



2023

Stormwater Management Strategy

Vision statement: The City of Calgary promotes healthy, resilient communities and waterbodies through proactive and collaborative stormwater management.





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Stormwater Strategy – A framework for action

Vision – The City of Calgary promotes healthy, resilient communities and waterbodies through proactive and collaborative stormwater management.

Supporting principles

- Stormwater risks are adaptively managed to prioritize public health and safety.
- Stormwater is valued as a sustainable resource and its management is integrated within city building to contribute to vibrant neighbourhoods.
- Stormwater management protects the environment and enhances the health of receiving waterbodies.
- Stormwater services and investments maximize social, economic and environmental values, at optimal lifecycle costs.
- Stormwater management is a shared responsibility.
- The City leads by example to promote innovation and foster collaboration.
- Stormwater management is resilient to a changing climate.
- The City will partner with industry and other interested parties to align growth, development, and stormwater management practices.

Targets

- Decrease the percentage of properties at risk within communities at risk of pluvial flooding.
- Reduce the average annual damages (AAD) from pluvial flooding.
- Increase the area (m²) of greened stormwater practices.
- Maintain Total Suspended Solids (TSS) and Total Phosphorous (TP) loadings to the Bow River.
- Establish stormwater rate, volume and contaminant loading targets to the Bow River and tributaries.
- Increase the city-wide average riparian health score.
- Increase the Triple Bottom Line (TBL) score of stormwater infrastructure.
- Decrease the number of stormwater customer concerns.
- Increase the number of Calgarians who agree that stormwater service in their community is of good value.

Cornerstones to achieve goals

Cornerstone 1: Making established communities more resilient.

Cornerstone 2: Proactively managing and maintaining our assets.

Cornerstone 3: Utilizing low impact development.

Cornerstone 4: Setting stormwater performance measures.

Goals and outcomes

Create safe and vibrant neighbourhoods, while striving for equitable service for all Calgarians.

1. The livability and vibrancy of our communities, the protection of public health and safety, and the protection of natural and urban ecosystems is being positively transformed and enhanced by innovative, practical and achievable stormwater solutions.
2. Stormwater management systems are resilient to climate change.
3. The level of service among communities has been made more equitable through investment in established areas.

Share responsibilities with Calgarians and with the surrounding regions for being good stewards of our communities and environment.

4. Stormwater is managed at the sub-watershed level to enhance and protect Calgary's waterbodies.
5. Calgarians share in the responsibility of stormwater management and in the protection of the environment, and they value stormwater management solutions in the community.
6. Calgarians are empowered with the information they need to understand their impacts and take action.
7. The City is collaborating with strategic partners to leverage ideas, knowledge and expertise for the design and delivery of innovative and effective stormwater management solutions.
8. Surface water quality regulatory standards are being met or exceeded.

Promote and attain healthy and resilient watersheds.

9. The City is leading by example, investing in grey, green and natural infrastructure to reduce the risk of flooding impacts and to enhance the health of our watersheds.

Provide infrastructure and services that maximize value for Calgarians.

10. The City's planning, operation and maintenance of grey, green and natural infrastructure is more efficient and effective.
11. The City's strengthened governance and business processes overcome competing city-building priorities and support the implementation of practical, affordable, adaptive and innovative solutions.
12. Decision-making is informed by evidence-based data, including social, economic and environmental benefits with performance indicators to measure progress.



1

Introduction

Calgary has grown to over 1.3 million people on a land area of more than 850 square kilometers. Our rapid growth has led to much of our natural prairie landscapes being replaced with more hard surfaces, contributing to higher volumes of stormwater runoff, which is resulting in urban flooding and polluting our rivers, creeks and wetlands. In the face of a changing climate, Calgary will experience shifting precipitation patterns, higher intensity storms, drier and longer summers, earlier melting of the snowpack, rain on snow, and increased severity of streambank erosion. Without a clear course of action, the health of our waterways will continue to decline, impacting our water quality, fish and wildlife habitat and community aesthetics. Our stormwater management system will increasingly become overwhelmed, putting people and property at risk.

As economic, social and environmental dynamics shift, our approach to Stormwater Management is rapidly evolving, requiring more collaboration and the involvement of interested parties with respect to municipal infrastructure, processes and jurisdiction. It calls for more and different levels of expertise and resources, as our drainage system has evolved from underground pipes to include the use of runoff for irrigation, stormwater wetlands, green and natural infrastructure. And while Calgary is fortunate to be located close to the headwaters in the Rockies with few upstream communities allowing us to enjoy clean water, we need to take collective responsibility for managing our stormwater and ensuring our rivers and streambanks are healthy for our downstream neighbours who depend on them.

∴ *Communities are seeking ways to better manage stormwater runoff, improve water quality and decrease pressure on the stormwater system. And, when we see stormwater as a resource, we can harness it for more resilient, vibrant communities amid a changing climate.*



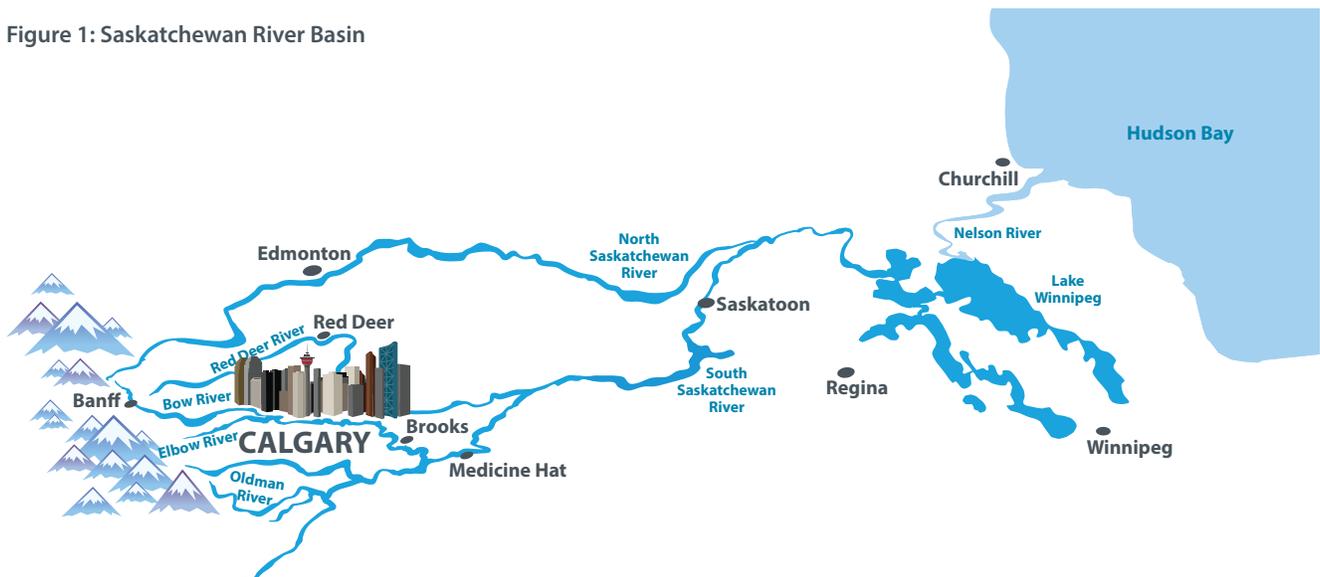
PHOTO CREDIT: THEOPORA VAN DUN

Bridgeland Bioretention Project

Like other cities around the world, we must recognize that when stormwater is seen as a resource, it can be harnessed to make communities more resilient, safe and vibrant. Effective stormwater management has the potential to minimize life cycle costs, enable sustainable development and improve aesthetics and quality of life

through open space features such as wetlands. And by working together and taking accountability to manage stormwater at the property, community, city and regional level, we can create the environment for more adaptive and innovative solutions.

Figure 1: Saskatchewan River Basin



Vision statement

The City of Calgary promotes healthy, resilient communities and waterbodies through proactive and collaborative stormwater management.

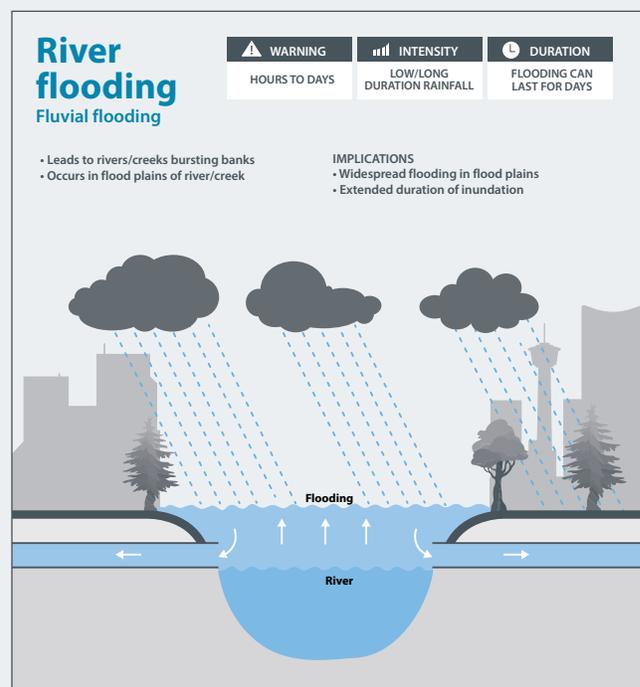
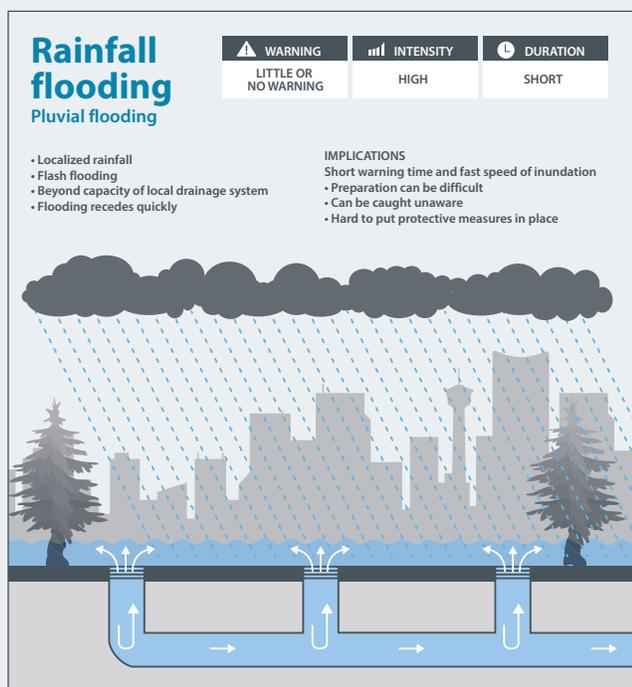
The City of Calgary's 2023 Stormwater Management Strategy sets out a clear direction to transform stormwater management. Flowing from existing mandates, the Strategy is aligned with overarching policies and direction, including Council's Strategic Direction of Economic, Social and Climate Resilience. It defines a vision, principles, goals and outcomes for valuing, sharing the responsibility for and proactively managing stormwater at the watershed and sub-watershed level.

The Strategy will enable us to support growth, reduce the risk of flooding, protect our watersheds and source water, and keep our infrastructure in good operating condition. It addresses priority areas for improvement, including reducing risks to vulnerable communities, investing in enhanced infrastructure, and improving accountability through shared responsibility and stronger collaboration. It outlines cornerstone programs, key to defining and interpreting targets and implementing the Strategy's short- and long-term actions.

Understanding pluvial flooding

A common misconception about flood is that you must be located near a body of water to be at risk. In fact, a pluvial flood, such as from a summer thunderstorm, creates a flood independent of a downstream river or creek. Pluvial flooding can happen in any location, even in areas with no waterways in the vicinity. A fluvial, or river flood, occurs when the water level in a river or creek rises and overflows onto the surrounding banks, shores and neighbouring land. The water level rise could be due to excessive rain or snowmelt.

The 2023 Stormwater Management Strategy is focused on reducing the risks and impacts related to pluvial flooding, while Calgary's Flood Resilience Plan outlines the actions needed to build Calgary's resilience specific to river flooding.





How will the Strategy be used?

Within The City, The 2023 Stormwater Management Strategy will inform investments and decision-making across the organization, provide a line of sight to targets and inform business plans that will advance innovation and enhance the value of the services to residents. The City will improve policies, processes, operations and services by strengthening our use of strategic risk and asset management plans, evidence-based knowledge, and research and data analysis tools.

Stormwater management is fundamentally connected to all land use activities, requiring Calgarians, businesses, development and building industries and our regional partners, as well as The City of Calgary, to share in the responsibility for meeting our goals. Anchored by collaboration and shared responsibility, the goals, principles and actions will help direct these collective efforts, helping to embed stormwater management as a fundamental component of city building. In addition,



Figure 2: How the strategy supports Calgarians, businesses and service delivery

they outline necessary actions for The City to improve its planning policies, tools and approval process and to resolve competing priorities and requirements. Overall, the goals and actions should provide an increased level of clarity and predictability to the development and building industries and watershed management organizations on The City's commitment to advancing innovative solutions and creating more equitable service between sub-watersheds and communities. This Strategy sets our direction for the next 20 years, demonstrating our commitment to proactive and collaborative stormwater management to promote healthy and resilient communities and waterbodies – work that delivers multiple benefits for Calgarians.

The work to develop the Strategy included internal and external engagement to set a long-term vision, set goals

and inform principles. It also builds on the foundation of existing plans, programs and mandates in place to ensure alignment and strengthen integration. Engagement with interested parties, internal and external, and the public will continue to shape and inform the Strategy's actions to ensure it is responsive to the unique challenges within Calgary's social, economic and environmental context.

The strategic actions are envisioned to be updated at regular intervals to capture learnings and reflect progress. The City will report to Calgarians, interested parties and Council through ongoing reporting and communications on the progress of implementing The 2023 Stormwater Management Strategy, ensuring they remain aligned and responsive to Council's Strategic Direction, which is guided by economic, social and resilience considerations.



Figure 3: Factors that influenced the development of the strategy



2

Shaping Calgary’s approach to stormwater management

The stormwater management challenges we face are complex and interrelated, demanding a forward looking and comprehensive strategy with a coordinated set of targets and actions that address priority areas for improvement.

To set a clear course towards a transformed approach to stormwater management, we must consider the key factors and emerging risks specific to a Calgary context that will impact our actions and influence our outcomes. This includes urbanization and densification, climate change, understanding our flood risks, funding constraints, regulatory changes, inequitable service, changing expectations, our past, present and future land-use planning practices and development, and the unique nature and needs of our sub-watersheds and watersheds.

Urbanization and densification

Calgary is expected to grow substantially in the coming decades, both in new communities on the outskirts of Calgary and within established communities through densification (e.g., infill development and redevelopment). The cumulative impact of urbanization not only increases the runoff volume by as much as 10 to 20 times, which results in flooding and stream

erosion if not mitigated, but also impacts the quality of stormwater. Stormwater contributes approximately ten times more total suspended solids (TSS) to the Bow River than the outflow from our wastewater treatment plants. In addition, stormwater discharges result in higher concentrations of bacteria, nutrients, pesticides and metals in our waterways.

While ponds and low impact development (LID) practices in communities built since 2000 have significantly reduced the amount of larger sediments and other contaminants reaching our waterways, smaller sediments and dissolved contaminants increasingly require attention. In addition, there are large areas of the city, specifically older established communities with little to no treatment.

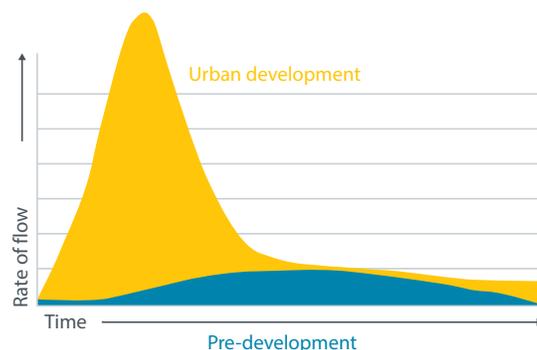


Figure 4: Changed hydrology due to urbanization

Climate change

As we continue to face a changing climate, Calgary will experience shifting precipitation patterns, higher intensity storms, hotter, drier, and longer summers, earlier melting of the mountain snowpack, more frequent rain on snow, and increased severity of river and creek bank erosion. Collectively this will result in the stormwater system being overwhelmed more often, and more pollutants reaching our waterways. Improved understanding of the impacts on the stormwater system, as well as adapting the design, construction, operation and maintenance of our stormwater infrastructure will help mitigate the impacts of a changing climate.

Flood risk

Historically, areas of Calgary with high stormwater flooding risk have been addressed reactively, responding through the Community Drainage Improvements (CDI) program or operational activities after the fact. Protecting the public and reducing damage to property from flooding (rain and snow melt) that impacts homes, businesses and communities requires an incremental and proactive approach coupled with adaptive risk management. With a changing climate, flexibility is paramount to position operations to the stormwater challenges of today and those of the future. Improved asset monitoring, inspection and replacement planning, and modernized maintenance procedures will help pinpoint and remedy potential infrastructure deficiencies before their failure impacts our communities.

The costs of pluvial flooding

Based on insurance industry data provided by the industry group CatIQ to the National Research Council of Canada, the average annual damages of pluvial flooding in Calgary may be in the order of \$52 million to \$78 million per year.

These damages are expected to increase significantly with climate change. When considering climate impacts, the insurance industry estimates suggest annual damages to increase in the order of four to five times current damage.

The impacts of pluvial flooding are far reaching across the city, stretching beyond the more confined areas subject to river flooding. While all communities can experience pluvial flooding, the risks are heightened in established communities which rely largely on a piped system, lack deliberate overland grading considerations in the design and use undersized pipes to manage stormwater.



Funding considerations

Currently, all single-family residential, multi-family residential and industrial, commercial, and institutional customers pay a flat monthly rate for stormwater management services. The rate provides a relatively consistent source of revenue to operate and maintain the existing stormwater system. There is opportunity to explore how all customers can be encouraged to adjust their behaviour to reduce impacts on the public stormwater system and the watershed.

Historically, The City has received levies from the development industry to fund upfront capital infrastructure projects that accommodate growth, in addition to developers funding on-site stormwater infrastructure. The dynamics of our economy influence the nature and timing of investments by both developers and The City. Through ongoing collaboration on offsite levies and other matters, The City will continue to work with the development industry to explore alternative funding opportunities and infrastructure improvements.

In addition, resourcing for operation and maintenance of our evolving stormwater management infrastructure should keep up with growth.

Regulatory changes

There are provincial and federal regulatory requirements that The City is mandated to meet for its drinking water, wastewater and stormwater management. The regulatory environment continues to evolve, resulting in the need to manage and design stormwater infrastructure to meet increasingly stringent standards and regulatory requirements. Also, there are times that gaps in current federal or provincial requirements need to be addressed when it is in the best interest of The City, its residents and business community. This requires flexibility in operational planning and has implications for future operational needs. The complexity of this service demands improved engagement with residents, customers and other interested parties.

Inequitable service

The level of service provided by Calgary's stormwater infrastructure varies across the city due to the era that communities were built, reflecting evolving design standards, building practices, data availability and expectations. Older communities rely largely on an undersized piped system, lacking deliberate overland grading considerations in the design. Over time, stormwater management approaches have evolved from storm drains and pipes to include the use of overland drainage systems, wet ponds, dry ponds, stormwater wetlands and more recently the use of Low Impact Development (LID) features. Focusing investments on older communities to enhance their level of service will help create a more equitable service for all Calgarians. This can be achieved through a combination of grey and natural infrastructure on private and public land, retrofitting existing infrastructure where feasible, and incentivizing property owners to manage stormwater on their properties. Key to addressing the varied needs throughout our city is ensuring we are choosing the right infrastructure for the right place at the right time, being careful to not take a one-size-fits-all approach to stormwater management.

Reducing vulnerabilities

The development industry and The City have made infrastructure investments to reduce the vulnerability of residents and businesses. These vulnerabilities include:

- Public safety risks and damage to buildings, personal property and public infrastructure.
- Interruption of the movement of emergency responders, goods and services, and commuters if roads and bridges are impassable.
- Pollution of waterbodies, erosion of river and creek banks and damage to fish and wildlife habitat.
- Contamination of drinking water supplies for Calgary and downstream communities.
- Interruption of the vibrant recreation and tourism sectors connected to healthy rivers.

While much work has been done, achieving our vision of healthy, resilient communities and waterbodies through proactive, collaborative stormwater management requires continued effort and focus.

Changing expectations

Historically, residents have expected basic services like draining away stormwater, providing safe drinking water and treating wastewater. However, resident expectations have increased to include minimizing the risk of flooding before it occurs, ponds and wetlands that resemble recreational freshwater lakes, enhanced operations of the system (e.g., addressing aesthetics, odours, trap low or local ponding and sidewalk icing) and addressing drainage issues between neighbours. Residents are also expecting to participate in urban planning and have a much greater understanding of infrastructure and resident responsibilities than

previous generations. Practically, this means that the nature and design of our stormwater infrastructure is evolving. In addition, current resourcing of staff to address stormwater infrastructure such as cleaning out storm drains and storm ponds, restoring riparian areas or addressing existing pluvial flooding concerns no longer meets resident expectations. Engaging more residents, managing expectations in an inclusive manner, being transparent on resourcing capabilities and bolstering the training, tools, techniques, and expertise of staff will improve prioritization and management of stormwater infrastructure moving forward.

Calgary's stormwater infrastructure

Like other cities across the country, Calgary's stormwater infrastructure addresses runoff from rainfall events in two ways:

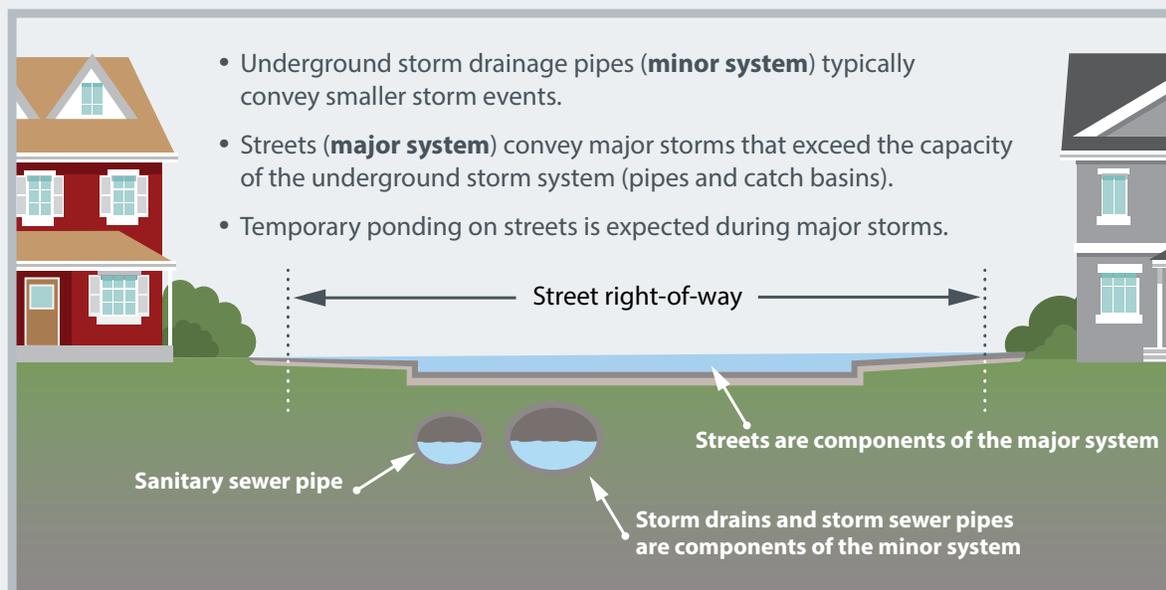
1. Via the piped storm sewer system which accommodates the runoff for day-to-day events.
2. Via an overland drainage system which accommodates runoff when it exceeds the capacity of the storm sewer system.

Together, they are typically designed to have a 1:100 year level of service (LOS) which means that the chance of flooding has a one in 100 or one per cent chance of occurring in any given year.

As part of the overland drainage system, runoff is either conveyed away or temporarily stored, draining at a controlled rate into the storm sewer system so that its

capacity is not exceeded. Temporary storage of runoff on the surface is a key feature of modern drainage design.

Significant differences exist in the overland drainage systems in communities built before and after 1988. In communities built before 1988 the overland drainage system was overlooked when these communities were first built and the specifications used for the design of the storm sewer system resulted in significantly smaller pipes than what is currently provided in new subdivisions. In new communities the runoff in excess of the capacity of the storm sewer system is conveyed away or stored in such a way that it doesn't impact people or flood buildings; however, in older communities it follows the route of least resistance, often ending up in buildings, resulting in significant damages.



Land-use planning practices and development

The City of Calgary has grown substantially since its initial Stormwater Strategy was developed in 2005, with Calgary’s population growing by more than 320,000 residents. The City now has over 4,500 kilometres of storm sewer, 60,000 storm drains and 350 ponds and stormwater wetlands to manage and operate.

Stormwater management is essential to land-use planning and development, including new development, infill development and redevelopment. It must balance Calgary’s urban development goals with managing the increased risks to Calgary’s source water and receiving body water quality, and with diminishing natural prairie landscapes, riparian areas, habitat, and biodiversity, while providing reliable, affordable drainage functions. Older communities, which are expected to grow in population as densification is encouraged, already face stormwater infrastructure deficiencies. Within these established communities, redeveloping parcels of land will need to reflect current stormwater expectations, in addition to public infrastructure investments for larger community-wide projects. Developing clear and concise standards, development requirements and approval processes will provide clarity, streamline decision-making, and support the implementation of stormwater practices. Consideration of a wide range of regulations, policies, plans, and strategies is required to ensure alignment and integration of the many layers of stormwater management planning.

Community outreach and education

Stormwater runoff is not constrained by property lines and has no discrete point of origin. It is impacted by the behaviours and activities of every individual and property owner, requiring the community to share in the responsibility of managing it. But sharing in the responsibility – and taking action – relies on the active participation of an engaged community.

Building an engaged community is dependent on increasing awareness among Calgarians about the causes and impacts of pluvial flooding in Calgary, the importance in investing in our stormwater system, the need for collaboration and innovation and how they can play an active role.

While much work has already been done to help Calgarians understand our stormwater system and the actions they can take, efforts must continue to ensure Calgarians are empowered with the knowledge and capacity to take an active role. Supporting conversations about stormwater management, prioritizing communication and education efforts, building capacity and fostering collaboration are key to inspiring lasting action.



Figure 5: Stormwater and land use planning



3

Transforming stormwater management

The Stormwater Strategy provides strategic direction and guidance for how we proactively and collaboratively manage stormwater for more healthy and resilient communities and waterbodies. Supporting principles help guide decision making while four interrelated goals and related outcomes define where we want to go and how we know when we get there. Finally, key targets allow us to measure our progress along the way. Together, these elements provide an integrated decision-making process that allows us to set a course of action that focuses on key areas for improvement.

Supporting principles

- Stormwater risks are adaptively managed to prioritize public health and safety.
- Stormwater is valued as a sustainable resource and its management is integrated within city building to contribute to vibrant neighbourhoods.
- Stormwater management protects the environment and enhances the health of receiving waterbodies.
- Stormwater services and investments maximize social, economic and environmental values, at optimal lifecycle costs.
- Stormwater management is a shared responsibility.
- The City leads by example to promote innovation and foster collaboration.
- Stormwater management is resilient to a changing climate.
- The City will partner with industry and other interested parties to align growth, development and stormwater management practices.

Goals and outcomes

Create safe and vibrant neighbourhoods, while striving for equitable service for all Calgarians.

1. The livability and vibrancy of our communities, the protection of public health and safety, and the protection of natural and urban ecosystems is being positively transformed and enhanced by innovative, practical and achievable stormwater solutions.
2. Stormwater management systems are resilient to climate change.
3. The level of service among communities has been made more equitable through investment in established areas.

Share responsibilities with Calgarians and with the surrounding regions for being good stewards of our communities and environment.

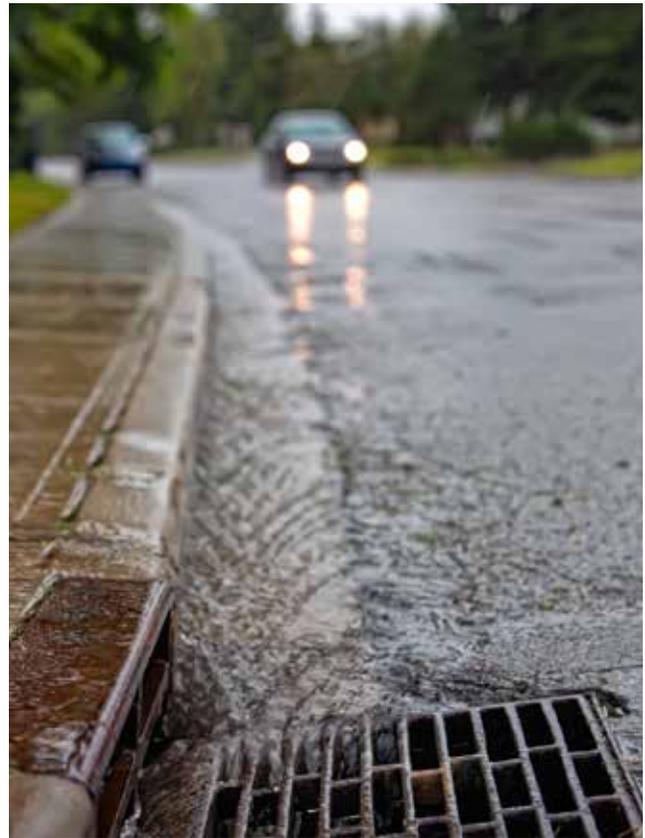
4. Stormwater is managed at the sub-watershed level to enhance and protect Calgary's waterbodies.
5. Calgarians share in the responsibility of stormwater management and in the protection of the environment, and they value stormwater management solutions in the community.
6. Calgarians are empowered with the information they need to understand their impacts and take action.
7. The City is collaborating with strategic partners to leverage ideas, knowledge and expertise for the design and delivery of innovative and effective stormwater management solutions.
8. Surface water quality regulatory standards are being met or exceeded.

Promote and attain healthy and resilient watersheds.

9. The City is leading by example, investing in grey, green and natural infrastructure to reduce the risk of flooding impacts and to enhance the health of our watersheds.

Provide infrastructure and services that maximize value for Calgarians.

10. The City's planning, operation and maintenance of grey, green and natural infrastructure is more efficient and effective.
11. The City's strengthened governance and business processes overcome competing city-building priorities and support the implementation of practical, affordable, adaptive and innovative solutions.
12. Decision-making is informed by evidence-based data, including social, economic, and environmental benefits with performance indicators to measure progress.



Measuring our progress

To measure progress towards attaining safe and vibrant neighbourhoods, shared responsibility, healthy and resilient watersheds, and maximized service value, the following nine targets have been established:

- Decrease the percentage of properties at risk within communities at risk of pluvial flooding.
- Reduce the average annual damages (AAD) from pluvial flooding.
- Increase the area (m²) of greened stormwater practices.
- Maintain Total Suspended Solids (TSS) and Total Phosphorous (TP) loadings to the Bow River.
- Establish stormwater rate, volume and contaminant loading targets to the Bow River and tributaries.
- Increase the city-wide average riparian health score.
- Increase the Triple Bottom Line (TBL) score of stormwater infrastructure.
- Decrease the number of stormwater customer concerns.
- Increase the number of Calgarians who agree that stormwater service in their community is of good value.

Sharpening our focus: The cornerstones

The aim of the Strategy is to guide the transformation of stormwater management to support resilient and vibrant communities and healthy waterways at optimal lifecycle costs. Advancing our resilience requires a holistic and integrated approach that begins with focusing on four key integrated cornerstones and corresponding key short term actions to help us meet the goals collaboratively developed within the strategy. These cornerstones align with Council's Strategic Direction 2023-2026 for resilience, guided in particular by economic, social and climate resilience.

Together, these cornerstones will help us advance innovation and enhance the value of services to Calgarians, and ensure our subsequent efforts remain focused. More detailed actions are outlined in the strategic actions table.

Cornerstone 1: Making established communities more resilient

The level of service (LOS) is not uniform across the city or between communities. A large portion of the city's older built form does not meet the current design standards used for new subdivision development and requires significant investment to provide an equitable LOS. The LOS of Calgary's stormwater infrastructure varies across the city reflecting the era that communities were built, as well as evolving design standards, building practices and expectations. With a limited ability to improve overland drainage, we must look for innovative solutions and work with property owners, communities, and The City to share the responsibility of managing stormwater.

While programs like the Community Drainage Infrastructure (CDI) program and operational activities have helped address areas with high stormwater flooding risk, investments in older communities continue to be required to enhance their LOS, especially in the face of climate change. In addition, redevelopment and infill development should occur in such a way that flooding risks for neighbouring parcels do not worsen. This cornerstone is focused on making established communities more resilient, allowing them to ultimately function with similar exposure as new subdivisions to damage or interruptions when a storm occurs. While achieving perfectly equitable service may be unrealistic, we must commit to addressing challenges to ensure we can provide reliable service to all Calgarians.

Supporting residents and businesses

- + Reduced stormwater flooding risks and reduced associated damages.
- + Reduced inequity and enhanced community vitality.
- + Infill development and redevelopment do not worsen impacts to neighbouring parcels of land or properties.
- + Improved knowledge of what actions residents can take to reduce their risks.
- + Reduced insurance rates when investments into infrastructure upgrades are accounted for by the insurance industry.



PHOTO CREDIT: THEODORA VAN DUIN

Key actions

Refine the CDI program to:

- Prioritize communities to address current infrastructure deficiencies, inequity and vitality considerations, integrity of the existing stormwater infrastructure, impacts on the receiving water bodies, and envisioned growth and transportation upgrades.
- Transition to a proactive approach addressing flooding concerns before they occur.
- Quantify the investment needed across the entire city to inform the cost of service.
- Maximize the Triple Bottom Line (TBL) score of stormwater investments.
- Increase climate resiliency.

Guide redevelopment and infill development in established areas to:

- Ensure flooding risks to neighbouring parcels of land do not worsen.
- Promote multi-purpose use of public space, reconciling programming and community vitality with stormwater functions.

Related outcomes and alignment to targets

Outcomes:

- The livability and vibrancy of our communities, the protection of public health and safety, and the protection of natural and urban ecosystems is being positively transformed and enhanced by innovative, practical, and achievable stormwater solutions.

- The level of service among communities has been made more equitable through investment in established areas.
- The City is leading by example, investing in grey, green and natural infrastructure to reduce the risk of flooding impacts and to enhance the health of our watersheds.
- The City is collaborating with strategic partners to leverage ideas, knowledge and expertise for the design and delivery of innovative and effective stormwater management solutions.
- Calgarians share in the responsibility of stormwater management and in the protection of the environment, and they value stormwater management solutions in the community.
- Calgarians are empowered with the information they need to understand their impacts and take action.

Targets:

- Decrease the percentage of properties at risk within communities at risk of pluvial flooding.
- Reduce the average annual damages (AAD) from pluvial flooding.
- Increase the area (m²) of greened stormwater practices.
- Increase the Triple Bottom Line (TBL) score of stormwater infrastructure.



Cornerstone 2: Proactively managing and maintaining our assets

Assets age with time and require timely maintenance and renewal to ensure Calgarians can depend on reliable and continued service. Increasing expectations from residents to provide higher levels of service combined with funding constraints and competing priorities can complicate how we manage infrastructure.

This cornerstone focuses efforts on asset management and maintenance, a strategic approach to proactively plan and maintain our infrastructure sustainably and adaptively. Within this Strategy, an Asset Management and Maintenance Plan will set the direction needed to meet our levels of service, ensuring we know how and where to prioritize resources, where additional investments are required to meet resident expectations and ultimately, transform stormwater management.

Key actions

Develop an asset management and maintenance plan to:

- Improve asset monitoring, inspection and replacement.
- Modernize maintenance procedures to address risks before problems escalate.
- Determine operational resource needs – people, equipment, tools and skills to operate the system and deliver reliable service.
- Highlight additional investments needed to meet expectations of higher levels of service.

Related outcomes and alignment to targets

Outcomes:

- The City's planning, operation and maintenance of grey, green and natural infrastructure is more efficient and effective.
- Calgarians are empowered with the information they need to understand their impacts and take action.
- Surface water quality regulatory standards are being met or exceeded.

Targets:

- Decrease the number of stormwater customer concerns.
- Increase the number of Calgarians who agree that stormwater service in their community is of good value.
- Decrease the percentage of properties at risk within communities at risk of pluvial flooding.

Supporting residents and businesses

- + Reduced risk of flooding and impacts to property.
- + Reliable service that meets increasing expectations.
- + Cost efficient and reliable service delivery.
- + Reduced impacts to the environment.



Cornerstone 3: Utilizing low impact development

Low impact development (LID), which utilizes natural infrastructure, including Green Stormwater Infrastructure (GSI) and natural systems, is key to achieving our goals of managing stormwater in highly urbanized areas where density is encouraged, and where opportunities for large-scale infrastructure, such as ponds, is limited or absent. In addition, residents are looking for the expansion of the quality and quantity of our open and green spaces, which are also key to protecting and restoring the health of our waterbodies. When we shift our view of stormwater as a nuisance to manage to one where stormwater – and the management of it – can add vibrancy to our communities, we can explore solutions that address multiple challenges while offering multiple benefits.

This cornerstone highlights LID as an important tool that can allow us to integrate stormwater management practices into existing features of our built environment, increase green areas, reduce stormwater runoff and riparian erosion, and reduce the volume of pollutants entering our waterbodies. We can promote innovation and manage stormwater in a way that is uniquely suited for Calgary and supports our urban forestry, biodiversity, and wildlife ecosystems, reduces urban heat island effects, and addresses the social benefits Calgarians are looking for in the open and connected spaces within their communities. The right GSI solutions can help advance our resilience, addressing flood risk and the equity between communities, while contributing to their vibrancy.

Key actions

Develop a LID Program to:

- Optimize and integrate GSI and natural systems implementation in the Calgary context on public and private land.
- Incorporate lifecycle and triple bottom line considerations in implementation of infrastructure.
- Promote implementation of GSI and natural infrastructure on private land, either as part of infill development and redevelopment, or as retrofitting of existing properties.
- Enhance education of Calgarians, industry and City staff.
- Leverage existing construction projects to refine performance, maximize effectiveness and resolve technical questions.
- Streamline the application and review process and timeliness to facilitate and promote innovation.
- Improve internal capacity to support GSI projects by enhancing internal knowledge on GSI design, application review, construction, inspections, maintenance, and monitoring.

Supporting residents and businesses

- + Maximize social benefits and community vibrancy.
- + Protect our watersheds.
- + Strengthen resiliency.
- + Increase connectivity of green, open and natural spaces.

Low Impact Development (LID): An approach to land development that uses various land planning, design and management practices and technologies to simultaneously conserve and protect natural resource systems and reduce infrastructure costs, including the mitigation of the impacts of increased runoff and associated stormwater pollution resulting from development as close to its source as possible.

Natural infrastructure (NI)

Natural systems

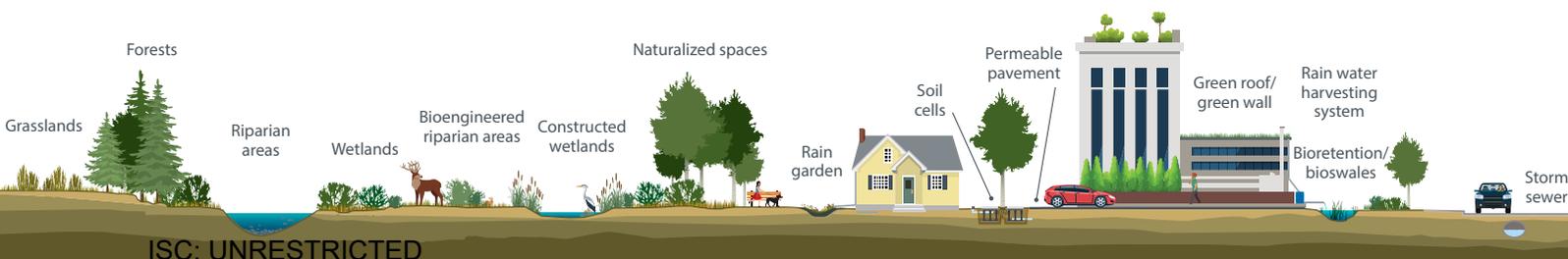
- Rivers
- Creeks
- Wetlands
- Riparian areas
- Grasslands
- Forests
- Protected areas

Green stormwater infrastructure (GSI)

- Resilient landscaping*
 - Street trees*
 - Rain gardens*
 - Green roofs/green walls*
 - Bioretention/bioswales*
 - Soil cells/Tree trenches*
- * Greened stormwater practices
- Rainwater harvesting systems
 - Bioengineered riparian areas
 - Constructed wetlands
 - Naturalized spaces
 - Naturalized stormwater ponds
 - Permeable pavement
 - Rain barrels
 - Stormwater capture ponds

Grey infrastructure

- Roads
- Traplows in parking lots
- Culverts
- Gutters
- Storm sewers
- Dry and wet ponds
- Oil/grit separators



Related outcomes and alignment to targets

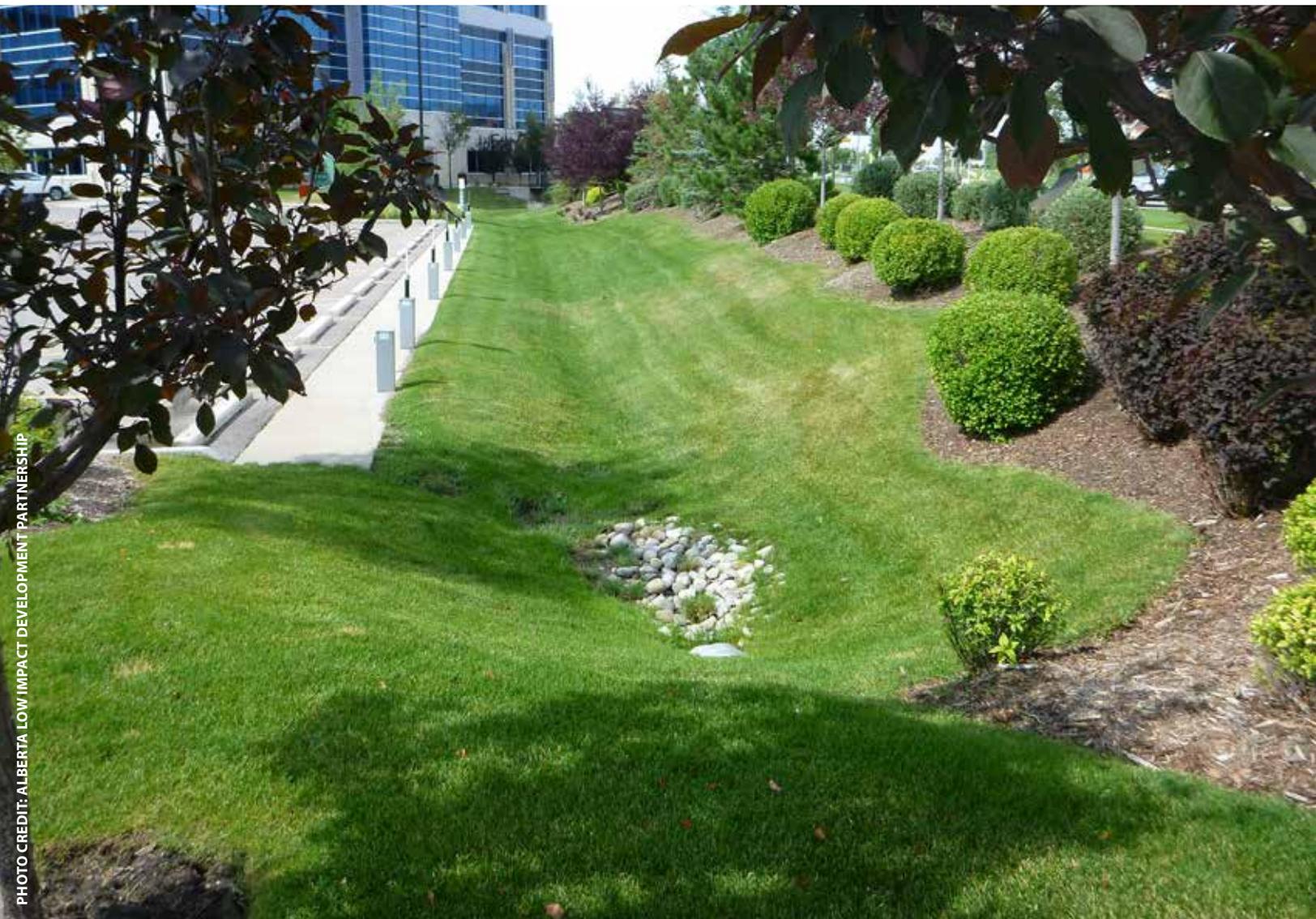
Outcomes:

- The livability and vibrancy of our communities, the protection of public health and safety, and the protection of natural and urban ecosystems is being positively transformed and enhanced by innovative, practical, and achievable stormwater solutions.
- Stormwater management systems are resilient to climate change.
- The City is leading by example, investing in grey, green and natural infrastructure to reduce the risk of flooding impacts and to enhance the health of our watersheds.
- The City's planning, operation and maintenance of grey, green and natural infrastructure is more efficient and effective.

- Calgarians share in the responsibility of stormwater management and in the protection of the environment, and they value stormwater management solutions in the community.
- Surface water quality regulatory standards are being met or exceeded.

Targets:

- Increase the area (m²) of greened stormwater practices.
- Maintain Total Suspended Solids (TSS) and Total Phosphorous (TP) loadings to the Bow River.
- Increase the Triple Bottom Line (TBL) score of stormwater infrastructure.
- Increase the number of Calgarians who agree that stormwater service in their community is of good value.



Cornerstone 4: Setting stormwater performance measures

Setting clear performance measures and expectations provides critical guidance to all of our stormwater-related activities, both by The City of Calgary and by the development and building industry, over the long term and facilitates adaptive management in stormwater management. Defining clear, transparent, and consistent performance measures with key participants, which are realistic and achievable, will facilitate accountability and create a clear road map to success. In addition, it offers clear insight and direction into areas of investments and risk, helping to guide decision-making while allowing us to gauge our progress, course correct and gather lessons learned.

Key actions

- Develop targets (TBL, properties at risk, AAD, LOS, sub-watershed rate, volume and water quality targets, greened area) based on science.
- Collaborate on how stormwater targets can be practically implemented.
- Create alignment among City of Calgary strategies and policies so we mutually reinforce each other's actions.
- Define equity and desired level of service in established communities, reflecting variability in expectations (e.g., property damage vs. critical infrastructure vs. transportation) and floodproofing opportunities.
- Evaluate practical and cost-effective options, tools, and policies for both public and private drainage infrastructure, being a function of the land use and parcel size.
- Provide clarity on how climate change resiliency is to be accounted for in the analysis and design of stormwater infrastructure.
- Remove barriers and red tape, streamlining the review and approval process.

Related outcomes and alignment to targets

Outcomes:

- Stormwater is managed at the sub-watershed level to enhance and protect Calgary's waterbodies.
- Surface water quality regulatory standards are being met or exceeded.
- The City's strengthened governance and business processes overcome competing city-building priorities and support the implementation of practical, affordable, adaptive and innovative solutions.
- Decision-making is informed by evidence-based data, including social, economic, and environmental benefits with performance indicators to measure progress.
- The City is collaborating with strategic partners to leverage ideas, knowledge and expertise for the design and delivery of innovative and effective stormwater management solutions.
- Calgarians share in the responsibility of stormwater management and in the protection of the environment, and they value stormwater management solutions in the community.
- Calgarians are empowered with the information they need to understand their impacts and take action.

Targets:

- Maintain Total Suspended Solids (TSS) and Total Phosphorous (TP) loadings to the Bow River.
- Establish stormwater rate, volume and contaminant loading targets to the Bow River and tributaries.

Supporting residents and businesses

- + Transparent decision making.
- + Clarity on expectations and approaches.
- + Shared accountability and responsibility.
- + Ability to measure progress.
- + Collaboratively address barriers.
- + Reduced red tape.



4

Strategic actions

The following strategic actions have been identified to achieve the goals of the Stormwater Strategy and the four cornerstones. Internally, all departments involved in the delivery of stormwater management services and approval of development applications will be guided by the direction in the updated Stormwater Strategy and the subsequent strategic actions. Externally, developers, landowners, drainage fee rate payers, watershed users and provincial regulators will have an interest in some of the strategic actions in the updated Stormwater Strategy. Administration has committed to ongoing engagement with interested parties during the implementation of relevant actions. The strategic items are subject to change and will have varying start dates, the desired completion dates are stated in the table.

Goal	Action	Timeline	
		Short-term (1-8 years)	Long-term (9-16+ years)
Safe and vibrant neighborhoods	Define the tolerable risks and the desired minimum level of service for greenfield communities and established areas that will lessen stormwater impacts for residents and the environment and will create more equitable level of service between communities.	●	
	Research the most suitable solutions and tools for stormwater management and the land-use planning outcomes to be achieved.	●	
	Develop a Low Impact Development/Green Stormwater Infrastructure Program.	●	
	Collaborate within The City and with interested parties to identify opportunities to integrate solutions within the public realm and on private land.	●	
	Re-evaluate the City's approvals process on risk tolerance and allow for flexibility to encourage innovation while ensuring functional requirements are met.	●	
	Work to set complementary City of Calgary priorities and policies for incorporating stormwater management into the broader city building context and improving processes to better serve Calgarians, Council and interested parties.	●	●
	Resolve conflicts in The City's review and approval process in order to streamline the decision-making process for the building and development industry's stormwater management investments.	●	
	Work within The City to create the framework and implementation plan for multi-beneficial public solutions that will contribute to the vibrancy of communities without compromising public health and safety and will protect the environment from the impacts of stormwater.	●	
	Update the approval process to include revised stormwater management best practices (e.g., property maintenance requirements, green stormwater infrastructure, and distributed stormwater solutions).		●
	Work with Council to position stormwater management as a valuable service that adds to Council priorities of community vibrancy, public health and safety, growth, and green communities.		●
	Work with regional partners (include province, regional partners, First Nations, Calgary Airport Authority) to position stormwater management as a valuable service.	●	
Work with development and industry (include construction, BILD, NAIOP, CICBA, BOMA) to position stormwater management as a valuable service.	●		

Cornerstone 1: Established communities

Cornerstone 2: Asset management and maintenance

Cornerstone 3: Utilize LID

Cornerstone 4: Stormwater targets

Other strategic actions

Goal	Action	Timeline	
		Short-term (1-8 years)	Long-term (9-16+ years)
Safe and vibrant neighborhoods	Strengthen the integration of stormwater management with the Flood Resilience Plan to leverage co-benefit opportunities for river and pluvial flood projects.	💧	
	Review and create relevant stormwater management policy language for the inclusion in the Municipal Development Plan, Land-Use Bylaw, and Local Area Plan to strengthen the connection to stormwater management and to provide clear, predictable, and efficient requirements.		💧
Shared responsibilities	Research and increase understanding of resident needs and current practices and impacts on the stormwater system to inform decision-making and design programs and services.	💧	
	Identify the specific roles and responsibilities that landowners, industrial-commercial-institutional customers, residents, the development industry, and watershed groups could adopt to contribute to reducing the impacts on the stormwater system. Work collaboratively to formalize.	💧	
	Build a stronger working relationship with partners to leverage ideas, exchange knowledge and identify ways to collect, analyze and share data for collective use.	💧	
	Share the financial and performance risks of stormwater infrastructure with partners to foster innovation.	💧	
	Create pluvial flood risk maps/tool to inform residents and property owners of their flood risk.	💧	
	Develop and implement a Stormwater Engagement and Education Plan to increase understanding and awareness of the stormwater system to residents (e.g., value of stormwater, pollution prevention, infrastructure design and operation, stormwater safety etc.).	💧	
	Increase residents' capacity to take actions to reduce the impacts of stormwater from their properties and to ensure the safety of themselves and their property for where they live, work and play.	💧	
	Incentivize property owners to adopt best management practices.		💧

Cornerstone 1: Established communities

Cornerstone 3: Utilize LID

Other strategic actions

Cornerstone 2: Asset management and maintenance

Cornerstone 4: Stormwater targets

Goal	Action	Timeline	
		Short-term (1-8 years)	Long-term (9-16+ years)
Healthy and resilient watersheds	Strengthen the integration of stormwater management policies, bylaws, strategies, guidelines, and targets to leverage co-benefit opportunities to enhance and protect natural assets.	●	
	Determine the desired level of service, standards, development requirements, and investment priorities for each watershed and sub-watershed to inform development practices that will reduce the impacts on the waterways.	●	
	Explore how The City can buffer against financial disincentives on development resulting from more stringent stormwater policies, targets and the development context for sub-watersheds that are more sensitive.	●	
	Explore investing in projects on private land in established areas.	●	
	Explore mandatory controls for low density residential development and create an implementation plan and pilot program.	●	
	Track regulatory requirements, stormwater quality impacts, emerging contaminants of concern and climate impacts to proactively protect watershed health and provide clean, high quality source water.	●	
	Explore the extent of contamination to stormwater from sanitary system cross-connections and create implementation plan to eliminate the issue.	●	
	Create an integrated stormwater infrastructure investment and implementation plan.		●
Implementation of the stormwater infrastructure investment plan.		●	

Cornerstone 1: Established communities

Cornerstone 3: Utilize LID

Other strategic actions

Cornerstone 2: Asset management and maintenance

Cornerstone 4: Stormwater targets

Goal	Action	Timeline	
		Short-term (1-8 years)	Long-term (9-16+ years)
Maximize service value	Explore how customer behaviour can be adjusted to reduce impacts on the public stormwater system and the watershed, as function of customer type, land use and parcel size.		●
	Define the target parameters for TBL and greened areas score.	●	
	Develop performance and customer level of service indicators and targets that will govern business decisions and investment priorities.	●	
	Lead by example at city-owned private sites and facilities to increase resiliency and reduce operational impacts on the stormwater system.	●	●
	Create a proactive Operation and Maintenance Plan to address resourcing, training and design gaps for grey, green and natural infrastructure that will guide current and future business decisions.	●	
	Create an Asset Management Plan to inform future decision-making and address climate vulnerabilities for grey, green and natural infrastructure.	●	
	Identify knowledge gaps and strengthen the collection and use of data to inform decision-making.	●	
	Proactively analyze drought and flood risk, economic conditions, population growth and climate change to develop and implement flexible stormwater solutions to future-proof infrastructure and services.		●
	Explore opportunities for utilizing or obtaining suitable parcels of land within The City and region for stormwater management.	●	
	Work with the insurance industry to increase the level of understanding of Calgary's current and future pluvial flood investments that reduce the risk of property and environmental damages to better inform rates and insurance coverage offered to residential and commercial property owners.	●	●
	Create an implementation and resourcing plan to deliver the actions of the strategy.	●	

Cornerstone 1: Established communities

Cornerstone 3: Utilize LID

Other strategic actions

Cornerstone 2: Asset management and maintenance

Cornerstone 4: Stormwater targets



Shepard wetland

PHOTO CREDIT: PAUL SAULNIER

Appendix 1

Key terms

List of acronyms

- AAD:** Average Annual Damages
- CDI:** Community Drainage Improvements
- CoC:** City of Calgary
- CSA:** Canadian Standards Association
- DSSP:** Development Site Service Plan
- EPEA:** Environmental Protection and Enhancement Act
- GSI:** Green Stormwater Infrastructure
- LOS:** Level of service
- LID:** Low Impact Development
- MDP:** Municipal Development Plan
- NRCan:** Natural Resources Canada
- TBL:** Triple Bottom Line
- TSS:** Total Suspended Solids

Key stormwater strategy terms

- Vision:** A forward-thinking description of the desired future state.
- Principle:** Foundational values that guide decision making.
- Goals:** Tangible statements of what will be done to achieve the vision.
- Targets:** A quantifiable performance level or change in level to be attained by a specific date.
- Cornerstone:** Key short-term areas of focus to help meet the goals of the Stormwater Strategy.
- Actions:** The specific and definable activities to be taken to achieve the goals.

Key stormwater management terms

Biodiversity: The variability among living organisms—animals, plants, their habitats, and their genes—from all sources including terrestrial and aquatic ecosystems, and the ecological complexes of which they are part. This includes diversity within species, between species, and of ecosystems (adapted from International Union for Conservation of Nature). (CoC)

Detention: Temporary storage with a controlled release rate, where the outflow volume of stormwater is equal to the inflow volume of stormwater. (CSA)

Ecosystem: The interaction between organisms, including humans, and their environment. Ecosystem health/integrity refers to the adequate structure and functioning of an ecosystem, as described by scientific information and societal priorities. (MDP)

Established area: Established areas comprise older residential communities, usually those planned and developed before the 1990s. They are primarily residential communities containing a mix of low and medium-density housing with support retail in relatively close proximity. (Adapted from CoC)

Equitable service: Fair, just and reasonable treatment of people, giving all members of society the opportunity to fully participate, regardless of ability. (MDP)

Flood resilience: The ability of a system (both natural and built infrastructure) to recover from an extreme event with minimal damages, functionality, disruptions and socio-economic impacts during and after an extreme flooding event. (CSA)

Flood risk: A combination of the probability of occurrence of a flood event (flood frequency) and the socio-economic consequences of that event when it occurs (through exposure to the flood hazard). (CSA)

Green Stormwater Infrastructure: Green Stormwater Infrastructure (GSI) is an example of nature-based solutions that incorporate natural features and processes into stormwater management. Measures such as infiltration, evapotranspiration, harvesting, filtration and retention are used to reduce stormwater rates and volumes and remove contaminants at or close to the source of runoff. GSI aims to mimic the natural water cycle and provides multiple ecosystem and community benefits. (Adapted from MDP)

Greened stormwater practices: When the City, development and building industries, or residents take an active role in increasing the footprint of vegetation-based solutions. Vegetation-based solutions are a subset of GSI and have significant co-benefits beyond stormwater management, including addressing urban heat island impacts, enhancing aesthetics and improving air quality. Examples of vegetation-based solutions include resilient landscaping, green roofs and soil cells, but does not include other types of GSI, such as porous asphalt and rainwater harvesting.

Grey infrastructure: In the context of stormwater management and flood prevention, grey infrastructure refers to engineered and constructed measures and systems, such as pipes (sewers), pumps and pumping stations, catch basins or storm drains, tunnels, culverts, ditches and detention ponds. (CSA)

Impervious surface: Mainly artificial surfaces that prevent the absorption of water into the ground (e.g., paved surfaces such as roads and parking lots, as well as buildings, driveways and hardscaping). (Adapted from CSA)

Indicator: A variable that is representative of progress towards the achievement of an objective, policy or action. (MDP)

Infill: Development within urban boundaries not related to large-scale development plans, but rather smaller scale development in remnant vacant parcels. (CSA)

Integrated watershed management: A continuous adaptive approach of managing human activities and ecosystems at the watershed scale that integrates multiple concepts and methods, including water and land use planning and management (e.g., protected areas, source water protection, etc.), and evaluates and manages cumulative effects from multiple environmental stressors. It takes a whole-of-cycle approach to address the important interconnectedness between watershed protection, climate resiliency and city building. (CoC)

Land use: Land use refers to the purpose the land serves; for example, residential, industrial, commercial or institutional development, recreation, wildlife, habitat or agriculture. (Adapted from NRCan)

Level of service: A system capacity generally expressed in terms of return period in years. Note: For example, for a dual drainage system, the level of service corresponds to the protection against flooding sought for the whole drainage system with the minor and major components operating in tandem. (Adapted from CSA)

Local area plan: Larger-scale area redevelopment plans aligned with the *Municipal Government Act* regulations, and usually prepared at a community level within established communities. Local area plans lay out a future vision for a community and they are developed through a collaborative engagement process that uses local knowledge from residents, community-based groups, business owners and other participants. (Adapted from MDP and LAP Guide)

Low impact development: An approach to land development that uses various land planning, design and management practices and technologies to simultaneously conserve and protect natural systems and reduce infrastructure costs including the mitigation of the impacts of increased runoff and associated stormwater pollution resulting from development as close to its source as possible. (Adapted from MDP and CSA)

Master drainage plan: A (conceptual) stormwater drainage plan prepared for a large drainage area, usually serviced by one or more outfalls. (Adapted from MDP)

Municipal Development Plan: Shared vision for how Calgary grows and develops over the next 60 years. It consists of the Municipal Development Plan, Community Guidebooks and the Calgary Transportation Plan.

Natural infrastructure: An interconnected network of natural systems and Green Stormwater Infrastructure applicable at multiple scales in the land use and mobility framework. Natural systems include the conservation and integration of traditional green elements such as trees, wetlands, riparian areas and parks. Green Stormwater Infrastructure include systems and technologies designed to mimic ecological functions or to reduce impacts on ecological systems. Examples include resilient landscaping, soil cells and green roofs. (Adapted from MDP)

Overland drainage: Streets, channels (ditches and swales), ponds, natural streams and valleys that accommodate runoff, including excess runoff from storms over and beyond the capacity of the storm sewer system. The overland system makes up what is called the “major” drainage system since it largely conveys flows in excess of the capacity of the storm sewer or “minor” system during larger magnitude, infrequent storm events. (Adapted from CSA)

Public realm: The space between and within buildings that are publicly accessible, including streets, squares, parks and open spaces. These areas and settings support or facilitate public life and social interaction. (MDP)

Public safety: Ensuring public needs are met by reducing hazards and vulnerability. (CSA)

Redevelopment: Conversion of existing urban uses of lower value and significance to other preferred uses per a community plan (e.g., brownfield redevelopment to residential uses). (CSA)

Resilience: The capacity of individuals, communities, institutions, businesses and systems to adapt and thrive despite chronic stresses (e.g., water shortages) and acute shocks they experience (e.g., floods). (MDP)

Retention: Temporary storage with a controlled release rate, where the outflow volume of stormwater is smaller than the inflow volume of stormwater. (CSA)

Return period: An estimated average time between events of a similar size or intensity. For example, the return period of a flood might be 100 years, otherwise expressed as its probability of occurring being 1/100, or one per cent in any one year. (CoC)

Riparian areas: Areas where the plants and soils are strongly influenced by the presence of water. They are transitional lands between aquatic ecosystems (wetlands, rivers, streams or lakes) and terrestrial ecosystems. (MDP)

Runoff: The amount of water deriving from precipitation/snowmelt, not otherwise evapotranspired, infiltrated or stored, that flows across the landscape. (CSA)

Sediment: Sediment refers to soil particles that have been detached and mobilized by soil erosion agents. (CoC)

Source water: The natural waters of the Bow and Elbow rivers prior to its treatment and distribution as drinking water to our customers. (CoC)

Stormwater infrastructure: Referring to engineered (grey) and natural conveyance, storage and treatment systems for stormwater, including storm drains, wet and dry ponds, low impact development, wetlands and outfalls. (Adapted from calgary.ca)

Storm drains: Metal grates typically installed at the edge of roads that capture rainwater and snowmelt off sidewalks, streets and roads. (CoC)

Storm sewer: A pipe to carry stormwater (including excess rainwater, melted snow and ice) in underground pipes. (Adapted from CSA)

Stormwater: Rain, melting snow and ice that washes off driveways, parking lots, roads, yards, rooftops and other surfaces. (CSA)

Stormwater management: Planning, design and implementation of systems that mitigate and control the impacts of man-made changes to runoff and other components of the hydrologic cycle. Note: Stormwater management is better known as “rainwater management” in much of the world. (CSA)

Sub-watershed: Part of a larger watershed, which drains to one point within a watershed. (CSA)

Total Suspended Solids: Includes organic and inorganic materials that are suspended in stormwater and treated wastewater. These materials enter our waterways and can negatively impact water quality and aquatic habitat. Urban runoff from stormwater contributes a significantly higher proportion of Total Suspended Solids to the Bow River compared to wastewater effluent. (CoC)

Trap lows: Sags or depressions that are located along roads, in parking lots or in parks. Trap lows are part of the major overland system and provide stormwater storage areas local to the area where the flows are generated. Temporary storage is created during major rainfall events through the selection of specific types of catchbasins and/or the use of inlet control devices. Trap lows are a vital component of the major system in that they minimize the cascading of overland flows from one development to another, and therefore reduce the potential for property flooding or people being washed off by the force of moving water. (CoC)

Urban heat island effect: Describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with one million people or more can be 1 to 3°C warmer than its surroundings. In the evening, the difference can be as high as 12°C. Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water pollution. (CoC)

Urbanization: Refers to the city building associated with an increasing number of people that live and work in urban areas. It predominantly results in the physical growth of urban areas, be it horizontal or vertical. (CoC)

Vibrant neighbourhoods: Integration of stormwater into community development and redevelopment focusing on diverse needs and multi-purpose opportunities. Proactively manage stormwater while being adaptable and flexible to changing influences that advances social, environmental and economic goals simultaneously. (Adapted from the MDP)

Watershed: An area of land delineated by topography where all excess precipitation drains to a specific point such as a wetland, lake, stream or river. A watershed can be made up of a number of sub-watersheds that contribute to the overall drainage of the watershed. A watershed is sometimes referred to as a basin, drainage basin or catchment area. (Adapted from CoC)

Wetland: A natural area of land that is saturated with water either permanently or seasonally. It contains plants and the water is quite shallow. Natural wetlands offer many benefits for water quality, biodiversity, and aesthetics. Examples of wetlands are bogs, marshes and swamps. (Adapted from CoC)

