

Calgary



# Calgary's Flood Resilience Plan

April 2022

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# Introduction

The June 2013 flood experienced in Calgary was catastrophic. One Calgarian's life was lost and thousands of residents were forced to evacuate their homes. The downtown core was inaccessible for a week resulting in significant economic loss, and roads and critical infrastructure were disrupted for days. Many whose homes were flooded faced trauma as they coped with the challenge of rebuilding or the permanent loss of their home. The 2013 flood remains one of Canada's costliest disasters.

As a river city, we will always need to prepare, respond, and adapt to floods. And the pressures of a changing climate bring a greater risk of more severe and frequent flooding in the future. That's why building resilience to flooding is one of The City's top priorities. While we can't prevent future floods, we have developed a comprehensive program and adaptive plan to reduce its impact to our city.

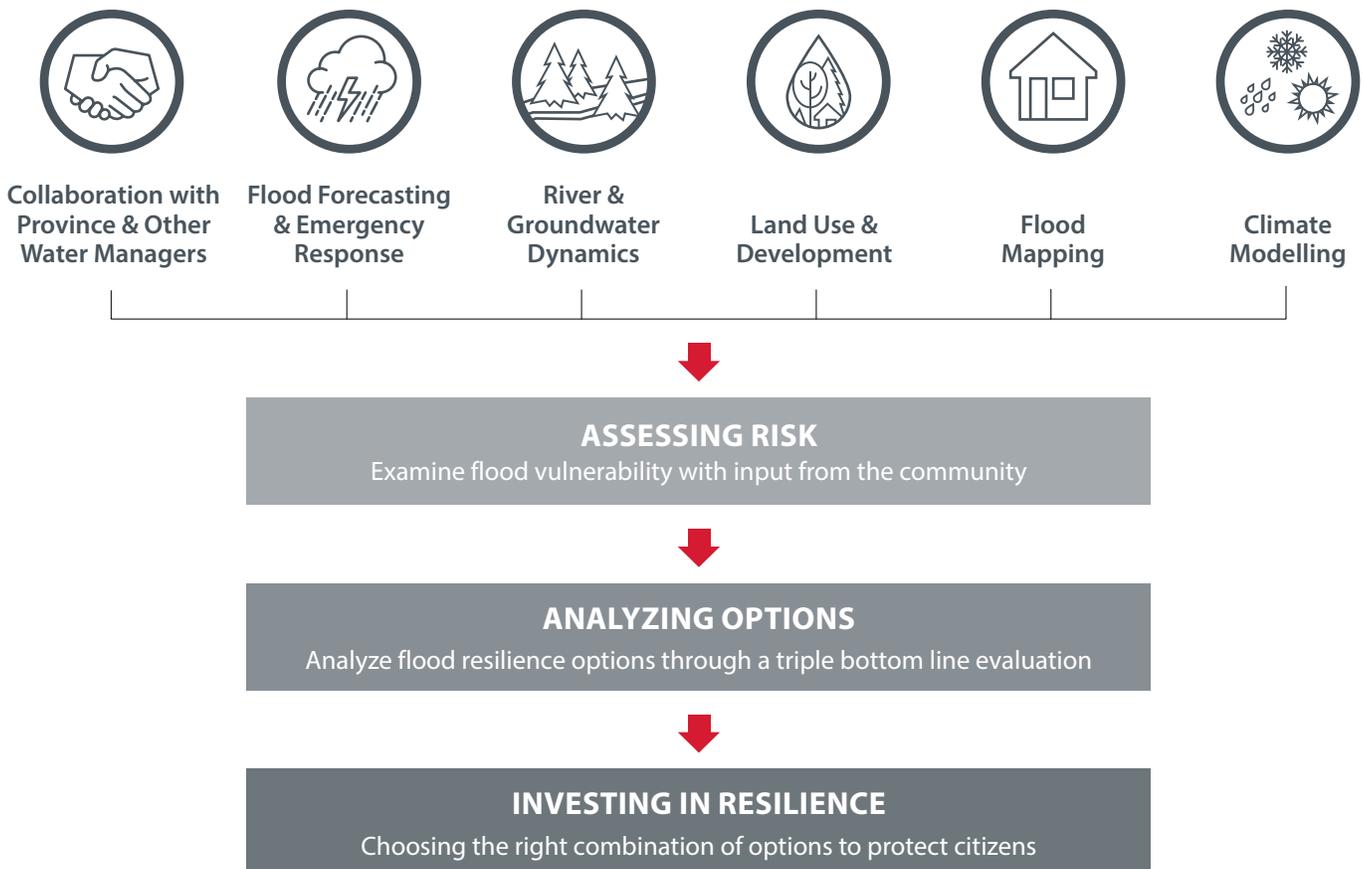
This document outlines our journey towards flood resiliency in the years after the 2013 flood. It summarizes how Calgary's flood program was developed with citizen engagement, the actions we've taken to date to reduce Calgary's flood risk, and our roadmap forward as we continue to build Calgary's resiliency to river flooding.



# Understanding Calgary's flood risk

Flood risk is dynamic. It evolves with changes to the rivers, our built environment and to the climate. Calgary's rivers were altered by the 2013 flood and will continue to change, so we are continuously improving our understanding of this dynamic risk. Addressing vulnerabilities through increased understanding of flood risk helps us to be better prepared to protect public safety and infrastructure when flooding happens.

## Inputs to assessing flood risk



Insured losses for weather-related disasters in Canada totaled over \$18 billion in the past decade, doubling the total of the previous three decades.

## Why is Calgary prone to flooding?

### Short, steep river systems

Calgary sits at the confluence of two rivers. The Bow River and the Elbow River, and several small creeks have short, steep river systems that travel from the mountains to Calgary, so flooding can happen quickly and with little warning.

There are many factors for flooding to occur, the most important one being heavy rainfall upstream of Calgary, which can account for 80 per cent of the river flow during a flood. The mountains greatly influence weather patterns, and a single day of heavy rainfall in the mountains, combined with a melting snowpack, can change river flows enough to cause flooding in Calgary.

### Quickly changing weather patterns

River floods are most likely between mid-May to mid-July when heavy rains are most common. Despite advanced forecasting techniques, weather conditions can change very quickly and it's challenging to predict heavy rainfalls in the mountain areas. While large rainstorms can usually be seen 5-7 days out, **we may only have 24 hours or less to confirm what's coming.**

## How a changing climate and urbanization are driving up risk and costs

As our climate changes, experts predict our risk of river flooding will only increase. Shifting precipitation patterns will bring on warmer spring temperatures, an earlier melt of the mountain snowpack and more intense storms in the Bow and Elbow watersheds. This means our high river flow season may shift earlier in the year and we could see bigger floods happening more often.

Our city and the region are also growing. Density and land use is increasing in some river communities and spaces. This can leave more people and businesses vulnerable to the impacts of flooding.

According to the Canadian Institute for Climate Choices, the costs of extreme weather events – economic, social and environmental, are continuing to rise. Insured losses for weather-related disasters in Canada totaled over \$18 billion in the past decade, doubling the total of the previous three decades. This underscores the need to be proactively adapt and make investments to reduce their impact.

Frequency of weather-related insured catastrophic loss events per year

**300% more**

than in the last decade compared to the 1980s

In 2016, weather-related insured catastrophic losses equalled

**~30%** of Canada's GDP growth

Source: Canadian Institute for Climate Choices ([climatechoices.ca/reports/tip-of-the-iceberg](http://climatechoices.ca/reports/tip-of-the-iceberg))



Approximately 75,000 Calgarians live in the floodplain<sup>1</sup>.

<sup>1</sup> 1:1000 flood inundation area, Calgary Civic Census 2019.

## Flood mapping

The City of Calgary and Government of Alberta use flood maps to understand flood risk, to inform how we choose to build and develop in the floodplain, and to help avoid the damages caused by flooding. We use two types of flood maps:

### Inundation maps

- Maps multiple flood sizes.
- Used for emergency planning.
- Shows naturalized river flows (doesn't consider reservoirs, which may reduce flood flows).
- Last updated by the Government of Alberta in 2020 (draft).

### Flood hazard area maps

- Maps 1:100 flood (Alberta's minimum standard) and includes floodway and flood fringe regulatory zones.
- Used for policy and regulation such as The City's Land Use Bylaw.
- Last updated by the Government of Alberta in 1983. New maps under development.

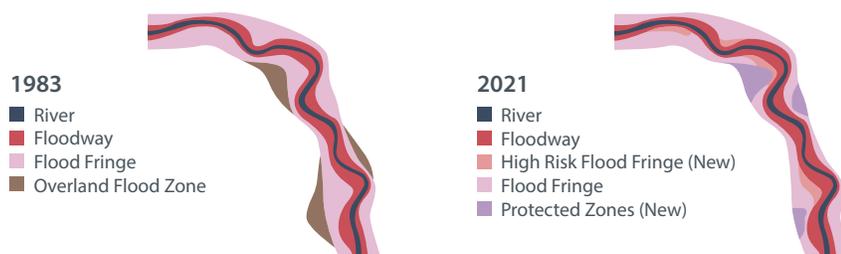
## Flood hazard area maps

The Government of Alberta is taking a new approach to revising its Flood Hazard Area maps, which are expected to be released by 2023. New maps will reflect the latest understanding of how a 1:100 flood would impact Calgary. The maps will also introduce some changes to the flood hazard classifications.

- The floodway zone, where flows are deepest, fastest and most destructive, will remain, but the boundaries may shift.
- The flood fringe zone, the area outside of the floodway, will be divided into three levels of flood hazard:
  - A new **High-Hazard Flood Fringe Zone**, which is an area outside of the existing floodway, but where the flow during a 1:100 flood would still be deep or fast.
  - **Flood fringe**, an existing classification but the boundaries may have changed.
  - A new **Protected flood fringe**, where dedicated flood mitigation infrastructure protects the area to at least the 1:100 flood level.

Further details on these changes and how we are responding can be found on p.30.

### Old (1983) & New (2021) Provincial Flood Hazard Mapping Categories



## What is a 1:100 flood?

A 1:100 (100-year or 1% flood) flood has a one per cent chance of happening in any given year or a 22 per cent chance of happening during the lifetime of a 25-year mortgage.

This doesn't mean that after a 1:100 flood occurs it won't happen again for another 100 years. It's possible for major floods to happen in back-to-back years, and in the face of climate change, it's possible this will lead to changes in how flooding frequency is calculated in the future.

Smaller floods tend to occur more often than larger floods over time.

For example:

- 1:10 flood has a 10 per cent chance of happening in any given year.
- 1:200 flood has a 0.5 per cent chance of happening in any given year.

## What's at risk

**\$2.2B**

when a 1:100-year flood occurs

**\$12.3B**

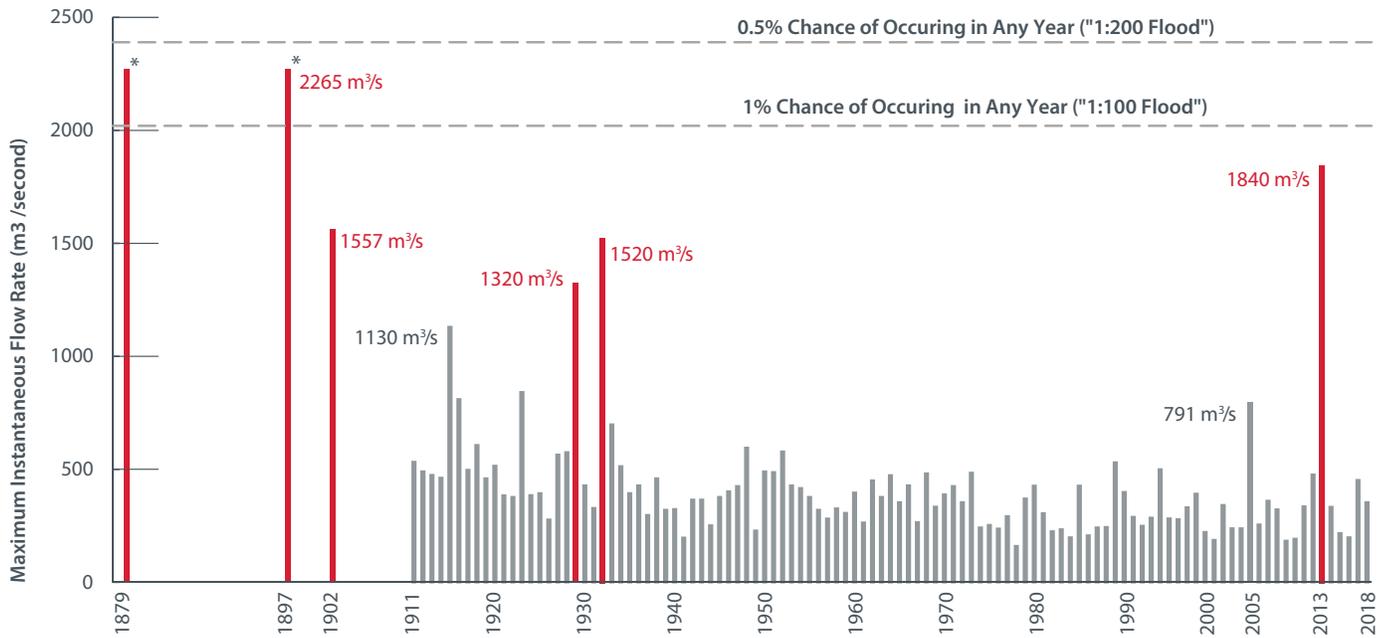
when a 1:1,000-year flood occurs

Source: IBI Group/Golder, 2021. Total flood damages include direct damage to buildings and infrastructure during river floods (including groundwater flooding), as well as indirect damages due to impacts to traffic, waste disposal, emergency operations costs, and habitat restoration.

## Calgary's history of flooding

Historical records indicate that Calgary experienced floods of similar magnitude on both the Elbow and the Bow Rivers, but no floods of the size of the 2013 event have occurred since 1932.

### Historic maximum flows on the Bow River at downtown Calgary



\* Estimated based on historical high water marks.

\*\* Return period flow estimates are from Bow and Elbow River Basin-Wide Hydrology Assessment and 2013 Flood Documentation Report prepared for The City of Calgary and The Province of Alberta, Sept. 2014.



# Calgary's most damaging flood: June 20, 2013



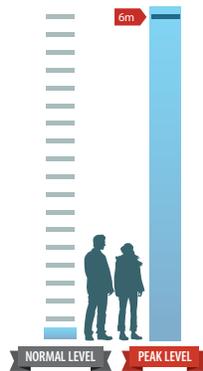
## A record-breaking rainfall

In June 2013, Calgary experienced its largest flood since 1932. Extraordinary rainfall in the Rocky Mountains and foothills over several days led to high water levels in and around the city.

The storm dumped

**300mm**

in two days or  
**100X**  
the normal rate.



The rivers were

**5–6 metres**

higher than normal summer levels.

At its peak, the Elbow River breached the top of the Glenmore Dam by

**2.2 metres.**

## A speedy response

As the waters rushed down the rivers towards Calgary, within hours The City of Calgary issued a flood warning, activated the Municipal Emergency Plan, and declared a state of local emergency. To protect the safety of thousands of Calgarians, evacuation notices were given, leaving them only several hours before the floodwaters reached Calgary. Temporary flood barriers were constructed at many critical locations throughout the city.



Evacuations in  
**26 communities**

affected **110,000 Calgarians.**

**30,000 sandbags**

were laid by hand. If laid end to end they would stretch for



Operations of the Glenmore Dam and TransAlta's reservoirs to hold back more floodwaters prevented an even more devastating flood from hitting parts of Calgary.

Before the flood, The City lowered the water level in the Glenmore reservoir by 3.5 metres, the limit at which drinking water could still be provided,

to make room for the incoming flood water, reducing the peak of the Elbow river flow by 44 per cent. Without these actions, flood damages would have been more catastrophic.

TransAlta also responded quickly and was able to reduce the flood level in the Bow River through operations at its six upstream reservoirs.

The Elbow river inflow peaked at

**1,240 m<sup>3</sup>/sec.**  
(12X the regular rate)

Outflow below the Glenmore Dam was

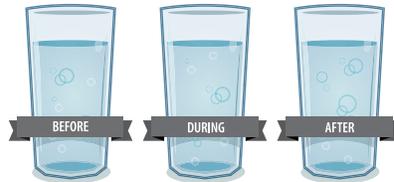
**700 m<sup>3</sup>/sec.**  
(about 7X normal)

## Maintaining clean drinking water

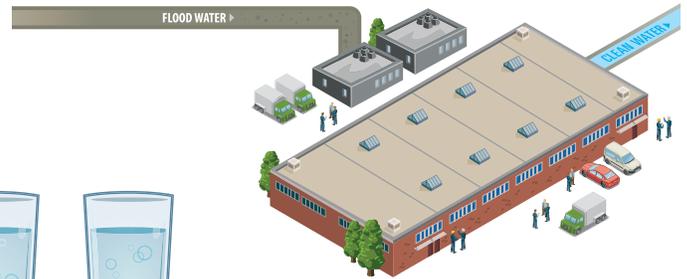
Throughout all of this, The City was able to maintain drinking water quality for Calgarians.

**\$180M** investment

in an advanced filtration system before the flood resulted in clean drinking water during the flood.



Quality of drinking water remained **at the same high level** before, during and after the flood



Drinking water from the water treatment plants was

**100,000X** cleaner than flood water coming in

## The impact

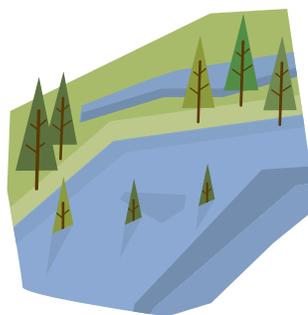
Despite these protective measures, there was major flooding over the banks of the lower Elbow River, and the Bow River overtopped its banks in several areas. Significant flood damage was caused by overland flooding, rising groundwater, storm water back-up and sewer back-up.

Extensive emergency response was required across river communities in Calgary. All routes into the core were closed for days as the water flooded tunnels and damaged roads. Homes, cars and valuables were damaged or destroyed. The Bonnybrook Wastewater Treatment Plant was inundated with floodwaters.

**16 LRT Stations** were closed.



**More than 50 bus routes** were cancelled or detoured.



**30 parks** across Calgary were flooded.

More than **1,600 people** registered at community support centres on the first day.



**More than 20 bridges** were closed.



**34,000 locations** were without power.



**~4,000 businesses** were impacted.

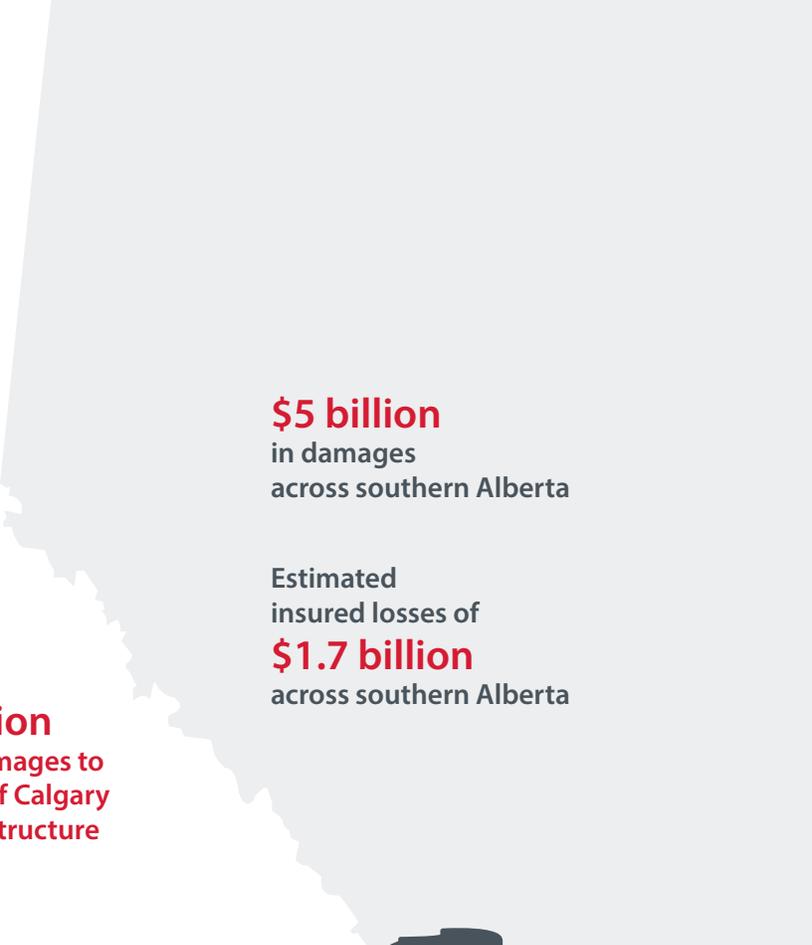


## The costs

The 2013 was the most costly Canadian disaster at the time. Individuals, private companies, insurers and all levels of government shared in the financial costs.



Over **\$400 million** in damages to City of Calgary infrastructure

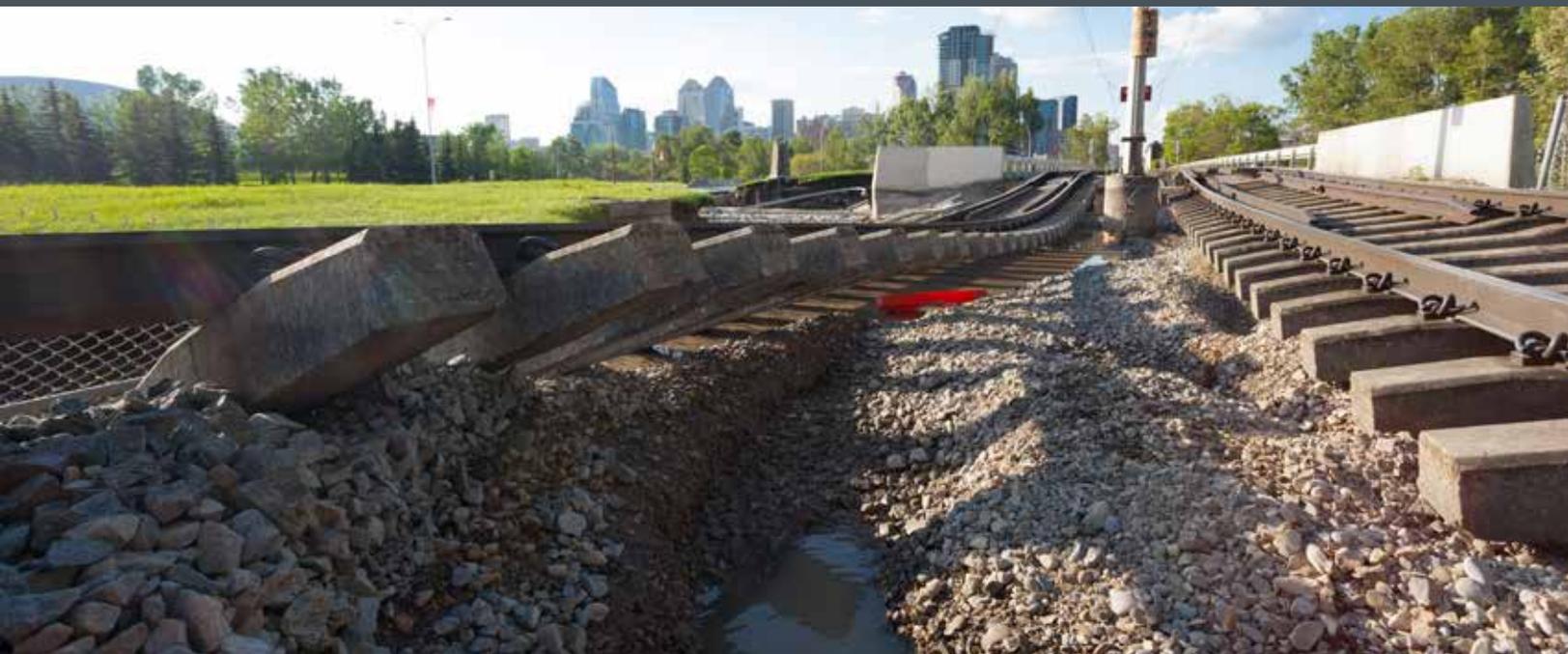


**\$5 billion** in damages across southern Alberta

Estimated insured losses of **\$1.7 billion** across southern Alberta



**\$55 million** in emergency response costs to The City of Calgary



## The recovery

Extensive resources were mobilized by The City of Calgary and the Government of Alberta, and an army of volunteers sprang up to deal with the immediate aftermath.

**100 metres of track** were replaced in one week to re-open the south line of the LRT.

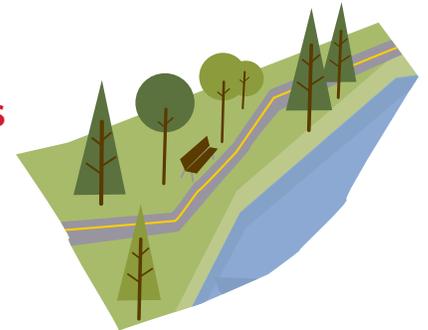


**0.3 lane kilometres** of Macleod Trail rebuilt in 1.5 days.



**95% of requests** for residential pumping completed in the first seven days.

**More than 70% of parks** were partially or fully re-opened in one week.



Following the flood, we repaired damage, restored services and worked to make sure the city would be better prepared for the next extreme flood.

The City received \$200M from the Government of Alberta for flood recovery and to support future readiness. In the months following the flood, we made sure infrastructure was more flood resilient as it was rebuilt, stockpiled additional supplies for emergency flood response, and updated the Municipal Development Plan to enhance policy direction on land use in flood prone areas and the Land Use Bylaw to improve protection for private property.

We also worked closely with utility providers to improve the resilience of power supply and communication systems, strengthened forecasting and monitoring and worked closely with citizens so they were better prepared for high river flow season.

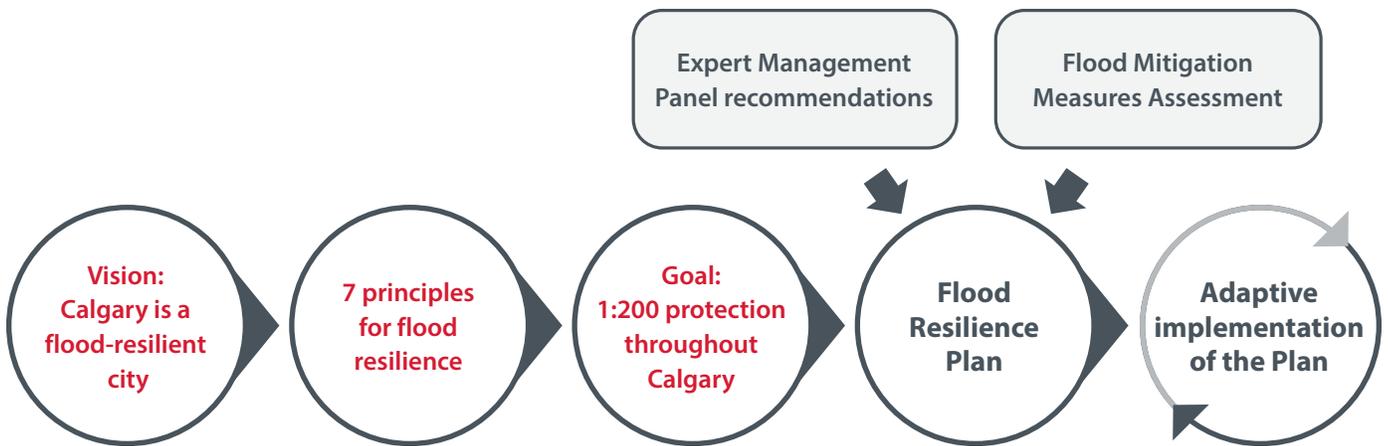
More than 200 City sites had to be repaired or restored after 2013 including buildings, bridges, roads, C-train tracks, water utility infrastructure, riverbanks, fish habitat, parks, and other infrastructure. Full repair and restoration of all of the sites took almost five years to complete.

# Calgary's Flood Resilience Program

As flood recovery efforts continued following the 2013 flood, The City recognized that an in-depth, long-term approach was needed to reduce Calgary's risk of future flooding and protect public safety.

A river Flood Resilience Program was established to develop and implement actions that protect Calgary through timely, cost-effective, and practical flood risk management, while respecting community values and staying adaptable to future uncertainties. The program includes several elements, which are described in further detail below.

## The Flood Resilience Program



Over 200 written submissions were received from citizens in over 70 communities.

## The Expert Management Panel on River Flood Mitigation

Shortly after the 2013 flood, The City of Calgary formed an independent Expert Management Panel on River Flood Mitigation made up of experts from various backgrounds, including engineering, planning, public policy, economics, environmental science, and public administration to identify and recommend opportunities to reduce the risk of future river flooding in Calgary.

The Panel identified six theme areas to guide the development of their recommendations.

Theme	Goal
Climate change	Identify how the changing climate affects how we manage our rivers and surrounding areas, and build our infrastructure.
Watershed Management	Explore and identify how human activity affects the area in and around where our rivers flow.
Event Forecasting	Explore and identify ways to forecast future weather and river flow events to maximize lead time.
Storage, Diversion, Protection	Explore and identify ways to manage water flow into and through Calgary.
Infrastructure & Property Resilience	Explore and identify ways to make our buildings and homes more resistant to extreme events.
Managing Flood Risk	Explore and identify additional steps to further reduce the risk of extreme flood events.

## Listening to communities

Early in the process, the Panel invited Calgarians to share their ideas and comments to cast a wide net for possible actions and to understand their perspectives. Over 200 written submissions were received from citizens in over 70 communities. Talking to residents and businesses was a priority and included numerous community open houses and meetings with groups representing flood-affected communities. Public input provided insight into how the 2013 flood affected people in the city and ideas to better prepare for the next flood.



The Panel recommended 27 immediate, short-term, medium-term, and long-term actions across the six theme areas to make Calgary more flood resilient (see Appendix A).

The recommendations included distinct actions, such as expanding the available water storage at the Glenmore Reservoir, to broader initiatives like developing a comprehensive climate adaptation plan and implementation tools to reduce infrastructure and operational vulnerabilities. The *Report from the Expert Management Panel on River Flood Mitigation* was approved by City Council in June 2014<sup>2</sup>. Later that year, City Council approved an implementation plan for the recommendations with funding committed to help implement the actions<sup>3</sup>.

### A flood resilience team is established

Following recommendations from the 2014 Expert Management Panel report, a permanent flood resilience team was established to develop and oversee the implementation of the 27 actions from the Expert Management Panel, through the development and implementation of a strategic and adaptive Flood Resilience Plan for The City.

<sup>2</sup>PFC2014-0512 River Flood Mitigation Panel Final Report - Calgary's Flood Resilient Future: Report from the Expert Management Panel on River Flood Mitigation

<sup>3</sup>PFC2014-0777 Implementation Plan for River Flood Mitigation and Establishing Corporate Resiliency

## Guiding principles for Calgary's Flood Resilience Program

To ensure Calgary is resilient to river flooding both now and in the future, our approach is guided by a **goal of 1:200 flood protection across Calgary**, prioritizing investments that can be done quickly and within our control, and focusing on projects with high returns on investment when possible.

Our work is guided by a set of principles to ensure decision-making is consistent with the overall goal of the Flood Resilience Program.

1. Prioritize public safety and critical services.
2. Take a social, economic, and environmental decision-making approach to cost-beneficial flood resiliency decisions.
3. Be flexible to emerging social, economic, and environmental conditions – such as the potential impacts of climate change – and adaptable to future uncertainties.
4. Use an integrated watershed management approach (consider drought, water supply, water quality, and the value of natural areas) to flood resilience.
5. Strive for comparable resilience for all river flood risk areas.
6. Share responsibility among The City, property owners, and the other orders of government.
7. Maintain an open dialogue with citizens and businesses to address community concerns and communicate flood risk.



## Flood Mitigation Measures Assessment

To fulfill several of the Expert Management Panel's recommendations, in 2015 The City updated the Government of Alberta's flood damage model for Calgary, which estimated the social, economic, and environmental costs of flood damage from the 2013 flood. Calgary's flood risk exposure with no mitigation in place, was assessed at approximately **\$168M per year** (based on 2015 data and expressed in average annualized damages over 100 years).

With this understanding, we undertook the Flood Mitigation Measures Assessment to examine various flood mitigation options, including a range of structural, operational, policy-related, and education-based flood mitigation measures to reduce future flood damages and enhance Calgary's resilience to future flooding.

### Cost-benefit was only one part of the decision-making

As part of the assessment, we conducted a sustainability analysis to ensure that flood mitigation scenarios and recommended tactics were considered through multiple lenses.

## Sustainability analysis criteria – four themes\*

### Social well-being

- Complete communities
  - Vulnerable populations
  - Equitable protection
  - River aesthetics
  - Recreation access
  - Emergency access
  - Risk transparency
- 

### Ease of implementation

- Timelines of implementation
  - Adaptability & flexibility
  - Jurisdictional control
  - Regulatory complexity
- 

### Environmental protection

- Water security
  - Riparian health & ecosystem function
  - Water quality & contamination prevention
- 

### Economic well-being

- Economic protection
- Cost to implement
- Cost-benefit ratio
- Damages averted
- Residual damages

\*Equal weight applied to each theme.



The Flood Mitigation Measures Assessment determined that significant flood risk remains for Calgary until upstream reservoirs are built. It identified structural and non-structural mitigation measures that would work with the upstream reservoirs to maximize flood resilience. This work was summarized in a report to City Council<sup>4</sup>.

The following key takeaways informed development of our Flood Resilience Plan:

- The Government of Alberta's Springbank Off-Stream Reservoir project and improved Glenmore Dam gates will protect downstream communities from most risks for floods as severe as 2013's.
- A new upstream reservoir on the Bow River, TransAlta operations, and community barriers are required on the Bow River to mitigate at least a 2013 flood event.
- The Government of Alberta's seasonal operating agreement with TransAlta Corporation, in place until 2026, is a key component of flood risk reduction on the Bow River.
- Community flood mitigation implementation measures must be adaptable to Government of Alberta decisions and include extensive community engagement.
- Future changes to land use planning, development policies, and regulations must align with and reflect potential Government of Alberta flood hazard area regulations, federal guidelines, and structural mitigation in place.
- Buyout of all properties in the floodplain would cost billions and was considered financially and socially infeasible. Supporting mitigation at the property-owner level can reduce risk of flood damage. The City should explore the development of a property level mitigation program for property owners.

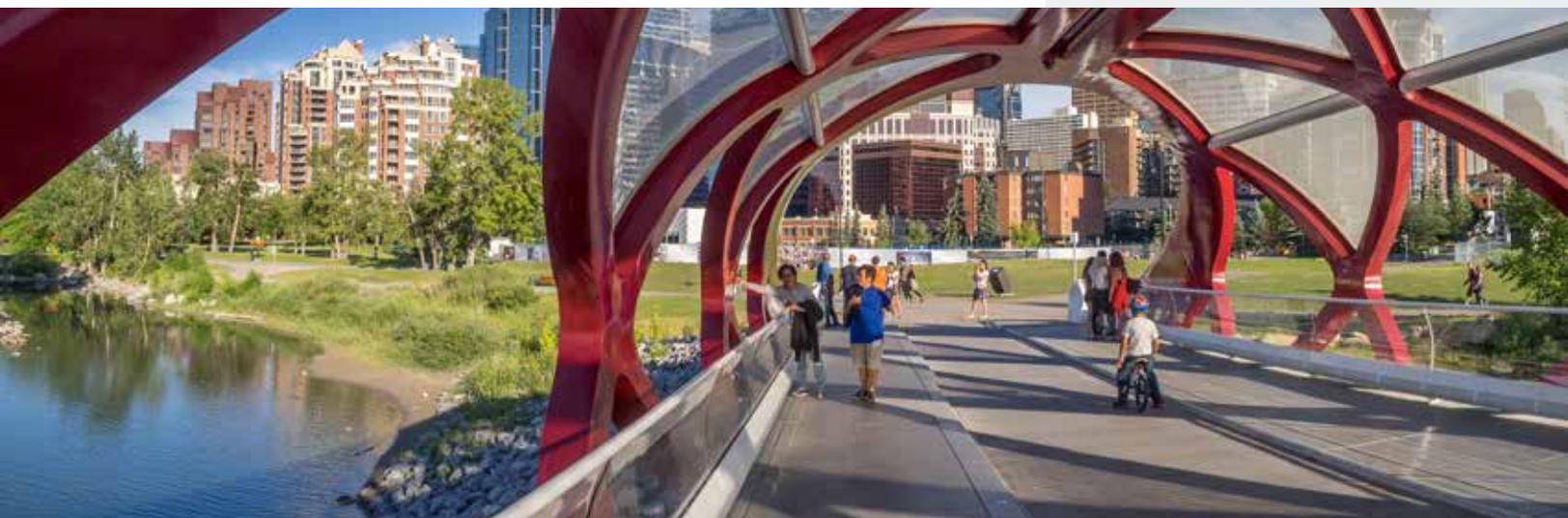
<sup>4</sup>UCS2017-0266 Flood Mitigation Measures Assessment Report

## Extensive public engagement

We included citizens in the Flood Mitigation Measures study to ensure the assessment and subsequent development of the Flood Resilience Plan reflected their concerns and priorities. This included:

- A community advisory group made up of flood affected and non-flood affected communities, environmental groups and business community to bring perspective on mitigation measures and sustainability analysis.
- Telephone survey
- Public engagement workshop sessions that explored citizen and key stakeholder input on mitigation measures and how they could optimally be combined
- Stakeholder meetings

The City also met with the Expert Management Panel on River Flood Mitigation to gather their perspectives on how the recommended approach aligned with their original vision.

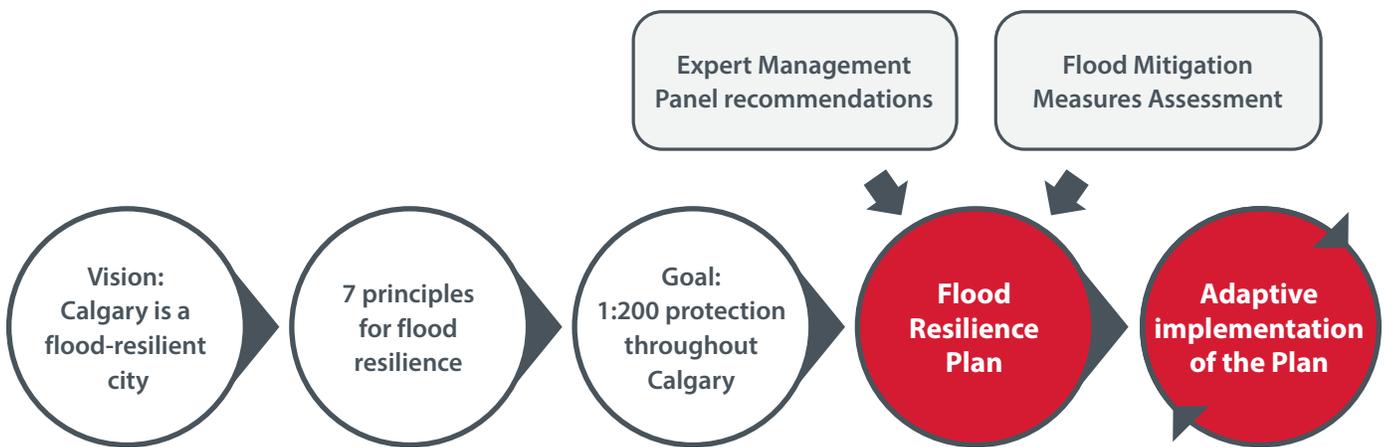


# A plan for a flood resilient future

Drawing on the Expert Management Panel Report, the flood program’s principles, the Flood Mitigation Measures Assessment, and the community engagement undertaken through these processes, The City of Calgary’s Flood Resilience Plan was developed and focus areas were approved by City Council in 2017<sup>5</sup>.

The Plan employs a mix of solutions that includes upstream and community infrastructure projects, operational efficiencies, advances in forecasting, monitoring, and emergency response, policy and regulatory improvements, educational tools, and other mitigation efforts to reduce the impacts of flooding in Calgary.

<sup>5</sup> UCS2017-0266 Flood Mitigation Measures Assessment Report and 2016 Flood Resiliency Update



The Plan is anchored on a three-layered approach that combines upstream, community-level, and property-level mitigation measures working together to achieve a 1:200 level of protection throughout Calgary. This approach is:

### Integrated

Projects within the three layers work with each other to increase flood resilience.

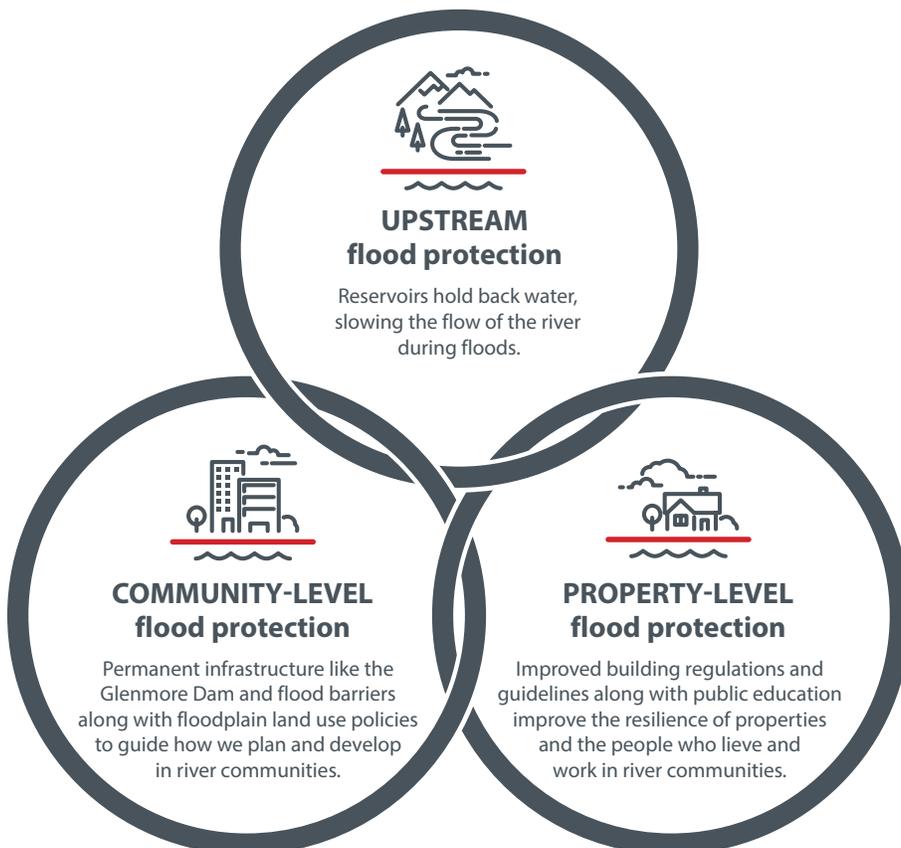
### Adaptative

The plan gives us flexibility to respond to:

- decisions made by other orders of government
- opportunities that will save The City money
- opportunities to integrate with other City projects to achieve the best outcome for the area
- uncertainty inherent with a changing climate

### Shares responsibility

Flood resilience can't be achieved by one entity alone. All orders of government as well as property owners must share this responsibility.



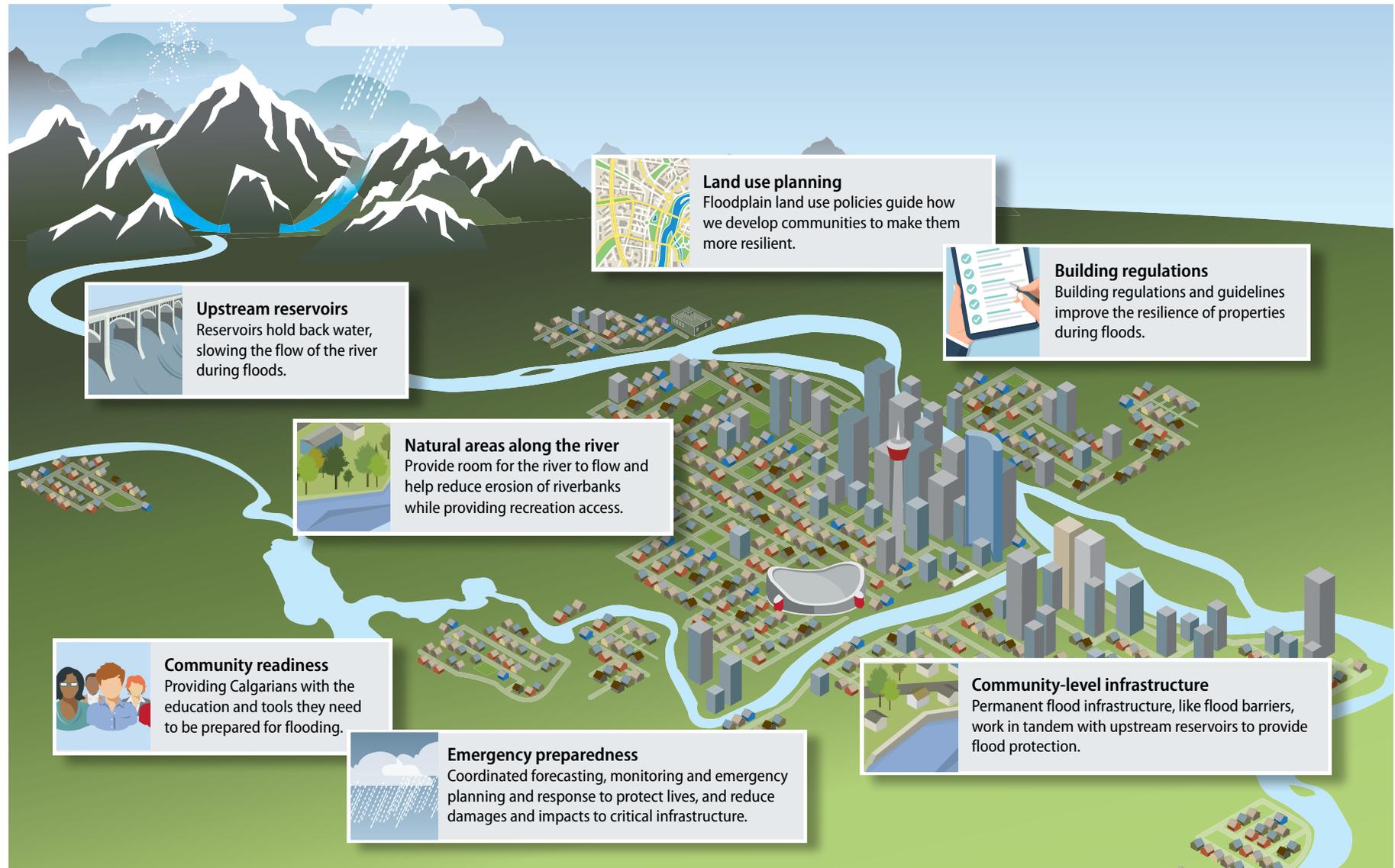
## Funding the Plan

After the 2013 flood the Government of Alberta and Government of Canada committed funds to build the Springbank Reservoir on the Elbow River and support The City in building flood mitigation in Calgary, such as community barriers, bridge and stormwater management upgrades, and new forecasting and mapping tools. The remainder of the cost was raised through The City's Water Utility rates, which also covers regular operating costs and The City's annual flood readiness campaign.

Going forward, funding for some flood mitigation projects is not yet confirmed, including a future upstream reservoir on the Bow River, where a feasibility study is underway. As The City identifies new opportunities to reduce Calgary's flood risk, we will evaluate the most effective ways to fund and deliver these projects.

## Flood Resilience Plan in action

With climate change bringing an expected increase in severe storms, each of the measures below are unique tools that work together to improve our resilience. They influence and support each other to prevent flooding, minimize damage, and help people, homes, communities and the city to quickly recover.



## Corporate alignment

Calgary's Flood Resilience Plan supports multiple corporate strategies. Examples of how our work helps achieve corporate priorities are highlighted throughout this document. A detailed summary of City of Calgary documents with goals and objectives related to flood resilience is found in Appendix B.

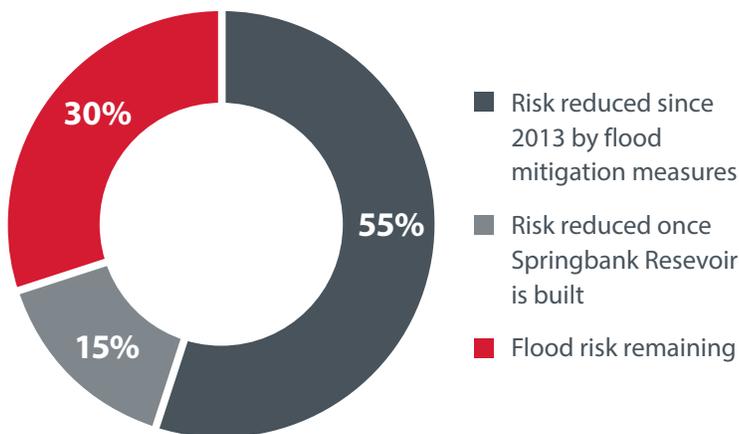
Corporate Strategy	Alignment
Municipal Development Plan (updated 2020)	4.4 Flood Hazard Areas
Calgary's Greater Downtown Plan (2021)	Strategic move 2: A green network for a healthy environment
Resilient Calgary Strategy (2019)	Pillar 1: The Future of Calgary's Economy Pillar 4: Future Ready Infrastructure
Climate Resilience Strategy (2018)	River Flood Management Program Natural Assets Adaptation Program
Environmental Strategy (2021)	Goal: Build resilience to flooding
One Calgary One Water: A framework for Calgary's water secure future (2020)	Priority Action 4: Advocate for a new upstream reservoir on the Bow River



A 2019 Public Safety Canada report found that for every \$1 invested in flood mitigation efforts, \$7 to \$10 can be saved in post-flood recovery costs.

## Implementing the Plan: 2022 status

Since 2013, The City of Calgary, with financial assistance from the Government of Alberta and the Government of Canada, has invested in **over \$150M in new flood mitigation infrastructure**. This has reduced our city's flood risk by 55 per cent and our risk of flood damages by \$90M every year.



### How is the cost of flood damages calculated?

The City uses **Average Annual Damage** to estimate the expected cost of flood damages to Calgary, and to show the cost of damage avoided once flood mitigation is in place. The Average Annual Damage estimates the costs of flood damage in a given year, based on the probability of different sized floods.



## Upstream flood protection

Key action	Rationale	Status as of 2022
<p><b>Elbow River – Advocate for the Government of Alberta to build the Springbank Off-Stream Reservoir (SR1)</b></p>	<p>This “dry reservoir” will divert floodwaters from the Elbow River into the reservoir, where it would be temporarily stored and released slowly back into the river.</p> <p>SR1 will reduce flood risk significantly on the Elbow River. Together with the higher gates at the Glenmore Dam SR1 will protect to a 2013 flood and reduce damages by over \$3B through the next century.</p>	<p>Construction underway.</p> <p>The reservoir will be operational in 2024 and fully complete the following year.</p>
<p><b>Bow River – Advocate for the continued TransAlta operational agreement with the Government of Alberta</b></p>	<p>TransAlta’s Ghost Reservoir can be operated to protect Calgary from smaller floods and complement the function of community barriers for even higher protection. This seasonal operating agreement with TransAlta Corporation manages flows on the Bow River upstream of Calgary to help protect communities along the Bow River against the impacts of both floods and drought.</p>	<p>Operating agreement renewed for 2021 – April 2026</p>
<p><b>Bow River – Advocate for the Government of Alberta to build an upstream reservoir for flood mitigation and water supply</b></p>	<p>A new upstream reservoir on the Bow River would manage and slow down the river flows through Calgary during potential flood events.</p> <p>A new upstream reservoir offers the most flexible way to reduce the impacts of severe weather including flood damages to all Calgary communities on the Bow River, and will enhance the function of community barriers to provide an even higher level of protection. A new reservoir will also help provide climate adaptability and increase water supply capacity during a drought.</p>	<p>Government of Alberta Bow River Reservoir Options Phase 2 feasibility study is underway. Anticipated completion in 2023 followed by the decision on whether to move to Phase 3.</p>



## Community-level flood protection

Key action	Rationale	Status as of 2022
<b>Structural measures</b>		
<b>Higher gates at the Glenmore Dam</b>	<p>New 2.5-metre-high steel gates installed at the Glenmore Dam double the Glenmore Reservoir's storage capacity, improving our ability to control high river flows in the spring on the Elbow River. The Glenmore Dam gates will work with SR1, once it's completed, to manage a 2013-size flood.</p> <p>Doubling the reservoir capacity also increases water supply during the fall/winter when river flows are slower.</p>	Completed in 2020
<b>Flood barriers in vulnerable communities</b>	<p><b>West Eau Claire and Downtown</b></p> <p>This barrier will protect Downtown, Chinatown, East Village and Eau Claire communities from a 1:200 flood event while integrating into the public space that connects Calgary's downtown with the Bow River.</p> <p>Construction of removable flood barriers installed in the lower deck of Centre Street Bridge to prevent flooding into Chinatown.</p> <p><b>Sunnyside-Hillhurst</b></p> <p>The Sunnyside flood barrier will protect Sunnyside and Hillhurst from 1:100 flood event.</p> <p>The barrier will be incorporated within the Memorial Parkway Program, to improve the entire public space surrounding Memorial Drive from 14th Street to Centre Street, including new places for commemoration and access to the river, and a reimagining of Memorial Drive to improve how people move around.</p>	<p>The West Eau Claire flood barrier was completed in 2018.</p> <p>The Downtown flood barrier will be operational in spring 2022.</p> <p>Centre Street bridge improvements were completed in 2018.</p> <p>The Sunnyside-Hillhurst flood barrier is expected to be operational by 2025.</p>

	<p><b>Bowness</b> A proposed barrier in Bowness would be effective at reducing damage from overland flooding. The project would need to be built on private land, so The City worked closely with the community throughout initial studies. Many community members wanted more details on the Government of Alberta's plans for an upstream reservoir before progressing further. As a result, The City is not moving forward with further work related to a barrier until Government of Alberta work progresses.</p> <p><b>Heritage Drive</b> A flood barrier along Heritage Drive SE beneath the Graves Bridge ensures this important access route on Glenmore Trail remains open during a flood and is critical for maintaining access for emergency responders and reducing disruption to traffic. The barrier incorporates some public art and public pathway protection.</p>	<p>Feasibility study completed in 2021.</p> <p>As more information on the Government of Alberta plans for an upstream Bow River Reservoir becomes available The City will re-evaluate its approach for Bowness.</p> <p>Completed in 2019.</p>
<p><b>Bonnybrook Wastewater Treatment Plant flood mitigation</b></p>	<p>A berm is being constructed to protect the Bonnybrook Wastewater Treatment Plant, which services one-third of our population.</p>	<p>The 700-meter-long east portion of the flood protection berm was completed in fall 2021 and construction of the south berm is ongoing.</p>
<p><b>12 Street SE and 9 Avenue SE bridge replacement in Inglewood</b></p>	<p>Raising two bridges to prevent damage during high water events and maintain access for fire and emergency services for the community of Inglewood-Ramsay.</p>	<p>12 Street SE bridge completed in 2017.</p> <p>9 Ave SE underway – expected completion in 2022.</p>
<p><b>Upper Plateau Separation in Sunnyside</b></p>	<p>A larger, dedicated pipe will provide an express route to move stormwater from communities on top of the hill directly to the river, bypassing Sunnyside and helping prevent flooding in the area.</p>	<p>Expected completion in 2023.</p>
<p><b>Roxboro and Sunnyside Pump Stations</b></p>	<p>Construction of new pump stations to move water out of the community during heavy storms and river flooding.</p>	<p>Roxboro completed in 2018.</p> <p>Sunnyside completed in 2020.</p>
<p><b>Stormwater system and outfall upgrades</b></p>	<p>Resilience upgrades to 15 stormwater outfalls to prevent back-flooding into affected communities.</p>	<p>Completed in 2018.</p>

<b>Western headworks site condition improvements</b>	Area improvements to allow operation of a nearby outfall gate, reducing flood risk for Inglewood, Calgary Zoo, Deerfoot Trail and Pearce Estate Park. Additional improvements improved emergency access for river emergencies and gate operations during a flood.	Completed in 2018.
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**Non-structural measures**

<b>Updating Government of Alberta flood inundation and Flood Hazard Maps</b>	The City provided technical feedback to the Government of Alberta on drafting updated flood inundation maps. These maps are used by The City to inform our emergency response planning and infrastructure design.	Draft inundation maps released online in 2020. Final inundation maps expected to be released with new Flood Hazard Area maps.
	The City is working closely with the Government of Alberta on new Flood Hazard Area maps being developed for Calgary to understand what impacts new maps and classification changes could have in Calgary. New maps will reflect the latest understanding of how a 1:100 flood would impact Calgary and will introduce some changes to flood hazard classifications. The new maps will show some Calgary communities with increased flood hazard areas and others showing decreased flood hazard areas.	Updated Flood Hazard maps are anticipated to be released in 2023.

<b>Modernizing floodplain land use policies and building regulations to guide how we plan and develop in river communities</b>	We are updating the Calgary River Valleys Plan, which directs how we develop and regulate in the floodplain. The Plan will respond to new Government of Alberta Flood Hazard Maps and consolidate floodplain policy to direct updates to the Land Use Bylaw, Municipal Development Plan, and other plans and regulations. This work will explore the relationship between structural measures and land use policy direction.	Initial updates to the Land Use Bylaw and Municipal Development Plan were completed in 2014.  Comprehensive update to the Calgary River Valleys Plan initiated.
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<b>Refinements to forecasting, monitoring, and emergency response planning</b>	The City’s comprehensive forecasting, monitoring and emergency response plan is reviewed annually with training exercises held every spring.  Emergency planning and response is critical to ensuring public safety, business continuity, and minimizing damage during a flood.	This work is ongoing with additional investments to be reviewed and made as necessary.  In 2020, we improved our forecasting platform with real-time precipitation and river flow data with the latest forecast models for our region.
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## Other community flood mitigation

### Calgary Zoo flood mitigation

The Calgary Zoo Flood Mitigation project includes protection above and below the ground surface, defending the island with a sealed sheet pile wall and dewatering system to protect animals and the Zoo from a 1:100 flood event.

Completed in 2018.

### Deane House flood wall and Inglewood flood barrier

Construction of a flood wall near the Deane House and behind homes on New Street to protect Inglewood.

Deane House completed in 2015.

Inglewood completed in 2011.

### Calgary Stampede

After 2013, the Calgary Stampede undertook several flood resiliency efforts, including building a new flood wall and improving their flood response plan. They also reclaimed sections of the Elbow riverbank while enhancing fish habitat in the Calgary Stampede area of the river.

Completed in 2014.





## Seamlessly adding flood protection into public spaces

Many places that need flood protection are where Calgarians live but are also well-loved places where they come to visit.

In West Eau Claire, flood protection for this area was designed to harmoniously incorporate functional elements such as a flood wall with a bench, a raised promenade and cycle path, stepped terraces, and the Delta Garden, which is a flood barrier integrated with raised topography and planters.

Together this infrastructure protects the safety of those that live in the area and the heart of the city and region's economy while enhancing the quality of life and experience for people living, working and visiting the area.

This design approach is continuing with the completion of the Downtown flood barrier.

In Sunnyside, we're using a similar approach. Work is underway to pursue an integrated vision to improve the entire public space surrounding Memorial Drive from 14th Street to Centre Street while adding critical flood protection. It will include:

- Creating more unique spaces that bring us together to connect with each other, our history and to nature.
- A focus on improving how people move around the area, whether it's by foot, bus, bike, or car for safer and easier passage.

- Providing more and safer access points for people to get to the river.
- Introducing new ways to enhance the vibrancy of the natural environment while preserving as many trees as possible. This includes the Memorial poplar trees that remember our fallen soldiers.

Once the flood barrier is complete, it will protect the Sunnyside-Hillhurst community from future flooding, averting an estimated \$2.7 million in flood damages annually.



## Property-level flood protection

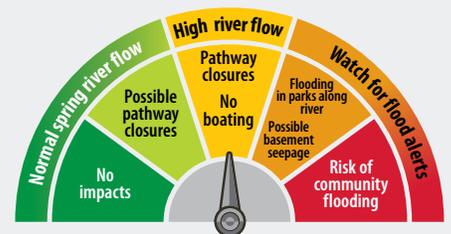
Key action	Rationale	Status as of 2022
Expand public education tools	<p>The City holds an annual Flood Readiness campaign every year from May 15 to July 15 to increase citizen awareness of flood risk.</p> <p>Several online resources are available at <a href="https://calgary.ca/floodinfo">calgary.ca/floodinfo</a>, including interactive maps to help Calgarians understand their own flood risk, suggestions on how to be prepared and tools to help them stay informed of river conditions throughout the high river flow season.</p> <p>We continue to build tools as part of a year-round effort to support citizens in reducing their risk from all types of flooding.</p>	Developed in 2015; reviewed, improved and delivered annually
Financial support for property owners	The City is researching and evaluating potential opportunities to support property owners with their flood resilience. Future programs should provide fair access to supports and be cost-beneficial where possible	Initiated
Recovery assistance	Monitor and support financial recovery assistance programs such as insurance and government support for property owners.	Ongoing

## Helping Calgarians understand river conditions

With many Calgarians keeping a close eye on the river every spring, a new tool was developed to help them quickly and easily make sense of the conditions, so they can be prepared.

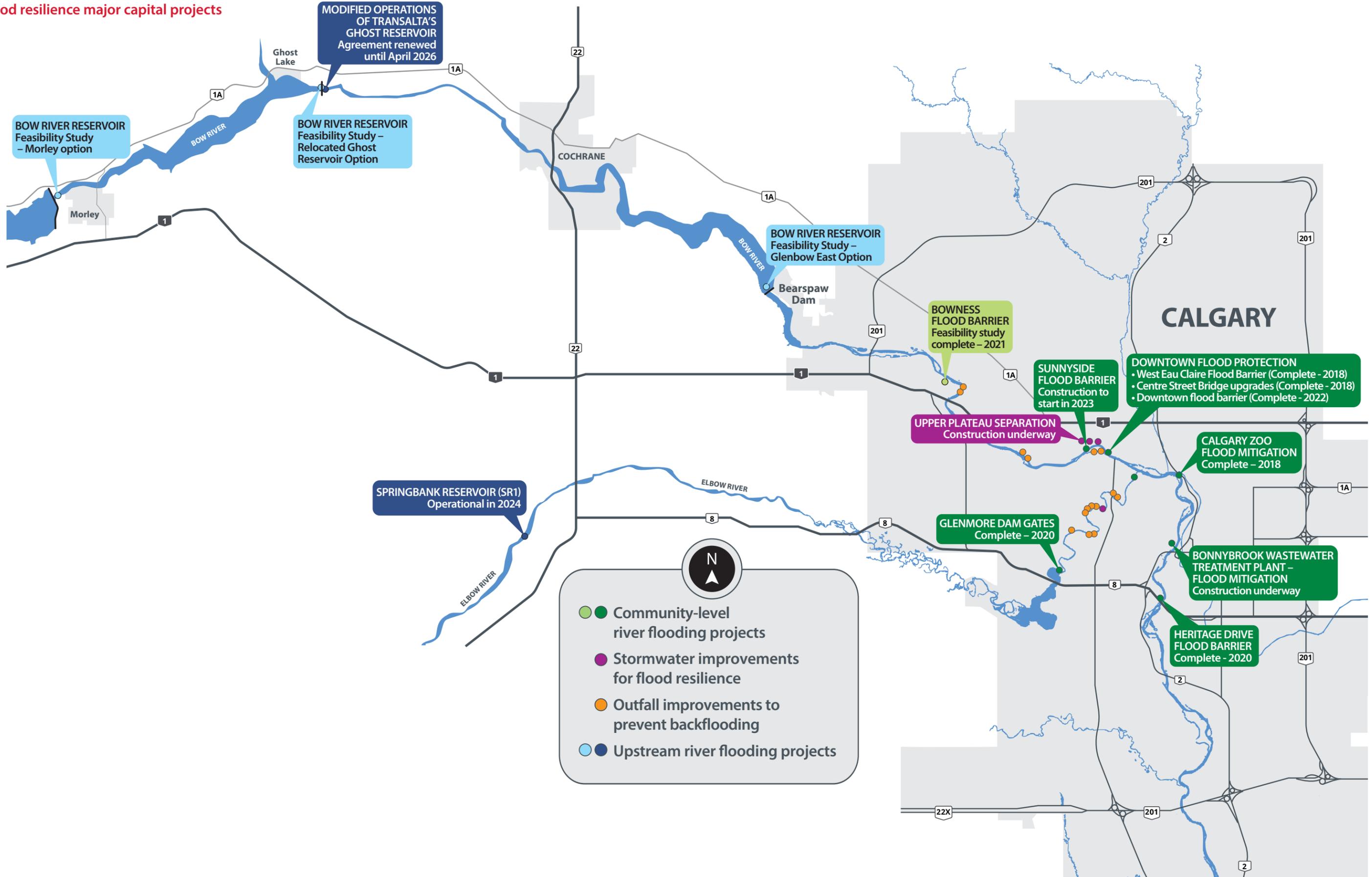
Updated each weekday during flood season, the flood dial provides Calgarians a quick snapshot of the daily river conditions to explain current river flows. We also provide details about the forecast and snowmelt over the next 24 hours and how it might affect river flows, how The City is responding to the current conditions and what citizens should do to be prepared.

Since the weather can change quickly, we encourage signing up for alerts to be advised of any changes.



Calgary River Conditions  
Bow and Elbow Rivers

Flood resilience major capital projects





## The path ahead

Calgary is better prepared today for flood events like the one in 2013. We've taken significant steps to reduce Calgary's exposure to flood damage, but there remains work to be done. The path to resilience is a complex process over many years with short, medium and long-term milestones.

Moving forward, as key projects and programs to increase resilience are implemented, we are continually monitoring, reviewing and adapting our flood resilience planning to respond to our current environment and to meet future challenges. We will continue ongoing work to understand climate risks, and factor them into each of the focus areas within our designs plans and other flood resilience work.

## Key focus actions going forward (2022-2025)



### Upstream flood protection

**Bow River upstream** – Support the Government of Alberta’s Bow River Working Group process evaluating three potential upstream reservoir sites. Whether a recommendation for one site to proceed to detailed design engineering and regulatory evaluation will be decided after a report on the three sites is released sometime in late 2023. This project will influence future flood mitigation decisions for some communities on the Bow River, and other investments The City may need to make.

**Elbow River upstream** – Continue collaboration with the Government of Alberta on the Springbank Off-Stream Reservoir’s technical operations committee to establish operational and monitoring coordination.



### Community-level flood protection

**Sunnyside-Hillhurst barrier** – Start construction of the Sunnyside Flood Barrier project by 2023, with an expected completion by 2025, while other components of the Memorial Parkway Program are explored and delivered.

**Bowness** - Assess the impacts of updated Flood Hazard Area Maps and land use planning work in the Calgary River Valleys Plan update, in addition to potential future upstream mitigation, on the community. Review, update and evaluate emergency response plans,

residual risk, and potential necessary community infrastructure once new maps and information on a reservoir is available.

### Land Use Planning, Development, Redevelopment, and Mapping

– Complete the Calgary River Valleys Plan update. A broader understanding of the importance and value of Calgary’s river valleys should form the foundation of this work. As such, the plan update will integrate extensive community engagement and uphold the City’s commitment to equity and reconciliation. The updated Plan will seek to balance the safety and resilience of river communities while ensuring they remain great places to live.

Recent reductions to the Provincial Disaster Relief Program reinforce the importance of updating City policy and building regulations to make properties more resilient to flooding. Strong building regulations complement structural flood mitigation to better manage flood risk.

As part of this process, we are reviewing our existing floodplain policies and regulations, and gathering feedback to update the Calgary River Valleys Plan. The desired outcome is a new policy framework guiding planning and land use decisions in and around our river valleys, and directing potential updates to our Municipal Development Plan, land use bylaw, or other documents in the Next Generation Planning Program. The completion of this work is dependent on the Government of Alberta’s release of updated Flood Hazard Area maps, and is expected to be complete in 2024+.

In alignment with Calgary’s Greater Downtown Plan, we will also continue to work with developers and project

teams to address flood resilience of major infrastructure and development in the downtown area, such as the Greenline, BMO Centre, Calgary Event Centre and new bridges in the area.



### Property-level flood protection

Supporting property owners and citizens – Continue working with Calgary’s floodplain communities to enhance public education and awareness. Investigate the feasibility, practicality, and ability to develop flood mitigation support programs for property owners.

**Recovery assistance** – Increase communications and education for property owners on ensuring they have the right insurance in the event of a disaster. Monitor developments with the Government of Canada’s work on its Flood Insurance and Relocation Program, including a report expected to be released in 2022.

**Emergency response** – Continue to evaluate, revise, and update emergency response plans with the latest information annually. The City’s emergency response planning will evolve to reflect new infrastructure in place, to maximize public safety and ensure an effective response.

**Forecasting** – Continue to invest and improve The City’s monitoring and forecasting network and capabilities, and look for opportunities to dovetail with improvements that the Government of Alberta is making in their forecasting systems.

# APPENDIX A: Expert Management Panel Recommendations

The 2014 Expert Management Panel on River Flood Mitigation remains the foundational document for The City's flood resilience program. This includes continuing to progress on the Panel's 27 recommendations, which are integrated into our Flood Resilience Plan.

Status as of April 2022



■ Complete   ■ Ongoing   ■ Work underway

Action areas and recommendations	Status
<b>ACTION AREA 1:</b> Develop options for protecting communities, infrastructure and private property to a higher flood level.	
a. Perform a social, economic and environmental analysis to evaluate the need for a minimum flood protection level above the 1:100 flood currently used for land-use planning and structural protection across Calgary.	<b>Complete</b>
b. Create graduated flood protection level requirements for City infrastructure.	<b>Ongoing</b>
c. Expand the review of the Land Use Bylaw and other development regulations to update flood resiliency requirements for private property in flood risk areas.	<b>Underway.</b> Expected completion in 2024.
d. Strengthen partnerships with utility providers to improve resiliency of their infrastructure and operations, with first priority to energy supply and communication networks.	<b>Complete</b>
<b>ACTION AREA 2:</b> Support Calgarians in managing their flood risk through improved notification, forecasting and preparedness.	
a. Pursue a common river forecasting platform with Alberta Environment and Sustainable Resource Development (AESRD) and TransAlta for faster and more accurate information and alerts about future flood events.	<b>Complete</b>
b. In partnership with AESRD and TransAlta, expand the network of river and weather monitoring stations upstream of Calgary and protect stations from damage during flooding.	<b>Complete</b>

c. Incorporate lessons learned from the 2013 flood to enhance communication channels to keep Calgarians informed of conditions that may lead to high river levels.	<b>Complete</b>
d. Expand the flood risk communication strategy and provide information and tools that empower Calgarians to make informed choices and better manage their personal flood risk.	<b>Complete</b>
e. Develop programs that support building-owners to implement flood resiliency measures.	<b>Underway</b>
<b>ACTION AREA 3:</b> <b>As part of an integrated City and Provincial program, perform social, economic and environmental assessments of capital works options to increase storage, divert water and increase protection through additional flood barriers in the city.</b>	
a. In partnership with the Province, compare the three major capital works options for mitigating floods on the Elbow River and identify the optimal investment plan: <ul style="list-style-type: none"> <li>i. A diversion from the Elbow River to the Bow River, in accordance with the conclusions of the feasibility studies underway.</li> <li>ii. The Springbank off-stream diversion and storage site.</li> <li>iii. The McLean Creek dry dam.</li> </ul>	<b>Complete</b>
b. Increase the operating water storage capacity of the Glenmore Reservoir on the Elbow River through modifications to the Glenmore Dam.	<b>Complete</b>
c. Continue to cooperate with TransAlta and the Province to increase flood storage on the Bow River through existing TransAlta facilities.	<b>Complete</b>
d. Construct additional or higher flood barriers in key locations throughout the city and update temporary flood barrier plans to protect against higher flood levels.	<b>Ongoing</b>
<b>ACTION AREA 4:</b> <b>Manage Calgary's floodplain to reduce impact from river floods over the long-term.</b>	
a. Review The City's existing land-use planning documents and develop amendments, new guidelines or policies that will minimize development in the floodplain over time.	<b>Underway. Expected completion in 2024.</b>
b. Prepare a time-phased plan to modify structures that constrain river flow during flood events, such as pathways and bridges.	<b>Ongoing</b>
c. In partnership with the Province, develop a time-phased plan to remove buildings from areas with high flood risk, while minimizing the disruption to affected communities.	<b>Complete</b>

<b>ACTION AREA 5:</b> <b>Improve understanding of flood risks, present and future.</b>	
a. Publish up-to-date, graduated flood maps for public information.	<b>Complete</b>
b. Urge the Province to regularly review and update official flood hazard maps.	<b>Underway.</b> Expected completion in 2022.
c. Maintain a comprehensive flood risk database integrated with existing geographic information systems (GIS).	<b>Complete</b>
d. Develop a suite of watershed-scale climate models to capture various weather event scenarios, with input from regional partners, post-secondary institutions and other levels of government.	<b>Complete</b>
e. Collaborate with academic and other partners to develop computer models that identify groundwater movement in Calgary in relation to flood conditions.	<b>Complete</b>
<b>ACTION AREA 6:</b> <b>Establish a vision and framework for ongoing flood resiliency activities for The City.</b>	
a. Establish a permanent team within The City to oversee flood preparedness and resilience.	<b>Complete</b>
b. Connect with the Provincial body overseeing flood protection and loss reduction and support the Province's continuing analysis of flood mitigation options and implementation of appropriate measures throughout the Bow and Elbow watersheds.	<b>Ongoing</b>
c. Evaluate social, economic and environmental impacts of flood mitigation options.	<b>Complete</b>
d. Develop a comprehensive climate adaptation plan and implementation tools to reduce The City's infrastructure and operational vulnerabilities.	<b>Complete</b>
e. Host a national flood risk management workshop to share best practices and develop an ongoing networking group.	<b>Complete</b>
f. Provide an annual update to City Council on progress related to the recommendations from the Expert Management Panel on River Flood Mitigation.	<b>Ongoing</b>

# APPENDIX B: Corporate alignment with the Flood Resilience Program

Corporate strategy	Alignment
<p><b>Municipal Development Plan (updated 2020)</b></p>	<p>Section 4.4 Flood Hazard Areas. Policy 4.a: Increase public safety, reduce private and public property damage, minimize municipal liability, and enhance the city’s flood resiliency (see detailed policies 4.a.i – 4.a.xii).</p>
<p><b>Calgary’s Greater Downtown Plan (2021)</b></p>	<p>Strategic move 2. A green network for a healthy environment.</p> <p>Goal: Greater downtown is well-connected to the Bow and Elbow River corridors which retain their ecological function and natural characteristics while providing spaces of activity and enjoyment for everyone.</p> <p>Short term action: Consider improvements incorporating flood mitigation where necessary, enhanced walking and wheeling infrastructure, and ecological restoration for the Bow River riverfront west of 10 Street S.W. and south along the Elbow River from the confluence.</p> <p>Medium to long term actions: Continue to work with developers, the business community and residents on flood mitigation and related resiliency measures in Greater Downtown. Continue working with developers and project teams to address flood resilience of major infrastructure and development in the downtown area, such as the Greenline, BMO Centre, Calgary Event Centre and new bridges in the area. Continue working with Calgary’s floodplain communities to enhance public education and awareness.</p>
<p><b>Resilient Calgary Strategy (2019)</b></p>	<p>Pillar 1: The Future of Calgary’s Economy – A resilient economy depends on reliable infrastructure to connect neighbours, digitally and physically. Outcome 1C: Strengthening resilience through business continuity.</p> <p>Pillar 4: Future Ready Infrastructure – Intentional investment in infrastructure will support our resilience to technological advances, shocking weather events and chronic aging of our assets. Outcome 4A: Calgary infrastructure investment is strategic, coordinated and future-focused Outcome 4B: Calgary services are supported by shock and stress resilient watershed systems.</p>
<p><b>Climate Resilience Strategy (2018)</b></p>	<p>River Flood Management Program: Enhanced long-term vision for flood resilience in Calgary to reflect changing climate conditions. Aligned land use planning processes with flood risks and management practices.</p> <p>Natural Assets Adaptation Program: Updated planning and development practices for soil and vulnerable locations such as river banks and flood prone areas.</p>

**Environmental Strategy (2021)**

Goal: Build resiliency to flooding:

- Implement Calgary's Flood Resilience Plan, which includes a combination of upstream, community
- and property-level flood mitigation to make Calgary more resilient to river flooding considering climate uncertainty and continued urban development.
- Advocate for the Province to implement upstream mitigation on the Bow and Elbow Rivers.
- Continue to work with communities on flood mitigation barriers to mitigate river flood risk.
- Enhance planning policy and regulations in flood risk areas to protect citizens, property, and Calgary's river valleys.
- Enhance flood risk awareness and education programming to support citizens.

**One Calgary One Water:  
A framework for Calgary's water  
secure future (2020)**

Priority Action 4: Advocate for a new upstream reservoir on the Bow River. The City will continue to advocate for a new provincially owned upstream reservoir on the Bow River as a major component in flood mitigation and drought management for the Calgary region.

# Glossary

**1:100 Flood, 1% Flood, or 100-year Flood** – A “one in one hundred” flood is a large flood that has a 1 per cent chance of occurring in any given year (as per current statistical flood models). It can also be called a 1 per cent flood, since the probability that it will be exceeded in any given year is one per cent. It is important to stress that there will not necessarily be one flood of this magnitude every 100 years. It is even possible to have more than one 1 in 100 flood in the same year.

**1:200 Flood or 1:200-year Flood** – A flood whose magnitude has a 0.5 per cent chance (or 1 in 200 chance) of being equaled or exceeded in any year. Like the one in 100 flood, it is possible to have more than one in 200 flood in the same year.

**Calgary River Valleys Plan (CRVP)** – The 1984 City plan which contains a range of policies to establish a coordinated approach, over a 20-year period, to the development, use and conservation of Calgary’s rivers/ creeks and immediately adjacent lands. The City is working on an update to this plan.

**City Council** – City Council is the main governing and legislative body for The City of Calgary. Its role is to ensure The City of Calgary provides services Calgarians need and want. Calgary City Council consists of the mayor and 14 City councillors, one representing each of Calgary’s 14 wards.

**Climate Change** – A long-term change in climate patterns, both globally and locally, caused by an increase in greenhouse gas emissions produced primarily through fossil fuel combustion. Climate change means the range in weather conditions expected in many regions, such as temperature, precipitation, and wind, will shift over the coming decades. It is a risk multiplier, with its impacts expected to include more severe and frequent extreme weather events such as flooding, heat waves, drought, wildfires, seasonal storms, and high wind and hail events.

**Climate Change Adaptation** – The process and actions to manage the actual and projected climate impacts and risk to reduce the effects on built systems, the natural environment, and people. It is one of the ways to respond to climate change, along with mitigation.

**Design Flood** – The design flood standard in Alberta is the 1:100 flood, which is a flood that has a 1% chance of occurring in any given year. Different sized floods have different chances of occurring – for example, a 1:200 flood has a 0.5% chance of occurring in any given year and a

1:500 flood has a 0.2% chance of occurring in any given year – but only the 1:100 design flood is used to define the floodway and flood fringe zones on flood hazard maps.

**Drought** – Periods of less than average precipitation over a certain length of time. Drought is naturally occurring and can cause imbalances in the hydrologic system. With climate change, our region can expect more frequent and severe droughts.

**Dry Dam or Dry Reservoir** – A dam or reservoir constructed for the purpose of flood control, allowing water to flow past at a maximum rate, above which it temporarily holds back floodwaters, releasing them over a period of time.

**Flood** – Abnormally high water flow or water level that overtops the natural or artificial confining boundaries of a waterway.

**Floodplain** – An area of normally dry land adjacent to a river that stretches to the base of the enclosing valley walls and is flooded during periods of high river flow.

**Floodway** – The portion of the flood hazard area where flows are usually deepest (>1 m), fastest (>1 m/s) and most destructive. The floodway includes the channel of a river and, in some places, the land next to the river. The floodway carries the bulk of the floodwater downstream. Current regulations prohibit new development within the defined floodway of the bow river in Calgary, as laid out in Calgary’s Land Use Bylaw Part 3 Division 3.

**Flood Barrier** – A permanent earthen embankment, wall, or a temporary wall constructed of sand bags or other materials, erected to provide protection from floods.

**Flood Berm** – An engineered barrier that keeps water from entering and flooding an area. Flood berms are typically designed to protect an area from flooding up to a specific flood water level and can be overtopped if flood water levels exceed the height of the berms. To be considered as a dedicated flood berm for flood mapping purposes, operational and maintenance responsibilities must be formally documented by provincial or municipal owners.

**Flood Forecasting** – The use of computer models that use weather forecasts to determine how much runoff will occur, what the resulting flow in our rivers will be, as well as when the peak flow will occur.

**Flood Fringe** – The flood hazard area outside of the floodway that is or could be flooded during a 1:100 flood. The flood fringe typically represents areas with shallower, slower, and less destructive flooding. Current regulations require mitigation measures for any development in the flood fringe, including raising the main floor above the 1:100 flood elevation, as laid out in Calgary's Land Use Bylaw Part 3 Division 3.

**Flood Hazard Area (FHA)** – In Alberta, the flood hazard area represents zones on official provincial maps that define the areas likely to be affected by surface water flooding during what is considered to be a 1:100 flood (1% chance of occurring in any given year) at the time of mapping. The flood hazard areas mapped by the Government of Alberta are updated periodically, with an update currently underway.

**Flood Hazard Map** – A flood hazard map is a specific type of flood map that identifies the area flooded for the 1:100 design flood, and divides that flood hazard area into different zones of risk. These zones are used to regulate development in our Land Use Bylaw. Flood hazard maps can also show additional flood hazard information, including the incremental areas at risk for more severe floods like the 1:200 and 1:500 floods.

**Flood Inundation Maps** – Flood inundation maps show areas at risk for different sized floods, including ice jam floods in some communities. These maps also identify areas that could be flooded if local berms fail, and are typically used for emergency response planning and to inform local infrastructure design. Older flood studies include maps for as many as three flood scenarios, including the 1:100 flood. Newer studies include maps for as many as thirteen scenarios, from the 1:2 flood to the 1:1000 flood. Flood inundation maps in the same area may be available for smaller or larger floods.

**Flood Mitigation** – Includes policies or structures that reduce the risk of floods to a community, either by preventing floodwater from entering the community or by reducing the potential damages or threats to public safety when flooding does occur. Flood mitigation infrastructure includes berms and dams with a dedicated flood mitigation purpose.

**Flood Protection** – Flood protection involves building and upgrading structures that hold back flood waters or prevent erosion or flood damage. Dikes, floodwalls,

diversion structures, erosion protection structures, debris traps, stormwater ponds, as well as some dams, reservoirs, and spillways all fall into this category.

**Flood Protection Level** – Flood magnitude (e.g. 1:100 flood) that infrastructure such as flood barriers are designed to withstand.

**Flood Resilience** – The ability of a system, community, or society exposed to flood hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a flood in a timely, efficient manner, including through the preservation and restoration of essential basic structures and functions through risk management.

**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).

**Flood Warning** – Rising stream levels will result in flooding of areas adjacent to the streams or rivers affected. Anyone situated close the river should take appropriate measures to avoid flood damage.

**High Hazard Flood Fringe** – a new zone designation pleon Flood Hazard Maps outside of the existing floodway, but where the flow during a 1:100 flood would still be deep (greater than 1 metre) and fast (greater than 1 metre/second).

**Infrastructure** – The technical structures that support a society, including roads, transit, water supply, sewers, power grid, telecommunications, etc.

**Land Use** – A permitted or discretionary use defined in the land use bylaw.

**Land Use Bylaw** – Legislative document that regulates development and land use in Calgary and informs decisions regarding planning applications.

**Municipal Development Plan (MDP)** – The MDP is a plan that guides growth and development in Calgary. It provides policies to support economic prosperity, efficient urban structure, great communities, good urban design, good connectivity, and environmental sustainability. It includes a land use plan with strategies to accommodate the additional 1.3 million people expected in the city in the 60-year time frame of the plan. The MDP is a statutory plan; that is, it is a type of plan required to follow the procedures outlined in the Municipal Government Act.

**Next Generation Planning Program** – Made up of nine initiatives, Next Generation Planning helps The City carry out the policies and meet the goals in the Municipal Development Plan and Calgary Transportation Plan (MDP/CTP). It: provides a coordinated and clear planning system for the whole city; modernizes our planning and development approach; updates and simplifies policy to meet the MDP and CTP, and; creates a better toolbox to allow for development and investment in Calgary.

**Overland Flooding** – Flooding of a property caused by the overflow of lakes, ponds, or rivers; or surface water from heavy rainfall or melting snow; or groundwater or rising of the water table entering a building at the ground level or seeping in through windows, doors, and walls.

**Policy** – A deliberate statement or plan to achieve an objective. Policies are instructive, directional, and positive, but not limited to a single course of action when some other course could achieve the same result.

**Protected Zone** – A new Flood Hazard Map zone where dedicated existing flood mitigation infrastructure, such as City-owned and maintained flood barriers, protect the area to at least the 1:100 flood level.

**Provincial Disaster Recovery Program** – A Program under the Government of Alberta which provides financial assistance for uninsurable loss and damage caused by emergencies and disasters.

**Recovery** – The process of returning a community, organization, businesses, institutions back to normality after a disaster.

**Regulation** – Created under authority granted by law, a regulation presents more specific requirements than the legislation itself.

**Reservoir** – A storage place for water created by the construction of a dam in a river valley. Water may be withdrawn for such purposes as irrigation, power generation, or water supply, or withheld from flowing into the river to mitigate the risk of flooding during a flood event.

**Riparian Area** – Transitional areas between upland and aquatic ecosystems. Riparian areas play an important role in protecting the river; they prevent excessive erosion, act as natural floodplains, provide riverbank stabilization, and offer aesthetic, economic, and recreational benefits.

**River Valley** – A valley (elongate depression on the Earth's surface) carved by a river during the course of its development. Includes a valley floor and valley sides.

**Stormwater** – Water from rainstorms or melting snow that goes into the storm drains in the road through an underground pipe system to our rivers.

**Stormwater Back up** – The City of Calgary's stormwater system empties into the Bow and Elbow rivers through large pipes. When the rivers rise, or there is excessive rainfall, water can flow back into the stormwater pipe system and spill back onto streets through stormwater drains.

**Stormwater Drainage Systems or Stormwater Infrastructure** – Used synonymously and refer to engineered conveyance systems for stormwater.

**Stormwater Outfall** – Engineered exit points by which stormwater leaves the pipe system and enters a river or creek.

**Sustainability** – Meeting the needs of the present without compromising the ability of future generations to meet their own needs. It includes environmental, economic, and social sustainability.

**Target** – A desired performance outcome for an indicator over a specified time period.

**Upstream Dam** – A dam is an engineered structure with the capacity to store water in a reservoir and thus regulate flows downstream. Not all upstream dams are considered dedicated flood mitigation infrastructure. Dam owners and operators must formally establish dedicated flood mitigation potential, in terms of dependable and significant peak flood flow reduction, for the impact of upstream dams to be considered as part of flood mapping for downstream communities.

**Upstream Mitigation** – Upstream physical measures such as dams and reservoirs are built to control or slow the flow of the river to reduce the risk of flooding to a community as a whole.

**Vulnerable Use** – Hospitals and medical facilities, Extended care facilities, Schools, Post-secondary education facilities, Correctional facilities, Rehabilitation treatment centres, Seniors residences.

**Wastewater** – A combination of liquid and water-carried pollutants from homes, businesses, industries, or farms; a mixture of water and dissolved or suspended solids.

**Watershed** – An area of land where waters flowing from different rivers, streams, lakes, and wetlands is conveyed to the same outlet. Other terms that are used to describe a watershed are drainage basin, catchment basin, catchment area and river basin. Large watersheds may contain several smaller sub-watersheds that drain into the same outlet.