FLOOD RESILIENCY AND MITIGATION

2019 Update Report

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EXECUTIVE SUMMARY

This report provides a comprehensive update to The City of Calgary's (The City's) flood resiliency and mitigation program in 2019. Building flood resilience remains a top priority for The City and recognizes the importance of reducing flood risk to its citizens.

The City's Flood Resilience Plan focuses on a combination of watershed, community, and property-level mitigation initiatives to reduce flood risk in Calgary. Originally approved in 2017, The City continued to make positive progress on flood mitigation efforts in 2019, and efforts in 2019 will support continued progress on major flood resilience initiatives in 2020. Building flood resilience continues to be a collaborative effort, and The City continues to work closely with the Government of Alberta and citizens to achieve this goal.

Major highlights in 2019 include:

- Installation of the new gates at the Glenmore Dam. The gates will be functional for the 2020 flood season, doubling Glenmore Reservoir's storage capacity and addressing up to 20 percent of the risk of a 2013-level flood event.
- Continuation of the Impact Assessment Agency of Canada's Environmental Impact Assessment for the Government of Alberta's Springbank Off-stream Reservoir. The Government of Alberta anticipates it will begin construction of the Reservoir once the Environmental Impact Assessment is completed and, combined with the new gates at the Glenmore Dam, will be able to mitigate a 2013-level flood event on the Elbow River.
- Initiation of the Government of Alberta conceptual assessment of three potential new reservoir sites upstream of Calgary for flood mitigation and water supply through its *Bow River Reservoir Options* project. An upstream reservoir on the Bow River remains a significant piece of The City's Flood Resilience Plan.
- Community engagement on the Downtown, Sunnyside, and Bowness barriers to support the detailed design, preliminary design, and feasibility assessment of the respective projects. These projects will address flood risk in three flood-prone areas on the Bow River.

This report also addresses projects impacted by the Government of Alberta's October 2019 budget, announcing the early termination of the Alberta Community Resilience Program, which supported the construction of some of The City's community mitigation projects. The City has assessed the impacts and reprioritized the Water Utility's stormwater investment plan to address these impacts. Barring additional external funding or increases to stormwater utility rates, The City anticipates that its Community Drainage Improvements program will be delayed by up to one business cycle to prioritize critical river flood mitigation projects in the downtown and Sunnyside community.

1. INTRODUCTION

Seven years after the devastating 2013 flood, building flood resilience remains a top priority for The City of Calgary (The City) and many projects have been completed to reduce Calgary's flood risk. However, the risks associated with a large-scale flood remain until key projects are constructed. Implementing The City's flood resilience plan, approved by City Council in 2017, continues to reflect The City's strategy of using a combination of watershed, community-level, and property-level mitigation to reduce damages from flooding. This strategy is designed to ensure that flooding in Calgary is managed, that The City is capable of adapting to ongoing climate uncertainty, and can support continued urban development.

In 2019, The City maintained its focus on working with communities to progress community flood resilience projects. Much of this ongoing work is being done to ensure that communities are thoroughly engaged, and any potential mitigation recommendations consider citizen concerns.

2. 2019 FLOOD SEASON

2.1 2019 SEASONAL CONDITIONS

Spring 2019 started off with a slightly below average snowpack and precipitation. Water levels on the Bow and Elbow River stayed within the normal range throughout most of the year, apart from one precipitation event in late June.

Calgary experienced peak flow through Calgary on the Bow River (300 m3/s) and Elbow River (107 m3/s) on June 21, mainly due to a combination of precipitation and snowmelt in the Bow watershed, and mainly precipitation in the Elbow watershed. Alberta Environment and Parks' River Forecast Centre issued a High Streamflow Advisory during this period, and The City issued a boating advisory June 19 to June 30 as a result. No emergency response activities were required in 2019.

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.

2.2 2019 FLOOD READINESS

The City of Calgary continues to promote its flood readiness campaign annually from May 15 to July 15. The information-based campaign is an opportunity for The City to inform citizens about its flood resilience plan, and their role in building flood resilience in Calgary, and to help citizens understand, prepare, and stay informed before, during, and after a flood event.

In 2019, The City introduced flood mitigation walking tours along the Bow River to replace open house events during the campaign, which had seen falling attendance in recent years. The walking tours provided valuable face-to-face interactions with the public to explain what actions they could take to increase their personal flood resilience while highlighting the flood resilience work completed by The City in West Eau Claire.

THE CITY OF CALGARY'S FLOOD READINESS CAMPAIGN TO INFORM CALGARIANS OF THEIR ROLE IN BUILDING FLOOD RESILIENCE AND HELP THEM UNDERSTAND, PREPARE, AND STAY INFORMED BEFORE, DURING, AND AFTER A FLOOD EVENT.

Additional activities undertaken in 2019 included:

- Year-round media coverage on flood and climate-related topics, with a focus on the May-July flood season
- Continued publication of a biweekly flood e-newsletter, distributed to over 1,500 subscribers from April to July
- Enmax bill inserts with actions citizens can take to protect against river and stormwater flooding
- Over 40 presentations delivered by City staff to the public

In addition to the campaign events, The City has begun scoping a citizen-focused, action-oriented flood risk awareness and education program. Design and development will continue for this program in 2020. More information on this work can be found in Section 3.5 below.

3. FLOOD RESILIENCE PLAN

3.1 BACKGROUND

The City's flood mitigation strategy continues to pursue a combination of watershed, community-level, and property-level mitigation components (Figure 1) to build comprehensive flood resilience throughout Calgary. The City's Flood Resilience Plan (the Plan) reflects this strategy which, informed by The City's Flood Mitigation Measures Assessment (FMMA), Council approved in 2017. The strategy is consistent with international best practices and recognizes that no single piece of mitigation can address all flood risk in Calgary.

The City continuously reviews and evaluates the Plan based on the best information available. Part of this includes ongoing investments in The City's flood forecasting capabilities, continual updates to The City's flood emergency response plans, year-round monitoring of conditions, and annual preparedness training for staff to ensure The City is ready to respond to a potential flood event. This supports The City's abilities to take an adaptive approach to its flood resilience work based on information gained about the hydrology of Calgary's watersheds and changing climate, while still reflecting a layered strategic approach to risk reduction.

The Plan was developed based on the recommendations of the 2014 *Expert Management Panel on River Flood Mitigation* report. More information on these recommendations and The City's progress on the panel's recommendations can be found in Appendix A.

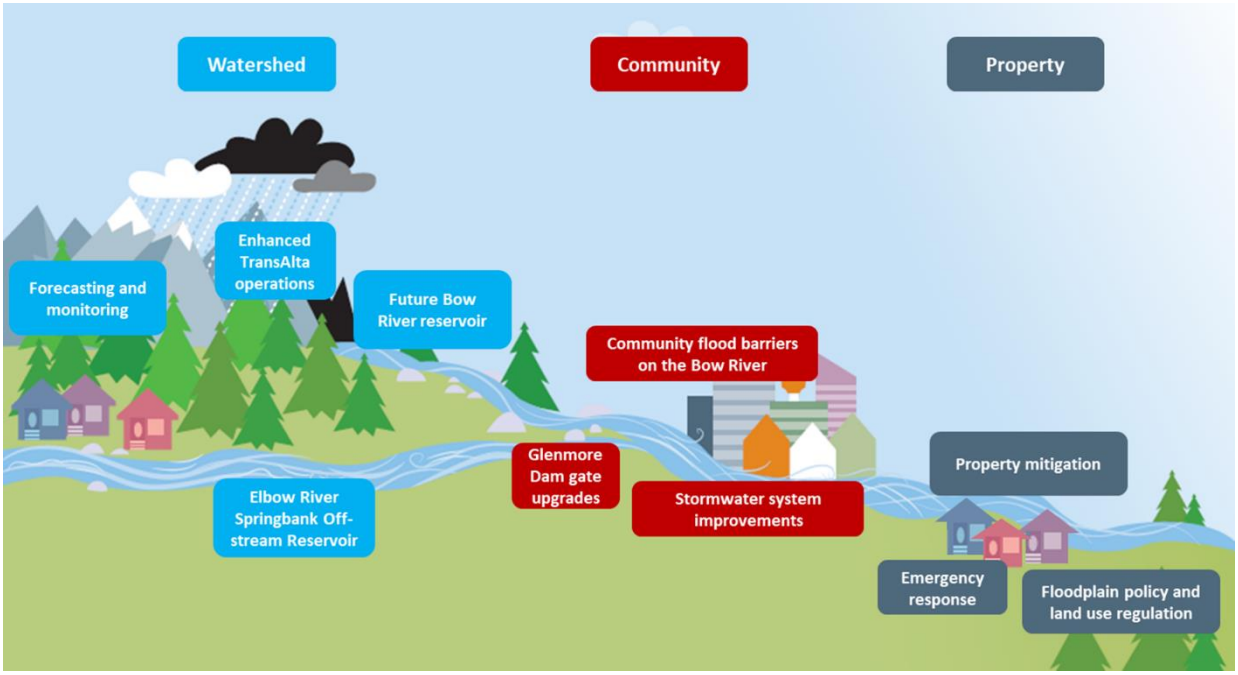


FIGURE 1: THE CITY'S FLOOD RESILIENCE STRATEGY CONSISTS OF WATERSHED, COMMMUNITY-LEVEL, AND PROPERTY-LEVEL FLOOD RESILIENCE COMPONENTS TO ACHIEVE RESILIENCE THROUHGOUT CALGARY.

3.2 2019 PROGRESS

In 2019, The City focused on working closely with communities to progress key community-level mitigation projects that are core to The City's Plan. This focus ensured that robust, comprehensive community engagement was undertaken, and community stakeholder's concerns were both well understood and considered by The City. Community feedback is a key component for the proposed Sunnyside and Bowness flood barrier projects which are undergoing preliminary design and feasibility study, respectively.

Ensuring upstream mitigation is constructed remains the most crucial outstanding component of The City of Calgary's overall flood strategy. The City continues to work closely with the Government of Alberta (GoA) to support progress on the implementation of upstream mitigation on the Bow and Elbow Rivers. With the Impact Assessment Agency of Canada's (IAAC) Environmental Impact Assessment (EIA) process for the Springbank Off-stream Reservoir (SR1) well underway, The City's advocacy efforts in 2019 were focused on mitigation on the Bow River.

3.3 ELBOW RIVER MITIGATION

Significant construction progress was made in 2019 on the gate upgrades at the Glenmore Dam, including delivery of the new gates for installation. The gates will be operational for the 2020 spring runoff season, with all work at the Dam completed before the end of 2020. This work is the most significant advancement for flood protection along the Elbow River since the Dam was built 85 year ago. With the new gates in place, 2005-level floods can now be able safely managed, and accounts for a reduction in 20 per cent of the total risk in a 2013-level flood.

The Springbank Off-stream Reservoir (SR1) remains a key mitigation component on the Elbow River, and will account for as much as an 80 per cent reduction in flood risk (Figure 2) once completed. Combined with the upgraded gates at the Glenmore Dam, The City anticipates that events as large as a 2013-level flood event will be fully mitigated. The EIA for the SR1 remains ongoing in 2019. The GoA submitted three additional information packages, based on the IAAC's 2019 July 24 request, in 2019 November and 2019 December.

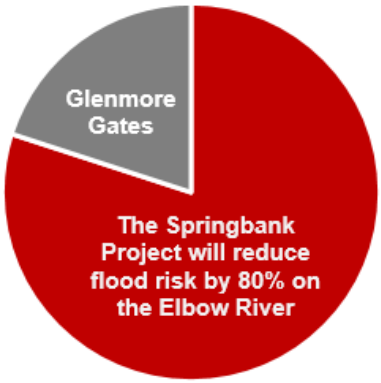


FIGURE 2: SR1, ALONG WITH GLENMORE GATES, WILL REDUCE FLOOD RISK ON THE ELBOW RIVER UP TO A 2013 SIZE FLOOD

As of 2020 February, IAAC is still in the process of reviewing the additional information. The GoA anticipates starting construction of SR1 after the EIA is completed. Throughout this work, The City continues to participate on the project's Technical Advisory Group that is led by the GoA and continues to advance the potential design of SR1.

3.4 BOW RIVER MITIGATION

As SR1's EIA continues to progress, mitigating flood risk on the Bow River is The City's priority in 2020.

The GoA announced 2018 November that it would undertake the *Bow River Reservoir Options* (BRRO) project, which includes a conceptual assessment for three potential upstream reservoir sites on the Bow River. The GoA continued this work throughout 2019, hosting three public open houses in 2019 October to provide information on the three potential sites. The scope of the current conceptual study includes identifying engineering, environmental, social, economic, cultural and traditional land use factors that should be considered for the projects. The conceptual study was completed in 2020 March, with a public report expected later in 2020. The GoA announced $15M in funding for the next phase of the project as part of its 2020 February budget, with the next phase beginning before the end of 2020.

The five-year seasonal Ghost Reservoir operating agreement between the GoA and TransAlta, originally signed in 2016, expires in 2021 March. Currently serving as the core piece of mitigation on the Bow River for Calgary, failure to extend the TransAlta agreement will result in an immediate increase in flood risk on the Bow River. The City's advocacy efforts continue to urge the GoA to begin work on the next phase of the BRRO project as soon as possible and extend its operating agreement with TransAlta. This is consistent with the results of The City's 2019 March YYCMatters campaign, which found that 83 per cent of Calgarians surveyed agree that upstream mitigation on the Bow River should be funded by the GoA (Figure 3).

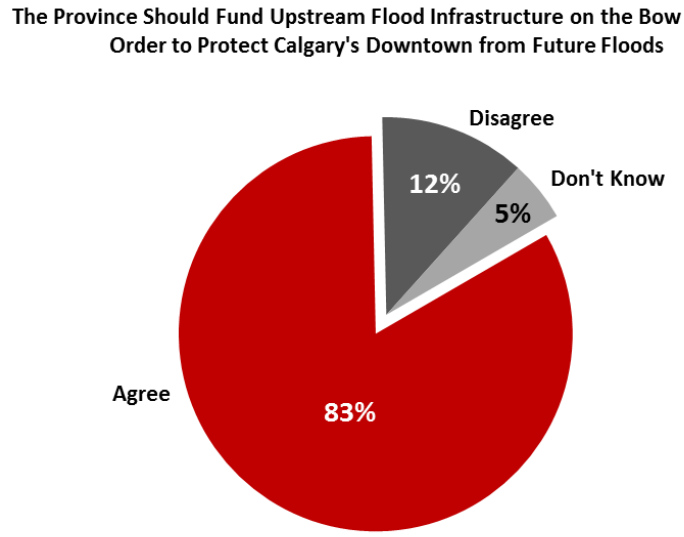


FIGURE 3: THE CITY, AS PART OF ITS YYCMATTER CAMPAIGN, CONDUCTED A SURVEY 2019 APRIL AND FOUND 83% OF CITIZENS SUPPORT THE GOA FUNDING UPSTREAM MITIGATION.

3.4.1 COMMUNITY MITIGATION

The City of Calgary continued to advance its community flood mitigation work throughout 2019. This included:

- Beginning construction of two stormwater liftstations in the community of Sunnyside (Sunnyside Pumpstation #1 and #2)
- Initiating construction of the 9 Avenue SE bridge replacement using a new flood resilient design
- Continuing the construction of the Heritage Drive flood barrier
- Advancing detailed design for the Downtown Flood Barrier and Upper Plateau Separation resilience projects
- Community engagement on preliminary design of the Sunnyside Flood barrier, and
- Community engagement on the feasibility of a barrier in the community of Bowness.

As part of its 2019 October budget, the GoA announced that funding for flood resilience projects, through the Alberta Community Resilience Program (ACRP) would be ending in 2021, three years earlier than anticipated. As of 2019, The City received $69.1M of the GoA's total $150M commitment announced in 2015 October, resulting in a final shortfall of $81M from the original commitment. The loss of funding has resulted in direct funding impacts for the Downtown Flood Barrier and Upper Plateau Separation projects, which have partial funding and are underway.

Both projects are critical to Calgary's flood resilience. The Upper Plateau Separation project will address stormwater flood risk in the community of Sunnyside and the Downtown Barrier project protecting Calgary's central business district from flooding up to a 1:200 event, ensuring Calgary's economy stays resilient and continues to grow**.** Despite the provincial funding impacts, The City remains committed to

The City remains committed to delivering the Downtown Barrier and Upper Plateau Separation, with both projects scheduled to

delivering the Downtown Barrier and Upper Plateau Separation, with both projects scheduled to begin construction before the end of 2020. This will delay previously scheduled Community Drainage Improvement (CDI) project by one year.

The City planned to leverage ACRP funding to deliver the Sunnyside and Bowness Flood Barriers, which were identified as key components of the Plan, once the projects were ready to proceed. Since receiving Council approval to proceed with these projects, The City spent 2019 working with Sunnyside to advance preliminary design of a barrier in their community, while working with community members in Bowness to explore the feasibility of a potential barrier.

3.4.2 SUNNYSIDE FLOOD BARRIER

As part of ongoing engagement with the community on the Sunnyside Flood Barrier project, The City hosted and attended several events with the community in 2019. These events were an opportunity to provide citizens with information on the project, its current status, ongoing studies, and helped The City gather feedback on potential barrier options for the project. Events included:

- Three pop-up booths in the community between April and October,
- A community open house in September,
- Meetings with the Hillhurst-Sunnyside Community Association, and
- Online engagement and feedback between September and October.

Four potential service level options were presented to the community, providing different levels of risk mitigation for the community and ranging from an estimated 1:20 service level to an estimated 1:200-year service level. At these events, participants were asked to rank the importance of various social criteria to help inform The City's triple-bottom line assessment. Participants were also asked to comment on the potential impacts and tradeoffs that the various potential options presented.

The City received feedback from 130 open house attendees and 415 online comments as part of the engagement period. Concerns for the previously proposed 1:20 barrier were raised by the community, on the grounds that the proposal did not address enough of the flood risk on its own. While the barrier, with a future upstream reservoir, would provide a 1:200 service level, community members felt the estimated time to completing a new reservoir would result in significant risk for the community until upstream mitigation was completed.

Different members of the community voiced support for either the 1:100 or 1:200 options, citing a preference to mitigate as much risk as possible while also recognizing the combined mitigation provided by both a barrier and upstream operations, costs, and environmental and social impacts. A full *What We Heard Report* for 2019, including activities and feedback from citizens, can be found at http://engage.calgary.ca/sunnyside-flood-barrier-project.

In addition to gathering feedback from citizens, The City also undertook several technical studies to inform the potential options presented to the community and address feedback received during engagement. Studies included:

- Groundwater condition studies, including hydrogeological and geotechnical studies to understand how groundwater flows through the community and seepage risks,
- Hydraulic studies using different river conditions to inform potential barrier heights and riverbank protection,
- Tree inventories and environmental reviews, and
- Cost-benefit analysis of the four potential options.

This work has been used to inform The City's understanding of conditions in the community, community members' values and concerns, the extent of flood risks, mitigation costs, and preliminary design considerations to ensure the project is effective. Based on feedback received from citizens and the technical and environmental studies, a 1:100 barrier is now being recommended. A 1:100 service level will ensure that a 2013-level flood is managed within the community. It will also minimize social and environmental impacts caused by construction of a larger barrier, such as reduced views and access to the river, and additional loss of trees. The barrier will support climate resiliency with the addition of a new reservoir on the Bow River. Prioritizing this project is possible within the Water Utility's existing investment plan, but will delay scheduled CDI projects by up to one business cycle.

Based on feedback received from citizens and the technical and environmental studies, a 1:100 barrier is now being recommended for the

3.4.3 BOWNESS FLOOD BARRIER

The City continues to work with residents and assess the feasibility of a flood barrier in the community of Bowness. Information events and pop-up booths were held in 2019 to increase awareness within the community of the current project phase and provide information about upcoming milestones. Over 100 one-on-one meetings with riverfront residents were also completed in 2019 to provide clearer information on the project's current status, next steps, and directly address any concerns residents might have. Door knocking was conducted in fall 2019 to increase awareness among non-riverfront residents, and a community session was also held in November with staff from The City of Calgary available to answer questions from residents at the event.

The City undertook several studies in 2019 to better understand the feasibility of a project in Bowness, including:

- 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

To facilitate conversations with the community and residents, the Bowness Flood Mitigation Working Group was formed in 2019 May to review and provide input on studies and engagement, with a focus on delivering the best flood mitigation solutions for the community of Bowness. The 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. The City's project team has attended the monthly working group meetings, providing information on The City's overall flood resilience plan. The City's project team has also engaged the Working Group to gather detailed feedback to augment and enhance the studies being undertaken. These meetings are expected to continue in 2020.

Any recommendations in Bowness will reflect community feedback, comprehensive technical study results, and triple-bottom-line

Results from the studies are currently being shared with the Working group at monthly meetings as they become available. Results will also be shared with the riverfront residents and the broader community for feedback. The City recognizes concerns raised by the community around upstream flows and potential impacts on homeowners caused by a barrier. The City is considering these concerns as it works to complete the feasibility assessment. A recommendation on whether to proceed with the next phase of the project will be brought to Council by Q4 2020. Any recommendations will reflect community feedback, comprehensive technical study results, and triple-bottom-line evaluation.

3.5 PROPERTY MITIGATION, POLICY AND MAPPING

Flood resilience for Calgary remains a shared responsibility amongst The City, the GoA, the federal government, and citizens. To support citizens in building their personal flood resilience, The City holds its Flood Readiness Campaign annually. In addition to the campaign, The City also began scoping and conducting research on the development of a potential Flood Risk Awareness and Education program in 2019. As part of the program, The City conducted research to better understand citizens' flood risk with support from Public Safety Canada's National Disaster Mitigation Program (NDMP). This research included 21 in-depth interviews with key stakeholders with flood response experience such as flood experts, academics, and first responders. These interviews were used to gather insights and lessons learned on the information required by citizens to increase level of resilience during a flood. Also included in this research was a random telephone survey of 801 citizens both inside and outside the flood zone, which was completed to better understand citizens' view on flood resilience, level of knowledge, actions taken and barriers to action. Once completed, The City will begin developing a framework in 2020 that will inform future programming for citizens and identify opportunities to support citizens in building their flood awareness and flood resilience.

Up-to-date flood maps are an important component of helping citizens understand their flood risk. Accurate maps are also critical for The City's ability to implement appropriate land use regulations and policy measures to reduce Calgary's flood risk. In 2019, The City provided inundation mapping information to the GoA based on its flood models to inform the GoA's ongoing flood mapping work. Updated maps from the GoA are still pending as of 2020 March. The City anticipates that updates to the Land Use Bylaw and relevant development policies will be needed following the release of updated Flood Hazard Area (FHA) maps and internal engagement with relevant business units.

4. STORMWATER FLOODING

In addition to river flooding, Calgary is at risk of local stormwater flooding due to intense rainfall or sudden snow and ice melt overwhelming existing stormwater systems. This typically occurs in established communities with older, undersized stormwater infrastructure and can be compounded by river flooding risks. Localized flooding can also occur due to poor surface grading, causing water to pool. Though 2019 did not see any unexpected stormwater flooding due to spring melt conditions, some areas with noted concerns did experience localized, temporary flooding. The City is working towards addressing risks in these areas 2020.

The City of Calgary continues to address areas with high stormwater flooding risk through its CDI program. Starting in 2020, The City will integrate successful lessons learned from its 2019 Integrated Stormwater Management Study of Renfrew into future CDI studies and projects. In addition to addressing stormwater flooding, the approach also considered opportunities to reduce water quality impacts, plan for future redevelopment and densification, manage climate change impacts, enhance asset management, and identify opportunities for green stormwater infrastructure. This approach will ensure that future stormwater infrastructure investments remain resilient and able to withstand future challenges brought on by climate uncertainty and urban development.

In 2019, The City of Calgary reprioritized all flood projects into a single list. A summary of identified projects under the river flood resilience and CDI program can be found in Appendix C. As new CDI studies are completed, additional projects will be added to the program list and prioritized based on their expected cost-benefit and reduction of risk to communities.

4.1 COMMUNITY DRAINAGE IMPROVEMENTS PROGRAM

In 2019, The City invested approximately $20M in CDI projects, with $5M in support from the GoA. As part of this work, the following projects were completed:

- The Christie Park (Westgate Optimist Park) Dry Pond, a multi-use stormwater storage facility that includes an off-leash dog park and pathways when not being used to store stormwater;
- The Braeside Dry Pond, a multi-use stormwater storage facility located on a school site that includes soccer playing fields when not being used to store stormwater;
- Most of the Woodlands Woodbine Secondary Drainage Improvements to improve stormwater management in Woodlands, Woodbine, and Cedarbrae; and

- The Confederation Regional Drainage Study. Based on the report's recommendations, monitoring will be set up at key locations for two years, starting in 2020. This will inform future steps for stormwater management in the area. No other work is planned at this time.

In addition to the above projects, construction started or continued to progress on:

- The Bebo Grove Wet Pond, located in Fish Creek Provincial Park; and
- Sunnyside Stormwater Lift Stations #1 and #2.

Design also advanced for the following projects:

- The Upper Plateau Separation detailed design, which provides stormwater and river flooding benefits; and
- Preliminary design work for numerous Northwest Inner-city CDI improvements (7 Avenue NW, 1 Avenue NW, 19 Street and 9 Avenue NW, 19 Street and 6 Avenue NW, 10 Street SW and Crescent Road, and South of Riley Park and Kensington Close).

THE BRAESIDE DRY POND WILL ADDRESS FLOODING CAUSED BY RAINFALL IN THE COMMUNITY OF BRAESIDE WHILE ALSO SERVING AS COMMUNITY RECREATION FACILITIES WHEN NOT STORING STORMWATER

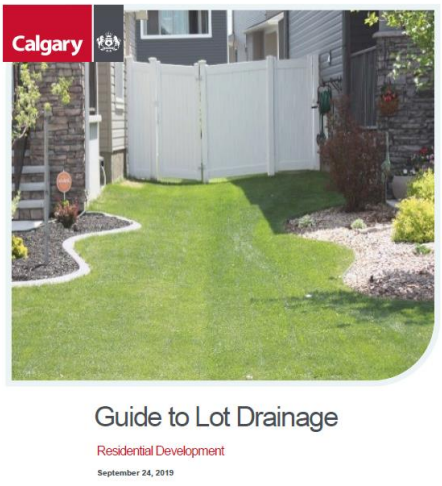
Value engineering was undertaken by The City for the Upper Plateau Separation project, resulting in an estimated cost savings of $10M. Additional cost savings of approximately $2M for Woodlands Woodbine Secondary Improvements and $1M savings for Sunnyside Stormwater Lift Station #2 were also identified in 2019. Further work on the Northwest Inner-city CDI improvements will be delayed as a result of prioritizing the Downtown Flood Barrier, Upper Plateau Separation, and Sunnyside Barrier projects, unless additional funding is secured or stormwater utility rates are increased. Estimated delays are included in Appendix C.

4.1.1 OTHER STORMWATER IMPROVEMENTS AND PROJECTS

The City of Calgary continues to improve its understanding of stormwater issues affecting areas in Calgary. The City received funds from Public Safety Canada and Alberta Emergency Management Association to develop models to identify extreme rainfall flooding risks throughout Calgary in 2017. The City successfully mapped Calgary's terrain to further identify low areas that are potentially at higher risk of rainfall related flood damages in 2019, and these maps will support modelling to identify low areas in Calgary at risk of severe stormwater flooding. Starting in 2020, The City intends to use this work to identify and support future CDI studies and stormwater infrastructure investments.

The City also recognizes that poor stormwater drainage on individual residential lots can cause localized flooding, property damage, impacts to public infrastructure, and public safety concerns. Significant progress was made by The City in 2019 to support Calgarians improve lot drainage and minimize damages from stormwater flooding, including:

- Publishing the Guide to Lot Drainage in September 2019. The Guide, available to the public, provides an overview of lot grading, drainage regulations and processes, and outlines tools and best practices to follow when planning, designing, constructing or maintaining stormwater drainage patterns in residential development, reducing the risk of flooding.
- Updating the Lot Grading webpage on Calgary.ca. Along with the Guide to Lot Drainage, these updates support ongoing public education to relevant stakeholders, with a focus on roles and responsibilities, to reduce flooding issues caused by poor lot drainage.



THE CITY'S GUIDE TO LOT DRAINAGE PROVIDES HOMEOWNERS INFORMATION ABOUT BEST PRACTICES TO FOLLOW WHEN PLANNING, DESIGNING, CONSTRUCTING, OR MAINTAINING STORMWATER DRAINAGE PATTERNS ON THEIR PROPERTY

In 2020, The City will continue to proactively identify opportunities to collaborate with industry and community stakeholders to identify issues relevant to lot drainage and development, such as through corporate initiatives like the Established Areas Growth and Change Strategy. Working with stakeholders will help The City identify relevant lot drainage and redevelopment issues and identify opportunities to improve future drainage regulations or processes.

5. ACTIONS FOR 2020

Significant flood resilience progress continued to be made in 2019 and efforts to increase flood resilience in 2020 will continue. Major community infrastructure projects are expected to be completed, provincial initiatives will continue to advance, and efforts to develop property-level supports will be pursued. The City has also begun preparations for the May-July flood season, and is monitoring conditions in the mountains and seasonal forecasts to ensure it is ready to respond to a potential flood event. In addition to this work, The City will be focusing on advancing the following items in 2020:

Watershed:

- Continue advocating for upstream mitigation on the Bow and Elbow Rivers and extension of the TransAlta agreement beyond 2021 with the GoA
- Monitor developments related to the GoA's *Bow River Reservoir Options* project
- Continue participating in the Impact Assessment Agency of Canada's Environmental Impact Assessment for SR1
- Completion of Glenmore Dam Infrastructure Improvements Program, including operation of upgraded gates for 2020 flood season

Community:

- Initiate construction on the Downtown Flood Barrier
- Complete detailed design for the Upper Plateau Separation
- Continue engagement efforts with communities to advance the Sunnyside Flood Barrier project and feasibility study of a flood barrier in Bowness
- Complete construction of the Bebo Grove Wet Pond, Sunnyside Pumpstation #1, and Sunnyside Pumpstation #2 CDI projects and complete new studies with integrated stormwater management principles

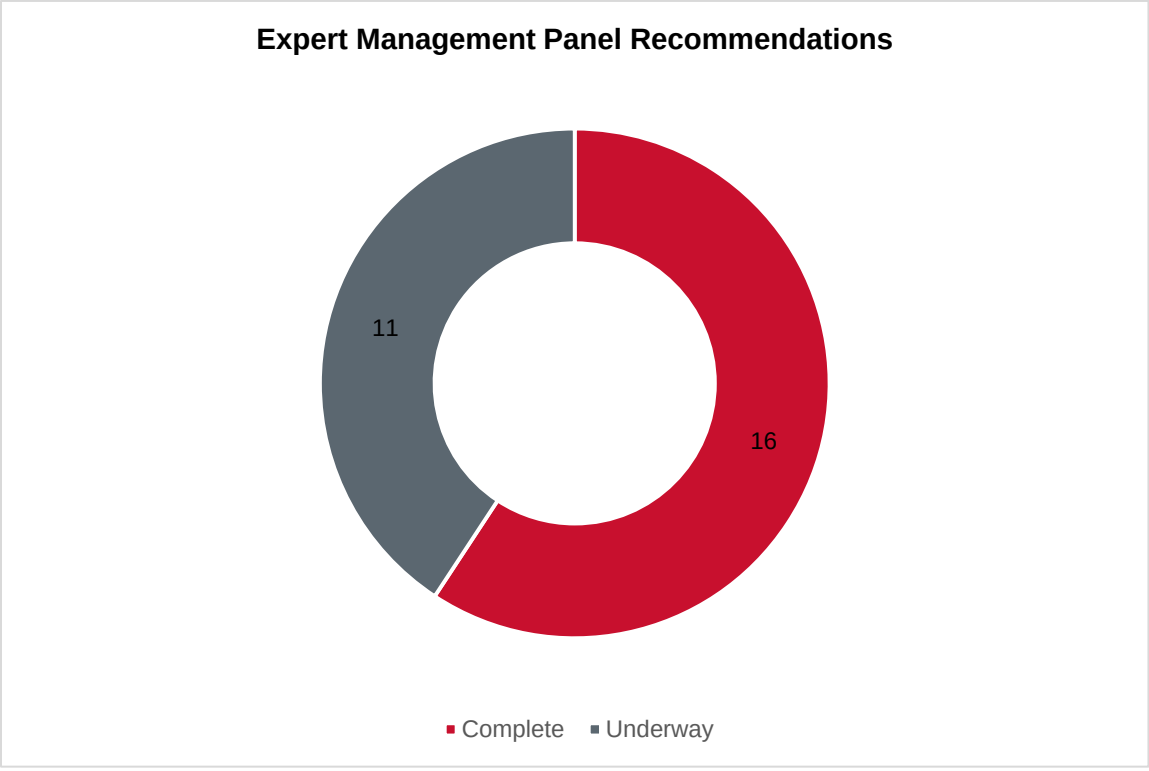
Property:

- Develop components of The City's flood risk awareness and education program
- Prepare for review of updated flood mapping from the GoA, and implications on The City's services
- Establish a framework to support future policy potential policy options and tools in anticipation of future flood hazard mapping from the GoA

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. 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 2020, 11 of the Expert Management Panels 27 recommendations remain underway, with the rest completed. The City continues to monitor progress on these recommendations in addition to working on advance its overall flood resilience strategy.



INVESTING IN FLOOD PROTECTION

Expert Management Panel recommendation	Status	Timeline	2019 update
Prepare a time-phased plan to modify structures that constrain river flow during flood events, such as pathways and bridges. (4b)	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. The City anticipates that updates to the Land Use Bylaw and relevant development policies will be needed following the release of updated FHA maps and internal engagement with relevant business units. Future construction or replacement of existing structures will be informed by future land use planning and development policy work.
Develop a comprehensive climate adaptation plan and implementation tools to reduce The City's infrastructure and operational vulnerabilities. (6d)	Underway	2020+	The City released its Climate Resilience Strategy in 2018. Flood resilience work continues independently but remains aligned with The City's overall climate resilience strategy and corporate resilience strategy.
Connect with the provincial body overseeing flood protection and loss reduction and support the GoA's continuing analysis of flood mitigation options and implementation of appropriate measures through the watersheds. (6b)	Underway	Ongoing	The GoA commissioned the *Bow River Reservoir Options Study* in 2019 to examine the feasibility of an upstream reservoir on the Bow River. Three potential sites are currently being studied, with initial results expected in the first half of 2020. The City continues to be supportive of this work and is advocating for continuation into the next phase once the study is completed and released. The City actively participates in the GoA's SR1 Technical Advisory Committee, to support the implementation of upstream mitigation on the Elbow.
Increase the operating water storage capacity of the Glenmore Dam on the Elbow River through modifications to the Glenmore Dam. (3b)	Complete	2020	The upgraded gates at the Glenmore Dam have been installed and will be operational for the 2020 flood season. The infrastructure improvement program at the reservoir remains ongoing and all work will be completed in 2020. The elevated gates will increase capacity at the Glenmore Dam 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. (3d)	Underway	Ongoing	The City's flood mitigation plan is currently underway and being implemented. As of 2020, detailed design for the Downtown Flood Barrier and Upper Plateau Separation projects are underway, with construction tentatively scheduled for 2020. The City has also identified a recommended service level for the Sunnyside Flood Barrier. Discussions with the communities of Sunnyside and Bowness regarding potential barriers is ongoing. The City is working with these communities to align potential mitigation measures with community values and will be discussing potential trade-offs in mitigation options as it works 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. (6f)	Complete	Ongoing	Annual updates are provided by Water Resources to Council's Standing Policy Committee on Utilities and Corporate Services.
Evaluate social, economic and environmental impacts of flood mitigation options. (6c)	Complete	2015-2016	A triple bottom line approach was used to assess possible flood mitigation measures as part of the FMMA. 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 GoA, compare the three major capital works options for mitigating floods on the Elbow River. (3a)	Complete	2015-2016	The Springbank Off-stream Reservoir (SR1) was announced by the GoA in 2015 and is currently undergoing a federal Environmental Impact Assessment by IAAC. The City is participating on the Technical Advisory Committee for the Environmental Assessment of SR1.
Establish a permanent team within The City to oversee flood preparedness and resilience. (6a)	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

Expert Management Panel Recommendation	Status	Timeline	2019 update
Urge the GoA to regularly review and update official flood hazard maps. (5b)	Underway	2020+	The City remains in communication with the GoA on their work regarding new Flood Hazard area (FHA) maps. The City continues to advocate for the completion and release of the new FHA maps to the public once thoroughly reviewed. In 2019, The City requested that any potential future draft FHA updates be shared with The City prior to release by the GoA to address any potential technical inconsistencies with The City's existing inundation mapping. The City anticipates that updated drafts will be shared by the GoA in 2020.
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. (5d)	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. (5e)	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. In 2019, 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 results of these studies will be received in 2020 and will inform any future decisions on these projects and could further inform The City's overall understanding of groundwater.
Maintain a comprehensive flood risk database integrated with existing geographic information systems (GIS). (5c)	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. (5a)	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

Expert Management Panel Recommendation	Status	Timeline	2019 update
Create graduated flood protection level requirements for City infrastructure. (1b)	Underway	Ongoing	Flood levels are currently considered as part of lifecycle project planning and implementation. For the Flood Mitigation Measures Assessment, a target 1:200 flood level was used as reference. Flood protection requirements may be considered after the GoA updates FHA maps and policy changes are assessed. The City anticipates that updates to the Land Use Bylaw and relevant development policies will be needed following the release of updated FHA maps and internal engagement with relevant business units. This action 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. (1c)	Underway	2020+	Flood resilience considerations will be included as part of the Municipal Development Plan and Land-use Bylaw reviews that started in 2019. The City continues to pursue this work in 2020 and is looking to explore potential additional options to reduce potential damages to development in areas of flood risk. This action 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. (4a)	Underway	2020+	The City is working on potential changes to floodplain development guidelines as part of the Municipal Development Plan and Land-use Bylaw reviews that started in 2019. This work will also be affected by any updates to the FHA mapping currently being undertaken by the GoA. This action aligns with The City's corporate resilience strategy and climate resilience plan.
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. (1a)	Complete	2017	The FMMA 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

Expert Management Panel Recommendation	Status	Timeline	2019 update
Pursue a common river forecasting platform with Alberta Environment and Parks (AEP) and TransAlta for faster and more accurate information and alerts about future flood events. (2a)	Underway	2020+	The GoA is currently developing a new forecasting platform that will be used by both The City and the GoA and will facilitate sharing of forecasting data. Throughout 2019, the GoA completed work on developing the platform. City-staff have received training on the platform for potential future integration into The City's forecasting operations.
Strengthen partnerships with utility providers to improve resiliency of their infrastructure and operations, with first priority to energy supply and communication networks. (1d)	Complete	2017	The Flood Emergency Response Manual is updated annually to ensure maximum protection of critical city infrastructure and vulnerable communities. CEMA has developed a critical infrastructure 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. (2b)	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 GoA. The City also continues to identify opportunities to install additional monitoring stations to improve data collection, including a new permanent monitoring station on Nose Creek in 2019, which was completed with support from Public Safety Canada's National Disaster Mitigation Program.
In partnership with the GoA, develop a time-phased plan to remove buildings from areas with high flood risk, while minimizing the disruption to affected communities. (4c)	Complete	2017	The voluntary Provincial buy-outs program is complete, and the GoA has begun demolition of properties. No further Provincial buyouts are planned at this time.
Continue to cooperate with TransAlta and the GoA to increase flood storage on the Bow River through operation of existing TransAlta facilities. (3c)	Complete	2016	The GoA and TransAlta have a 5-year agreement in place for Ghost Reservoir operations, ending in 2021 March. The Bow River Working Group has recognized the importance of this agreement for flood mitigation and identified extending the agreement as a "quick-win" opportunity. The City continues to communicate the critical value of this agreement to the GoA and the need to continue this agreement as it enters its final year.
Host a national flood risk workshop to share best practices & develop a networking group. (6e)	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

Expert Management Panel Recommendation	Status	Timeline	2019 update
Develop programs that support building owners to implement flood resiliency measures. (2e)	Underway	2020+	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 received approval for sources as part of One Calgary to support this work. This work will continue in 2020.
Incorporate lessons learned from the 2013 flood to enhance communication channels to keep Calgarians informed of conditions that may lead to high river levels. (2c)	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. (2d)	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 received approval for sources as part of One Calgary to support this work. This work will continue in 2020.

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	Ready for 2020 flood season	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	Underway	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	Underway	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	Underway	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.	2020
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+
Pearce Estate Park Flood Barrier	Cancelled	Construction of a permanent flood barrier in Pearce Estate Park near the community of Inglewood.	No longer required

APPENDIX C – COMMUNITY DRAINAGE IMPROVEMENT AND FLOOD MITIGATION PROJECT PRIORITIZATION LIST FEBRUARY 2020

Project Name	Cost Estimate ($000's)	Project Status	Original CDI Estimated Construction Date[1]	Revised Estimated Construction Date (Reduced ACRP Funding)[1]	Revised Estimated Construction Date (Reduced ACRP and Sunnyside Prioritized)[1]
Woodlands/Woodbine Bebo Grove & 24th Street SW Diversion (formerly Pond D)	*$21,200*	*Completed*	2018-2020	2018-2020	2018-2020
Woodlands/Woodbine - Braeside Dry Pond (formerly Pond A)	*$6,282*	*Completed*	2018-2019	2018-2019	2018-2019
Woodlands/Woodbine - Local Improvements	*$3,889*	*Construction*	2018-2020	2018-2020	2018-2020
North West Inner-City - Pump Station #1 – Sunnyside[2]	*$12,300*	*Construction*	2019-2020	2019-2020	2019-2020
North West Inner-City - Pump Station #2 – Sunnyside[3]	*$9,500*	*Construction*	2018-2020	2018-2020	2018-2020
North West Inner-City - Upper Plateau Separation[5]	*$49,400*	*Design*	2020-2022	2020-2022	2020-2022
Downtown Flood Barrier	*$21,073*	*Design*	2020-2022	2020-2022	2020-2022
Sunnyside Flood Barrier	*$27,900*	*Design*	N/A	N/A	*2021-2023*
North West Inner-City - South of Riley Park	*$11,200*	*Design*	2022-2024	*2023-2025*	*Beyond 2023*
North West Inner-City - Kensington Close	*$2,200*	*Design*	2022-2024	*2023-2025*	*Beyond 2023*
North West Inner-City - 10th Street[4]	*$10,900*	*Design*	2021-2023	*2022-2024*	*Beyond 2023*
North West Inner-City -- Crescent Road	*$1,100*	*Design*	2021-2023	*2022-2024*	*Beyond 2023*
North West Inner-City - 19th Street & 9th Avenue	*$2,100*	*Design*	2022-2024	*Beyond 2023*	*Beyond 2023*
North West Inner-City - 19th Street & 6th Avenue	*$600*	*Design*	2022-2024	*Beyond 2023*	*Beyond 2023*
North West Inner-City - 7th Avenue	*$2,000*	*Design*	2023-2024	*Beyond 2023*	*Beyond 2023*
North West Inner-City - 1st Avenue[4]	*$2,040*	*Design*	2023-2024	*Beyond 2023*	*Beyond 2023*
Tuxedo/Mount Pleasant - Phase 1, Phase 2, and local Improvements	$14,196	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
North West Inner-City - Pump Station #4 - Hillhurst	$11,700	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
North West Inner-City - Pump Station #3 - Hillhurst	$8,400	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Pineridge / Rundle Dry Pond B	$4,175	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Palliser/Oakridge - Phase 1 and 2	$18,326	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Pineridge / Rundle Storage Duct #2	$2,824	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Macleod Trail Project C – Meadowview Pond	$1,972	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Shawnessy Stormwater Upgrades	$20,197	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
North West Inner-City - 14th Street	$14,900	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Macleod Trail Project A – Manchester Yards	$2,692	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Palliser/Oakridge - Phase 3	$11,247	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
North West Inner-City - 17th Street & 23rd Avenue	$3,800	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Oakmount Dry Pond (Oakmont Way Rev Report)	$492	Study complete -- to be funded	Beyond 2023	Beyond 2023	Beyond 2023
Total	**$298,605**				

1 – Schedules subject to change based on external funding availability, new studies, and dependencies on other projects
2 -- With funding from ACRP and the New Building Canada Fund.
3 -- With funding from ACRP
4 -- These projects are linked via dependency to projects above.