

FLOOD RESILIENCY AND MITIGATION



2018 Update Report

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1. INTRODUCTION

The City of Calgary continues to make progress on building resiliency and reducing Calgary's flood risk. Significant progress has been made in the six years since the 2013 floods with numerous major infrastructure projects underway, as well as other pieces of ongoing work.

Following the 2013 floods, The City formed an independent panel of experts to examine how to reduce flooding in Calgary. In 2014, The *Expert Management Panel Report on River Flood Mitigation* outlined 27 recommendations to increase Calgary's flood resilience. Since 2014, all of the recommendations are either complete or underway. The remaining recommendations still underway continue in alignment with other initiatives within The City of Calgary, such as the development of The City's Corporate Resilience Strategy being done in partnership with 100 Resilient Cities and the Climate Resilience Strategy. Work to further build knowledge related to completed recommendations will also continue.

As of 2018, The City's focus is now on implementing its flood resilience plan that was approved by City Council in 2017. The plan includes a number of projects that, in conjunction with efforts by the Province and the federal government, serves as The City's vision and path to a flood resilient Calgary. The plan is part of The City's integrated approach to watershed management and remains a top priority under One Calgary. As The City works through its plan, it is committed to engaging with affected communities to gather their input and ensure any potential trade-offs are understood before any major projects proceed. The City will continue to report on progress annually as it enters this implementation phase.

2. SUMMARY OF 2018 ACTIVITIES

2.1 2018 SEASONAL CONDITIONS

Similar to 2017, the 2018 season started off with an above average snowpack. However, above average temperatures in early May resulted in earlier than usual spring run-off. Throughout May and June, river water levels on the Bow and Elbow rivers were high but did not reach levels where flooding occurred. Peak flow through Calgary on the Elbow River ($60 \text{ m}^3/\text{s}$) occurred on June 23 due to rainfall, while peak flow on the Bow River ($359 \text{ m}^3/\text{s}$) occurred on June 25 due to a combination of rainfall and snowmelt.

For safety concerns, a boating advisory was issued due to high flows on the Bow River from May 28 to June 1, and another advisory was issued for both rivers from June 23 to June 25. No emergency response activities were required in 2018, though the Province announced 2018 June 12 \$1M in funds to support The City's emergency response preparedness. Average temperatures along with normal or below normal precipitation proceeded throughout the rest of the summer, and flows in both the Bow and Elbow rivers dropped quickly to normal levels from June onwards. Flows in Calgary neared drought advisory levels from late August onwards, but normal operating conditions were maintained. Due to construction on the dam crest, the Glenmore Reservoir was drawn down below the normal flood season operating level in early 2018. The reservoir began refilling after the third week of July, recovering by the first week of September.

2.2 FLOOD READINESS



**Understand your flood risk.
Be prepared. Stay informed.**
Calgary is most at risk of river flooding
from May 15 to July 15.

*THE CITY HOLDS ITS FLOOD READINESS CAMPAIGN EVERY YEAR
BETWEEN MAY 15 AND JULY 15. 2018 MARKED THE FIFTH YEAR
ANNIVERSARY SINCE THE 2013 FLOODS.*

The City of Calgary holds its annual flood readiness campaign every year from May 15 to July 15. The campaign is intended to help citizens increase their personal flood preparedness by helping them understand, prepare and stay informed before, during and after a flood event. The campaign is also an opportunity for The City to inform citizens about its flood resilience plan, and citizens' role in building flood resilience in Calgary.

In 2018, Calgary marked the fifth anniversary of the 2013 floods. As part of the flood readiness campaign for 2018 The City increased its efforts in reaching out to citizens not only to increase awareness of flooding in Calgary, but also to share information and highlight key flood resilience projects that have been completed by citizens, The City, and the Province since 2013.

Activities undertaken in 2018 included:

- Two videos highlighting citizens' stories of mitigation and resilience
- Two open houses, with a total attendance of approximately 200 citizens
- Publication of a biweekly flood e-newsletter that was distributed to over 1,500 subscribers
- Media coverage from April to July that resulted over 1,800 news articles including nation-wide coverage, which reached approximately two-million individual reads and resulted in an approximate \$1.9M return-on-investment
- Social media posts that reached over 200,000 Calgarians
- Updates to The City's flood website at calgary.ca/floodinfo, resulting in approximately 42,000 visits from April to July
- Over 30 public presentations delivered by City employees to the public.

3. FLOOD RESILIENCE PLAN

3.1 BACKGROUND

The City presented its Flood Mitigation Measures Assessment (FMMA) to Council in 2017. The FMMA recommended that to mitigate against another 2013-level flood event, a combination of watershed, community, and property-level mitigation measures were required to provide a flexible and adaptable flood mitigation program that would provide the most cost-beneficial flood resilience. Based on the FMMA's results, Council recommended on 2017 April 10, that City Administration:

1. Work with Council to advocate for an upstream reservoir and continuation of the Provincial-TransAlta operational agreement for the Bow River.
2. Continue supporting the development of the Springbank Off-stream Reservoir on the Elbow River by the Province.
3. Develop an implementation and funding plan for community level flood mitigation and report back to Council through the SPC on Utilities and Corporate Services or the Priorities and Finance Committee by Q2 2017.
4. Explore the development of a property level mitigation program.
5. In alignment with Provincial mapping and policy updates, conduct further investigation on land use policy and building regulations for areas prone to flooding.
6. Work with City Council to confirm and communicate to other orders of government that flood mitigation is a top strategic priority for The City of Calgary.

The City's implementation plan was presented to City Council and approved on 2017 June 26, and proposed a vision based on upstream, community, and local mitigation. The City's approach is consistent with international best practices and recognizes that no single piece of mitigation is capable of eliminating flood risk in Calgary.

As of 2018, 12 of the Expert Management Panels 27 recommendations remain underway, with the rest completed (Figure 1). Of those 12 recommendations, three remain underway as planned, and three are ongoing as part of The City's collaboration with the Province. The remaining six recommendations are tied to The City's Corporate Resilience Strategy, Climate Resilience Strategy, and The City's review of its Municipal Development Plan and Land Use Bylaw. A summary of the recommendations and their progress can be found in Appendix A.

The City will continue to take an adaptive management approach and continually improve its understanding of flood risk in Calgary and identify actions as part of its flood resilience plan. This ensures The City uses the most current data to inform its decision making and modelling and possesses the most up to date knowledge of flood risk and how to manage flooding in Calgary.

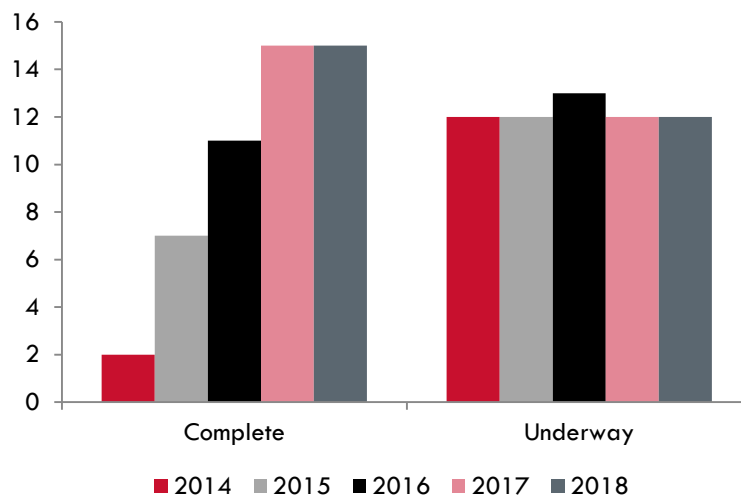


FIGURE 1: EXPERT MANAGEMENT PANEL RECOMMENDATIONS PROGRESS.

AS OF 2018 THE CITY'S FOCUS IS ON IMPLEMENTING ITS FLOOD RESILIENCE PLAN. OUTSTANDING RECOMMENDATIONS CONTINUE IN ALIGNMENT WITH CORPORATE INITIATIVES, INCLUDING THE CORPORATE RESILIENCE STRATEGY AND CLIMATE RESILIENCE PLAN.

4. 2018 PROGRESS

As of 2018, The City has been focused on implementing its flood resilience plan. The plan serves as the basis of The City's vision for a flood resilient Calgary (Figure 2). The multi-layered approach is intended to be flexible, enabling The City to react to variable conditions beyond its control, and supports The City's integrated watershed management approach. The flexibility also ensures The City can maximize flood mitigation work while recognizing that upstream mitigation alone cannot mitigate all flooding in Calgary, that community mitigation projects require extensive input from affected communities, and that building flood resilience is a long-term goal that requires ongoing effort. With support from the Province and federal government, completed infrastructure investments and improved emergency response planning have reduced Calgary's overall flood risk by as much as one-third.

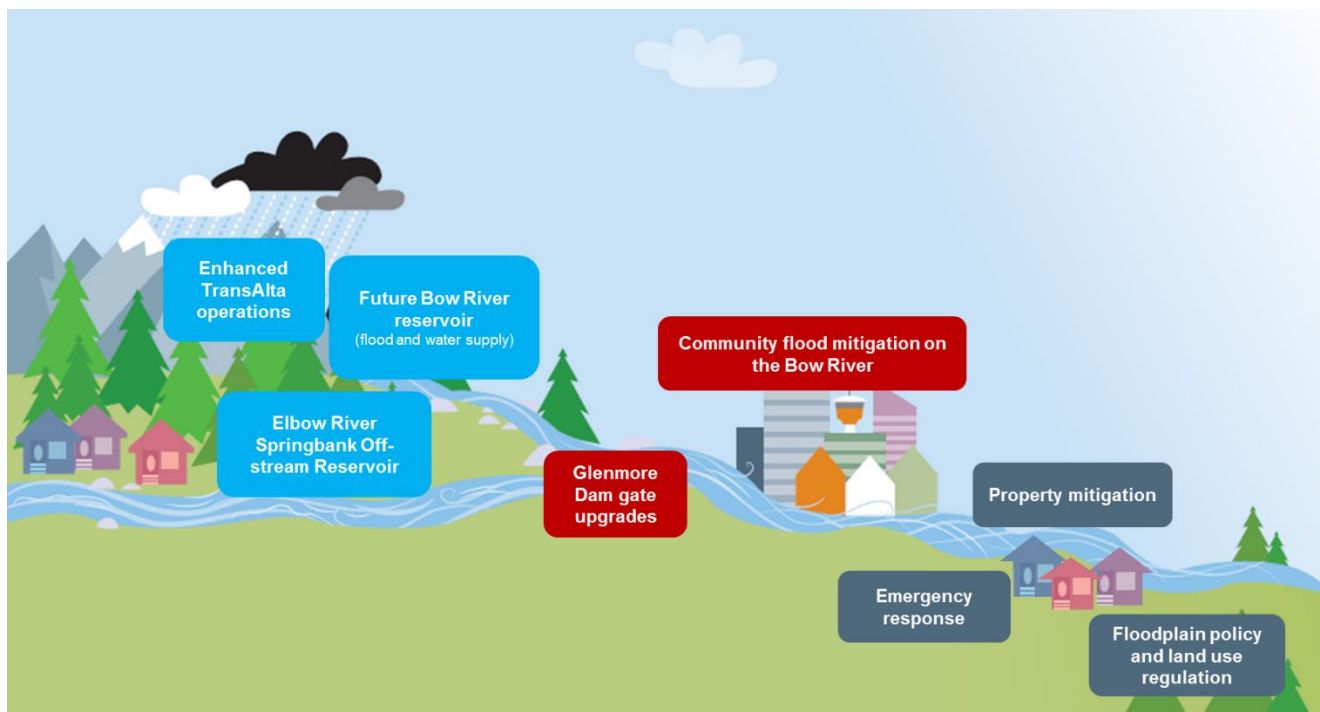


FIGURE 2: THE CITY'S FLOOD RESILIENCE PLAN RELIES ON UPSTREAM AND COMMUNITY INVESTMENTS, OPERATIONS, PROPERTY PROTECTION, AND FLOODPLAIN POLICY

4.1 ELBOW RIVER MITIGATION

The Province remains committed to the construction of the Springbank Off-Stream Reservoir (SR1), announced in 2015, to help mitigate flows on the Elbow River. Upon completion, the project, located approximately 15 kilometres west of Calgary, will work with the new gates being installed at the Glenmore Dam to mitigate floods as large as a 2013-level flood event (Figure 3).

Since 2016 June 23, SR1 has been subject to an Environmental Impact Assessment (EIA) by the Canadian Environmental Assessment Agency (CEAA). The Province submitted its Environmental Impact Statement 2018 June 29, and CEAA requested further information in 2018 August. As of 2019 April, the Province is compiling the required information. It is anticipated that the review will resume after the Province

submits their response to the information request. The City participates on the EIA's Technical Advisory Committee.

Land acquisition for the project by the Province remains ongoing. On 2019 January 30 the Province announced that it acquired 465 acres of land for the project, approximately 20 per cent of the land required. In addition to the land acquisition, Infrastructure Canada announced \$168M in funding support through its Disaster Mitigation and Adaptation Fund for the project on 2019 March 13.

The SR1 project has been verified by several independent consultants as the most cost-beneficial flood mitigation project on the Elbow River. The City continues to support the timely completion of this project and participate in the CEAA process to ensure SR1 is constructed as quickly as possible. The City is not supportive of other options or further delay. Failure to construct upstream mitigation as soon as possible will leave Calgary at risk of damages from another major flood.

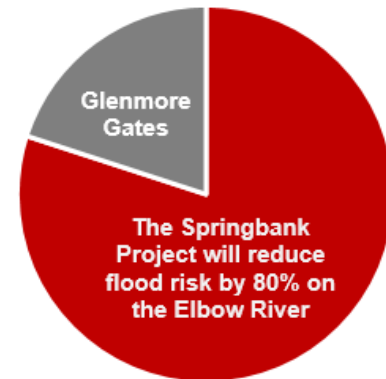


FIGURE 3: SR1, ALONG WITH GLENMORE GATES, WILL REDUCE FLOOD RISK ON THE ELBOW RIVER UP TO A 2013 SIZE FLOOD

The City has also raised the construction of upstream flood mitigation as an issue of regional concern with the Calgary Metropolitan Region Board (CMRB), citing the importance of having a flood resilient region, and the need to consider the presence of flood mitigation as part the region's long-term growth plans.

In conjunction with SR1, progress on the new elevated gates at the Glenmore Dam continues. This project is being completed as part of the larger infrastructure improvement program at the Glenmore Dam and is schedule to be operational in 2020. It should be noted that while the Glenmore Dam will provide significant flood mitigation for Calgary, it will not be able to manage a 2013-sized flood event without the completion of upstream mitigation.

4.2 BOW RIVER MITIGATION

4.2.1 UPSTREAM MITIGATION

Considering the progress on SR1 and at the Glenmore Dam, reduction of flood risk for communities along the Bow River is the focus of The City's flood resilience plan. The City of Calgary continues to advocate to the provincial and federal government for the need for upstream mitigation on the Bow River. Both an upstream reservoir and the continuation of the operations agreement between the Province and TransAlta are critical to ensure no communities in Calgary are at risk of flooding up to at least a 2013-level flood event. The Province's agreement with TransAlta is currently ongoing until 2021.

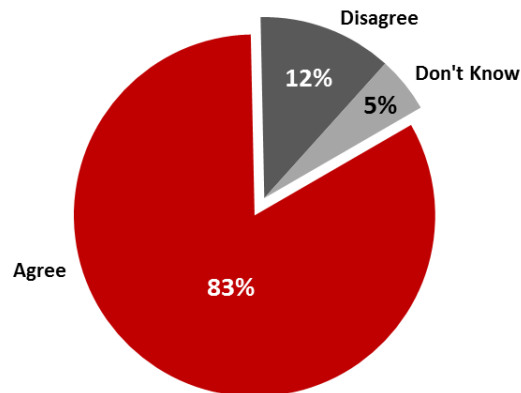
The City of Calgary continues to support the work done by the Province's Bow River Working Group to identify upstream mitigation options on the Bow River. Following the release of the *Bow River Water Management Project final report* in 2017 August, the Province committed to completing an upstream mitigation conceptual study for three potential sites. This work is currently underway and is anticipated

to be completed by the end of 2019. As part of The City's YYCMatters campaign, a citizen survey conducted between 2019 March 29 and 2019 April 3 found that 83% of Calgarians surveyed agree that upstream mitigation on the Bow River should be funded by the Province (Figure 4).

4.2.2 COMMUNITY MITIGATION

As part of The City's plan for the Bow River, the flood mitigation provided by the TransAlta agreement and a potential upstream reservoir must be complemented by community flood mitigation in key locations throughout Calgary. Community mitigation, along with an upstream reservoir, would mitigate damages up to at least a 2013-level flood event, and up to a 1000-year event in Calgary's downtown.

The Province Should Fund Upstream Flood Infrastructure on the Bow River in Order to Protect Calgary's Downtown from Future Floods



Design of the Downtown flood barrier is underway. Community

FIGURE 4: THE CITY, AS PART OF ITS YYCMATTER CAMPAIGN, CONDUCTED A SURVEY 2019 APRIL AND FOUND 83% OF CITIZENS SUPPORT THE PROVINCE FUNDING UPSTREAM MITIGATION.

engagement started in 209 April and construction is estimated to begin sometime in 2020. The Downtown flood barrier, once complete, will connect with the West Eau Claire Park flood barrier and extend to the Reconciliation Bridge to form a single, contiguous piece of flood mitigation infrastructure for Calgary's downtown. This design integrates seamlessly into The City's Eau Claire Public Realm Plan.

Three additional barriers were proposed in The City's flood resilience plan, in the communities of Bowness and Sunnyside, and in Pearce Estate Park/Inglewood. Consultants were hired to explore design options for the three barriers in 2018. Preliminary studies commenced and consultants are collecting additional information and research on potential options as part of the preliminary studies.

The proposed flood barrier in Bowness, unlike other community barriers, would require access to private lands on the river front. As part of developing flood resiliency for Bowness The City initiated engagement on the Bowness flood barrier project starting in fall 2018. The initial part of the engagement process was to collect local knowledge and get input on community values, identify areas of sensitivity, and understand other factors to be considered as part of the project.

During this period, The City:

- Attended five meetings with river front property owners
- Hosted a town hall for riverfront property owners on 2018 September 20
- Held an open house for the community at large on 2018 October 30
- Conducted online public engagement, and
- Initiated one-on-one meetings with individual property owners along the river front.

This phase of one-on-one meetings with riverfront property owners is expected to continue until late spring 2019. The City also began proactive efforts to communicate to stakeholders the need for and the benefits of all components of The City's flood resilience plan, the risks of not constructing community flood mitigation, and developed a series of educational materials for community members including:

- A comprehensive project information page on calgary.ca with up to date project information, frequently asked questions, studies and reports, contact information, and current estimated timelines.
- A video series to help address and clarify some of the common areas of concern raised by community members.
- A project specific e-newsletter that includes project updates, key dates, and educational articles on general flood topics and project questions.
- A project-specific email address to allow community members to directly contact the project team.

In addition to engagement and communication activities in Bowness, The City began a series of studies to inform the design and option analysis of the potential flood mitigation. This includes groundwater studies, geotechnical investigations, river modelling, stormwater management, landscape architecture and design, and biophysical impact assessment. These studies are expected to continue in 2019. Once completed, findings will be shared with community members during further engagement sessions anticipated to be held in late fall 2019. The studies and community feedback will be used to inform design options and potential next steps for the project beyond 2019.

In 2019 May, The City will conduct additional research to get a better understanding of community attitudes towards potential flood mitigation in Bowness via telephone surveys to riverfront property owners and the broader community. Two additional information pop-ups are also tentatively scheduled in 2019 July and 2019 August to update community members on the status of the studies and answer questions, and a working group is also being formed to ensure various stakeholders from across the community can provide their input.

An open house for the proposed Sunnyside barrier project was held on 2018 December 4 to present the project to the community and gather feedback to inform preliminary studies related to the project. Site condition assessments are currently underway, which will be used as part of the mitigation option analysis that will be completed in 2019 and will examine the cost-benefit of different potential service levels for the community. Options will be presented to the community in summer 2019 for input as studies are completed and will help inform community input as the project moves forward.

Modelling of river flows by a consultant for the Pearce Estate Park barrier was completed in 2019 April. The City is in the process of assessing the modelling data to determine next steps on the Pearce Estate Park barrier project.

In addition to the community barrier projects, two additional community mitigation projects were identified in The City's flood resilience plan:

- The Upper Plateau Separation project, which provides additional flood mitigation for the community of Hillhurst-Sunnyside by separating the stormwater system from communities located above it (Figure 5), and
- The 9th Avenue Bridge Replacement, which will prevent the bridge from being damaged during a flood event and maintain a critical access point for the community of Inglewood.

Preliminary design started for both projects in 2018, with construction for both projects beginning in late 2019 or 2020.

4.3 PROVINCIAL AND FEDERAL FUNDING

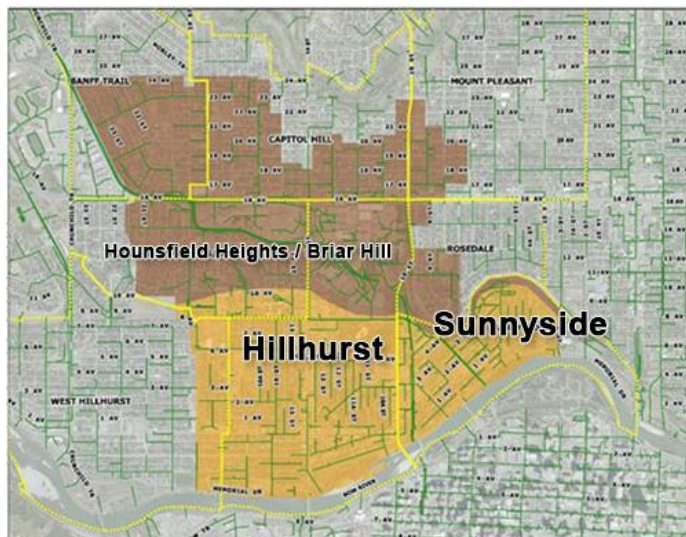


FIGURE 5: THE UPPER PLATEAU SEPARATION PROJECT WILL REDIRECT STORMWATER FROM COMMUNITIES LOCATED ON THE ESCARPMENT NORTH OF HILLHURST AND SUNNYSIDE TO REDUCE FLOOD RISKS. THIS PROJECT IS BEING COMPLETED WITH FUNDING SUPPORT FROM THE PROVINCE.

On 2015 October 26, Alberta Environment and Parks (AEP) committed \$150M over 10 years to The City of Calgary through the Alberta Community Resilience Program (ACRP) to support the construction of community-level flood mitigation projects. In 2018, funds were awarded for the following projects:

- Downtown Flood Barrier (\$4.15M)
- Upper Plateau Separation (\$4.15M)
- 9th Avenue Bridge Replacement (\$5.24M)

On 2019 March 6, a further \$15M was announced by the Province for the Downtown flood barrier (\$6.94M) and Upper Plateau Separation (\$8.06M) projects.

This brings the total funds received by The City of Calgary since 2015 to approximately \$69.1M, in support of 13 projects. The City completed five of the 13 projects in 2018:

- Centre Street Bridge Lower Deck Flood Barrier
- West Eau Claire Flood Barrier
- Roxboro Sanitary Liftstation Replacement
- Stormwater Outfall Improvements
- Western Headworks Site Condition Improvements

The remaining eight projects are underway. A summary of The City's progress on ACRP-funded projects can be found in Appendix B.

The City continues to recognize the importance of the external funding provided by the Province, as well as the \$10.6M provided through the New Building Canada Fund from the federal government in 2016 to support the Bonnybrook Wastewater Treatment Plant Flood Mitigation Program and the construction of



CONCEPTUAL DESIGN OF THE EAU CLAIRE PROMENADE, WHICH INCLUDES THE DOWNTOWN FLOOD BARRIER. FLOOD MITIGATION WILL CONNECT WITH THE FLOOD BARRIER IN WEST EAU CLAIRE PARK TO GREATLY REDUCE FLOOD DAMAGE RISK IN CALGARY'S DOWNTOWN. THIS PROJECT IS BEING COMPLETED WITH SUPPORT FROM THE PROVINCE THROUGH ITS ACRP PROGRAM.

Sunnyside Pumpstation #1. The investments from both orders of government have contributed significantly to The City's ability to build flood resilience in Calgary.

The two community barrier projects in Sunnyside and Bowness were submitted to ACRP in 2017 for funding consideration. The projects have been identified as eligible under the ACRP program

but have not yet received funding. Funding approval will be subject to the Province's funding criteria. The City will work with the Province to secure funding as engagement is completed and the direction of the projects is determined.

Throughout 2019 and beyond while technical studies and optional analysis is being done, The City will continue to work closely with community members to ensure that potential mitigation options receive input from citizens before advancing projects further. When potential mitigation options and details are clarified, The City will re-engage the Province on potential funding of these projects.

5. PROPERTY MITIGATION, POLICY AND MAPPING

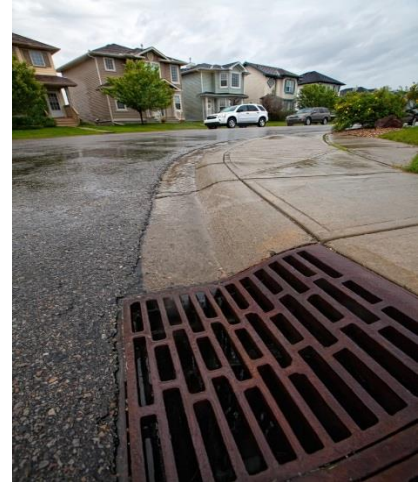
Land use planning regulations, policies to reduce flood risk, accessible and updated flood maps, and flood risk awareness and education on actions that citizens can take to protect their property are critical pieces of The City's flood resilience plan. In 2018, The City advanced initiatives in these areas, including:

- Development of a flood risk "story map" to make flood risk information more accessible and easier for citizens to understand.
- Overhaul of The City's flood web portal and webpages on calgary.ca for a more accessible and streamlined web experience. The new portal is anticipated to launch in spring 2019.
- Scoping of a project to research and develop an innovative and citizen-focused education program on flood risk awareness and property-level mitigation. The project will be conducted in 2019-2020.
- Work to integrate resilient design considerations such as accounting for groundwater flooding, climate change and appropriate standards for resilient critical infrastructure in proposed new development and redevelopment. A cross-departmental team including Water Resources and Planning and Development is leading this process.

- Review of The City's existing policies with consideration of watershed protection and increasing flood resilience is underway. This work is expected to continue through 2020 and will be conducted in alignment with The City's Municipal Development Plan review.

The City continues to communicate the need for updated flood hazard maps to the Province, and is monitoring the Province's progress, should updated flood hazard maps be released. As part of this work, The City continues to meet regularly with the Province regarding flood mitigation objectives, communications on major flood mitigation initiatives, and potential developments in provincial flood policy that could have implications on The City's flood resilience work. As part of this work The City continues to communicate that, based on The City's findings in the FMMA, removal of existing building and homes in the floodplain is not cost-beneficial and has been factored into The City's flood resilience plan.

The City of Calgary is also working with the Province and federal government on promoting best practices in flood risk, land use policy, and citizen action. All potential developments are being taken under consideration as The City proceeds with potential policy changes as they relate to development or redevelopment in the flood plain.



THERE ARE ABOUT 60,000 STORM DRAINGS IN CALGARY WHICH CAPTURE WATER OFF SIDEWALKS, STREETS, AND ROADS.

6. STORMWATER FLOODING

Local stormwater flooding occurs in communities when drainage infrastructure cannot manage the volume of stormwater from rain, or snow and ice melt. Localized flooding can also occur due to a lack of underground stormwater system capacity or surface grading issues.

In 2018, Calgary saw more localized drainage concerns than usual during the spring than in the summer. This was due to a long winter with larger than normal accumulation of snowpack in Calgary before a rapid spring melt occurred. To prepare for the melt period, The City used recent mapping of low lying areas within Calgary to help strategically target areas with a high likelihood of ponding. This approach minimized potential localized flooding concerns relative to past years.

Only one major localized flooding event that could have resulted in widespread flood damages occurred in 2018, in the established neighborhood of Parkland. However, The City implemented temporary initiatives such as sandbagging to divert excess stormwater away from properties in advance of the spring melt and received no concerns from the public regarding damages during the event.

6.1.1 COMMUNITY DRAINAGE IMPROVEMENTS PROGRAM

The Community Drainage Improvements (CDI) program invests in stormwater infrastructure improvements with a focus on established communities with the highest risk of local stormwater flooding. The Program uses a triple bottom line approach and prioritizes projects based on flood risk, potential impacts to the community and the cost-effectiveness of the proposed infrastructure upgrades.

A drainage study is first completed for selected communities, which assesses flood risk and presents options for upgrades. Investment decisions are then evaluated based upon which projects provide the greatest benefits to customers and communities. This is measured based on reduction to damages caused by local flooding as well as social, economic, and environmental impacts. A summary of identified projects under the CDI program can be found in Appendix C. The CDI Program regularly undertakes studies in communities with identified stormwater infrastructure concerns. As these studies are completed, projects are added to the program and completed on a cost-benefit priority basis.

As part of the 2016 Watershed Planning Update (UCS2017-0267), The City committed to report back to Council as part of the One Calgary process with opportunities to maximize investments within the CDI program. Strategies are currently underway to continue design innovations, seek external funding opportunities, and identify project synergies as part of the program's delivery.



THE BRAESIDE DRY POND WILL GREATLY REDUCE FLOODING DURING EXTREME RAIN EVENTS NEAR SOUTHLAND DRIVE SW AND BRAESIDE DRIVE SW.

In 2018, progress was made on a number of CDI projects, including:

- Completion of infrastructure upgrades in the community of Christie Park, underground storage for the Braeside Dry Pond, and 24 Street SW stormwater diversion trunk.
- Design for the Upper Plateau Separation project and Sunnyside Pumpstations #1 and #2
- Construction was started for the above ground components of the Braeside Dry Pond, the Bebo Grove Wet Pond, and additional community improvements as part of the Woodlands-Woodbine CDI.

The City was able to explore alternatives during the design process and identified \$10M in project savings as a result of design efficiencies for the Braeside Dry Pond project. The project will also function as a soccer field when not storing stormwater, providing additional community value. Value engineering was also undertaken for the Upper Plateau Separation project and options for potential savings are being reviewed. Once review is complete, it is anticipated that detailed design will take place in 2019. The City will periodically meet with stakeholders and seek input as necessary.

In 2019, the following work is currently anticipated to proceed as part of the CDI program:

- Initiation of design work for infrastructure improvements south of Riley Park and Kensington Close, as well as at 10 Street SW and Crescent Road;
- Detailed design of the Upper Plateau Separation project;

- Improvements at 7 Avenue NW, 1 Avenue NW, 9 Street and 9 Avenue NW, 19 Street and 6 Avenue NW; and
- The remaining construction at Braeside Dry Pond, Bebo Grove Wet Pond, and additional improvements as part of the Woodlands-Woodbine CDI work.

6.1.2 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. Project scoping started in 2018 and a consultant was hired in early 2019 to begin mapping Calgary's terrain to further identify low areas that are potentially at higher risk of rainfall related flood damages. The mapping and models will inform the severity of flooding in those low areas and will be completed by the end of 2019. Once complete, the models will guide potential infrastructure improvements to reduce stormwater flooding risk in communities.

Private residential drainage systems work with The City's broader drainage system to safely move stormwater from homes and streets and eventually to the river. Poor stormwater drainage on individual residential lots can cause localized flooding, property damage, impacts to public infrastructure, and public safety concerns. In 2018, The City continued progress on the Lot Drainage Improvement Project. Progress in 2018 focused on understanding the extent and nature of residential lot drainage issues, developed content for a Guide to Lot Drainage for property owners highlighting roles, responsibilities, tools, and techniques to improve drainage on private properties, and identifying opportunities to provide education to relevant stakeholders. The City plans to have a residential Guide to Lot Drainage completed and present potential revisions to the Lot Grading Bylaw in 2019.

6.1.3 INTEGRATED STORMWATER MANAGEMENT

The City has started using an integrated stormwater management (iSWM) approach to complement studies undertaken by within The City's CDI program. The goal of the approach is to improve the quality and resilience of stormwater services in mature communities. In conjunction with The City's drainage study focus on localized stormwater flooding control, iSWM studies will focus on the improving stormwater management for the following objectives:

- Reducing water quality impacts
- Planning for future redevelopment/densification
- Managing climate change impacts
- Enhancing asset management
- Identifying opportunities for green stormwater infrastructure

To test the integrated approach, a pilot iSWM study in the community of Renfrew was launched and is expected to be completed in spring 2019. Findings from this pilot study will help inform the framework for future integrated stormwater studies.

7. ACTIONS FOR 2019

- Deliver ongoing flood mitigation projects funded by ACRP
- Continue working with flood affected communities on the proposed community mitigation as part of The City's flood resilience plan
- Continue monitoring developments regarding SR1 and participate in the Environmental Impact Assessment processes, as necessary
- Support the Province's work on assessment of a new upstream reservoir on the Bow River, through the Bow River Working Group
- Continue advocating for and work with the Province on upstream mitigation on the Bow and Elbow Rivers, funding for eligible but unfunded ACRP projects, and renegotiation of the TransAlta agreement beyond 2021
- Develop components of The City's property level protection and flood risk awareness programs
- Continue work regarding development and redevelopment in flood affected areas and provide input to Municipal Development Plan and Land Use Bylaw Review
- Continue to deliver CDI projects, CDI studies, and work to integrate iSWM as part of new CDI studies
- Complete the Lot Drainage Improvement Project, including continuing residential education efforts, publication of the Guide to Lot Drainage, and reviewing the Lot Grading Bylaw

APPENDIX A – EXPERT MANAGEMENT PANEL RECOMMENDATIONS

INVESTING IN FLOOD PROTECTION

Calgarians believe that investment in flood mitigation is important and The City is working with all orders of government to build flood mitigation. To date, The City has received \$69.1M from the Alberta Community Resilience Program (ACRP) for 13 projects.

Investing in flood protection Expert Management Panel recommendation	Status	Timeline	2018 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. 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. (6d)	Underway	2018+	City Council approved The City's climate change resilience plan 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 Province's continuing analysis of flood mitigation options and implementation of appropriate measures through the watersheds. (6b)	Underway	Ongoing	The Province committed to completing a feasibility study for upstream reservoir options on the Bow River on 2018 November 22 as a follow-up to the Bow River Working Group's 2017 August <i>Bow River Water Management Project</i> report. The final report is expected to be complete in 2019. The City of Calgary is supportive of this process and continues to collaborate with the Province through the Bow River Working Group as needed. The City also continues to connect with provincial counterparts through regular meetings on watershed level solutions to flood mitigation.
Increase the operating water storage capacity of the Glenmore Reservoir on the Elbow River through modifications to the Glenmore Dam. (3b)	Underway	2020	The Glenmore Dam infrastructure improvement program includes a project to elevate the dam's gates to help control flooding and manage water supply. The construction of the gates is underway and the project is expected to be operational in 2020. The elevated gates will increase 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. (3d)	Underway	Ongoing	<p>The City's flood resilience plan is currently being implemented. The City has started initial design for the Downtown flood barrier, and has initiated discussions with the communities of Bowness and Sunnyside. The City has initiated and continues engagement with these communities to ensure potential mitigation measures are consistent with community values, and will be discussing potential trade-offs in mitigation options as it works with communities on these projects.</p> <p>The City continues to work with the Province, federal government, and affected communities regarding the barriers to address potential concerns identify opportunities.</p> <p>Temporary barrier planning continues to be updated on an annual basis as part of The City's flood preparedness and response plan. New products have been purchased to increase preparedness and reduce installation times.</p>
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 Province, 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 Province in 2015, and the Province 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 CEAA.
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

There will always be a risk of river flooding and Calgary Emergency Management Association (CEMA) has identified flooding as Calgary's number one hazard and risk. Improving The City's understanding of Calgary's flood risk is one its core strategies for building resiliency. The City continues to build on this work as part of its resiliency and mitigation program.

Understanding flood risk Expert Management Panel Recommendation	Status	Timeline	2018 update
Urge the Province to regularly review and update official flood hazard maps. (5b)	Underway	2019+	The City remains in communication with the Province 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, and is monitoring developments to determine the implications of new FHA mapping on Calgary.
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 the 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 Climate Resilience Strategy and Corporate Resilience Strategy. The City has also partnered with academic research consortium Global Water Futures to further develop its climate change modelling.
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. Additional groundwater studies are ongoing through the current community level flood barrier projects and will inform project design.
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.
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, including development of an interactive "storymap" that is being developed in 2019.

STRENGTHENING FLOOD-RELATED POLICIES

In addition to mitigation infrastructure, Land use policies, design standards, and flood-proofing building practices can greatly enhance community resilience to flooding. The City continues to communicate the importance of good policy and regulations with the Province and federal government in building resilience.

Strengthening flood-related policies Expert Management Panel Recommendation	Status	Timeline	2018 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. Flood resilience considerations will be included as part of the upcoming Municipal Development Plan and Land-use Bylaw reviews starting in 2019, and aligns with The City's Corporate Resilience Strategy and Climate Resilience Strategy.
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	2019+	Flood resilience considerations will be included as part of the upcoming Municipal Development Plan and Land-use Bylaw reviews starting in 2019, and aligns with The City's Corporate Resilience Strategy and Climate Resilience Strategy.
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	2019+	The City is working on potential changes to floodplain development guidelines or policies as part of the City-wide working group currently led by Calgary Growth Strategies. Flood resilience considerations will be included as part of the upcoming Municipal Development Plan and Land-use Bylaw reviews starting in 2019, and aligns with The City's Corporate Resilience Strategy and Climate Resilience Strategy. This work will also be affected by any updates to the FHA mapping currently being undertaken by the Province.
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 and used a 2013-flood event as reference. The City intends to protect to at least a 2013 flood-event. 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

The City recognizes the important role partnerships play in building flood resilience. The City depends on strong partnerships with the Province, the federal government, and other stakeholders such as TransAlta, flood-related organizations, and communities upstream to achieve resilience.

Partnering for a flood resilient Calgary Expert Management Panel Recommendation	Status	Timeline	2018 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	2019+	The City and AEP currently work together to share information to inform their respective forecasting platforms. The City received funds from the National Disaster Mitigation Program in 2017 to support this work, which started in 2018 and is ongoing. The Province is developing a new forecasting platform that will be used by both The City and the Province.
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 critical infrastructure 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	Since 2013, The City has repaired or replaced damaged monitoring stations and installed new stations. *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 Province and upgrades to the Bragg Creek monitoring station are scheduled to occur before 2021.
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. (4c)	Complete*	2017	The voluntary Provincial buy-outs program is complete and the Province 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 Provincial policy.
Continue to cooperate with TransAlta and the Province to increase flood storage on the Bow River through operation of existing TransAlta facilities. (3c)	Complete	2016	The Province and TransAlta have a five-year agreement in place for Ghost Reservoir operations, ending in 2021. 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.
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 remains involved in national initiatives, such as Public Safety Canada's work on development of national floodplain guidelines.

COMMUNICATING WITH CALGARIANS

It is critical for The City to keep Calgarians informed, provide resources and engage with citizens when it comes to building flood resiliency. The City continues engage stakeholders, provide updates on The City's flood resilience plan, and increase flood awareness.

Communicating with Calgarians Expert Management Panel Recommendation	Status	Timeline	2018 update
Develop programs that support building owners to implement flood resiliency measures. (2e)	Underway	2019+	The City continues to support building and homeowners' understanding of their flood risk through the annual Flood Readiness Campaign. In partnership with the Chamber of Commerce, CEMA developed a business continuity handbook for Calgary businesses. Further development of a formal program to educate and support owners has been considered and resources were approved as part of One Calgary to support this work in 2019-2022.
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 annually through The City's social media, local media and advertising, information sessions, and e-mail flood newsletter.
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.

APPENDIX B –CURRENT ACRP-SUPPORTED 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	Flood resilience improvements associated with a replacement 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
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.	2019
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.	2019
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.	2019
Sunnyside Pump station #2	Underway	Flood resilience improvements associated with an upgraded pump station in the community of Sunnyside.	2019
Glenmore Dam Elevated Hoists	Underway	Installation of 2.5m high automated steel gates to replace the existing 1.5m manual stop log system to increase storage at the Glenmore Reservoir.	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.	2020
9 th Avenue Bridge Replacement	In design	Raising of the 9 th Avenue Bridge to prevent damage during high water events and maintain access for fire and emergency services for the community of Inglewood.	2020
Bowness Flood Barrier	Applied September 2017	Construction of a permanent flood barrier in the community of Bowness.	2024+
Sunnyside Flood Barrier	Applied September 2017	Construction of a permanent flood barrier in the community of Sunnyside.	2022
Pearce Estate Park Flood Barrier	Applied September 2017	Construction of a permanent flood barrier in Pearce Estate Park near the community of Inglewood. This project is currently being reviewed by The City.	2024+

APPENDIX C – COMMUNITY DRAINAGE IMPROVEMENT PROGRAM PRIORITIZATION LIST FEBRUARY 2019

<u>Project Name</u>	<u>Cost Estimate (\$000's)¹</u>	<u>Benefit/Cost Ratio²</u>	<u>Project Status</u>	<u>Construction Date³</u>
Woodlands/Woodbine Bebo Grove & 24th Street SW Diversion (formerly Pond D)	\$22,143	9	Construction	2018-2020
Woodlands/Woodbine - Braeside Dry Pond (formerly Pond A)	\$6,836	9	Construction	2018-2019
Woodlands/Woodbine - Local Improvements	\$6,558	6	Construction	2018-2020
North West Inner-City - Pump Station #1 - Sunnyside ⁴	\$11,300	4	Construction	2019-2020
North West Inner-City - Pump Station #2 - Sunnyside ⁵	\$10,600	4	Construction	2018-2019
North West Inner-City - Upper Plateau Separation ⁵	\$61,000	7	Design	2020-2022
Westgate - Ditch Upgrade / G20C Outfall ⁶	\$4,809	1	Maintenance and Monitoring	2019-2022
North West Inner-City - Kensington Close	\$2,200	13	Design commence 2019	2019-2022
North West Inner-City -- Crescent Road	\$1,100	11	Design commence 2019	2019-2022
North West Inner-City - 7th Avenue	\$2,000	8	Design commence 2019	2019-2022
North West Inner-City - 19th Street & 9th Avenue	\$2,100	8	Design commence 2019	2019-2022
North West Inner-City - 19th Street & 6th Avenue	\$600	8	Design commence 2019	2019-2022
North West Inner-City - South of Riley Park	\$11,200	6	Design commence 2019	2019-2022
North West Inner-City - 10th Street ⁸	\$10,900	2	Design commence 2019	2019-2022
North West Inner-City - 1st Avenue ⁸	\$2,040	1	Design commence 2019	2019-2022
North West Inner-City - Pump Station #4 - Hillhurst	\$11,700	8	Study complete -- to be funded	Beyond 2022
North West Inner-City - Pump Station #3 - Hillhurst	\$8,400	7	Study complete -- to be funded	Beyond 2022
Pineridge / Rundle Dry Pond B	\$4,175	6	Study complete -- to be funded	Beyond 2022
Palliser/Oakridge - Phase 1 and 2	\$18,326	6	Study complete -- to be funded	Beyond 2022
Tuxedo/Mount Pleasant - Phase 1, Phase 2, and local Improvements	\$14,196	5	Study complete -- to be funded	Beyond 2022
Pineridge / Rundle Storage Duct #2	\$2,824	5	Study complete -- to be funded	Beyond 2022
Shawnessy Stormwater Upgrades	\$20,197	3	Study complete -- to be funded	Beyond 2022
North West Inner-City - 14th Street	\$14,900	2	Study complete -- to be funded	Beyond 2022
Palliser/Oakridge - Phase 3	\$11,247	2	Study complete -- to be funded	Beyond 2022
North West Inner-City - 17th Street & 23rd Avenue	\$3,800	2	Study complete -- to be funded	Beyond 2022
Oakmount Dry Pond (Oakmont Way Rev Report)	\$492	1	Study complete -- to be funded	Beyond 2022
Macleod Trail CDI Improvements ⁷	\$6,980	TBD	Study complete -- to be funded	TBD
Deer Run / Bonavista Downs	TBD	TBD	Study underway	TBD
Total	\$276,912			

1 -- All 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 -- Benefit/Cost ratio is based on original project scope and costing (2015). Has not been updated based on current pricing

3 -- Construction schedules / project prioritization are subject to change with the addition of new projects or availability of external funding.

4 -- With funding from ACRP and the New Building Canada Fund.

5 -- With funding from ACRP

6 -- In collaboration with Alberta Transportation. Westgate Ditch and outfall upgrades required due to Southwest Ring Road impacts.

7 -- Study and preliminary cost estimates are finalized. Cost benefit and prioritization for recommendations yet to be assessed.

8 -- These projects are linked via dependency to projects above. Separately they have a low B/C Ratio, but in combination remain high.