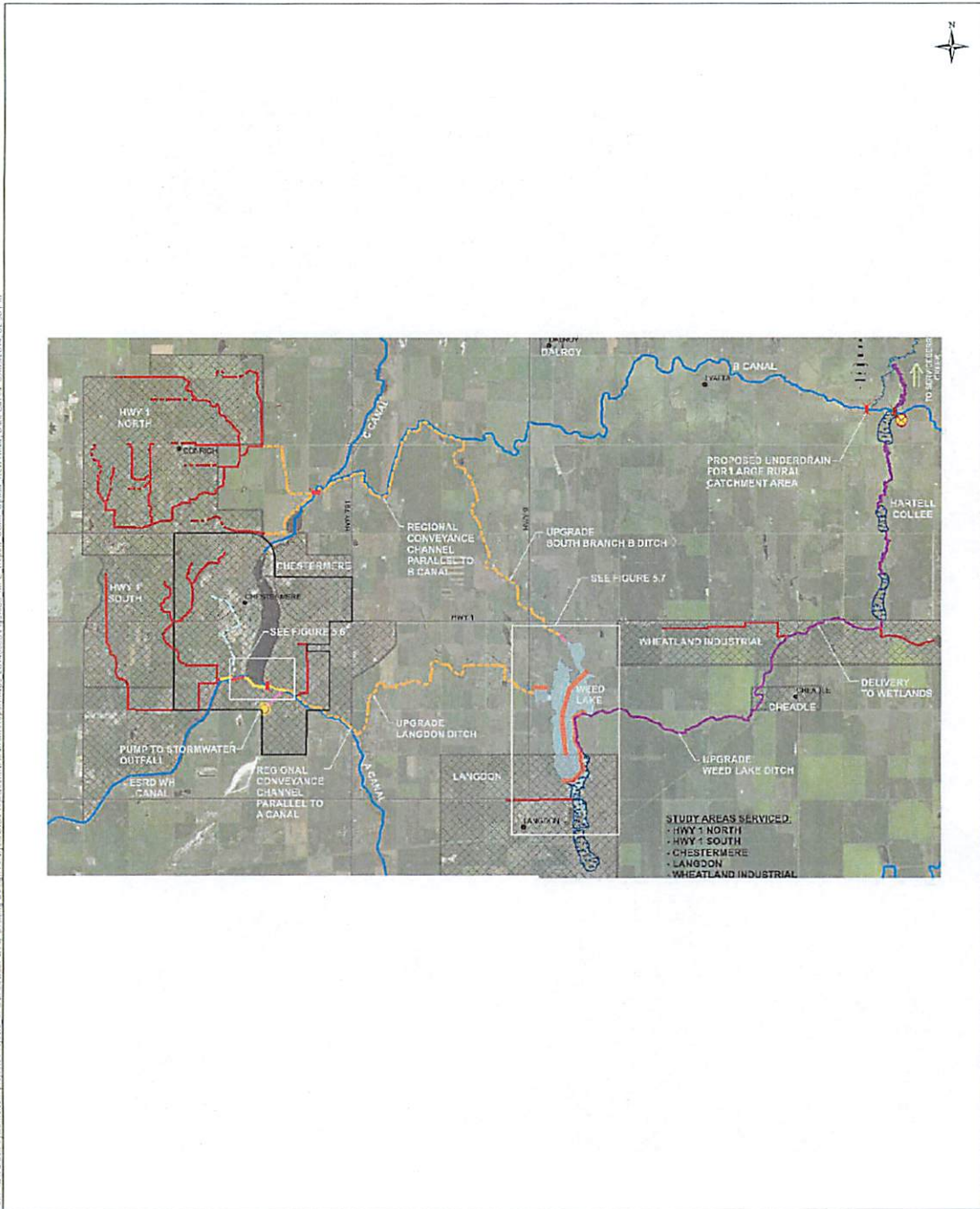
Regional conveyance infrastructure for this option generally consists of closed pipe systems, open conveyance channels, underdrains, and capacity upgrades/improvements to existing works, including Langdon Ditch, Weed Lake, and Hartell Coulee channel. Recommendations for local infrastructure (within study area) include LID practices to address water quality and volume control, and stormwater facilities to restrict discharges.

To move the process forward, CSMI suggested an implementation planning phase and a construction phase. The implementation phase includes water balance analyses, stakeholder consultation, development of governance and finance mechanisms, and development of various guidelines and water quality monitoring programs. The construction of regional works would follow the implementation phase and includes infrastructure staging.

There are several potential impacts of CSMI servicing option on the City of Chestermere that should be resolved prior to adoption of the plan:

- The preferred option for areas north of Chestermere will effectively reroute the West Creek flows around the northern Town boundary. This will have serious implications for both sustainability of important wetlands and the naturalized drainage channel in existing communities. The existing water licenses (i.e. golf course) will be impacted as well.
- The local (internal) drainage routes for Waterbridge area follow the alignments specified in the Shepard Regional Drainage Plan. Topographical review established that these conveyance routes cannot work by gravity.
- There are significant capacity upgrades required for the existing works (Langdon ditch, Weed Lake, Hartell Coulee) as well as new regional infrastructure construction (underdrains, regional pipes, open channels, wetlands). The timing of this infrastructure will impact the availability of servicing. Interim servicing option will have to be relied on for many years before the connection to regional infrastructure is possible. It should be noted that CSMI plan recommends infrastructure staging from upstream to downstream, with the completion of initial stages to allow for off-season release option.

The CSMI options have been resented to City Council, however the Council has postponed the adoption of the plan until the subsequent study phase is completed and infrastructure costs and timing of construction are better defined.



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CSMI Option

Figure
6

Figure 6 - CSMI Option

3.3 The City of Calgary Initiatives

The City of Calgary's commitment to sustainable management of its water resources is articulated within several governing documents including:

- Total Loading Management Plan
- Municipal Development Plan
- Bow River Basin Watershed Management Plan

The City has issued interim stormwater targets and is now working on the ultimate City-wide stormwater targets development project. These ultimate targets, once developed, will allow The City to meet its regulatory commitments with respect to Total Suspended Solids (TSS) loadings. The interim stormwater targets have a volume target of 40 mm and a pre-development rate target for new development areas draining to the Bow River. Similarly, an interim volume target of 40 mm applies to City lands in the Shepard Drainage Corridor. This targets may have potential implications to the stormwater planning for the City of Chestermere if any areas contribute drainage to the City of Calgary infrastructure (i.e., if some version of SRDP is implemented).

4.0 LID STRATEGY AND STORMWATER REUSE

4.1 Drivers for LID Implementation

Over the past decade, stormwater management philosophy in the region has evolved significantly. The focus has shifted from conventional practices that protect property from flooding, to integrated solutions such as LID and “green infrastructure” options that protect and preserve natural hydrology and improve watershed health.

The U.S. Environmental Protection Agency defines low impact development (LID) as “an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible”. This approach focuses on maintaining or restoring the natural hydrological processes of a site, Key principles in LID include:

- Preservation of natural soil infiltrating potential;
- Small scale, integrated stormwater management controls dispersed throughout the site;
- Minimizing and disconnecting impervious areas;
- Controlling stormwater as close to its source as possible;
- Prolonging stormwater runoff flow paths and times; and
- Creating multi-functional landscapes.

The benefits of LID implementation are numerous – both runoff peak flows and volumes are reduced, resulting in reduced pollutant loadings and improved hydrological balance in the watershed, improved infrastructure utilization and potential financial savings, and fewer constraints to urban growth. LID and “green infrastructure” implementation is a proactive approach based on prevention and managing problems at the source, rather than at the end of pipe. Through large scale LID implementation in addition to conventional stormwater options, the stormwater systems are able to manage the entire spectrum of rainfall events, and perform close to a natural hydrologic regime.

4.2 Applicability for the City of Chestermere

Some concerns have been raised about the cost-effectiveness and feasibility of LID implementation in the context of Chestermere. The recent watershed studies in the region and decades of international experience have clearly established that conventional infrastructure, even with an end-of-pipe solutions such as retention facilities, cannot meet all environmental objectives, and in many cases problems are merely passed on downstream. If the City wishes to meet broad stormwater and environmental objectives and keep pace with other municipalities in the region, it should promote large-scale LID implementation that focuses on site adaptive planning and source control measures.

A successful LID program should be flexible, allowing consideration of site-specific conditions and factors such as local climate, topography, soils, and hydrogeological conditions. Concerns have been raised about using LID in

cold weather and semi-arid conditions of Chestermere; to ease these concerns, it should be noted that there are several examples of cold climate communities that successfully use LID. The keys to successful implementation are to use LID in conjunction with conventional stormwater practices to ensure that full spectrum of rainfall events is managed, and to adapt LID designs to local conditions.

LID is an evolving field and while the implementation is still new in the region, both Calgary and Edmonton have developed LID technical guidance documents that can be used in the Chestermere context. The guidelines will be undergoing regular updates through continuing research efforts and design and construction experience.

For LID to be most effective, consideration for implementation must start early in the community planning process, and it must involve a multi-disciplinary team that includes professionals in the fields of urban planning, landscape architecture, stormwater management, geotechnical engineering, soil and vegetation science.

4.3 LID Types, Performance and Applicability

The following are the LID practices that can be considered in the City of Chestermere. Other practices not listed here (such as proprietary filter systems) may be proposed as well if deemed appropriate for a specific project. Implementation of any LID systems would require an approval from the City of Chestermere.

- Roof Leader disconnection
- Planter boxes
- Green roofs
- Bioretention
- Swales
- Absorbent landscaping
- Porous pavements
- Impervious area reductions
- Rainwater harvesting and reuse

The choice of LID tools will depend on site-specific conditions, nature of the development and land uses, expected performance (treatment or volume reduction), and cost-effectiveness. Regardless of which LID type is used, proper design and construction considerations are important to ensure long-term effectiveness and reduce future operational and maintenance costs. Calgary and Edmonton LID guidelines provide technical details and specifications and address construction, operational and maintenance considerations.

The following is a brief overview of recommended LID practices. The Performance and Applicability Matrix is presented in Table 1.

4.3.1 Roof Leader Disconnection

Although the City Bylaws specify that roof leaders must be disconnected, in some instances they still drain on impervious areas (driveways, streets or paved lanes) which in hydrologic sense constitutes direct connection to storm sewer system. Ideally, “disconnected” roof leaders will direct rooftop runoff onto absorbent landscaping, away from building foundations. To increase the practice effectiveness, a splash pad should be placed at the base of the roof leader to prevent erosion of topsoil when storm results in high energy discharge.

Disconnected roof leader systems are comprised of three primary components:

- Roof leader
- Erosion resistant splash pad
- Absorbent landscaping

The beneficial stormwater functions achieved by disconnecting roof leaders include:

- Increased time of concentration
- Increased water quality
- Evapotranspiration (plant uptake)
- Decreased stormwater volume
- Decreased runoff rate

Roof leader disconnection is widely applicable to a variety of land uses that contain standalone buildings with absorbent landscaping such as single and multi-family residential, commercial, industrial and institutional sites.

4.3.2 Planter Boxes

Planter boxes are gardens contained on all sides by a box and may be raised or inset into the surroundings. They can have an infiltration component if the native soils support that but typically they have a sub-drain directed to downstream stormwater facilities. Runoff is received from rooftops through disconnected roof leaders and from walkways and other impervious areas through overland runoff.

Planter boxes can have several key components and a few optional components that depend on the stormwater functions they have been designed for:

- Impervious box surrounding all sides
- Plantings suitable for the natural water regime
- Mulch
- Topsoil
- Under-drain (optional - when infiltration is not an option)
- Impervious base (optional - when infiltration is not an option)

The beneficial stormwater functions achieved by box planters include:

- Reduced impervious area
- Increased time of concentration
- Increased water quality
- Evapotranspiration
- Decreased stormwater volume
- Decreased runoff rate

Planter boxes can be implemented in a variety of land uses, though they are typically used in commercial and institutional areas that have large impervious areas. Planter boxes are ideal in retrofit situations as they can reduce impervious area without tearing up existing hard surfaces.

4.3.3 Green Roofs

Green roofs are rooftop gardens. There are two types of green roofs, extensive and intensive. Extensive green roofs have relatively shallow soil depth and are planted with native plants that require minimal or no maintenance following establishment. Extensive green roofs are designed without irrigation systems and roof access to the public may or may not be allowed. While the building structure is important to consider, it is possible to retrofit some buildings with a green roof provided the structure is sufficient to accommodate the added weight of saturated soil. Intensive green roofs resemble a typical garden or park on top of a building. They have much deeper topsoil than the extensive green roofs and are planted with trees, shrubs and all manner of plants. Intensive green roofs often require irrigation during dry periods and public access is generally encouraged. The structural requirements for intensive green roofs are significant and retrofit opportunities are rare.

Green roofs have several key components and the difference between the two types is in the details of these components:

- Vegetation
- Growth medium (topsoil)
- Drainage layer
- Root barrier
- Insulation
- Waterproof barrier
- Structural support

The beneficial stormwater functions achieved by green roofs include:

- Reduced impervious area
- Increased time of concentration
- Increased water quality
- Evapotranspiration
- Decreased stormwater volume
- Decreased runoff rate

Green roofs are most often implemented on large multi-family residential, commercial, industrial and institutional buildings. They have also been implemented successfully on single family homes and parking garages.

4.3.4 Bioretention (Rain Gardens)

Bioretention facilities are designed to capture stormwater for treatment and retention. The term 'bioretention area' is synonymous with 'rain garden' and the two are often used interchangeably. Rain gardens have plantings specifically chosen for their ability to thrive in local climate and weather patterns. Where soil conditions permit they may have a gravel storage zone beneath the topsoil that relies on infiltration for drawdown. Commonly an underdrain is installed to discharge excess water to downstream facilities, preventing oversaturated conditions.

Bioretention areas have several key components including:

- Flow entrance (e.g. curb cut inlet)
- Pre-treatment zone
- Ponding area
- Plant materials
- Mulch layer
- Topsoil/filter medium
- Overflow outlet
- Underdrain (optional)
- Gravel retention (optional)

The beneficial stormwater functions achieved in bioretention areas are:

- Reduced impervious area
- Increased time of concentration
- Increased water quality
- Infiltration (shallow and potentially deep)
- Evapotranspiration
- Decreased stormwater volume
- Decreased runoff rate

Bioretention areas can be included in both new build and retrofit situations, wherever there is space for a garden. They are commonly implemented in public rights-of-way to treat road runoff, in parks for treatment of site runoff, and on residential, commercial and institutional sites to capture runoff from impervious areas. Bioretention areas can be designed to treat runoff from industrial sites but care must be taken to ensure that the plants and soils selected are appropriate for the pollutants present in the runoff.

4.3.5 Swales

Swale types range from simple grass swales to bioswales with treatment and retention capacity, to naturalized drainageways that provide large flow capacity and can include wetland components. The common denominator is that all swales are a conveyance system replacing conventional storm pipes. Grass swales provide some stormwater treatment by encouraging sediment to drop out in the grass. Bioswales use specifically designed planting and amended soils to treat water for particulates, metals, hydrocarbons and nutrients. Where native soils permit, bioswales can be designed to facilitate deep infiltration. Naturalized drainageways have large storm conveyance as a primary goal and often replace conventional storm trunks. Naturalized drainageways

often have baseflow that is used to sustain wetland features, providing treatment for sediment, nutrients and other pollutants.

Swales have several key components including:

- Grass or plant materials
- Topsoil
- Check dams/drop structures (flow rate control)
- Under-drain (for shallow slopes or poorly draining sub-soils)
- Gravel retention/infiltration gallery (optional)

The beneficial stormwater functions achieved in swales are:

- Reduced impervious area
- Increased water quality
- Infiltration (optional)
- Evapotranspiration
- Decreased runoff rate

Since a swale’s primary focus is conveyance resulting in a linear footprint, the locations for swales are often limited to public land including road rights-of-way, environmental and municipal reserves, parks and utility corridors. Swales can also be implemented on a site or development level on residential, commercial, institutional and industrial land uses.

4.3.6 Absorbent Landscaping

Absorbent landscaping utilizes the natural properties of soil and plants to facilitate healthy growth, absorb runoff and encourage infiltration. Increased topsoil depth in all landscaped areas contributes to these goals. Development of shrub and planting beds also helps to retain water on site. There is no specific structure related to absorbent landscaping but key considerations during construction include preventing compaction of sub-soils, increasing depth of topsoil and grading the site to direct runoff to landscaped areas.

Absorbent landscaping should not be installed within building envelope to prevent seepage of stormwater into building foundations and basements.

4.3.7 Porous Pavement

Porous or permeable pavement allows water to drain through the pavement structure into the subgrade where it either infiltrates or slowly makes its way to downstream facilities through an underdrain system. Types of porous pavement include modular and cobble block pavers, porous asphalt and concrete and structurally reinforced grass and gravel. Porous pavement has been very successfully implemented in cold climates when it is located, designed, constructed and maintained properly.

Porous pavement has the following structural components:

- Pavement layer
- Rock filter course

The beneficial stormwater functions achieved with porous pavement installation are:

- Reduced impervious area
- Increased time of concentration

- | | |
|---|---|
| <ul style="list-style-type: none"> ■ Rock sub-base ■ Reservoir course ■ Underdrain (optional – in tight soil) ■ Insulation (optional – to protect shallow utilities) ■ Seepage barrier (optional – to protect adjacent buildings/roadways) | <ul style="list-style-type: none"> ■ Increased water quality (filtration, decreased temperature) ■ Infiltration (optional) ■ Decreased stormwater volume (optional with infiltration) ■ Decreased runoff rate |
|---|---|

Porous pavement can be highly successful in cold climates provided that it is situated appropriately. High traffic areas, high pollutant areas and areas where significant amounts of sand are used for snow management are inappropriate for porous pavement. Pedestrian areas (walkways, pathways, plazas), parking stalls and residential road parking areas can all be suitable locations provided sand is not used for ice management. These types of locations can be found in any land use type.

4.3.8 Impervious Area Reduction

Site planning to reduce impervious area may include narrower roads, shared driveways, reduced lot setbacks and alternate parking lot surfaces. Other methods to reduce impervious area include roof leader disconnection, green roofs, planter boxes, swales and porous pavement. Reduced impervious area slows down surface runoff and allows more of it to soak into the soil for evapotranspiration by plants and recharge of groundwater stores. This is accomplished at the planning level to determine an alternate site layout that can achieve the same density with less impervious area.

The beneficial stormwater functions achieved in reducing impervious areas are:

- Increased time of concentration
- Increased water quality
- Increased infiltration (depending on subsoils)
- Increased evapotranspiration
- Decreased runoff volume
- Decreased runoff rate

Reduced impervious areas can be accomplished on any land use type both through planning and implementation of low impact development methods.

4.3.9 Rainwater Harvesting and Reuse

Rainwater harvesting collects rainwater from rooftops and stores it in a cistern or rain barrel for future use. Currently rainwater can be reused for irrigation and approved indoor non-potable uses so long as the plumbing meets federal code and CSA standards. Reducing the amount of runoff that enters the storm system also prevents the pollutants contained in that water volume from entering the system. Rainwater is relatively clean

as it has not yet been in contact with driving or landscaped surfaces that contribute significant amount of pollutants.

Rainwater harvesting and reuse systems have the following structural components:

- Gutters and downspout
- Leaf screens, roof washers or first flush diverters
- Filter
- Cistern with overflow outlet
- Pump system
- Pipe system to final use

Rainwater harvesting and reuse reduces stormwater volume. It is a very versatile practice and can be applied to any building on any land use type. The size and type of cistern is likely to change based on land use type and the size of associated buildings. Above ground cisterns and rain barrels can be easily installed in retrofit situations.



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Table 1 - LID Performance and Applicability Matrix


















Item	Stormwater BMP	Photo	Applicability	Cold Climate Suitability	Suitable Native Soil	Land Use							Stormwater Management Objectives			Opportunities	Constraints	Lifecycle (assume well operated and maintained)	Maintenance Requirements	Costs		
						Single Family Residential	Multi Family Residential	Public	Road/ROW	Park/MR/ER	Institutional	Commercial	Industrial	Peak Flow Reduction	Volume Control					Water Quality	Capital	Annual O&M
Low Impact Development																						
1	Roof Leader Disconnection		high	high	All	X								X			Increases travel time of runoff to discharge point (which reduces peak flow), may reduce runoff volume through infiltration/retention if directed to pervious area and infiltrated.	Pools or saturated areas may develop if overlaid drainage paths are defined or soil conditions are not conducive to infiltration.	150 yrs	Remove blockages in roof gutters and at roof leader inlet/outlet as required.	None to low depending on how the leader is currently designed	no more than a connected leader
2	Flariter Box		high	low - operations significantly restricted during winter	Subsoil: <13 mm/hr, infiltrating <13 mm/hr	X	X	X		X				X	X	X	Increases travel time of runoff, water quality benefits (plant and soil uptake of pollutants, lower runoff water temperature), some retention/retention capacity, improved aesthetics.	Additional cost for drain rock gallery below soil, typically limited to treating only roof runoff unless we flash with adjacent sidewalk, pavement, etc.	25 yrs	Similar requirements to general landscaping - inspect twice within first six months, followed by annual inspection, long term maintenance / replacement of plant and soil materials, flush perforated underdrain pipe as required to remove blockages.	medium (\$30-\$350/m ² , median \$200/m ²)	\$13-30/m ²
3	Extensive Green Roof		medium	medium - must account for soil capacity loss during winter	All		X	X			X		X	X	X	X	Vegetation provides extra insulation (lower heating/cooling costs for buildings), extends roof lifespan as it is protected from temperature variation and UV, provides sound insulation, saturated soils increase fire resistance (suitable for large roof areas and roof slopes up to 30 degrees), low maintenance after initial plant establishment, research indicates that green roofs have same or longer life than conventional roof (15-20 years); no need for irrigation after initial plant establishment, often suitable for retrofit projects, access to roof can be accommodated.	Higher insurance premiums are likely, not suitable to areas prone to high levels of salt/chemicals, minimal volume control for storm events >25mm, higher capital costs than conventional roof, local experience in design and construction methodology, reduction in stormwater benefits during wet winter months, limited choice of plants (native species only), not typically used as a recreational space.	25 yrs	Similar to typical landscaping requirements long-term maintenance of plant and soil materials	medium (minimum \$230/m ²)	\$3-44/m ²
4	Intensive Green Roof		low	medium - must account for soil capacity loss during winter	All			X		X		X		X	X	X	Vegetation provides extra insulation (lower heating/cooling costs for buildings), extends roof lifespan as it is protected from temperature variation and UV, provides sound insulation, saturated soils increase fire resistance, greater diversity of plants and habitats (native and non-native species), aesthetically pleasing, often used as a recreational/employee amenity area.	Higher insurance premiums are likely, not suitable to areas prone to high levels of salt/chemicals, minimal volume control for storm events >25mm, higher capital costs than conventional roof, local experience in design and construction methodology, reduction in stormwater benefits during wet winter months, can be significant additional weight loading on roof, often a need for irrigation system to sustain plants, higher capital and maintenance costs over extensive roof.	25 yrs	Similar to typical landscaping requirements long-term maintenance of plant and soil materials	high (>\$50/m ²)	\$3-44/m ²
5	Bioretention		high	medium - modifications required to account for loss of infiltration and surface capacity during winter	Subsoil: <13 mm/hr, infiltrating <13 mm/hr	X	X	X	X	X	X		X	X	X	X	Effective treatment and removal of suspended solids, metals, nutrients and hydrocarbons, groundwater recharge potential if pervious soils are present, micro-scale habitat and reduction of urban "heat island" effects, aesthetic benefits.	Requires relatively flat slopes to be able to optimize water quality treatment through the system, requires modest land area, additional costs for drain rock gallery and perforated underdrain pipe, not recommended for areas with high sediment loads, not appropriate where water table or bedrock is shallow.	20 yrs	Long-term maintenance of plant and soil materials (similar to typical landscaping requirements), flush perforated underdrain pipe as required to remove blockages.	medium (\$30-\$250/m ² , median \$200/m ²)	\$13-30/m ²
6	Bioswale		high	high	Subsoil: <13 mm/hr, infiltrating <13 mm/hr	X	X	X	X	X	X		X	X	X	X	Effective treatment and removal of suspended solids, metals, nutrients and hydrocarbons, micro-scale habitat and reduction of urban "heat island" effects, aesthetic benefits, stormwater can be retained by providing additional ponding and/or subsurface storage, and infiltrated if pervious soils are present, aesthetic benefits, used for treating runoff from parking lots / roads.	Additional costs for drain rock gallery and perforated underdrain pipe below swale, not recommended for areas with high sediment loads, not appropriate where water table or bedrock is shallow, vegetation must be selected to withstand moderate flow velocities and erode forces of design events, vegetation in fall/lines along roadways must be selected to prevent impediment of sightlines	20 yrs	Long-term maintenance of plant and soil materials (similar to typical landscaping requirements), remove debris from swale as required, flush perforated underdrain pipe as required to remove blockages.	medium (\$25-\$250/m ² , median \$147/m ²)	\$13-18/m ²
7	Grass Swale		high	high	All	X	X	X	X	X	X		X	X	X	X	Water quality benefits, stormwater can be detained by providing additional ponding and/or subsurface storage, and infiltrated if pervious soils are present, used for treating runoff from parking lots / roads, less expensive than bioswale.	Rural look, pollutant uptake not as effective as bioswale, possible tripping hazard for pedestrians.	20 yrs	Long-term maintenance of plant and soil materials (similar to typical landscaping requirements), remove debris from swale as required, flush perforated underdrain pipe as required to remove blockages.	low (\$11-\$35/m ² , median \$25/m ²)	\$0-2-\$1/m ²
8	Naturalized Drainage Way		high	high	All			X	X	X			X	X	X	X	Effective treatment and removal of suspended solids, metals, nutrients and hydrocarbons, micro-scale habitat, stormwater can be detained by providing additional ponding and/or subsurface storage, and infiltrated if pervious soils are present, aesthetic benefits, ideal for reducing storm trunks or serving large areas, may be used in areas with shallow groundwater table to feed "wetland" areas.	Vegetation must be selected to withstand moderate flow velocities and erode forces of design events, vegetation in fall/lines along roadways must be selected to prevent impediment of sightlines	75 yrs	Long-term maintenance of plant and soil materials (similar to typical landscaping requirements), remove debris as required	medium (\$20-\$250/m ² , median \$147/m ²)	\$13-18/m ²
9	Absorbent Landscaping		high	high	All	X	X	X	X	X		X	X	X	X	X	Enhanced and deep topsoil acts as sponge to absorb and hold water, thriving plant community (better access to water and nutrients, increased root depth), water quality benefits (plant and soil uptake of pollutants, lower runoff water temperature)	Pools or saturated areas may develop if overlaid drainage paths are not well planned/constructed and defined	25 yrs	Long-term maintenance of plant and soil materials (similar to typical landscaping requirements)	medium (\$11-\$250/m ²)	\$0-2-\$18/m ²

Table 1 - LID Performance and Applicability Matrix

Item	Stormwater BMP	Photo	Applicability	Cold Climate Suitability	Suitable Native Soil	Land Use							Stormwater Management Objectives			Opportunities	Constraints	Lifecycle (Assume well operated and maintained)	Maintenance Requirements	Costs	
						Single Family Residential	Multi Family Residential	Public	Road/ ROW	Park/MR/ER	Institutional	Commercial	Industrial	Peak Flow Reduction	Volume Control					Water Quality	Capital
10	Porous Pavement		low	medium - not effective where sand is used for snow mgmt, or where there is heavy traffic volume or compaction from heavy equipment	Non-infiltrating. Alt. infiltrating: >13 mm/yr	X	X	X					X	X	X	Reduces generation of stormwater runoff, research indicates reduction in snow accumulation due to psychrometric warming through pores. Mean 15-20 years when properly designed/constructed/maintained. groundwater recharge potential if pervious soils present; pollutant removal, possible aesthetic improvement if pavers used, useful in parking lots (lots), driveway, road shoulders, sidewalks, other low traffic areas.	Not recommended for high traffic volume areas, areas with high levels of dust or sediment wearoff, deep profile grasses, pavement clogging possible if not properly maintained, effectiveness limited by stability of subsoils, drainage characteristics and groundwater conditions.	20 yrs	Long-term maintenance includes quarterly sweeping (and vacuuming if equipment is available); sand can not be used for snow mgmt as it clogs surface pores.	High (\$345-\$500 /m ² , median \$450 /m ²); Typically 10-15% higher than traditional asphalt	\$10-18 /sq/m ²
11	Reduce Impervious Area		high	high	All	X	X	X	X	X	X	X	X	X	X	Direct reduction in impervious area requires to less stormwater runoff generated and more pervious area for storage and infiltration.	Practically in application depends on intended land use(s).	>100 yrs	Typically more maintenance required for non-pervious surfaces (usually related to landscape costs).	Depends on extent of implementation, e.g. conventional storm sewer system cost may be reduced in scope if less runoff is generated (smaller pipe sizes)	N/A
12	Rainwater Harvesting and Reuse		high	high - modifications if reuse is outdoor (similar to irrigation systems)	All	X	X						X	X	Reduces peak and volume of stormwater runoff, lowers building water demands (and costs) as water can be used for toilets, air conditioning (cooling systems & irrigation, rain barrels and cisterns come in several shapes that can be selected to match building form.	Requires additional infrastructure to store and distribute "grey water", size limitations (max volume = 10,000 gallons for cisterns and 100 gallons for rain barrels), overflow systems to storm or sanitary system are required.	20 yrs	Bi-annual inspection for clogging and part replacements, cisterns should also undergo water quality assessments for fecal coliform, bacterial sediment, heavy metals and annual sediment removal = \$750-\$1250 per year; maintenance costs will vary if grey water distribution system is introduced.	medium (cistern: \$212-1000/m ²)	\$135 each (similar to irrigation system blow-out)	
13	Stormwater Harvesting and Reuse		high	high - modifications for operations under ice may be required	All								X	X	Reduces peak and volume of stormwater runoff, lowers potable water demands for irrigation	Uses other than irrigation are not allowed by Federal and Provincial regulations	20 yrs	Bi-annual inspection for clogging and part replacements	Low \$60 /m ²	1/6th of construction costs	
14	Constructed Wetland		high	high - modifications for operations under ice may be required	clay or clay liner					X			X	X	Reduces peak and volume of stormwater runoff, provides water quality treatment, aids amphibian and waterfowl habitat	Maintenance higher than stormwater ponds.	20 yrs	Long-term maintenance of plant and soil materials (similar to typical landscape requirements); remove trash, inspect outlet for clogging; remove sediment from forebay	medium (\$30-\$250 /m ² , same as bio-retention/rain garden)	\$113 /sq/m ² (same as bio-retention/rain garden)	
Conventional Approach																					
15	Hydrodynamic Separator/VQ Line		low	high - winter operations may include steaming to open outlets	N/A			X	X		X	X		X	Water quality benefits - 50% Total suspended solids (TSS) removal and is full control device to remove 90% of oil and grease.	End-of-pipe solution, high capital and maintenance costs.	70 yrs	Remove accumulated sediment from device using vacuum truck on an annual (or extended) basis.	High \$120,000 for 50% TSS removal (2 units)	medium (\$100 /sq based on vacuum truck once annually)	
16	Storm Sewers, Manholes and Catchbasins		medium	high - winter operations may include steaming to open outlets	N/A	X	X	X	X	X	X	X			Conventional drainage system conveys water offsite without any visual indication that systems are in place.	High capital costs, no water quality, environmental or aesthetic benefits.	75 yrs	Flush storm sewer system once every 5 years (typical); remove accumulated sediments in catch basins on annual basis.	High \$10,000 /sq (manholes and CIBs installed); \$700/m (storm pipe installed)	low (\$30 /sq, pipe \$9 /m)	
17	Storm Pond		high	high - modifications for operations under ice may be required	clay or clay liner								X	X	Allows storage for reuse, evaporation and controlled discharge	High land requirements, safety issues	25 yrs	Remove trash, inspect outlet for clogging, dredge sediment	Low \$60 /m ²	1/6th of construction costs	

4.4 LID Effectiveness

The City of Calgary's Water Balance Spreadsheet, a well-established, locally-based tool for assessing hydrologic conditions at development sites, was used to explore the relationship between land use and various stormwater control strategies for Chestermere. The results illustrate the value that LID can bring to the overall management (i.e. reduction) of runoff in the community.

For the analysis, several key aspects of land use and LID strategies were tested using the Water Balance Spreadsheet, with results discussed in the paragraphs following. The impacts on annual average runoff volume were investigated with respect to several key variables:

- Impervious surface fraction for a site;
- Disposition of stormwater after it runs off impervious surfaces;
- Use of deep absorbent landscaping (soils) in place of standard topsoils;
- Use of bioswales (or other bioretention filter systems such as rain gardens); and
- Irrigation of municipal reserve land with treated runoff (stormwater reuse).

All runs of the "Water Balance Spreadsheet" for this analysis used a standard long-term average annual precipitation depth of 409.7 mm. Other input parameters such as soils composition and evapotranspiration values also remained uniform among the various model runs.

The results presented here are based on hypothetical development areas and will vary for an actual development with specific site conditions and designs. Further, the results are directly dependent on the assumptions made for various input parameters. Nonetheless, the examples discussed here provide a reasonable overview of the expected runoff reductions that can be anticipated from use of LID strategies.

Figure 8 illustrates the basic relationship between Average Annual Runoff (AAR; expressed in millimetres per year) from a development site and both the fraction of the site covered by impervious surfaces and whether those impervious surfaces drain directly to a storm drain (i.e. are "connected") or are redirected to pervious surfaces such as lawns (i.e. are "disconnected"). As shown, there is a positive, linear correlation between percent imperviousness and AAR when the impervious surfaces are directly connected to storm drains. When the runoff from these same impervious surfaces is redirected to pervious surfaces (lawns) such that runoff can percolate into the soil or be taken up by plants (evapotranspiration, or ET), the AAR is reduced (except at the two extremes, namely, 0% and 100% impervious fractions¹).

¹ To reinforce the obvious, at 0% imperviousness, there is no runoff from impervious areas to redirect; at 100% imperviousness, there is no place to which runoff from impervious areas can be redirected. At each extreme, whether the impervious surfaces are connected or disconnected is immaterial.

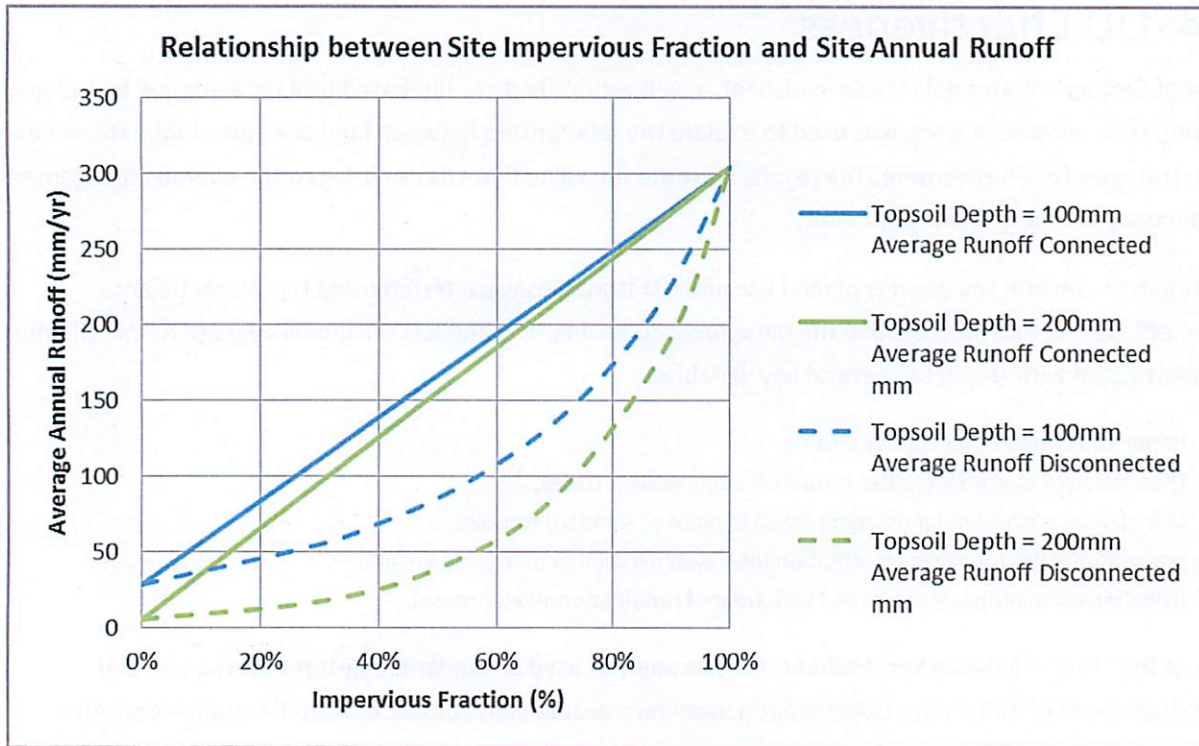


Figure 8 - Relationship between Site Impervious Fraction and Site Annual Runoff

Figure 8 also shows that increasing the depth of soils used for pervious surfaces (from 100mm to 200mm) decreases the AAR, up to more than five-fold; this affect is reduced the greater the impervious fraction. Further, the plot shows that the absolute magnitude of the reduction (when impervious surfaces are disconnected) is greatest when the impervious fraction is around 70%, but quickly reduces to zero at 100%.

This plot illustrates several critical aspects of a low impact, sustainable approach to stormwater management:

- Average annual runoff is related linearly to the fraction of a site that is impervious;
- Directing runoff from impervious surfaces to pervious surfaces decreases the average annual runoff; and
- Increasing the depth of topsoil decreases the average annual runoff.

Figure 8 illustrated the basic principles of considering impervious fraction, disconnecting impervious surfaces and adjusting topsoil depth as adaptive site planning approaches to reducing runoff.

The "Water Balance Spreadsheet" was also used to illustrate the impact of using LID on more specific land uses. For example, Figure 9 illustrates how absorbent landscaping can be used to manage rainwater on typical residential lots for which the impervious fraction is generally in the range 30% to 70%, depending on the lot size and density characteristics of an area. This range was chosen to represent the likely range of single family residential lots that will be developed in Chestermere (which is also consistent with current zoning in the community). For purposes of this assessment, absorbent landscaping specifically refers to the use of amended

soils² with depth of 400mm, as compared to a standard topsoil depth of 200mm. As illustrated in Figure 9, the added depth provides significant runoff control benefits.

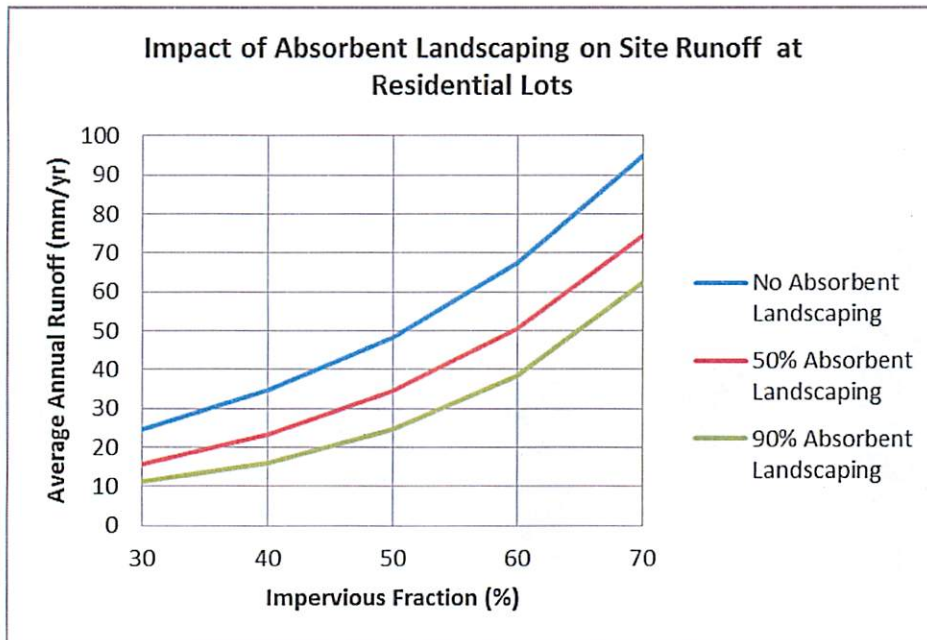


Figure 9 - Impact of Absorbent Landscaping on Site Runoff at Residential Lots

As noted, Figure 9 shows the impact of using absorbent landscaping in place of shallow topsoil. Since sites vary in their capacity to make use of absorbent landscaping across the entire lot, the figure shows the result of 50% and 90% of the pervious surfaces being replaced with absorbent landscaping. This figure is based on the assumption that 10% of the site’s impervious surfaces always remain directly connected while the remaining 90% of the impervious surfaces convey runoff onto the lawn. Further, this plot only considers runoff from the privately-owned property itself and not from the adjacent street right-of-way (ROW), (which is discussed in the paragraphs following).

Application of LID to street ROW can be challenging due to the presence of other infrastructure and the relatively narrow space which can remain pervious; nonetheless, the City could obtain significant benefits in runoff volume reduction and runoff quality treatment with thoughtful low impact designs. To illustrate, a standard 15m ROW, typical for Chestermere, has an average impervious fraction of about 80%, dedicated to the driveways, sidewalks and the carriageway itself. Based on the “Water Balance Spreadsheet” results, for this standard roadway design, where runoff is captured in catchbasins and directed to storm drains, the AAR is 245mm per year; simply by redirecting this runoff to the 20% of the ROW that is pervious surfaces (with 200mm of topsoil), AAR can be reduced to 155mm per year. The use of bioswales or absorbent landscaping in the boulevard strips either side of the roadway further reduces runoff to 132mm or 123mm per year, respectively.

² Amended soils have a specified value or range of organic matter, fines such as clay and other parameters within the soil materials that is intended to enhance the infiltration and treatment capabilities of the soils beyond that found in typical topsoils.

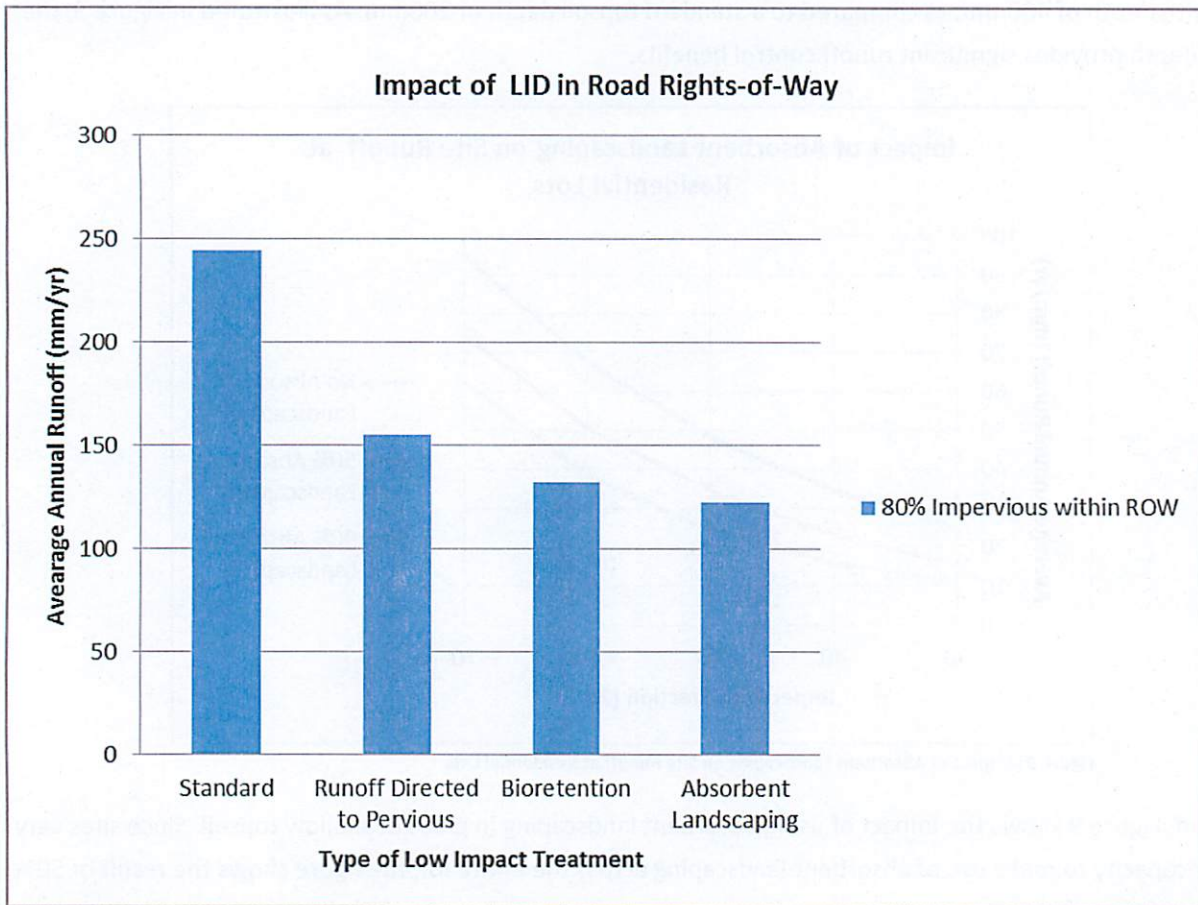


Figure 10 - Impact of LID in Road Rights-of-Way

Commercial and light industrial sites typically exhibit high impervious fractions due to the size of buildings and the extent of parking, thus making the use of absorbent landscaping a bit challenging. Bioswales (and rain gardens) are often used instead as they are compact, can fit into a variety of spaces and can provide general landscaping to a site. Using "Water Balance Model" results, Figure 11 shows how sites with impervious fractions varying from 60 to 95% can control runoff by using bioswales in lieu of standard landscaping. AAR for the standard landscaping is 215 mm and 274 mm for 70% and 90% imperviousness, respectively. Two levels of bioswale use are considered, with runoff directed to bioswales from 50% and 100% of impervious surfaces, which translate to small reductions of AAR by 8-10 mm per year to 16-21 mm per year, respectively. As shown, for land uses with high impervious fractions, simply providing bioswales does not yield significant runoff volume control; however, it can provide significant water quality improvements to the runoff. The addition of deep amended soils to all remaining pervious lawn areas would enhance runoff volume control at commercial and light industrial sites.

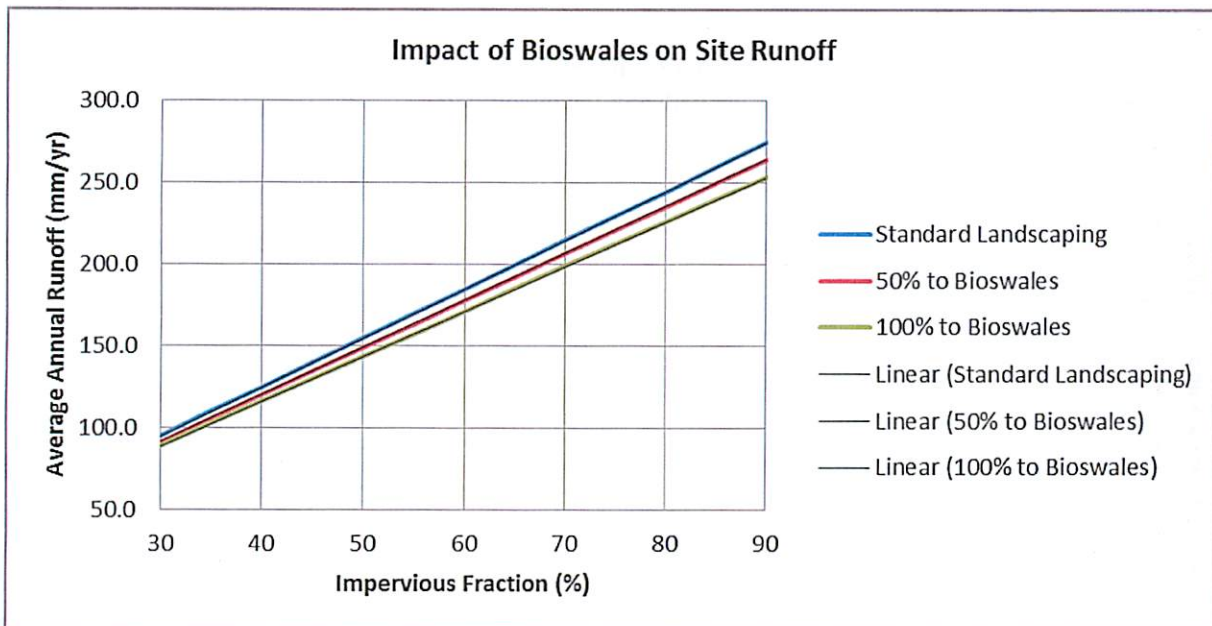


Figure 11 - Impact of Bioswales on Site Runoff

Finally, stormwater reuse for irrigation is becoming a common way to manage runoff from development, although it has regulatory considerations that are described in the following section. Most often stormwater reuse is implemented for an entire neighbourhood or development due to the infrastructure (treatment system, pumps, etc.) required for its use. Individual residential lots are generally better served by rainwater harvesting than stormwater reuse.

Areas often targeted for irrigation with stormwater are municipal reserve lands (parks), public green spaces, school yards, and sometimes even street boulevards. Figure 12 illustrates the impact on AAR of irrigating the municipal reserve portion of a typical 65 hectare single family residential area of 55% imperviousness that includes a 10% set aside for the reserve (6.5 hectares). Two cases are shown on Figure 12, all impervious surfaces are directly connected so that all runoff is available for stormwater reuse and 40% of impervious surfaces are redirected to pervious surfaces (lawns) where infiltration and ET can occur. As shown, stormwater reuse can yield significant reductions in AAR.

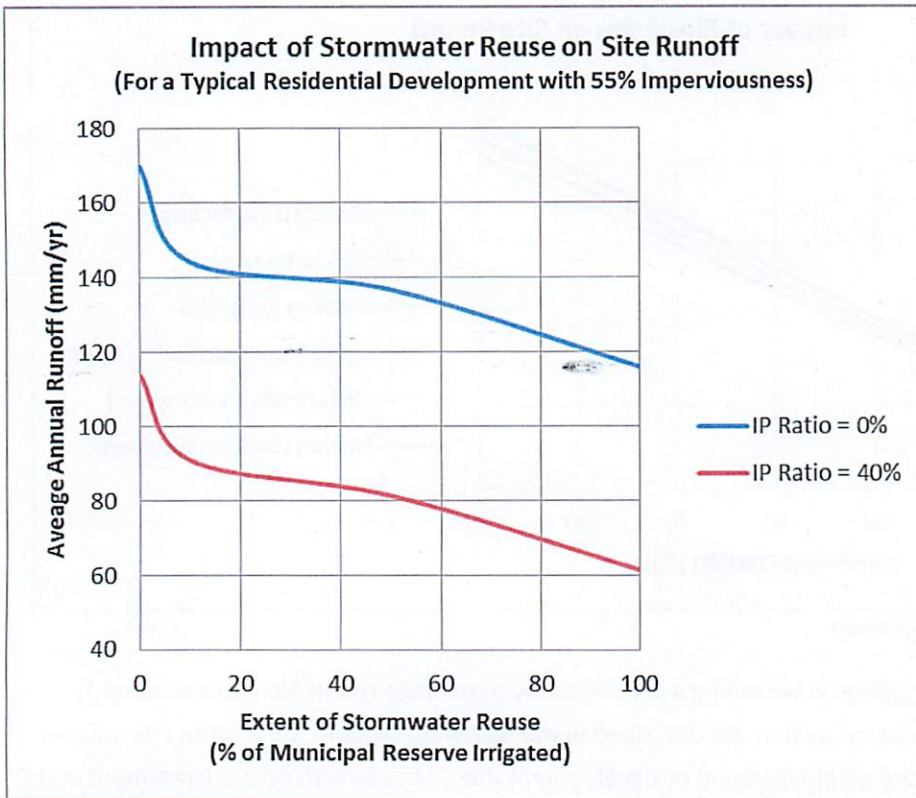


Figure 12 - Impact of Stormwater Reuse on Site Runoff

This LID effectiveness analysis illustrates the significant reductions in average annual runoff that can be achieved through the use of various low impact stormwater management approaches. A combination of LID strategies, specifically stormwater reuse and absorbent landscaping, can achieve the volume target of 40mm specified in the Plan. LID achieves these reductions by relying on the processes of infiltration and evapotranspiration that dominate the natural hydrologic cycle in pre-development conditions.

4.5 Stormwater Reuse Considerations

Stormwater capture and reuse can be defined as the collection of runoff from a drainage system in a stormwater management facility and reuse of that runoff for non-potable end use, primarily irrigation. This is different from rainwater harvesting, which typically refers to roof water collected in a storage tank.

Large scale implementation of stormwater reuse for irrigation purposes can have significant benefits for urban water management. Environmental benefits are achieved through reduced runoff volumes and associated stream impacts, reduced pollutant wash-off and loadings, and improved catchment hydrology. Financial savings are also an important consideration. Stormwater reuse offsets increased demand for potable water by providing an alternative water source for irrigation use, which is one of the more significant demands on the potable water system during summer months.

While stormwater reuse is a beneficial practice from sustainability perspective, there are some regulatory considerations. In 2010, AESRD released the Interim Policy on Stormwater Reuse that allows stormwater reuse for irrigation purposes if certain conditions, summarized in Appendix D, are met. Under this policy, AESRD allows reuse as a beneficial practice within the catchment area of the pond for irrigation of green space.³ However, the practice is not to be used as means of disposal of stormwater (for example, irrigation of roads and parking lots). Uses other than irrigation of open spaces within the catchment area of a source pond may be subject to licensing requirements.

The components of stormwater capture and reuse systems include stormwater management facility (wet pond), irrigation intake, treatment, pump system, distribution piping, and irrigation system.

Key design considerations for stormwater reuse systems include:

- Land use within the contributing catchment – ponds located in industrial areas, in proximity to known pollution “hot spots”, or receiving runoff from major highways that are heavily sanded during winter months are less suitable for reuse due to higher levels of pollutant loadings.
- Assurance of supply – facility’s ability to deliver reliable irrigation water supply and recharge post-withdrawal is usually a factor of catchment size and demand area.
- Operability during drought conditions – there should be sufficient base flow to replenish the extracted irrigation volume during prolonged drought, otherwise pond operations may be compromised.
- Potable make-up water system may be needed which would considerably increase project costs; the need for potable backup system is site and project specific and should be discussed with City staff during planning stages.
- Proximity to demand locations – for reuse applications to be cost-effective, the irrigation area must be reasonably close to the stormwater facility. Limiting the length of the distribution network reduces the capital expenditures as well as operational and maintenance costs.

³ The Interim policy allows the reuse of essentially only the delta stormwater (mean annual predevelopment and projected mean annual post development volumes of water lost to the evapotranspiration for the catchment area) on the site

- Water quality and treatment considerations – stormwater can be highly polluted and optimal water quality should be achieved through appropriate site selection, provision of adequate treatment, and regular post-construction water quality monitoring. Treatment is employed to manage both operational and public health concerns. The City of Calgary Stormwater Reuse Guidelines provide target levels for contaminants of concern and treatment requirements.
- Public access controls – If treatment is limited, public access controls can minimize health risks. Public access controls include operational approaches such as watering at night, restricting access during irrigation and until vegetation is dry, providing warning signage, and limiting public access to irrigated areas.

Irrigation demand is highly site - and project-specific and must be quantified by a certified irrigation designer for each reuse application. An Irrigation Master Plan should be submitted in conjunction with a Staged Master Drainage Plan submission when stormwater capture and reuse systems are employed. It is inadvisable to over-irrigate parks and playing fields in order to maximize the potential for runoff volume reduction. Over-irrigation can compromise plant health, create soggy parks and sports fields, and result in surface runoff. If applying more irrigation water is a part of the stormwater management plan to reduce runoff volumes, then landscape design, plant material, and soil amendments must be selected to withstand the increased irrigation.

5.0 STORMWATER SYSTEM PLANNING CONSIDERATIONS

The City of Chestermere and CUI have adopted the City of Calgary Stormwater Management Guidelines (2011) as a technical support document for design and construction of its stormwater management infrastructure. The information in this section builds on the existing guidelines and provides additional information on key regulatory, planning and environmental aspects.

5.1 Regulatory Considerations

Alberta Environment and Sustainable Resources Development (AESRD) is the main regulatory body that regulates stormwater discharges from the City. Two provincial legislations govern the quality, quantity and use of water - the *Environmental Protection and Enhancement Act* (EPEA) and the *Water Act*, which are briefly described below.

5.1.1 EPEA

The purpose of EPEA is to "support and promote the protection, enhancement and wise use of the environment". This Act focuses more on quality-based outcomes. In general, EPEA authorization is required for the construction and operation of a storm drainage system including the stormwater management facilities (SWMF), the sewer system, any other appurtenances used to collect storm drainage. Water quality and treatment standards and requirements are regulated by EPEA.

5.1.2 Water Act

The Water Act is primarily focused on water quantity and water use. The purpose of the Water Act is to "support and promote the conservation and management of water, including the wise allocation of water". The diversion and use of all surface water in Alberta, including stormwater, requires a licence under the Water Act. Stormwater management facilities (wet ponds) and wetlands require approvals under the Water Act. In case of preserved wetlands (i.e. wetlands that are not impacted by land development, are usually taken as Environmental Reserve (ER) and are not subject to compensation), the water regime of the wetlands and evaporative losses may not be changed, otherwise a water licence requirement may be triggered.

5.2 Water Quality Considerations

5.2.1 Total Suspended Solids (TSS)

Since 1998, provincial regulation requires that all new development and redevelopment areas provide stormwater treatment by removing 85% of Total Suspended Solids (TSS) particles of 50 microns or higher. In new development areas, this requirement is usually met in a wet stormwater management facility with a release rate of less than 15 L/s/ha. Incorporating treatment-based LID practices should also be considered to manage

pollutants at source, foster the “treatment rain” approach, and increase overall stormwater treatment effectiveness.

Smaller developments where wet pond construction is not an option, or commercial, industrial or institutional land uses, typically use oil and grit separators to meet water quality targets.

Establishing restrictive runoff volume targets can also help meet water quality objectives, since runoff volume discharges directly impact pollutant loadings. Several communities in the region have implemented volume targets for catchment areas within the Bow River watershed, as a strategy to reduce pollutant loadings and meet regulatory commitments.

5.2.2 Phosphorus Management Plan

In addition to Total Suspended Sediment (TSS), phosphorus has emerged as a pollutant of concern. Recent monitoring information for Bow River Basin shows that between 17% and 35% of phosphorus comes from stormwater. AESRD has been working with municipalities and watershed stakeholders in the region to develop a Phosphorus Management Plan. Under the Plan, municipalities will be expected to control phosphorus loadings to a specified limit. Recommended control strategies include non-structural source control measures, runoff volume reduction, and treatment LID implementation.

5.3 Wetlands Preservation and Management

The study area is a significant wetlands region. The City of Chestermere considers their wetlands to be valuable community amenities and recognizes that wetlands play a significant role in watershed protection through their capacity to improve water quality, reduce flooding and erosion, and maintain habitat and biodiversity. In 2013, the City completed the Wetland Inventory and subsequently developed and adopted the Wetlands Policy.

The Wetland Inventory identified a total of 275 wetlands that cover approximately 325 ha, or 14% of the study area (Figure 13). A total of 28 wetlands in the study area were ranked as Exceptional ecological and hydrological significance, with another 45 wetlands being ranked as High significance. The remaining 202 wetlands were ranked as Moderate significance (Figure 14). When development setbacks (10m on Class I and II; 30m on Class III to VI) were applied to wetlands within the study area, Exceptional and High significance wetlands and riparian areas comprise approximately 16% of the study area. The intent of the Wetland Policy is to help direct future land use decisions such that impacts to significant wetlands can be minimized, and the important ecological and social values of these wetlands can be conserved.

The City recognizes that, while every effort should be made to preserve environmentally significant wetlands, development impacts are sometimes unavoidable. The following general guidelines are provided to ensure better integration of wetlands and stormwater management during the land development process:

- ▶ A Biophysical Impact Assessment (BIA) should be completed at the Area Structure Plan or Outline Plan stage and should identify wetlands that will be preserved, wetlands that will be integrated with stormwater concept, and wetlands that will be compensated.
- ▶ Preserved wetlands are fully protected in their natural state and are not a part of post-development stormwater management system, however highly treated stormwater needs to be diverted to the wetlands to ensure their survival post-development.
- ▶ A Staged Master Drainage Plan (SMDP) report should describe how the preserved wetlands are going to be maintained. Generally, a water balance analysis needs to be conducted on the wetland, with continuous simulation software utilizing 50 years of climate data, to establish the hydroperiod and the average annual pre-development runoff volume the wetland was receiving, as well as to assess potential pre-development discharge rates and volumes. This will provide the basis for evaluating the impacts of post-development discharges and establishing the post-development stormwater volume inputs to the wetlands, to ensure that pre- and post-development wetland hydroperiods are matched. The source of stormwater inputs would be a nearby stormwater wet pond.
- ▶ If wetlands are to be integrated with the post-development concept, the SMDP needs to include a description and necessary analyses to show how they are to be included into the post-development stormwater system, with inflow rates, frequency of inundation, vegetation and habitat management plans. Depending on the level of integration and engineering of these wetlands, these wetlands may be subject to compensation.
- ▶ Only highly treated stormwater may be discharged to preserved wetlands; the type and level of treatment and expected inflow water quality should be described in the SMDP report. In addition to treatment provided by wet ponds, a mechanical filter system (such as "Jellyfish") may need to be considered to ensure adequate level of pollutant and nutrient removal.

5.4 Stormwater Targets Definition

Several guiding documents and regional planning studies were considered for establishing stormwater targets for the study area:

- Shepard Regional Drainage Plan set the release rate from developed areas to the regional naturalized drainage system at 0.8 l/s/ha and the annual volume target at 40mm to 90mm, for the entire Shepard drainage Corridor. The release rate was set based on optimizing the size of regional drainage infrastructure, but it also reflects the pre-development runoff rates for the study area. The volume target is based on the recommendations of the Bow River Basin Watershed Management Plan⁴.
- CSMI report proposed the rate target in the range of 0.8 l/s/ha to 2.0 l/s/ha. Volume targets were not specifically established in the report; however the next study phase (currently underway) includes the water balance analysis and is likely to recommend an overall target.
- The City of Calgary set an interim 40mm volume target for new development area in the Bow River watershed. The primary intent is to meet the City's long-term regulatory commitments as outlined in their Total Loadings Management Plan. The targets apply to Shepard Drainage Corridor as well.

At this time, it is uncertain whether the City of Chestermere will adopt the SRDP or CSMI long-term servicing option. Given the regional context as well as potential future regulatory constraints, the recommended stormwater targets for the City are:

- Stormwater rate target of 0.8 l/s/ha
- Annual runoff volume target of 40mm

The post-development rate target of 0.8 l/s/ha refers to a release rate from a stormwater management facility to a stormwater trunk or regional conveyance system. The stormwater piping within developments and upstream of a stormwater facility should be designed with a minimum Unit Area Release Rate (UARR) of 70 L/s/ha. In case of steep slopes or highly impervious areas (e.g. road drainage) the UARR can be increased to balance pipe sizes and surface storage requirements (trap lows). This should be determined at the SMDP stage.

It is important to note that analyses conducted for this study (Sections 4.5 and 5.6) have shown, at the broad level, that 40mm volume targets can be achieved by mandating and encouraging wide-spread LID (especially absorbent landscaping) and stormwater reuse implementation. The following should be considered for all new developments:

- Stormwater capture and reuse for irrigation should be a standard practice applied to all neighbourhood green spaces, school yards, sports fields, and parks.

⁴ The Bow River Basin Watershed Management Plan recommended that municipalities limit post-development effective imperviousness to 10-20%, to achieve close to pre-development hydrologic conditions. This translates into 40mm to 90mm runoff volume target. The City of Chestermere expressed support for the Plan when the Phase 1 was circulated to municipalities within the Basin (2008).

- Absorbent landscaping depth of 400mm should be applied to all public green spaces, and encouraged on private lots as well.
- Rainwater harvesting and reuse should be encouraged on residential properties, through education and outreach programs (e.g. rain barrel sales).
- Better site planning practices that reduce impervious surfaces and incorporate some LID should be encouraged through planning process.

5.5 LID Implementation

Integration of LID practices in land development projects is supported by various planning policies; however it is not yet a mandatory design requirement. Usually, it is the responsibility of the developers and their design teams to determine whether to include LID into site planning and which practices would be appropriate.

The LID implementation to reduce runoff volumes and improve overall water quality is recommended in both SRDP and CSMI reports. City should continue to encourage LID implementation through policy development and setting a timeline for adoption of minimum LID requirements for new developments. Of note, LID implementation does not eliminate (or even significantly decrease) the need for conventional stormwater infrastructure, as LID practices are only effective for smaller rainfall events and do not provide adequate stormwater control for 1:100 year rainfall event.

5.6 Stormwater Facility Considerations

All new developments within the study area will be required to construct wet stormwater management facilities for both peak flow attenuation and water quality treatment. Generally, facilities should have a minimum 2 hectares surface area as per provincial guidelines. Facilities that are less than minimum size do not perform as well in terms of sediment removal and tend to have more operational problems, especially related to odor, algal growth, and turbidity.

The following analysis, utilizing the City of Calgary's Water Balance Spreadsheet, was undertaken to determine the impacts of various development planning options and stormwater management design considerations on stormwater management facility requirements.

The analysis was based on the following assumptions:

- Stormwater facilities are wet ponds, designed in accordance with the City of Calgary's Stormwater Management Guidelines, and sized to achieve the stormwater rate target of 0.8 l/s/ha and volume target of 40mm. The permanent pool is designed to include dead storage and irrigation storage which fluctuates with irrigation demand. The active storage zone is sized for flood control. The minimum facility size is 2 hectares.
- Spray irrigation of all community green spaces, parks, school sites, and sports fields will be with captured stormwater. Maximum 25mm/week will be applied, and will be based on seasonal irrigation scheduled for 5 months of each calendar year (May-September).

- All public green spaces will be designed with 400mm depth of absorbent landscaping. A topsoil depth of 200mm was assumed for residential lots for a conservative approach, although deeper topsoil should be encouraged on private lots.
- Land uses will be mainly residential (single and some multi-family) with neighbourhood commercial development, resulting in the average imperviousness of 55%. Municipal Reserve (MR) requirement is 10% of the developable area. Some of the models were also adjusted for varying percentages (1% to 10%) of Environmental Reserve (ER) to account for preservation of wetlands and other environmentally sensitive areas.
- The range of modelled catchment sizes is from ¼ Section to 1 ½ Sections of land (in ¼ Section increments), or approximately 65 ha to 389 ha respectively.

The amount of hard surface area within the development that is directly connected to the storm sewer⁵ influences the storm pond sizing and the ability of the development to meet volume targets. The amount of hard surface connected to green spaces can be influenced by:

- Requiring roof leaders and storm drains to discharge over greenways and grassy surfaces upstream of storm sewer catchbasins in road Rights-of-Way (ROW).
- Implementing the requirement of green strips or grassed strips of land between sidewalks and storm sewer catchbasins in ROWs.
- Routing pathway drainage over green spaces and greenways prior to capture into a storm sewer catchbasin or stormwater management facility.
- Allowing for curb cuts along roadways that encourage road drainage to divert from the ROW to greenways, pervious landscape and LID features prior to capture into a storm sewer catchbasin or stormwater management facility.

Typically, to achieve 30% of directly connected surface, only the roads would drain directly to catchbasins, with all other hard surface (roofs, sidewalks, driveways) would be routed over green spaces prior to capture into the underground storm pipe network. On the other extreme, 70% directly connected represents a development scenario where only runoff from residential roof leaders in single family areas is routed over pervious landscaping prior to stormwater capture and other hard surfaces in the development drain directly to the underground storm pipe network. Directly connected percentages were varied for all models to assess how this impacts the sizing of the stormwater management facilities.

With the land use and design considerations described above, several models were run to support the decision making process for the City of Chestermere and area developers⁶.

⁵ Hard surface (impervious area) contributing runoff directly to storm sewer catchbasins is considered "Directly Connected %" throughout this analysis. Interception of runoff from hard surfaces by green/pervious area is considered disconnected, thereby decreasing the directly connected percentage. Lower "Directly Connected %" indicates greater potential for evapotranspiration and infiltration into pervious or absorbent landscape

⁶ It is important to note that frequency analysis is typically required to size ponds up to the 1:100yr volume requirement and a freeboard is typically required above the 1:100yr HWL depth. This would need to be checked at the detailed design stage, and was ignored in this report. The HWL indicated is based on maximum WBS results only.

One finding was that the amount of ER (assumed between 1-10%) did not influence the proportion of developable area required for a pond in a catchment area. This simplified the modeling approach such that the amount of ER could be ignored for all base scenarios. In reality, during detailed design the percentage of ER will have an influence because modification to stormwater reuse parameters will be required in order to supplement the preserved wetlands with stormwater volume inputs.

The following graphical representation of the results supports the determination of the approximate total catchment sizes to be controlled by a single stormwater management facility, indicate proportion of developable area required for a pond, show the range of active storage utilized, approximate pond volume requirements, and demonstrate the influence of pond losses and catchment losses on achieving the runoff volume target for the ultimate design scenario.

Figure 15 demonstrates the effectiveness of reducing the volume of runoff to a stormwater management facility by routing impervious surface runoff over pervious and absorbent landscaping prior to capture and pond attenuation. As the directly connected percentage decreases, the proportion of developable area taken up by the pond decreases. Also, as total catchment area increases, the required land-use of the pond area decreases.

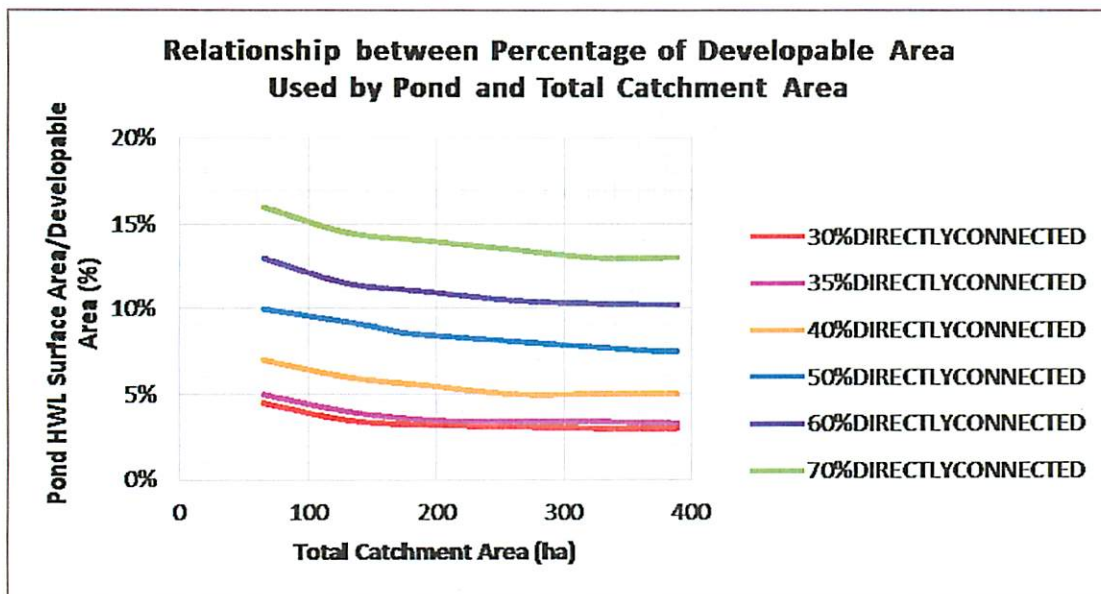


Figure 15 - Relationship between Percentage of Developable Area Used by Pond and Total Catchment Area

According to the results in Figure 15, 10-12% of developable area can be saved by maximizing the amount of hard surface runoff that is routed over pervious and absorbent landscaping in the catchment. Reduction of pond areas and number of ponds required in a subdivision can also reduce the operation and maintenance costs for the City.

Figure 16 demonstrates how total pond volume, based on the assumed layout of a pond as indicated in previous discussions, increases with total catchment area. It also indicates how decreasing directly connected percentages, or encouraging hard surface runoff routed over green areas, can reduce total pond volume requirements significantly. This graph can be used to optimize required pond volume based on catchment size and directly connected percentage, and also provides an indication of required earth works on the site.

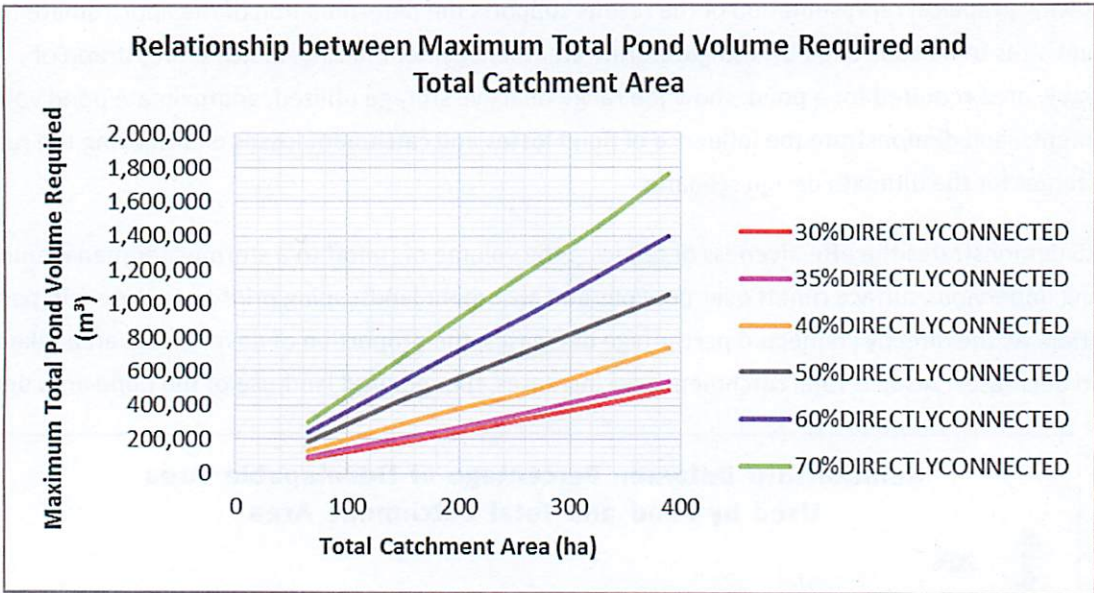


Figure 16 - Relationship between Maximum Total Pond Volume Required and Total Catchment Area

Figure 17 shows the relationship between active pond storage used and total catchment area. As directly connected percentage decreases, a greater proportion of the available active storage is utilized. This graph can be consulted in order to maximize the effectiveness of the pond.

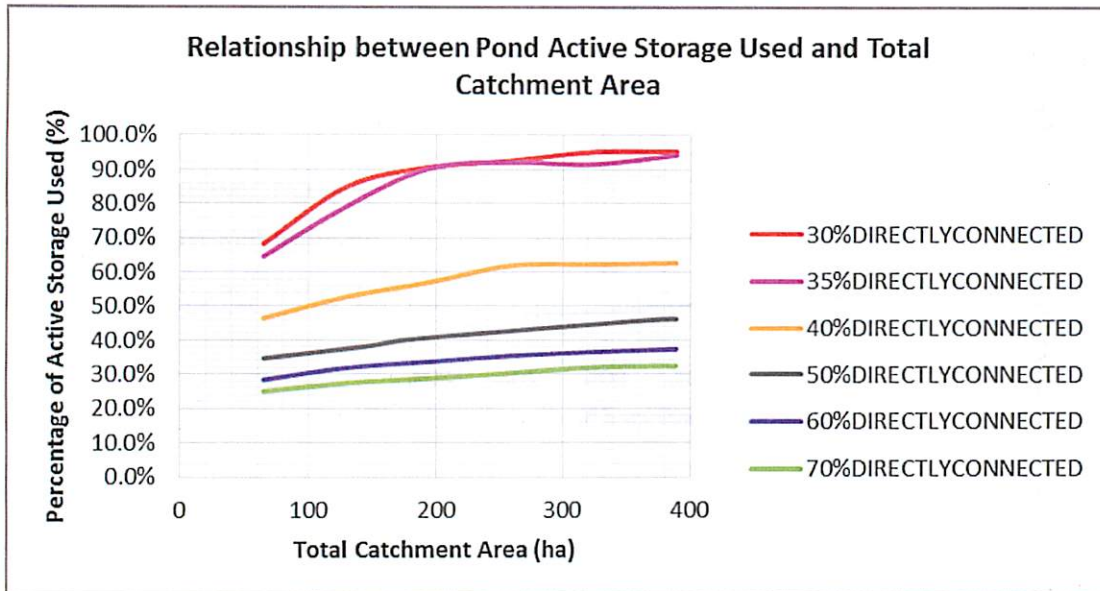


Figure 17 - Relationship between Pond Active Storage Used and Total Catchment Area

Figures 18 and 19 indicate the average annual equivalent depth of various catchment and pond losses. Basically, as catchment losses increase, the runoff volume to the pond decreases. Irrigation demand was the same for every scenario modeled, as indicated in Figure 18.

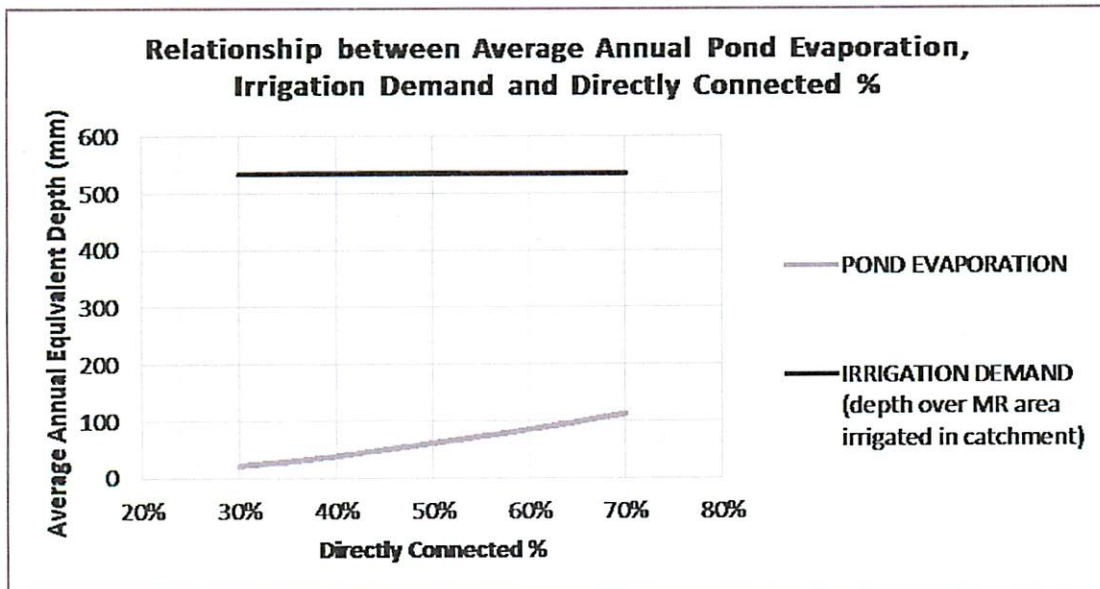


Figure 18 - Relationship between Average Annual Pond Evaporation, Irrigation Demand and Directly Connected %

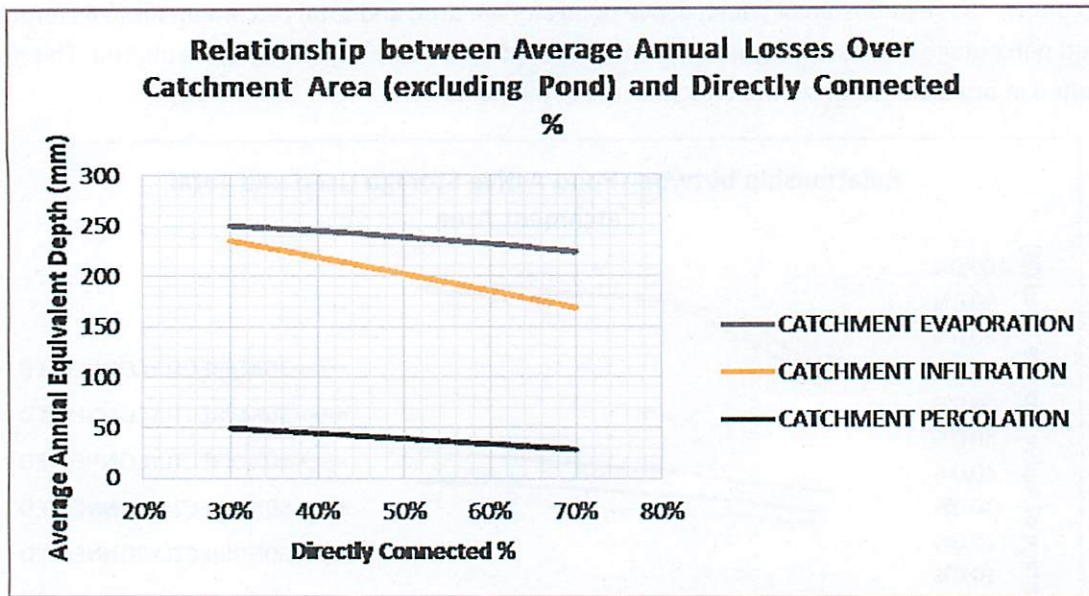


Figure 19 - Relationship between Average Annual Losses Over Catchment Area (excluding Pond) and Directly Connected %

These results indicate that source control practices that encourage greater losses in the catchment area prior to runoff into the storm pond, decrease pond volume and surface area requirements and increase the overall developable area. Specifically, stormwater reuse in conjunction with land-use decisions that increase overland runoff through green ways from all surface types can result in an efficient pond design that maximized developed area in a subdivision. All graphical figures lead to one conclusion, source control practices not only help meet runoff volume targets, but decrease pond storage requirement and increase developable land yield.

6.0 STORMWATER SERVICING STRATEGIES FOR PLAN AREA

6.1 Interim On-site Servicing Options and Development Staging

6.1.1 General Considerations

In the near term, until the City Council makes a decision on the regional servicing plan that the City of Chestermere will endorse (i.e. SRDP or CSMI) and the regional drainage infrastructure is constructed, interim servicing options will need to be implemented to allow land development in the study area to proceed.

Interim servicing needs to be robust and able to function in a safe and economical manner for a potentially long time. With this in mind, the City does not wish to implement practices that have in the past proven unreliable or costly from an operational and maintenance perspective, such as evaporation ponds or stormwater pumping schemes. Instead, the “zero release” options are to be considered⁷.

Trying to design a “zero release” system on an interim basis, with the intent of ultimately tying into a regional drainage system, presents significant challenges from both technical and economic perspective. “Zero release” systems by necessity must rely on large scale capture and reuse of stormwater. These systems can be expensive to implement and, in a current regulatory climate, can be subject to regulatory as well as land use constraints.

Interim servicing scenarios should be determined at the ASP or Outline Plan and SMDP stage. Some important considerations for interim servicing scenarios are presented below:

- Interim servicing concepts (including grades, elevations, minor system design, etc.) must be such to allow for seamless connection to the permanent servicing infrastructure, once it becomes available.
- Because the interim servicing may be in place for a long time, any type of “temporary” stormwater facilities are strongly discouraged. The facilities should be sized and built for ultimate conditions (i.e. to achieve stormwater rate target of 0.8 l/s/ha and volume target of 40mm) even if downstream infrastructure (trunk, outfall) is not in place and connections are not possible. Area that can be serviced by this facility in the interim must be delineated in the SMDP. The SMDP should describe and analyze both interim and ultimate servicing options.
- For “zero release” systems, irrigation is the only means of stormwater disposal. The irrigated area should be located either within the Outline Plan boundary, or in the same land ownership as the Outline Plan area.

⁷ “Zero release”, in this case, would be defined as no discharge to areas or drainage courses outside of the City boundaries.

6.1.2 Interim On-site Servicing - Design Analysis

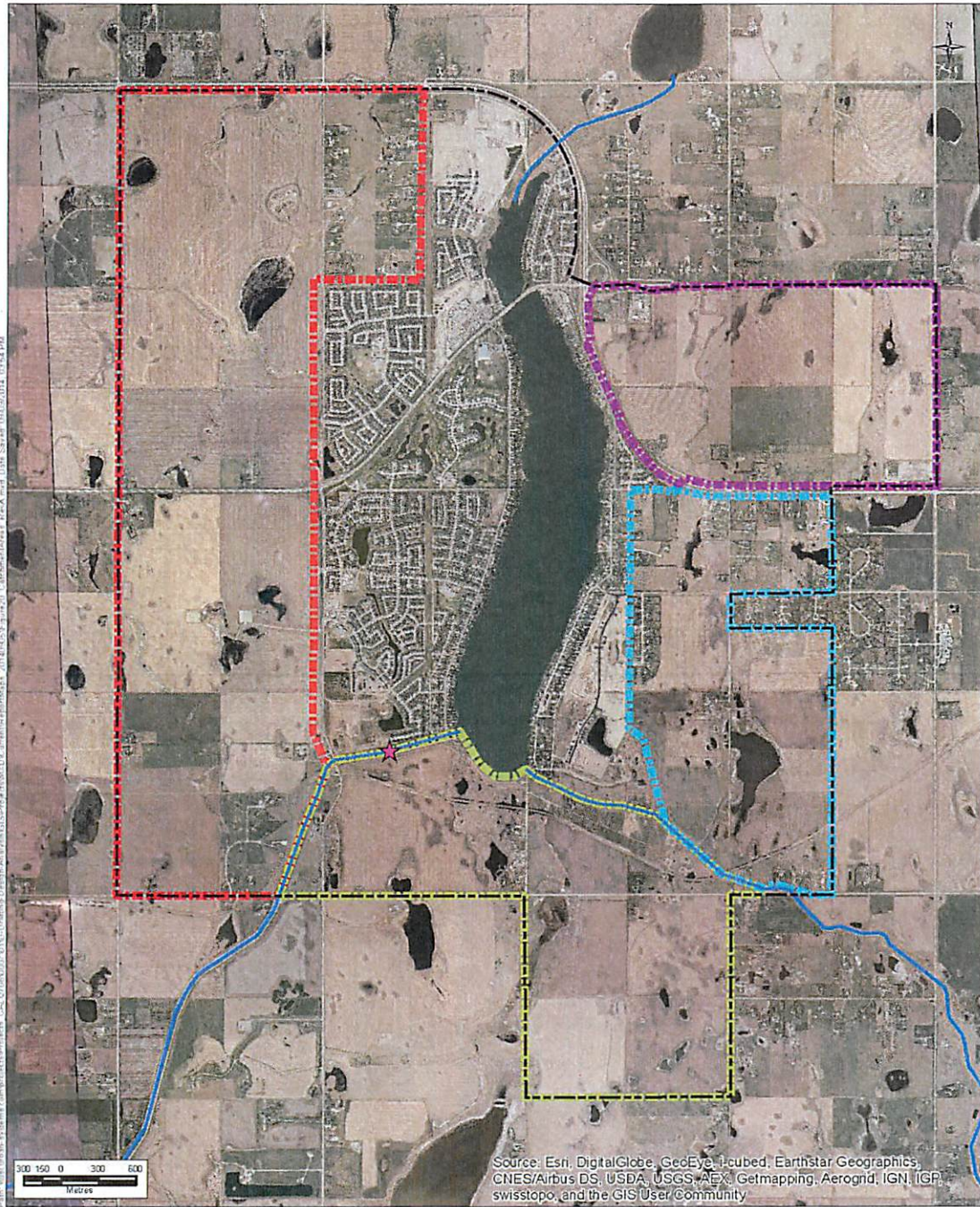
The following design analysis was undertaken to determine the extent of land for each post-development catchment that can be developed with interim servicing, with a permanent stormwater facility built to ultimate design parameters, and irrigation and the only facility outflow. The analysis is based on the assumptions and modeling parameters as described in Section 5.6.2.

The study area was divided into zones, determined as the East, South and West catchments (Figure 20). The East catchment excludes the Bayfield Industrial area, because Bayfield has a permanent servicing scheme in place which will be described in the following section. The following table summarizes the total areas of each annexed zone.

Table 2 - Catchments and Areas

Catchment	Area (ha)
East	445.0
South	548.4
West	1122.1

Three scenarios were run: (1) zero discharge with undeveloped irrigation land zone; (2) zero discharge with 50% of private lot pervious space irrigated as well as an undeveloped irrigation land zone; and (3) zero discharge with 75% of private lot pervious space irrigated as well as an undeveloped irrigation land zone. The spectrum of results through these scenarios is meant to demonstrate potential avenues for increasing developable land area in the interim scenario.



- Key
- ★ Undrain
 - Irrigation Canal
 - ▭ Chestermere Boundary
 - ▭ West Catchment
 - ▭ South Catchment
 - ▭ East Catchment
 - ▭ Dayfield Industrial

Catchment Areas

Figure
20

Figure 20 - Catchment Areas

The ultimate pond size requirements for a ¼ section of land (65 ha) with 40% directly connected impervious surfaces assuming 5% ER (removed from pond sub-catchment) was utilized for the base parameters of the three interim scenarios.

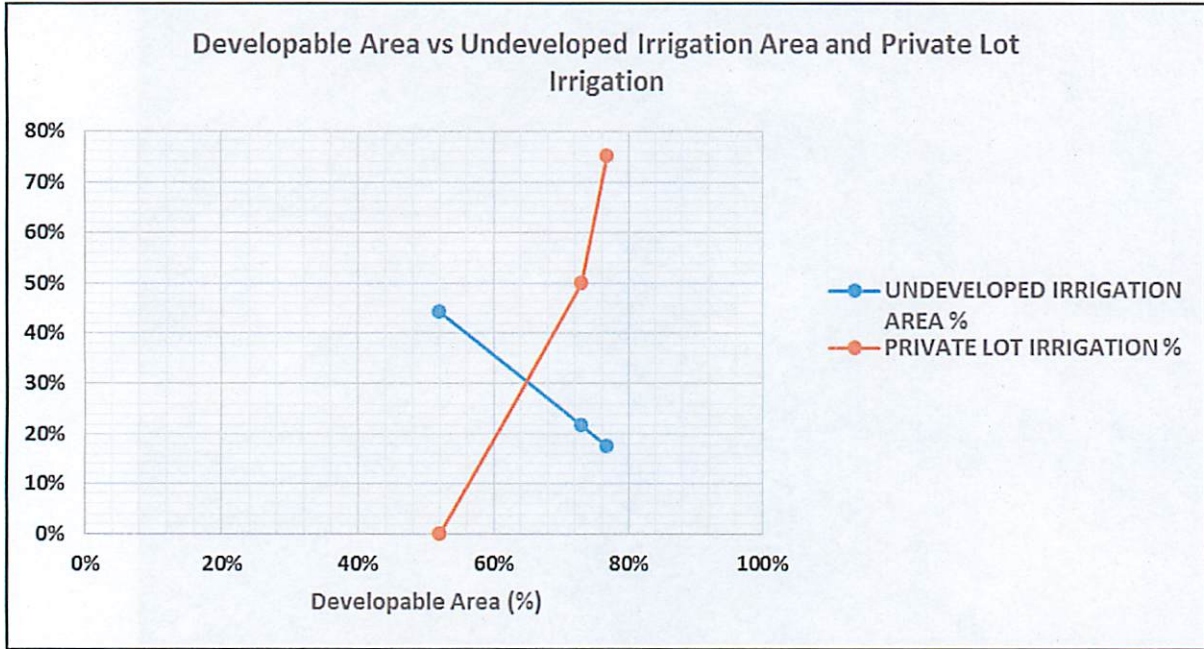


Figure 21 - Relationship between Developable Area and Average Percentage of Irrigation Zone

The average percentages of developable area for each zone and average percentage of irrigation zone area in each annexed zone is summarized in the following table.

Table 3 - Interim Developable Area & Irrigation Area Requirements

Scenario	Zone	Average Developable Area Excluding Ponds and 5% ER (ha)	Average Irrigation Zone Area (ha)	Average Pond Area Requirement (ha)	Net Developable Area (%)	Irrigation Zone Area (%)	Pond Area (%)
1	East	220	186	17	52%	44%	4%
1	South	271	229	21	52%	44%	4%
1	West	554	469	43	52%	44%	4%
2	East	309	93	21	73%	22%	5%
2	South	380	115	26	73%	22%	5%
2	West	778	235	53	73%	22%	5%
3	East	326	72	25	77%	17%	6%
3	South	401	89	31	77%	17%	6%
3	West	821	181	64	77%	17%	6%

Table 3 indicates that net developable area increases significantly if stormwater irrigation is applied to private lots.

Because the “zero release” stormwater systems are highly managed systems, the above estimates of interim net developable area are based on a **very conservative approach** in order to minimize the potential risk to the City of Chestermere. The high safety factors in the analytical approach were based on a number of conservative assumptions, including:

- The undeveloped irrigation area is within the catchment area of a source pond.
- The irrigation is only applied to green spaces (public and private, depending on the scenario analyzed) and undeveloped land set aside for this purpose. Parking lots, roads, etc. were not considered as irrigable areas. Rainwater harvesting is not included as an option.
- Because of potential existing development of the downstream areas, and uncertainties related to the existence of safe overland escape routes, it is assumed that the runoff above the 1:100 year will have to be contained within the stormwater facility.
- Additional freeboard was assumed to provide increased safety in case the irrigation system becomes temporarily inoperable.

It is important to note that although these conservative assumptions are appropriate for this planning level exercise, during more detailed design and at the SMDP stage, when more site-specific land use information is available, a higher percentage of developable area can be proposed to the City of Chestermere. Typically, the safety factors can be significantly reduced if it can be shown that there is a safe overland escape route, that there are no negative impacts and/or flooding of downstream areas in case the system failure, and that there are adequate precautions in place to ensure reliable operation of the irrigation system.

6.2 Interim Off-site Discharge - Outlet to South

As the City's request, a potential interim off-site discharge option with controlled release south to Shepard slough complex was investigated (Figure 22). This option requires that the City secure a viable outlet south of the Chestermere boundary to discharge stormwater. This concept is based on "true" predevelopment conditions, prior to the construction of the WID canal, when the study area was an integral part of the Shepard Slough contributing catchment. Under an "ultimate" scenario, stormwater discharging to this location could be conveyed to the Shepard Ditch via the conveyance system proposed under the SRDP. However, in the interim, it would be necessary to negotiate an allowable discharge (e.g. rate and/or volume) with AESRD and downstream landowners.

This discharge option was considered for the South catchment and a portion of the West catchment (south of 17th Ave). After careful assessment, a number of implementation constraints and potential downstream impacts were identified that make this option impractical and costly:

- There are no public Rights-of-Way to convey stormwater discharges to Shepard slough complex. The only possible discharge route that would work topographically crosses private property.
- Potential flood risks along the preferred interim discharge route will need to be assessed and mitigating measures proposed and implemented.
- Potential impacts to biodiversity, especially in the vicinity of the Shepard slough complex will need to be assessed and managed on an ongoing basis. The selection of discharge targets may require water balance analyses and biophysical impact assessments. An approval under the Water Act may be required for these additional discharges to the slough complex.
- This option requires significant investments for West catchment area (underdrain, various associated approvals). There are more cost-effective and easier to implement interim servicing options for this catchment, as described in the previous section.

Currently, only South catchment discharges pre-development flows to the slough complex. An interim off-site discharge to the slough complex for this catchment can be considered (and more likely to be approved by AESRD) if stormwater discharges can be restricted to pre-development rates and volumes, to avoid impacts. Since pre-development volumes are generally very low in this area (5 – 10 mm), this solution would likely be very expensive to implement.

6.3 Interim Off-season Release to WID

WID allows off-site release of stormwater runoff to their irrigation canals. This is presented in the CSMI report as an interim servicing option. Under this scenario, the entire stormwater runoff from the development area is stored in stormwater holding ponds and released after the irrigation season is completed (after September 30). The WID discharge water quality guidelines do not have to be met for off-season release.

This option could be a viable short-term servicing solution, especially for smaller development areas located close to the irrigation canals. However, there are several disadvantages:

- The stormwater holding ponds have to be sized to accommodate runoff during the entire irrigation season, resulting in larger facilities than for the ultimate development scenario.
- The water quality in WID system can still be negatively impacted by off-season release, especially if large areas are developed with this servicing scheme.
- There is a limited 8-10 week window that during which the ponds can discharge (after the irrigation season is over and before the winter conditions).

To ensure that this option is compatible with long-term servicing, the pond should be constructed to its ultimate size and then the area that can be serviced in the interim should be delineated. Combining off-site release to WID and irrigation with stormwater during spring and summer would result in a larger net developable area.

6.4 Servicing Considerations for Major Catchments

This section describes long-term stormwater planning considerations for major catchments within the study area. A brief overview of the challenges and potential solutions is provided for each of the catchment areas. These are not necessarily an exhaustive list, but represent reasonable conditions based on current situation, known development constraints, and level of community planning within the associated catchment area. With some exceptions, the stormwater infrastructure sizing and specific locations are not included, since that level of detailed stormwater information is more appropriate for future MDP and SMDP level reports. The information presented in Section 5 can be used to estimate approximate facilities sizing and land requirements.

6.4.1 West Catchments

The West catchment area, shown on Figure 23, encompasses approximately 1122 hectares. The City expects the majority of urban growth over the next 25 years to take place in this catchment, and both land use and stormwater planning has been underway for several years. The Waterbridge MASP has been approved in February 2014. Some initial stormwater servicing considerations were described in the report titled "Conceptual Stormwater and Environmental Considerations Leading Towards the Sustainable Management of Stormwater for the Waterbridge Area Structure Plan Area" (Westhoff Engineering Resources, Inc., 2012). A conceptual stormwater management servicing plan was also included within the ASP document.

The West catchment has many valuable wetland complexes and environmentally sensitive areas. In particular, the City wished to preserve wetlands W1 and W2. Wetland W1 is a large wetland that usually has standing water. The wetland is an integral part of West Creek system and provides significant attenuation of West Creek flows as well as water quality treatment benefits. W2 is a wetland complex proposed to be enhanced and integrated with an Eco park concept.

The ASP describes the general wetland management approach and states:

“Wetland mitigation deals with how wetlands will be impacted by the urban development of the lands around them and the manner in which they can/will be integrated into the stormwater drainage system. This integrative approach will emphasize the conservation of natural wetlands, while recognizing that engineering solutions and reconstructive measures are integral to achieving the long term sustainability and function of a wetland. Moreover, a variety of options can be introduced depending upon the situation to protect and enhance wetlands. Compensation, by the developer, shall be provided when appropriate, consistent with the Alberta and City of Chestermere Wetland Policies. The means to achieve this integration is through a Wetland Mitigation Plan. This plan will address the manner in which wetlands will be integrated into the stormwater drainage system, the method of enhancement and restoration of wetlands and the approach to wetland compensation. The Wetland Mitigation Plan will be provided at the Outline Plan stage.”

The West catchment has significant stormwater management constraints. Large West Creek flows enter the catchment at the north end and need to be conveyed and managed through the site in both interim and ultimate servicing scenarios. West Creek system and its importance to the City of Chestermere is described in Section 2.2. Additionally, the WID restrictions to post-development flows are particularly relevant to West catchment and West Creek flow management, since post-development stormwater flows generated within the catchment cannot be discharged in Chestermere Lake, West Creek Basin or WID system unless treated to WID requirements. The SRDP solution has a number of technical constraints (Section 3.1) and also introduces uncertain financial and infrastructure timing issues. The CSMI option also has governance, financial and infrastructure timing considerations. Until regional issues are resolved and the infrastructure is constructed and operational, the interim servicing concepts should be implemented.

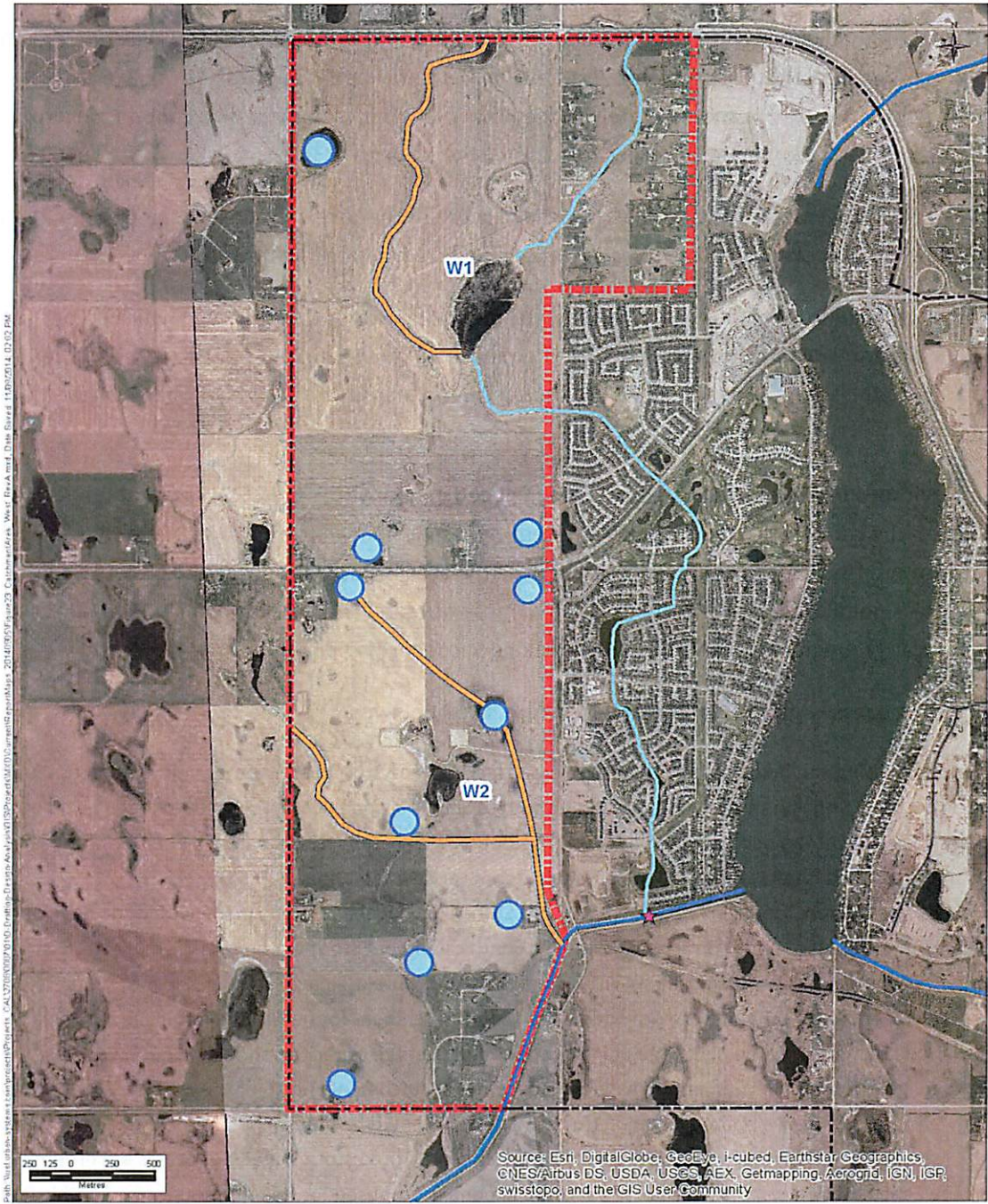
The following are stormwater servicing considerations for West Catchment. The proposed ultimate servicing plan, shown on Figure 23, is based on the information provided in the Waterbridge ASP.

- The interim servicing should rely on a “zero release” scenario as described in Section 6.1. Additionally, areas closer to WH Canal should consider off-season release (Section 6.3), subject to approvals from WID.
- Post-development flows cannot be discharged to the West Creek, Chestermere Lake or WH Canal. This applies to both interim and ultimate servicing scenarios.
- Interim solutions need to be compatible with the ultimate servicing to allow for future connection. Interim systems should be designed so that both SRDP and CSMI options can be implemented in the future. Stormwater facilities should be designed for ultimate conditions even when a part of interim servicing.

- Both external inflows from area north of the City boundary and internally generated flows should be accommodated through the West catchment in an overland drainage system (naturalized drainage channels) as shown on Figure 23. The overland drainage system should be integrated with environmentally significant areas where possible.

The future SMDP reports should include the following aspects:

- Description of both interim and ultimate servicing options, and a retrofit plan to connect to the ultimate servicing
- Description of how the proposed servicing will be integrated with both SRDP and CSMI concepts
- Appropriate Rights-of-Way, PULs, and easements for conveyance of external and internal flows through an overland system
- A Wetland Management Plan



- Key**
- ★ Underdrain
 - Irrigation Canal
 - Existing Drainage
 - Naturalized Conveyance Channel
 - West Catchment
 - Proposed Ponds
 - Chestermere Boundary

West Catchment

Figure
23

Figure 23 - West Catchment

6.4.2 South Catchments

South catchment includes all areas within the City boundary located south of Chestermere Lake and irrigation canals. The total catchment area is 549 hectares. Pre-development drainage is by natural drainage paths to Shepard slough complex (Figure 22) and ultimately to the Bow River. This catchment also contains several important wetlands. In particular, the City wishes to preserve the wetland W3.

It should be noted that area north of the railroad tracks and south of the Lake is actually located within the 2004 City boundary and as such, stormwater from this parcel can be discharged to Chestermere Lake.

There is one approved planning document within this catchment, Edgewater Crossing ASP, which comprises approximately 188 hectares of land located at the southern edge of Chestermere Lake. The ASP is bordered by Township Road 240 to the south, Range Road 282 to the east, WH Canal to the west, and Chestermere Lake to the northwest.

The long-term servicing considerations for the area are included in both SRDP and CSMI regional servicing concepts. Although the catchment is south of WID system, it was included in the CSMI assessment at the request of Chestermere Utilities Incorporated (CUI) because the area is slated for moderate growth and the SRDP infrastructure is not likely to be constructed for a number of years. The CSMI option involves pumping stormwater northward to regional CSMI infrastructure along Secondary A Canal.

Stormwater servicing considerations for this catchment are listed below:

- The interim servicing should be based on “zero release” facilities and stormwater reuse for irrigation, as described in Section 6.1. Additionally, an option to discharge south to Shepard slough complex, as described in Section 6.2, could be considered at the developers’ discretion. This option would, however, result in higher costs and lengthy approval process, and is not necessarily the optimal interim servicing solution.
- In the absence of regional servicing decision (SRDP or CSMI), allowances should be made within the development for the implementation of either options. Specifically, South catchment stormwater infrastructure (trunks) should be oversized for catchment areas north of WID system that contribute drainage to future SRDP system. Alternatively, Rights-of-Way should be provided within South catchment for naturalized drainage channels recommended in the SRDP. The discharge point locations and oversize capacities should be determined at the SMDP stage, and should reflect approved servicing concepts for catchments north of the WID system. A location and allowance for the future pumping station (for CSMI option) should be determined at the SMDP stage as well.
- Figure 24 shows the internal servicing concept for the catchment. Three stormwater wet ponds are proposed to service the Edgewater Crossing ASR area. One additional pond is proposed for the area south of Township Road 240. The optimal location for the pump station (for CSMI option) is shown as well. This internal servicing concept is compatible with both regional servicing plans and provides some additional flexibility to the City.
- Existing depressions and lower class wetlands can be used for stormwater pond siting (subject to AESRD approval and compensation).

- Wetlands that are to be preserved should be identified in the ASP. The corresponding SMDP report should include the wetland water balance assessment as outlined in Section 5.3. The pre-development and post-development wetland hydroperiods should match. A Wetland management Plan should be prepared in conjunction with the SMDP report.

The following are considerations for the SMDP being prepared in support of Edgewater crossing ASP:

- The SMDP should provide sufficient level of design detail for the entire ASP area. The proposed infrastructure must be sized based on topography and not just land ownership boundaries. This should eliminate various isolated “orphan parcels” without access to storm servicing.
- The SMDP should show that interim servicing options are compatible with both regional drainage plans.
- The Plan should also describe how the pipe oversize will be managed, or where the naturalized drainage channels would be located.

6.4.3 East Catchments

East catchment is a 445 hectares area north of Secondary A Canal, east of 2004 City limits and south of Hwy 1, as shown on Figure 25. The ownership is fragmented with large county residential developments, especially in the north of the area. The stormwater runoff flows mostly south to A Canal. There are several significant wetland areas; the City wishes to preserve wetland W4 which is a Class V wetland of exceptional environmental value.

There are no approved planning documents for this area. The City is currently developing an ASP for the north part of the catchment (East Acreages ASP).

Stormwater servicing considerations for this catchment are listed below:

- The interim servicing should be based on “zero release” facilities and stormwater reuse for irrigation, as described in Section 6.1. Because of the fragmented ownership, the planning for the entire catchment must be sufficiently advanced and ultimate pond locations and sizing must be determined before any interim servicing scenarios are approved. This will ensure that interim servicing can be easily transitioned to permanent.
- The areas with fragmented ownership and existing development are more suited to a combination of distributed stormwater facilities and large-scale LID implementation than larger wet ponds, although every effort should be made to follow the minimum pond size guidelines. General pond sizing guidelines are presented in Section 5.6.
- Existing depressions and lower class wetlands can be used for stormwater management purposes (subject to AESRD approval and compensation).
- Wetlands that are to be preserved should be identified in the ASP. The corresponding SMDP report should include the wetland water balance assessment as outlined in Section 5.3. The pre-development and post-development wetland hydroperiods should match. A Wetland management Plan should be prepared in conjunction with the SMDP report.

A stormwater trunk conveying flows south will be required regardless of which regional drainage option will be implemented for long-term servicing. The trunk location and discharge points should be determined at the SMDP stage. The sizing is to be based on 0.8 l/s/ha release rate. Depending on which option is selected for ultimate servicing of Bayfield.

6.4.4 Bayfield Industrial

This catchment, shown on Figure 25, encompasses 405 hectares north of Hwy 1. The area has an approved ASP and is slated for primarily commercial and industrial development. The area developer has acquired a land parcel in Rocky View County, east of Bayfield, to be utilized for a stormwater wet pond and constructed wetland for servicing of subcatchment S1. The stormwater management concept for the site has been approved, and is presented in the Mountain View Park Stormwater Master Drainage Plan report (Stantec, 2009). The concept incorporates the following features:

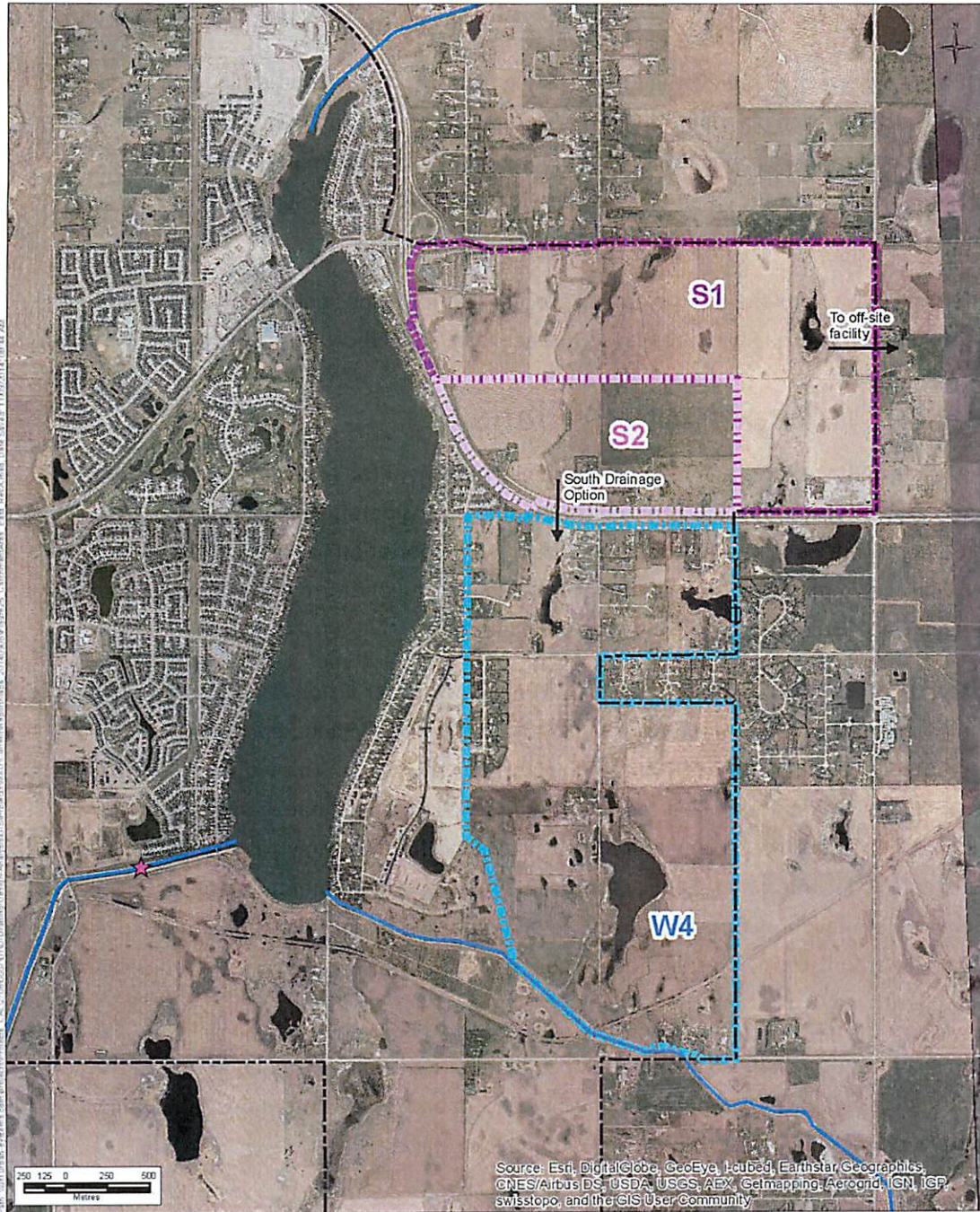
- The wet pond, located east of Bayfield area in Rocky View County, will receive all stormwater runoff from Bayfield subcatchment S1. The runoff will be stored and reused for irrigation of open space areas within Bayfield. The facility is based on a “zero release” concept.

- The runoff in excess of pond capacity will spill to the adjacent constructed wetland and disposed through infiltration and evapotranspiration. The wetland has adequate capacity to accommodate drainage from additional 64 hectares of industrial development within Rocky View County.
- Perimeter ditches will be constructed to prevent off-site flows from reaching the wet pond/wetland system and overwhelm the facilities.
- An extensive LID system will be incorporated within the site to provide source control of stormwater and reduce the volume of runoff reaching the wet pond and wetland.

While Bayfield stormwater concept provides a practical servicing strategy, there are several issues that should be addressed in future development applications:

- The stormwater application area appears undersized. Typically, if irrigation is the only means of stormwater disposal, the irrigable area is almost equal to the development area, even with large scale LID application. The Water Balance Spreadsheet should be used in continuous simulation analysis of future development phases.
- Both minor and major system flows should be conveyed to off-site stormwater facilities. The stormwater infrastructure in the East catchment will not be sized to accept overland flows from Bayfield area.
- The City cannot be responsible for operation and maintenance of off-site facilities located in Rocky View County. Development agreements should specify responsibilities for monitoring, operation and maintenance.
- An overland escape route must be delineated and agreements must be secured from impacted landowners in case the facility overflows.
- It is recommended that future stormwater plans in Rocky View County include an allowance for permanent connection from the facility to the future stormwater system, when one becomes available. This would reduce risks associated with permanent “zero release” systems.

The Mountain View Stormwater Plan also includes a servicing concept for subcatchment S2, based on the same general principle – a future “zero release” facility located within S2, and irrigation of open space as the only means of stormwater disposal. While this is now an approved stormwater concept, the “zero release” systems should only be considered as an interim option since they require a lot of irrigable area and thereby reduce developable land yield. For the ultimate servicing of subcatchment S2, the City should consider release south to East catchment (through East Acreages ASP area) at 0.8 l/s/ha release rate. If this option is adopted, the stormwater trunk through East catchment (and potentially South catchment, if SRDP is the preferred long-term servicing option) will need to be oversized to accept these flows.



East Catchment

Figure
25

Figure 25 - East Catchment

7.0 PLANNING PROCESS IMPROVEMENTS

One of the MDP objectives was to review the City's existing planning process and provide direction for stormwater expectations at each planning stage. This is especially important with greater implementation of LID infrastructure in addition to more conventional stormwater systems. Developing a clear understanding of stormwater requirements at various planning levels provides guidance to City staff as well as area developers and helps minimize the risks of poor stormwater planning.

There are four main levels within the City's planning process that have specific stormwater requirements – Master Area Structure Plans, Area Structure Plans, Outline Plans, and Subdivision/Development Permit.

7.1 Master Area Structure Plans

A Master Area Structure Plan serves as a high level planning document for large development areas (generally in excess of 260 hectares). It will highlight significant development considerations and establish policy, specific land use mixes and development densities, open space concepts, transportation network, stormwater management and utility servicing, sustainable development initiatives, and phasing of future Area Structure Plans. These decisions collectively determine the community form and identity.

The stormwater requirements for an MASP level would be a Stormwater Vision Report. To align with the Municipal Development Plan requirements for a MASP, the Stormwater Vision Report should highlight significant development considerations relevant to the stormwater system. This would include high level servicing aspects, such as regional servicing considerations, description and management of flows outside of City boundary, flow direction, and large stormwater infrastructure locations, if known at this planning stage. The Vision report should also include general policy statements related to implementation of LID, preservation of wetlands and environmentally significant features, use of naturalized drainage channels in place of conventional pipe networks, alignment of stormwater and open space concepts, and other aspects and sustainable water resource management.

The stormwater vision report can be a stand-alone document, or it could be included as part of the MASP. The objective is to provide a high level stormwater servicing concept and policy statements that would guide the more detailed stormwater planning at the ASP and Outline Plan stages.

7.2 Area Structure Plans

An Area Structure Plan is the next level of detail to the MASP. It includes detailed mix of land uses, park space plans, refined densities and housing types, population projections, sustainable development initiatives, more detailed stormwater and utility servicing design, and phasing for future outline plans.

The stormwater requirement for this level would be a Master Drainage Plan (MDP) report. The drainage area for an MDP should not be based on jurisdictional or property boundaries, as this may not provide the best servicing concept for the area. The report must satisfy constraints imposed by topography, land uses, and land ownership.

The MDP should include:

- Delineation of catchment boundaries beyond the ASP boundaries and quantification of off-site inflows that need to be accommodated through the ASP area
- Description of how off-site inflows would be managed through the ASP area
- Receiving water body and/or outfalls
- Quantification of off-site flow releases with a letter of permission from downstream landowners if the flows cross private property
- Proposed general servicing concept, including preliminary location and sizing of stormwater infrastructure for each servicing option, with discharge locations
- Relevant correspondence and approvals from regulators and project stakeholders pertaining to infrastructure location
- Types, locations and approximate land requirements for any LID practices, effectiveness for volume reduction or treatment, and if LID practices are on private or public property
- Water quality enhancements and effectiveness of proposed stormwater concept to meet water quality requirements
- If wetlands were identified in the environmental assessments, identification of wetlands that will be preserved or enhanced and description how this will be achieved
- Description of interim servicing options and development staging

The MDP should also identify environmental studies and reports (Biophysical Impact Assessment, Biophysical Inventory, Hydrogeological and Geotechnical reports) appropriate to the MASP area and discuss any items that have to be addressed prior to report approval.

7.3 Outline Plan

The Outline Plan provides information necessary to support a Land Use Redesignation application and may include detailed site design, road networks and servicing plans. To align with the Municipal Development Plan requirements for an Outline Plan, at the Outline Plan stage a Staged Master Drainage Plan is required.

The SMDP should include:

- Overall site description and location with respect to adjacent MDP or SMDP reports
- All overland flows crossing boundary limits (inflows as well as outflows) and their locations with reference to related previous reports
- Permitted release rate for storm trunks, discharge points with capacities, approximate sizes and alignments
- Location, size, volume and land requirements for stormwater ponds
- Type, location and land requirements for LID practices, their estimated effectiveness for meeting stormwater objectives, and assumptions made (i.e. I/P ratio, depth of topsoil)

- Layout and design details (including cross-sections) of any Low Impact Development methods (i.e. bioswales, rain gardens, irrigated areas, porous pavement)
- If stormwater reuse schemes are proposed, an Irrigation Master Plan should be submitted that specifies typical plant species and irrigation water demand, proposed alignment of stormwater reuse distribution network, and preliminary information on intake, pump system, and treatment
- If there are multiple landowners within the Plan area, enclosed statement of agreement with affected owners for location of stormwater facilities (unless this was secured at the MDP stage)
- If wetlands are to be fully preserved, identify how they will be impacted by development and describe mitigation measures
- If wetlands are to be conserved or enhanced, describe how they are to be included into the post-development flow regime. Include inflow rates, frequency of inundation, vegetation and habitat management
- A Wetland Management Plan (template provided in Appendix A)
- Water quality enhancements and their effectiveness to meet regulatory requirements
- Preliminary designs of major ponds and LID/BMPs

7.4 Subdivision/Development Permit

The subdivision application is the last step in creating a new community or industrial/commercial area. The stormwater requirements are at the plan level, and provide construction details.

The stormwater requirements include a detailed Stormwater Management Report (SMR), and for each subdivision phase, and a Pond Report if the development includes a pond. The information is to be presented with technical details in construction drawing packages. This may include major and minor system design and pond design elements such as inlet and outlet control structure, landscape design, etc.

The SMR should include:

- Reference to relevant MDP and SMDP reports, and supplemental information that rationalizes any changes
- Infrastructure oversize requirements.
- Clearly labeled and quantified overland flows and/or minor system flows that cross phase boundary limits, and downstream impact assessment if the flows are increased
- Criteria for sizing of minor system (UARR) and minor system sizing table
- All stormwater treatment facilities and treatment LIDs within the phase, or reference to other water quality enhancement provisions.
- Design details and sizing calculations for any LID practices within the development phase.
- Description of computer model, methodology, design storm parameters, catchment parameters, catchbasin/invert curves, manhole losses, and/or storage curves.
- Overland flows, velocities and depths for all critical segments within phase boundaries, and overland escape routes
- Trap low location, depth, spill information; and ICDs and catchbasin information
- Surchage (HGL) analysis on a site-specific basis for areas impacted by the High Water Level (HWL) from stormwater ponds or other conditions. Tabulate HGL results.
- LID design details and cross-sections
- Irrigation system design details, if stormwater is used for irrigation.

7.5 Submission Checklists

Relevant submission checklists are in the Appendix B. They are based on the City of Calgary checklists, but have been revised to include information specific to the City of Chestermere planning process and stormwater requirements.

In addition, the City of Calgary has recently released checklists for LIDs approved for use in Calgary. These checklists provide very detailed LID design requirements based on new City of Calgary LID Technical Guidelines; and should be used by City approvals staff and Chestermere Utilities Incorporated (CUI) to facilitate review of LID infrastructure designs.

8.0 RECOMMENDATIONS

8.1 General

The Integrated Stormwater Master Plan for Chestermere presents a stormwater management approach that includes a combination of conventional stormwater management facilities and LID practices to meet regional stormwater targets as well as environmental and sustainability objectives.

Stormwater rate target of 0.8 l/s/ha and volume target of 40mm are recommended for implementation within the study area. This is consistent with regional planning studies and watershed protection initiatives.

Preliminary analytical assessment has established that recommended stormwater targets can be achieved with a combination of stormwater reuse for irrigation, varying degrees of impervious area disconnection and widespread implementation of absorbent landscaping and other LID measures. Of note, any stormwater reuse schemes must adhere to AESRD's Interim Policy on Stormwater Reuse (Appendix D).

There are two potential regional servicing solutions for the study area – the Shepard Regional Drainage Plan and the CSMI servicing alternative. The City Council will not choose the preferred regional option until further governance and financing studies are completed. Both options provide an implementable solution, however both are expensive and have infrastructure timing limitations. Interim servicing will be required for all catchment areas to move the development forward. Interim servicing must be compatible with ultimate servicing options to allow for easy connection once ultimate services become available.

The servicing review for major catchments provided in Section 6.4 describes both interim and ultimate stormwater planning considerations, including an overview of the challenges and potential solutions. The presented concepts, although high level, ensure that servicing is compatible with both regional options.

Discharge to WID during irrigation season is not recommended for either interim or ultimate servicing of the study area. Off-season release to irrigation canals can be considered as described in Section 6.3, and will be subject to WID approval.

West Creek flows need to be managed through the study area for both interim and ultimate conditions. This is described in Sections 2.2, 3.1 and 6.4.1. If CSMI option is adopted for implementation, adequate baseflows must be released to West Creek north of the City limits, to maintain the naturalized drainage system through the existing developments and provide source water for wetland W1.

8.2 Specific System Planning Considerations

8.2.1 Stormwater Facility Sizing

The following recommendations are based on the modeling assessment presented in Section 5.6:

- Optimal contributing catchment area should be in the 65-130 hectares range;
- 30-40% directly connected percentages should be included in land use and design decisions;
- Approximately 3-7% (5% average) of the developable area will be required for stormwater management facilities for the ultimate design; this will increase to 10% for interim servicing options; and
- Approximately 50-90% of the active storage will be utilized during the 1:100 year event.

8.2.2 LID Implementation

Implementation of source control LID practices has a number of important benefits for meeting sustainable stormwater management objectives, and it is also supported by City's planning policy. The restrictive stormwater targets recommended for the City of Chestermere can only be achieved with LID implementation, including at a minimum:

- Stormwater reuse for irrigation of all green spaces within the community
- Absorbent landscaping of 400mm minimum depth for public areas
- Hard surface disconnection

Other LID practices can be considered for implementation, subject to City's approval. The LID strategy presented in Section 4 provides some further guidance for LID implementation. The City should establish minimum LID requirements for all new subdivisions and set a target date for implementation.

8.2.3 Wetlands Management

The study area is a significant wetlands region. Wetlands preservation and management should be a part of a SMDP report, as described in Section 5.3. A Wetlands Management Plan template is included in Appendix A.

8.2.4 Water Quality Considerations

Stormwater wet ponds and oil/grit separators are adequate to meet current water quality enhancement requirements with respect to TSS. LID implementation and stormwater volume control will further reduce pollutant discharges. In addition, The City of Chestermere may wish to consider bylaw changes and educational programs to limit phosphorus loadings.

8.3 Financial Considerations

The City of Chestermere should continue to work with regional stakeholders on the governance and financing mechanisms for regional conveyance infrastructure. A stormwater development fee (as part of off-site levies) should be applied to all new developments to collect funds for regional infrastructure construction. Preliminary cost estimates for SRDP and CSMI options indicate higher costs for SRDP option, however this may change once the more detailed cost estimates become available.⁸

In addition, the City and/or CUI will need a sustainable funding source to operate and maintain extensive future stormwater systems in the study area (both interim and ultimate). Currently, revenue sources include taxation and a flat drainage fee charged to residents and businesses. An alternative would be a **variable stormwater charge** that can be set up to finance both capital and O&M programs. If the fee is set proportionate to the amount of generated runoff and pollutants, it can also act as an incentive for implementation of more sustainable stormwater management options.

⁸ It should be noted that CSMI provides a staged approach that can be funded as development proceeds

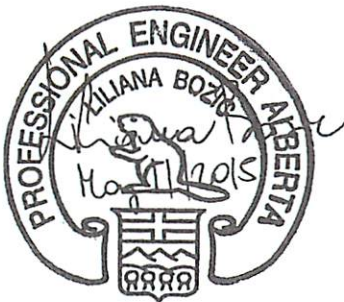
9.0 CORPORATE AUTHORIZATION

This report, titled Chestermere Integrated Stormwater Master Plan, was prepared for the City of Chestermere. The material in this report reflects the best judgement of Urban Systems Ltd. based on the information available at the time of preparation. Any use that the third party makes of this report, or reliance on or decisions made based on it, is the responsibility of the third party. Urban Systems Ltd. accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based on this report.

URBAN SYSTEMS LTD.

PERMIT TO PRACTICE URBAN SYSTEMS LTD.	
Signature	<i>[Handwritten Signature]</i>
Date	<i>May 13/15</i>
PERMIT NUMBER: P 3836	
The Association of Professional Engineers, Geologists and Geophysicists of Alberta	

Responsible Engineer:



Liliana Bozic, M.Sc., P.Eng.
Senior Water Resources Engineer



Integrated Business Group
2015

30. SUPPLEMENTAL AUTHORITY

The Board of Directors of the Company has authorized the Board of Directors to execute and deliver, and to cause the Company to execute and deliver, the Supplemental Authority in the form of the Supplemental Authority attached hereto, in order to effectuate the purposes of the Supplemental Authority. The Board of Directors has also authorized the Board of Directors to execute and deliver, and to cause the Company to execute and deliver, the Supplemental Authority in the form of the Supplemental Authority attached hereto, in order to effectuate the purposes of the Supplemental Authority.

BY THE BOARD OF DIRECTORS:

FOR THE BOARD OF DIRECTORS:

DATE: _____

BY THE BOARD OF DIRECTORS:



BY THE BOARD OF DIRECTORS:

DATE: _____

Appendix A

Sample Requirements for a Wetland Management Plan



URBAN SYSTEMS

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Urban Systems International, Inc.

The following is the information that is recommended for inclusion in the Wetland Management Plan, based on the City of Calgary requirements for reports of this nature. The Wetland Management Plan is intended to be used to fulfill the requirements for AESRD approval, for wetlands that are slated for full preservation (i.e., will not be used in any fashion as stormwater management facilities), and will receive treated stormwater as make-up water. The intent is not change the hydrologic regime, but rather to understand it so that it can be mimicked through pumping in the post-development situation. The following steps are recommended:

1. Define baseline hydrological and ecological conditions. To the extent possible, define characteristics of:
 - i. Hydrologic regime (i.e., depth, duration, frequency, seasonality of flooding). Development of annual hydrograph showing historical range of natural variability is recommended.
 - ii. Wetland classification according to Stewart and Kantrud, including mapping of emergent and open water zones, for a range of wet (e.g., 1929, 1932, 1955, 2005, 2013) and dry years (e.g., 1974, 2003). Analyze the historical natural variation in open water and emergent vegetation area within the wetland and describe the relationship between the hydrologic regime and the wetland zones.
NOTE: It is important to include consideration of the time of year of the imagery in this analysis. Ideally, aerial photographs are taken at the same time each year.
 - iii. Identify key biological indicators (e.g., rare species, bird nesting sites, shorebird habitat) to be assessed. These indicators will be used to identify the sensitivity of a particular wetland to changes in hydrology and water quality.
2. Estimate change in hydrologic regime. Assess effect of proposed development on the hydrologic regime in the wetland and compare to baseline.
3. Estimate effect of the predicted hydrologic change on wetland class and distribution of emergent and open water zones.
4. Estimate the effect of predicted hydrologic and land use changes to water quality.
5. Estimate the effects of the predicted hydrologic change, water quality changes, change to wetland class and emergent/open water distribution on key biological indicators. Where possible, the effects should be quantified; however, in the absence of quantitative data, qualitative descriptions may be used.
6. For any predicted negative effects, describe mitigation measures that can be implemented to reduce these effects.
7. A comparison of pre and post-development evaporative regimes. The use of historic air photos might be of assistance with this. If evaporation increases – AESRD will require a water diversion licence.

8. Provide hydrographs for wet years and dry years – on a yearly basis. One graph with varying hydrographs from wet and dry regimes will help to understand the upper and lower limits of what can be expected each year. This will enable the preparation of an operational regime to better understand when and how much will be pumped.

Appendix B

Submission Checklists

Master Drainage Plan Report



Use this checklist to ensure that all requirements for the Master Drainage Plan Report have been met.

Project: _____

Developer: _____

Consultant: _____

Contact Name: _____ Contact E-mail: _____

The undersigned agree and certify that all requirements on this checklist have been reviewed and properly identified as part of this submission. The undersigned understand that this checklist will be used as a tool for review of the Master Drainage Plan Report by the Town of Chestermere and confirm that a review of the Master Drainage Plan Report has been undertaken by a responsible professional member.

Permit to Practice Stamp or Number

Engineers Stamp

YES NO N/A

- | | | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Submit two (2) hard copies and one electronic copy the report that are signed and include the Professional Engineer's stamp and the company's permit number. |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Cover letter that highlights any unresolved issues or areas where guidelines or checklist items cannot be met. |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. Include plastic sleeve behind title page for future correspondence. |
| <input type="checkbox"/> | <input type="checkbox"/> | 4. State design objectives and reference to appropriate Area Structure Plan |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Identify Watershed, Regional Master Drainage Plans, or any other drainage plan or report appropriate to submission. |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. Include relevant correspondence and approvals from regulators and project stakeholders pertaining to off-site flow releases, if any. |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Explicitly state and quantify all off-site flow releases and provide a letter of permission from downstream landowners if the flows cross private property before entering regional drainage system. |
| <input type="checkbox"/> | <input type="checkbox"/> | 8. Identify Biophysical Impact Assessment, Biophysical Inventory, and Geotechnical reports appropriate to the submission and discuss any items that have to be addressed prior to report approval. |
| <input type="checkbox"/> | <input type="checkbox"/> | 9. Include a Study Area and Location figures. Include overall site description and show location, section number and major roadways. Include area in hectares. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> 10. Delineate the drainage boundaries beyond the plan limit if appropriate. |
| <input type="checkbox"/> | <input type="checkbox"/> | 11. Include a drawing showing catchment and subcatchment area boundaries on 11"x17" size paper. Boundaries should match those of existing reports, unless supplemental information is included to rationalize the changes. |
| <input type="checkbox"/> | <input type="checkbox"/> | 12. State the permitted release rate (L/s/ha) for minor system and storm ponds. State the volume control target. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> 13. Include the proposed land use concept and describe servicing options. For each option, identify the location of stormwater ponds. Include types and locations of any LID practices. Describe the assumptions made (irrigation |

rates, topsoil depths, soil parameters). Specify if LID practices are on private or public property.

- 14. Identify receiving water body and outfall(s).
- 15. If wetlands were identified in the BIA or other wetland assessment, identify wetlands that will be preserved or enhanced and describe how this will be achieved.
- 16. Include brief description of computer model, methodology, and input parameters.
- 17. Include schematic that matches the submitted drawings and computer model
- 18. Attach computer model input and output files including continuous and single event simulation for stormwater storage requirements, and continuous simulation for average annual volume requirements.
- 19. Address water quality issues/improvements.

Comments:

Staged Master Drainage Plan (SMDP) Checklist



Project: _____

Developer: _____

Consultant: _____

Contact Name: _____ Contact E-mail: _____

The undersigned agree and certify that all requirements on this checklist have been reviewed and properly identified as part of this submission. The undersigned understand that this checklist will be used as a tool for review of the Staged Master Drainage Plan (SMDP) by the Town of Chestermere and confirm that a review of the SMDP has been undertaken by a responsible professional member.

Permit to Practice Stamp or Number

Engineers Stamp

YES NO N/A

- | | | | |
|--------------------------|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | | 1. Submit two (2) hard copies and one electronic copy of the report that are signed and include the Professional Engineer's stamp and the company's permit number. |
| <input type="checkbox"/> | <input type="checkbox"/> | | 2. Cover letter that highlights any unresolved issues or areas where guidelines or checklist items cannot be met. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3. Include title and number of Outline Plan (if applicable). |
| <input type="checkbox"/> | <input type="checkbox"/> | | 4. Include plastic sleeve behind title page for future correspondence. |
| <input type="checkbox"/> | <input type="checkbox"/> | | 5. State design objectives |
| <input type="checkbox"/> | <input type="checkbox"/> | | 6. Identify Watershed, Stormwater Vision Reports, Master/Staged Master Drainage Plans, or any other drainage plans appropriate to the submission. |
| <input type="checkbox"/> | <input type="checkbox"/> | | 7. Identify Biophysical Impact Assessment, Biophysical Inventory, and Geotechnical reports appropriate to submission and discuss any items that have to be addressed prior to report approval. |
| <input type="checkbox"/> | <input type="checkbox"/> | | 8. Study Area and Location figures showing overall site description and location, section number and major roadways, and area in hectares. Include two figures: one showing the location of the area with respect to the Town of Chestermere, and the other showing the study area and surrounding Stormwater Vision Reports and Master/Staged Master Plans. |
| <input type="checkbox"/> | <input type="checkbox"/> | | 9. Include a drawing showing the catchment and subcatchment area boundaries. Preferably 11"x17" size paper. Boundaries should match those of existing reports, unless supplemental information is included to rationalize the changes. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 10. Explicitly state all overland flows crossing boundary limits and their locations with reference to related reports. |
| <input type="checkbox"/> | <input type="checkbox"/> | | 11. State the permitted release rate (L/s/ha) for minor system and storm ponds. |
| <input type="checkbox"/> | <input type="checkbox"/> | | 12. Include the proposed land use concept and identify the location and land requirements for stormwater ponds and any other Best Management Practices including Low Impact Development. |

YES NO N/A

13. If stormwater re-use is proposed, submit the Irrigation Master Plan that specifies typical plant species and irrigation demand.
14. For stormwater re-use schemes, include the proposed alignment of stormwater re-use distribution network. Specify how treatment requirements will be met.
15. All stormwater management facilities are entirely located within the applicants' property limits or offsite details are provided.
16. Explicitly state the developer controls the land that offsite facilities occupy or statement of agreement with affected stakeholders is enclosed.
17. Identify approximate trunk sizes and alignment, servicing routes and overland drainage routes.
18. Identify receiving water body and outfall.
19. If wetlands were identified in the BIA or other wetland assessment, identify how the existing pre-development drainage system will be impacted by the development. If wetlands are to be preserved or enhanced, describe how they are to be included into the post-development flow regime (ie. Flow rates, frequency, vegetation, and habitat management).
20. State the permitted average annual volume (mm) from the catchment and identify how that volume has been allocated within the study area.
21. Identify the parameters used to calculate the post-development average annual volume. (ie. evaporation rates, soil infiltration parameters, etc.)
22. Describe the Low Impact Development techniques used, and assumptions made. (ie. I/P ratio, depth of topsoil, etc)
23. Provide a figure showing the layout and design details (including cross-sections) of any Low Impact Development methods (ie bioswales, rain gardens, irrigated areas, porous pavement)
24. Include brief description of computer model, methodology, design storm parameters, and computer input parameters.
25. Include schematic that matches the submitted drawings and computer model

YES NO N/A

- | | | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 26. Attach computer model input and output files including continuous and single event simulation for stormwater storage requirements, and continuous simulation for average annual volume requirements. |
| <input type="checkbox"/> | <input type="checkbox"/> | 27. Address water quality issues/improvements. |

Comments:

Stormwater Management Report (SWMR) Checklist



Project: _____

Phase: _____

Developer: _____

Consultant: _____

Submission ID: _____

Contact Name: _____

Contact E-mail: _____

Development Agreement #: _____

Construction Drawing #: _____

The undersigned agree and certify that all requirements on this checklist have been reviewed and properly identified as part of this submission. The undersigned understand that this checklist will be used as a tool for review of the stormwater Management Report by the Town of Chestermere and confirm that a review of the Stormwater management Report (SWMR) has been undertaken by a responsible professional member

Permit to Practice Stamp or Number

Engineers Stamp

YES NO N/A

- | | | | |
|--------------------------|--------------------------|---|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Submit two (2) hard copies and one electronic copy of the report that are signed and include the Professional Engineer's stamp and the company's permit number. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Cover letter that highlights any unresolved issues or areas where guidelines or checklist items cannot be met. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. Include plastic sleeve behind title page of report for future correspondence. | |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 4. Include Outline Plan Number in the cover letter & on the title page of report |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Include the legal land location and the area in hectares in site description | |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. State design objectives | |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Identify Stormwater Vision Reports, Master and/or Staged Master Drainage Plans and/or previous SWMR appropriate to this submission. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 8. Ensure that study area and location sketches include overall site descriptions and show location, section number and major roadways, include contours or adjacent properties. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 9. Identify external areas including size, show on figure or map. Identify oversize requirements. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 10. Include criteria for sizing of minor system (UARR). | |
| <input type="checkbox"/> | <input type="checkbox"/> | 11. Ensure that catchment boundaries match those of existing reports, or ensure that supplemental information is included to rationalize any changes. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 12. Explicitly state all overland flows and/or minor system flows crossing boundary limits and their locations with references to preceding related reports. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 13. Ensure that any increase in overland and/or minor systems flows offsite will have minimal impact on affected downstream infrastructure. | |
| <input type="checkbox"/> | <input type="checkbox"/> | 14. Identify all stormwater treatment facilities and other LIDs within the development. If no water quality treatment is provided within the phase or development, identify downstream ponds or water quality enhancement provisions. | |

- 15. Provide design details and sizing calculations for any LID practices within the development area. Ensure that design parameters specified in the SMDP are met. Submit the appropriate City of Calgary LID checklists.
- 16. Include a brief description of computer model, methodology, design storm parameters, catchment parameters, catchbasin/invert curves, manhole losses, and/or storage curves.
- 17. Include a schematic that matches the submitted drawings and computer model.
- 18. Attach a computer model input and output files.
- 19. Include a figure/table delineating sub catchments and sizes of the subcatchments within the subdivision phase.
- 20. Show overland flows, velocities and depths for all critical segments within phase boundaries. Clearly label trap low spill information. Confirm that Alberta Environment depth-velocity guidelines have been addressed, and confirm that all drainage gutters fully contain the 1:100 year peak flow rate without overtopping/spillover.
- 21. Avoid overland flow discharge or spilling into natural areas such as ravines.
- 22. Ensure that the trap low storage table shows all trap lows in the phase and those on the boundary.
- 23. Include summary table of minor system flows for the 1 in 100 year event or other approved storm trunk design method to ensure that pipe design flows are not exceeded.
- 24. Include surcharge (HGL) analysis on a site-specific basis for areas impacted by the High Water Level (HWL) from stormwater ponds or other conditions. Tabulate HGL results.
- 25. Tabulate all assumed and/or computed overland and minor system flows entering and/or exiting phase or development.
- 26. Tabulate permissible discharge rates and on-site storage requirements for private sites within development.
- 27. Include quarter section lines and street names on a plans submitted. Use legible font sizes for pertinent information on the plans.

28. Submit a full size overland drainage drawing (identical to the drawing in the construction set that includes. ;

- Professional Engineer's stamp which has been signed and dated.
- Subdivision phase and construction boundary
- Q,v,d's for critical segments
- Trap low storage table
- Trap low location and outline at spill elevation
- ICD,s catch basin types, and interconnected catch basins
- Details/cross sections for spills as required
- Overland escape routes (arrow) must be clearly delineated
- Concrete drainage gutter locations and details for deep or non-standard gutter sections.
- Direction of drainage flow (arrow) including slopes, high point and low points
- Catchments ID's
- Original ground contour lines
- LID design details and cross-sections

29. Submit a full-size storm drainage drawing (identical to drawing in construction set) that includes;

- Professional Engineer's stamp which has been signed and dated
- Drainage area boundary lines
- Drainage area sizes and release rates
- Minor system table that follows a logical flow pattern
- ICD's catch basin types, and interconnected catch basins
- Pipe layout including pipe sizes and manhole numbers
- Overall drainage plans if applicable
- Pipe numbering system if applicable.
- Irrigation main alignments

Comments:

[Empty rectangular box for comments]

Subdivision Application Requirements Checklist:



Stormwater and Ponds

Project: _____

Phase: _____

Developer: _____

Consultant: _____

Contact Name: _____

Contact E-mail: _____

Use this checklist to ensure that all submission requirements for Preliminary or Final Construction Drawings have been met.

The undersigned agree and certify that all requirements on this checklist have been reviewed and properly identified as part of this submission. The undersigned understand that this checklist will be used as a tool for review of the stormwater Management Report by the Town of Chestermere and confirm that a review of the Stormwater Management Report (SWMR) has been undertaken by a responsible professional member

Permit to Practice Stamp or Number

Engineers Stamp

GENERAL REQUIREMENTS:

YES NO N/A

- | | | | |
|--------------------------|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1. Cover letter highlights any unresolved issues or areas where guidelines or checklist items cannot be met. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 2. The Master and Staged Master Drainage Plans appropriate for the submission are noted on the cover letter. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3. Boundary conditions conform to the approved Stormwater Vision, Master and Staged Master Drainage Plans. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 4. The subdivision design includes components such as LID, temporary servicing, stormwater reuse, lift stations, and flood fringe area. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 5. All storm infrastructure designs, including LID, are in conformance with the current governing Guidelines and Standard Specifications. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 6. Subdivision and lot layout conforms to the approved Tentative Plan. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 7. All revisions and/or adjustments to storm designs are indicated on the cover letter, all cover sheets, building grade plans, and block profiles. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 8. All offsite storm infrastructure required to service this development are installed and operating, or under construction. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 9. Relevant construction and development boundaries are indicated throughout the submission |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 10. Utility Rights-of-Way (RoWs) are indicated and meet the required standards. |

STORM COVER SHEETS

YES NO N/A

- | | | | |
|--------------------------|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1. The storm design conforms to the approved current Staged Master Drainage Plan (SMDP). |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 2. The storm design/layout conforms to the approved current outline plan. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3. All areas tributary to the storm sewer system (including off-site and upstream areas) are included in the storm sewer design tables. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 4. The storm sewer design tables are included with the cover sheets and have been checked and verified. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 5. The storm pipes are subject to potential surcharge conditions. If YES, an explanation of the effects and remedial solutions are provided in the cover letter. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 6. Design of the storm sewer system conforms to all City of Calgary guidelines and specifications. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 7. A storm sewer oversize table is included with the submission on the cover sheet and has been checked and verified. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 8. The Storm Water Management Report (SWMR) has been submitted. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 9. The SWMR has been approved. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 10. Design conforms to the approved SWMR. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 11. The pipe alignment and minimum horizontal separation required are standard. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 12. Relevant construction and development boundaries are indicated. |

OVERLAND DRAINAGE PLAN

YES NO N/A

- | | | | |
|--------------------------|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1. Information on the overland drainage cover sheet conforms to the approved SWMR. If the SWMR has been submitted but has not yet been approved, select N/A and explain in the comments section. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 2. Relevant construction and development boundaries are indicated on drawings. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3. All overland drainage infrastructure not defined in the Standard Specifications: Sewer Construction has been detailed on the plans. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 4. Lot drainage conforms to the approved SWMR. If the SWMR has been submitted but has not yet been approved, select N/A and explain in the comments section. |

PONDS

YES NO N/A

- | | | | |
|--------------------------|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1. The cover letter includes the following: |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | a. Highlights of any issues or areas of design that are not consistent with the approved Staged Master Drainage Plan. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | b. Development Agreement Number. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | c. Staged Master Drainage Plan, and/or Stormwater Management Report title(s) associated with the pond. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | d. Alberta Environment Approval Number. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | e. Legal land description and municipal address. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 2. The pond meets all guidelines outlined in The City of Calgary's Standard Specifications: Sewer Construction and Stormwater Management & Design Manual. If not, provide supplementary information. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3. Drawings show the following: |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | a. Site location within Chestermere, including nearby roadways. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | b. Quarter Section lines and street names. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | c. Legal boundaries. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | d. Construction boundary. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | e. Drainage boundaries. |

- f. Catchment areas and sizes.
- g. Pond Contours and grading showing pond bottom, Normal Water Level (NWL), Lower Water Level (LWL), Upper Water Level (UWL), High Water Level (HWL), and Free Board (FB) elevations where applicable.
- h. Side and bottom slopes.
- i. Sediment Forebay or alternative - design and volume.
- j. Monitoring equipment (location of panel and sensors, access to panel, elevations for alarms, and dead band).
- m. Land use for surrounding area.
- n. Stage, elevation, surface area, storage, discharge table.
- o. Piping information and block profiles for sections upstream of the pond inlet and downstream of the control structure.
- p. Structure details, including rim elevations, gratings, trash racks, coatings, weir wall and orifice details, bypass gate valves, access hatch, and rip rap erosion protection.
- q. Overland flow inlet details.
- r. Overland escape route and details.
- s. Sub-drain layout and details where applicable.
- t. Property line elevations surrounding the pond.

- 4. Pond liner details are provided.
- 5. Cross-sections are provided (complete with elevations of liner, NWL,LWL, UWL, HWL, FB, etc.).
- 6. Water re-use details (pump stations, pretreatment, controls, irrigation main line, intake, etc) are provided.
- 7. If this facility is a zero-release facility with water re-use, then the area inundated and level are shown if the water re-use system is non-operational.
- 8. Forebay berm details and cross sections are provided. The forebay berm has an impermeable core and is geotechnically stable under submerged conditions.
- 9. Proposed landscaping drawings and/or details are included (perimeter landscaping and vegetation, benching and side slope changes, wetland vegetation, irrigation, and utility easements).
- 10. Provisions have been made for access to the pond forebay for cleaning and maintenance purposes.

- 11. The maintenance vehicle access road to the outlet control structure and the top of the outlet control structure are both above the FB.
- 12. All stormwater management facilities are entirely located within the Developer's property limits.

Comments:

Appendix C

Model Input and Output Files

*Please see the included CD for this information

Model 1000 and 1000 Plus

Appendix D

AESRD Interim Policy on Stormwater Reuse



Urban Systems
Solutions for the Future

Alberta ESRD Interim Policy on Stormwater Reuse

The use of stormwater has become an emerging issue due to the constraints within the Bow River basin and the closure of the basin to accepting applications for new allocations of water as per the South Saskatchewan River Basin Water Management Plan and the Bow, Oldman and South Saskatchewan River Basin Water Allocation Order.

Alberta Environment has been working on guidance with respect to the use of stormwater (i.e. storm drainage). AENV recognizes the desire of communities and individuals to use storm drainage in certain circumstances as a source of water, but we must balance this with managing the resource for existing water right holders and the environment. Alberta Environment has developed the following position to strike a balance in order to allow individuals and communities to utilize storm drainage while ensuring existing water users and the environment are protected.

Use of storm drainage

Application of storm drainage to land within the catchment area of the storm drainage collection system, is not considered as a diversion and does not require a licence under the Water Act if:

- *the sole purpose is for continued drainage of the water for the management of the storm drainage collection system; and*
- *the volume of water applied to land within the catchment area does not exceed the evapotranspiration limits.*

The evapotranspiration limit is the volume of water that is applied annually to land within the catchment area that is less than or equal to the difference between the mean annual pre-development and projected mean annual post development volumes of water lost to evapotranspiration for the catchment area. "Catchment area" means the area of land within the immediate watershed boundary which directly contributes water to the storm drainage collection system. Estimates of pre-development evapotranspiration to be used for these calculations are listed on the map titled "Alberta Aerial Evapotranspiration" which is attached.

The application of storm drainage to land within the catchment area of the storm drainage collection system is an activity that may require an approval under the Water Act. The Storm Water Guidance Document, Alberta Environment, March, 2006 provides guidance as to when an approval is required, the guide is attached.

Use of storm drainage for purposes other than application to land within the catchment area constitutes a diversion, and a licence under the Water Act is required.

The application of storm drainage volumes in excess of the evapotranspiration volumes described is a diversion that requires a licence under the Water Act