FLOOD RESILIENCY AND MITIGATION

2020 Update Report

Table of Contents

EXECUTIVE SUMMARY

This report provides an update on The City of Calgary's flood resiliency and mitigation program activity in 2020. Flood resilience remains a top priority for The City and Calgarians. The City's Flood Resilience Plan focuses on a combination of upstream, community, and property-level mitigation initiatives to reduce flood risk in Calgary.

Highlights by The City in 2020 include:

- Completion of the new upgraded gates at the Glenmore Dam. The new gates double the Glenmore Reservoir's water storage capabilities, and will mitigate 20 per cent of a 2013-level flood the Elbow River through Calgary. The new gates were also operated for the first time in 2020.
- Completion of detailed design for the Downtown flood barrier and advancing preliminary design for the Upper Plateau Separation and Sunnyside flood barrier projects. These three projects are critical to building Calgary's flood resilience.
- Securing $20.8M from Infrastructure Canada's Investing in Canada Infrastructure Program for the Downtown flood barrier and Upper Plateau Separation flood mitigation projects. This offsets the financial impacts experienced by the early termination of the Alberta Community Resilience Program.
- Securing approximately $33M in Municipal Stimulus Program funding from the Government of Alberta for The City's Community Drainage Improvements program and Local Drainage Improvement projects. This funding will accelerate upgrades to The City's stormwater infrastructure in the communities of Sunnyside, Kensington, and Tuxedo, reducing flooding from intense rainfalls.
- Successful transition to a shared forecasting platform with the Government of Alberta. This increases The City's forecasting accuracy and enhances The City's ability to respond to potential flood events.

As of 2021, The City has successfully reduced its flood risk by over 50 per cent. This will be further reduced as additional flood mitigation is completed by The City, and through additional investments made by the Government of Alberta. Major milestones by the Government of Alberta in 2020 include:

- The Natural Resources Conservation Board announcing the Springbank Off-stream Reservoir Project's formal regulatory hearing starting 2021 March 22. This is the last major remaining regulatory approval required before the Government of Alberta can proceed with construction of the project.
- Completion of Phase 1 of the *Bow River Reservoir Options* study. The study is assessing the feasibility of three potential sites for a new reservoir on the Bow River upstream of Calgary. Phase 2 of the study has been started as of 2021 and will recommend one site for further study.
- Launching public consultation of the Government of Alberta's new draft inundation maps for Alberta, including Calgary. These maps will update flood mapping information across the province and will inform updates to future regulatory Flood Hazard Area maps.

Despite a challenging year with the COVID-19 pandemic forcing work to be done differently, The City remains on track in its efforts to reduce flooding in Calgary and providing high quality services to Calgarians.

1. INTRODUCTION

Eight years after the devastating 2013 flood, building flood resilience remains a top priority for The City of Calgary (The City). During this time, The City has been implementing its Flood Resilience Plan, approved by City Council in 2017. The plan reflects The City's strategic approach that combines watershed, community-level, and property-level mitigation to increase flood resiliency. This strategic approach is designed to ensure that flood risk in Calgary is reduced, is flood resilient in spite of climate uncertainty, and that development is sustainable without adversely affecting flood risk.

Despite the ongoing COVID-19 pandemic, significant milestones and notable progress in a number of areas of the Flood Resilience Plan were achieved. This was done through continued collaboration with the Government of Alberta and seeking ways to continue work with stakeholders and progress community resilience efforts. The City continues its focus on implementing the plan in 2021 and working with community stakeholders and the Government of Alberta to ensure Calgary is resilient to future flood risk.

2. 2020 FLOOD SEASON

2.1 2020 SEASONAL CONDITIONS

Spring 2020 started off with an above average snowpack. Summer precipitation was average along the eastern slopes and above average in Calgary. Water levels on the Bow and Elbow River stayed within the normal range throughout most of the year, with short periods of above average flow due to multiple moderate precipitation events.

Calgary experienced a peak flow through Calgary on the Bow River (350 m^3/s) in early June, while the Elbow River peak flow (75 m^3/s) occurred in late May, with both resulting from a combination of precipitation and snowmelt. No emergency response activities were required in 2020. There was a boating advisory in place for two periods during June and early July for the safety of boaters and rafters.

Flow on the Bow and Elbow River remained in the normal range from the summer through fall, and the Glenmore Dam was able to refill from its drawdown for the flood season by mid-July. With the Glenmore Dam upgrades completed, this winter has been the first time reservoir operators have been able to keep the reservoir at a higher elevation than historically possible, allowing for improved water security through the winter months when river flows are naturally low.

2.2 2020 FLOOD READINESS

Calgary's river flood risk remains highest from May 15 to July 15. The City continues to run its flood readiness campaign annually to inform citizens about its Flood Resilience Plan, remind citizens of their role in building flood resilience, and to help citizens understand, prepare, and stay informed before, during, and after a flood event.

In response to the COVID-19 pandemic and heightened interest during flood season, The City began its seasonal communications early and adjusted some of its tactics in 2020 to provide Calgarians with up-to-date information on river conditions. This included additional emergency preparedness tips and resources to help Calgarians be prepared for flooding while following COVID-19 guidelines.

In 2020, The City increased efforts to keep Calgarians informed about flood conditions when prolonged rain and severe weather was in the forecast. Supplementary e-newsletters and social media ads targeting river communities served to update Calgarians on the conditions, what impacts they might expect to see, and information on the risk of overland flooding. The City will continue these efforts and communicating earlier in the year in response to positive public feedback in 2020 and a continued desired to know more about early spring conditions.

Additional activities undertaken in 2020 included:

- Updating calgary.ca/floodinfo homepage with a revamped layout. Content focused on flood preparedness to ensure key actions for residents were clear along with additional COVID-19 emergency preparedness tips. Over the course of flood season, the web page saw nearly 20,000 visits, an increase of 230 per cent from 2019.
- Creating an animated video to explain the significance of the Glenmore Dam improvements and the role of the new gates in reducing flooding on the Elbow River. The video was viewed over 1,400 times and reached 25,000 Calgarians.
- Creating a summary of The City's Flood Resilience Plan that explains the interconnection of upstream, community and property-level components, including initiatives on the Bow and Elbow River.
- Continuing The City's biweekly flood e-newsletter, distributed to over 1,500 subscribers from April to July.
- A river conditions dial was tested with internal stakeholders to provide updates on river conditions and received positive feedback (Figure 1).

In 2021, The City will seek opportunities to build on citizens' appetite for updates on river conditions by advancing the start of its flood readiness campaign. In addition, the e-newsletter will be shifting to a weekly format to deliver more timely updates on river conditions and will include a river conditions dial as a quick visual tool to help quickly convey the river flows and potential impacts. The City continues to find ways ensure citizens get the information they need on flooding in a timely manner.

FIGURE 1: THE RIVER CONDITIONS DIAL WAS TRIALED INTERNALLY IN 2020 TO PROVIDE AT-A-GLANCE UPDATES ON RIVER CONDITIONS.

In addition to the campaign events, The City continues to work on developing flood risk awareness and education programming for citizens. More information on this work can be found in Section 2.7 below.

A key component of The City's flood readiness efforts includes year-round monitoring and forecasting of weather conditions. The City significantly enhanced its forecasting capabilities in 2020, moving to a shared forecasting platform with the Government of Alberta. This new platform shares real-time weather data with the Government of Alberta, enhances The City's ability to anticipate potential flood events and supports The City's ability to enact emergency response plans in advance of potential flood events.

2.3 BACKGROUND

The City's Flood Resilience Plan continues to pursue a flood resilience strategy that considers a combination of watershed, community-level, and property-level mitigation (Figure 2) to build comprehensive, layered flood resilience throughout Calgary. Approved by City Council in 2017, the plan remains consistent with international best practices, recognizing that flood risk can never be completely eliminated, and no single piece of mitigation is capable of reducing flood risk to acceptable levels on its own.

The Flood Resilience Plan was developed based on the recommendations of the 2014 *Expert Management Panel on River Flood Mitigation* report. As of 2021, all of the Panel's recommendations are either underway or complete. While The City will continue to pursue the recommendations from the Expert Management Panel, future annual updates will focus primarily on implementing the plan. The City's progress on the panel's recommendations can be found in Appendix A.

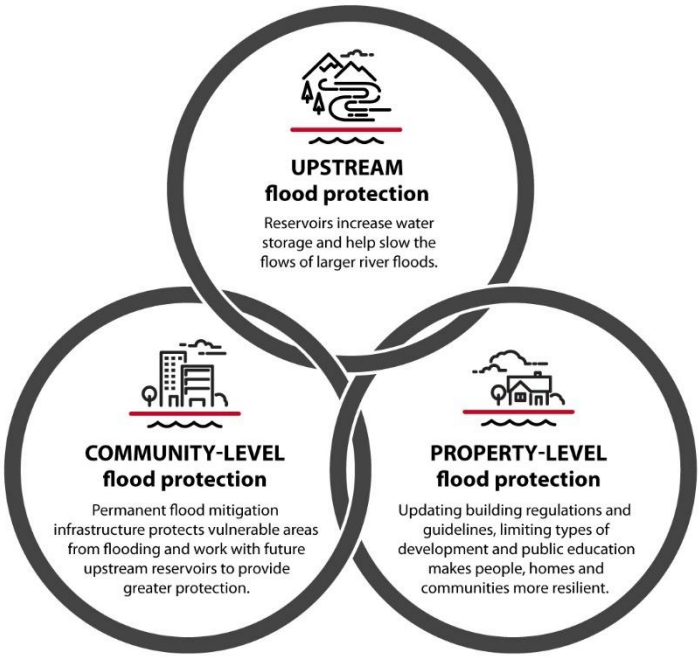


FIGURE 2: THE CITY OF CALGARY'S FLOOD RESILIENCE PLAN RELIES ON A COMBINATION OF UPSTREAM, COMMUNITY-LEVEL, AND PROPERTY-LEVEL MEASURES WORKING TOGETHER TO MAXIMIZE CALGARY'S FLOOD RESILIENCE.

The City regularly reviews and updates its data on flooding in Calgary, invests in The City's flood forecasting capabilities, conducts year-round monitoring of conditions, continually updates flood emergency response plans, and conducts annual preparedness training for staff to ensure The City is ready to respond to potential flood events. The City goes through these efforts to ensure decision-

making considers the most accurate information available, and the plan can adapt as new information on issues, such as climate change, become clearer.

2.4 2020 PROGRESS

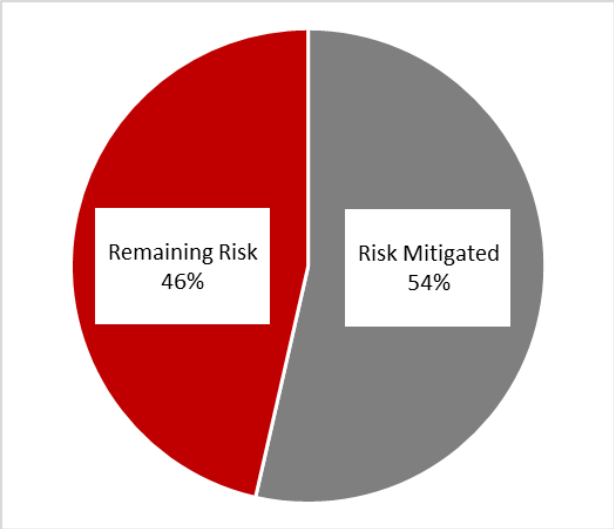


FIGURE 3: AS OF 2020, CALGARY'S THE RISK OF POTENTIAL DAMAGES FROM FLOODING HAS BEEN REDUCED BY OVER 50 PER CENT.

Through its ongoing efforts to build flood resilience and work with other orders of government and communities, The City of Calgary has successfully reduced the potential damages from river flooding in Calgary by over 50 per cent (Figure 3). In 2020, The City continued to work with stakeholders to move community-level mitigation forward. The City remains committed to working with community stakeholders to understand and address their concerns and seek practical flood mitigation solutions.

The City also provided technical input to the Government of Alberta as it updated its flood inundation maps and prepared for public engagement on the maps in 2021. The City also supported the Government of Alberta as it started Phase 2 of its *Bow River Reservoir Options* study, and began its preparations for the Natural Resources Conservation Board's Environmental Impact Assessment public hearing for Springbank Off-stream Reservoir (SR1) project that was scheduled 2021 March 22. Upstream mitigation remains a work in progress, and new reservoirs on the Bow and Elbow Rivers are critical outstanding components to Calgary's flood resilience.

Starting in 2020, The City also began reviewing its approach to floodplain policy. This work aims to modernize Calgary's approach to development in the floodplain and balance urban planning interests to support flood resilient communities. Updating Calgary's floodplain policy and regulations will reflect The City's commitment to building and maintaining safe, vibrant, and resilient river communities. More information on this work can be found in section 3.5.

2.5 ELBOW RIVER MITIGATION

2020 marked a milestone in The City's efforts to reduce flood risk on the Elbow River thanks to the completion of the infrastructure upgrades at the Glenmore Dam, which included new higher, automated steel gates. This work is the most significant advancement for flood protection along the Elbow River since the Dam was built 85 year ago.

The addition of new, higher gates doubles the volume of available water storage at the Glenmore Reservoir. In addition to allowing greater control of flows through Calgary during a flood, this volume provides future water supply resilience for Calgary and helps meet the needs of a growing city. The gates were fully functional for the 2020 runoff season that runs from May through July, which is when flood risk is typically highest in Calgary.

The new gates were completed with the support of the Government of Alberta's Alberta Community Resilience Program. The new gates will work with SR1, once it is completed, to fully mitigate against a 2013-sized flood through Calgary.

SR1 remains the largest piece of upstream mitigation measure on the Elbow River, and will account for as much as an 80 per cent reduction in flood risk once completed. SR1 finished undergoing Environmental Impact Assessment review by the Environmental Impact Assessment process with the Impact Assessment Agency of Canada in 2020. As of 2021, the Agency released its draft decision in 2021 January, and with a final decision anticipated around 2021 June.

The City participated in the Natural Resource Conservation Board's pre-hearing conference for SR1 on 2020 December 2. The pre-hearing was an opportunity for stakeholders to state their interest in the project and determine if they would be granted the opportunity to voice whether they think SR1 is in the public interest or not. The City was granted full participant status at the project's 2021 March 22 formal hearing. The Government of Alberta anticipates if SR1 is approved, it will be functional two years from the start of construction, and completed three years from start of construction.

THE NEW UPGRADED GATES AT THE GLENMORE DAM REDUCE CALGARY'S FLOOD RISK ON THE ELBOW RIVER.

2.6 BOW RIVER MITIGATION

With the completion of the Glenmore Dam improvements and Springbank Off-Stream Reservoir proceeding with its Environmental Impact Assessment, the majority of the remaining risk remains on the Bow River. The Flood Resilience Plan identifies three main components for flood mitigation on the Bow River: A new reservoir upstream of Calgary, community barriers for communities at greatest risk of flooding, and continuation of the Government of Alberta's operating agreement with TransAlta Utilities.

The Government of Alberta announced 2018 November Phase 1 of its *Bow River Reservoir Options* study, which was a conceptual assessment of potential upstream reservoir sites on the Bow River. The Government of Alberta completed Phase 1 of its study in 2020 March, and identified three potential reservoir sites upstream of Calgary (Figure 4). The Government of Alberta began Phase 2 of its study in 2020 November. Phase 2 will incorporate geotechnical data in assessing the feasibility of the three sites, recommend one site to move forward into more detailed study, and will assess alternatives-to a reservoir that could achieve a similar outcome. In the Government of Albertas 2020 February budget,

$15M in funding was announced for Phase 2. This budget was confirmed in their 2021 February budget. This work is expected to continue until 2023. The City remains supportive of this work and continues to state its importance for the Calgary Metropolitan Region in spite of ongoing economic and public health challenges. The City remains in regular contact with the Government of Alberta to stay up to date on the progress of the study.

The five-year seasonal Ghost Reservoir operating agreement between the Government of Alberta and TransAlta, originally signed in 2016, was renewed in 2021 March. This agreement remains a valuable piece of mitigation on the Bow River for Calgary until an upstream reservoir on the Bow River is constructed, reducing the risk of smaller flood events on the Bow River causing damages through Calgary.

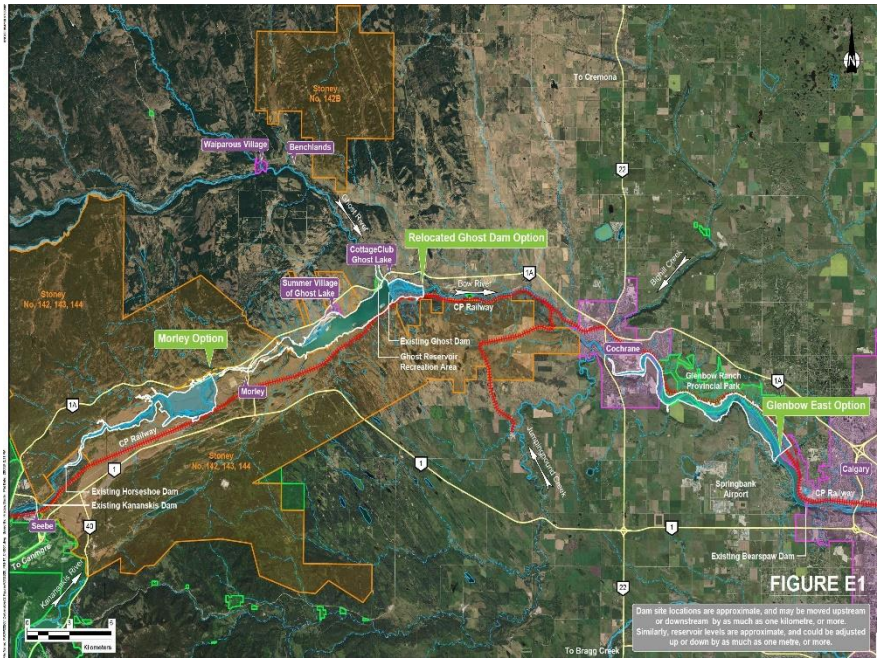


FIGURE 4: PHASE ONE OF THE GOVERNMENT OF ALBERTA'S *BOW RIVER RESERVOIR OPTIONS* STUDY IDENTIFIED THREE POTENTIAL SITES FOR AN UPSTREAM RESERVOIR ON THE BOW RIVER. *SOURCE: GOVERNMENT OF ALBERTA*

2.6.1 COMMUNITY MITIGATION

The City continued to advance its community flood mitigation work throughout 2020. This included:

- Completing the construction of the Heritage Drive flood barrier and stormwater liftstations in the community of Sunnyside (Sunnyside Pumpstation #1 and #2).
- Continuing construction of the 9th Avenue SE bridge, which includes flood resilient design elements.
- Completing detailed design for the Downtown Flood Barrier and starting detailed design for Upper Plateau Separation project.
- Completing preliminary design for the Sunnyside Flood barrier.

- Continuing engagement and completing more technical studies to inform The City's understanding of flooding conditions in the community of Bowness.

SUNNYSIDE PUMPSTATION #1 WAS COMPLETED IN 2020 WITH FUNDING SUPPORT FROM THE ALBERTA COMMUNITY RESILIENCE PROGRAM AND THE NEW BUILDING CANADA FUND TO REDUCE STORMWATER FLOODING IN THE COMMUNITY OF SUNNYSIDE

In 2019, the Government of Alberta announced that the Alberta Community Resilience Program would be terminated early. This resulted in a shortfall of $81M from its original $150M commitment, affecting the Downtown Flood Barrier and Upper Plateau Separation projects. In 2020, Infrastructure Canada, in partnership with the Government of Alberta, announced $20.8M in new funding for the Downtown Flood Barrier and Upper Plateau Separation projects through their Investing in Canada Infrastructure Program to address the previous loss of Alberta Community Resilience Program funding. This ensures The City can continue to deliver these projects without delay.

The Downtown Flood Barrier project will reduce flooding in Calgary's central business district up to a 1:200 event. This ensures Calgary's economy stays resilient, continues to grow, and the risk of flooding impacting economic recovery will be reduced**.** The Upper Plateau Separation project will address ongoing stormwater flood risk in the community of Sunnyside. Both projects are tentatively scheduled to begin construction before the end of 2021. As of 2020, the preliminary design of the Sunnyside Flood Barrier was completed and detailed design is currently underway.

The City continues to work with Bowness to explore the feasibility of a potential flood barrier for the community. Community engagement efforts continued throughout 2020 primarily through monthly meetings with the Bowness Flood Mitigation Working Group to communicate information to stakeholders and hear their feedback. The Working Group is made up of members from the Bowness Community Association, Bowness Business Improvement Area, Bowness Responsible Flood Mitigation Society, Bowness Senior's Association, the Ward 1 Councillor's office, and the general community.

In addition to engagement in 2020, The City shared details on the feasibility of a potential flood barrier with the community in 2021 January. Eight online information sessions were held with the community in 2021 January 13 to 2021 January 20, and an online engagement portal was active from 2021 January 4 to 2021 February 28 to gather community feedback. One-on-one meetings were also held from January to March with riverfront homeowners to provide them with an update on their flood risk.

Additional technical studies for Bowness were completed at the request of the community to better understand the community's hydrological conditions. These studies included:

- A detailed groundwater study to understand groundwater seepage in the community and the relationship between groundwater seepage and river flows.
    - A third-party technical review of the study was conducted to confirm the results. This was completed at the request of homeowners.
- Hydrotechnical modeling of river flows.
- Stormwater management studies.
- Geotechnical investigations.
- A biophysical field survey.

These studies were completed to inform the feasibility of a potential barrier in the community. During the engagement process, approximately 40 per cent of impacted homeowners indicated a strong preference to know more about the anticipated level of mitigation an upstream reservoir will provide and how a barrier will work with upstream mitigation before advancing progress on a potential barrier. Another 30 per cent were not supportive of a barrier at this time. The City will re-assess the community's flood risk, barrier feasibility, and re-engage the community, after the Government of Alberta completes Phase 2 of its *Bow River Reservoir Options* study.

2.7 PROPERTY MITIGATION, POLICY AND MAPPING

Flood resilience for Calgary remains a shared responsibility amongst The City, the Government of Alberta, the federal government, and citizens. The City continues to work to raise awareness of and support citizens in building their resilience to flooding. As part of The City's development of a flood education and awareness program, an education framework was developed in 2020 based on public research completed in 2019. The framework is focused on identifying opportunities to support citizens in taking an active role in flood awareness and strengthening community capacity. In 2021, work will focus on understanding communities' readiness to act, identifying engagement opportunities, and designing and developing educational tools and approaches that are tailored to individual community needs.

Up-to-date flood maps are an important tool for citizens to understand their flood risk and are critical for The City's ability to make appropriate flood mitigation decisions. In 2020 November, the Government of Alberta released draft inundation maps for Alberta, including Calgary. The maps use the latest data and models to identify where water will flow during a flood, and what land could be flooded in different sized floods. The updated inundation maps will inform the Government of Alberta's update of their Flood Hazard Area maps, which identify the regulated floodway and flood fringe zones, and are used to guide future land use, development and building regulations.

The anticipated Flood Hazard Area map update reflect the latest understanding of how a 1:100 flood would impact Calgary and include new flood hazard zone classifications. As a result, The City is undertaking a comprehensive review of our existing floodplain policies, exploring how to approach these new zones while balancing The City's commitment to building and maintaining safe, vibrant, and resilient river communities. The project will consider The City's progress in flood mitigation, linking land use policy to structural protection to balance urban planning and flood resiliency interests. The

deliverable will include an update the Calgary River Valleys Plan, which will inform updates to the Land Use Bylaw and The City's NextGen planning system to guide what development should and should not occur in each of the flood hazard zone classifications. This work will require significant city-wide engagement with residents, businesses, and other stakeholders and will take place once the Government of Albertas draft Flood Hazard Area maps are publicly available.

3. STORMWATER MANAGEMENT

Established communities built before 1988 are typically at higher risk of stormwater flooding due to older, undersized infrastructure. Stormwater flooding in communities close to the Bow and Elbow Rivers can also be compounded by river flooding risks. The City continues to address areas with high stormwater flooding risk through its Community Drainage Improvements program. The City continues to develop data and tools to better identify and quantify existing local stormwater flood risks in Established Areas in Calgary. This was done through the *Community-Scale Localized Flood Risk Mapping and Hydrologic Modelling* (City-wide Stormwater Modelling Project). The City-Wide Stormwater Modelling Project is updating The City's stormwater modelling and will help inform future investment plans and stormwater management program strategies. This project is expected to be completed in 2021, and an implementation plan will be developed later in 2021.

THE CITY OF CALGARY'S COMMUNITY DRAINAGE IMPROVEMENTS PROGRAM INVESTS IN UPGRADING THE STOMRWATER SYSTEM IN OLDER COMMUNITIES TO REDUCE THEIR SOTRMWATER FLOOD RISK.

The City-also continues to support Corporate and Regional Growth and Planning Initiatives to support development, mitigate flood risks and meet regulatory and environmental requirements:

- Work will commence in 2021 on the Belvedere Master Drainage Plan and the East Calgary Regional Drainage Studies, both critical in planning stormwater management for the eastern parts of Calgary. This work will establish stormwater management plans to ensure regulatory compliance, protect natural resources, and address stormwater management risk as part of the development of these areas.
- Work was completed on the Forest Lawn Creek Master Drainage Implementation Plan in 2020, with an investment strategy to be developed in 2021. This study assessed the current and anticipated post-development conditions of Forest Lawn Creek, recommending stormwater management concepts to protect the watershed while supporting future development.
- The City continues to be an active participant, board member, and financial contributor to the Cooperative Stormwater Management Initiative. The cooperative is comprised of three municipalities and one irrigation district that will accommodate stormwater from developments in three municipalities, ultimately draining east to the Red Deer River while keeping it separate from water intended for agricultural use.

- Water Resources continues to support corporate planning initiatives such as Main Streets, Local Area Planning, and the Established Areas Growth and Change Strategy, with a significant focus of the 2021 work plan on stormwater management strategies in support of planning and growth objectives. This work ensures that opportunities to improve stormwater management, address risks to existing customers, enhance the use of stormwater in the public realm, and support growth are identified and integrated into future development throughout Calgary.

3.1 COMMUNITY DRAINAGE IMPROVEMENTS PROGRAM AND LOCAL DRAINAGE IMPROVEMENTS

In 2020, The City invested approximately $16.3M in Community Drainage Improvement projects. As part of this work, the following was completed:

- Construction of Bebo Grove Wet Pond, located in Fish Creek Provincial Park, and Sunnyside Stormwater Lift Stations #1 and #2.
- Detailed design of Upper Plateau Separation which provides river flooding benefits. Construction is expected to begin in 2021.
- Preliminary Design of the 10 St NW Community Drainage Improvements package, as well as Local Drainage Improvements at 7 Avenue NW, 1 Avenue NW, 19 Street and 9 Avenue NW, 19 Street and 6 Avenue NW, and Sunnyhill Lane. Preliminary design for the Kensington Community Drainage Improvements package was started and will be finalized in 2021, with construction to begin in 2021.
- Accelerated design for the Tuxedo Community Drainage Improvements projects, including the proposed Tuxedo dry pond and associated trunk upgrades, 35 Ave NE trunk upgrade, 18 Av NE diversion pipe, and Local Drainage Improvements in the Tuxedo area.

THE BEBO GROVE WET POND WILL ALLOW FOR STORAGE OF STORMWATER DURING RAIN EVENTS AND IMPROVE THE QUALITY OF THE WATER DISCHARGED TO FISH CREEK.

Additional stormwater improvements as part of the Woodlands Woodbine drainage improvements also remain underway and will improve stormwater management in the communities of Woodlands, Woodbine, and Cedarbrae.

While The City's Community Drainage Improvements program is focused on larger scale stormwater system infrastructure upgrades and communities, more site-specific improvements to reduce localized flooding continue to be delivered throughout the city. In 2020, The City invested approximately $1.18M on Local Drainage Improvements. The City also developed a ranking

tool to assess and prioritize future Local Drainage Improvements investments. As part of this work, project efficiencies were also identified between the Community Drainage Improvements program and specific Local Drainage Improvements sites, including in the Northwest Inner-City, Tuxedo, and Macleod Community Drainage Improvement study areas.

In addition to the Investing in Canada Infrastructure Program funding announced by Infrastructure Canada for the Upper Plateau Separation project, the Government of Alberta announced approximately $33M in funding from its Municipal Stimulus Program in 2020 December to accelerate the delivery of projects identified in The City's Community Drainage Improvements program and Local Drainage Improvements priority projects, which will be used to support stormwater system improvements in the communities of Sunnyside, Kensington, and Tuxedo.

4. ACTIONS FOR 2021

Despite challenges associated with COVID-19, The City of Calgary's flood resiliency and mitigation program continued to see major success, with flood risk in Calgary now reduced by over 50 per cent. The public hearing for SR1 in 2021 will be another key decision point for flood mitigation in Calgary, and additional projects underway will continue to further reduce Calgary's flood risk once they are completed.

Preparations for the May-July spring runoff season are well underway, and The City is monitoring conditions in the mountains and seasonal forecasts to ensure it is ready to respond to a potential flood event. The City has a dedicated team in place that is focused on annual spring runoff preparations, ensuring that the necessary resources are in place to prepare, stay updated, and quickly respond to a flood. Flood response plans are reviewed annually and will consider how COVID-19 may require some things to be done differently in 2021, building on the experience of flood season during COVID-19 conditions in 2020. This includes ensuring citizens and staff are able to continue practicing physical distancing where required during a potential response.

For 2021, The City will be focusing on the following items:

Upstream:

- Monitor progress and support where possible Phase 2 of the Government of Alberta's *Bow River Reservoir Options* project and advocate for continued progress on a new upstream reservoir on the Bow River.
- Monitor for next steps after conclusion of Natural Resources Conservatin Board's public hearing on Springbank Off-stream Reservoir porject and support the Government of Alberta as necessary.

Community:

- Initiate construction on the Downtown Flood Barrier, Upper Plateau Separation, and Sunnyside flood barrier projects.
- Complete city-wide modelling of Calgary's stormwater system and identify areas of risk.

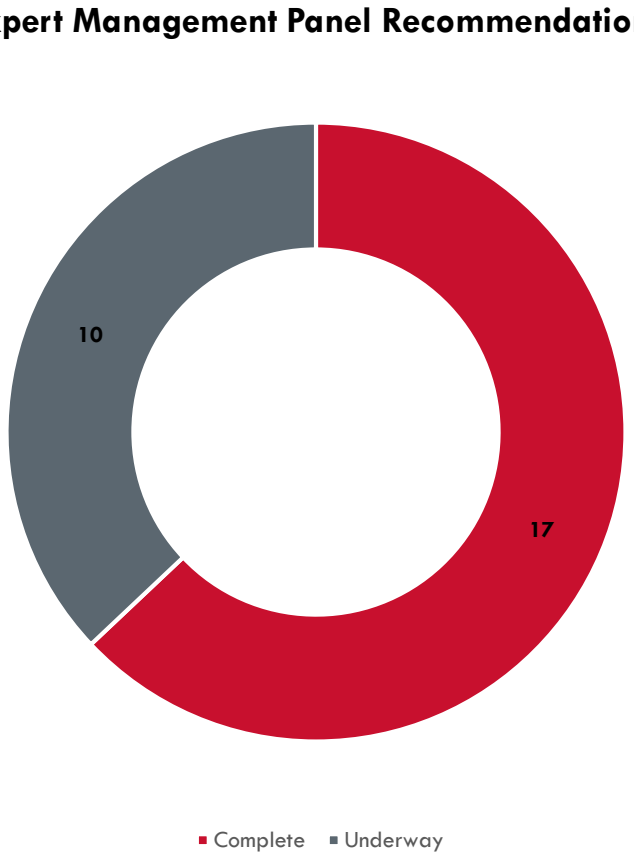
- Accelerate detailed design and construction of Northwest Inner-City and Tuxedo Community Drainage Improvements projects and Local Drainage Improvements projects.
- Complete the Deer Run Community Drainainge Improvements study.

Property:

- Develop components of The City's flood risk awareness and education program.
- Continue collaboration with the Government of Alberta on its flood mapping work, provide input on future Flood Hazard Area map updates, and prepare for implications new mapping.
- Continue work on reviewing The City's Land Use in flood-affected areas, preparing for future updates to the Land Use Bylaw, River Valleys Plan, and associated development tools.

APPENDIX A – EXPERT MANAGEMENT PANEL RECOMMENDATIONS

The 2014 Expert Management Panel on River Flood Mitigation remains the foundational document for The City's flood resiliency and mitigation program. Seven years after the 2013 floods, The City has undertaken significant work in various areas to make Calgary more flood resilient. This includes continuing to progress on the panel's 27 recommendations. As of 2021, 10 of the Expert Management Panel's 27 recommendations remain underway, with the rest completed. The City continues to monitor progress on these recommendations while advancing its overall flood resilience strategy.



INVESTING IN FLOOD PROTECTION

Investing in flood protection Expert Management Panel recommendation	Status	Timeline	2020 update
Prepare a time-phased plan to modify structures that constrain river flow during flood events, such as pathways and bridges.	Underway	Ongoing	Flood levels are currently considered as part of lifecycle project planning and implementation. Repair and reconstruction of bridges and pathways after 2013 were designed to withstand the 100+ year level flood, as are current bridge construction projects. Future construction or replacement of existing structures will be informed by future land use planning and development policy work. Flood resilience considerations will be included as part of the upcoming Municipal Development Plan and Land-use Bylaw reviews starting in 2019.
Develop a comprehensive climate adaptation plan and implementation tools to reduce The City's infrastructure and operational vulnerabilities.	Underway	2021+	The City released its climate change resilience plan in 2018, with Corporate progress reporting annually. Flood resilience work continues and is aligned with The City's overall climate resilience plan and corporate resilience strategy.
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 through the watersheds.	Underway	Ongoing	Phase 1 of the *Bow River Reservoir Options* Study was completed in 2020, recommending three potential sites for a new reservoir. Phase 2 integrate hydrotechnical data on the three options, and is expected to begin in 2021. The City continues to support the Government of Alberta's work towards building watershed mitigation on the Bow River.
Increase the operating water storage capacity of the Glenmore Reservoir on the Elbow River through modifications to the Glenmore Dam.	Complete	2020	The upgraded gates at the Glenmore Reservoir are complete and fully operational as of 2020. The elevated gates doubles the capacity at the Glenmore Reservoir and, operated in tandem with the proposed Springbank Reservoir, will provide mitigation for a 2013-level flood on the Elbow River.
Construct additional or higher flood barriers in key locations throughout the city and update temporary flood barrier plans to protect against higher flood levels.	Underway	Ongoing	The City continues to implement its Flood Resilience Plan. Construction of the Downtown Flood Barrier, Upper Plateau Separation, and Sunnyside Flood Barrier are expected to begin in 2021. Recommendations on next steps for the Bowness Flood Barrier were presented to Council on 2021 April 28. The City is working with communities to ensure potential mitigation measures are consistent with community values, and will be discussing potential trade-offs in mitigation options as it work with communities on these projects. Temporary barrier planning continues to be updated on an annual basis as part of The City's flood emergency response procedures.

Provide an annual update to City Council on progress related to the recommendations from the Expert Management Panel on River Flood Mitigation.	Complete	Ongoing	Annual updates are provided by Water Resources to Council's Standing Policy Committee on Utilities and Corporate Services. As of 2021, the 27 recommendations made by the Expert Management Panel in 2014 are all either underway or complete. The City will continue to report annually as it implements the remaining pieces of its Flood Resilience Plan.
Evaluate social, economic and environmental impacts of flood mitigation options.	Complete	2015-2016	A triple bottom line approach was used to assess possible flood mitigation measures as part of the Flood Mitigation Measures Assessment. The Assessment determined that a combination of upstream mitigation, community level mitigation, and property level mitigation was the most cost-sustainable approach to reducing Calgary's flood risk. The recommendations generated from this assessment were approved by Council in April 2017 (UCS2017-0266)
In partnership with the Province, compare the three major capital works options for mitigating floods on the Elbow River.	Complete	2015-2016	The Springbank Off-stream Reservoir was announced by the Government of Alberta in 2015, and the Government of Alberta has proceeded with this project, which is currently undergoing a federal environmental impact assessment. The City is participating on the Technical Advisory Committee for the Environmental Assessment of SR1 currently being undertaken by Impact Assessment Agency of CAnada.
Establish a permanent team within The City to oversee flood preparedness and resilience.	Complete	2015-2016	Funding requests for a permanent team were approved in December 2014. The Watershed Planning Division was established in 2015, and supports this team.

UNDERSTANDING FLOOD RISK

Understanding flood risk Expert Management Panel Recommendation	Status	Timeline	2020 update
Urge the Province to regularly review and update official flood hazard maps.	Underway	2022	The Government of Alberta undertook public engagement on updated inundation mapping in 2020 and completed engagement in 2021. Inundation maps will inform updated Flood Hazard Area (maps from the Government of Alberta. The City has requested that any potential future draft Flood Hazard Area updates be shared with The City prior to release by the Government of Alberta to address any potential technical inconsistencies with The City's existing inundation mapping. The Government of Alberta has agreed to share draft Flood Hazard Area maps ahead of any potential public engagement.
Develop a suite of watershed-scale climate models to capture various weather event scenarios, with input from regional partners, post-secondary institutions and other orders of government.	Underway	Ongoing	Projected trends in precipitation and temperature were developed for the 2050s and 2080s and were used to conduct a vulnerability and risk assessment to identify high risk climate scenarios for Calgary and region. Further climate analysis is required to support the update of design standards in preparation for changing climate conditions. Considering climate uncertainty remains a core consideration in The City's flood mitigation work, and understanding climate implications on flood continue in alignment with The City's corporate resiliency strategy and climate resilience plan.
Collaborate with academic and other partners to develop computer models that identify groundwater movement in Calgary in relation to flood conditions.	Complete	2017	In 2016, The City completed two assessments on groundwater impacts relating to flooding, which were included in The City's updated Flood Damage Assessment. The City conducted site-specific groundwater studies, which include on-site sampling, were included as part of the initial feasibility studies for the Downtown, Sunnyside, and Bowness barrier sites. The City continues to ensure it has the best understanding of groundwater in Calgary's river communities and intends to use the collected data to conduct further analysis in 2021.
Maintain a comprehensive flood risk database integrated with existing Geographic Information Systems.	Complete	2015-2016	In 2016, The City produced a GIS based flood risk damage profiles at the community level. This data was created as part of The City's Flood Damage Assessment and has been incorporated into The City's GIS database. The City continues to update this information as additional data is collected.
Publish up-to-date, graduated flood maps for public information.	Complete	2015	Inundation maps prepared by The City for up to 100-year return periods have been posted to Calgary.ca/floodinfo and are available to the public. Work continues to make this information easier to access for Calgarians.

STRENGTHENING FLOOD-RELATED POLICIES

Strengthening flood-related policies Expert Management Panel Recommendation	Status	Timeline	2020 update
Create graduated flood protection level requirements for City infrastructure.	Underway	Ongoing	Flood levels are currently considered as part of lifecycle project planning and implementation. For the Flood Mitigation Measures Assessment, a 1:200 level was used as reference. Flood resilience considerations will be included as part of The City's upcoming review of its existing floodway development regulations and associated planning tools in 2021. This work aligns with The City's corporate resilience strategy and climate resilience plan.
Expand the review of the Land Use Bylaw and other development regulations to update flood resiliency requirements for private property in flood risk areas.	Underway	2021+	Flood resilience considerations will be included as part of The City's upcoming review of its existing floodway development regulations and associated planning tools in 2021. This work aligns with The City's corporate resilience strategy and climate resilience plan.
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.	Underway	2021+	The City is undertaking a review of its flood-prone areas development policies. This work will link Calgary's land use policy to structural flood protection, balancing urban planning interests to support resilient communities. The major driver is the Province's plan to update Calgary's flood hazard area maps which will reflect the latest understanding of how a 1:100 flood would impact Calgary and the new Flood Hazard Area zone classifications for river communities. The review intends to eventually update the Calgary River Valleys Plan and integrate it within the Next Gen planning system. This will inform updates to the Land Use Bylaw, Municipal Development Plan, and other planning documents. This work aligns with The City's corporate resilience strategy and climate resilience plan and will be influenced by any updates to the Flood Hazard Area mapping currently being undertaken by the Government of Alberta.
Perform a social, economic and environmental analysis to evaluate the need for a minimum flood protection level above the 1:100 flood for land-use planning and structural protection across Calgary.	Complete	2017	The Flood Mitigation Measures Assessment completed in 2016 and 2017 analyzed a variety of scenarios up to a 1:200 flood event. The City continues to look at community projects in terms of potential mitigation, and considers potential service levels in the context of The City's overall strategy, which includes a combination of upstream, community, and local flood mitigation. The City currently reviews all Area Structure Plans, Area Redevelopment Plans, building permits, and City projects to identify flood risks and structural requirements based on various flood protection levels.

PARTNERING FOR A FLOOD RESILIENT CALGARY

Partnering for a flood resilient Calgary Expert Management Panel Recommendation	Status	Timeline	2020 update
Pursue a common river forecasting platform with Alberta Environment and Parks and TransAlta for faster and more accurate information and alerts about future flood events.	Complete	2020	The Government of Alberta has developed a new forecasting platform that will be used by both The City and the Government of Alberta that allows for data between both organization to be shared quickly, providing better warning of potential flooding.
Strengthen partnerships with utility providers to improve resiliency of their infrastructure and operations, with first priority to energy supply and communication networks.	Complete	2017	The Flood Emergency Response Manual is updated annually to ensure maximum protection of critical city infrastructure and vulnerable communities. The Calgary Emergency Management Agency (CEMA) has developed a critical infrastructure (CI) strategy to support CI owners in their understanding of disaster risk and how to reduce their risk. CEMA has identified core utility providers and businesses as key stakeholders.
In partnership with Alberta Environment and Parks and TransAlta, expand the network of river and weather monitoring stations upstream of Calgary and protect stations from damage during flooding.	Complete	2017	This recommendation is considered complete. However, as part of forecasting platform discussions, expansion and modernization of The City's forecasting platform is being done in partnership with the Government of Alberta. The City also continues to identify opportunities to install additional monitoring stations to improve data collection.
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.	Complete	2017	The voluntary provincial buy-outs program is complete and the Government of Alberta has begun demolition of properties. No further Provincial buy-outs are planned at this time. This recommendation is considered complete but may be re-visited in the future, depending on potential future Provincial policy.
Continue to cooperate with TransAlta and the Province to increase flood storage on the Bow River through operation of existing TransAlta facilities.	Complete	2016	The Government of Alberta and TransAlta have a 5-year agreement in place for Ghost Reservoir operations and was renewed in 2021.
Host a national flood risk workshop to share best practices & develop a networking group.	Complete	2015	The City hosted the 2015 Livable Cities Forum on Building Flood Resilient Communities in September 2015 in partnership with Canadian Water Resources Association and ICLEI Canada. The City is involved in national initiatives that bring together various stakeholders to share and develop new practices, mapping and guidelines to reduce flood risk.

COMMUNICATING WITH CALGARIANS

Communicating with Calgarians Expert Management Panel Recommendation	Status	Timeline	2020 update
Develop programs that support building owners to implement flood resiliency measures.	Underway	2021+	The City continues to support building and homeowners understand their flood risk through annual communication through its Flood Readiness Campaign. The City received funding from Public Safety Canada's National Disaster Mitigation Program in 2019 to develop additional educational programs on flood awareness for citizens, and also received approval for sources as part of One Calgary to support this work. A framework for education was developed in 2020, and work to implement that framework and develop programs will continue in 2021.
Incorporate lessons learned from the 2013 flood to enhance communication channels to keep Calgarians informed of conditions that may lead to high river levels.	Complete	Ongoing	The City established a cross-corporate communications plan and flood readiness communications plan. Updates, information, and general communications are provided annual through The City's social media, local media and advertising, information sessions, and e-mail flood newsletter. The City continues to use lessons learn to improve its communication with citizens and enhance its Flood Readiness Campaign each year.
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.	Complete	2015-2016	The City established a cross-corporate communications plan and flood readiness communications plan, including providing information through annual open houses scheduled during flood season and regular newsletter and website updates. The City received funding from Public Safety Canada's National Disaster Mitigation Program in 2019 to develop additional educational programs on flood awareness for citizens, and also received approval for sources as part of One Calgary to support this work.

APPENDIX B –CURRENT FLOOD MITIGATION PROJECTS

Project Name	Project Status	Project Description	Estimated Completion Date
Centre Street Bridge Lower Deck Flood Barrier Improvements	Completed	Construction of removable flood barriers that will be installed in the lower deck of Centre Street Bridge to prevent flooding into Chinatown.	2018
West Eau Claire Flood Barrier	Completed	Construction of a flood barrier along the Bow River downstream of Eau Claire to the Peace Bridge.	2018
Roxboro Sanitary Liftstation Replacement	Completed	Replacement of sanitary liftstation in the community of Roxboro.	2018
Stormwater Outfall Improvements	Completed	Resilience upgrades to fifteen stormwater outfalls to prevent potential back flooding into affected communities.	2018
Western Headworks Site Condition Improvements	Completed	Area improvements to allow operation of a nearby outfall gate, reducing flood risk for Inglewood, the Calgary Zoo, Deerfoot Trail, and Pearce Estate Park. Additional improvements for emergency road access for river emergencies and gate operations during a flood event.	2018
Glenmore Dam Elevated Hoists	Completed	Installation of 2.5m high automated steel gates to replace the existing 1.5m manual stop log system to increase storage at the Glenmore Dam.	2020
Bonnybrook Wastewater Treatment Plant Flood Mitigation	Underway	Construction of a flood barrier on the eastern perimeter of the Bonnybrook Wastewater Treatment Plant, with groundwater and stormwater management enhancements to protect the plant from flooding.	2020
Heritage Drive Permanent Flood Barrier	Completed	Construction of an earth-filled berm along Glenmore Trail at Heritage Drive and Glendeer Circle SW (underneath Graves bridge) to prevent flooding of major infrastructure and roadways in the area.	2020
Sunnyside Pump station #1	Completed	Construction of a new, flood dedicated, two-storey pump station to dewater the community of Sunnyside during high water events for river and stormwater management.	2020
Sunnyside Pump station #2	Completed	Flood resilience improvements associated with an upgraded pump station in the community of Sunnyside.	2020
9th Avenue Bridge Replacement	Underway	Raising of the 9th Avenue Bridge to prevent damage during high water events and maintain access for fire and emergency services for the community of Inglewood.	2021
Downtown Flood Barrier	In design	Construction of a permanent flood barrier from Jaipur Bridge to Reconciliation bridge.	2022+
Upper Plateau Separation	In design	Partial separation of Hillhurst-Sunnyside's stormwater system from communities located above in the upper plateau catchment area.	2022+
Sunnyside Flood Barrier	In design	Construction of a permanent flood barrier in the community of Sunnyside.	2022+
Bowness Flood Barrier	Feasibility study	Construction of a permanent flood barrier in the community of Bowness.	2024+

APPENDIX C – COMMUNITY DRAINAGE IMPROVEMENT PROGRAM AND FLOOD RESILIENCE PROJECT PRIORITIZATION LIST MARCH 2021

Project Name	Cost Estimate[1] ($000's)	Project Status	Construction Date[2]
Woodlands/Woodbine - Local Improvements	*$6,340*	*Completed (Maintenance Period)*	2018-2019
Woodlands/Woodbine - Braeside Dry Pond	*$20,817*	*Completed (Maintenance Period)*	2018-2020
Woodlands/Woodbine - Bebo Grove Wet Pond & 24th Street SW Diversion	*$3,807*	*Completed (Maintenance Period*	2018-2021
North West Inner-City - Pump Station #1 – Sunnyside[3]	*$12,768*	*Completed (Maintenance Period)*	2019-2020
North West Inner-City - Pump Station #2 – Sunnyside[4]	*$10,557*	*Completed (Maintenance Period)*	2018-2020
Downtown Flood Barrier[6]	*$21,073*	*Design*	2021-2023
Sunnyside Food Barrier	*$34,200*	*Design*	2021-2023
North West Inner-City - Upper Plateau Separation[6]	*$57,549*	*Procurement*	2021-2022
North West Inner-City - 19 St, 7th Avenue, 1st Avenue, Sunnyhill Lane[5, 7]	*$7,606*	*Design*	2021-2022
North West Inner-City - 10th Street NW[5, 7]	*$11,468*	*Design*	2021-2022
North West Inner-City – Kensington[7]	*$13,603*	*Design*	2021-2022
Tuxedo - High Point Diversion and Local Improvements[7]	$3,069	*Procurement*	2021-2022
Tuxedo - 35 Ave NE Trunk[7]	$4,285	*Procurement*	2021-2022
Tuxedo – Tuxedo Dry Pond and Trunk Upgrades[7]	$10,387	*Procurement*	2021-2022
North West Inner-City - Pump Station #4 - Hillhurst	$11,700	Study complete -- to be funded	Beyond 2023
North West Inner-City - Pump Station #3 - Hillhurst	$8,400	Study complete -- to be funded	Beyond 2023
Pineridge / Rundle Dry Pond B	$4,175	Study complete -- to be funded	Beyond 2023
Palliser/Oakridge - Phase 1 and 2	$18,326	Study complete -- to be funded	Beyond 2023
Pineridge / Rundle Storage Duct #2	$2,824	Study complete -- to be funded	Beyond 2023
Macleod Trail Community Drainage Improvements – Project C (Meadowview Pond)	$1,972	Study complete -- to be funded	Beyond 2023
Shawnessy Stormwater Upgrades	$20,197	*Planning*	Beyond 2023
North West Inner-City - 14th Street	$14,900	Study complete -- to be funded	Beyond 2023
Macleod Trail CDI Project A – Manchester Yards	$2,692	Study complete -- to be funded	Beyond 2023
Palliser/Oakridge - Phase 3	$11,247	Study complete -- to be funded	Beyond 2023
North West Inner-City - 17th Street & 23rd Avenue	$3,800	Study complete -- to be funded	Beyond 2023
Oakmount Dry Pond (Oakmount Way Rev Report)	$492	*Planning*	Beyond 2023
Total	**$318,254**		

1 -- Cost Estimates are based on 2015 pricing assumptions, except for projects under design or construction, where updated pricing is indicated based on the current project stage.
2 -- Schedules subject to change based on external funding availability, new studies, and dependencies on other projects.
3 -- With funding from the Alberta Community Resilience Program and New Building Canada Fund.
4 -- With funding from the Alberta Community Resilience Program.
5 -- These projects are dependent on other projects underway.
6 – With funding from the Alberta Community Resilience Program and Investing in Canada Infrastructure Porgram.
7 – With funding from the Municipal Stimulus Program.